



**UNITED STATES ARMY  
ENVIRONMENTAL HYGIENE  
AGENCY**

**ABERDEEN PROVING GROUND, MD 21010-5422**

**A  
E  
H  
A**

PHASE I  
GROUND-WATER QUALITY ASSESSMENT NO. 38-26-0475-84  
REDSTONE ARSENAL, ALABAMA  
JANUARY - JUNE 1984

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AL 35898.



DEPARTMENT OF THE ARMY  
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY  
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

Mr. Fox/d1c/AUTOVON  
584-2953

REPLY TO  
ATTENTION OF

HSHB-ES-G/WP

24 SEP 1984

SUBJECT: Phase 1, Ground-water Quality Assessment No. 38-26-0475-84, Redstone Arsenal, Alabama, January - June 1984

Commander  
US Army Materiel Command  
ATTN: AMCSG  
5001 Eisenhower Avenue  
Alexandria, VA 22333-0001

EXECUTIVE SUMMARY

The purpose and essential findings of the inclosed report follow:

a. Purpose. To conduct a ground-water quality assessment in accordance with regulatory requirements. This assessment defines the ground-water contamination problem including the rate, extent of migration, and concentration of hazardous wastes or hazardous waste constituents in the ground water.

b. Essential Findings.

(1) Ground-water flow is to the southeast at a low velocity. The highest concentration of DDT (0.60  $\mu\text{g/L}$ ) was found in downgradient well RS010. Based on the rate of ground-water flow and the total time since landfill operations were initiated, the extent of contaminant migration is very small.

(2). Although mitigating factors show that minimal benefit would be derived by further definition of ground-water conditions at the DDT Hazardous Waste Landfill, Phase 2 of the ground-water quality assessment plan will be implemented by this Agency if required by the regulatory authority.

FOR THE COMMANDER:

1 Incl  
as

*Karl J. Daubel*  
KARL J. DAUBEL, P.E.  
Colonel, MSC  
Director, Environmental Quality

CF:  
Cdr, AMCOM I&SA (AMCIS-RI-IC) (2 cy)  
Cdr, MICOM (2 cy)  
Cdr, HSC (HSCL-P)  
Cdr, Redstone Ar (3 cy)

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ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO  
ATTENTION OF

HSHB-ES-G/WP

PHASE 1  
GROUND-WATER QUALITY ASSESSMENT NO. 38-26-0475-84  
REDSTONE ARSENAL, ALABAMA  
JANUARY - JUNE 1984

1. AUTHORITY.

a. Letter, DRSMI-KLC, MICOM, 19 June 1984, subject: Implementation of Ground-water Quality Assessment.

b. Meeting between AMC and this Agency, 24 July 1984, subject: Mission Services, FY 85.

2. REFERENCES. See Appendix A for a listing of references.

3. PURPOSE. To conduct a ground-water quality assessment in accordance with reference 1. This assessment defines the ground-water contamination problem including the rate, extent of migration, and concentration of hazardous wastes or hazardous waste constituents in the ground water.

4. GENERAL.

a. Personnel Contacted.

(1) Mr. M. William Schroder, Environmental Coordinator, Facilities Engineering Division, Redstone Arsenal.

(2) Mr. Ronald Hagler, Ecologist, Facilities Engineering Division, Redstone Arsenal.

(3) Mr. Paul Moser, Environmental Geologist, Water Resources Division, Geological Survey of Alabama.

b. Location and Mission. Redstone Arsenal is located to the southwest of Huntsville, Alabama, in the southwest part of Madison County. The installation is bounded by the Tennessee River on the south and occupies 60.4 square miles. Redstone Arsenal's primary mission is to develop, manufacture, and test rocket motors and missiles. Training for personnel in the use of missile systems and munition materiel is conducted by the US Army Missile and Munition Center and School. The Marshall Space Flight Center of the National Aeronautics and Space Administration, which is a tenant activity at Redstone Arsenal, researches, develops, tests, and manufactures space vehicles and components.

c. DDT Hazardous Waste Landfill Description. The DDT Hazardous Waste Landfill was constructed in 1979 and operated from July 1979 to August 1982. The DDT-contaminated materials from the former DDT manufacturing area, the DDT drainage ditch, and former DDT disposal sites were excavated and placed in the landfill. The DDT Hazardous Waste Landfill is located near the center of Redstone Arsenal in the northwest corner of the Sanitary Landfill Area as shown on Figure 1. The construction details for the DDT Hazardous Waste Landfill are shown in Appendix B. Only pits 4, 5, and 6 were utilized for disposal of approximately 10,000 cubic yards of DDT-contaminated materials. The volumes placed in each pit were: Pit 4 - 1,000 cubic yards, Pit 5 - 5,000 cubic yards, and Pit 6 - 4,000 cubic yards.

## 5. FINDINGS AND DISCUSSION.

### a. Regional Geohydrology.

(1) Topography. Redstone Arsenal lies within the Highland Rim Section of the Interior Low Plateau. In general, the topography is gently rolling, with elevations ranging predominantly between 600 and 650 feet above mean sea level. Two areas have pinnacle-shaped mountains which are located in the north-central (1,239 feet) and southwest (830 feet) parts of the arsenal.

(2) Regional Geology. Bedrock at Redstone Arsenal is Mississippian in age and consists predominantly of limestone with some sandstone and chert. The bedrock has a gentle dip to the southeast and has extensive joints and bedding planes. Table 1 describes the bedrock formations present at Redstone Arsenal, and Figure 2 shows the areal extent of these formations. The Tuscumbia limestone, the most extensive bedrock unit on the arsenal, displays the solution channels and caves typical of karst development. A residual soil or regolith has formed over most of the arsenal as a result of weathering of the bedrock formations. The soluble material in limestone bedrock has been removed, leaving an insoluble residue of clay, sand, and chert above the bedrock. The predominant soil at the arsenal is clay and silty clay, with lenses of sand and chert.

(3) Regional Ground water. The major water-producing aquifer on the arsenal is the Tuscumbia limestone. The regional ground-water flow direction is south towards Huntsville Spring Branch and the Tennessee River. Ground water in limestone occurs in fractures and bedding planes that may be enlarged by solution weathering. The solution channels serve as conduits for the movement of large quantities of ground water. The Tuscumbia limestone aquifer is the source of ground water for several large-capacity wells located immediately west of the arsenal. A shallow water table aquifer in the residual overburden is present over most of the installation. Much of this overburden is low-permeability clay with some lenses of water-bearing sand. The clay may act as a confining bed for local artesian or perched water table conditions.

TABLE 1. BEDROCK GEOLOGY OF REDSTONE ARSENAL, ALABAMA\*

Period	Formation	Lithology	Thickness
Mississippian	Bangor Limestone	Light-to-medium gray, massively bedded, fossiliferous limestone. Thin beds of grayish-green and moderate red shale and light-gray dolomitic limestone occur in the upper part.	400-500 feet
	Hartselle Sandstone	Light-gray and very-pale-orange sandstone, cross-bedded in part, interbedded with grayish-green and light-gray fossiliferous shale and occasionally sandy, fossiliferous limestone.	<80 feet
	Pride Mountain Formation	Light-greenish-gray and pale-yellowish-brown fossiliferous shale with thin interbeds of clayey fossiliferous limestone. Mapped with the underlying Monteagle Limestone.	10-22 feet
	Monteagle Limestone	Light-gray, fossiliferous, crystalline, and oolitic limestone with thin interbeds of fossiliferous shale and minor amounts of chert.	200-220 feet
	Tuscumbia Limestone	Light-gray to light-brownish-gray fossiliferous limestone containing chert lenses and nodules.	150 feet (average)
	Fort Payne Chert	Very-light-gray to light-gray fossiliferous limestone, siliceous and dolomitic limestone, and dolostone with thin beds of nodular chert.	155-185 feet
Devonian	Chattanooga Shale	Dark-gray to black fossiliferous shale with a discontinuous sandstone at the base.	10 feet

\* Source - Reference 2.

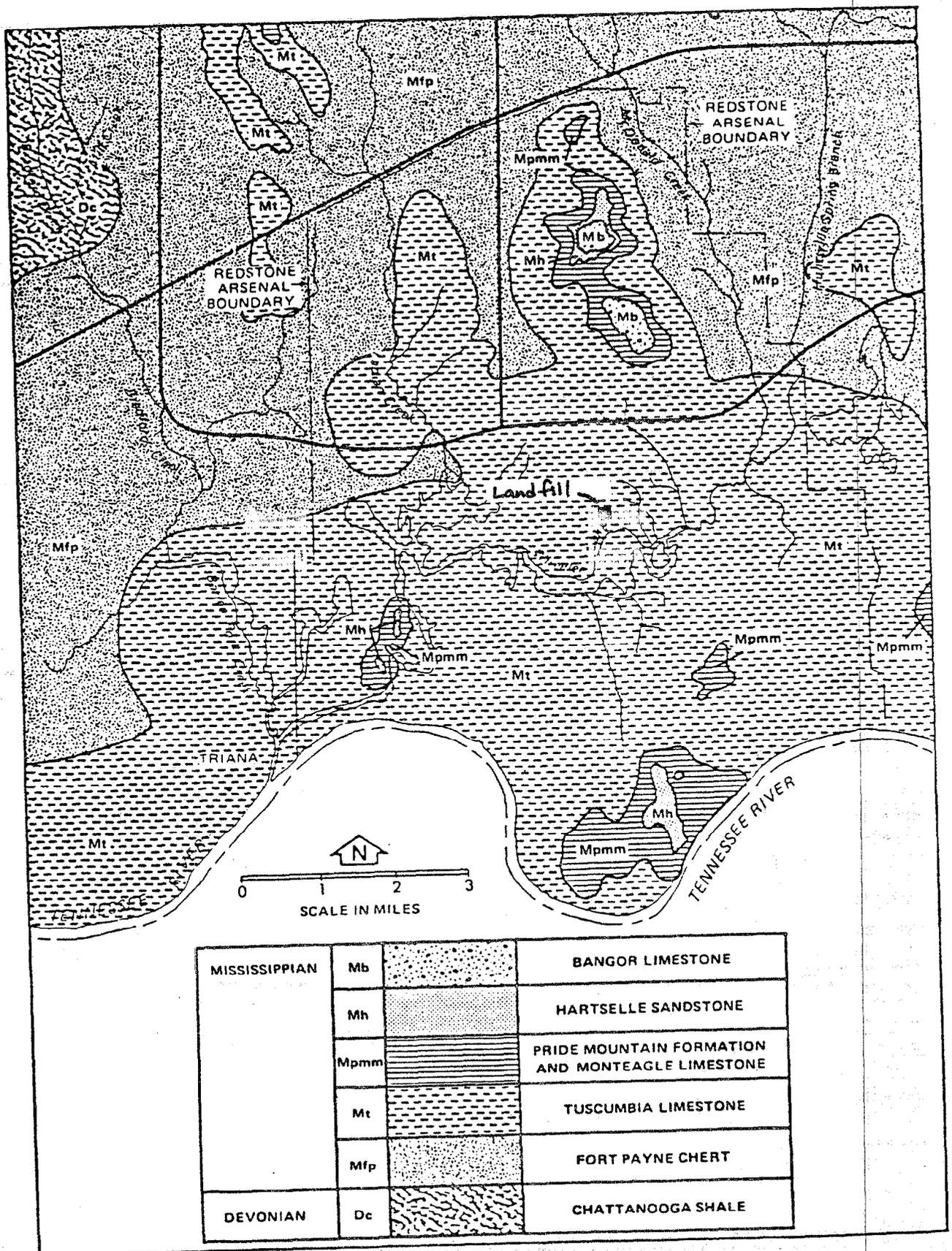


FIGURE 2. Bedrock Geology of Redstone Arsenal (Source: reference 2).

b. Local Geohydrology.

(1) The DDT Hazardous Waste Landfill lies on a local topographic high area as shown on Figure 1. Eight bore holes (RS007 to RS014) were drilled to define the subsurface material at the site when it was proposed in 1978. Monitoring wells were constructed in bore holes RS010 and RS011. After the permit was approved, five additional bore holes (RS015 to RS019) were drilled for placement of two additional monitoring wells (RS015 and RS016) and eight suction lysimeters (RS017 to RS019). To upgrade the ground-water monitoring system at the site, four monitoring wells: RS081, RS082, RS083, and RS084 were installed in January 1984 (reference 3). Locations for all test borings, monitoring wells, and lysimeters are shown on Figure 3. Clay and silty or sandy clay were the dominant materials in all the borings, with the plasticity generally increasing with depth (Appendix C). Small sand lenses and chert zones were common, and thick clayey sands were encountered in bore holes RS007, RS008, RS011, RS018, RS082, and RS084. Analyses of soil samples for selected physical properties are provided in Appendix D. Additional soil test results for grain size and Atterburg limits are reported in references 3 through 5. All monitoring well and lysimeter construction details are provided in Appendix E.

(2) Ground-water flow at the DDT Hazardous Waste Landfill is to the southeast as shown on Figure 4. Local ground-water discharge zones along the Huntsville Spring Branch to the south and the deep drainage channel to the east probably control the flow direction of shallow ground water at the DDT Hazardous Waste Landfill. There are no drinking water wells near or downgradient from the landfill to affect ground-water flow patterns. Monitoring wells RS011 and RS084 are not used in the flow map (Figure 3) because each is affected by perched ground water in silty sand and clayey sand horizons which appear to be laterally discontinuous. Earlier ground-water elevations in monitoring well RS016 were generally 6 feet higher than those found at monitoring well RS010. These data add control to the western side of the ground-water flow map. The ground-water flow rate is based on permeabilities of soil samples shown in Appendix D. The ground-water flow rate is estimated at 0.04 feet/year as shown in calculations presented in Appendix F.

c. Ground-water Quality Assessment. Three rounds of ground-water samples have been taken from seven monitoring wells with results provided in Table 2. Monitoring wells RS010 and RS084, which are the downgradient wells, have the highest concentration of the sum of DDT isomers (DDTR). The highest concentration of DDTR was found in ground water from RS010 at a level of 0.60 µg/L. Assuming DDT in ground water moves at the same rate as the ground-water flow, the rate would be less than 1 foot per year. The extent of contamination from the DDT Hazardous Waste Landfill would be based on the average velocity of ground-water flow times the number of years since the first DDT hazardous wastes were placed in the landfill (July 1979). This calculation shows the extent of contamination to be less than 1 foot. However, due to the presence of thin sandy and cherty zones, minor zones of higher hydraulic conductivity may exist, but the effects of this on the shallow ground-water aquifer cannot be defined with existing data. If a worst-case scenario concerning migration of DDT from the Landfill were considered, the ground-water discharge zone will ultimately be Huntsville Spring Branch, which is already heavily contaminated with DDT from other sources.

Y-1504,500  
X-252,950

Y-1504,480  
X-254,140

DDT HAZARDOUS  
WASTE LANDFILL

BENCH MARK #1  
ELEV. 627.82'

FENCE CORNER  
Y-1503,016.1  
X-252,976.1

FENCE CORNER  
Y-1502,573.4  
X-253,500.5

FENCE CORNER  
Y-1502,219.3  
X-253,500.6

TEST WELLS			
WELL NO.	DEPTH OF WELL	DEPTH TO WATER	ELEV.
R.S-010	74.2'	45.9'	617.94'
R.S-011	60.9'	17.8'	622.08'
R.S-015	66.4'	15.0'	606.27'
R.S-016	55.0'	25.8'	616.86'
R.S-017	50.0'	31.0'	623.06'
R.S-018	46.0'	28.0'	627.28'
R.S-019	30.0'	17.5'	608.16'
R.S-017	37.8'	19.95'	574.44'
R.S-016	34.0'	15.06'	574.97'
R.S-019	54.1'	37.74'	605.63'
R.S-080	29.0'	7.45'	567.29'

LEGEND	
	FENCE
	PROPERTY LINE
	ROAD
	OLD DUMPS
	PROPOSED DUMPS
	EXISTING DUMPS
	CONTOURS
	BUILDINGS
	UTILITY POLES
	TEST WELLS

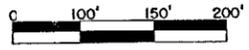
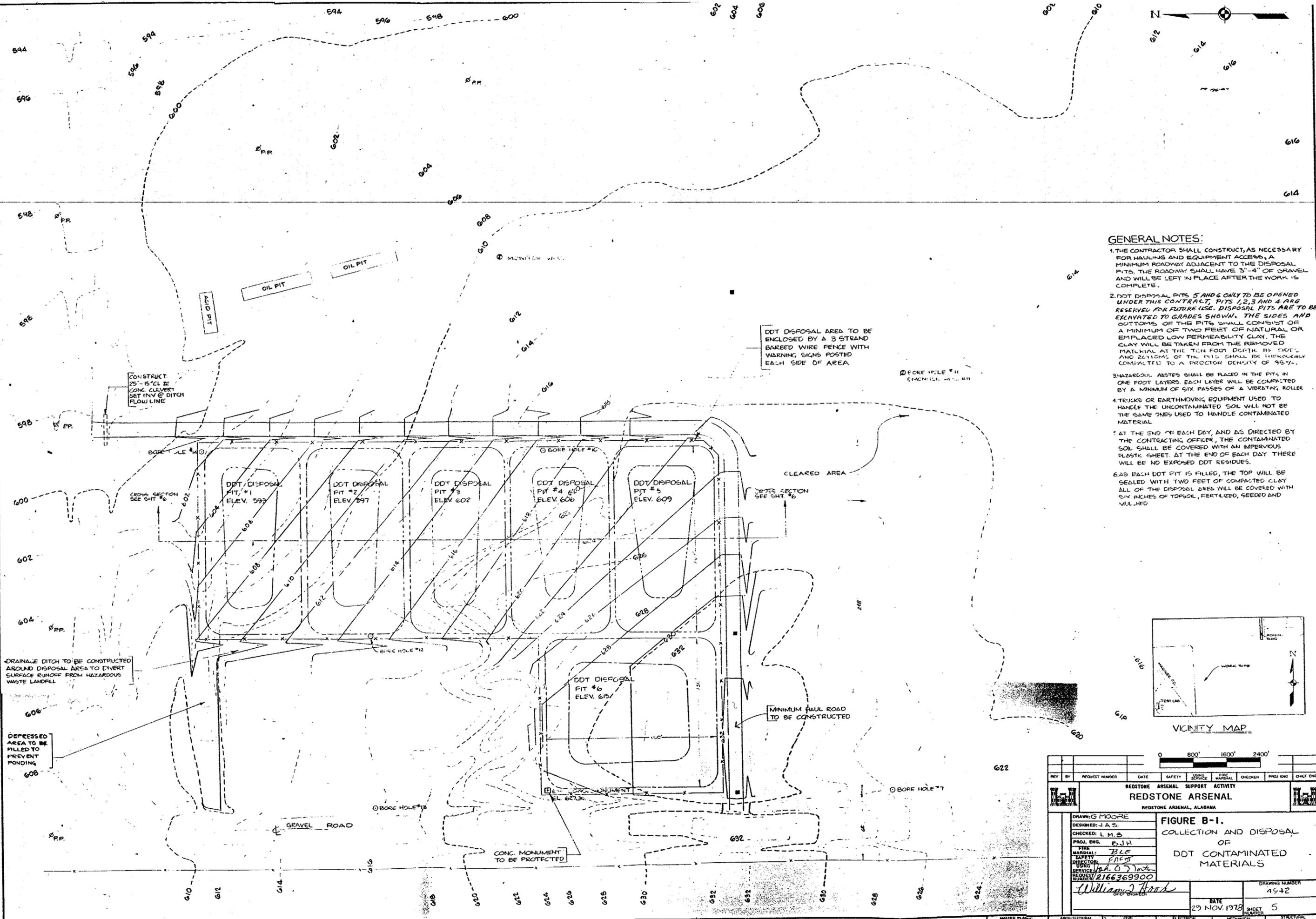
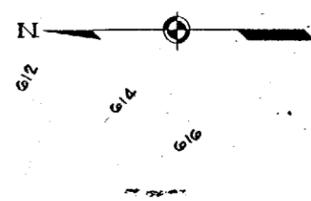


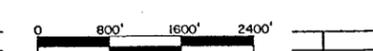
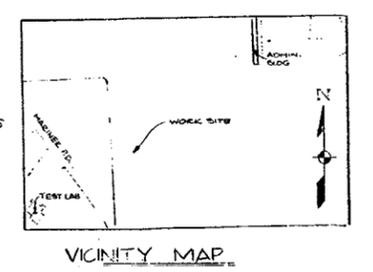
FIGURE 1.

REV	BY	REVISION NUMBER	DATE	SAFETY	SERV	FIN	CHKR	PROJ	DRG	CHK
<b>REDSTONE ARSENAL SUPPORT ACTIVITY</b> <b>REDSTONE ARSENAL</b> REDSTONE ARSENAL, ALABAMA										
DRAWN: RJD PAT/RL		<b>TOPOGRAPHIC MAP</b> <b>OF THE</b> <b>SANITARY FILL AREA</b>								
CHECKED: FRC										
DESIGNED: JLS		DATE: <i>Aug 25 1984</i> BY: <i>505B</i>								
PROJ. ENG. BJH										
SITE MAP		DRAWN: <i>505B</i> DATE: <i>AUG-25-84</i> BY: <i>505B</i>								

Ground-water Quality Assessment Plan No. 38-26-0441-84, 26-29 569 83

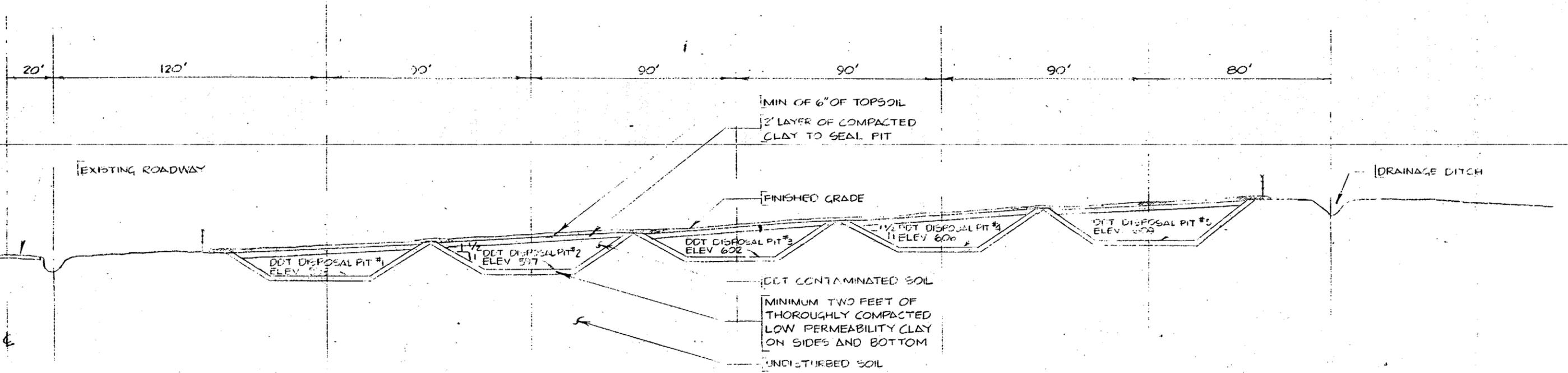


- GENERAL NOTES:**
1. THE CONTRACTOR SHALL CONSTRUCT, AS NECESSARY FOR HAULING AND EQUIPMENT ACCESS, A MINIMUM ROADWAY ADJACENT TO THE DISPOSAL PITS. THE ROADWAY SHALL HAVE 3"-4" OF GRAVEL AND WILL BE LEFT IN PLACE AFTER THE WORK IS COMPLETE.
  2. DDT DISPOSAL PITS 5 AND 6 ONLY TO BE OPENED UNDER THIS CONTRACT. PITS 1, 2, 3 AND 4 ARE RESERVED FOR FUTURE USE. DISPOSAL PITS ARE TO BE EXCAVATED TO GRADES SHOWN. THE SIDES AND BOTTOMS OF THE PITS SHALL CONSIST OF A MINIMUM OF TWO FEET OF NATURAL OR EMPLACED LOW PERMEABILITY CLAY. THE CLAY WILL BE TAKEN FROM THE REMOVED MATERIAL AT THE TEN FOOT DEPTH. THE END AND BOTTOMS OF THE PITS SHALL BE THOROUGHLY COMPACTED TO A PROCTOR DENSITY OF 98%.
  3. HAZARDOUS WASTES SHALL BE PLACED IN THE PITS IN ONE FOOT LAYERS. EACH LAYER WILL BE COMPACTED BY A MINIMUM OF SIX PASSES OF A VIBRATING ROLLER.
  4. TRUCKS OR EARTHMOVING EQUIPMENT USED TO HANDLE THE UNCONTAMINATED SOIL WILL NOT BE THE SAME ONES USED TO HANDLE CONTAMINATED MATERIAL.
  5. AT THE END OF EACH DAY, AND AS DIRECTED BY THE CONTRACTING OFFICER, THE CONTAMINATED SOIL SHALL BE COVERED WITH AN IMPERVIOUS PLASTIC SHEET. AT THE END OF EACH DAY THERE WILL BE NO EXPOSED DDT RESIDUES.
  6. AS EACH DDT PIT IS FILLED, THE TOP WILL BE SEALED WITH TWO FEET OF COMPACTED CLAY. ALL OF THE DISPOSAL AREA WILL BE COVERED WITH SIX INCHES OF TOPSOIL, FERTILIZED, SEEDING AND MULCHED.

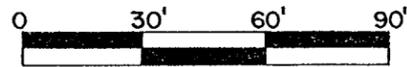


REV	BY	REQUEST NUMBER	DATE	SAFETY	ENGINEERING SERVICE	FIRE MARSHAL	CHECKER	PROJ. ENG.	CHIEF ENG.
<b>REDSTONE ARSENAL SUPPORT ACTIVITY</b> <b>REDSTONE ARSENAL</b> REDSTONE ARSENAL, ALABAMA									
DRAWING: G. MOORE DESIGNED: J. A. S. CHECKED: L. M. S. PROJ. ENG.: P. J. H. FIRE MARSHAL: B. L. E. SAFETY DIRECTOR: F. A. H. USING SERVICE: J. O. J. [unclear] REQUEST NUMBER: 2166369900 [Signature]					<b>FIGURE B-1.</b> <b>COLLECTION AND DISPOSAL</b> <b>OF</b> <b>DDT CONTAMINATED</b> <b>MATERIALS</b>				
								DRAWING NUMBER	
								4542	
								DATE	
								29 NOV. 1978	
								SHEET NUMBER	
								5	

Ground-water Quality Assessment Plan No. 38-26-0411-84, 28-29 Sep 83



CROSS SECTION  
HAZARDOUS WASTE LANDFILL



REV	BY	REQUEST NUMBER	DATE	SAFETY	USING SERVICE	FIRE MARSHAL	CHECKER	PROJ ENG	CHIEF ENG
REDSTONE ARSENAL SUPPORT ACTIVITY <b>REDSTONE ARSENAL</b> REDSTONE ARSENAL, ALABAMA									
DRAWN: G. MOORE DESIGNED: J. A. S. CHECKED: L. M. B. PROJ. ENG. P. J. H. FIRE MARSHAL: B. L. E. SAFETY DIRECTOR: [Signature] USING SERVICE: [Signature] REQUEST NUMBER: 2166369900						<b>FIGURE B-2.</b> COLLECTION AND DISPOSAL OF DDT CONTAMINATED MATERIALS			
[Signature] CHIEF ENGINEER						SCALE NOTED		DRAWING NUMBER 4942	
						DATE 29 NOV 1978		SHEET NUMBER 6	

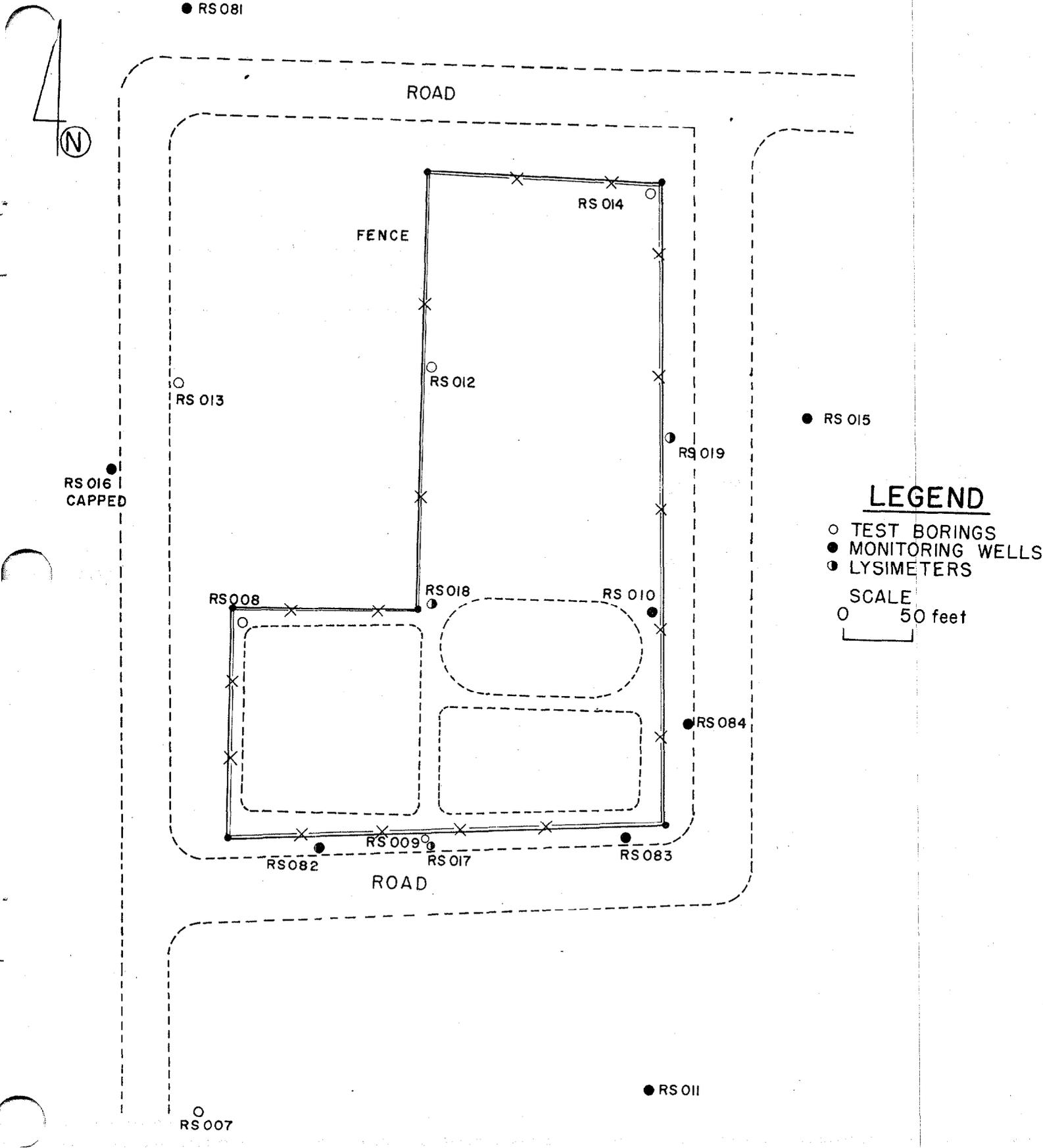


FIGURE 3 DDT HAZARDOUS WASTE LANDFILL, REDSTONE ARSENAL

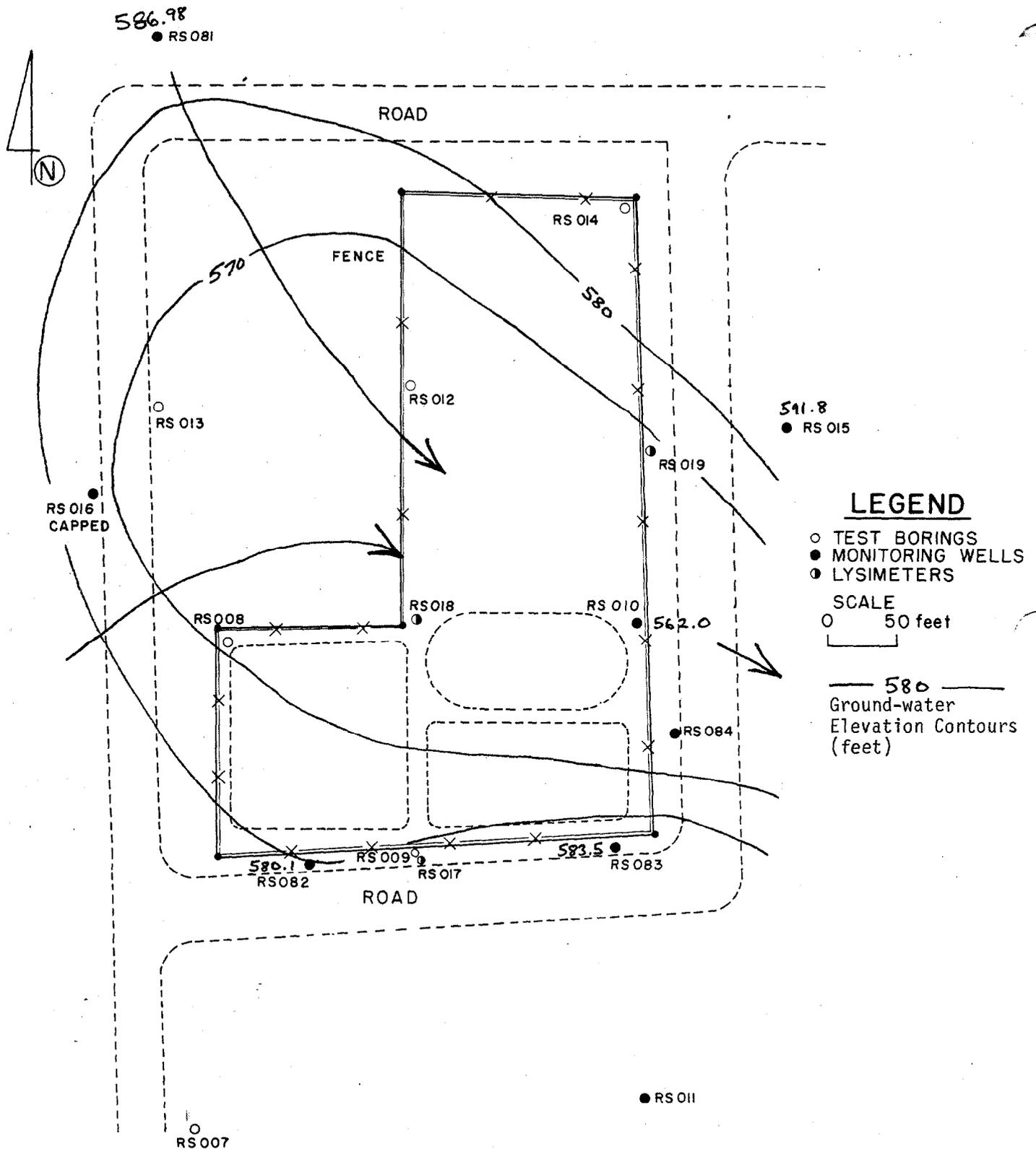


FIGURE 4. Ground-water Flow at the DDT Hazardous Waste Landfill, Redstone Arsenal (Ground-water levels measured 31 March 1984)

TABLE 2. GROUND-WATER QUALITY RESULTS FOR DDT\*

Well No.	CONCENTRATION DDTR† (µg/L)		
	31 Mar 84	25 Apr 84	27 Jun 84
RS010	0.57	0.60	0.45
RS011	0.04	0.09	ND
RS015	ND	ND	ND
RS081	0.08	0.05	ND
RS082	0.31	0.05	0.04
RS083	0.31	0.07	0.08
RS084	0.57	0.31	0.30

\* Appendix G presents instructions for sampling and analysis which were followed during Phase 1 work.

† DDTR includes the sum of concentrations for these isomers: o,p'-DDE; p,p'-DDE; o,p'-DDD; p,p'-DDD; o,p'-DDT; and p,p'-DDT. Isomer detection limit is 0.02 µg/L for clean samples.

ND - not detected

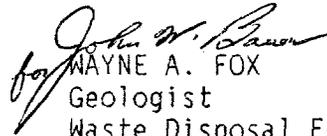
d. Characteristics of DDT in an Aquifer. The shallow aquifer at the DDT Hazardous Waste Landfill is predominantly clay, which will strongly adsorb DDT. Clay minerals were found to quickly adsorb DDT from aqueous solutions and have a great potential for retaining DDT (reference 6). The low solubility of DDT (at approximately 1.2 µg/L) also gives DDT a low potential for migration in ground water. Widespread use of DDT prior to its ban makes it possible to find very low concentrations of DDT at most monitoring well locations, including the background well. The use of unfiltered samples for DDT analysis is a complicating factor since any DDT adsorbed to the clay particles in a ground-water sample would cause concentrations to be higher than the actual concentration of DDT in solution. Only dissolved DDT in ground water will be capable of migrating in the aquifer.

## 6. CONCLUSIONS.

a. This ground-water quality assessment provides detailed information on the rate, extent (calculated prediction), and the concentration of hazardous wastes in the ground water.

b. The combined factors of low permeability in the shallow aquifer, low solubility of DDT, and high adsorption potential of DDT to clay in the aquifer make the potential for migration of DDT from the DDT Hazardous Waste Landfill negligible.

c. Although mitigating factors at the DDT hazardous Waste Landfill show that there would be minimal benefit in further definition of ground-water conditions at the Landfill, Phase 2 of the ground-water quality assessment plan (as contained in reference 7) will be implemented by this Agency, if required by the regulatory authority.

  
for WAYNE A. FOX  
Geologist  
Waste Disposal Engineering Division

APPROVED:

  
FREDERICK W. BOECHER  
MAJ(P), MSC  
Chief, Waste Disposal Engineering Division

APPENDIX A

REFERENCES

1. Alabama Department of Public Health, Hazardous Waste Management Regulations, promulgated pursuant to Act 129 of 1978, effective 19 November 1980, revisions effective 19 July 1982.
2. Environmental Geology and Hydrology, Huntsville and Madison County, Alabama, Geological Survey of Alabama, Atlas Series 8.
3. "Report of Monitoring Well Services at Redstone Arsenal, Alabama," Testing Incorporated, 26 March 1984, Contract No. DAAH03-84-M-0498.
4. "Report of Soils Testing Performed at the DDT Landfill Site, Redstone Arsenal, Alabama," Testing Incorporated, 1978, Contract No. DHCAH03-78-M-2210.
5. "Report of Geohydrology Characterization and Well/Lysimeter Installation at Redstone Arsenal, Alabama," Testing Incorporated, 1979, Contract No. DAAH03-78-C0180.
6. Adsorption of Pesticides by Clay Minerals, Journal of the Sanitary Engineering Division, Proc. ASCE, Volume 96, No. SA 5: 1057-1078, 1970.
7. Letter, HSHB-ES-G/WP, this Agency, 14 March 1984, subject: Ground-water Quality Assessment Plan No. 38-26-0441-84, Redstone Arsenal, Alabama, 26-29 September 1983.

Phase 1, Ground-water Quality Assessment No. 38-26-0475-84, Jan - Jun 84

APPENDIX B

CONSTRUCTION DETAILS FOR THE DDT  
HAZARDOUS WASTE LANDFILL

APPENDIX B

CONSTRUCTION DETAILS FOR THE DDT  
HAZARDOUS WASTE LANDFILL

APPENDIX C

BORING LOGS FOR MONITORING WELLS,  
LYSIMETERS, AND TEST BORINGS  
(Source: References 3, 4, and 5)

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-7  
 Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>87.5</u> ft.	Completion Depth <u>87.5</u> Ft.	Date: <u>8-10-78</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling <u>39.5</u> Ft.	Weather: <u>Cloudy &amp; Rain</u>
Auger _____ ft.	Depth to Water in Boring <u>72</u> hrs. <u>37.7</u> Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. <u>626.5</u>	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
				Topsoil				
			1	Very stiff red silty sandy clay (10R 3/6) (Sandy Clay - USDA)	CL	4.5	$\frac{8}{11-14}$	15.6
10			2	Same as No. 1 (10R 3/6) (Sandy Clay - USDA)	CL	3.5	$\frac{3}{7-7}$	20.4
			3	Same as No. 1 (10R 4/6) (Sandy Clay - USDA)	CL	3.75	$\frac{5}{9-9}$	23.7
20			4	Same as No. 1 (10R 4/8) (Sandy Clay - USDA)	CL	2.75	$\frac{4}{8-16}$	19.8
			5	Same as No. 1 (10R 4/8) (Sandy Clay - USDA)	CL	2.5	$\frac{10}{15-12}$	17.1
30			6	Loose Reddish Yellow Sand (medium-grain) (2.5YR 4/8) (Sand - USDA)	SP-SM	*	$\frac{8}{10-17}$	6.7
			7	Same as No. 6 (2.5YR 4/8) (Sand - USDA)	SP-SM	*	$\frac{13}{15-14}$	8.9

(continued on Page 2)

REMARKS: \* Too much sand for accurate PPR

**TESTING**  
 P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-7 (Page 2)

Job No. 78-45

CLIENT: P&C, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>87.5</u> ft.	Completion Depth <u>87.5</u> Ft.	Date: <u>8-11-78</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling <u>39.5</u> Ft.	Weather: <u>Cloudy &amp; Hot</u>
Auger _____ ft.	Depth to Water in Boring <u>72</u> hrs. <u>37.7</u> Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. <u>626.5</u>	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
			8	Loose to medium dense clayey sand (2.5YR 4/8) (Clayey Sand - USDA)	SC	*	$\frac{23}{18-11}$	19.5
			9	Stiff yellow red and gray highly plastic clay with traces of soft stone (7.5YR 5/0) (Clay - USDA)	CH	2.0	$\frac{5}{7-7}$	38.2
50			10	Stiff gray, red and yellow highly plastic clay with soft stone and sand traces (10YR 6/8) (Clay - USDA)	CH	1.75	$\frac{1}{4-6}$	38.9
			11	Same as No. 10 (10YR 6/8) (Clay - USDA)	CH	1.75	$\frac{4}{7-7}$	27.4
60			12	Same as No. 10 (10YR 6/8) (Clay - USDA)	CH	1.75	$\frac{5}{7-5}$	39.4
			13	Same as No. 10 (10YR 6/8) (Clay - USDA)	CH	1.5	$\frac{4}{6-6}$	27.4
70			14	Stiff yellow and brown highly plastic clay with weathered rock and large sand lenses (10YR 5/8) (Clay - USDA)	CH	2.0	$\frac{5}{8-6}$	22.5
			15	Same as No. 14 (10YR 5/8) (Clay - USDA)	CH	1.25	$\frac{4}{4-4}$	34.7

(continued on Page 3)

REMARKS: \* Too much sand for accurate PPR

**TESTING**  
INCORPORATED  
 P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-7 (Page 3)

Job No. 78-45

CLIENT: P&C, Proc Div, Dir For Proc & Prod, Bldg, 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>87.5</u> ft. Rock _____ ft. Auger _____ ft.	Completion Depth <u>87.5</u> Ft. Depth to Water in Boring @ Drilling <u>39.5</u> Ft. Depth to Water in Boring <u>72</u> hrs. <u>37.7</u> Ft. Elevation Ft. <u>626.5</u>	Date: <u>8-11-78</u> Weather: <u>Cloudy &amp; Hot</u> Driller: <u>B. Butler</u>
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DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
80				16	Same as No. 14 (10YR 5/8) (Clay - USDA)	CH	.75	$\frac{7}{9-10}$	33.1
				17	Same as No. 14 (10YR 5/8) (Clay - USDA)	CH	.75	$\frac{8}{10-11}$	37.0
90					Refusal - Probably rock or boulder				
100									
110									
120									

REMARKS: \_\_\_\_\_ C-4 \_\_\_\_\_

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-8  
 Job No. 78-45

CLIENT: P&C, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>62.1</u> ft.	Completion Depth <u>62.1</u> Ft.	Date: <u>8-11 &amp; 14-78</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling <u>48.0</u> Ft.	Weather: <u>Hot</u>
Auger _____ ft.	Depth to Water in Boring <u>24</u> hrs. <u>50*</u> Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. <u>626.9</u>	

DEPTH FT.	SYMBOL	SAMPLES Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
			Topsoil				
		1	Very stiff red sandy silty clay (10R 4/6) (Silty Clay - USDA)	CL	4.0	$\frac{4}{8-11}$	23.7
10		2	Same as No. 1 (10R 4/8) (Silty Clay)	CL	4.0	$\frac{7}{9-10}$	19.7
		3	Very stiff yellow & red silty sandy clay (2.5YR 4/8) (Sandy Clay)	SC	4.5	$\frac{4}{7-10}$	20.4
20		4	Very stiff gray, brown and yellow medium plastic clay with soft stone (7.5YR 6/8) (Clay - USDA)	CL	4.0	$\frac{4}{7-8}$	35.6
		5	Very stiff yellowish brown medium plastic to highly plastic clay with large amounts of sand and soft stone (7.5YR 5/6) (Clay - USDA)	CH	4.5	$\frac{5}{10-16}$	21.1
30		6	Same as No. 5 (7.5YR 5/6) (Clay - USDA)	CH	3.75	$\frac{4}{7-9}$	29.2
		7	Same as No. 5 (7.5YR 5/6) (Clay - USDA)	CH	3.0	$\frac{5}{9-11}$	29.6

(continued on Page 2)

REMARKS: \* Boring was closed at 12'. Closed region was penetrated and a water surface was detected at approximately 50'.

**TESTING**  
 P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-8 (Page 2)

Job No. • 78-45

CLIENT: P&C, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>62.1</u> ft.	Completion Depth <u>62.1</u> Ft.	Date: <u>8-14-78</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling <u>48.0</u> Ft.	Weather: <u>Clear &amp; Hot</u>
Auger _____ ft.	Depth to Water in Boring <u>24</u> hrs. <u>50'</u> * Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. <u>626.9</u>	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
			8	Same as No. 5 (7.5YR 5/6) (Clay - USDA)	CH	2.75	$\frac{4}{5-9}$	34.7
			9	Very stiff yellowish brown highly plastic clay with weathered rock (5YR 5/6) (Clay - USDA)	CH	2.5	$\frac{3}{11-9}$	42.7
50			10	Same as No. 9 (5YR 5/6) (Clay - USDA)	CH	0.5	$\frac{6}{6-8}$	42.7
			11	Very stiff brown highly plastic clay with sand and weathered rock (5YR 4/6) (Clay - USDA)	CH	2.0	$\frac{5}{9-9}$	26.4
60			12	Very stiff brown highly plastic clay with sand and dense layers of weathered rock (5YR 4/6) (Clay - USDA)	CH	0.75	$\frac{12}{12-5}$	27.5
				Refusal - Probably rock or boulder				
70								
80								

REMARKS: \* Boring was closed at 12'. Closed region was penetrated and a water surface was

located at approximately 50'

**TESTING**  
 P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-9

Job No. 78-45

CLIENT: P&C, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>69.7</u> ft. Rock _____ ft. Auger _____ ft.	Completion Depth <u>69.7</u> Ft. Depth to Water in Boring @ Drilling <u>69.7</u> Ft. Depth to Water in Boring <u>120</u> hrs. <u>56.8</u> Ft. Elevation Ft. <u>631.7</u>	Date: <u>8-08 &amp; 09-78</u> Weather: <u>Cloudy &amp; Humid</u> Driller: <u>B. Butler</u>
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DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
				Topsoil, silt & organic material				
			1	Stiff red sandy silty clay (10R 3/6) (Silty Clay - USDA)	CL	2.5	$\frac{5}{6-8}$	26.1
10			2	Same as No. 1 (10R 3/6) (Silty Clay - USDA)	CL	3.25	$\frac{5}{9-12}$	20.6
			3	Very stiff yellowish red silty sandy clay (2.5YR 4/7) (Sandy Clay - USDA)	CL	4.5+	$\frac{6}{13-18}$	16.7
20			4	Very stiff gray, yellow & brownish red highly plastic clay w/sand lenses & soft stone (5YR 5/6) (Clay - USDA)	CH	4.5+	$\frac{5}{8-12}$	25.7
			5	Very stiff reddish yellow highly plastic clay with dense chert (7.5YR 5/6) (Clay - USDA)	CH	4.25	$\frac{10}{11-13}$	22.2
30			6	Very stiff reddish yellow highly plastic clay with dense weathered chert (10YR 5/6) (Clay - USDA)	CH	3.25	$\frac{23}{24-12}$	23.4
40			7	Very stiff yellowish brown highly plastic clay with weathered chert, black ore traces, and sand lenses (7.5YR 5/8) (Clay - USDA)	CH	3.25	$\frac{3}{8-9}$	26.3

REMARKS:

(continued on Page 2)

**TESTING**  
INCORPORATED  
 P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-9 (Page 2)  
 Job No. 78-45

CLIENT: P&C, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING	Completion Depth <u>69.7</u> Ft.	Date: <u>8-09-78</u>
Standard <u>69.7</u> ft.	Depth to Water in Boring @ Drilling <u>69.7</u> Ft.	Weather: <u>Partly Cloudy &amp; Hot</u>
Rock _____ ft.	Depth to Water in Boring <u>120</u> hrs. <u>56.8</u> Ft.	Driller: <u>B. Butler</u>
Auger _____ ft.	Elevation Ft. <u>631.7</u>	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	z	w
			8	Very stiff yellowish brown highly plastic clay with black ore traces & sand lenses (5YR 5/6) (Clay - USDA)	CH	2.5	$\frac{11}{7-10}$	36.3
			9	Very stiff brown highly plastic clay with sand lenses and weathered chert (7.5YR 5/6) (Clay - USDA)	CH	2.5	$\frac{4}{7-10}$	25.2
50			10	Very stiff yellowish brown highly plastic clay with black ore traces, sand lenses and weathered rock (5YR 5/8) (Clay - USDA)	CH	2.5	$\frac{6}{5-7}$	39.4
			11	Same as No. 10 (5YR 5/6) (Clay - USDA)	CH	2.0	$\frac{5}{5-6}$	34.6
60			12	Same as No. 10 (5YR 5/6) (Clay - USDA)	CH	1.5	$\frac{5}{6-7}$	36.0
			13	Same as No. 10 (5YR 5/6) (Clay - USDA)	CH	0.75	$\frac{9}{19-12}$	20.4
70				Refusal - Probably rock or boulder				
80								

# TESTING INCORPORATED

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-10  
 Job No. 78-45

CLIENT: P&C, Proc Div For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>74.2</u> ft.	Completion Depth <u>74.2</u> Ft.	Date: <u>8-07-78</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling <u>1 hr-59.0</u> Ft.	Weather: <u>Clear &amp; Hot</u>
Auger _____ ft.	Depth to Water in Boring <u>144</u> hrs. <u>46.6</u> Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. <u>617.8</u>	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube end/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
				Topsoil and silt				
			1	Stiff red sandy silty clay (2.5YR 3/6) (Silty Clay - USDA)	CL	3.0	$\frac{4}{5-5}$	18.7
10			2	Same as No. 1 (2.5YR 3/6) (Silty Clay - USDA)	CL	3.5	$\frac{5}{6-7}$	20.7
			3	Same as No. 1 (2.5 YR 3/6) (Silty Clay - USDA)	CL	2.75	$\frac{4}{7-7}$	24.7
20			4	Very stiff yellow red sandy clay (2.5YR 3/6) (Sandy Clay - USDA)	CL	3.5	$\frac{6}{8-10}$	19.7
			5	Same as No. 4 (2.5YR 3/6) (Sandy Clay - USDA)	CL	2.0	$\frac{5}{6-8}$	17.1
30			6	Very stiff gray and red highly plastic clay with layers of sand and soft stone traces (2.5YR 6/4) (Clay - USDA)	CH	2.5	$\frac{4}{7-14}$	36.0
			7	Very stiff gray, red & yellow highly plastic clay with layers of sand, soft stone traces and chert (2.5YR 4/8) (Clay - USDA)	CH	3.0	$\frac{6}{8-12}$	29.5
40				(continued on page 2)				

REMARKS: \_\_\_\_\_ C-9 \_\_\_\_\_

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-10 (Page 2)

Job No. 78-45

CLIENT: P&C, Proc Div For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING	Completion Depth <u>74.2</u> Ft.	Date: <u>8-07 &amp; 08-78</u>
Standard <u>74.2</u> ft.	Depth to Water in Boring @ Drilling <u>1 hr-59.0</u> Ft.	Weather: <u>Clear &amp; Hot</u>
Check _____ ft.	Depth to Water in Boring <u>144</u> hrs. <u>46.6</u> Ft.	Driller: <u>B. Butler</u>
Gear _____ ft.	Elevation Ft. <u>617.8</u>	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
			8	Same as No. 7 (2.5YR 5/8) (Clay - USDA)	CH	3.5	$\frac{6}{13-18}$	20.7
			9	Very stiff brownish yellow highly plastic clay with weathered chert (5YR 5/8) (Clay - USDA)	CH	3.0	$\frac{5}{8-10}$	28.2
50			10	Very stiff yellow cherty clay (weathered) (7.5YR 5/8) (Clay - USDA)	CH	*	$\frac{5}{11-12}$	30.0
			11	Very stiff reddish yellow highly plastic clay with weathered chert and sand (2.5YR 5/6) (Clay - USDA)	CH	2.5	$\frac{4}{8-8}$	27.6
60			12	Very stiff yellow brown sandy highly plastic clay with chert (5YR 4/6) (Clay - USDA)	CH	*	$\frac{4}{8-12}$	29.7
			13	Same as No. 12 (5YR 4/6) (Clay - USDA)	CH	*	$\frac{8}{19-15}$	32.0
70			14	Soft yellow brown sandy highly plastic clay with chert (5YR 4/6) (Clay - USDA)	CH	0.75	$\frac{0}{5-3}$	44.0
				Refusal - Probably rock or boulder				
80								

REMARKS:

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-11

Job No. 78-45

CLIENT: P&C, Proc Div For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>60.9</u> ft.	Completion Depth <u>60.9</u> Ft.	Date: <u>8-09 &amp; 10-78</u>
Rock _____ ft.	Depth to Water in Boring @ Completion <u>51.0</u> Ft.	Weather: <u>Partly Cloudy &amp; Hot</u>
Spur _____ ft.	Depth to Water in Boring <u>96</u> hrs. <u>25.0</u> Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. <u>621.7</u>	

DEPTH FT.	SYMBOL	SAMPLES Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
10			1	Very stiff red silty sandy clay (2.5YR 3/6) (Sandy Clay - USDA)	CL	4.0	$\frac{6}{8-9}$	18.1
			2	Loose yellow clayey sand (2.5YR 4/8) (Clayey Sand - USDA)	SC	2.0	$\frac{8}{7-7}$	12.9
			3	Stiff yellow silty sand (7.5YR 6/8) (Loamy Sand - USDA)	SM	*	$\frac{7}{6-7}$	14.3
20			4	Very stiff medium plastic clay with sand lenses and soft stone traces (10YR 6/8) (Clay - USDA)	CL-CH	4.0	$\frac{5}{10-10}$	24.9
			5	Same as No. 4 (10YR 6/8) (Clay - USDA)	CL-CH	4.5	$\frac{6}{8-10}$	19.1
30			6	Very stiff brown highly plastic clay with dense chert with sand (7.5YR 5/6) (Clay - USDA)	CH	*	$\frac{17}{14-15}$	24.2
			7	Very stiff brown highly plastic clay with dense chert with large sand lenses (7.5YR 5/8) (Clay - USDA)	CH	2.25	$\frac{4}{6-7}$	26.0

(continued on Page 2)

REMARKS: \* Too much sand or chert for PPR

**TESTING**  
 P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-11 (Page 2)  
 Job No. 78-45

CLIENT: P&C, Proc Div For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>60.9</u> ft.	Completion Depth <u>60.9</u> Ft.	Date: <u>8-09-78</u>
Rock _____ ft.	Depth to Water in Boring @ Completion <u>51.0</u> Ft.	Weather: <u>Partly Cloudy &amp; Hot</u>
Auger _____ ft.	Depth to Water in Boring <u>96</u> hrs. <u>25.0</u> Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. <u>621.7</u>	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
			8	Same as No. 7 (7.5YR 5/8) (Clay - USDA)	CH	2.75	$\frac{3}{6-9}$	29.7
			9	Brown sandy clay with weathered chert (7.5YR 5/8) (Sandy Clay - USDA)	CL	1.0	$\frac{5}{10-10}$	25.0
50			10	Brown sandy clay with dense weathered chert (7.5YR 5/8) (Sandy Clay - USDA)	CL	0.75	$\frac{10}{10-12}$	25.1
			11	Very stiff brown cherty clay plus weathered rock (7.5YR 4/6) (Clay - USDA)	CH	*	$\frac{7}{12-22}$	26.2
60			12	Same as No. 11 (7.5YR 4/6) (Clay - USDA)	CH	*	$\frac{19}{25-50}$	30.2
				Refusal - Probably rock or boulder				
70								
80								

REMARKS: \* Too much chert for PPR

Boring No. RS-12

Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Print

<b>TYPE OF DRILLING</b> Standard <u>49.8</u> ft. Rock _____ ft. Auger _____ ft.	Completion Depth <u>49.8</u> Ft. Depth to Water in Boring @ Drilling <u>35.0</u> Ft. Depth to Water in Boring <u>72</u> hrs. <u>28.0</u> Ft. Elevation Ft. _____	Date: <u>9-29-78</u> Weather: <u>Clear &amp; Hot</u> Driller: <u>B. Butler</u>
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DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
				Topsoil with red sandy silty clay				
			1	Very stiff dark red silty sandy clay (2.5YR 3/6) (Sandy Clay - USDA)	CL	2.5	$\frac{4}{7-8}$	22.5
10			2	Very stiff yellow and brown sandy clay (5YR 5/8) (Sandy Clay - USDA)	CL	4.5	$\frac{6}{7-11}$	22.9
			3	Same as No. 2 (5YR 5/8) (Sandy Clay - USDA)	CL	4.5	$\frac{7}{12-14}$	24.4
20			4	Very stiff gray, yellow and brown highly plastic clay w/sand & weathered soft stone (2.5R5/6) (Clay - USDA)	CH	4.0	$\frac{5}{10-10}$	28.4
			5	Very stiff brown highly plastic clay with dense chert (5YR 5/8) (Clay - USDA)	CH	3.25	$\frac{11}{37-12^{**}}$	40.1
30			6	Very stiff yellow and brown cherty clay (5YR 5/8) (Clay - USDA)	CH	*	$\frac{14}{13-17}$	24.2
			7	Same as No. 6 (5YR 5/8) (Clay - USDA)	CH	2.0	$\frac{5}{7-8}$	37.6

(continued on Page 2)

REMARKS: \* Too much chert for PPR. Note: Shelby tube at 30' damaged in dense material

**TESTING**  
 INCORPORATED  
 P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-12 (Page 2)

Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Print

TYPE OF DRILLING	Completion Depth <u>49.8</u> Ft.	Date: <u>9-29-78</u>
Standard <u>49.8</u> ft.	Depth to Water in Boring @ Drilling <u>35.0</u> Ft.	Weather: <u>Clear &amp; Hot</u>
Reck _____ ft.	Depth to Water in Boring <u>72</u> hrs. <u>28.0</u> Ft.	Driller: <u>B. Butler</u>
Auger _____ ft.	Elevation Ft. _____	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
0								
1								
2								
3								
4								
5								
6								
7								
8			8	Very stiff yellow and brown cherty clay (5YR 5/6) (Clay - USDA)	CH	1.5	$\frac{6}{7-8}$	27.9
9			9	Same as No. 8 (5YR 5/6) (Clay USDA)	CH	*	$\frac{4}{13-11}$	42.7
10								
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12								
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16								
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REMARKS: \* Too much chert for PPR.

# TESTING INCORPORATED

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-13  
 Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Print

TYPE OF DRILLING Standard <u>49.9</u> ft.	Completion Depth <u>49.9</u> Ft.	Date: <u>10-03-78</u>
Rock _____ ft.	Depth to Water in Boring @ Completion <u>41.0</u> Ft.	Weather: <u>Clear &amp; Hot</u>
Auger _____ ft.	Depth to Water in Boring _____ hrs. _____ Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. _____	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
				Topsoil				
			1	Stiff red sandy silty clay (10R 4/8) (Silty Clay - USDA)	CL	2.0	$\frac{4}{5-6}$	23.0
10			2	Very stiff yellowish red silty sandy clay with soft stone (2.5YR 4/8) (Sandy Clay - USDA)	CL	4.5	$\frac{6}{7-8}$	18.3
			3	Very stiff reddish yellow silty sandy clay with red sandy lenses (7.5YR 5/8) (Sandy Clay - USDA)	CL	4.25	$\frac{6}{8-11}$	21.7
20			4	Stiff yellow medium plastic clay with sand and chert (7.5YR 5/8) (Sandy Clay - USDA)	CL	4.0	$\frac{4}{5-6}$	36.1
			5	Very stiff brown cherty clay (2.5YR 5/8) (Clay - USDA)	CH	*	$\frac{6}{10-10}$	40.4
30			6	Very stiff brown highly plastic clay with sand and dense chert (5YR 5/6) (Clay - USDA)	CH	2.25	$\frac{13}{9-8}$	33.3
40			7	Stiff brown highly plastic clay with dense sand lenses and traces of chert (5YR 4/4) (Clay - USDA)	CH	1.75	$\frac{4}{5-8}$	30.5

(continued on Page 2)

MARKS: \* Too much chert for accurate PPR.

**TESTING**  
 INCORPORATED  
 P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-13 (Page 2)  
 Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Print

TYPE OF DRILLING Standard <u>49.9</u> ft.	Completion Depth <u>49.9</u> Ft.	Date: <u>10-03-78</u>
Rock _____ ft.	Depth to Water in Boring & Completion <u>41.0</u> Ft.	Weather: <u>Clear &amp; Hot</u>
Auger _____ ft.	Depth to Water in Boring _____ hrs. _____ Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. _____	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
48			8	Very stiff brown highly plastic clay with weathered rock and sand (2.5YR 4/6) (Clay - USDA)	CH	1.75	$\frac{6}{9-7}$	26.1
49			9	Same as No. 8 (2.5YR 4/6) (Clay - USDA)	CH	2.0	$\frac{5}{10-6}$	28.8
50				Refusal - probably rock or boulder				
60								
70								
80								

REMARKS: \_\_\_\_\_

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-14

Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Print

TYPE OF DRILLING Standard <u>51.0</u> ft.	Completion Depth <u>51.0</u> Ft.	Date: <u>10-02-78</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling <u>42.3</u> Ft.	Weather: <u>Clear &amp; Hot</u>
Auger _____ ft.	Depth to Water in Boring <u>24</u> hrs. <u>41.5</u> Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. _____	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	F Unified Soil Classification	PPR	Z	W
				Topsoil				
			1	Stiff brown silty clay (7.5YR 4/4) (Silty Clay - USDA)	CL	1.0	$\frac{3}{4-4}$	22.5
10			2	Stiff reddish brown silty clay (5.0YR 4/6) (Silty Clay - USDA)	CL	1.0	$\frac{4}{4-6}$	20.3
			3	Firm dark red silty clay (2.5YR 3/6) (Silty Clay - USDA)	CL	1.5	$\frac{3}{3-4}$	20.6
20			4	Firm red silty sandy clay (2.5YR 4/6) (Sandy Clay - USDA)	CL	1.25	$\frac{2}{2-3}$	22.5
			5	Same as No. 4 (2.5YR 4/6) (Sandy Clay - USDA)	CL	2.0	$\frac{4}{4-6}$	19.7
30			6	Stiff yellow and brown highly plastic clay with dense chert (2.5YR 4/8) (Sandy Clay - USDA)	MH	*	$\frac{3}{6-5}$	44.3
			7	Very stiff yellowish red silty cherty clay (5.0YR 5/8) (Sandy Clay - USDA)	MH	*	$\frac{4}{10-10}$	32.9

(continued on Page 2)

REMARKS: \* Too much chert for PPR.

# TESTING INCORPORATED

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-14 (Page 2)

Job No. 78-45

CLIENT: P&C BR, Proc Div, Dir For Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Print

TYPE OF DRILLING Standard <u>51.0</u> ft.	Completion Depth <u>51.0</u> Ft.	Date: <u>10-02-78</u>
Rock _____ ft.	Depth to Water in Boring & Drilling <u>42.3</u> Ft.	Weather: <u>Clear &amp; Hot</u>
Auger _____ ft.	Depth to Water in Boring <u>24</u> hrs. <u>41.5</u> Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. _____	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
			8	Stiff reddish brown sandy clay with dense chert (2.5YR 4/6) (Sandy Clay - USDA)	MH	1.0	$\frac{5}{6-7}$	21.4
			9	Same as No. 8 (2.5YR 4/6) (Sandy Clay - USDA)	MH	0.5	$\frac{4}{5-3}$	30.7
50			10	Firm brown sandy clay with dense chert (2.5YR 4/8) (Sandy Clay - USDA)	MH	0.5	$\frac{2}{3-4}$	26.7
				Boring Terminated				
60								
70								
80								

REMARKS: \_\_\_\_\_

**TESTING**  
 P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-015  
 Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>66.4</u> ft.	Completion Depth <u>66.4</u> Ft.	Date: <u>11-14 &amp; 15-78</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling <u>65.0</u> Ft.	Weather: <u>Cloudy &amp; Warm</u>
Auger _____ ft.	Depth to Water in Boring <u>24</u> hrs. <u>27.0</u> Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. _____	

DEPTH FT.	SYMBOL	SAMPLES	She by Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
				Topsoil and sandy silt				
10			1	Stiff drak red silty sandy clay (10R 3/6) (Sandy Clay - USDA)	CL	4.0	$\frac{5}{6-7}$	18.0
			2	Same as No. 1	CL	2.5	$\frac{5}{3-5}$	17.4
			3	Same as No. 1	CL	2.5	$\frac{5}{7-7}$	23.4
20			4	Same as No. 1	CL	2.5	$\frac{5}{7-10}$	16.8
			5	Very stiff yellow and red medium plastic sandy clay (2.5YR 4/8) (Sandy Clay - USDA)	CL	3.75	$\frac{7}{10-13}$	32.1
30			6	Stiff yellow and red medium plastic sandy clay (2.5YR 4/8) (Sandy Clay - USDA)	CL	3.75	$\frac{6}{7-7}$	48.5
			7	Stiff yellow and red medium plastic sandy clay with sand lenses (2.5YR 4/8) (Sandy Clay - USDA)	CL	2.75	$\frac{5}{6-8}$	30.6

(continued on page 2)

REMARKS: \_\_\_\_\_ C-19

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-015 (Page 2)  
 Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>66.4</u> ft.	Completion Depth <u>66.4</u> Ft.	Date: <u>11-14 &amp; 15-78</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling <u>65.0</u> Ft.	Weather: <u>Cloudy &amp; Warm</u>
Auger _____ ft.	Depth to Water in Boring <u>24</u> hrs. <u>27.0</u> Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. _____	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
			8	Stiff yellow and red medium plastic sandy clay with sand lenses and soft stone (2.5YR 4/8) (Sandy Clay - USDA)	CL	3.25	$\frac{5}{10-8}$	31.4
			9	Same as No. 8	CL	2.0	$\frac{6}{6-8}$	57.5
50			10	Same as No. 8	CL	2.25	$\frac{4}{5-7}$	30.9
			11	Same as No. 8	CL	2.5	$\frac{4}{8-7}$	22.1
60			12	Same as No. 8	CL	1.5	$\frac{3}{6-7}$	33.8
			13	Stiff brown highly plastic clay with sand and weathered rock (7.5YR 4/6) (Clay - USDA)	CH	0.5	$\frac{7}{8-10}$	22.5
				Refusal - Probably rock or boulder				
70								
80								

REMARKS: \_\_\_\_\_ C-20 \_\_\_\_\_

**TESTING**  
 P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-016  
 Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809  
 PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, Alabama  
 BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>55.0</u> ft.	Completion Depth <u>55.0</u> Ft.	Date: <u>11-15-78</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling <u>50.0</u> Ft.	Weather: <u>Cloudy &amp; Warm</u>
Auger _____ ft.	Depth to Water in Boring _____ hrs. _____ Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. _____	

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
				Topsoil, silt and red silty sandy clay				
10			1	Stiff red silty sandy clay (10R 4/8) (Sandy Clay - USDA)	CL	2.25	$\frac{4}{6-7}$	25.9
			2	Stiff red silty sandy clay with coarse to medium grained sand lenses	CL	3.75	$\frac{7}{12-11}$	22.2
			3	Very stiff yellow and red medium plastic clay with sand and dense soft stone (2.5YR 5/8) (Clay - USDA)	CL	*	$\frac{5}{6-9}$	35.5
20			4	Very stiff yellow and brown medium plastic clay with sand and soft stone (5YR 5/6) (Clay - USDA)	CL	4.25	$\frac{6}{9-8}$	25.0
			5	Same as No. 4	CL	3.5	$\frac{5}{9-10}$	37.3
30			6	Very stiff yellow and brown medium plastic clay with sand, soft stone and chert (5YR 5/6) (Clay - USDA)	CL	*	$\frac{6}{8-10}$	25.4
			7	Stiff yellow and brown medium plastic clay with sand, chert and black ore traces	CL	3.0	$\frac{6}{6-7}$	43.6
40				(continued on page 2)				

REMARKS: \* Too much chert for PPR

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-016 (Page 2)

Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>55.0</u> ft. Rock _____ ft. Auger _____ ft.	Completion Depth <u>55.0</u> Ft. Depth to Water in Boring @ Drilling <u>50.0</u> Ft. Depth to Water in Boring _____ Ft. Elevation Ft. _____	Date: <u>11-15-78</u> Weather: <u>Cloudy &amp; Warm</u> Driller: <u>B. Butler</u>
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DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
50				8	Very stiff red medium plastic clay with sand lenses, chert and layers of gray highly plastic clay (2.5YR 4/6) (Clay - USDA)	CL	2.25	$\frac{4}{6-9}$	28.7
				9	Very stiff brown medium plastic clay with sand and chert (5YR 4/6) (Clay - USDA)	CL	1.5	$\frac{4}{6-8}$	33.4
				10	Very soft yellow highly plastic clay with chert and possible open voids (5YR 5/8) (Clay - USDA)	CH	*	$\frac{7}{2-0}$	40.2
60					Refusal - Probably rock or boulder				
70									
80									

REMARKS: \* Too much chert for PPR

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-017  
 Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>50.0</u> ft.	Completion Depth <u>50.0</u> Ft.	Date: <u>12-11-78</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling _____ Ft.	Weather: <u>Clear &amp; Cold</u>
Auger _____ ft.	Depth to Water in Boring _____ hrs. _____ Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. _____	

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
			Topsoil mixed w/red silty sandy clay				
		1	Red Silty Sandy Clay (10R 4/6) (Sandy Clay - USDA)	CL	2.25	$\frac{4}{5-6}$	23.9
10		2	Same as No. 1	CL	4.0	$\frac{7}{10-11}$	19.5
		3	Very stiff yellow and red silty sandy clay (25YR 4/8) (Sandy Clay - USDA)	CL	4.5+	$\frac{7}{9-14}$	22.1
20		4	Very stiff gray, red and yellow medium plastic clay w/sand lenses and dense soft stone (5YR 5/8) (Clay - USDA)	CL	4.5+	$\frac{9}{14-19}$	17.8
		5	Very stiff gray, red and yellow medium plastic clay w/sand lenses and soft stone (5YR 5/8) (Clay - USDA)	CL	3.5	$\frac{7}{9-12}$	27.3
30		6	Same as No. 5		2.5	$\frac{5}{11-11}$	28.8
		7	Very stiff gray, red and yellow medium plastic clay w/black ore traces (5YR 5/6) (Clay - USDA)	CL	3.0	$\frac{8}{11-15}$	24.7

(continued on page 2)

REMARKS:

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-017 (Page 2)

Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>50.0</u> ft. Rock _____ ft. Auger _____ ft.	Completion Depth <u>50.0</u> Ft. Depth to Water in Boring @ Drilling _____ Ft. Depth to Water in Boring _____ hrs. _____ Ft. Elevation Ft. _____	Date: <u>12-12-78</u> Weather: <u>Sunny &amp; Mild</u> Driller: <u>B. Butler</u>
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DEPTH FT.	SYMBOL	SAMPLES	LYSIMETER INSTALLATION	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
40				8	Very stiff gray, red and yellow medium plastic clay w/thick sand lenses and soft stone traces (Clay - USDA)	CL	2.5	$\frac{6}{10-11}$	26.6
				9	Same as No. 8	CL	3.0	$\frac{7}{8-13}$	20.8
50					Boring Terminated				
60									
70									
80									

REMARKS: \_\_\_\_\_

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-018  
 Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>46.0</u> ft.	Completion Depth <u>46.0</u> Ft.	Date: <u>12-11-78</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling _____ Ft.	Weather: <u>Clear &amp; Cold</u>
Auger _____ ft.	Depth to Water in Boring _____ hrs. _____ Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. _____	

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
			Mixture of topsoil & red sandy silty clay				
		1	Very stiff red sandy silty clay (10R 4/6) (Silty Clay - USDA)	CL	2.25	$\frac{6}{7-9}$	24.0
10		2	Same as No. 1	CL	2.5	$\frac{7}{12-15}$	23.5
		3	Very stiff yellowish red clay w/sand (10R 4/8) (Sandy Clay - USDA)	SC	2.5	$\frac{10}{11-11}$	13.0
20		4	Same as No. 3	SC	2.5	$\frac{7}{7-11}$	15.0
		5	Very stiff yellowish red clay w/soft sand stone (10R 4/8) Sandy Clay - USDA)	SC	3.5	$\frac{8}{10-10}$	16.9
30		6	Very stiff gray, yellow and red medium plastic clay w/dense sand (2.5YR 4/8) (Clay - USDA)	CL	3.5	$\frac{6}{8-9}$	24.1
		7	Very stiff gray, yellow and red medium plastic clay w/soft stone (2.5YR 4/8) (Clay - USDA)	CL	4.0	$\frac{5}{8-9}$	20.7

(continued on page 2)

**TESTING**  
P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-018 (Page 2)

Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prod, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING	Completion Depth <u>46.0</u> Ft.	Date: <u>12-11-78</u>
Standard <u>46.0</u> ft.	Depth to Water in Boring @ Drilling _____ Ft.	Weather: <u>Clear &amp; Cold</u>
Rock _____ ft.	Depth to Water in Boring _____ hrs. _____ Ft.	Driller: <u>B. Butler</u>
Auger _____ ft.	Elevation Ft. _____	

DEPTH FT.	SYMBOL	SAMPLES	LYSINETER INSTALLATION	SAMPLE NO.	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
40				8	Very stiff gray, yellow and red medium plastic clay w/sand lenses (Clay - USDA) (2.5YR 4/8) (Clay - USDA)	CL	3.5	$\frac{6}{9-10}$	20.6
				9	Same as No. 8	CL	1.0	$\frac{6}{8-8}$	25.1
					Boring Terminated				
50									
60									
70									
80									

REMARKS: \_\_\_\_\_

**TESTING**  
 P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS-019

Job No. 78-68

CLIENT: P&C, Proc Div for Proc & Prbd, Bldg. 4488, Redstone Arsenal, AL 35809

PROJECT LOCATION: DDT Landfill Site, Redstone Arsenal, AL

BORING LOCATION: See Boring Sketch

TYPE OF DRILLING Standard <u>30.0</u> ft.	Completion Depth <u>30.0</u> Ft.	Date: <u>11-16-78</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling _____ Ft.	Weather: <u>Partly Cloudy &amp; Mild</u>
Auger _____ ft.	Depth to Water in Boring <u>4</u> hrs. <u>26.0</u> Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. _____	

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	Unified Soil Classification	PPR	Z	W
10			1 Stiff red silty sandy clay (2.5YR 3/6) (Sandy Clay - USDA)	CL	3.0	$\frac{4}{5-7}$	20.7
			2 Same as No. 1	CL	2.5	$\frac{4}{5-7}$	22.0
			3 Same as No. 1	CL	2.5	$\frac{4}{6-9}$	20.6
20			4 Same as No. 1	CL	2.5	$\frac{4}{7-8}$	20.9
			5 Very stiff red medium plastic clay w/sand and soft stone (2.5YR 4/6) (Clay - USDA)	CL	4.25	$\frac{6}{9-12}$	35.9
30			Boring Terminated				
40							

REMARKS:

# TESTING INCORPORATED

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Lab & Base Support Branch,

CLIENT: Procurement Division D, P & PD, USAMICOM, Bldg. 4488, Redstone Arsenal, AL 35898

PROJECT LOCATION: DDT Landfill Monitoring Wells, Contract No. DAAH03-84-0498

BORING LOCATION: N 1,504,571.0; E 253,079.6

TYPE OF DRILLING Standard <u>40.5</u> ft.	Completion Depth <u>40.5</u> Ft.	Date: <u>1-09-84</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling <u>29</u> Ft.	Weather: <u>Partly Cloudy &amp; Mild</u>
Auger _____ ft.	Depth to Water in Boring _____ hrs. _____ Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. <u>608.5</u>	<u>DR 55-2</u>

DEPTH FT.	SYMBOL	SAMPLES Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	Plasticity	USCS	Z	W
				Topsoil				
			1	VERY STIFF dark red: 2.5 YR 3/6 sandy silty CLAY 20% silt; 10% fine to medium sand (moist; residual/alluvial)	MP	CL	$\frac{5}{7-8}$	27.3
10			2		MP	CL	$\frac{7}{12-13}$	30.3
			3	VERY STIFF red and olive yellow: 2.5 Y 6/8 sandy CLAY with traces of soft stone 20% fine to medium sand (moist; residual/alluvial)	MP	CL	$\frac{6}{9-10}$	19.9
20			4		MP	CL	$\frac{5}{7-9}$	24.0
			5	STIFF yellow and red: 2.5 YR 4/8 CLAY with 20% soft stone fragments (moist; residual)	HP	CH	$\frac{4}{5-7}$	41.9
30			6	STIFF yellow and red: 2.5 YR 4/8 CLAY with 40% layered chert (moist; residual)	HP	CH	$\frac{7}{8-8}$	33.6
			7	STIFF yellow red: 5 YR 5/6 CLAY with 40% layered chert (moist; residual)	HP	CH	$\frac{7}{7-8}$	26.5
40			8		HP	CH	26	---

REMARKS:

34-x

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS082  
 Job No. 13403

CLIENT: Lab & Base Support Branch,  
 Procurement Division, D, P & PD, USAMICOM, Bldg. 4488, Redstone Arsenal, AL 35898

PROJECT LOCATION: DDT Landfill Monitoring Wells, Contract No. DAAH03-84-0498

BORING LOCATION: N 1,503,952.1; E 253,114.6

TYPE OF DRILLING	Completion Depth <u>40.5</u> Ft.	Date: <u>1-06-84</u>
Standard <u>40.5</u> ft.	Depth to Water in Boring @ Drilling <u>31</u> Ft.	Weather: <u>Partly Cloudy &amp; Mild</u>
Rock _____ ft.	Depth to Water in Boring _____ hrs. _____ Ft.	Driller: <u>B. Butler</u>
Auger _____ ft.	Elevation Ft. <u>633.3</u>	<u>DR 55-2</u>

DEPTH FT.	SYMBOL	SAMPLES Shelby Tube and/or Water Tbl.	SAMPLE NO.	DESCRIPTION OF MATERIAL	plasticity	USCS	Z	W
				Dark red silty sandy CLAY				
				Topsoil				
				Red and yellow silty CLAY				
			1	STIFF dark red: 2.5 YR 3/6 silty sandy CLAY 25% fine to medium sand; 20% silt (moist; residual/alluvial)	MP	CL	$\frac{4}{5-5}$	15.6
10			2	VERY STIFF dark red: 2.5 YR 3/6 silty sandy CLAY 25% fine to medium sand; 20% silt (moist; residual/alluvial)	MP	CL	$\frac{4}{6-7}$	17.9
			3		MP	CL	$\frac{7}{10-11}$	17.9
20			4		MP	SC	$\frac{10}{10-11}$	11.7
			5	MEDIUM DENSE red: 2.5 YR 4/6 clayey SAND 30% fines (moist; residual/alluvial)	MP	SC	$\frac{9}{11-14}$	15.6
30			6		MP	SC	$\frac{8}{11-14}$	16.1
			7	VERY STIFF yellow and red: 2.5 YR 4/6 sandy CLAY with traces of gray clay 40% fine to medium sand (moist; residual)	MP	CL	$\frac{7}{9-10}$	18.5
40				VERY STIFF reddish yellow: 7.5 YR 6/8 CLAY with streaks of sandy clay and softstone*	HP	CH	5	16.9

REMARKS: \* traces, 10% fine to medium sand (moist; residual) 10-10

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS083 (Page 1 of

Job No. I3403

CLIENT: Lab & Base Support Branch,  
Procurement Division, D, P & PD, USAMICOM, Bldg. 4488, Redstone Arsenal, AL 35898

PROJECT LOCATION: DDT Landfill Monitoring Wells, Contract No. DAAH03-84-0498

BORING LOCATION: N 1,503,953.3; E 253,304.4

TYPE OF DRILLING Standard <u>50.5</u> ft.	Completion Depth <u>50.5</u> Ft.	Date: <u>1-06-84</u>
Rock _____ ft.	Depth to Water in Boring @ Drilling <u>DRY</u> Ft.	Weather: <u>Sunny &amp; Mild</u>
Auger _____ ft.	Depth to Water in Boring _____ hrs. _____ Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. <u>624.0</u>	<u>DR 55-2</u>

DEPTH FT.	SYMBOL	SAMPLES Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Plasticity	USCS	Z	W
			Topsoil				
		1		MP	CL	$\frac{5}{5-5}$	22.1
10		2	STIFF dark red: 2.5 YR 3/6 sandy silty CLAY 25% silt and 20% fine to medium sand (moist; residual/alluvial)	MP	CL	$\frac{5}{8-9}$	21.8
		3		MP	CL	$\frac{8}{13-11}$	21.5
20		4	VERY STIFF gray, yellow, and red: 2.5 YR 4/8 CLAY with softstone and traces of sand 10% soft stone fragments (moist; residual; alluvial)	HP	CH	$\frac{7}{8-9}$	36.3
		5	VERY STIFF gray and reddish yellow: 7.5 YR 6/8 sandy CLAY 15% medium sand (moist, residual/alluvial)	MP	CL	$\frac{6}{12-12}$	18.9
30		6		MP	CL	$\frac{6}{10-10}$	28.7
		7	VERY STIFF strong brown: 7.5 YR 5/6 CLAY with sand streaks and softstone traces 30% fine to medium sand in streaks (moist; residual)	HP MP	CL-CH	$\frac{6}{8-11}$	20.2
40				HP MP	CL-CH	$\frac{6}{8-9}$	39.5

REMARKS:

continued on Page 2

# TESTING

P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS083 (Page 2 of 2)

Job No. 13403

CLIENT: Lab & Base Support Branch,  
Procurement Division, D, P & PD, USAMICOM, Bldg. 4488, Redstone Arsenal, AL 35898

PROJECT LOCATION: DDT Landfill Monitoring Wells, Contract No. DAAH03-84-0498

BORING LOCATION: N 1,503.953.3; E 253,304.4

TYPE OF DRILLING Standard <u>50.5</u> ft. Rock _____ ft. Auger _____ ft.	Completion Depth <u>50.5</u> Ft.	Date: <u>1-06-84</u>
	Depth to Water in Boring @ Drilling <u>Dry</u> Ft.	Weather: <u>Sunny &amp; Mild</u>
	Depth to Water in Boring _____ hrs. _____ Ft.	Driller: <u>B. Butler</u>
	Elevation Ft. <u>624.0</u>	<u>DR 55-2</u>

DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Plasticity	USCS	Z	W
48		9	9	VERY STIFF strong brown: 7.5 YR 5/6 CLAY with sand streaks and softstone traces 30% fine to medium sand in streaks (moist; residual)	HP MP	CL-CH	$\frac{7}{5-7}$	21.5
50		10	10	STIFF yellowish red: 5 YR 5/8 cherty CLAY 40% chert fragments (moist; residual)	HP	CH	$\frac{13}{17-14}$	---
50.5				Boring Terminated				

REMARKS: \_\_\_\_\_

**TESTING**  
 P.O. BOX 1087 • DECATUR, ALABAMA 35602

Boring No. RS084

Job No. 13403

CLIENT: Lab & Base Support Branch,  
 % Procurement Division, D, P & PD, USAMICOM, Bldg. 4488, Redstone Arsenal, AL 35898

PROJECT LOCATION: DDT Landfill Monitoring Wells, Contract No. DAAH03-84-0498

BORING LOCATION: N 1,504,036.5; E 253,361.8

TYPE OF DRILLING  
 Standard 40.5 ft.  
 Rock \_\_\_\_\_ ft.  
 Auger \_\_\_\_\_ ft.

Completion Depth 40.5 Ft.  
 Depth to Water in Boring @ Drilling 26.5 Ft.  
 Depth to Water in Boring \_\_\_\_\_ hrs. \_\_\_\_\_ Ft.  
 Elevation Ft. 619.8

Date: 1-09-84  
 Weather: Sunny & Mild  
 Driller: B. Butler  
 DR 55-2

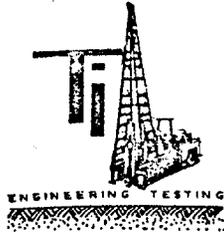
DEPTH FT.	SYMBOL	SAMPLES	Shelby Tube and/or Water Tbl. SAMPLE NO.	DESCRIPTION OF MATERIAL	Plasticity	USCS	z	w
10			1	STIFF to VERY STIFF dark red: 2.5 YR 3/6 silty sandy CLAY 30% fine to medium sand; 20% silt (moist; residual/alluvial)	MP	CL	$\frac{7}{8-9}$	17.8
			2		MP	CL	$\frac{6}{6-6}$	17.7
			3		MP	CL	$\frac{6}{8-10}$	22.3
20			4	VERY STIFF dark red: 2.5 YR 3/6 silty sandy CLAY with sand streaks 40% fine to medium sand; 15% silt (moist; residual/alluvial)	MP	CL	$\frac{6}{9-9}$	18.5
			5		MP	CL	$\frac{8}{8-9}$	14.8
30			6	LOOSE red: 2.5 YR 4/8 silty clayey fine SAND 20% clay; 10% silt (saturated; residual/alluvial)	NP	SC	$\frac{4}{3-4}$	19.3
			7		NP	SC	$\frac{3}{5-5}$	18.2
40			8		NP	SC	$\frac{3}{5-5}$	16.9

5-5

REMARKS:

APPENDIX D

SOIL ANALYSES  
(Source: References 4 and 5)



# TESTING

INCORPORATED

P. O. BOX 1087

1736 5TH AVENUE S E

DECATUR, ALABAMA 35601

PHONE: 205 • 353-2910

TABLE NO. 1

## REPORT OF SOIL ANALYSIS

CLIENT P&C BR, Proc Div, Dir for Proc & Prod, Redstone Arsenal, AL 35809JOB PROJECT DDT Landfill Site, Redstone Arsenal, AL

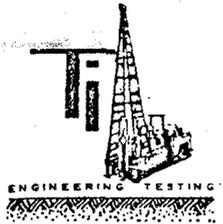
SAMPLE FROM \_\_\_\_\_

SOURCE OF MATERIAL \_\_\_\_\_

SAMPLE LOCATION:	Boring No.	Boring No.	Boring No.	Boring No.	Boring No.	Boring No.
	RS-7	RS-8	RS-8	RS-9	RS-9	RS-10
	Sample No.	Sample No.	Sample No.	Sample No.	Sample No.	Sample No.
	ST-5	ST-6	ST-7	ST-1	ST-2	ST-8
Dept. Ft	29.5 - 30.5	14.0 - 16.5	29.0 - 31.0	14.5 - 16.0	29.5 - 30.5	29.5 - 31.5
Unconfined Compressive Strength, P.S.F.						
Vane Shear Strength, P.S.F.						
Unit Weight, Wet, Lbs. Per Cu. Ft.	*	117.7	131.8	130.7	**	121.2
Unit Weight, Dry, Lbs. Per Cu. Ft.	*	99.3	109.9	114.7	**	97.0
Moisture Content, Percent	11.5	18.5	19.9	14.0	**	24.9
Specific Gravity						
Solid Volume Weight Lbs. Per Cu. Ft.						
Liquid Limit	NP	46	36	81	51	64
Plastic Limit	NP	32	19	37	22	29
Plasticity Index	NP	14	17	44	29	35
Classification	SP-SM	SC	SC	CH	CH	CH
PERMEABILITY k (cm/sec)	*	$2 \times 10^{-6}$	$1 \times 10^{-7}$	$3 \times 10^{-8}$	**	$3 \times 10^{-7}$

## REMARKS:

- \* Sample too sandy to hold together for undisturbed testing
- \*\* Too little recovery for testing.
- NP Non-plastic (Atterberg limits not measureable)



# TESTING INCORPORATED

P. O. BOX 1087 1736 5TH AVENUE S E DECATUR, ALABAMA 35601 PHONE: 205 - 353-2910

TABLE NO. 1 (cont'd)

## REPORT OF SOIL ANALYSIS

CLIENT P&C BR, Proc Div, Dir For Proc & Prod, Redstone Arsenal, AL 35809

JOB PROJECT DDT Landfill Site, Redstone Arsenal, AL

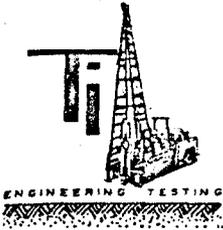
SAMPLE FROM \_\_\_\_\_

SOURCE OF MATERIAL \_\_\_\_\_

SAMPLE LOCATION:	Boring No. RS-11 Sample No. ST-3 Dept. Ft	Boring No. RS-11 Sample No. ST-4 27.0 - 29.5	Boring No. RS-12 Sample No. ST-9 15.0-17.5	Boring No. RS-12 Sample No. S-6 30.0-31.0	Boring No. RS-13 Sample No. ST-10 15.0-17.5	Boring No. RS-13 Sample No. S-6 30.0-31.0
Unconfined Compressive Strength, P.S.F.						
Vane Shear Strength, P.S.F.						
Unit Weight, Wet, Lbs. Per Cu. Ft.	*	131.7	110.5	---	116.5	---
Unit Weight, Dry, Lbs. Per Cu. Ft.	*	108.9	87.0	---	93.5	---
Moisture Content, Percent	14.3	20.9	27.0	---	24.6	---
Specific Gravity						
Solid Volume Weight Lbs. Per Cu. Ft.						
Liquid Limit	NP	50	53	62	32	71
Plastic Limit	NP	15	27	27	21	36
Plasticity Index	NP	35	26	35	11	35
Classification	SM	CL-CH	CH	CH	CL	MH
PERMEABILITY (cm/sec)	$2 \times 10^{-4}$	$1 \times 10^{-7}$	$1 \times 10^{-8}$			

REMARKS:

\* Sample too sandy to hold together for undisturbed testing



# TESTING INCORPORATED

P. O. BOX 1087 1736 5TH AVENUE S E DECATUR, ALABAMA 35601 PHONE: 205 - 353-2910

TABLE NO. 1 (cont'd)

## REPORT OF SOIL ANALYSIS

CLIENT P&C, Proc Div, Dir For Proc & Prod, Redstone Arsenal, AL 35809

JOB PROJECT DDT Landfill Site, Redstone Arsenal, AL

SAMPLE FROM \_\_\_\_\_

SOURCE OF MATERIAL \_\_\_\_\_

SAMPLE LOCATION:	Boring No.					
	RS-14					
	Sample No.					
	S-6					
Dept. Ft	30.0-31.0					
Unconfined Compressive Strength, P.S.F.						
Vane Shear Strength, P.S.F.						
Unit Weight, Wet, Lbs. Per Cu. Ft.	--					
Unit Weight, Dry, Lbs. Per Cu. Ft.	--					
Moisture Content, Percent						
Specific Gravity						
Solid Volume Weight Lbs. Per Cu. Ft.						
Liquid Limit	58					
Plastic Limit	34					
Plasticity Index	24					
Classification	MH					

REMARKS:

APPENDIX E

MONITORING WELL AND LYSIMETER  
CONSTRUCTION DETAILS

(Source: References 3, 4 and 5)

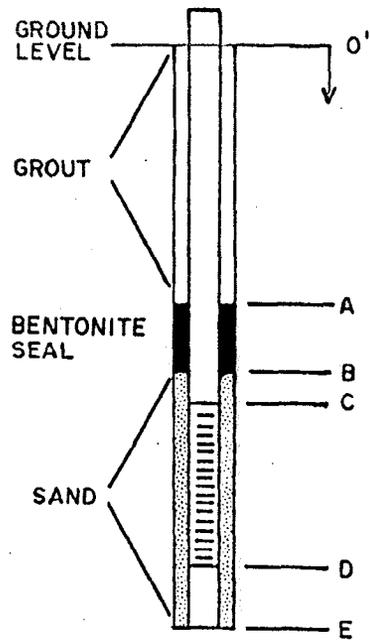
TABLE E-1. MONITORING WELL CONSTRUCTION DETAILS

Well Number	Diameter (inches)	Total Depth (feet)	Depth to Top of Well Screen (feet)	Length of Well Screen (feet)	Depth to Water (feet)
RS010	2	74.2	59.2	10.0	52.86
RS011	2	60.9	45.9	10.0	23.14
RS015	2	66.4	51.0	10.4	22.13
RS016	2	55.0	40.0	10.0	35.34

TABLE E-2. GROUNDWATER MONITOR WELL SUMMARY

PROJECT DDT Wells  
 DAAH03-84-M-0498  
 Redstone Arsenal, AL

DATE 14 Mar 1984



A - TOP OF BENTONITE SEAL  
 B - TOP OF SAND  
 C - TOP OF WELL SCREEN  
 D - TOP OF SEDIMENT TRAP  
 E - TOTAL WELL DEPTH

WELL NO.	RS081	RS082	RS083	RS084			
A	21.0	44.0	47.1	19.8			
B	24.0	47.0	50.1	22.8			
C	25.0	48.0	51.1	23.8			
D	40.0	68.0	66.1	38.8			
E	40.2	68.2	66.3	39.0			
GROUT THICKNESS	21.0	44.0	47.1	19.8			
BENTONITE SEAL THICKNESS	3.0	3.0	3.0	3.0			
LENGTH OF PIPE	42.8	71.0	69.2	41.9			
LENGTH OF STANDPIPE	2.6	2.8	2.9	2.9			
LENGTH OF SCREEN	15.0	20.0	15.0	15.0			
LENGTH OF SEDIMENT TRAP	0.2	0.2	0.2	0.2			
SCREEN SLOT SIZE	0.01"	0.01"	0.01"	0.01"			
INITIAL WATER LEVEL	29.0	31.0	Dry	26.5			
24 HOUR WATER LEVEL	26.6	57.9	50.9	24.9			
GROUND LEVEL ELEVATION	608.5	633.3	623.7	619.8			
REMARKS							

E-3

MONITOR WELL INSTALLATION

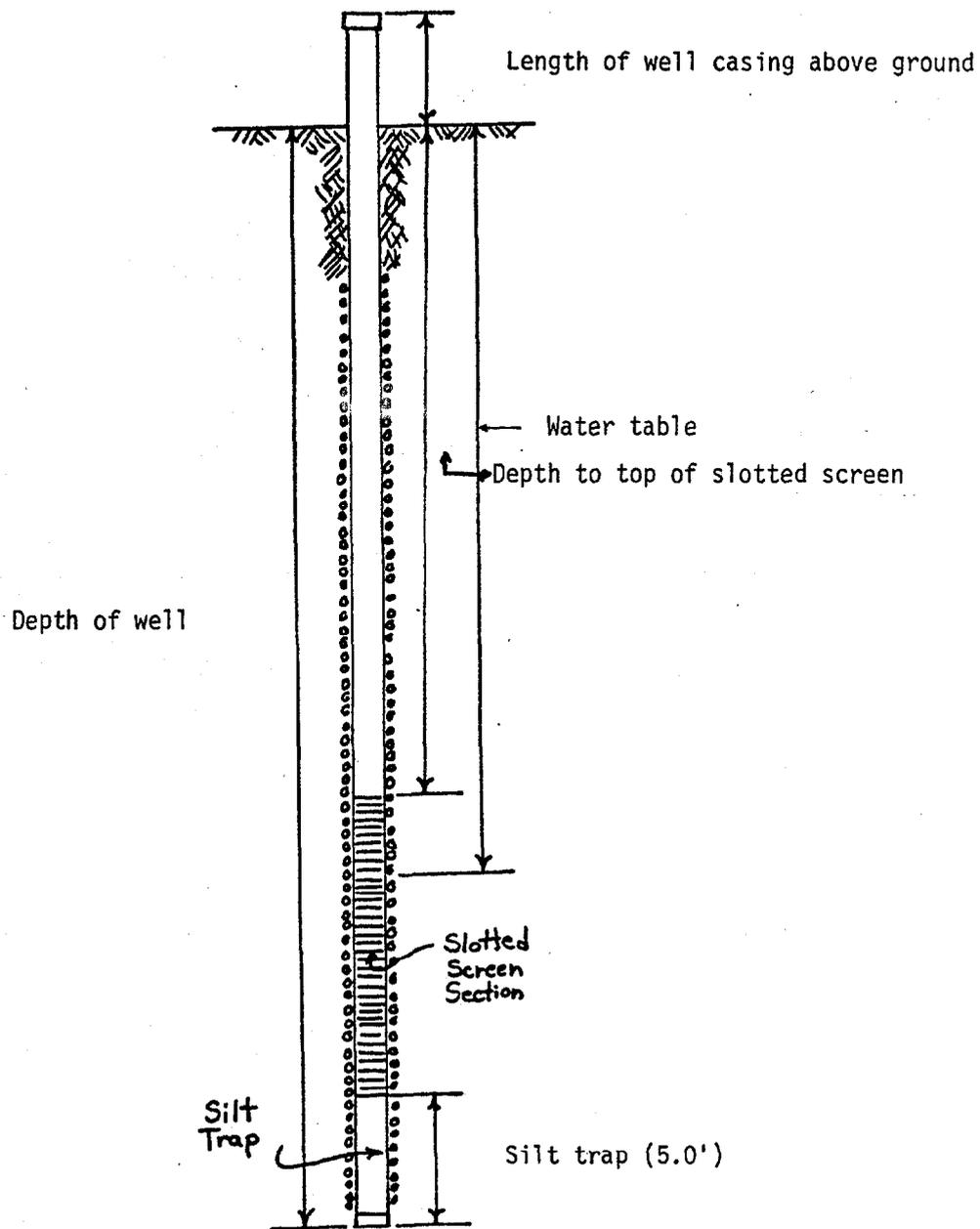
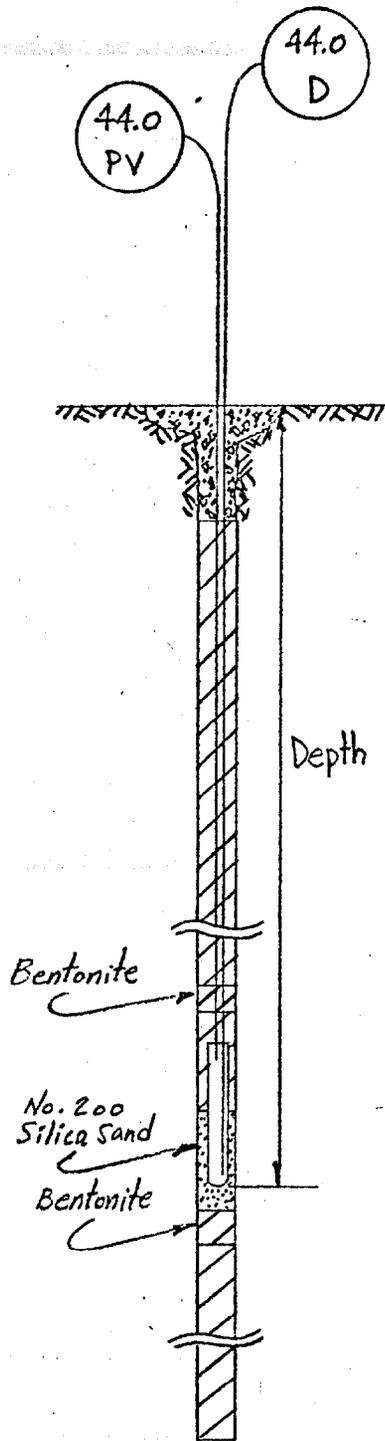


FIGURE E-1. Monitor Well Installation.



<u>Hole No.</u>	<u>Depth (Ft.)</u>
RS-017	16.0
RS-017	31.0
RS-017	44.0
RS-018	17.5
RS-018	28.0
RS-018	39.5
RS-019	17.5
RS-019	24.5

Sample illustration for Lysimeter installed at 44.0' in RS-017

Access tubing marked as labeled:

44.0 - Depth of installation

PV - Pressure Vacuum Tube

D - Discharge Tube

FIGURE E-2. Lysimeter Installation.

APPENDIX F

GROUND-WATER FLOW RATE CALCULATIONS

1. Ground-water flow rate equation:  $V = \frac{Ki}{n}$

where V = velocity of ground-water flow  
K = permeability (hydraulic conductivity)  
i = hydraulic gradient  
n = aquifer effective porosity

2. Average ground-water flow velocity estimate:

$K = 3.88 \times 10^{-4}$  ft/day (K value is the average of permeability tests for undisturbed soil samples for RS010, RS011, and RS012)

$i = 0.0304$  (monitoring well RS081 to RS010)

$n \approx 0.10$  (conservative estimate for predominantly clay aquifer)

$$V = \frac{(3.88 \times 10^{-4} \text{ ft/day})(.0304)}{0.10} = 0.000117 \text{ ft/day or approximately } 0.04 \text{ ft/year}$$

APPENDIX G

INSTRUCTIONS FOR COLLECTION, PREPARATION,  
AND CHEMICAL ANALYSIS OF GROUND-WATER SAMPLES\*

1. WELL PURGING. All monitoring wells must be pumped or bailed prior to sampling to ensure that samples are representative of the ground water and do not contain water which has been standing in the casing. For this monitoring program, at least five volumes of water in the well casing should be removed. However, for a low-yield well which does not quickly recharge as it is pumped, the well should be pumped or bailed dry and the sample then obtained as soon as the well recharges. When calculating the amount of water which must be purged, subtract depth to water (from ground surface) from the total depth of the well and then multiply by 0.16 for a 2-inch well, 0.37 for a 3-inch well, or 0.65 for a 4-inch well to obtain the volume of standing water in the well. The amount pumped prior to sampling should be recorded on the field data log sheet. The depth at which the pump should be set when purging a well will depend on well construction details, water depth in the well, and well recharge rate. For a well which does not recharge as it is pumped, the pump intake should be as deep as possible in the well, but not so deep as to pick up the sediment which has accumulated in the well bottom. In wells which recharge as they are pumped, the pump intake should be about 5 feet below the surface of the water in the well. The pump will have to be lowered if the water level in the well drops during pumping. Pumping in this manner will ensure that the water which has been standing in the well will be efficiently removed and a representative sample taken. When pumping or sampling a well, great care must be exercised to ensure that contaminants are not introduced into the well or a sample. A sampler or sample tubing, or a bailer or bailer cable, must not be allowed to contact the ground or a dirty surface in a vehicle or sampling equipment box. Plastic sheeting may be used for each well sampled. Sampling equipment must be thoroughly cleaned before it is placed in its storage case. In those situations where there is windblown dust at the sampling site, it will be impossible to obtain a good sample. Sampling should be postponed until a more favorable time.

2. SAMPLING.

a. The sample containers should be rinsed several times with a small amount of water pumped from the well prior to filling. All of these containers must be filled to overflowing so that no headspace remains. Samples should be protected from light and kept cool from the time they are collected.

b. Sampling equipment must be thoroughly cleaned between sampling at each well. This may normally be accomplished by rinsing thoroughly with tap water. At least 2 to 3 gallons of water should be pumped through the tubing and pump with each rinsing. If a bailer is used, it should be rinsed three times with tap water and then rinsed three times with distilled water. In those cases where a sampler becomes contaminated by pumping oily or greasy

---

\* These instructions were followed during all Phase 1 work.

water, it should be rinsed first with soapy water and then rinsed thoroughly with clean water. It may be necessary to disassemble a pump to effectively clean it of oil and grease. Acetone rinsing is an effective method of removing oil and grease contamination, but should not be used unless it is certain that the materials used to construct the pump or bailer will not be affected.

3. SAMPLE PRESERVATION AND ANALYTICAL METHODS. Samples will be preserved as shown in Table G-1. Analytical methods are listed in Table G-2.

TABLE G-1. PREPARATION OF GROUND-WATER SAMPLES FROM MONITORING WELLS

Parameter Group	Container Size & Type	Field Preparation	Chemical Preservation	Refrigeration at 4°C using Metal Cooler and 2 or 3 Ice Packs
DDT, DDD, DDE	One 1-quart glass bottle, narrow neck w/Teflon®-lined cap	Unfiltered	None	Yes

® Teflon is a registered trademark of E. I. DuPont de Nemours and Co., Inc., Wilmington, DE. Use of trademarked name does not imply endorsement by the US Army, but is intended only to assist in identification of a specific product.

TABLE G-2. ANALYTICAL METHODS

Parameter	Methodology*
DDT	EPA 608
DDD	EPA 608
DDE	EPA 608

\* "Method of Organic Chemical Analysis of Municipal and Industrial Wastewater," EPA 600/4-82-057, July 1982

4. QUALITY ASSURANCE. Quality assurance will be performed using the procedures outlined in the Manual for the Certification of Laboratories Analyzing Drinking Water, Criteria and Procedures, Quality Assurance, EPA-570/9-82-002, October 1982.