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DEFINITION OF CONTAMINATED GROUND-WATER PLUMES AT SELECTED WASTE DISPOSAL SITES NAVAL WEAPONS SUPPORT CENTER, CRANE, INDIANA

by

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PREFACE

This report is the second of six studies performed by personnel of the Engineering Geology and Rock Mechanics Division (EGRMD), Geotechnical Laboratory (GL) of the U. S. Army Engineer Waterways Experiment Station. Funding for this study was authorized by Order for Work and Services-NAVCOMPT Form 2275 (2-81) Number N0016483WR0G185 dated 17 May 1983 and amended 9 and 16 September 1983.

The field work was conducted during the periods 7 June 1983 to 11 October 1983. Data reduction was performed from October 1983 to April 1984 and report preparation was accomplished during this same period. The drilling was performed by the Exploration Group (EG), GL, under the supervision of Mr. Joseph B. Dunbar, Site Characterization Unit (SCU), Engineering Geology Applications Group (EGAG) of the EGRMD. Mr. Dunbar prepared the report and Mr. Dale L. Barefoot (SCU) assisted in data compilation.

The study was conducted under the direct supervision of Mr. Jerald D. Broughton, Acting Chief, SCU, under the general supervision of Mr. John H. Shamburger, Chief, EGAG, Mr. Mark A. Vispi, Chief, EG, Dr. Don C. Banks, Chief, EGRMD, and Dr. William F. Marcuson III, Chief, GL.

Special acknowledgment is extended to Ms. Cathy Andrews and Mr. Jim Hunsicker of the Naval Weapons Support Center for their assistance during the study.

Commander and Director of WES during the conduct of the study was COL Tilford C. Creel, CE. The Technical Director was Mr. F. R. Brown.

CONTENTS

	Page
PREFACE	1
PART I: INTRODUCTION	3
Background	3
Purpose and Scope	3
PART II: DISPOSAL SITE HYDROGEOLOGY	6
Mustard Gas Burial Grounds	6
Ammunition Burning Grounds and Old Burning Pit	11
Pest Control Area	11
PART III: GROUND-WATER CONTAMINATION LIMITS	19
Mustard Gas Burial Grounds	19
Ammunition Burning Grounds	19
Old Burning Pit	21
Pest Control Area	26
PART IV: CONCLUSIONS AND RECOMMENDATIONS	28
Conclusions	28
Recommendations	28
BIBLIOGRAPHY	29
APPENDIX A: FIELD BORING LOGS	A1
APPENDIX B: GRAPHIC FIELD LOGS	B1
APPENDIX C: WELL COMPLETION DIAGRAMS	C1
APPENDIX D: GROUND-WATER ELEVATIONS	D1
APPENDIX E: CHEMICAL TEST RESULTS OF WATER SAMPLES	E1

PART I: INTRODUCTION

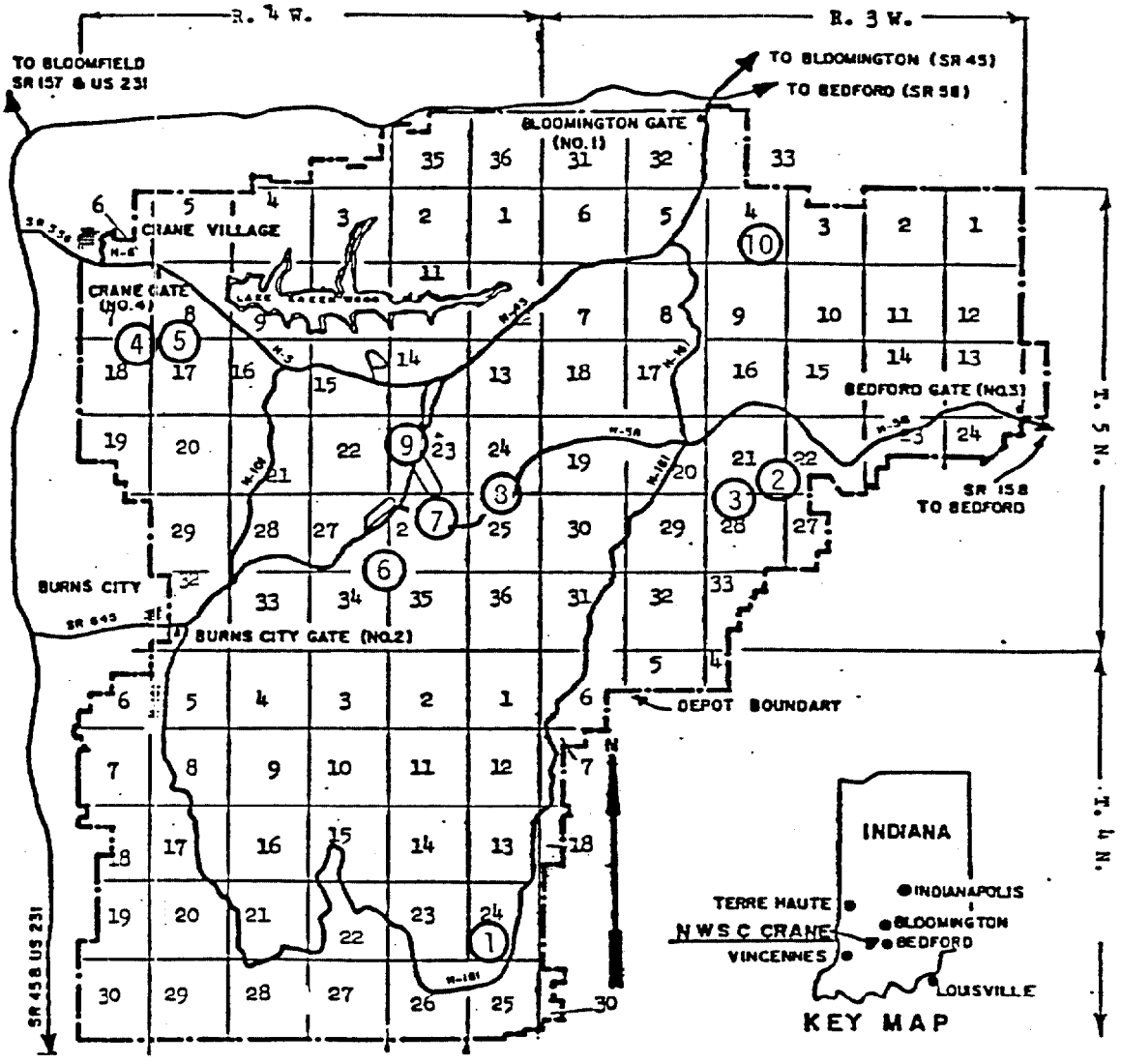
Background

1. The Waterways Experiment Station (WES) installed ten ground-water monitoring networks around hazardous waste disposal sites at the Naval Weapons Support Center (NWSC) during the period from August 1981 to December 1981 (Figure 1). The results from this work were presented in the WES draft report "Hydrogeological Investigation of Waste Disposal Sites at the Naval Weapons Support Center, Crane, Indiana" (Dunbar 1982). Ground-water contamination was detected at three waste disposal sites and the NWSC contracted the WES to define the horizontal limits of ground-water contamination at each disposal site. To define the horizontal limits of the contaminated ground-water plumes, the WES installed additional monitoring wells at the Mustard Gas Burial Grounds (MGBG), the Ammunition Burning Grounds (ABG), and the Old Burning Pit (OBP) during the period from October to December 1982 and January to February 1983. The WES plume definition study was temporarily suspended because chemical test results of ground water from the most recently sampled wells were unavailable. The work performed and results obtained in this plume definition study are presented in the WES draft report "Definition of Contaminated Ground-Water Plumes at Selected Waste Disposal Sites ..." (Dunbar 1983).

2. This report is a continuation of the above work and includes the addition of a fourth site, Pest Control Area (PCA), by the NWSC. The approach to define contamination limits, field exploration, and laboratory testing is presented in the previous WES reports and will be omitted in this report.

Purpose and Scope

3. The purposes of this investigation were (a) complete the definition of horizontal contamination limits at the MGBG, the ABG, and the OBP; and (b) define the horizontal contamination limits near monitoring well WES-9-3-81 at the Pest Control Area (PCA) and determine whether the buried waste disposal tank at the PCA is leaking hazardous chemicals to the ground water. Activities during this investigation included drilling, selected soil sampling, well installation, well sampling, and data analysis including chemical analysis of



LOCATION PLAN

SCALE = GRID LINES FORM MILE SQUARES

Site Number	Site Name
1	Mustard Gas Burial Grounds
2	Dye Burial Grounds
3	Ammunition Burning Grounds
4	McComish Gorge
5	Old Burning Pit
6	Demolition Area and Old Rife Range (included under Site 6 but separate area)
7	Highway 58 Dump Site A
8	Highway 58 Dump Site B
9	Pest Control Area
10	Rockeye Site

Figure 1. Location of Naval Weapons Support Center and Ground-Water Monintoring Networks.

water samples. The results from the chemical analysis are presented to identify the contaminants that exceeded drinking water standards. The Environmental Manager for the NWSC analyzed the chemical results to identify well contamination.

PART II: HYDROGEOLOGY OF DISPOSAL SITE

Mustard Gas Burial Grounds - Site 1

Well and cross-section locations

4. Twelve plume definition wells (WES-1-6-82 to WES-1-17-83) were installed down gradient of the MGBG in previous studies. Ten plume definition wells (WES-1-18-83 to WES-1-27-83) were installed along the western boundary of the MGBG during this study as shown by Figure 2. Cross-section locations for this study and the previous study are shown on Figure 2.

Geology

5. The geology of the MGBG down gradient from the fenced disposal site was defined by cross sections A-A' and B-B' in the previous study, and consists of two to 15 ft of soil (clay, silt, sand, and gravel) underlain by Pennsylvanian age sedimentary rock from the Mansfield formation of the Raccoon Creek Group (Table 1). The Mansfield formation is composed of predominantly interbedded sandstone, shale, and scattered coal seams and is more than 110 ft thick at the MGBG. The sandstone ranges from various shades of brown, to white or buff, to light and dark grey. The sandstone is fine to very fine-grained and contains lenses and thin beds of shale and siltstone. Shale occurrence in the formation increases with a color change to a darker grey. The shale is generally soft, uniform, and the color ranges from grey to dark grey. Several seams of bituminous coal are encountered beneath the MGBG and are brownish black to black, soft, blocky in appearance, and contain less than 1 percent oxidized sulfides, particularly pyrite.

6. Cross section C-C' in Figure 3 is a westward extension of cross section B-B' from the earlier report and runs parallel to the approximate regional dip of the sedimentary beds. The lateral variability of rock types at the MGBG is shown by this section and cross section D-D' in Figure 4, which runs parallel along the ridge face in the second line of borings from the MGBG disposal site. The rock beds at the MGBG are typically less than 1 in. thick but range up to massive beds in excess of 20 ft and consist of alternating shale, siltstone, and sandstone. Coal underlying the MGBG is in discontinuous seams of less than 1 in. thick to discontinuous beds 1 to 2 ft thick as shown by Figure 4. Boring logs from this study are presented in Appendix A. Appendix B graphically summarizes the lithology.

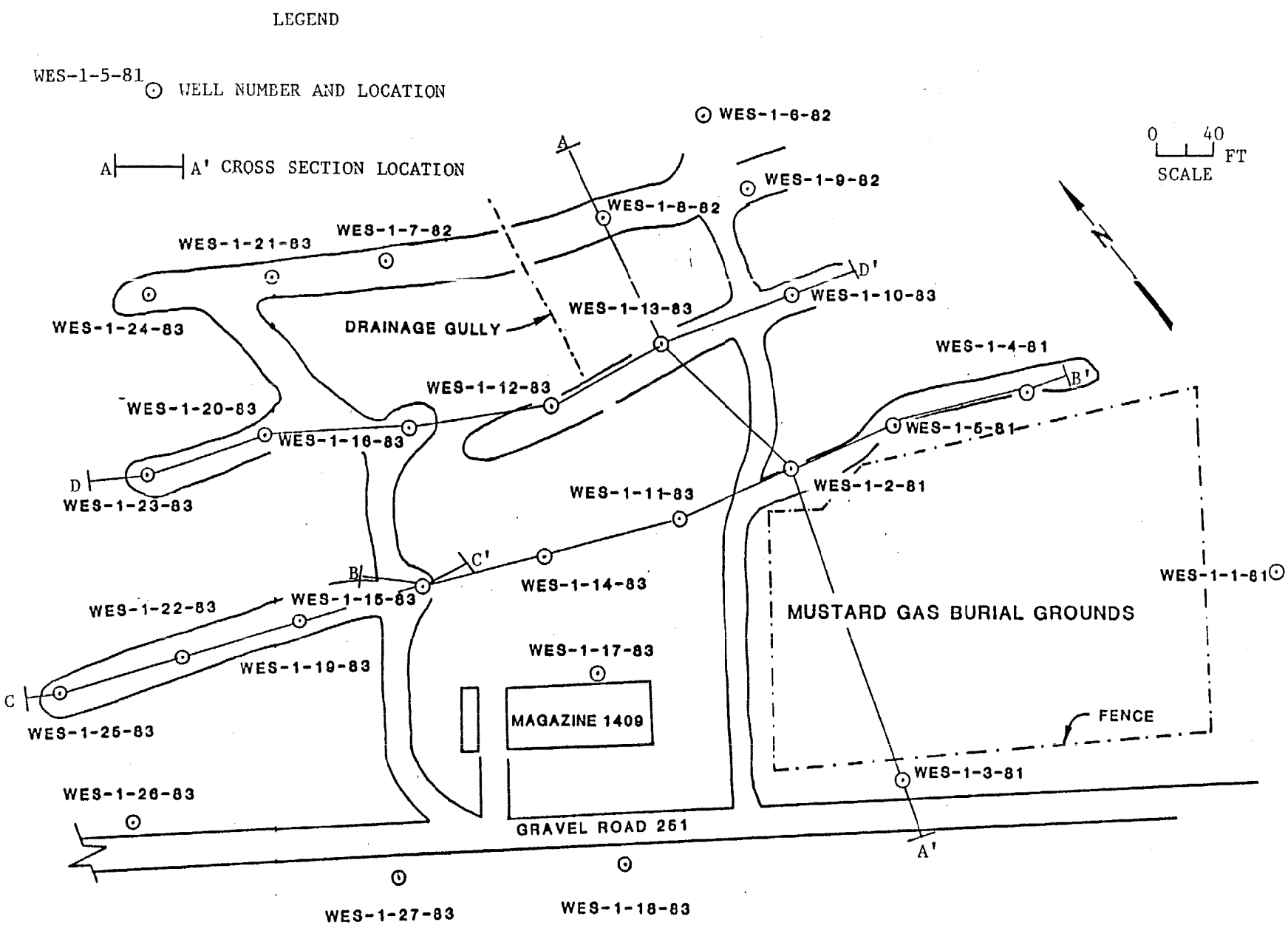


Figure 2. Mustard Gas Burial Grounds Boring and Cross-Section Locations

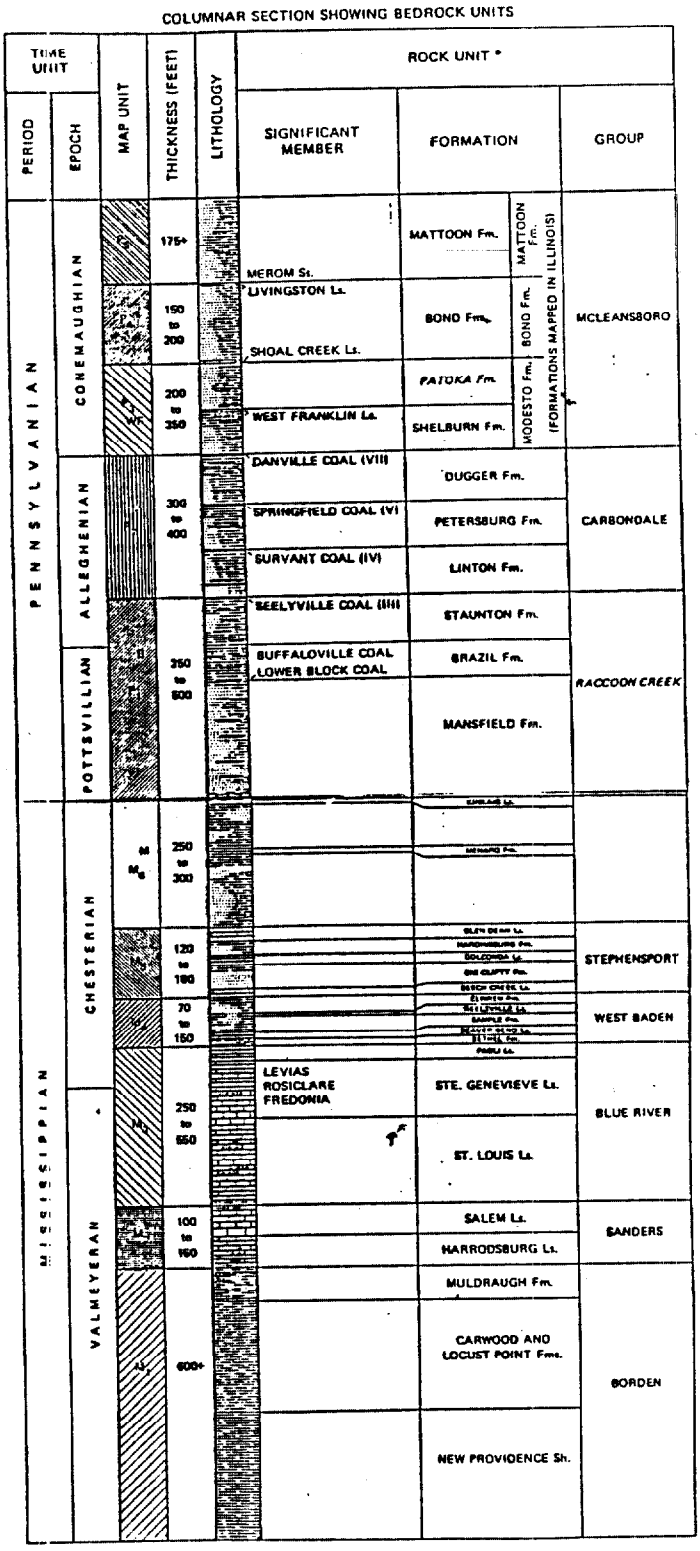


Table 1. Stratigraphy of Naval Weapons Support Center

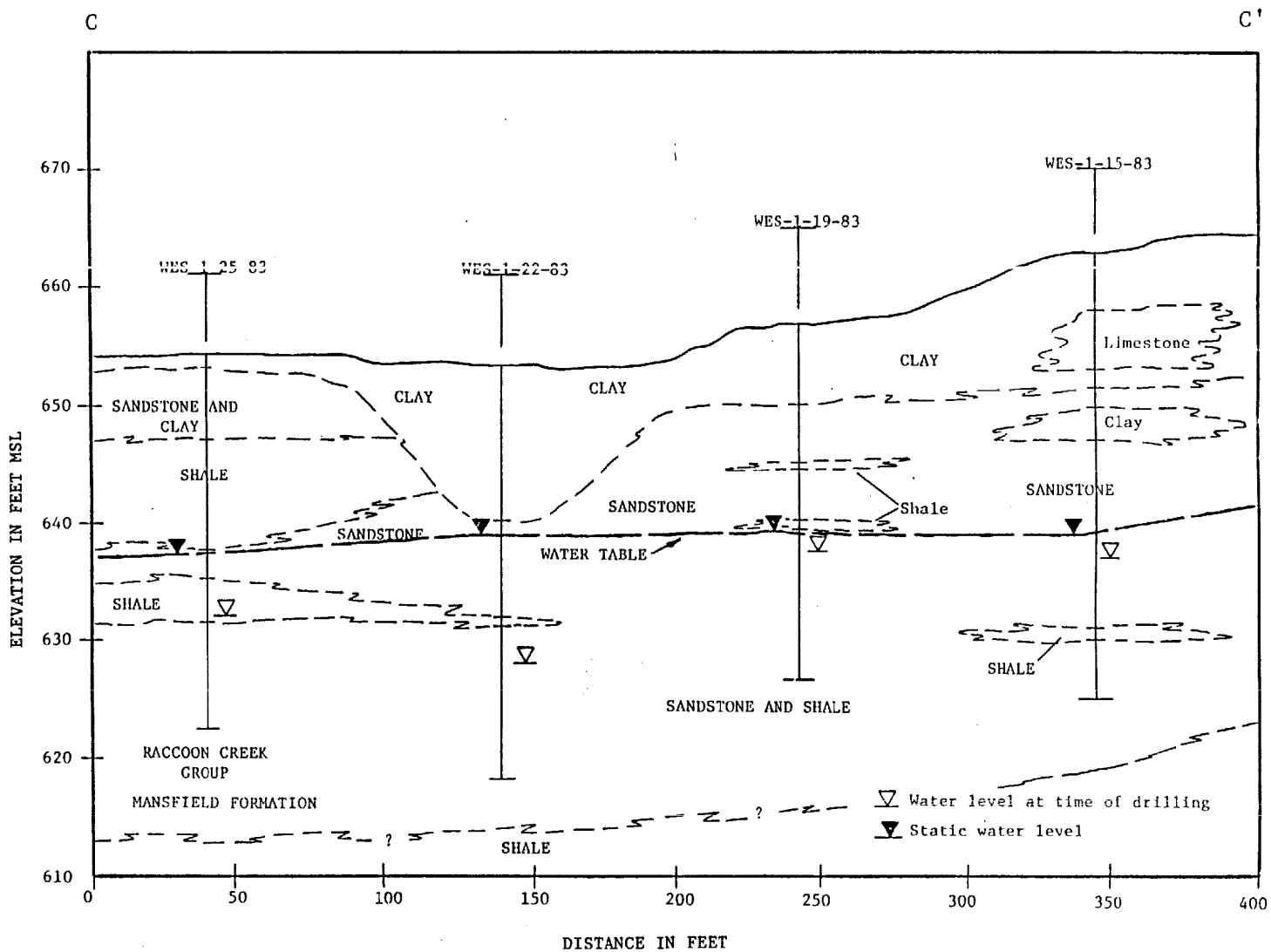


Figure 3. Mustard Gas Burial Grounds Geological Cross Section C-C'

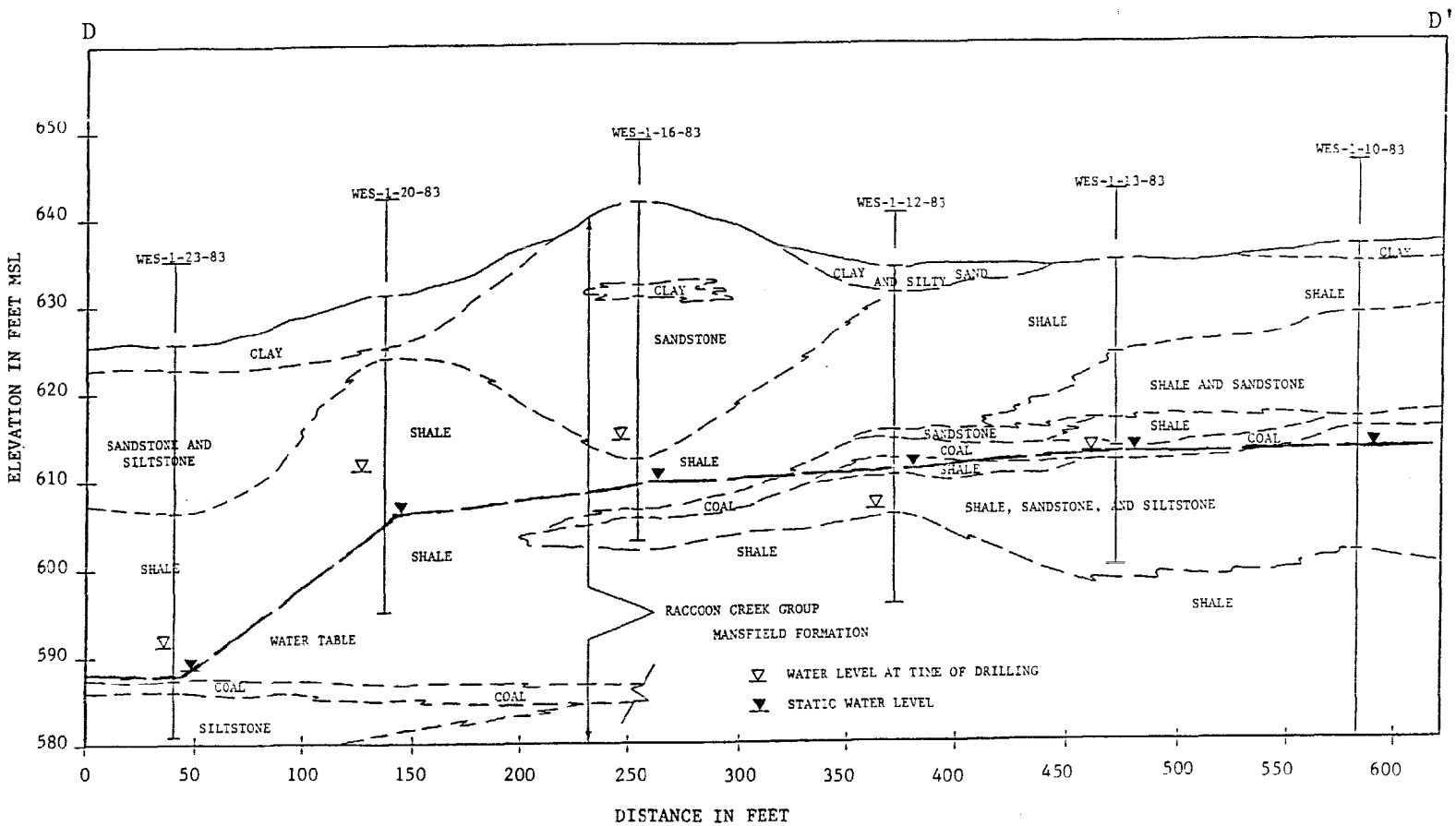


Figure 4. Mustard Gas Burial Grounds Geological Cross Section D-D'

Ground water

7. Ground-water flow at the MGBG is through fractures in the sedimentary rock. The water table averages 15.5 ft below ground surface. The ten additional monitoring wells installed for this study does not change previous findings. The ground-water contour map in Figure 5 shows flow towards the north and northwest with gradients steepest at the ridge face. Well completion diagrams and ground-water measurements are presented in Appendices C and D, respectively.

Ammunition Burning Grounds - Site 3 and Old Burning Pit - Site 5

8. Work at the ABG and OBP was contingent on confirmatory chemical test results of water samples from one monitoring well at each disposal site. No additional monitoring wells were installed at either waste disposal site, because water chemistry results did not show the presence of contamination in any monitoring well.

Pest Control Area - Site 9

Well and boring locations

9. Nine wells were installed in two areas in the PCA in 1981 for the ground-water monitoring network (Figure 1). Four monitoring wells were installed west of Building 2189, down gradient from an area reported to have used for a waste disposal site, and three monitoring wells were installed down gradient from a buried waste storage tank in the gravel parking lot adjacent to Highway 349. For the plume definition study the WES installed five monitoring wells (WES-9-10-83 to WES-9-14A-83) to define contamination limits in the vicinity of monitoring well WES-9-3-81. Four borings (WT-1-83 to WT-4-83) were drilled at the buried waste disposal tank to determine whether the tank was leaking hazardous chemicals into the ground water. Monitoring well and boring locations at the PCA are shown in Figure 6.

Waste tank

10. The plume definition study at the PCA was approached in the same manner as outlined in earlier studies conducted at the MGBG, ABG, and OBP. The waste tank study consisted of drilling four borings along the tank perimeter to define the tank site hydrogeology and allow the NWSC to sample ground water.

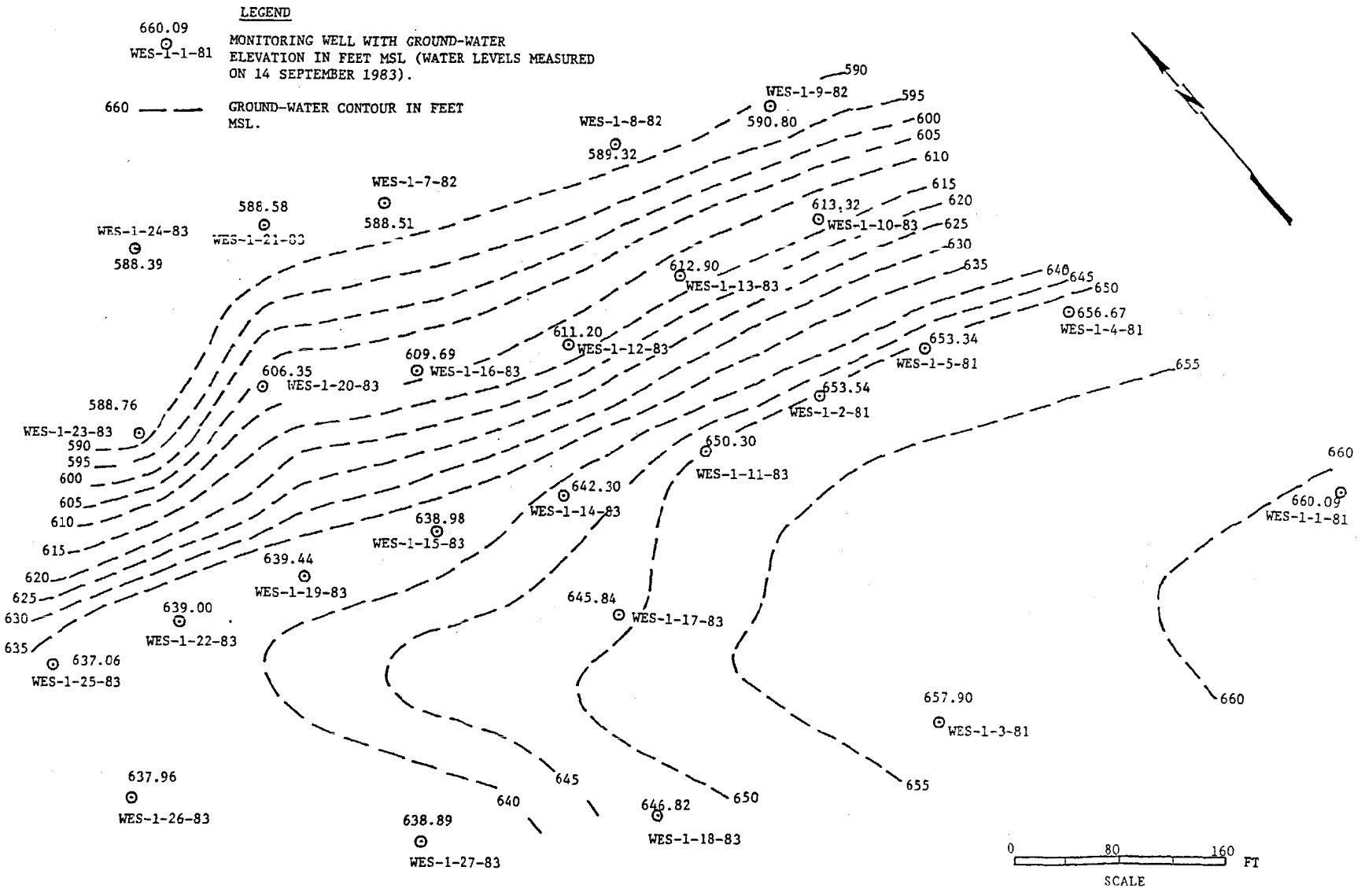


Figure 5. Mustard Gas Burial Grounds Ground-Water Contour Map

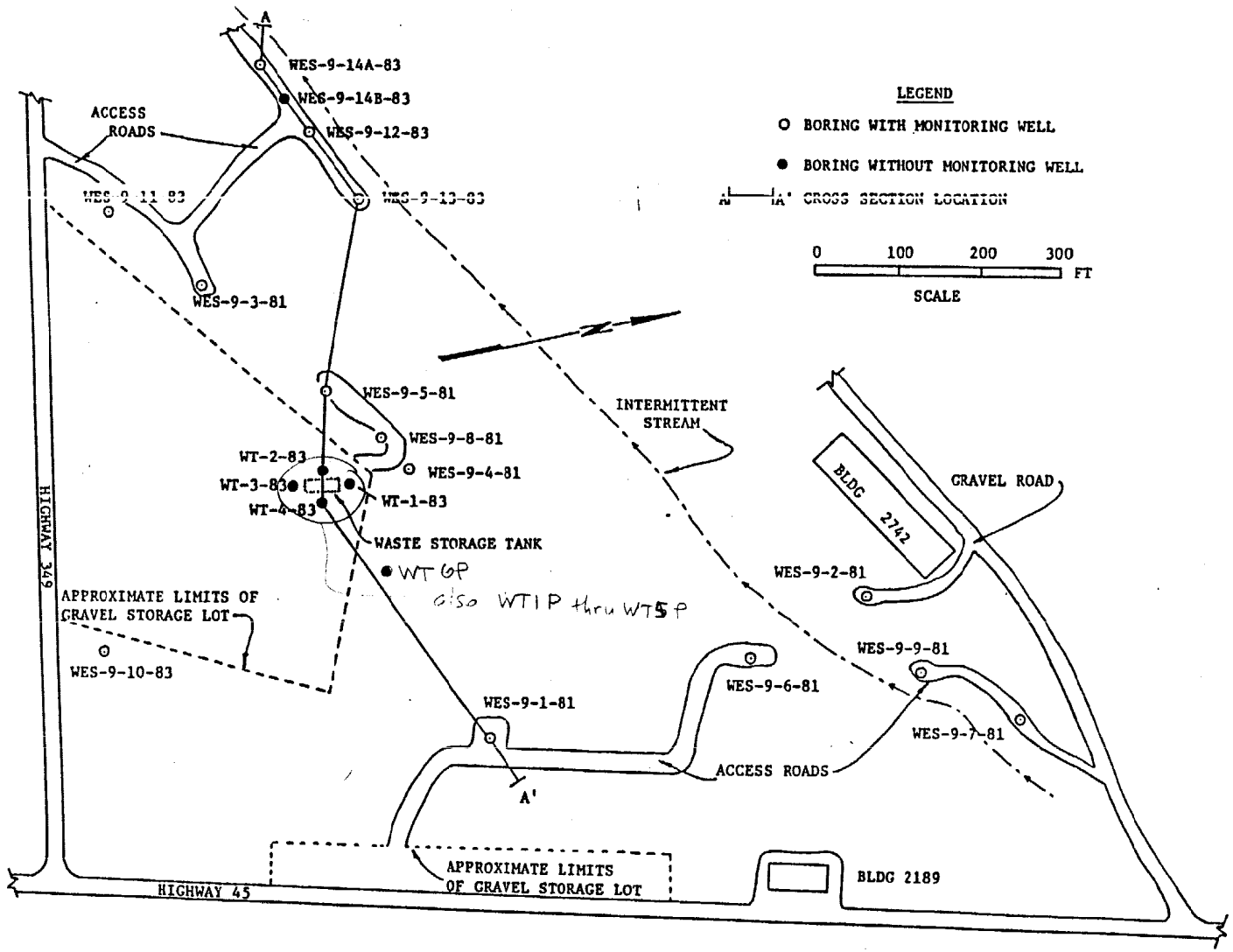


Figure 6. Pest Control Area Boring and Cross-Section Location

The chemical test results from ground-water samples and the comparison between ground-water levels in open borings to fluid levels in the tank, should determine if communication exists between the tank contents and the water table. Ground-water elevations from existing PCA monitoring wells indicated the buried waste tank was partially submerged below the water table.

11. The buried waste tank was installed in the early 1970's. Exact tank specifications and construction details were unknown at the time of the study, particularly the tank length, diameter, and depth to top of tank below ground surface. The tank base was approximately 15 ft below ground surface as determined by a weighted line and the tank length was in excess of 25 ft as determined from the two vent pipes extending above ground surface. The NWSC pumped the contents from the tank prior to drilling the borings (about 1 ft of sludge remained in the bottom of the tank). The four borings were drilled 10 ft from the estimated tank perimeter and consisted of three rock bit borings and one core barrel boring to accurately define tank site lithology. Borings were terminated approximately 10 ft below the water table. Selected soil samples were taken within 5-ft interval in all tank borings and submitted to NWSC for chemical analysis. Borings were grouted several weeks after drilling, following completion of the tank study. The tank was not leaking hazardous chemicals to the ground water. The waste storage tank was excavated and removed in late September 1983 by NWSC personnel after completion of the tank study.

Geology

12. The geology of the PCA consists of 2 to 10 ft of soil (clay and clayey sand) underlain by Pennsylvanian age sedimentary rocks of the Mansfield Formation of the Raccoon Creek Group (Table 1). Sedimentary rocks underlying the PCA consist of interbedded sandstone, clay shale, shale, occasional limestone, and coal. Sandstone and shale are the predominant rock types underlying the PCA. Bedding thickness is variable, ranging from thinly bedded sandstone and shale sequences of less than 1 in., to massive sandstone beds of 10 to 15 ft as encountered in boring WES-9-5-81 or moderately thick dark gray shale beds of 3 to 6 ft as in boring WES-9-1-81. Typically, sandstone at the PCA is brown to light grey, very fine-grained, and primarily composed of quartz sand. A weathered, 1 to 2-ft seam of bituminous coal underlies the surface of the PCA, approximately 15 ft below ground surface at the gravel storage lot. The coal ranges from brownish black to black, blocky in texture, soft, and contains

approximately 1 percent sulfides, particularly pyrite.

13. The geology of the PCA along the approximate regional dip of the sedimentary beds is shown in cross section A-A' in Figure 7. The waste tank is shown in the cross section along with a schematic of the tank, showing the general construction characteristics (tank outline in the cross section is distorted due to the exaggerated horizontal scale of section). The tank foundation lies on the coal bed at the 712-ft msl elevation. Overlying the coal bed is approximately 7.5 ft of highly weathered, thinly bedded sandstone and clay or clay shale. Sandy and gravelly clay soils overlie the waste tank and average 8.5 ft in thickness.

14. The geology of the PCA area downgradient from monitoring well WES-9-3-81 is shown in section A-A'. The sedimentary lithology in this area is similar to that near the waste tank and Building 2189. The subsurface is composed of a thick sequence of thinly bedded sandstones and shales which grade into a dark grey shale at about the 653 ft msl elevation as defined by borings WES-9-14A-83 and WES-9-14B-83. The shale is approximately 6 ft thick and is underlain by a very fine-grained, light grey sandstone at about elevation 647 ft msl. Boring logs from the latest PCA borings are presented in Appendix A. Appendix B graphically summarizes the boring lithology.

Ground water

15. Ground water at the PCA flows through the soil or in rock fractures with the water table averaging 14 ft below ground surface. Ground-water flow is to the west-northwest at the buried waste storage tank and monitoring well WES-9-3-81 as shown by Figure 8. Ground-water elevations range from about 720 ft msl near monitoring wells WES-9-1-81 and WES-9-10-83 to about 695 ft msl near monitoring wells WES-9-12-83 and WES-9-13-83, a difference of more than 25 ft. At the waste tank, the water table is approximately 7.5 ft below ground surface with a rapid decline in elevation down gradient from the waste tank (see Fig. 7). Ground-water information at the tank site was confirmed upon removal of the waste tank, when ground-water seepage was observed in the opening left by the tank. Down gradient from monitoring well WES-9-3-81, the water table is found within a few feet of ground surface and is believed to drop below the stream bed as shown by the cross section. Monitoring well WES-9-14A-83 was dry and is not shown in the ground-water contour map. Problems in determining the depth to the water table were experienced at this location.

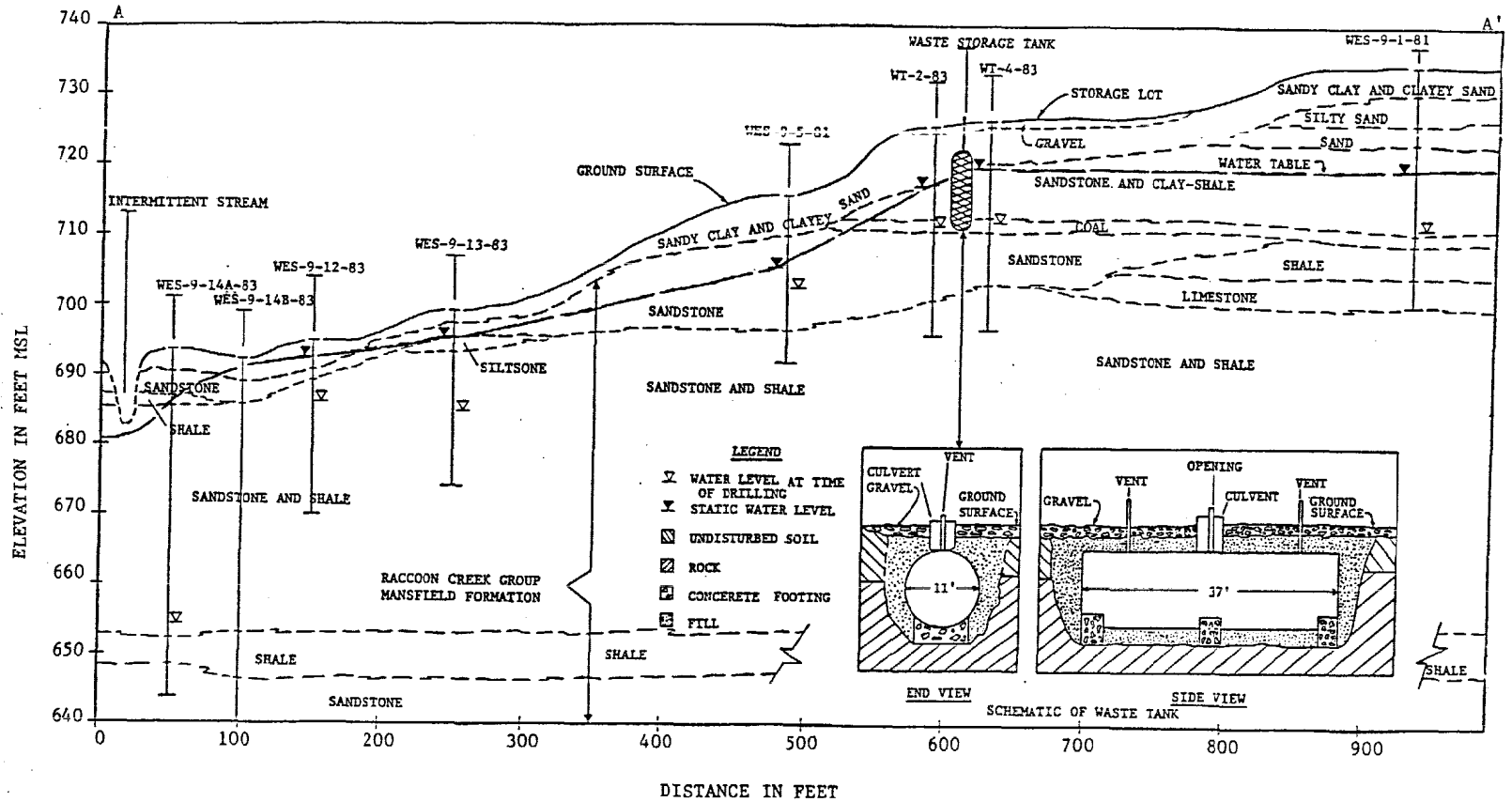


Figure 7. Pest Control Area Geological Cross Section A-A'

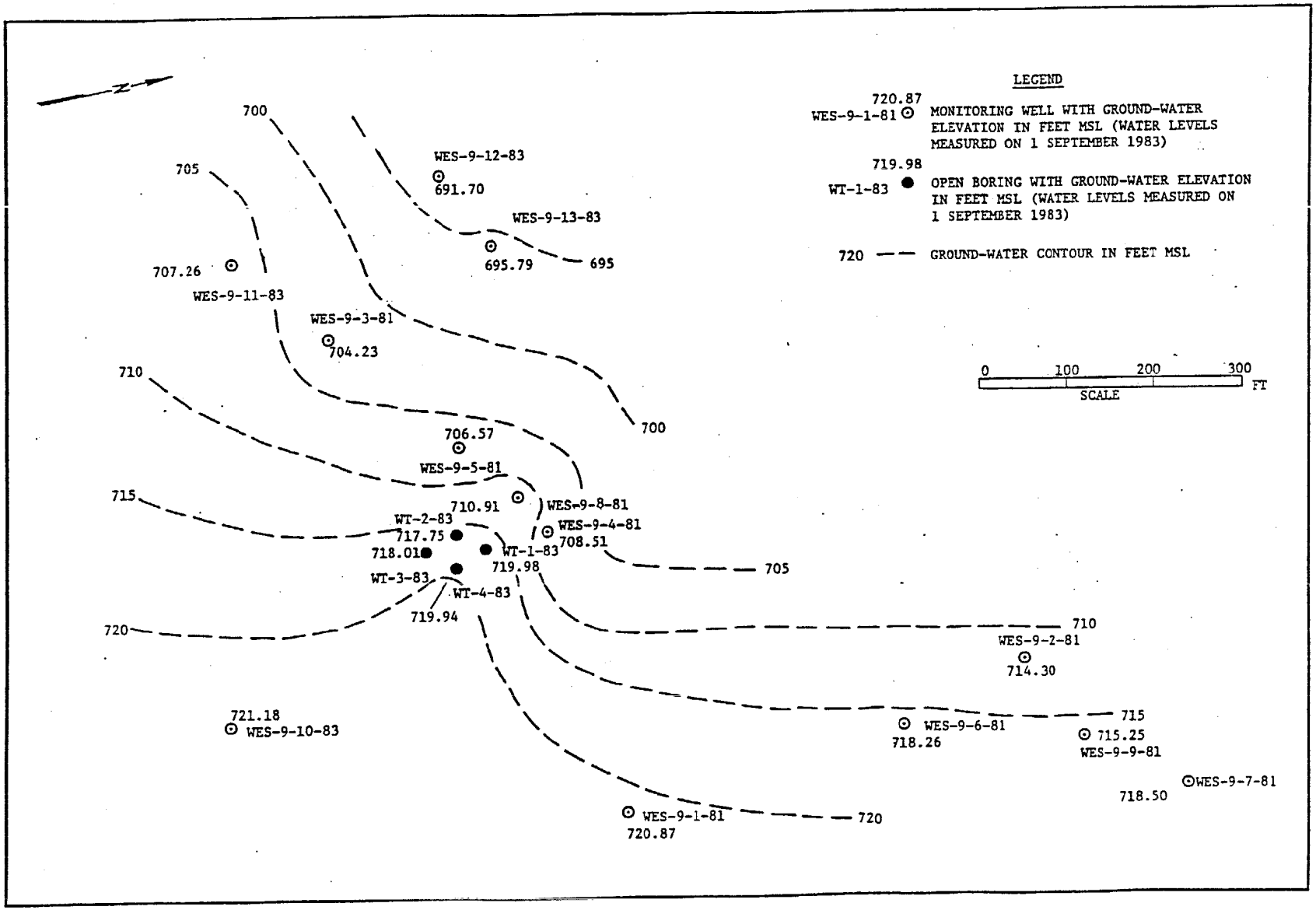


Figure 8. Pest Control Area Ground-Water Contour Map

Rock fractures at monitoring well WES-9-14A-83 and boring WES-9-14B-83 are not developed or contain sufficient clay filling to significantly reduce ground-water movement at this location. Well completion diagrams for the latest PCA monitoring wells are presented in Appendix C. Water level measurements from PCA borings and monitoring wells are presented in Appendix D. Included in Appendix D are waste tank measurements.

PART III: GROUND-WATER CONTAMINATION

Mustard Gas Burial Grounds - Site 1

16. Chemical analysis in previous studies identified nine contaminated monitoring wells at the MGBG from a total of 17 monitoring wells. Ten additional monitoring wells were installed at the MGBG during the latest phase of the plume definition study. Chemical analysis identified contamination in three additional wells for a total of 12 contaminated monitoring wells at the MGBG. Ten compounds were identified with concentrations exceeding the 50 parts per billion (ppb) limit: (1) 1, 2-dichloroethane, (2) 1, 1, 2-trichloroethane, (3) 1, 1, 2, 2-tetrachloroethane, (4) chloroform, (5) 1, 1-dichloroethylene, (6) trans-1, 2-dichloroethylene, (7) bromoform, (8) dibromochloromethane, (9) tetrachloroethylene, and (10) trichloroethylene. Monitoring well WES-1-2-81, the original contaminated well, contains the majority of compounds and the highest concentrations from among the 12 contaminated wells. The contaminated ground-water plume at the MGBG is roughly rectangular in shape with an approximate down gradient length of 300 ft (not 450 ft as reported earlier) and a lateral width of approximately 600 ft as shown by Figure 9. The distribution of the contaminated wells indicates the predominant plume migration direction is to the west-northwest rather than due north. The chemical test results from the 10 new wells installed at this disposal site are presented in Appendix E.

Ammunition Burning Grounds - Site 3

17. Contamination limits at the ABG-Little Sulphur Creek disposal site were not defined in the previous study because questionable water sampling procedures were suspected of causing a high trichloroethylene level in monitoring well WES-3-24-83. A second chemical analysis of ground water from WES-3-24-83 identified this well as uncontaminated. Three contaminated monitoring wells were identified by the chemical analysis from 16 monitoring wells installed at this site. Seven compounds were identified with concentrations exceeding the 50 ppb limit: (1) 1, 1, 2, 2-tetrachloroethane, (2) chloroform, (3) 1, 1-dichloroethylene, (4) trans-1, 2-dichloroethylene, (5) methylene chloride, (6) tetrachloroethylene, and (7) trichloroethylene. Monitoring well WES-3-7-81, the

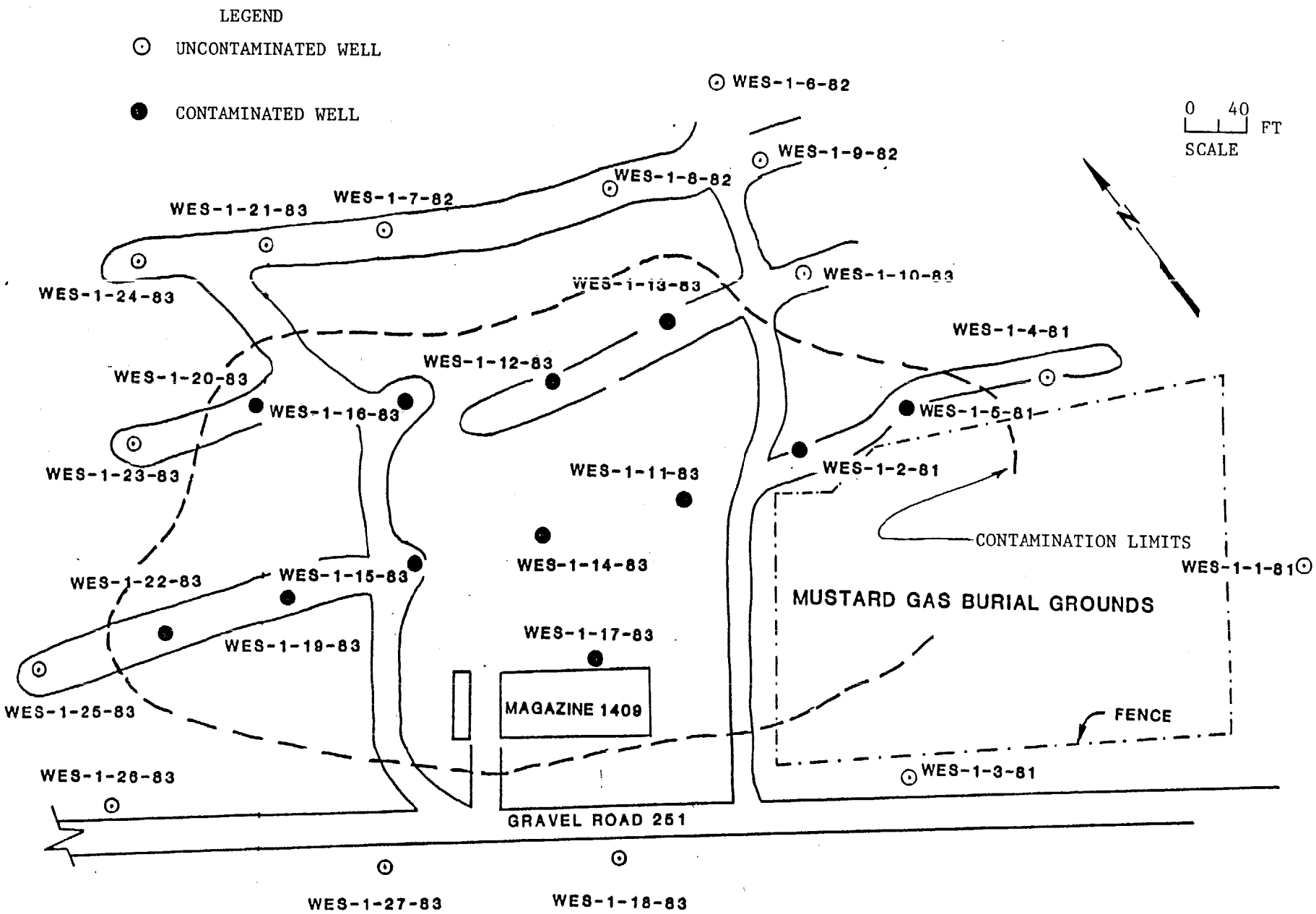


Figure 9. Mustard Gas Burial Grounds Contamination Limits

original contaminated well, contains the majority of compounds and the highest concentrations from the three contaminated wells. The contaminated ground-water plume at the ABG is roughly oval-shaped with a width of approximately 180 ft and a length of approximately 325 ft as shown in Figure 10. The chemical test results for monitoring well WES-3-24-83 are presented in Appendix E.

18. The contaminated ground-water plume coincides with the direction of ground-water flow (see Figure 11). As shown by the ground-water contour map, the water table aquifer at WES-3-7-81 is mounded with only the southern portion of the mound shown. At this well ground water flows towards the east, south, and west. The distribution of contaminated wells indicates the primary flow direction from WES-3-7-81 is to the east and west where the water table gradients are steepest. South of well WES-3-7-81 contaminants were not detected in monitoring wells WES-3-11-82, WES-3-13-82, WES-3-14-82, and WES-3-22-83 where gradients are not as steep.

Old Burning Pit - Site 5

19. Contamination limits at the OBP disposal site were not defined in the previous study because questionable water sampling procedures were suspected of causing a high trichloroethylene level in monitoring well WES-5-17-83. A second chemical analysis of ground water from WES-5-17-83 identified this well as uncontaminated. Two contaminated monitoring wells were identified by the chemical analysis from 19 monitoring wells installed at this site. Three compounds were identified with concentrations exceeding the 50 ppb limit: (1) trans-1, 2-dichloroethylene, (2) chloroform, and (3) trichloroethylene. Monitoring well WES-5-4-81, the original contaminated well, contains all compounds and the highest concentrations of contaminants in the contaminated wells. The contaminated ground-water plume at the OBP is irregular in shape with a width ranging from 90 to 195 ft and a length of approximately 500 ft as shown in Figure 12. The contaminated ground-water plume is moving north-northwest in the direction of ground-water flow (see Figure 13). The chemical test results for monitoring well WES-5-17-83 are presented in Appendix E.

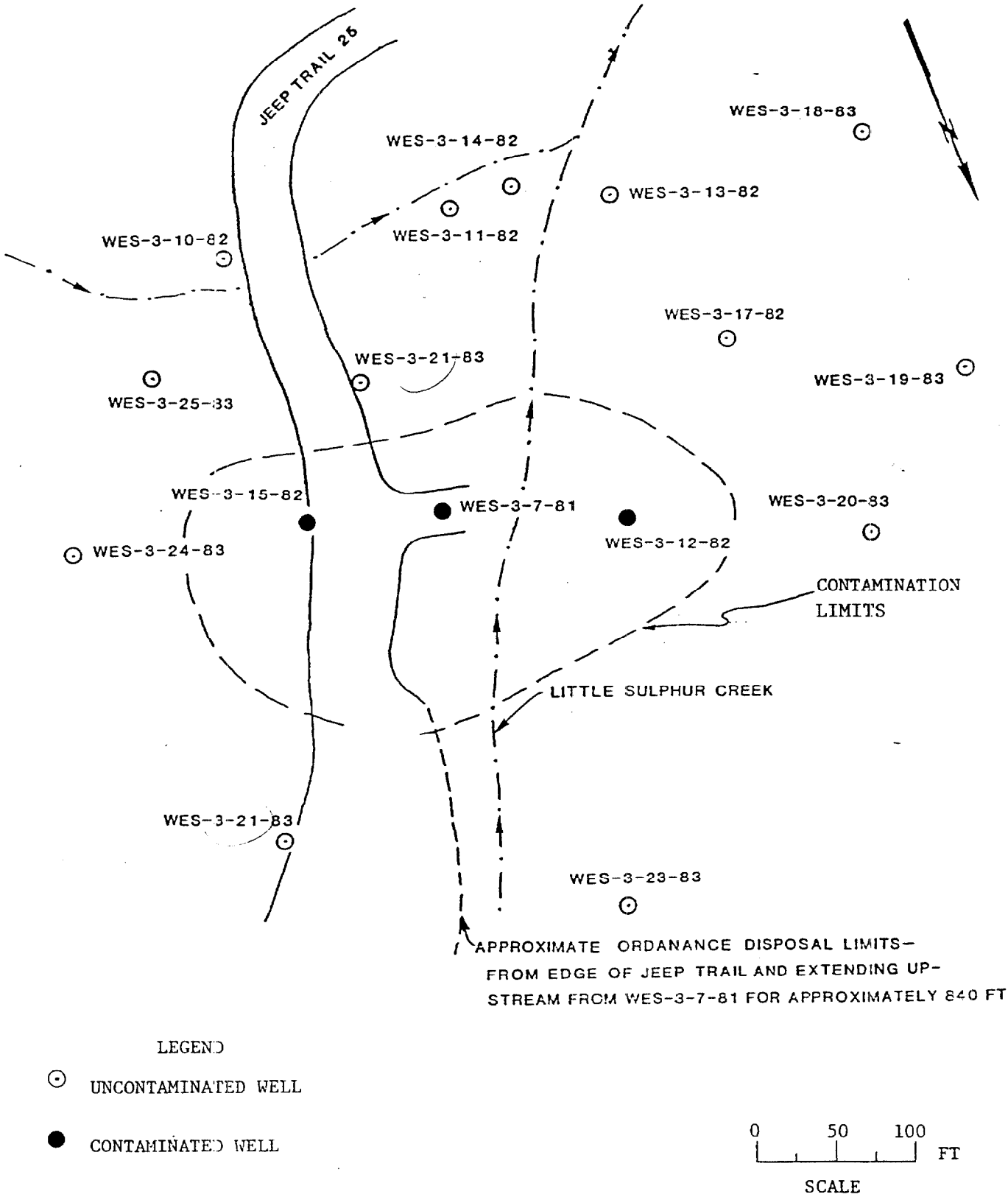


Figure 10. Ammunition Burning Grounds Contamination Limits

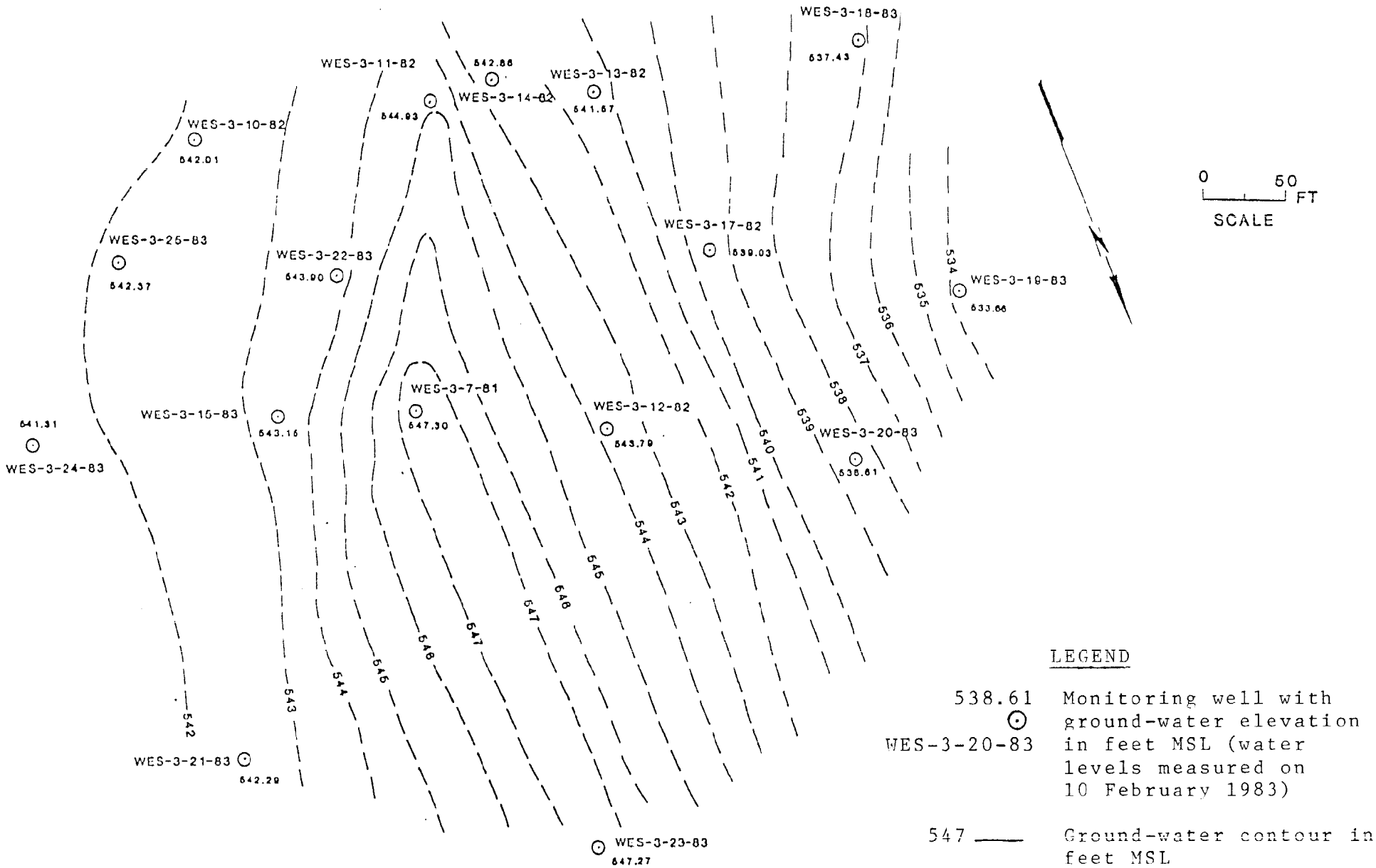


Figure 11. Ammunition Burning Grounds Ground-Water Contour Map

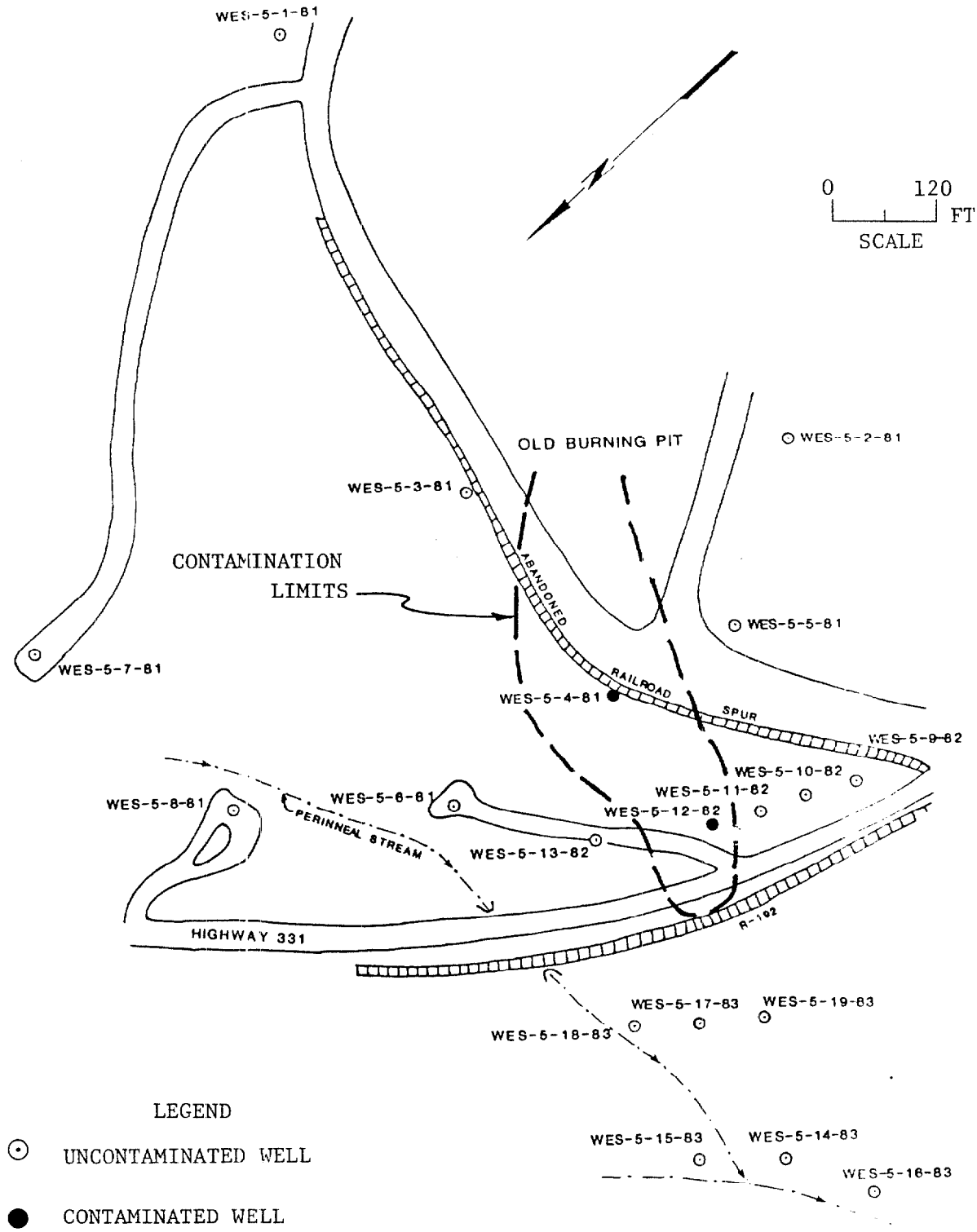


Figure 12. Old Burning Pit Contamination Limits

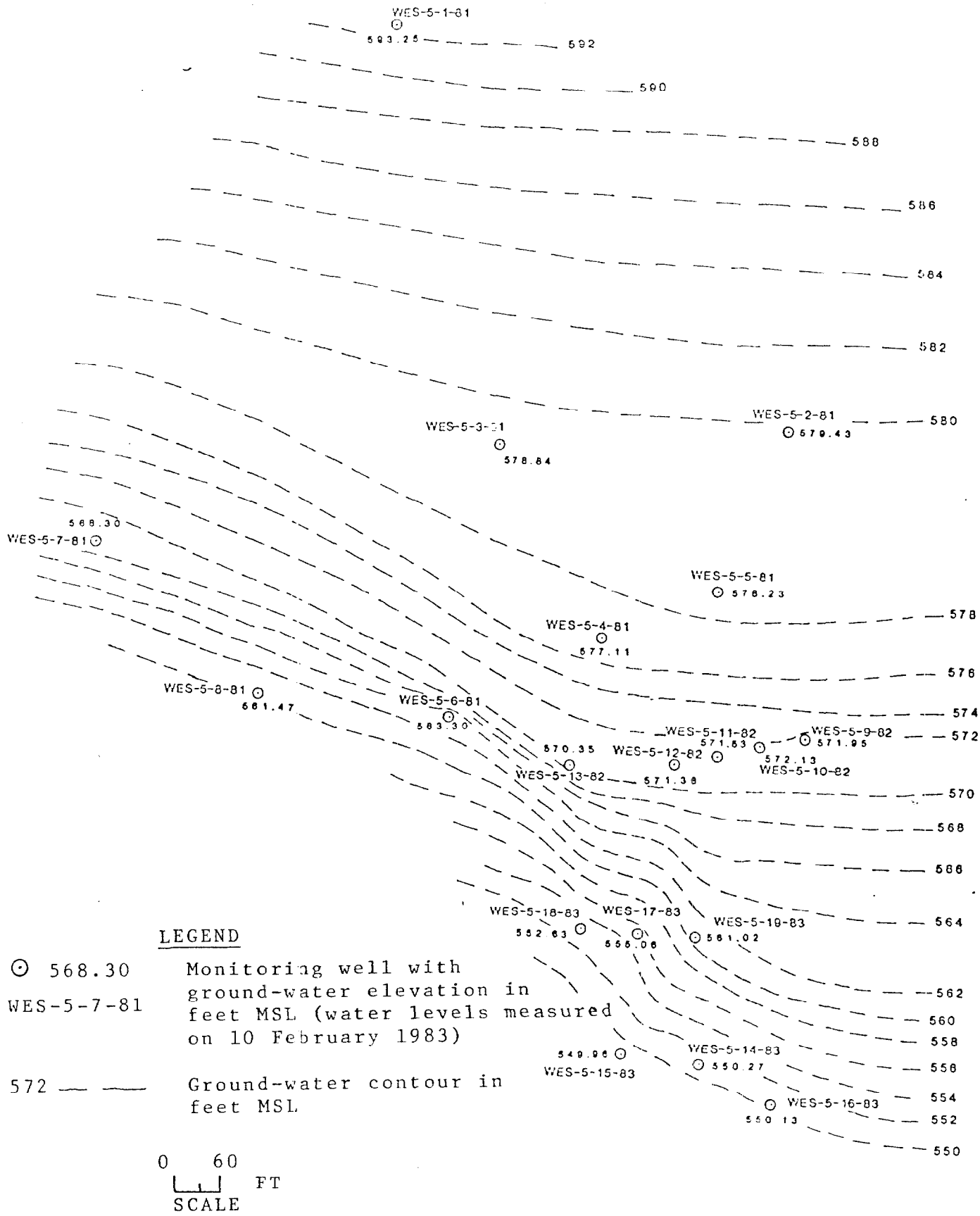


Figure 13. Old Burning Pit Ground-Water Contour Map

Pest Control Area - Site 9

Gravel storage lot

20. Chemical analysis has identified no contamination in the five monitoring wells (WES-9-10-83 to WES-9-14A-83) installed to define the plume limits around WES-9-3-81. The chemical analysis identified two compounds in WES-9-3-81 with concentrations exceeding the 50 ppb limit: trans-1, 2-dichloroethylene and trichloroethylene. The contaminated plume as currently defined in Figure 14 is approximately circular in shape with a diameter of approximately 150 ft. Three additional wells are needed down gradient of monitoring well WES-9-3-81 to define the plume limit with an accuracy of 75 ft (half the well spacing distance between a clean well and a contaminated well) as proposed for the plume study.

Waste tank

21. Water samples from open borings drilled around the waste tank were analyzed for polychlorinated biphenyls (PCBs), heavy metals (lead, copper, chromium, etc.), and volatile halogenated organic compounds (see complete list in Appendix E). PCBs were not detected in waste tank water samples. Heavy metal concentrations were generally low in each boring, but some metal concentrations were slightly above minimum Environmental Protection Agency Water Quality Criteria Guidelines for Human Health. The high heavy metal concentrations in the ground-water sample taken at about 14 ft during drilling in boring WT-2-83 are probably due to the mixing of near-surface contaminated sediment with the ground water. The ground-water sample was obtained from the air-jet, which removes drill cuttings from around the drill site. The sample was taken because of water color and the presence of a slight odor. Analysis for volatiles identified concentration levels slightly above the NWSC 50 ppb limit for trichloroethylene in all sampled borings. Although contamination was present in ground-water samples from around the waste tank, monitoring wells down gradient of the tank (WES-9-4-81, WES-9-5-81 and WES-9-8-81) were uncontaminated. Chemical test results from PCA borings and monitoring wells are presented in Appendix E.

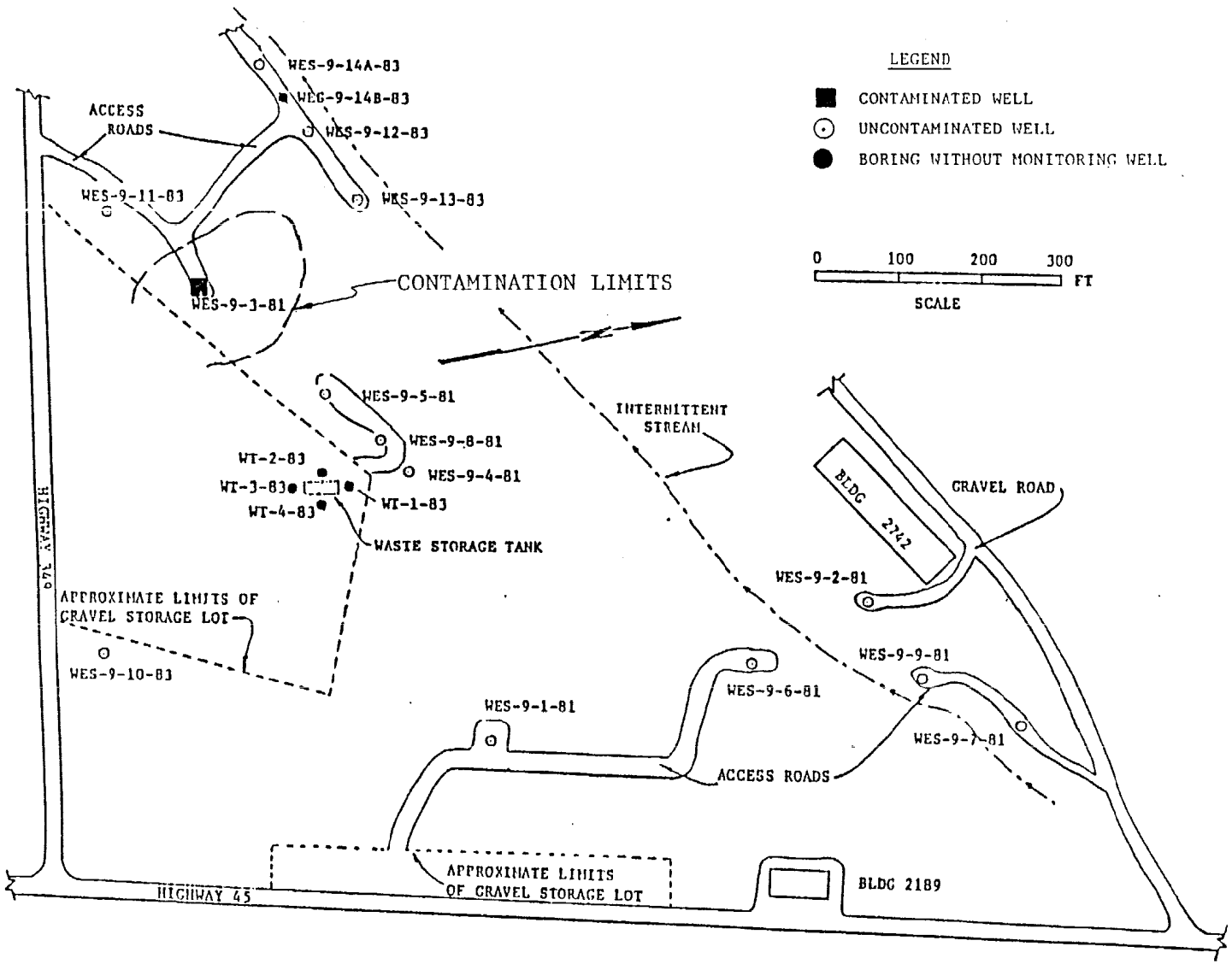


Figure 14. Pest Control Area Contamination Limits

PART V: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

23. Based on the results of this study the following conclusions are made:

(a) The present horizontal limits of ground-water contamination are defined at the MGBG, ABG, OBP and PCA. The accuracy of the plume limits at the PCA are less than the minimum 75-ft resolution requirements proposed for the study.

(b) Chemical analysis of water samples from monitoring wells from the four disposal sites have defined contamination plumes composed of volatile halogenated organic compounds. The MGBG contained the highest number of different halogenated compounds (ten compounds), followed by the ABG (seven compounds), the OBP (three compounds), and the PCA (two compounds). The compounds trans-1, 2-dichloroethylene and trichloroethylene were found at all four disposal sites.

(c) The buried hazardous waste disposal tank at the PCA was not leaking hazardous chemicals into the ground water and later removal of the tank confirmed this. Ground-water contamination at the PCA tank site was probably caused by spills during tank filling or the contents removal process.

Recommendations

24. The following recommendations are made:

(a) Should greater accuracy in defining plume limits be required by the NWSC at the PCA, three additional monitoring wells are required down gradient and midway between WES-9-3-81 and the most distant down gradient line of wells.

(b) Future scheduled sampling of monitoring wells at the ABG and OBP should also include water samples from the streams flowing through the disposal sites to determine if offsite transport of contaminants is occurring.

(c) Surface monitoring should include: one sample location up gradient of the disposal area, two sample locations within the disposal site boundaries, and one sample location down gradient of the site.

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APPENDIX A

FIELD BORING LOGS

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 17 June 1983
Location Mustard Gas Burial Grounds Job No. 441-C150.13CR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 658.40 Boring No. WES-1-18-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	17 Jun	0.0	3.0	0.0	30.5			5-5/8" Rock	Bit		Clay (CL): brown, sandy, damp, slight to moderate cohesion, organic matter.
		3.0	11.0								Sandstone: light brown, soft weathered, very fine-grained, quartz sand.
		11.0	12.5								Sandstone: dark brown, weathered, soft, very fine-grained, quartz sand.
		12.5	13.5								Sandstone: light brown, weathered, soft, very fine-grained, quartz sand.
		13.5	13.7								Shale: light grey, soft.

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BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-1-18-83

SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
		13.7	14.0								Sandstone: light brown, soft, very fine-grained, quartz sand.
		14.0	16.5								Shale: light grey, soft.
		16.5	18.0								Sandstone: dark brown, very fine-grained, soft, wet at 18 ft.
		18.0	19.5								Sandstone and shale: brown, light grey, soft, thinly bedded.
		19.5	19.7								Sandstone: brown, weathered, very fine-grained.
		19.7	21.5								Sandy shale: dark grey, soft, sandy - very fine-grained.

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BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-1-18-83

SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
		21.5	24.0								Sandstone and shale: sandstone grades from dark brown to brown, shale ranges from light grey to dark grey, soft, thinly bedded.
		24.5	30.5								Sandstone: brown, tan, dark brown, soft, very fine-grained, quartz sand.
	18 Jun										Open hole overnight - water level at 14.04 ft. Installed monitoring well.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 3 of 3 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 17 June 1983

Location Mustard Gas Burial Grounds Job No. 441-G150.13GR21/22

Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 656.79 Boring No. WES-1-19-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	17 Jun	0.0	6.5	0.0	30.2			5-5/8" Rock	Bit		Clay (CL): brown, soft, sandy, organic matter, slight to moderate cohesion.
		6.5	11.5								Sandstone: brown, very fine-grained, soft.
		11.5	12.5								Shale: grey, very soft.
		12.5	15.0								Sandstone: light brown, very fine-grained, soft.
		15.0	16.0								Sandstone: light grey - same.
		16.0	16.5								Sandstone: brown - same.
		16.5	17.0								Clay/Shale: grey, very soft, damp.

Sheet 1 of 2 Sheets

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BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-1-19-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		17.0	30.2								Sandstone: brown, grey, dark
											brown, very fine-grained, quartz
											sand, soft, thinly bedded with
											trace of shale.
	18 Jun										Open hole overnight - water level
											at 19.2 ft. Installed monitoring
											well.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 2 of 2 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 20 June 1983
Location Mustard Gas Burial Grounds Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 631.35 Boring No. WES-1-20-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	20 Jun	0.0	6.0	0.0	36.1			5-5/8" Rock	Bit		Clay (CL): brown soft, gravelly, damp.
		6.0	7.0								Sandstone: brown, very fine-grained, soft, weathered.
		7.0	36.1								Shale: grey, light grey, dark grey, soft, uniform, water at 20 ft.
	21 Jun										Hole open overnight - water level at 24.55. Installed monitoring well.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 1 of 1 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 20 June 1983
Location Mustard Gas Burial Grounds Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 603.82 Boring No. WES-1-21-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
	20 Jun	0.0	6.5	0.0	40.5			5-5/8" Rock	Bit		Clay (CL): brown, soft, gravelly, damp.
		6.5	9.5								Clay (CL): grey, soft, uniform.
		9.5	16.5								Clay (CL): brown, soft, uniform.
		16.5	24.5								Shale: grey, soft, uniform.
		24.5	40.5								Shale: light grey, grey, dark grey, soft, water at 28 ft.
	21 Jun										Installed monitoring well.

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Sheet 1 of 1 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 8 July 1983
Location Mustard Gas Burial Grounds Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 653.55 Boring No. WES-1-22-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	8 Jul	0.0	13.0	0.0	35.0			6" Rock Bit			Clay (CL): brown and grey, sandy, soft to stiff.
		13.0	21.5								Sandstone: brown, weathered, very fine-grained, soft, damp at 17.5 (no water).
		21.5	22.0								Siltstone: brown, soft, weathered, damp at 22 ft.
		22.0	32.0								Sandstone: brown, light grey, soft, weathered, very fine-grained, water at 25 ft.
		32.0	35.0								Shaley Sandstone: brown, grey, dark grey, soft, weathered, very fine-grained.

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BORING LOG
FIELD DATA

Project _____ Site _____ Date _____

Location _____ Job No. _____

Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-1-22-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
	9 Jul										Installed monitoring well.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 2 of 2 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 9 July 1983
Location Mustard Gas Burial Grounds Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 625.81 Boring No. WES-1-23-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	9 Jul	0.0	3.0	0.0	40.4			6" Rock Bit			Clay (CL): brown, soft to stiff, sandy.
		3.0	6.5								Sandstone: brown very fine-grained, soft.
		6.5	9.0								Sandstone and clay: very fine-grained, brown sandstone and soft, brown clay, damp.
		9.0	17.5								Siltstone: grey, very soft.
		17.5	19.0								Sandstone: brown, very fine-grained, soft, weathered.
		19.0	38.5								Shale: grey, dark grey, soft, damp spot at 30 ft with slight water.

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Sheet 1 of 2 Sheets

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-1-23-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		38.5	39.5								Coal: black, soft.
		39.5	45.0								Siltstone: light grey, soft.
											Water level overnight: 34 ft.
	11 Jul			40.4	45.0			6" Rock Bit			Drilled 10 ft below water depth.
											Rinsed mud from hole several times.
											Installed monitoring well.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 2 of 2 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 9 July 1983
Location Mustard Gas Burial Grounds Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 600.57 Boring No. WES-1-24-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	9 Jul	0.0	3.5	0.0	30.4			6" Rock Bit			Clay (CL): brown, soft to stiff, sandy.
		3.5	9.0								Sandstone: brown, very fine-grained, soft.
		9.0	17.0								Clay and sandstone: brown, soft, sandy clay with interbedded very fine-grained, soft sandstone.
		17.0	26.5								Shale: grey, dark grey, soft, water at 20 ft.
		26.5	28.0								Siltstone: light grey, soft.
		28.0	30.4								Shale: dark grey, soft.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 1 of 1 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 6 August 1983
Location Mustard Gas Burial Grounds Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 654.16 Boring No. WES-1-25-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	6 Aug	0.0	1.0	0.0	32.0			6" Rock Bit			Clay (CL): brown, soft, sandy, dry.
		1.0	7.0								Sandstone and clay: brown, grey, very weathered, thinly bedded, very fine-grained.
		7.0	16.5								Shale: brown, grey (15.5-16.5) soft, weathered, thinly bedded.
		16.5	19.0								Sandstone: brown, light grey, thinly bedded, soft, very fine-grained.
		19.0	21.8								Shale: brown and grey, soft.
		21.8	32.0								Sandstone and shale: brown, grey,

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BORING LOG
FIELD DATA

Project _____ Site _____ Date _____

Location _____ Job No. _____

Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-1-25-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
											dark grey, thinly bedded, very fine-
											grained, soft, water at 22 ft.
	6 Aug										Installed monitoring well.

Sheet 2 of 2 Sheets

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 6 August 1983
Location Mustard Gas Burial Grounds Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 670.21 Boring No. WES-1-26-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	6 Aug	0.0	4.0	0.0	55.0			6" Rock Bit			Sandy clay (CL): brown, soft, dry.
		4.0	15.3								Sandstone: tan, brown, very fine-grained, weathered, thinly bedded with siltstone and clay shale.
		15.3	17.3								Clay shale: brown, soft.
		17.3	21.6								Sandstone and clay shale: brown, grey, thinly bedded, soft, very fine-grained.
		21.6	30.1								Shale: brown, grey, soft, thinly bedded.
		30.1	41.2								Sandstone and shale: light to dark grey, thinly bedded, very

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BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-1-26-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
											fine-grained.
		41.2	45.0								Sandstone: brown, reddish brown,
											soft, very fine-grained. Water at
											45 ft.
		45.0	49.5								Sandstone and shale: brown, light
											to dark grey, thinly bedded, very
											fine-grained, soft.
		49.5	52.0								Shale: grey, dark grey, soft.
		52.0	55.0								Sandstone: dark brown, soft, very
											fine-grained.
	6 Aug										Installed well.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 2 of 2 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 6 August 1983
Location Mustard Gas Burial Grounds Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 659.75 Boring No. WES-1-27-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	6 Aug	0.0	2.3	0.0	25.0			6" Rock Bit			Clay (CL): brown, dark brown, dry, soft, sandy.
		2.3	29.3								Sandstone: brown, tan, very fine-grained, thinly bedded with siltstone and shale, weathered, soft, hard at 23 ft.
	6 Aug			--	30.0			6" Rock Bit			Crooked hole - used guide to straighten and sheared drill rod with bit - moved over 6 in. and drilled alongside existing hole to intersect drill tools.
	9 Aug										Recovered rod and bit except for approximately 2 ft section of rod. Unable to recover small piece.

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BORING LOG
FIELD DATA

Project _____ Site _____ Date _____

Location _____ Job No. _____

Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-1 27-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	10 Aug			0.0	40.0			6" Rock Bit			Moved 10 ft east and drilled another boring. Grouted boring with rod.
		29.3	40.3								Shale: grey, dark grey, thinly bedded with approx 5-10% very fine-grained sandstone, soft to medium, water at 30 ft.
											Installed monitoring well.
	10 Aug										

Sheet 2 of 2 Sheets

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BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 20 July 1983
Location Pest Control - Hazardous Waste Tank Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 726.03 Boring No. WT-1-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Cont	CLASSIFICATION AND REMARKS
1	20 July	0.0	1.5	0.0	8.1	0.0	5.0	5"Folding Auger		*Jar	Gravel: limestone-medium
2		1.5	6.0			5.0	8.1			*Jar	Sandy clay(CL): brown, very fine-grained sand, gravelly (slight), stiff to very stiff.
		6.0	8.1								Sandy clay(CL) and sandstone fragments: brown, reddish brown, very fine-grained sand-sandstone, stiff to very stiff.
	20 July	8.1	30.0	8.1	30.0			6"Rock Bit			Sandstone, coal(water), shale; limestone - See boring log WT-4-83 for details.
	20 July			0.0	1.0			6" Casing			6" Casing to keep hole open to monitor water levels.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 1 of 1 Sheets

* Jar sample given to NWSC for chemical analysis.

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 20 July 1983
Location Pest Control Hazardous Waste Tank Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 725.67 Boring No. WT-2-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Cont.	CLASSIFICATION AND REMARKS
1	20 July	0.0	1.5	0.0	8.6	0.0	5.0	5"Folding Auger		*Jar	Gravel: limestone-medium.
2	20 July	1.5	6.6			5.0	8.6			*Jar	Sandy clay(CL): brown, very fine-grained sand, gravelly (slight), stiff to very stiff.
		6.6	8.6								Sandy clay (CL) and sandstone fragments: see above-sandstone is very fine-grained, weathered, brown,to reddish brown.
		8.6	30.0	8.6	30.0			6"Rock Bit			Sandstone, coal(water at 14.1), shale, limestone, see boring log WT-4-83 for details.
				0.0	1.0			6" Casing			6" Casing to keep hole open to monitor water levels-rinsed mud from hole.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 1 of 2 Sheets

* Jar sample given to NWSC for chemical analysis

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WT-2-83

SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
											Obtained water sample from jet at
											14.1 ft. Sample was black and had
											oily appearance. Water was encoun-
											tered near vicinity of tank base
											(approximately 14-15 ft below
											ground surface).

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 2 of 2 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 21 July 1983
Location Pest Control - Hazardous Waste Tank Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 725.23 Boring No. WT-3-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Cont	CLASSIFICATION AND REMARKS
1	21 Jul	0.0	1.5	0.0	10.6	0.0	5.0	5"Folding Auger		*Jar	Gravel: limestone-medium
2	21 Jul	1.5	10.6			5.0	10.6			*Jar	Sandy clay(CL): brown, damp, very soft, contaminated (slight odor), gravelly.
				10.6	30.0			6"Rock Bit			Sandstone, coal (water), shale, and limestone-See drilling log for boring WT-4-83
	21 Jul			0.0	1.0			6" Casing			6" Casing to keep hole open to monitor water levels

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

* Jar sample given to NWSC for chemical analysis

Sheet 1 of 1 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 21 July 1983
Location Pest Control - Hazardous Waste Tank Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 726.54 Boring No. WT-4-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER		Cont	CLASSIFICATION AND REMARKS
1		0.0	1.5	0.0	6.6	0.0	5.0	5"Folding Auger		*Jar	Gravel: limestone-medium
2		1.5	6.6			5.0	6.6			*Jar	Sandy clay (CL): brown, dark brown,
											very fine-grained sand, gravelly,
											soft to stiff.
				6.6	11.6	6.6	10.7	4x5½"Core Barrel			Run 1-See drilling log on page 2.
				11.6	15.1	11.6	14.3	4x5¼"Core Barrel			Run 2
				15.1	20.7	16.0	20.7	4x5½"Core Barrel			Run 3
				20.7	25.2	20.7	25.2	4x5½"Core Barrel			Run 4
				25.2	25.7	25.2	25.7	4x5½"Core Barrel			Run 5
				25.7	30.7	25.7	30.7	4x5½"Core Barrel			Run 6

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

*Jar sample given to NWSC for chemical analysis.

Hole No. WT-4-83

DRILLING LOG	DIVISION US Navy	INSTALLATION Crane, IN	SHEET 2 OF 4 SHEETS

1. PROJECT NWSC Ground-Water Study	10. SIZE AND TYPE OF BIT 4x5½-in. Diamond
2. LOCATION (Coordinates or Station) Pest Control-Waste Storage Tank	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY CEWES	12. MANUFACTURER'S DESIGNATION OF DRILL Failing
4. HOLE NO. (As shown on drawing title and file number) WT-4-83	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED Two; UNDISTURBED Zero
5. NAME OF DRILLER C. Drake	14. TOTAL NUMBER CORE BOXES Zero
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 21 July 1983; COMPLETED 22 July 1983
7. THICKNESS OF OVERBURDEN 6.6 ft	17. ELEVATION TOP OF HOLE 726.54 ft MSL
8. DEPTH DRILLED INTO ROCK 24.1 ft	18. TOTAL CORE RECOVERY FOR BORING 89.2% %
9. TOTAL DEPTH OF HOLE 30.7 ft	19. SIGNATURE OF INSPECTOR Harold D. Drake

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
720.54	6		See boring log page 1			
719.54	7		fractured Sandstone and clay: brown, reddish brown, rounded to angular, very fine-grained, sandstone lenses interbedded with soft to stiff, sandy clay. Core is very weathered and very brittle. Sandstone is very friable			
718.54	8					WL - Run #1 Began 8:30 Rec 4.1' End 8:57 Loss 0.9' Time 27 min Gain - Drl time 27 min Hyd press 270 PSI Water press - RPM 100 + Drl Action Smooth Water ret Brown Remarks Drilled with water
717.54	9					
716.54	10					
715.54	11		Loss Run 1 RQD= 38%	82%	-	
714.54	12		Sandstone and clay- See above			WL - Run #2 Began 9:20 Rec 2.7' End 9:31 Loss 0.8' Time 11 min Gain - Drl time 11 min Hyd press 180 PSI Water press - RPM 100 + Drl Action Smooth Water ret Brown Remarks
713.54	13					
712.54	14		lignite: black,soft,sandy Loss Coal: black,soft,brittle, with sulfides-little recovery	77.1%	-	
711.54	15		Run 2 RQD= 77.1% Coal: same Loss			
710.54	16					

G FORM 1836 AR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.

Hole No. [illegible]

DRILLING LOG	DIVISION	INSTALLATION	SHEET 3 OF 4 SHEETS

1. PROJECT	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
710.54	16					
709.54	17		Sandstone: light to dark grey with dendritic coal and sulfides. Sandstone changes from a clean, uniform, predominantly quartz sandstone at 18.2 ft to a shaley sandstone. From 18.2 ft sandstone is interbedded with 10% thinly bedded shale. Sandstone is very fine-grained and slightly friable, higher percentage of fines.			Run #3 Begun 10:15 Rec 4.7' End 10:40 Loss 0.9' Time 25 min Gain - Drl time 25 min Hyd press 200 PSI Water press - RPM 100+ Drl Action Smooth Water ret Brown Black Remarks
708.54	18					
707.54	19		closed closed honeycombed			
706.54	20		closed Run 3 RQD= 83.9%	83.9%	-	WL Run #4 Began 11:02 Rec 4.5' End 11:32 Loss - Time 30 min Gain - Drl time 30 min Hyd press 230 PSI Water press - RPM 100+ Drl Action Smooth Water ret Dark Grey Remarks
705.54	21					
704.54	22		Sandstone: same as above			
703.54	23					WL - Run #5 Began 12:52 Rec 0.5' End 1:13 Loss - Time 21 min Gain - Drl time 21 min Hyd press 100 PSI Water press - RPM 100+ Drl Action Rough Water ret Dark Grey Remarks Blocked off
702.54	24		Sandstone and shale: 60 to 70% black, dark grey shale thinly bedded with 30 to 40% grey, very fine-grained sandstone	100%		
701.54	25		Run 4 RQD= 91% Sandstone and Shale	-		
700.54	26		Run 5 RQD= 0.0%			

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PROJECT | HOLE NO.

Hole No. WI-4-83

DRILLING LOG	DIVISION	INSTALLATION	SHEET 4 OF 4 SHEETS

1. PROJECT	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
700.54	26					
			Shale (60-70%) and Sandstone (30-40%): grey and dark grey, very thinly bedded.			
699.54	27					Oil - Run #6 Began 1:40 Rec 5.0' End 2:17 Loss - Time 37 min Gain - Drl time 37 min Hyd press 230 Water press - RPM 100+ Drl Action Smooth Water ret Dark Grey Remarks
698.54	28		Shale: black, soft			
697.54	29		Shale: black, soft			
696.54	30		Shale (50%) and sandstone (50%): grey and dark grey, very thinly bedded	100%	-	
			Run 6 RQD= 90%			

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PROJECT | HOLE NO.

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 18 Aug 1983
Location Pest Control Area Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 727.48 Boring No. WES-9-10-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	18 Aug	0.0	11.6	0.0	11.6			5"Folding Auger			Clay(CL): brown, stiff, slightly damp, thinly bedded, sandy-less than 5% fine to coarse-grained.
	18 Aug	11.6	13.8	11.6	27.0			6"Rock Bit			Sandstone: brown, very fine-grained, soft, weathered.
		13.8	16.0								Sandstone and clay: brown, soft weathered, thinly bedded, very fine-grained.
		16.0	17.3								Siltstone: brown, soft, wet at 16 ft.
		17.3	19.2								Sandstone: brown, soft, very fine-grained.
		19.2	25.8								Shale: dark grey, soft, thinly bedded with sandstone lenses.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 1 of 2 Sheets

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-9-10-83

SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
		25.8	27.0								Sandstone: brown, very fine-grained,
											soft.
	18 Aug										Installed monitoring well.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 2 of 2 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study
Location Pest Control Area
Site Crane, IN
Date 18 Aug 1983
Drill Rig Failing
Inspector J. Dunbar
Operator C. Drake
Job No. 441-G150.13GR21/22
Surface El 715.41
Boring No. WES-9-11-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	18 Aug	0.0	8.6	0.0	8.6			5"Folding Auger			Sandy clay(CL): brown, soft to stiff, thinly bedded, sand content ranges from 20 to 30% and very fine-grained, dry.
	18 Aug			8.6	10.0			6"Rock Bit			Sandstone and Clay: brown, very fine-grained sandstone, weathered, soft, damp-water overnight at 9.1 ft.
	19 Aug	8.6	15.0	10.0	25.0			6"Rock Bit			
		15.0	18.7								Shale and limestone: light and dark grey, soft to very hard, thinly bedded.
		18.7	21.0								Sandstone: brown and grey, very fine-grained, soft.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 1 of 2 Sheets

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-9-11-83

SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
		21.0	25.0								Sandstone, shale, lignite: light to dark grey, black, very thinly bedded, soft.
	19 Aug										Installed monitoring well.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 2 of 2 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 19 Aug 83
Location Pest Control Area Job No. 441-C150.13CR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 694.93 Boring No. WES-9-12-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	19 Aug	0.0	4.6	0.0	4.6			5"Folding Auger			Sandy clay(CL): brown,soft to stiff,
											dry, very fine-grained sand.
	19 Aug			4.6	9.6	4.6	9.6	4x5-1/2"CoreBarrel			Run 1-See boring log for details.
				4.6	9.6			6-3/4"RockBit			Cleanout
	19 Aug			9.6	15.95	9.6	13.95	4x5-1/2"CoreBarrel			Run 2
				9.6	13.95			6-3/4"RockBit			Cleanout
	19 Aug			13.95	18.25	13.95	18.25	4x5-1/2"CoreBarrel			Run 3
				13.95	18.25			6-3/4"RockBit			Cleanout
	19 Aug			18.25	22.90	18.25	22.90	4x5-1/2"CoreBarrel			Run 4
	20 Aug			18.25	20.0			6-3/4"RockBit			Cleanout
	20 Aug			22.90	25.0			4x5-1/2"CoreBarrel			Run 5
	20 Aug										Installed monitoring well after
											blowing water from boring.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Hole No. WES-9-12-83

DRILLING LOG	DIVISION US Navy	INSTALLATION Crane, IN	SHEET 2 OF 4 SHEETS

1. PROJECT: NWSC Ground-Water Study	10. SIZE AND TYPE OF BIT: 4x5-1/2" diamond
2. LOCATION (Coordinates or Station): Pest Control Area	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: CEWES	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
4. HOLE NO. (As shown on drawing title and file number): WES-9-12-83	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED Zero; UNDISTURBED Zero
5. NAME OF DRILLER: C. Drake	14. TOTAL NUMBER CORE BOXES: Zero
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: --
	16. DATE HOLE: STARTED 19 August 83; COMPLETED 20 August 83
7. THICKNESS OF OVERBURDEN: 4.6 ft	17. ELEVATION TOP OF HOLE: 694.93 ft MSL
8. DEPTH DRILLED INTO ROCK: 20.4 ft	18. TOTAL CORE RECOVERY FOR BORING: 100% %
9. TOTAL DEPTH OF HOLE: 25.0 ft	19. SIGNATURE OF INSPECTOR: [illegible]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
690.93	4		See boring log page 1 for details			
689.93	5		-fractured Sandstone: brown, very fine-grained, weathered, soft			
688.93	6		Sandstone and shale: brown to light grey sandstone(50%) and dark grey to black shale (50%), thinly bedded(1/4-1/2"max) and horizontal in attitude, sandstone is very fine-grained and predominantly quartz. Core is weathered and breaks easily			AL Run 1 Began 11:32 Rec 5.0' End 11:50 Loss -- Time 18 min Gain -- Drl time 18 min Hyd press 200 PSI Water press -- RPM 100± Drl Action Smooth ~~Water~~ ret Brown Remarks
687.93	7					
686.93	8		MB - Machine Break Sandstone: light grey, massive, uniform, very fine-grained quartz sandstone, contains trace of lignite (1/2% ranging 1/16"to1/8" in thickness).			
685.93	9		-MB - Machine Break Run 1 RQD=80.0%	100%		
684.93	10		Sandstone: see above			
683.93	11		MB Sandstone and shale: light to dark grey sandstone and dark grey to black shale, very thinly bedded(1/16 to 1/4"thickness) horizontal in altitude, approximately equal proportion of shale and sandstone, breaks occur in shale seams, slight weathering and oxidation.			AL -- Run 2 Began 1:22 Rec 4.35' End 1:37 Loss -- Time 15 min Gain -- Drl time 15 min Hyd press 200 PSI Water press -- RPM 100± Drl Action Smooth Water ret Grey Remarks
682.93	12					
681.93	13					
680.93	14		Run 2 RQD=90.8%	100%	--	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) PROJECT HOLE NO.

Hole No. [illegible]

DRILLING LOG	DIVISION	INSTALLATION	SHEET 3 OF 4 SHEETS

1. PROJECT	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
680.93	14					
679.93	15		Shale and sandstone: same as above- breaks occur in shale			AL Run 3 Began 2:13 Rec 4.3' End 2:27 Loss -- Time 14 min Gain -- Drl time 14 min Hyd press 200 PSI Water press -- RPM 100+ Drl Action Smooth ~~Water~~ ret Grey Remarks
678.93	16					
677.93	17					
676.93	18		Run 3 RQD=58.1%	100%	--	
675.93	19		Shale (40%) and sandstone (60%): same as above			AL Run 4 Began 3:27 Rec 4.7' End 3:58 Loss -- Time 31 min Gain -- Drl time 31 min Hyd press 200 PSI Water press -- RPM 100+ Drl Action Smooth Water ret Grey Remarks
674.93	20					
673.93	21					
672.93	22		machine fractured			
			Run 4 RQD=100%	100%	--	
671.93	23		Sandstone (75%) and shale (25%): same as above			20 August 1983 Water level overnight at 3.35 ft. - Reamed hole to 20 ft with rock bit and water
670.93	24					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.

Hole No. [illegible]

DRILLING LOG	DIVISION	INSTALLATION	SHEET 4 OF 4 SHEETS

1. PROJECT
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number)
5. NAME OF DRILLER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
670.93	24		Sandstone(75%) and shale (25%): same as above			AL Run 5 Began 8:59 Rec 2.1' End 9:05 Loss -- Time 6 min Gain -- Drl time 6 min Hyd press 200 PSI Water press -- RPM 100± Drl Action Smooth Water ret Grey Remarks Drilled with water
669.93	25		Run 5 RQD=100%	100%		

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 20 Aug 1983
Location Pest Control Area Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 699.04 Boring No. WES-9-13-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	20 Aug	0.0	2.3	0.0	2.3			5"Folding Auger			Sandy Clay(CL): brown, soft to stiff, dry, organic matter (roots).
		2.3	3.8	2.3	25.0			6"Rock Bit			Sandstone: brown, very fine-grained, weathered.
		3.8	6.0								Siltstone: light grey, soft.
		6.0	25.0								Sandstone and shale: light to dark grey, very thinly bedded, soft, approximately equal proportions of shale and sandstone, water at 14 ft.
	20 Aug										Installed monitoring well.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 1 of 1 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 22 Aug 1983
Location Pest Control Area Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 693.21 Boring No. WES-9-14A-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	22 Aug	0.0	2.0	0.0	2.0			5"Folding Auger			Sandy clay(CL): brown, soft to stiff, dry, organic matter (roots), very fine-grained sand.
	22 Aug	2.0	3.1	2.0	45.1			6"Rock Bit			Sandstone and clay: brown, soft, thinly bedded, weathered.
		3.1	6.7								Sandstone: light grey, hard, very fine-grained.
		6.7	8.4								Shale: dark grey, soft, uniform.
		8.4	45.1								Sandstone and shale: light grey sandstone and dark grey to black shale, soft, very fine-grained sandstone, thinly bedded.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No.
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-9-14A-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
											Examined hole for water at 10, 15,
											18, 21, 24, 26, 30, 35, 40, and 45
											ft. Will leave boring open for
											several days to see if water appears.
	27 Sep			45.1	50.0			6"Rock Bit			Sandstone(?): no cuttings, drilled
											with water.
	28 Sep										Installed well.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 2 of 2 Sheets

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 23 Aug 1983
Location Pest Control Area Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 692.07 Boring No. WES-9-14B-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	23 Aug	0.0	3.6	0.0	3.6			5"Folding Auger			Sandy clay(CL): brown, soft to stiff, very fine-grained sand, organic matter (roots).
	23 Aug	3.6	6.8	3.6	60.0			6"Rock Bit			Sandstone: light grey, brown(4.7-5.1 ft), very fine-grained,soft,dry.
		6.8	39.3								Sandstone and shale: light grey sandstone and dark grey shale,thinly bedded, very fine-grained sandstone, dry-damp at 18.8, no water; damp at 23.8, no water.
		39.3	46.0								Shale: light and dark grey, soft, sandy.
	24 Aug	46.0	61.7	60.0	99.3			6"Rock Bit			Sandstone: light and dark grey.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-9-14B-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
											very fine-grained, shaley, soft-
											damp at 59-61 ft, no water.
	24 Aug										No water overnight
		61.7	65.5								Shale and sandstone: grey and dark
											grey, soft, very fine-grained, sand-
											stone, very thinly bedded.
		65.5	72.5								Shale: grey, dark grey, soft, damp
											(cuttings"pluging" bit)-no water.
		72.5	75.3								Sandstone and shale: same as above.
		75.3	81.8								Shale: grey, dark grey, soft to
											medium, dry,

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-9-14B-83

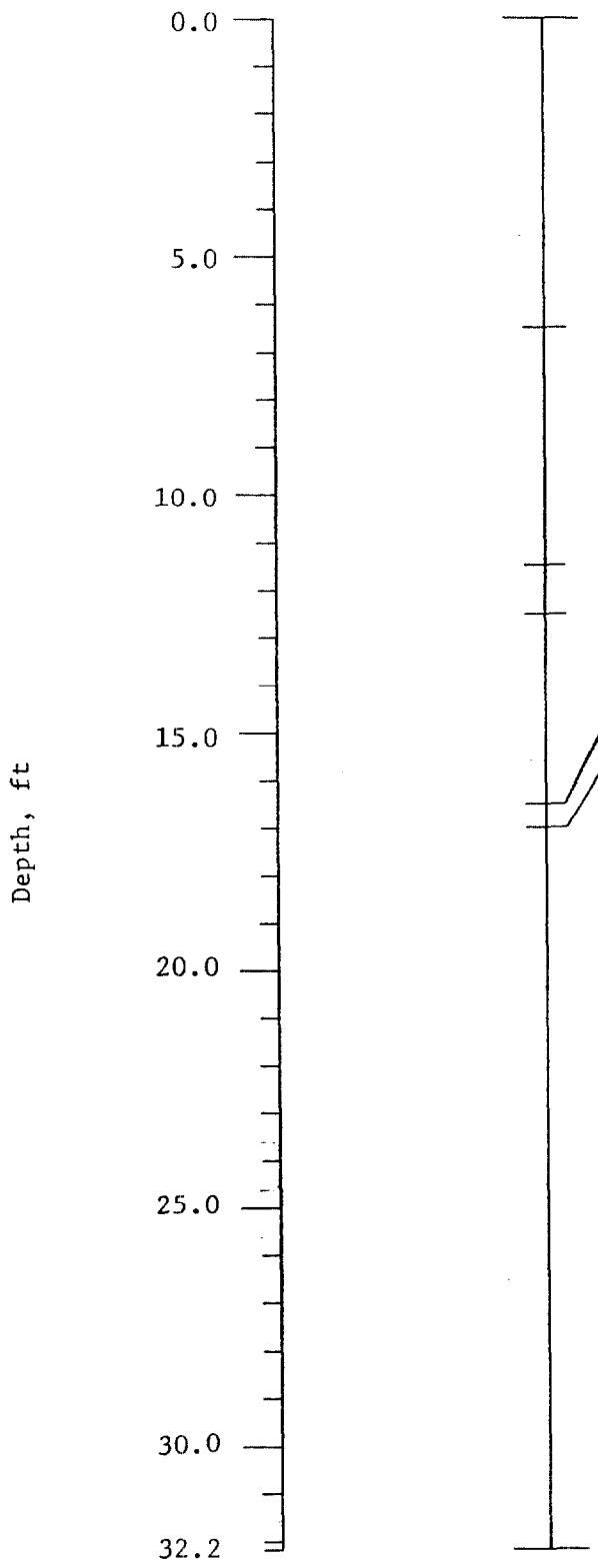
SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
		81.8	87.9								Sandstone and shale: grey, dark grey,
											soft to medium, very thinly bedded,
											contains lignite and siltstone, very
											fine-grained sandstone.
		87.9	95.6								Shale: grey and dark grey, soft.
		95.6	99.3								Sandstone and shale: light to dark
											grey, soft, thinly bedded, very
											fine-grained sandstone.
											Checked for water every 5 ft between
											5 and 50 ft, checked every 10 ft
											between 50 and 99 ft - no water.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 3 of 3 Sheets

APPENDIX B

GRAPHIC FIELD LOGS



656.79 ft MSL

Clay (CL): brown, soft, sandy, organic matter, slight to moderate cohesion.

Sandstone: brown, very fine-grained, quartz sand, soft.

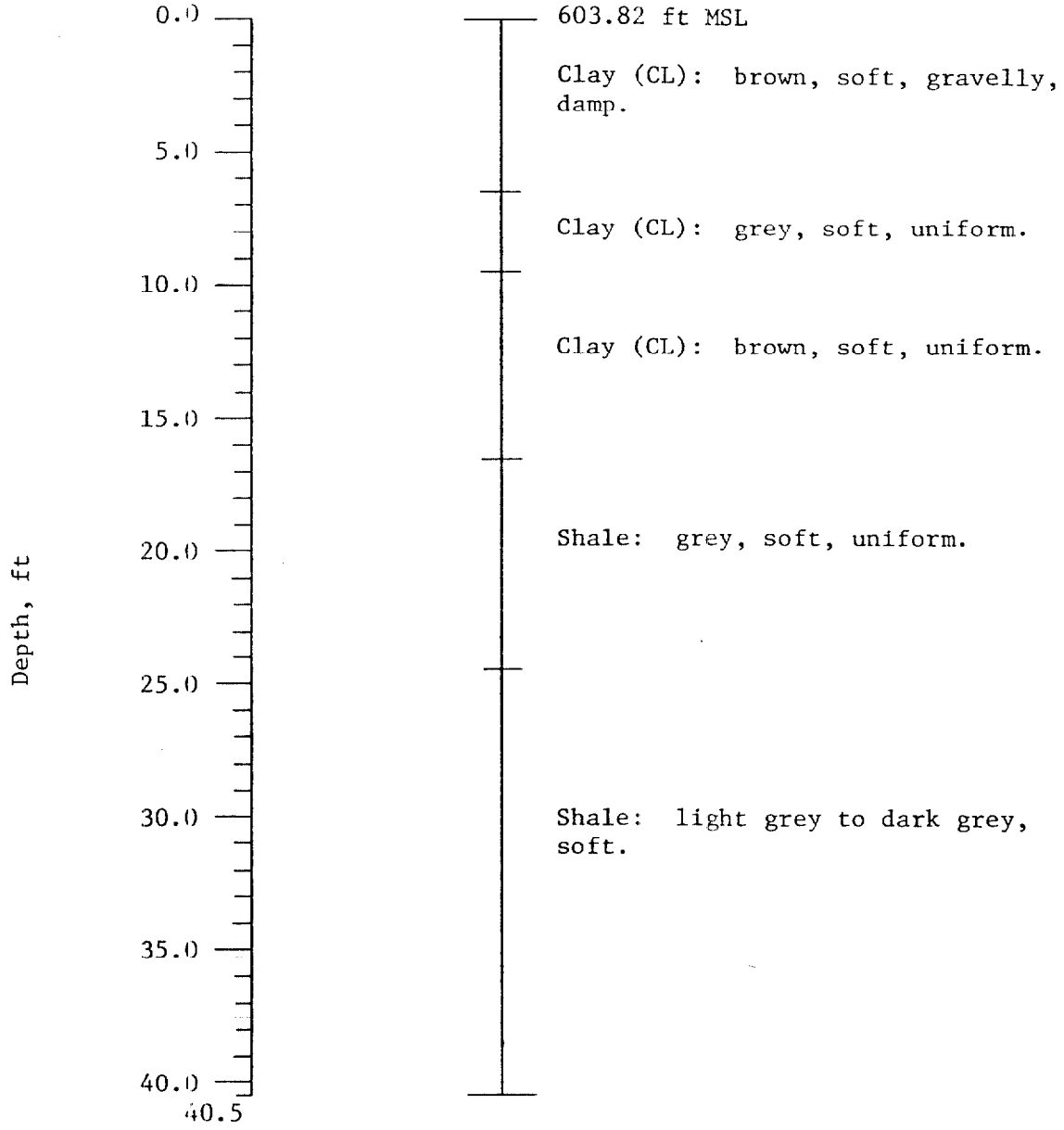
Shale: grey, very soft

Sandstone: light brown, brown, and grey, very fine-grained, soft.

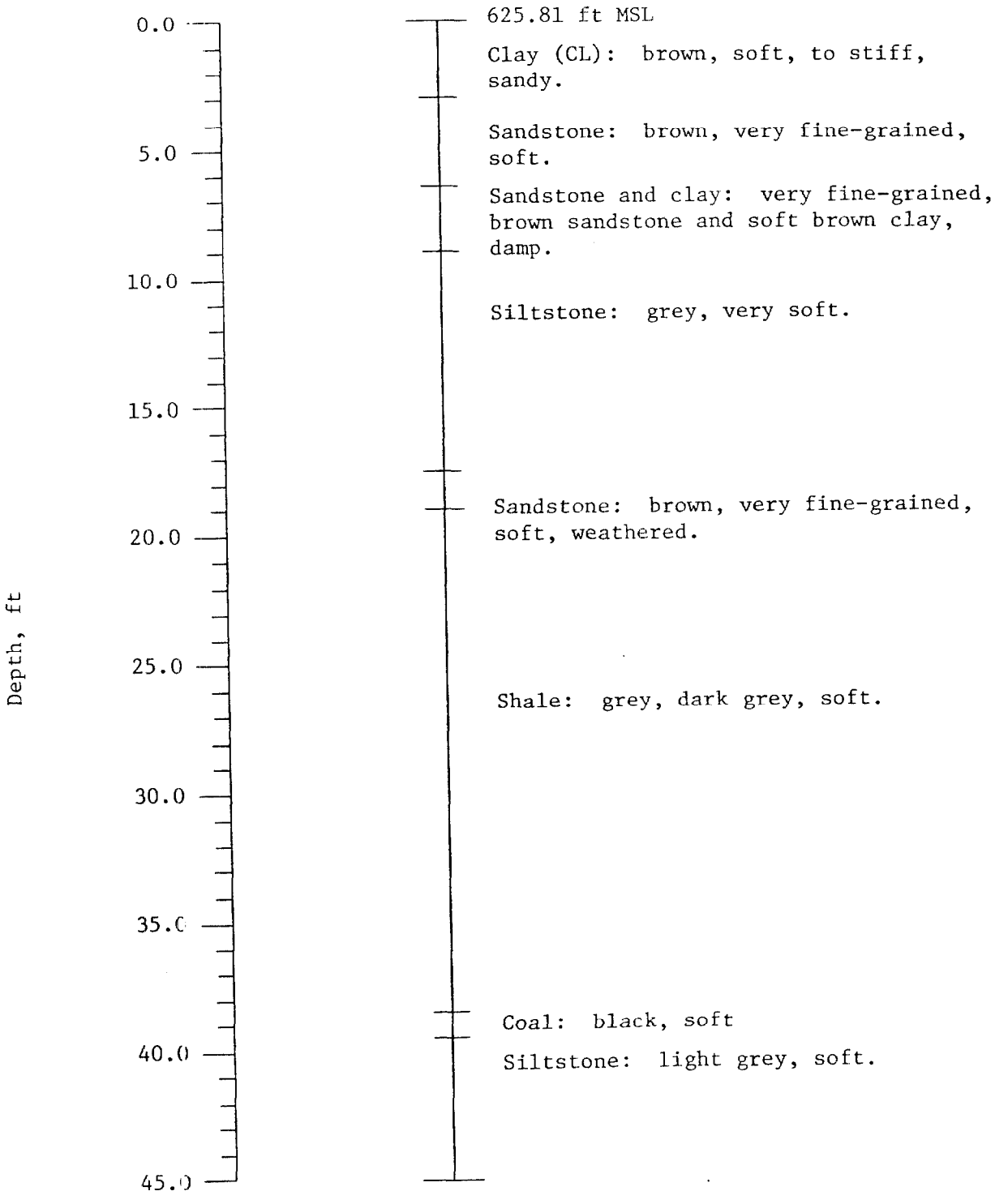
Clay/Shale: grey, very soft, damp.

Sandstone: brown, grey, dark brown, very fine-grained, quartz sand, soft, thinly bedded with trace of shale.

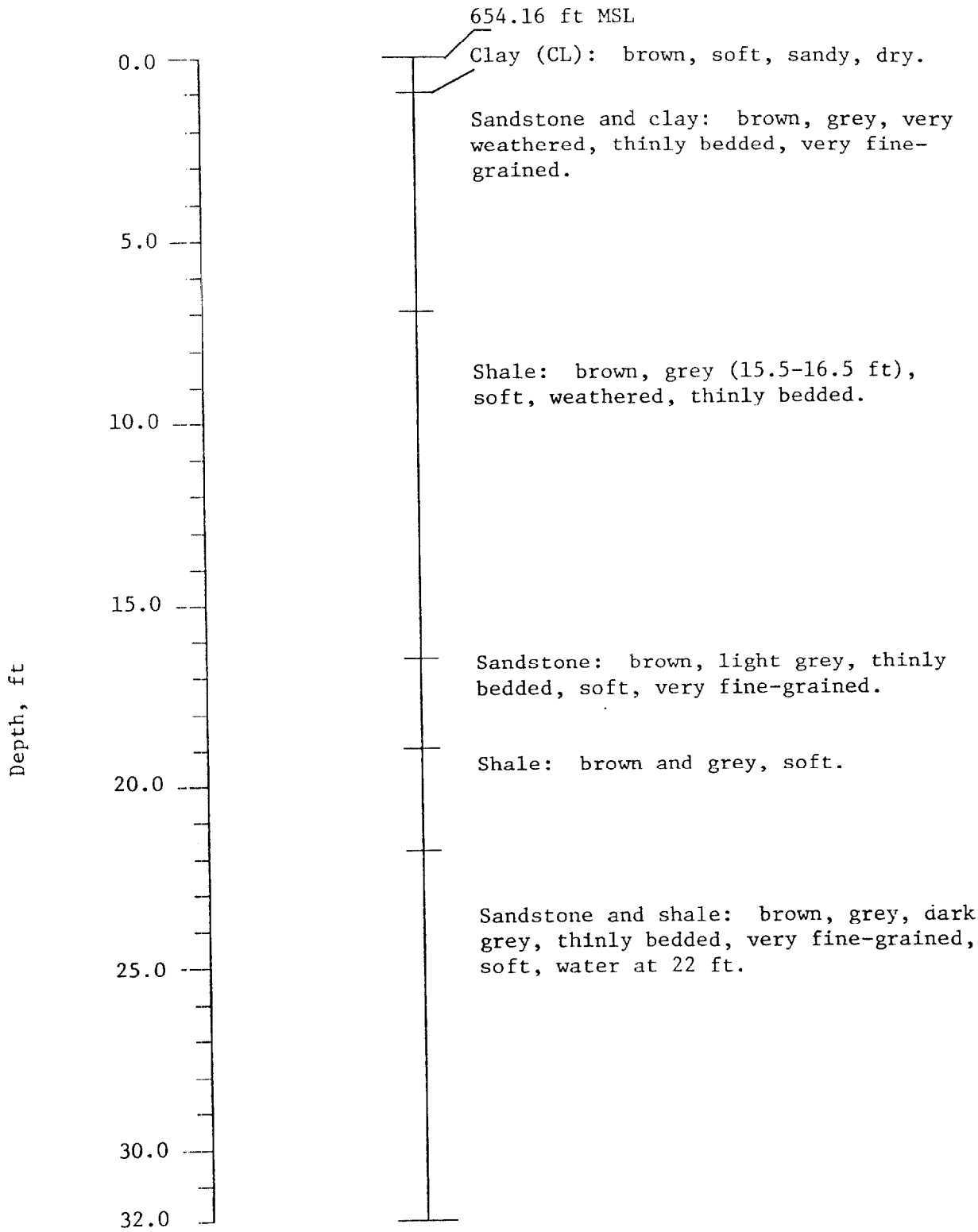
NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-19-83



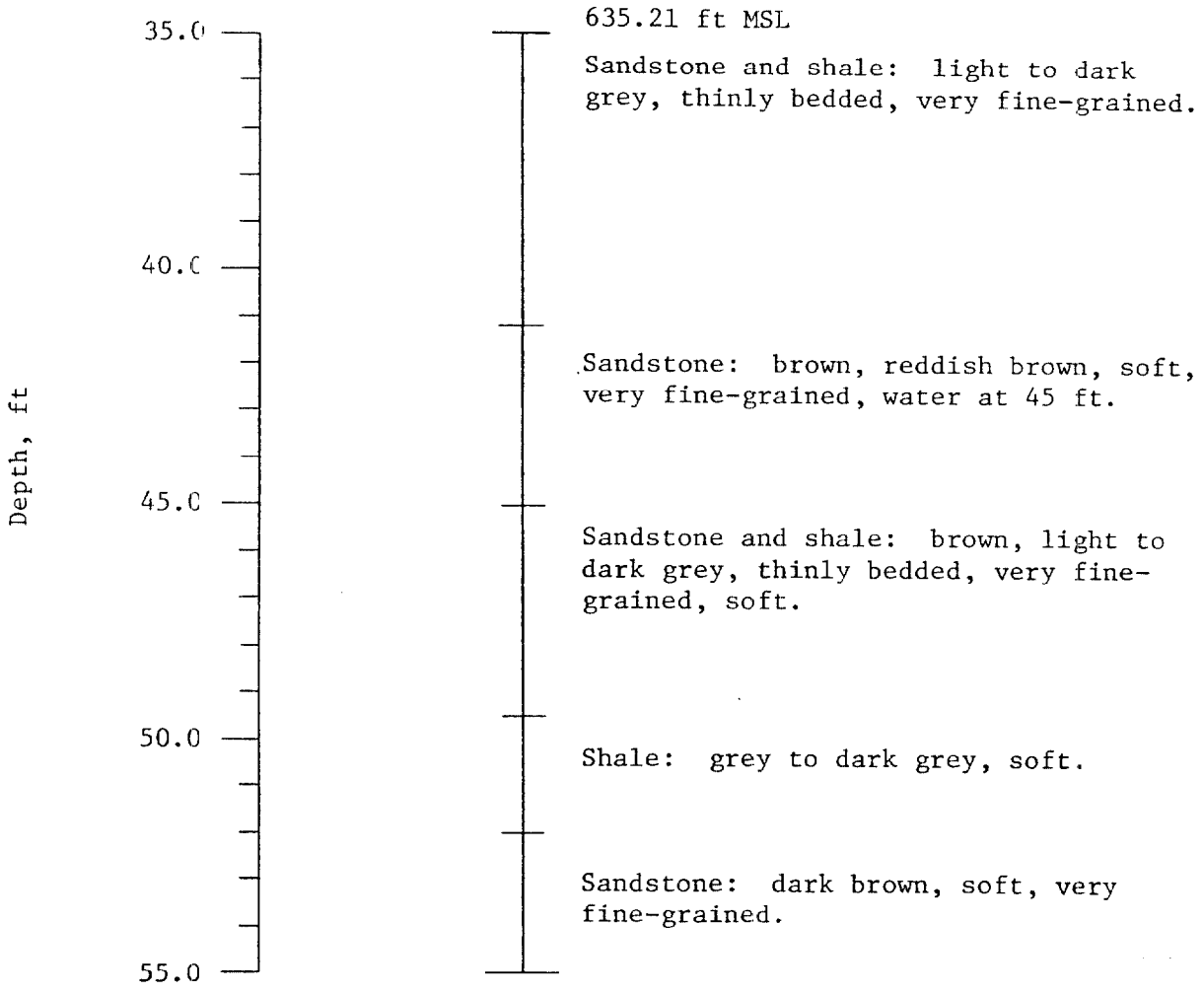
NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-21-83



NWSC, Crane, Indiana
Mustard Gas Burial Ground
Lithology
Boring Number: WES-1-23-83



NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-25-83



NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-26-83

726.54 ft MSL

Depth, ft

0.0

5.0

10.0

15.0

20.0

25.0

30.0

Gravel: limestone-medium.

Sandy clay (CL): brown, dark brown, very fin grained sand, gravelly soft to stiff.

Sandstone and clay: brown, reddish brown, rounded to angular sandstone lenses interbed with soft to stiff, sandy clay. Core is very weathered and very brittle. Sandstone is ve friable and very fine-grained.

Coal: black, soft, brittle, with sulfides, little recovery.

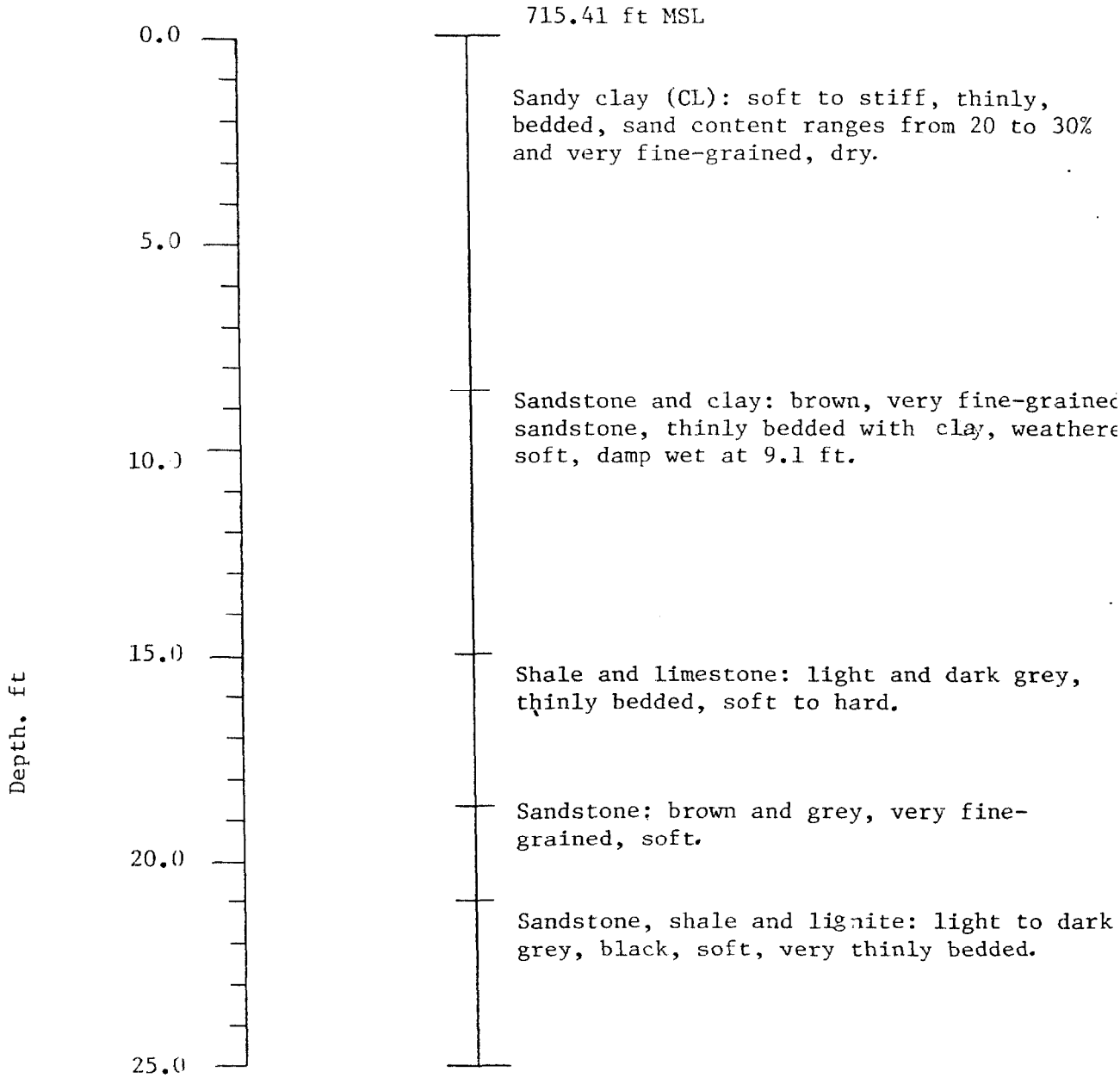
Sandstone: light to dark grey, very fine-grained, slightly friable, thinly bedded wit dark grey shale and dendritic coal and sulfide stringers.

Shale (60-70%) and sandstone(30-40%): black dark grey shale thinly bedded with very fine grained, grey sandstone.

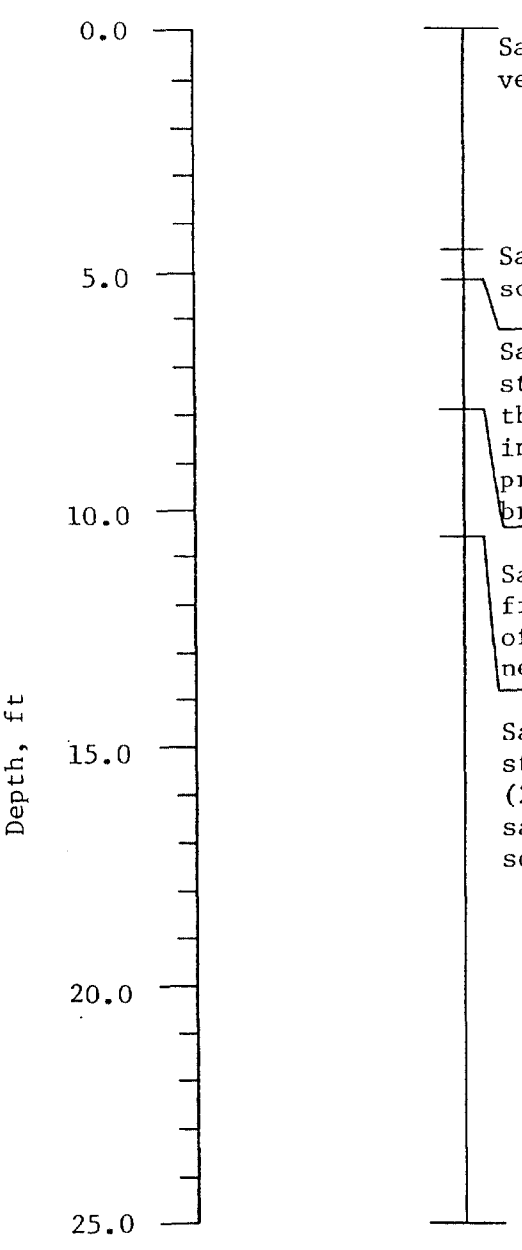
Shale: black, soft.

Shale (50%) and sandstone (50%): see above.

NWSC, Crane, Indiana
Pest Control Area-Hazardous Waste Storage Tank
Lithology
Boring Number: WT-4-83



NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9-11-83



694.93 ft MSL

Sandy clay (CL): brown, soft to stiff, dry, very fine-grained sand.

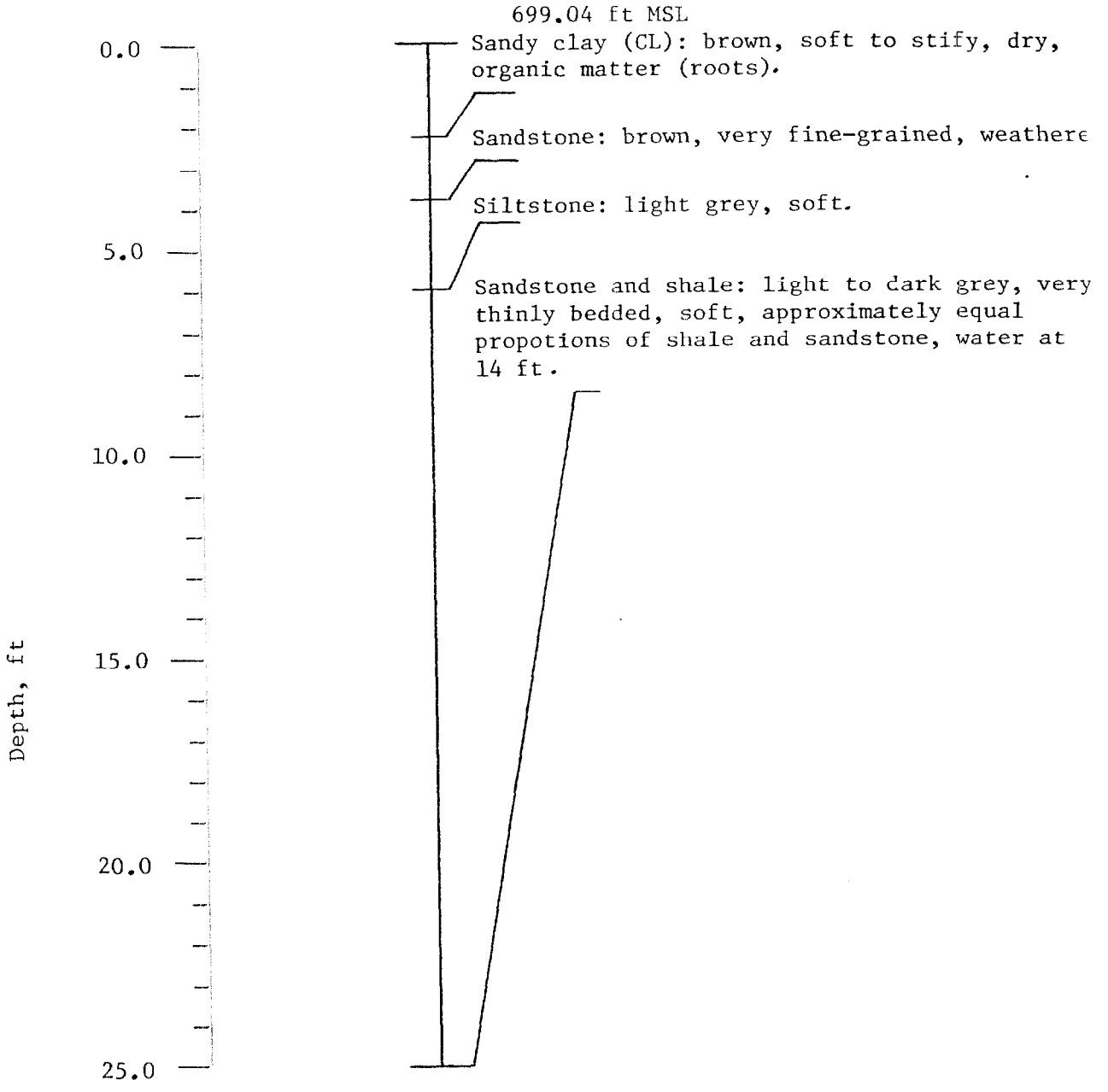
Sandstone, brown, very fine-grained, weathere soft.

Sandstone and shale: brown to light grey san stone (50%) and clark grey to black shale (5 thinly bedded (1/4 to 1/2" max) and horizont in atlitnde. Sandstone is very fine-grained predorninatly gqartz, core is weathered and breaks easily.

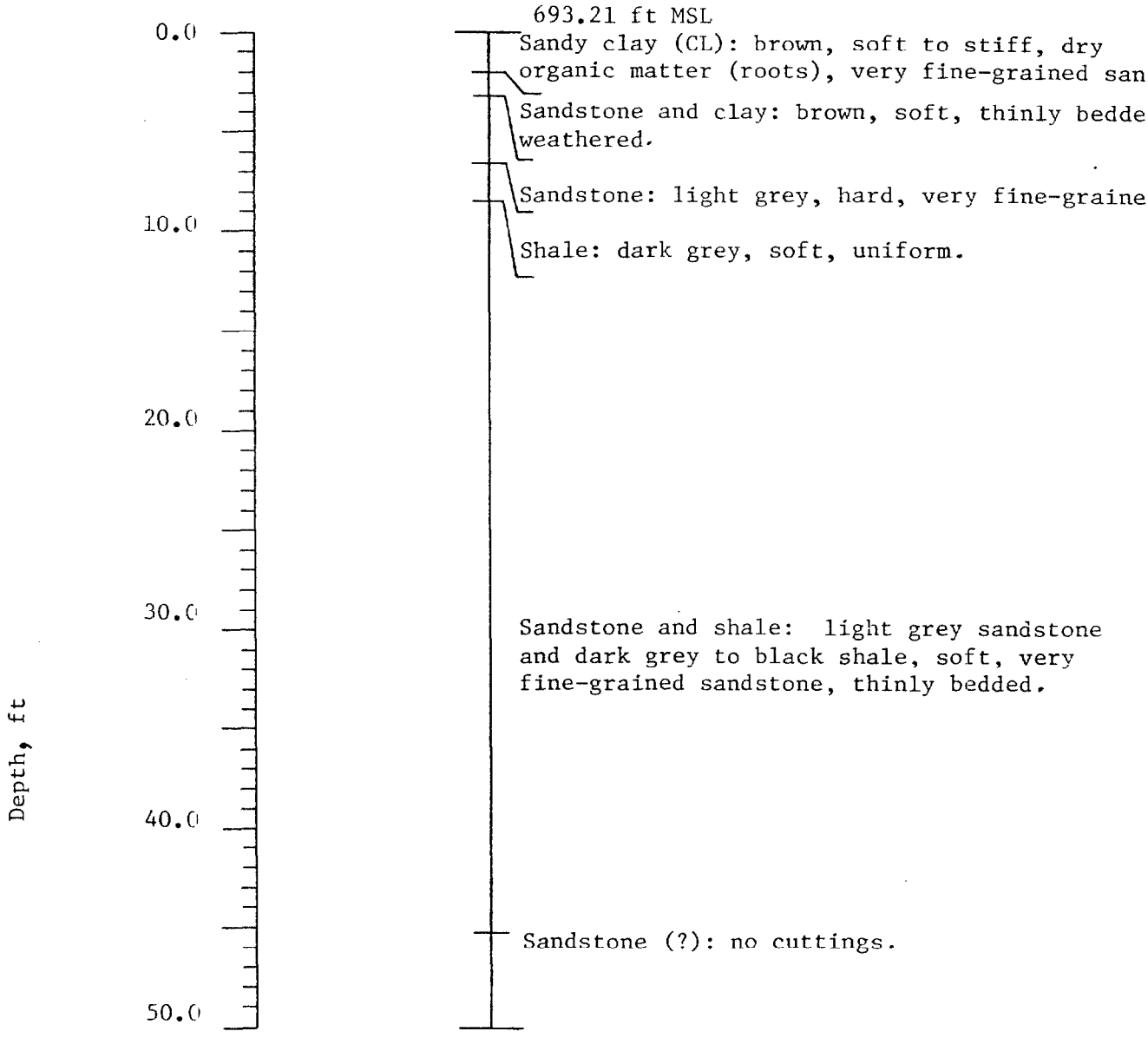
Sandstone: light grey, massive uniform, very fine-grained, quartz sandstone, contains tra of lignit (1/2% ranging from 1/6-1/8" thick-ness).

Sandstone and shale: light to dark grey sand-stone (50 to 75%) and dark grey to black sha (25 - 50%), very thinly bedded, horizontal, sandstone is very fine-grained and poorly sorted.

NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9-12-83



NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9-13-83



NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9-14A-83

692.07 ft MSL

Depth, ft

0.0

10.0

20.0

30.0

40.0

50.0

Sandy clay (CL): brown, soft to stiff, very fine-grained sand, organic matter (roots).

Sandstone: light grey, brown (4.7-5.1 ft). very fine-grained, soft, dry.

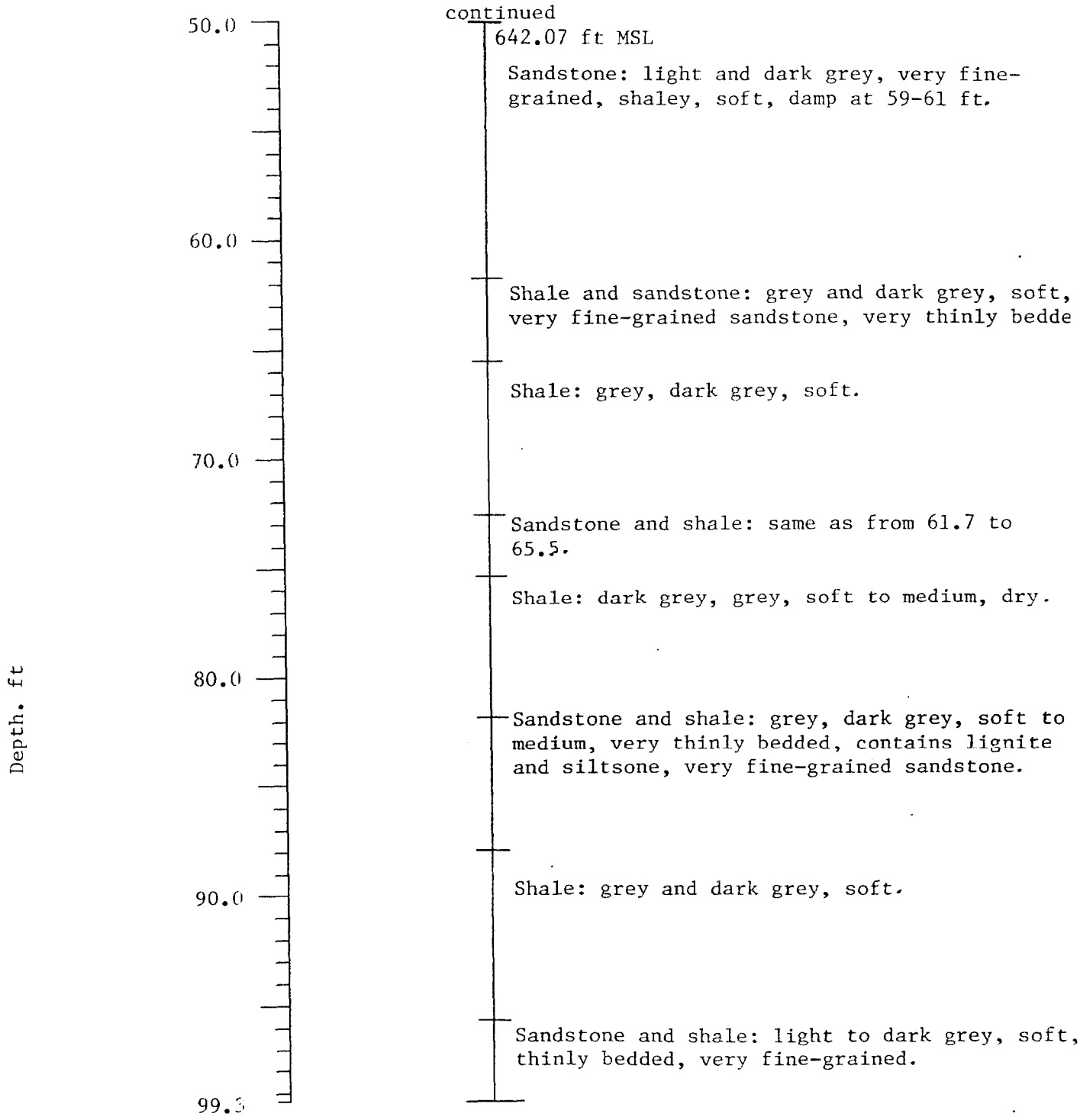
Sandstone and shale: light grey sahdstone and dark grey shale thinly bedded, very fine-grained sandstone, dry, damp at 18.8 and 23.8 ft.

Shale: light and dark grey, soft, sandy.

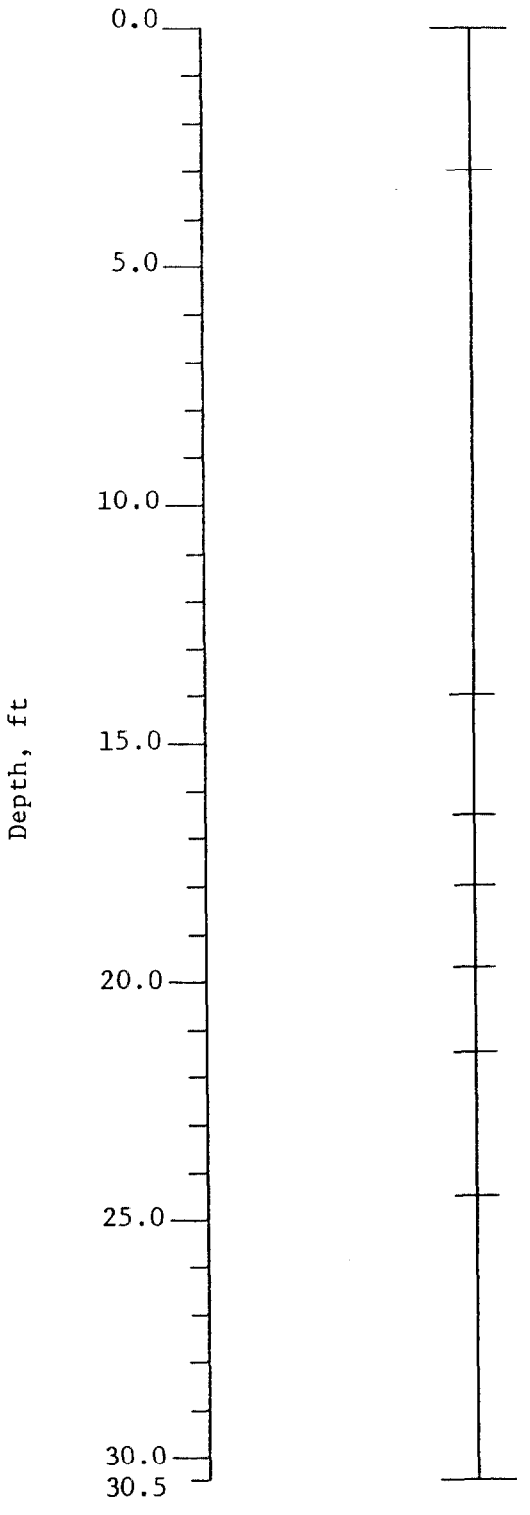
Sandstone: light and dark grey, very fine-grained, shaley, soft.

continued

NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9-14B-83



NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9-14B-83



658.40 ft MSL

Clay (CL): brown, sandy, damp, slight to moderate cohesion, organic matter.

Sandstone: light brown, dark brown, very fine-grained, quartz, weathered, soft. From 13.5 to 13.7 ft, grey shale.

Shale: light grey, soft.

Sandstone: dark brown, weathered, soft, very fine-grained, quartz sand.

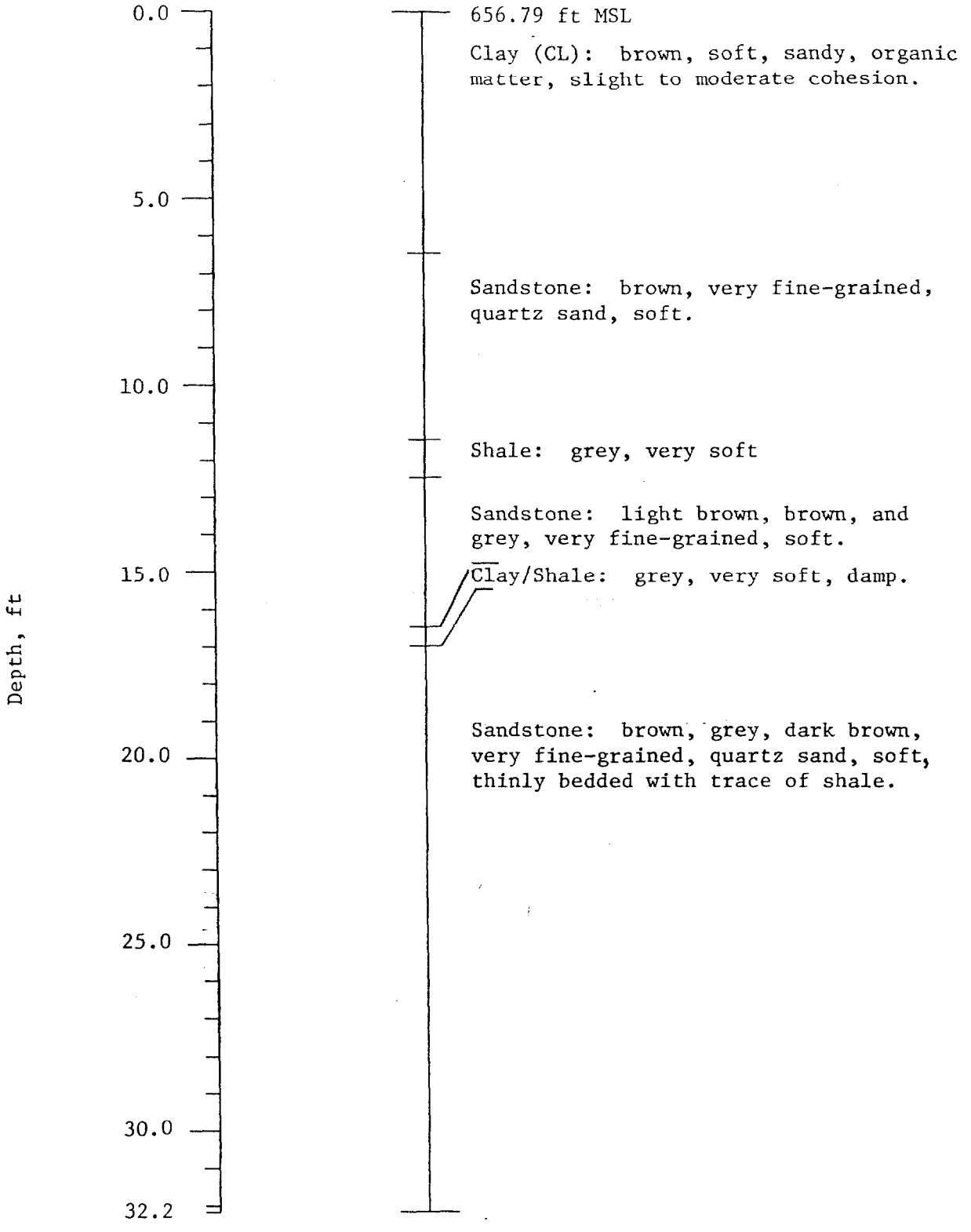
Sandstone and shale: brown, light grey, soft, thinly bedded.

Sandy shale: dark grey, soft very fine-grained, white quartz sand.

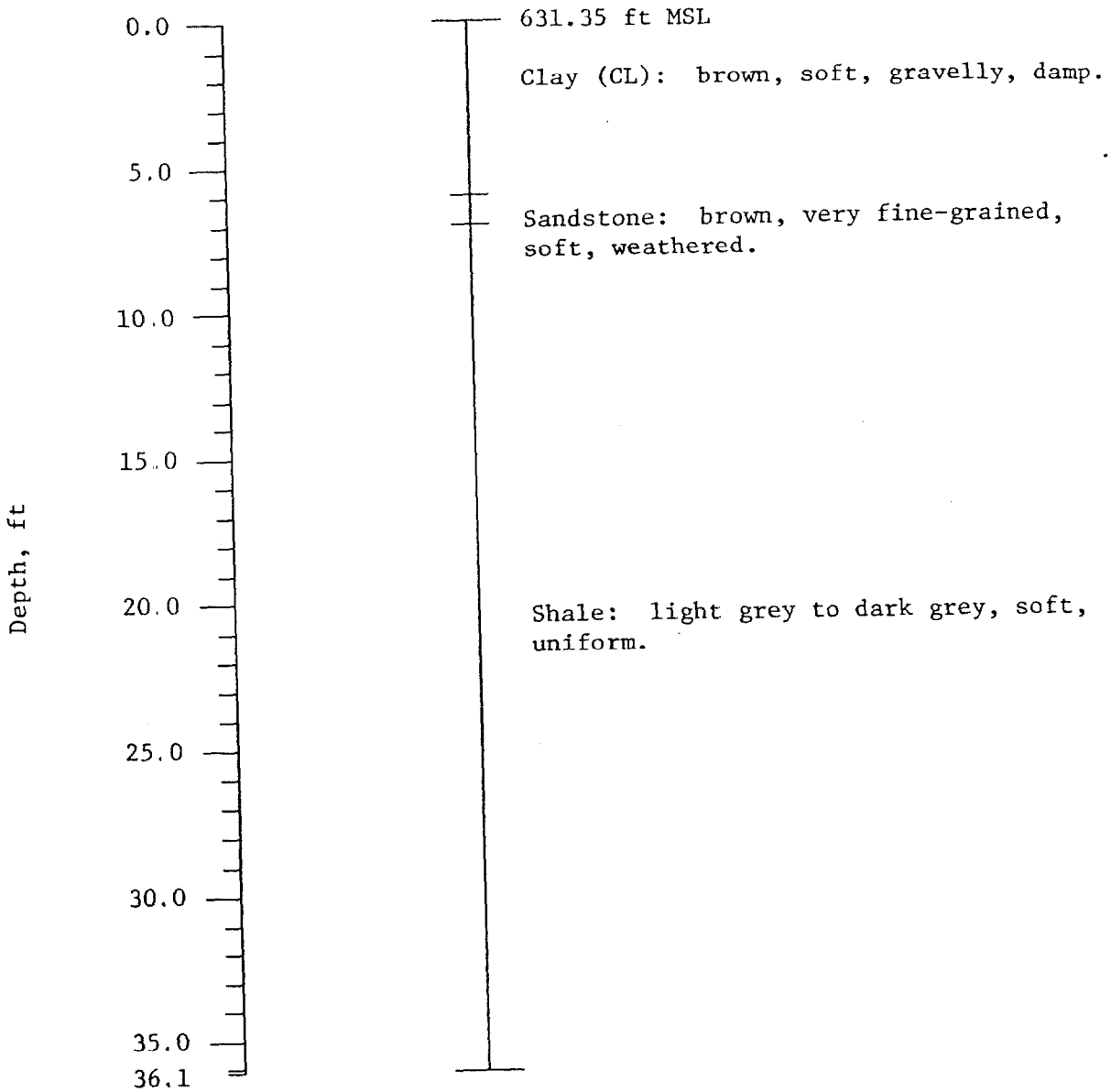
Sandstone and shale: various shades of brown and grey, thinly bedded.

Sandstone: brown, tan, dark brown, soft, very fine-grained, quartz sand.

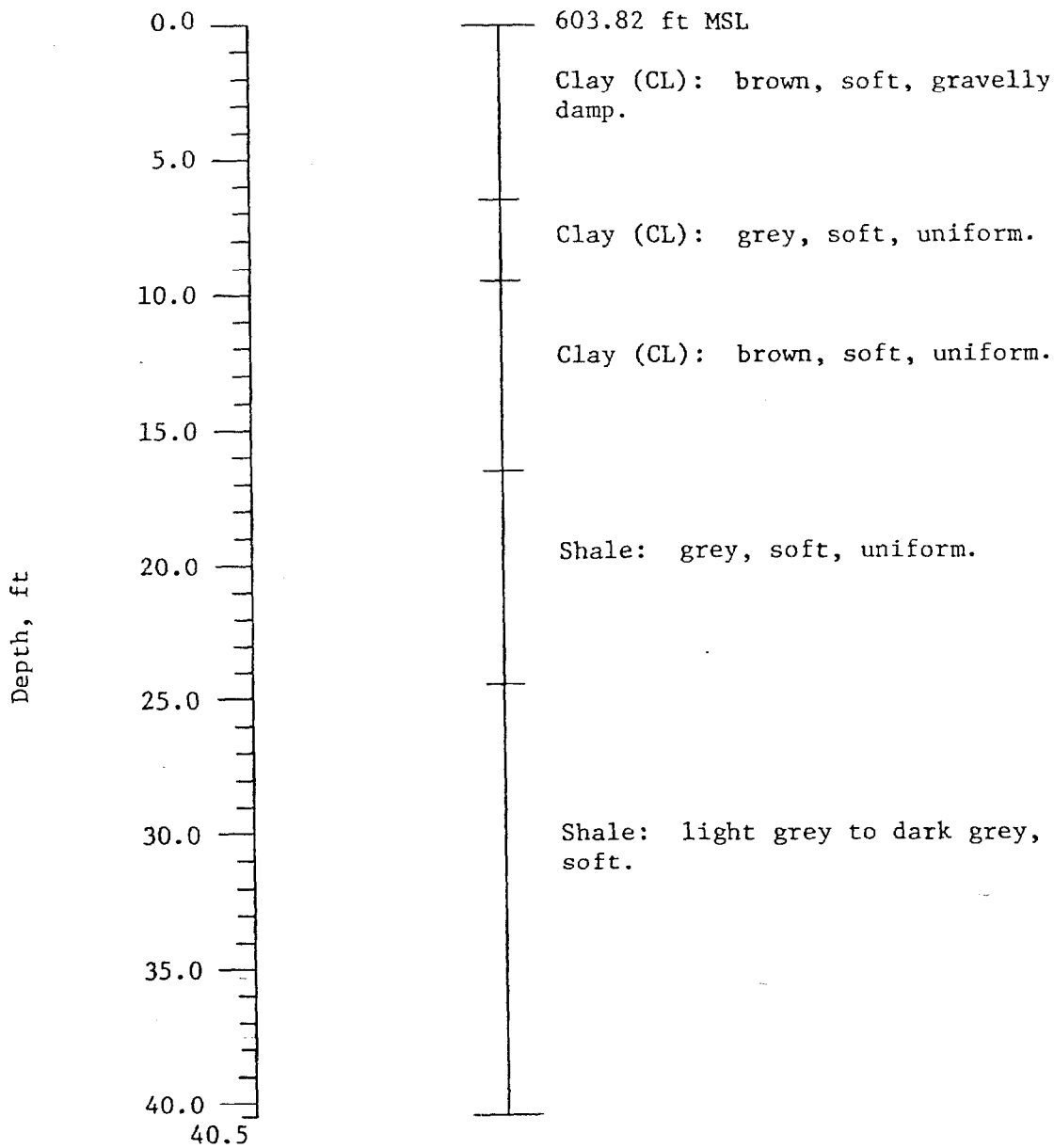
NWSC, Crane, Indiana
Mustard Gas Burial Grunds
Lithology
Boring Number: WES-1-18-83



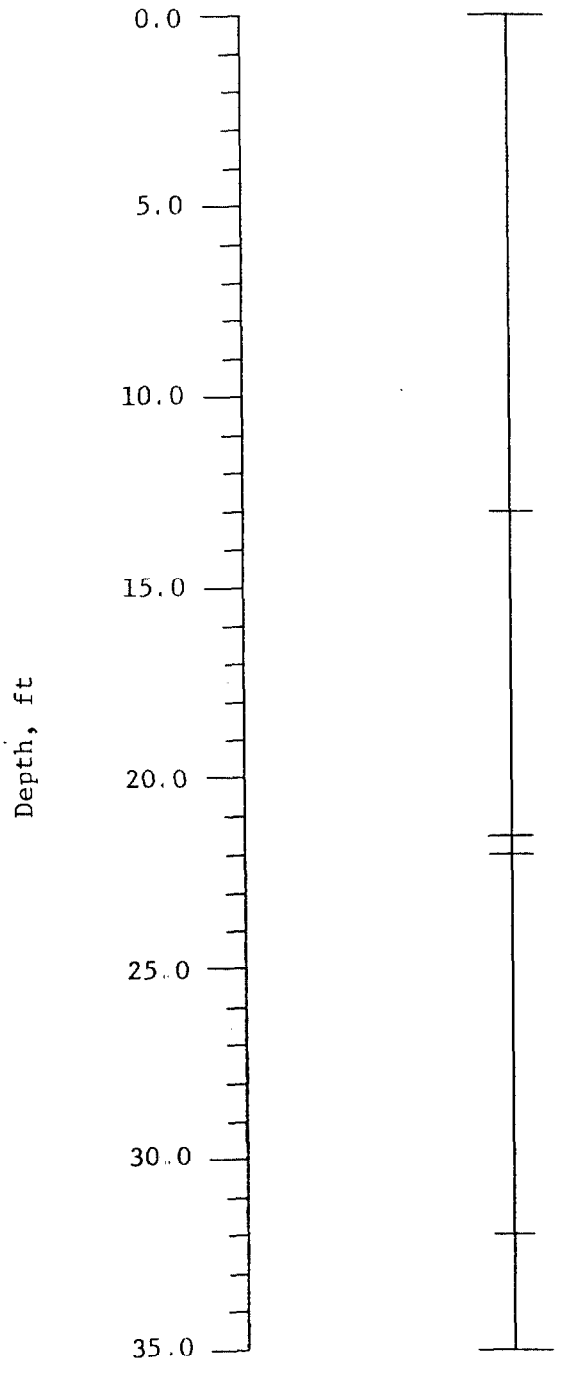
NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-19-83



NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-20-83



NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-21-83



653.55 ft MSL

Clay (CL): brown and grey, sandy, soft to stiff.

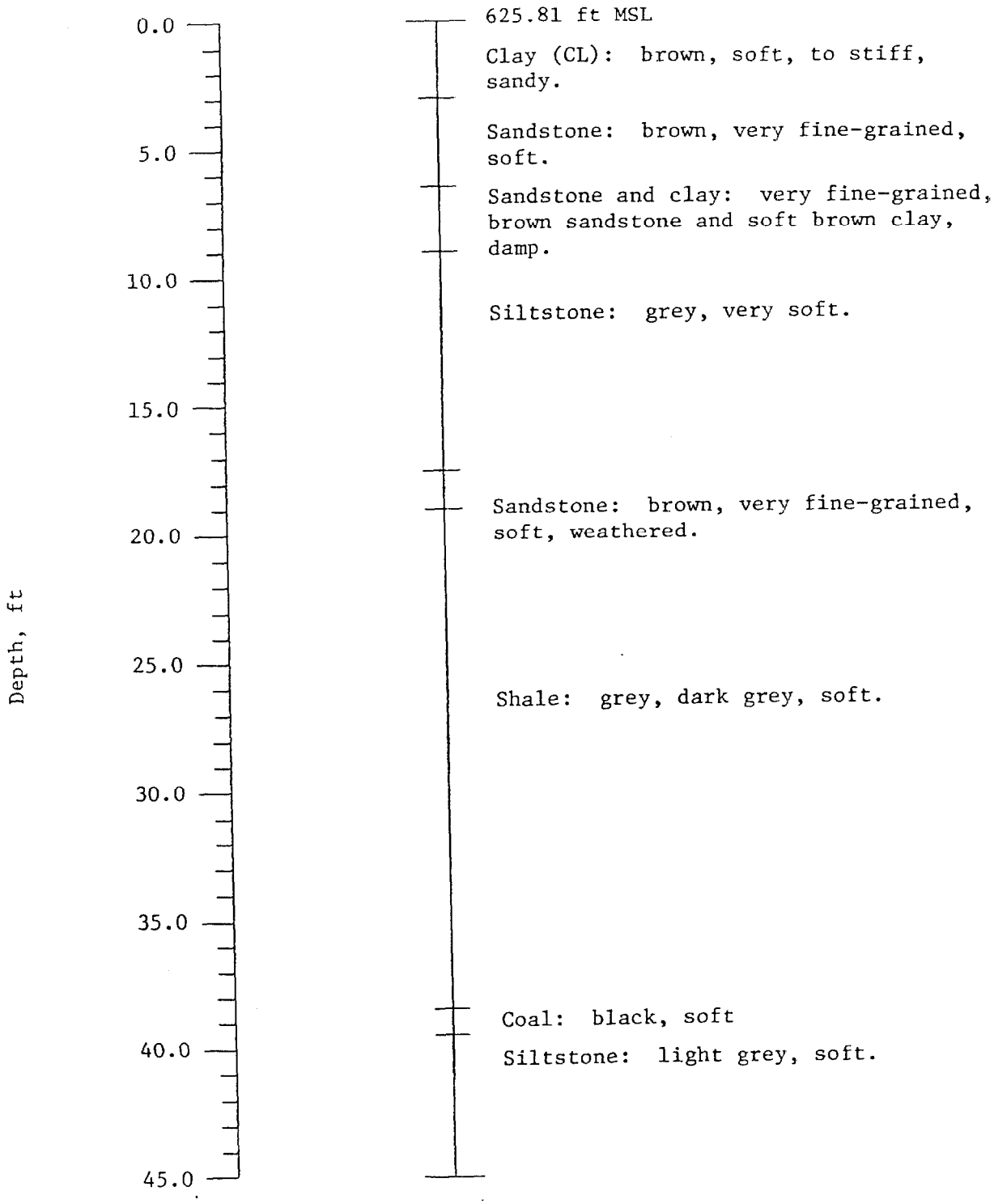
Sandstone: brown, weathered, very fine-grained, soft, damp at 17.5 ft.

Siltstone: brown, soft, weathered, damp.

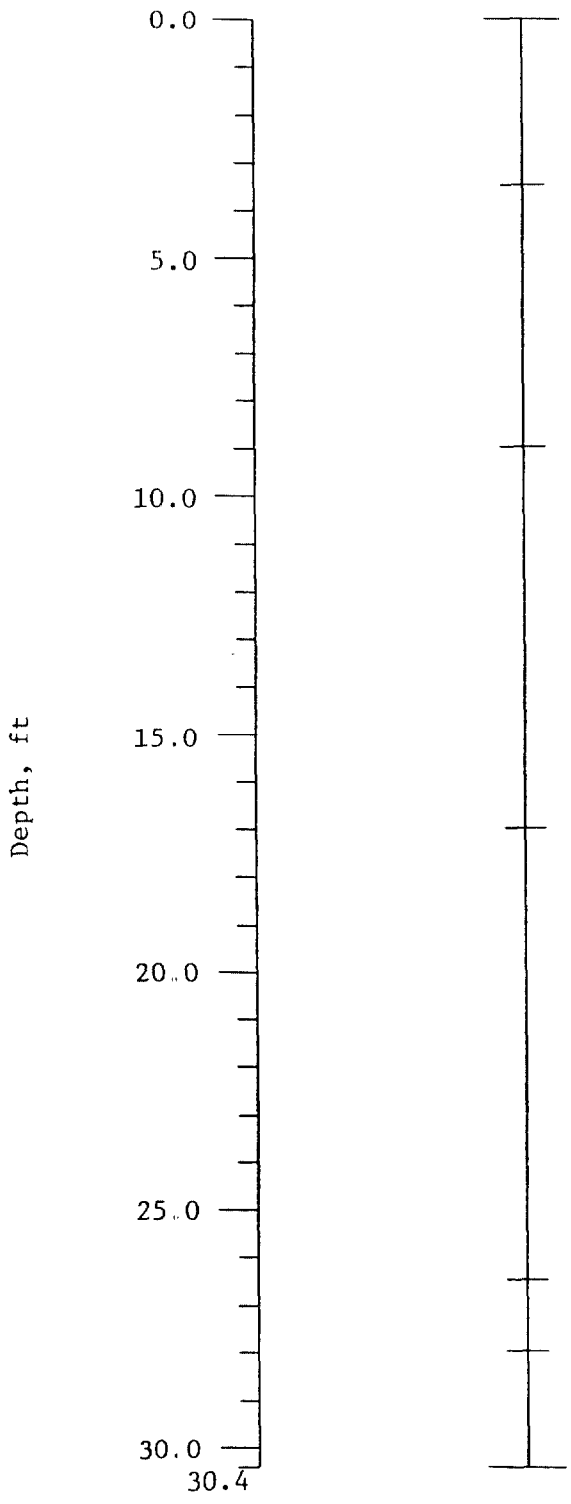
Sandstone: brown, light grey, soft, weathered, very fine-grained, water at 25 ft.

Shaley sandstone: brown, grey, dark grey, soft, weathered, very fine-grained.

NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-22-83



NWSC, Crane, Indiana
Mustard Gas Burial Ground
Lithology
Boring Number: WES-1-23-83



600.57 ft MSL

Clay (CL): brown, soft to stiff, sandy.

Sandstone: brown, very fine-grained, soft.

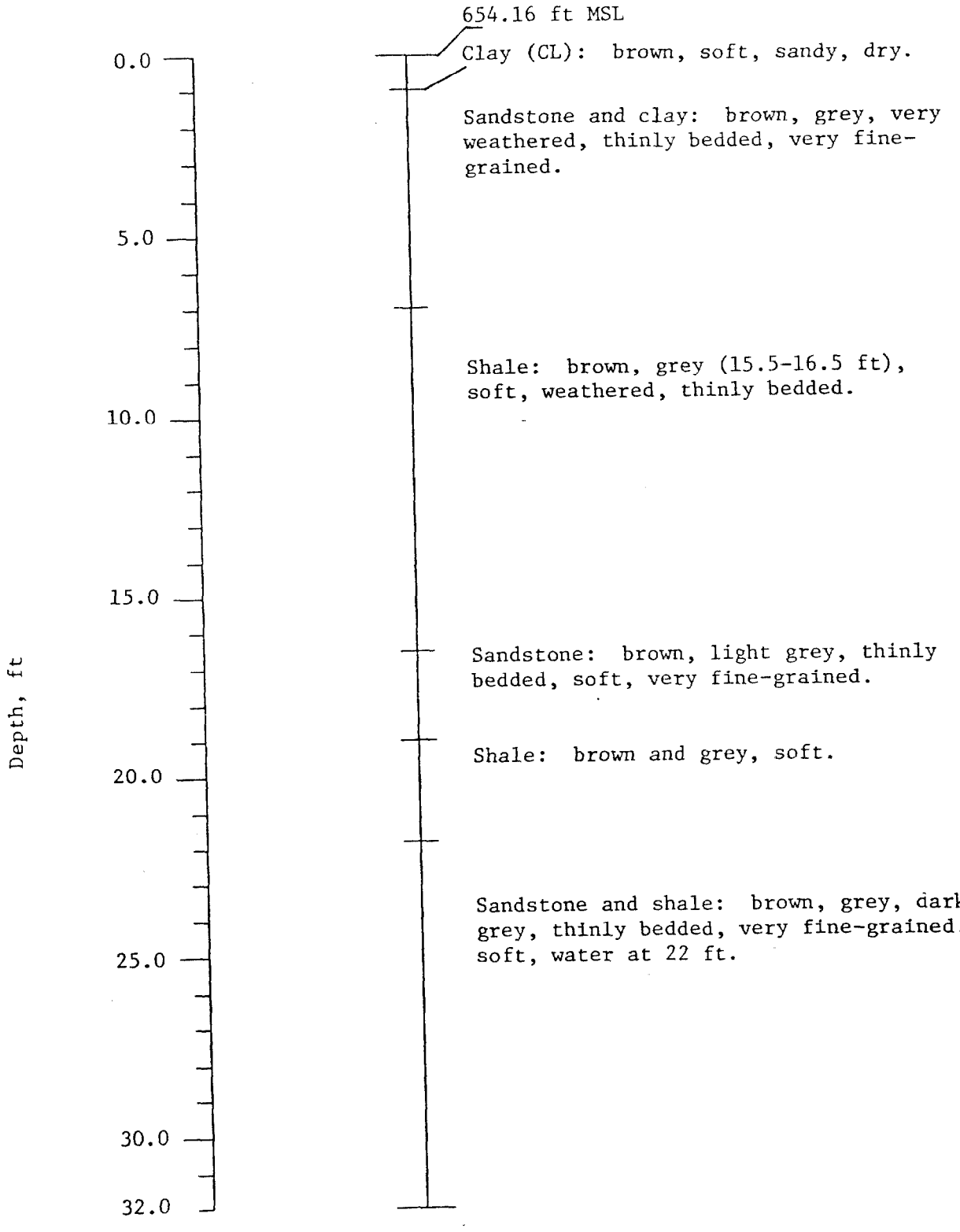
Clay and sandstone: brown, soft, sandy clay with interbedded, very fine-grained, soft sandstone.

Shale: grey, dark grey, soft, water at 20 ft.

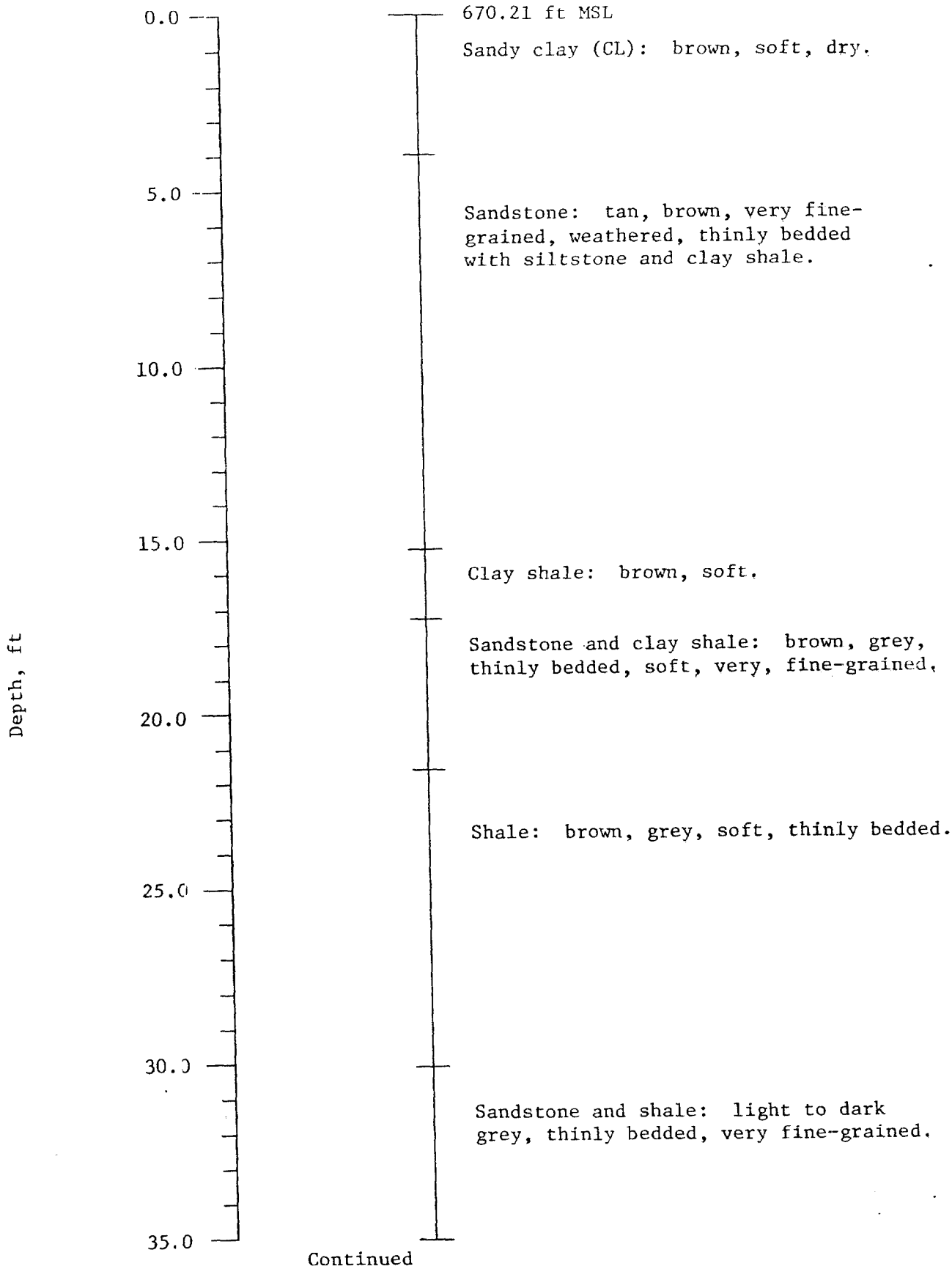
Siltstone: light grey, soft.

Shale: dark grey, soft.

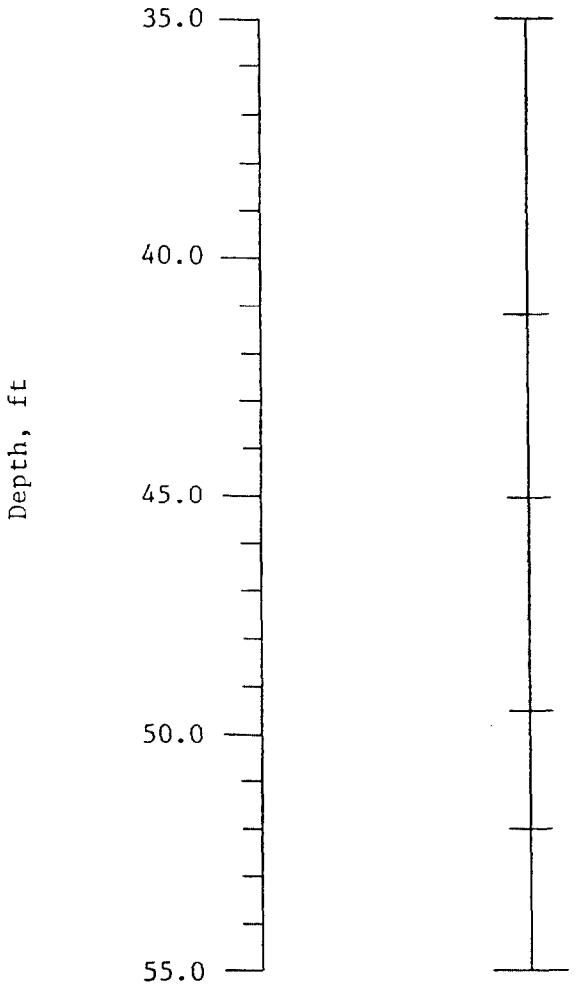
NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-24-83



NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-25-83



NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-26-83



635.21 ft MSL

Sandstone and shale: light to dark grey, thinly bedded, very fine-grained.

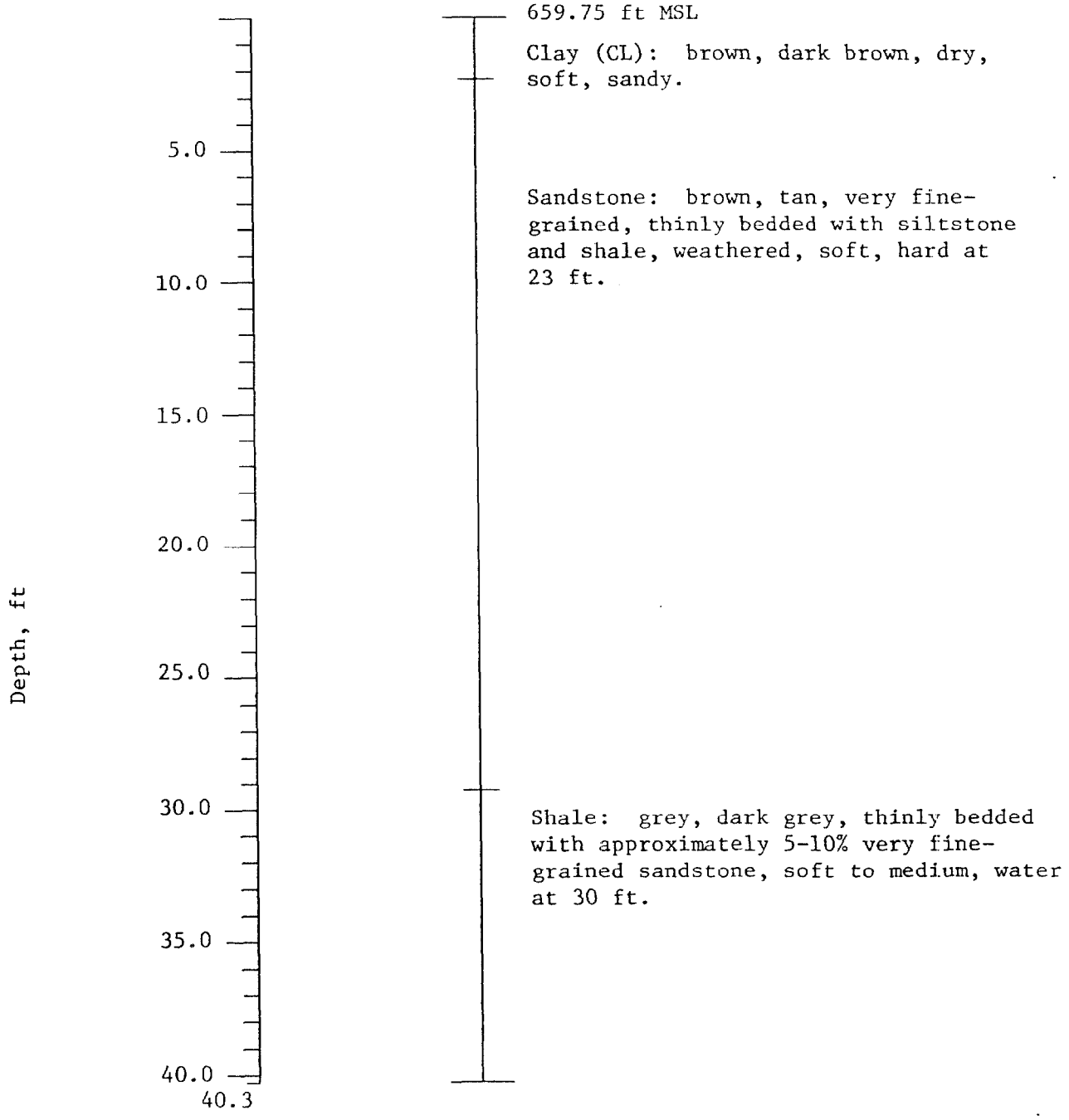
Sandstone: brown, reddish brown, soft, very fine-grained, water at 45 ft.

Sandstone and shale: brown, light to dark grey, thinly bedded, very fine-grained, soft.

Shale: grey to dark grey, soft.

Sandstone: dark brown, soft, very fine-grained.

NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-26-83



NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Lithology
Boring Number: WES-1-27-83

726.54 ft MSL

Depth, ft

0.0

Gravel: limestone-medium.

Sandy clay (CL): brown, dark brown, very fine-grained sand, gravelly soft to stiff.

5.0

Sandstone and clay: brown, reddish brown, rounded to angular sandstone lenses interbedded with soft to stiff, sandy clay. Core is very weathered and very brittle. Sandstone is very friable and very fine-grained.

10.0

Coal: black, soft, brittle, with sulfides, little recovery.

15.0

Sandstone: light to dark grey, very fine-grained, slightly friable, thinly bedded with dark grey shale and dendritic coal and sulfide stringers.

20.0

Shale (60-70%) and sandstone(30-40%): black or dark grey shale thinly bedded with very fine-grained, grey sandstone.

25.0

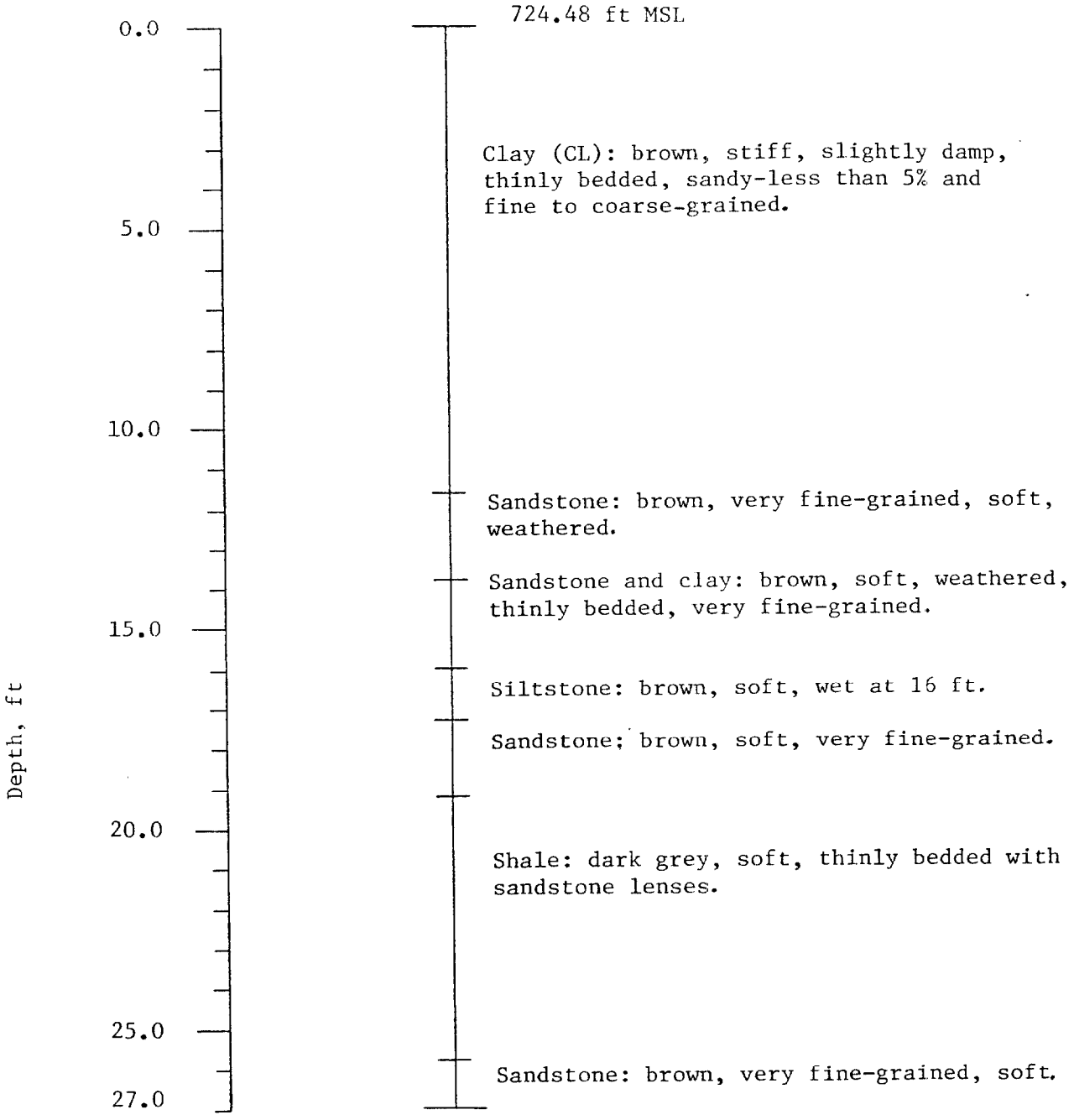
Shale: black, soft.

Shale (50%) and sandstone (50%): see above.

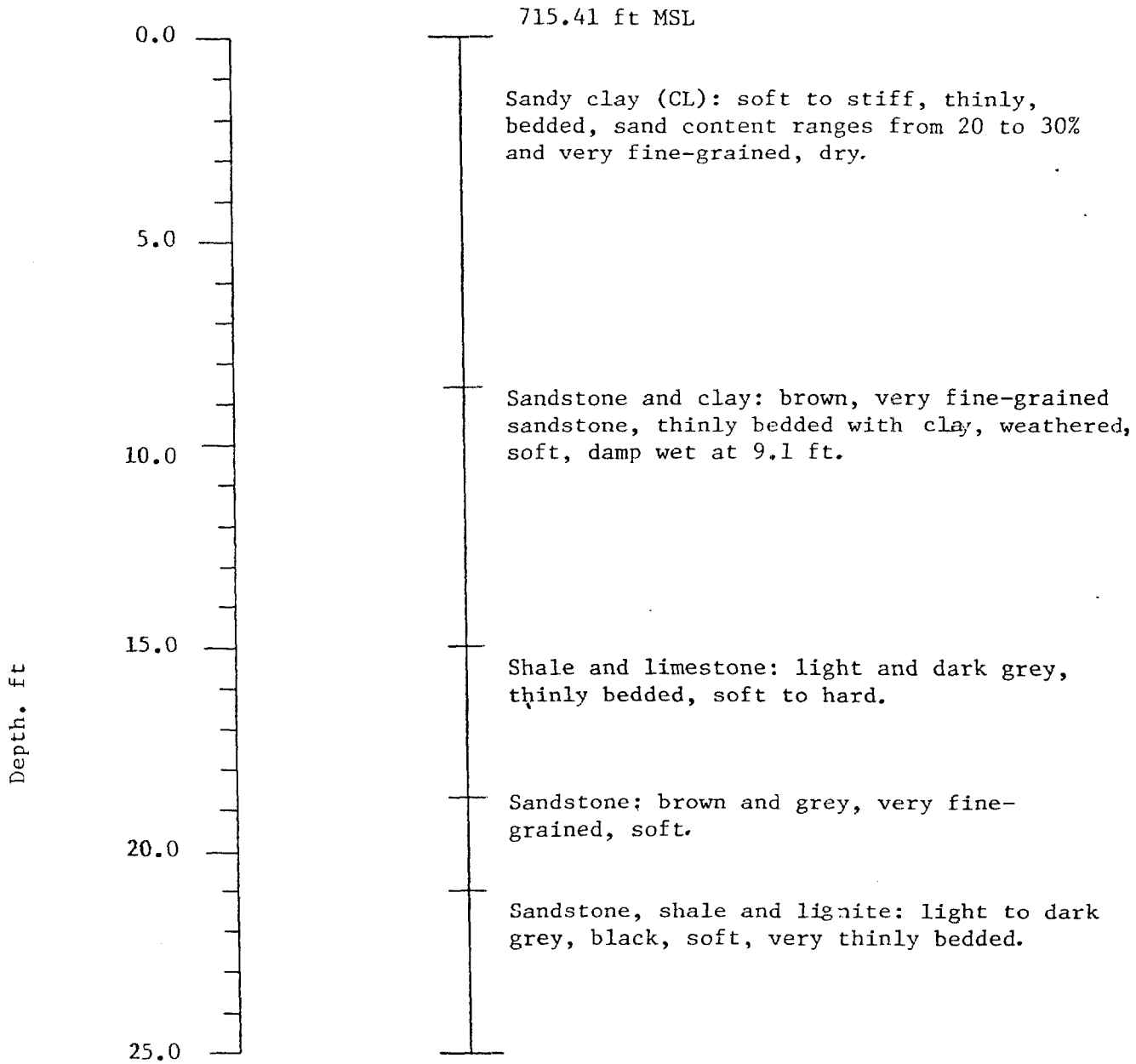
30.0

NWSC, Crane, Indiana
Pest Control Area-Hazardous Waste Storage Tank
Lithology

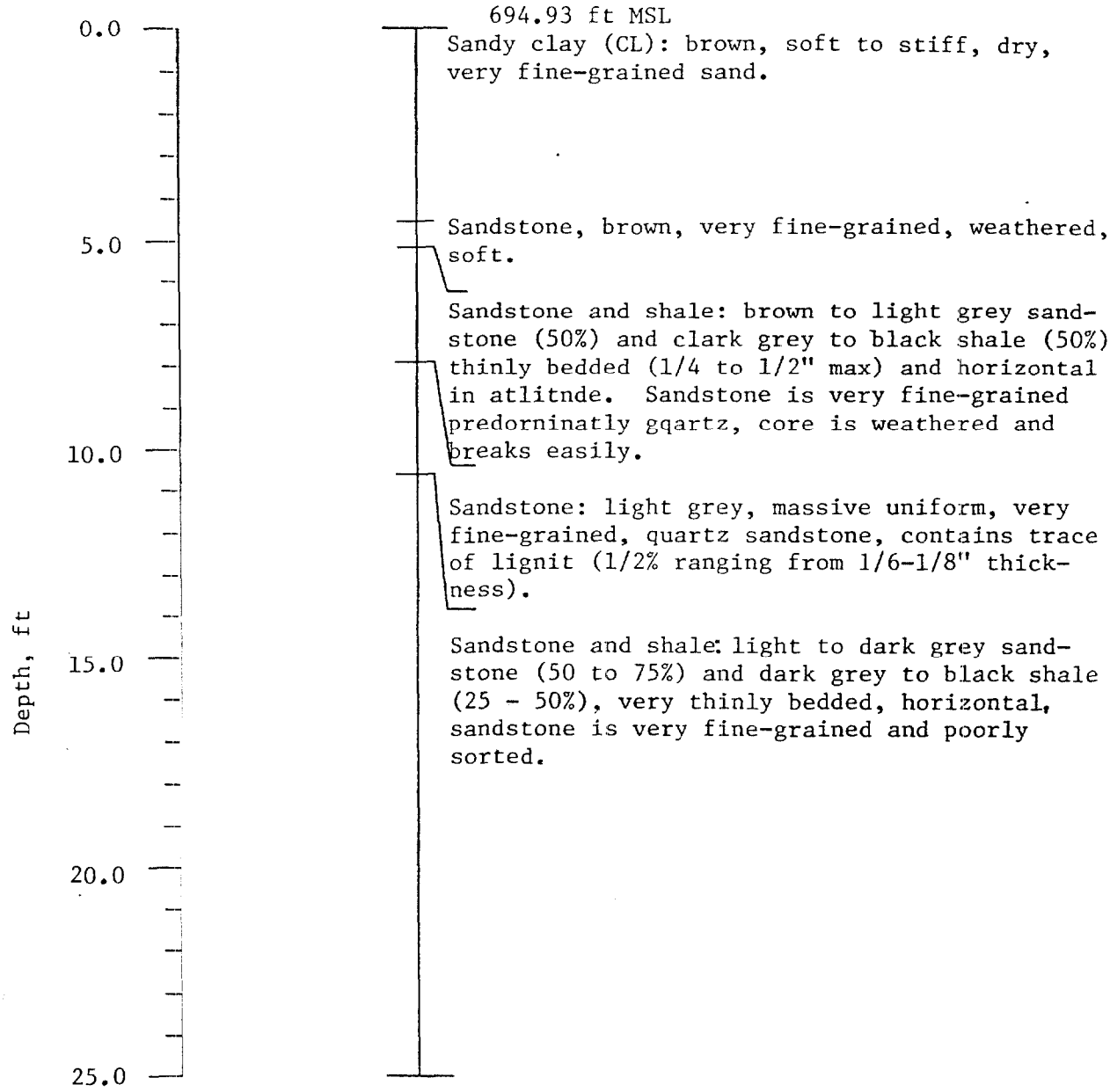
Boring Number: WT-4-83



NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9-10-83



NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9-11-83



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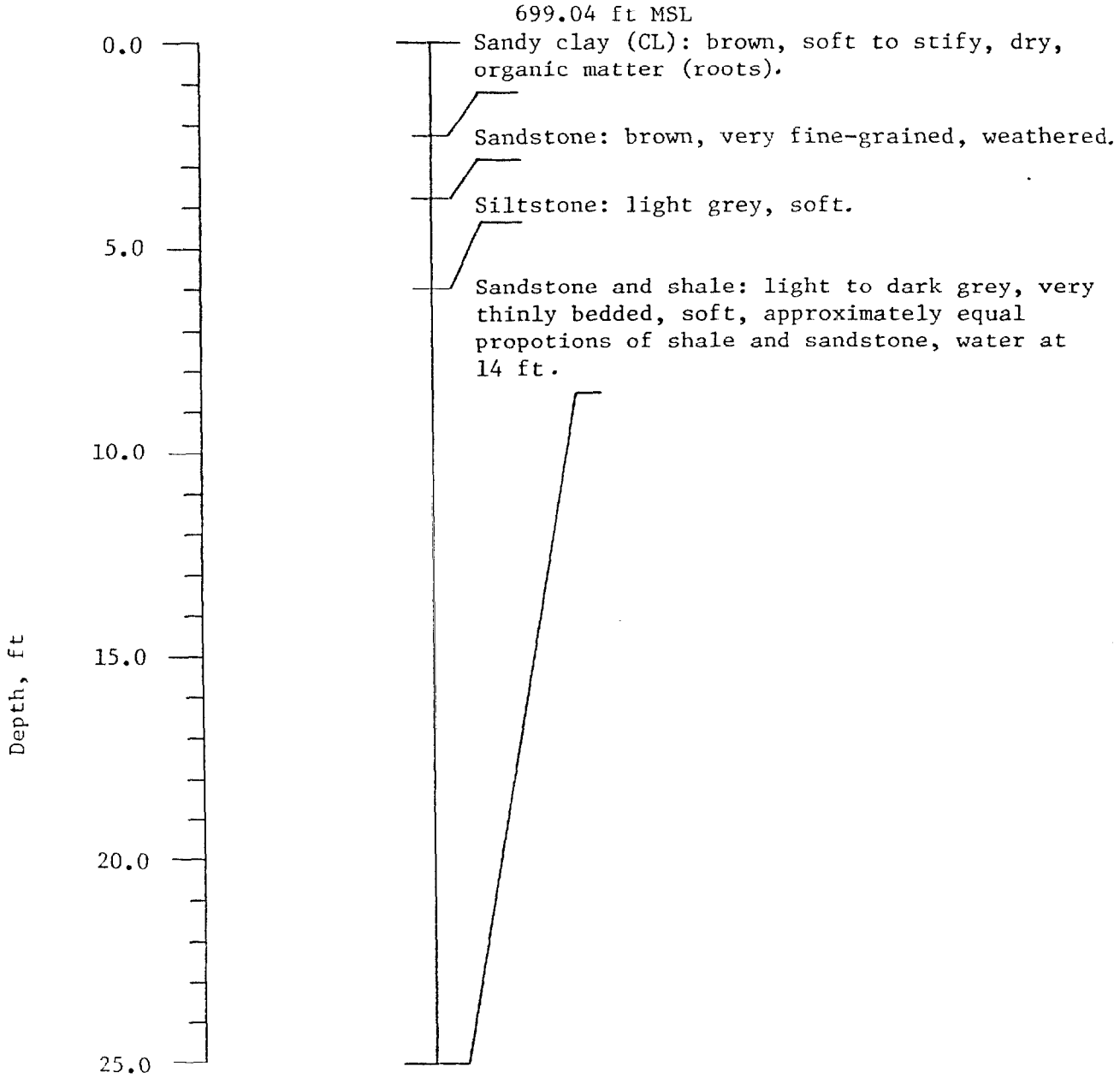
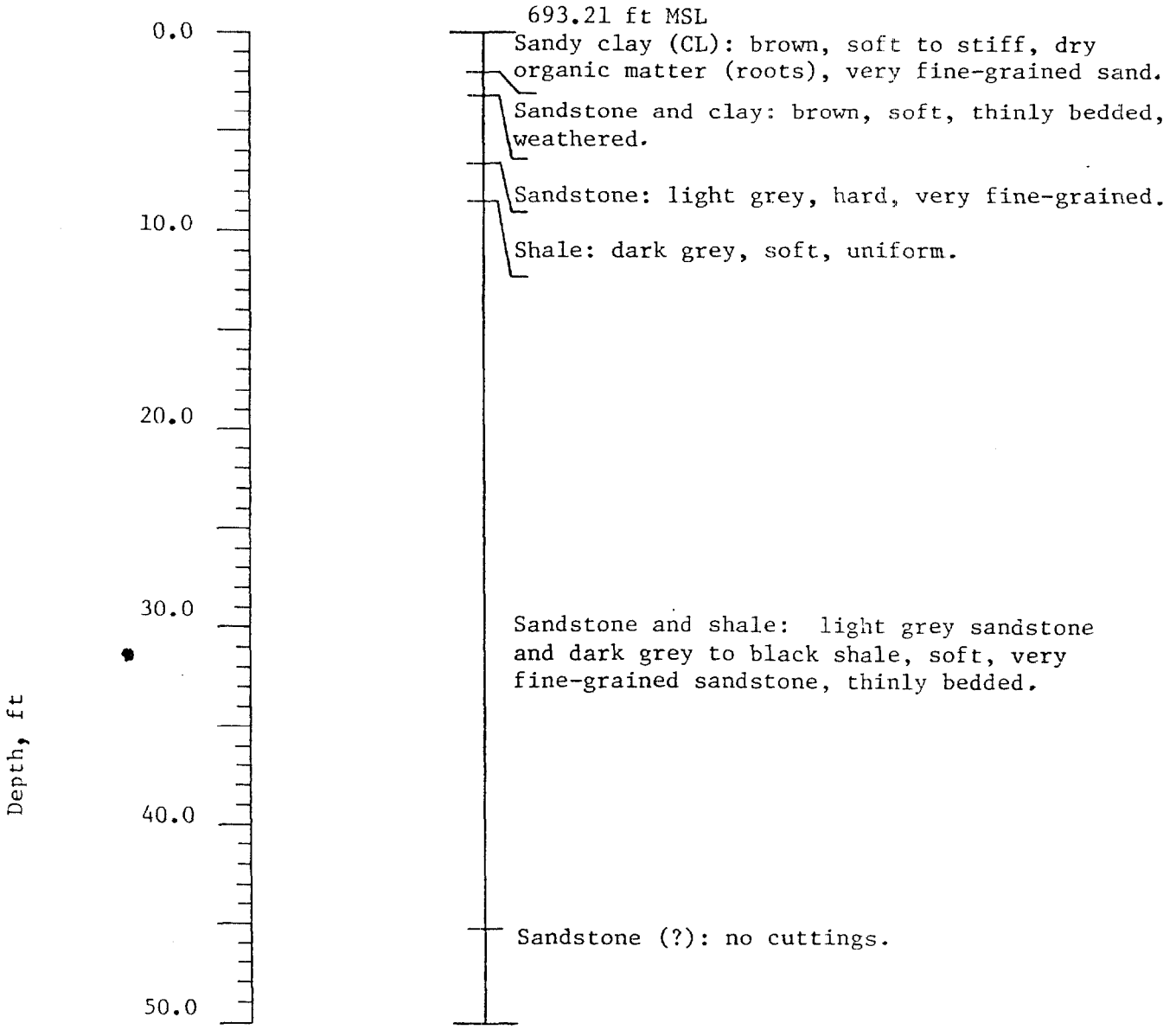
Pest Control Area
Lithology
Boring Number: WES-9-12-83



NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9-13-83



NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9-14A-83

692.07 ft MSL

Depth, ft

0.0

10.0

20.0

30.0

40.0

50.0

Sandy clay (CL): brown, soft to stiff, very fine-grained sand, organic matter (roots).

Sandstone: light grey, brown (4.7-5.1 ft). very fine-grained, soft, dry.

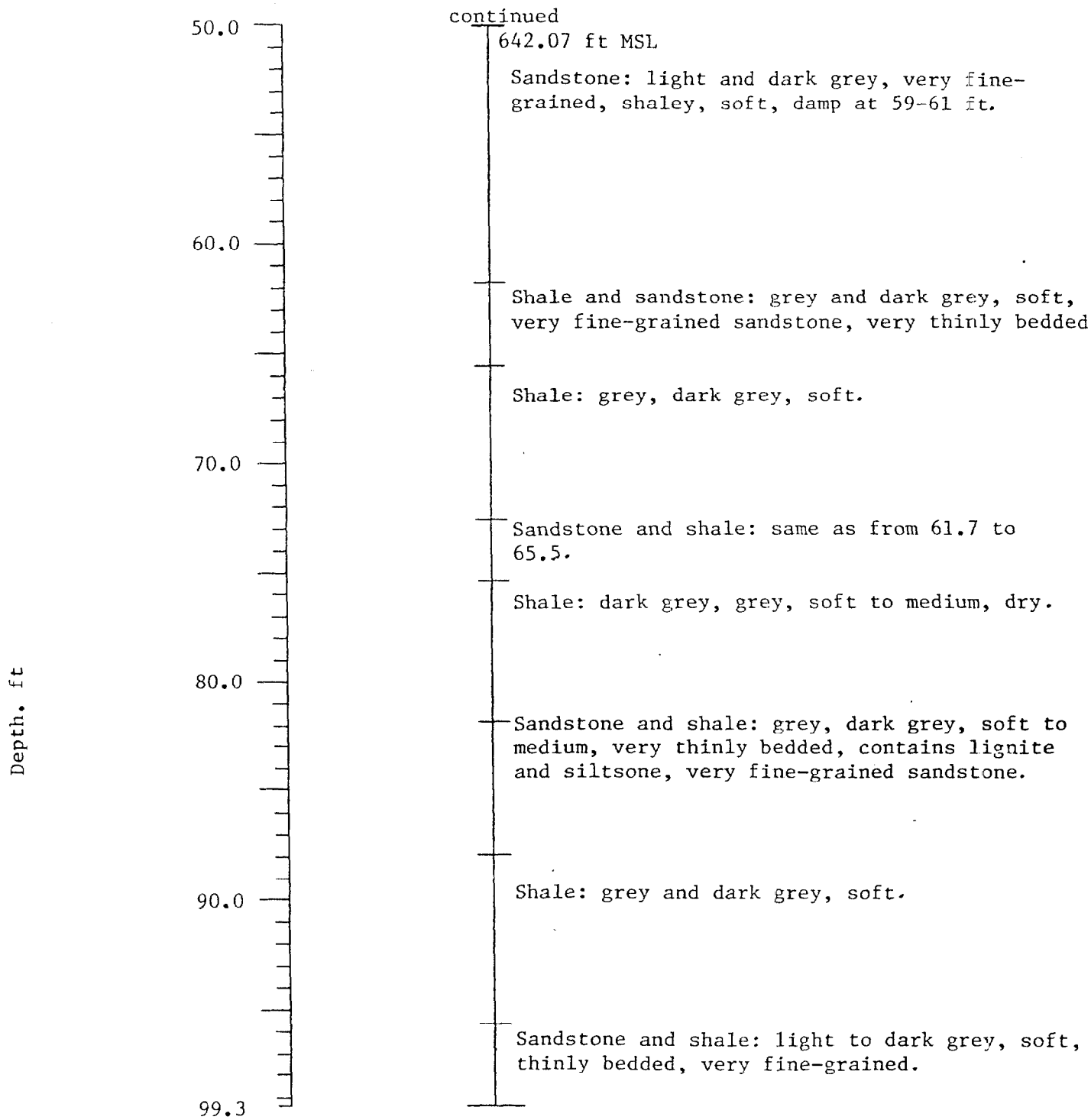
Sandstone and shale: light grey sandstone and dark grey shale thinly bedded, very fine-grained sandstone, dry, damp at 18.8 and 23.8 ft.

Shale: light and dark grey, soft, sandy.

Sandstone: light and dark grey, very fine-grained, shaley, soft.

continued

NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9 -14B-83



NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9-14B-83

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-13-83

Top of Pipe Elevation: 637.98 ft MSL

Screen Interval Elevation: from 615.01 to 605.56 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:39	22.78	615.20	
6 Jul 83	12:38	23.44	614.54	
13 Jul 83	2:14	23.75	614.23	
20 Jul 83	8:43	24.15	613.83	
27 Jul 83	3:57	24.13	613.85	
3 Aug 83	9:10	24.40	613.58	
10 Aug 83	10:30	24.48	613.50	
17 Aug 83	10:12	24.72	613.26	
24 Aug 83	11:36	24.94	613.04	
14 Sep 83	4:29	25.08	612.90	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-14-83

Top of Pipe Elevation: 659.14 ft MSL

Screen Interval Elevation: from 635.02 to 625.49 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:42	15.15	643.99	
6 Jul 83	12:42	15.83	643.31	
13 Jul 83	2:13	15.73	643.41	
20 Jul 83	8:30	15.93	643.21	
27 Jul 83	3:21	15.88	643.26	
3 Aug 83	9:20	16.14	643.00	
10 Aug 83	11:32	16.14	643.00	
17 Aug 83	10:16	16.38	642.76	
24 Aug 83	11:39	16.59	642.55	
14 Sep 83	4:07	16.84	642.30	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-15-83

Top of Pipe Elevation: 666.01 ft MSL

Screen Interval Elevation: from 640.91 to 631.41 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:22	26.40	639.61	
6 Jul 83	12:45	26.69	639.32	
13 Jul 83	2:23	26.53	639.48	
20 Jul 83	8:32	26.75	639.26	
27 Jul 83	3:25	26.62	639.39	
3 Aug 83	3:18	26.85	639.16	
10 Aug 83	10:56	26.84	639.17	
17 Aug 83	9:28	26.74	639.27	
24 Aug 83	11:03	26.91	639.10	
14 Sep 83	4:20	27.03	638.98	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-16-83

Top of Pipe Elevation: 644.94 ft MSL

Screen Interval Elevation: from 618.19 to 608.94 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:26	35.18	609.76	
6 Jul 83	12:30	35.10	609.84	
13 Jul 83	2:10	35.03	609.91	
20 Jul 83	8:40	35.10	609.84	
27 Jul 83	3:33	35.25	609.69	
3 Aug 83	9:13	35.10	609.84	
10 Aug 83	10:35	35.37	609.57	
17 Aug 83	9:31	35.12	609.82	
24 Aug 83	11:12	35.39	609.55	
14 Sep 83	4:26	35.25	609.69	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-17-83

Top of Pipe Elevation: 665.54 ft MSL

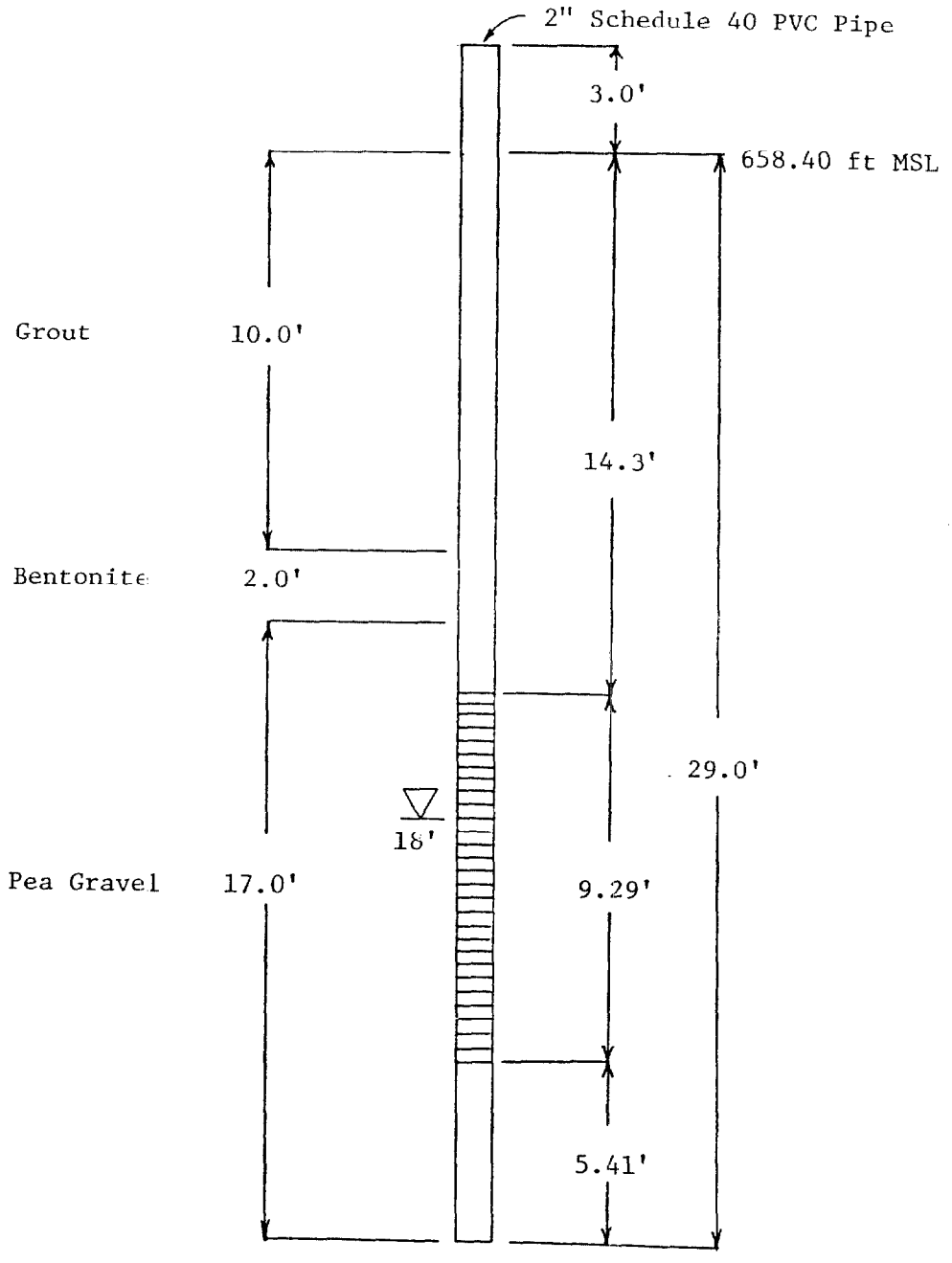
Screen Interval Elevation: from 639.29 to 629.99 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:44	18.44	647.10	
6 Jul 83	12:44	18.73	646.81	
13 Jul 83	2:21	18.75	646.79	
20 Jul 83	8:28	18.72	646.82	
27 Jul 83	3:22	18.88	646.66	
3 Aug 83	9:21	19.24	646.30	
10 Aug 83	11:35	18.96	646.58	
17 Aug 83	10:19	19.10	646.44	
24 Aug 83	11:41	19.50	646.04	
14 Sep 83	4:09	19.70	645.84	

APPENDIX C

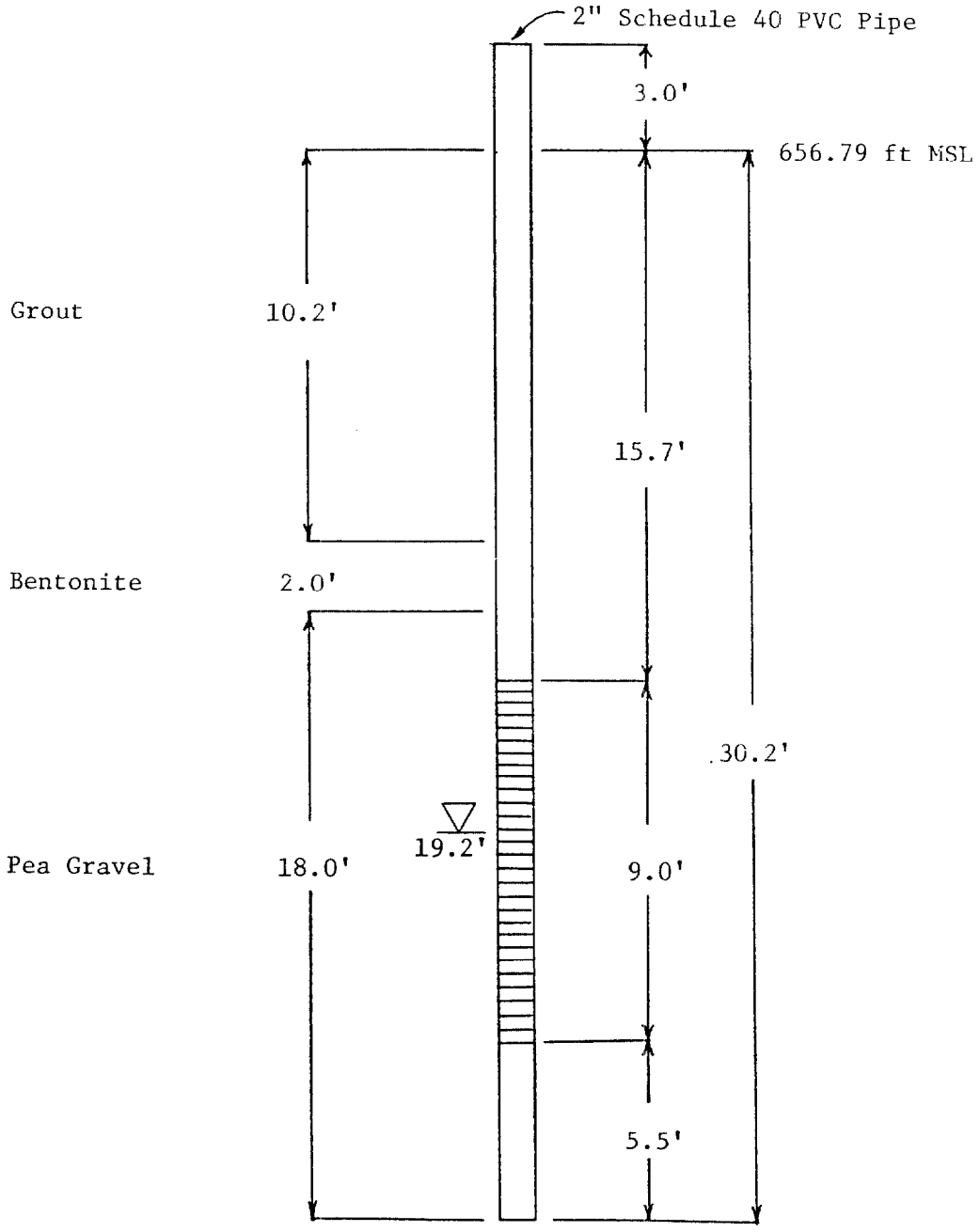
WELL COMPLETION DIAGRAMS



Water depth at time of drilling

Well Screen

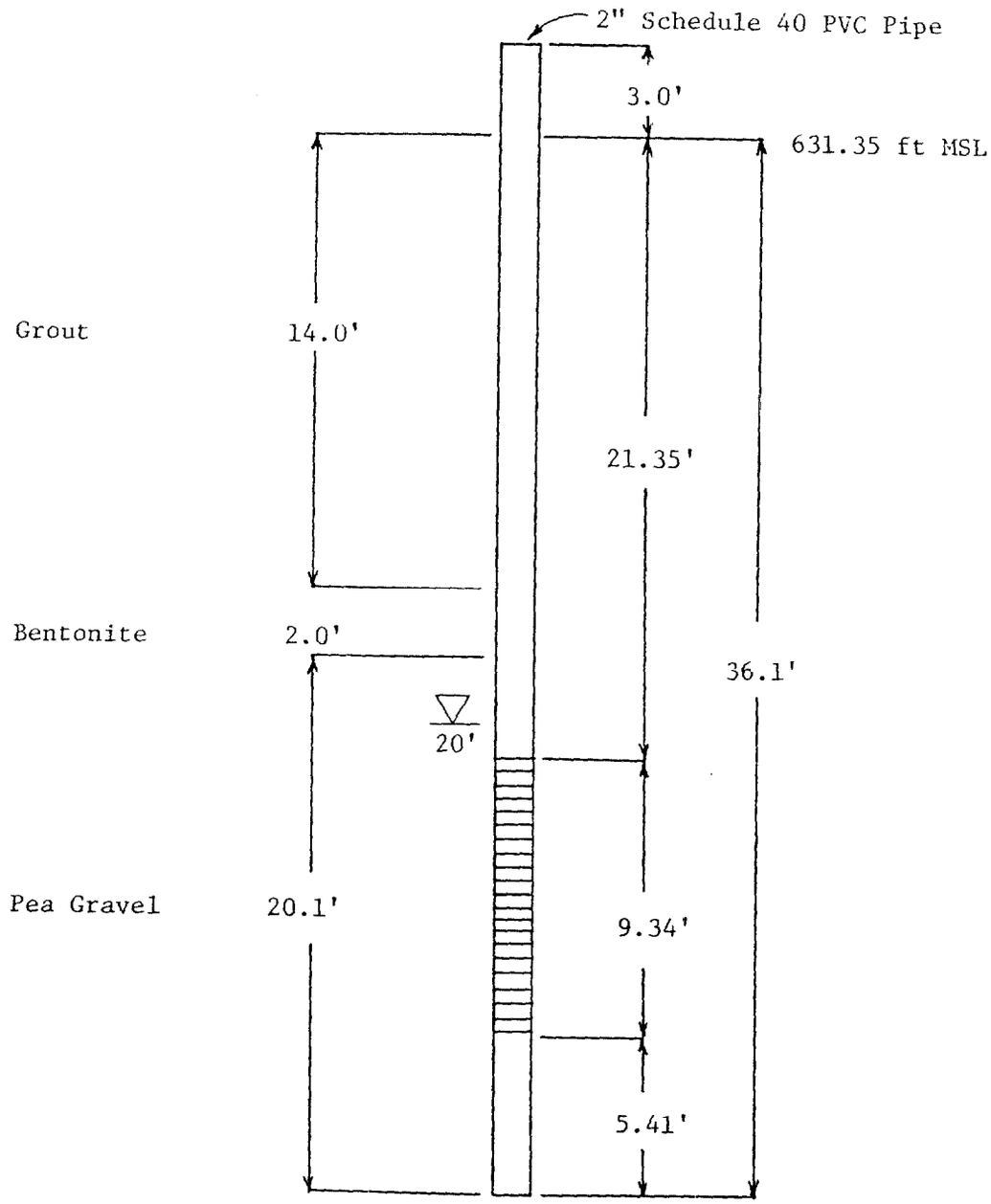
NWSC, Crane, Indiana
Mustard Gas Burial Ground
Well Completion
Boring Number: WES-1-18-8



Water depth at time of drilling

Well Screen

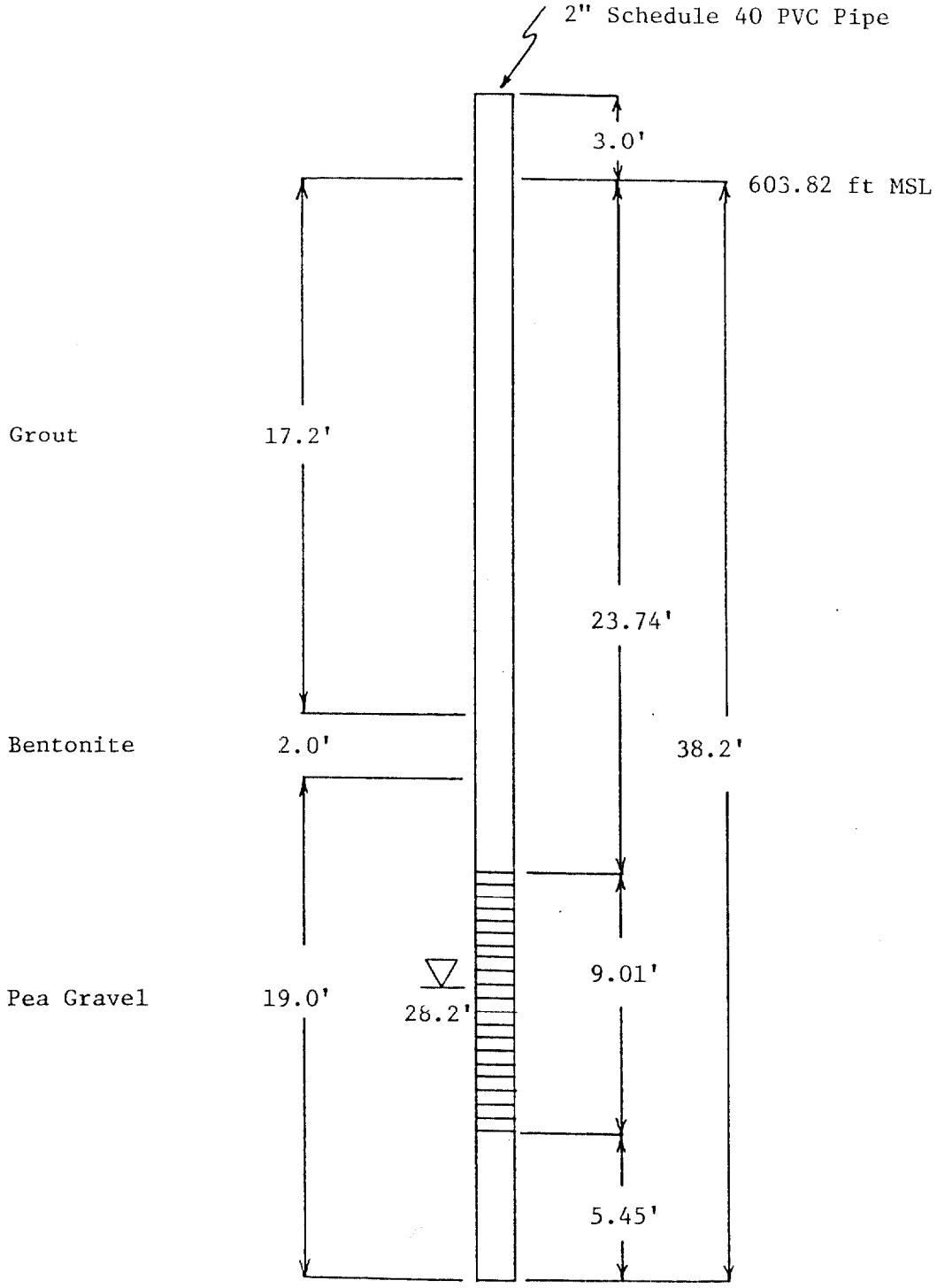
NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Well Completion
Boring Number: WES-1-19-83



Water depth at time of drilling

Well Screen

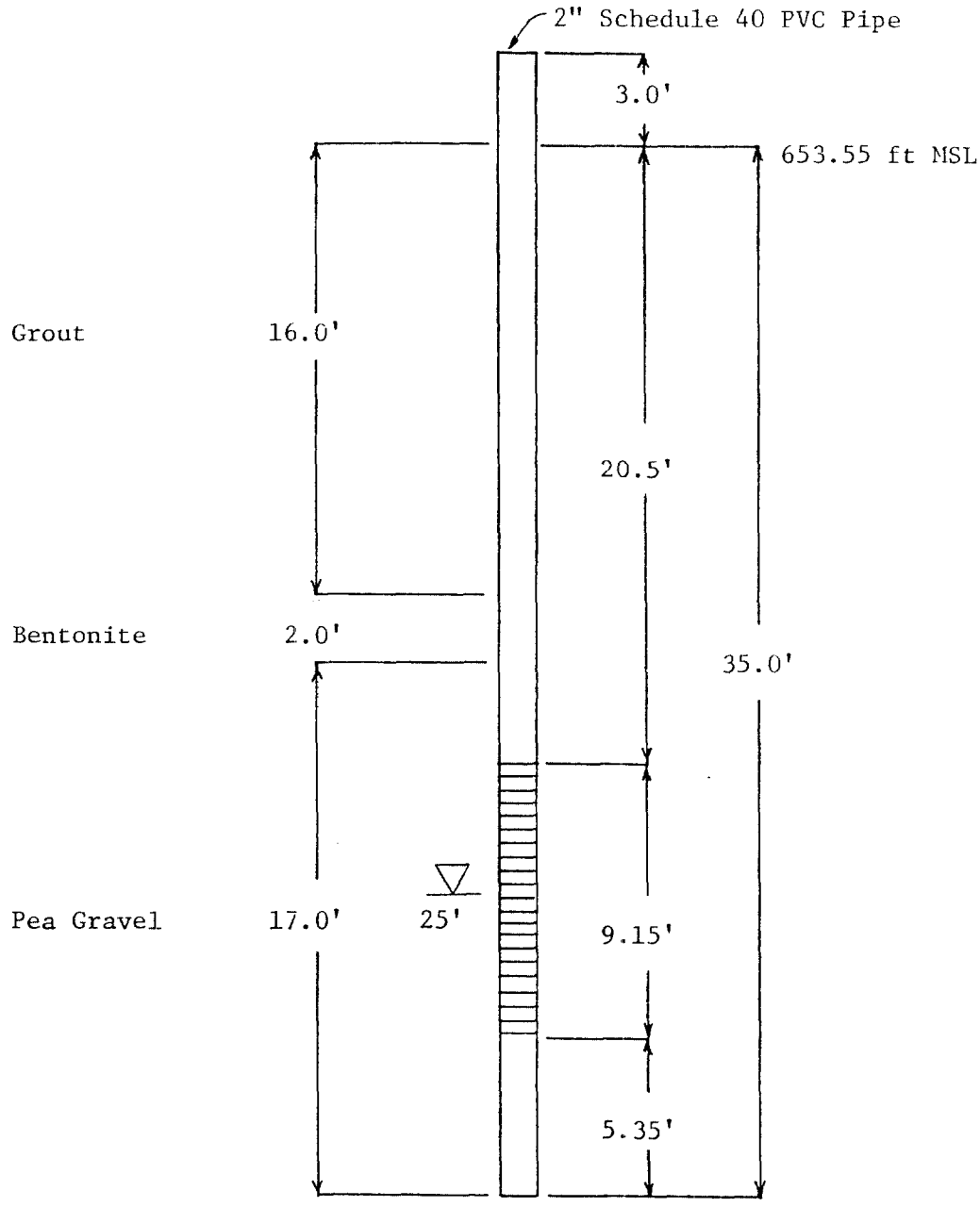
NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Well Completion
Boring Number: WES-1-20-83



Water depth at time of drilling

Well Screen

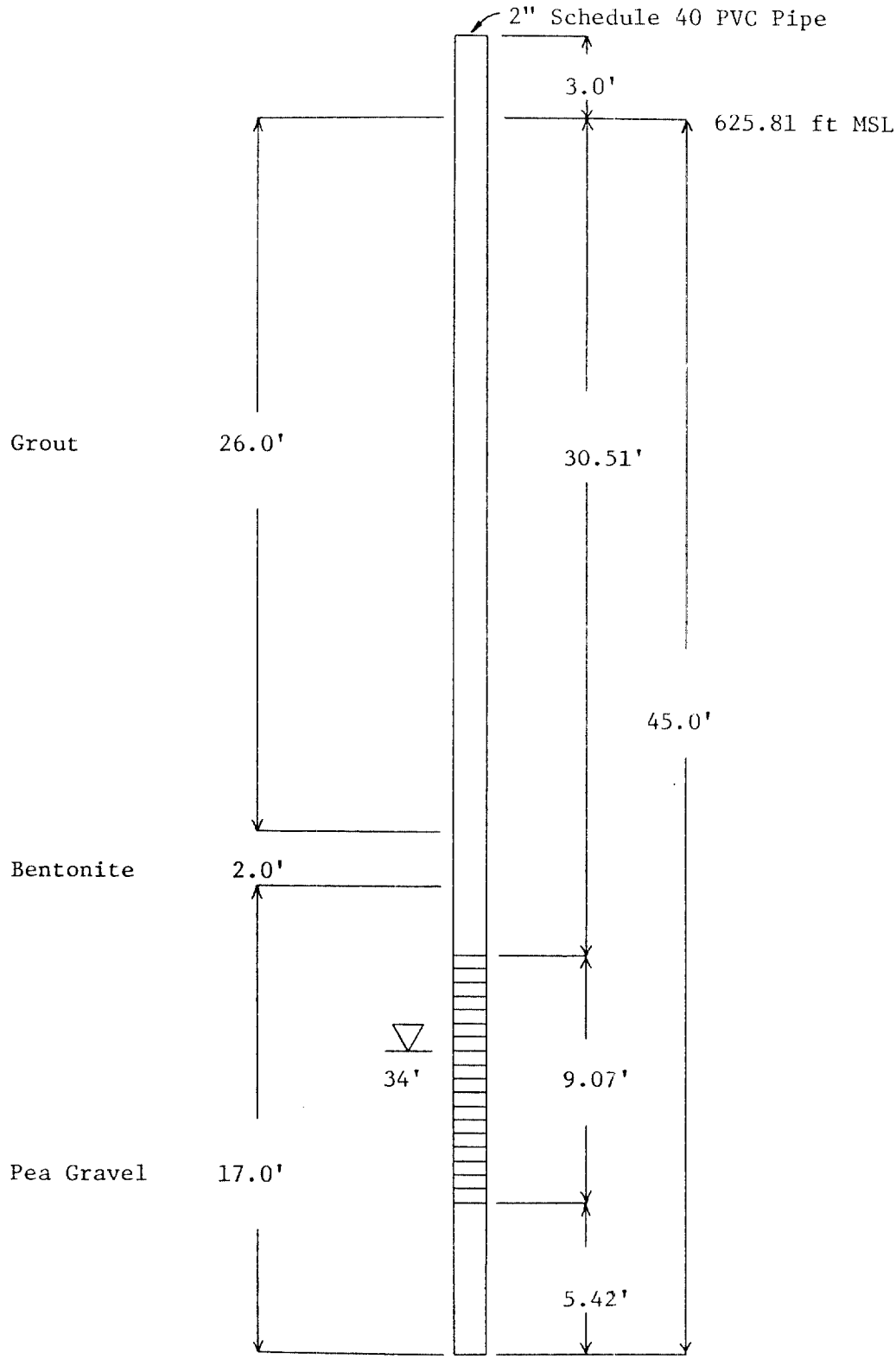
NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Well Completion
Boring Number: WES-1-21-83



Water depth at time of drilling

Well Screen

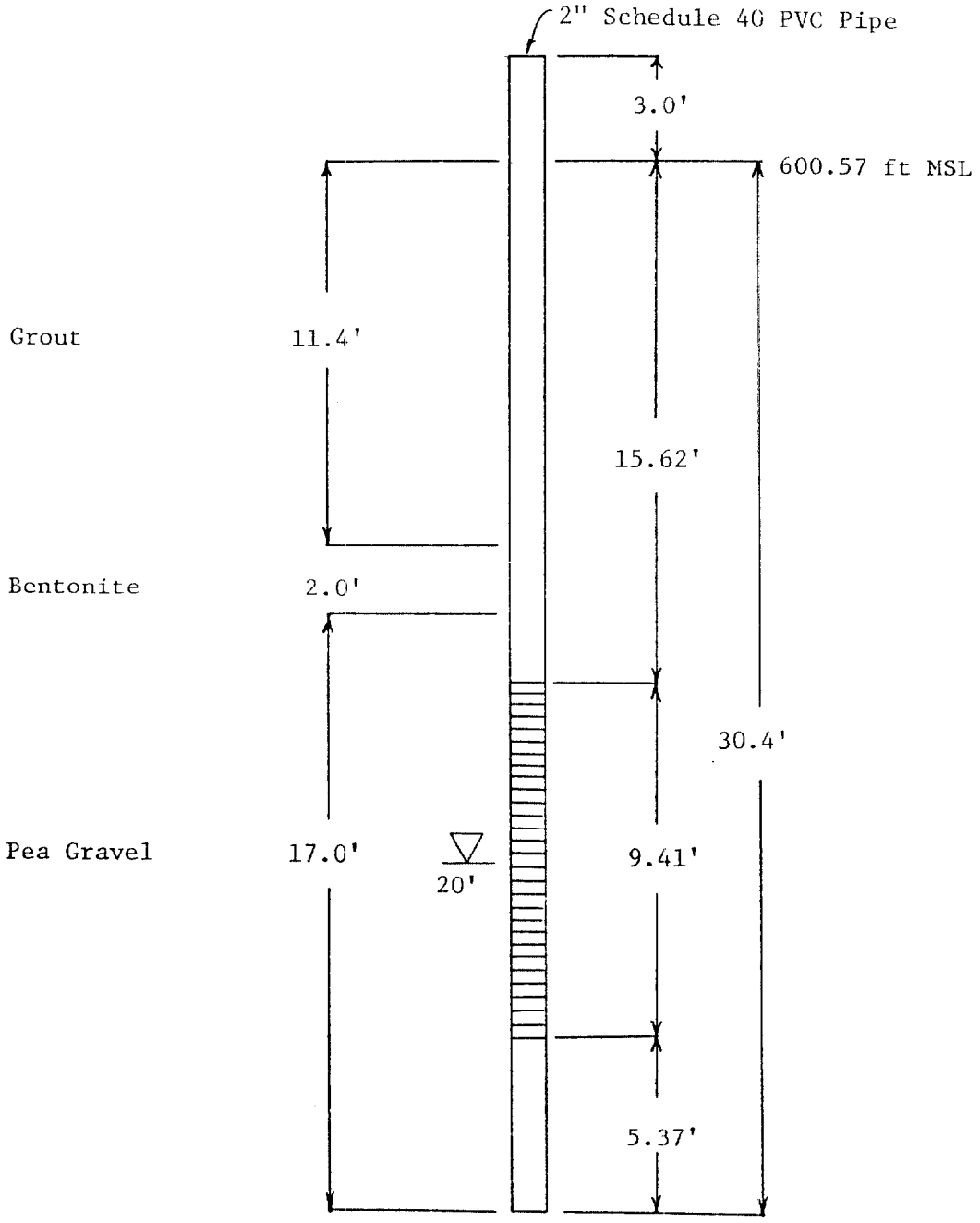
NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Well Completion
Boring Number: WES-1-22-83



Water depth at time of drilling

Well Screen

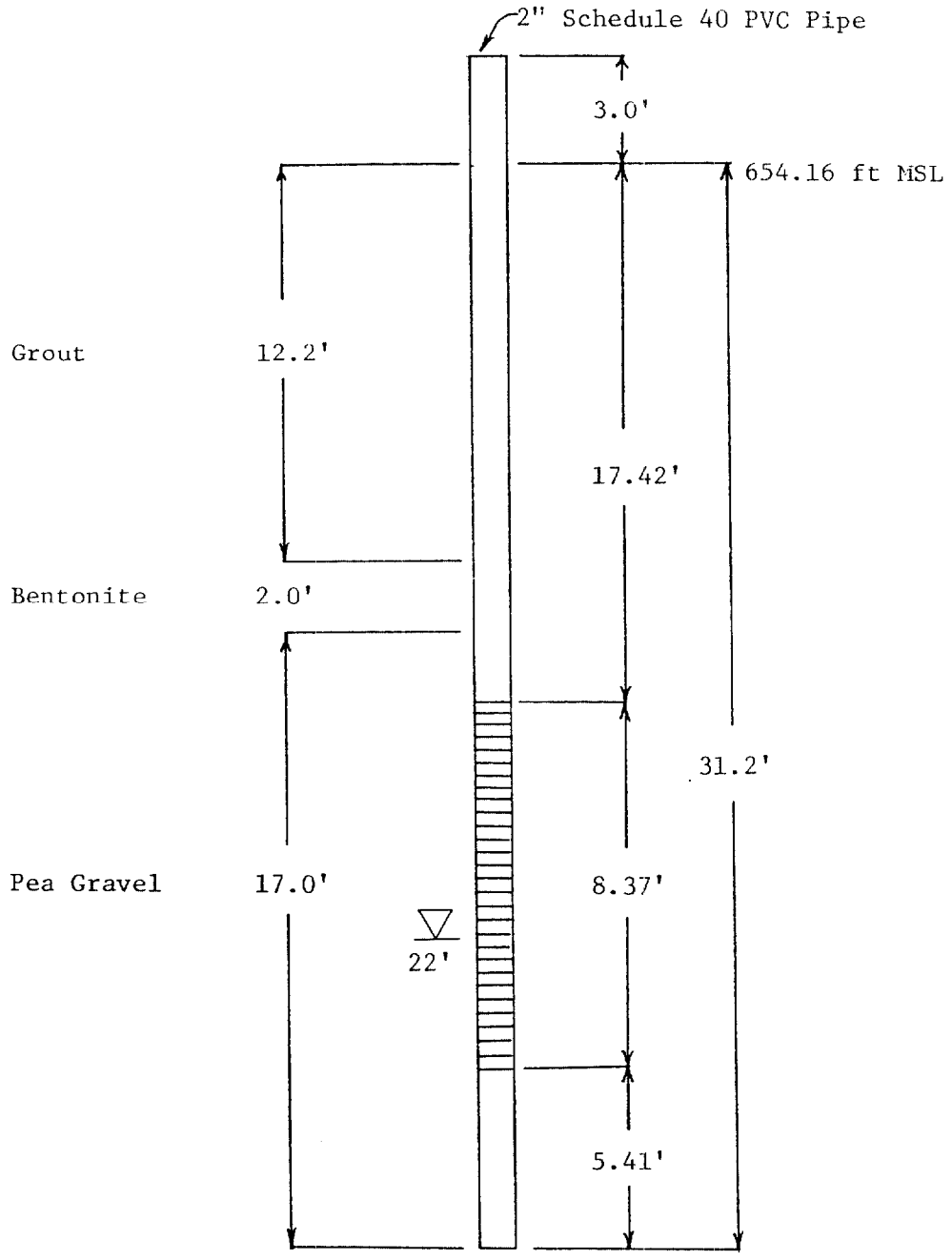
NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Well Completion
Boring Number: WES-1-23-83



Water depth at time of drilling

Well Screen

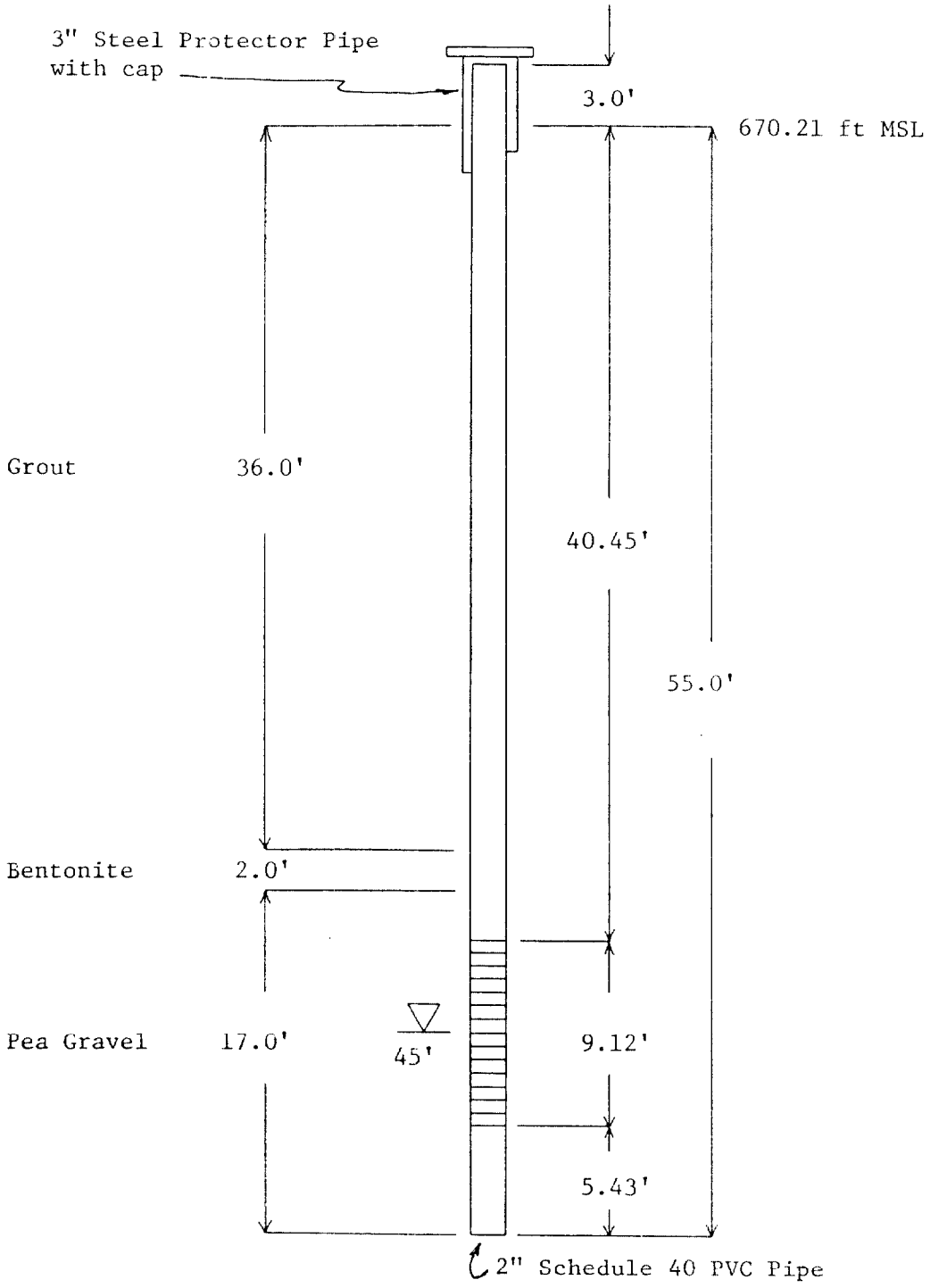
NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Well Completion
Boring Number: WES-1-24-83



Water depth at time of drilling

Well Screen

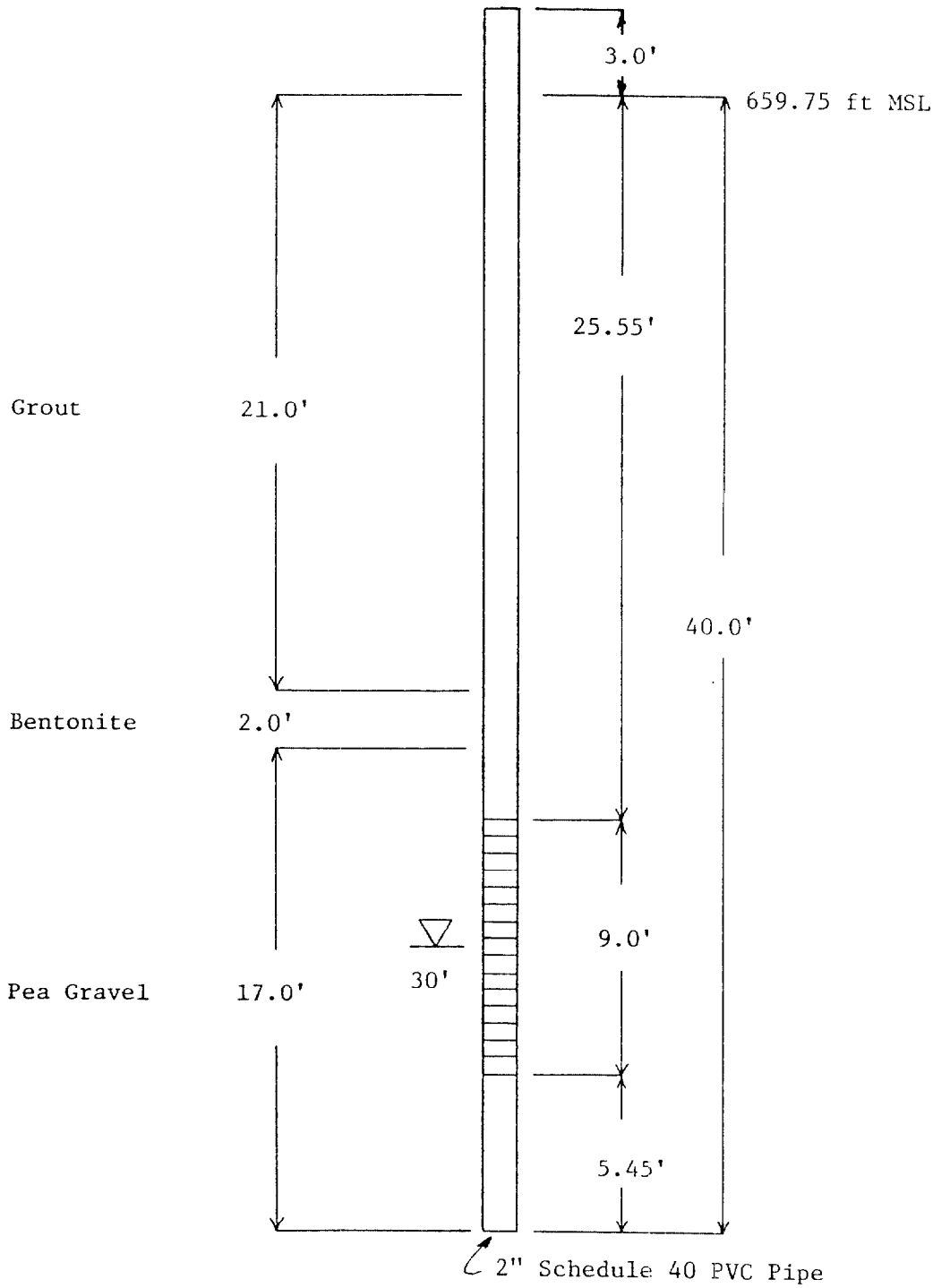
NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Well Completion
Boring Number: WES-1-25-83



Water depth at time of drilling

Well Screen

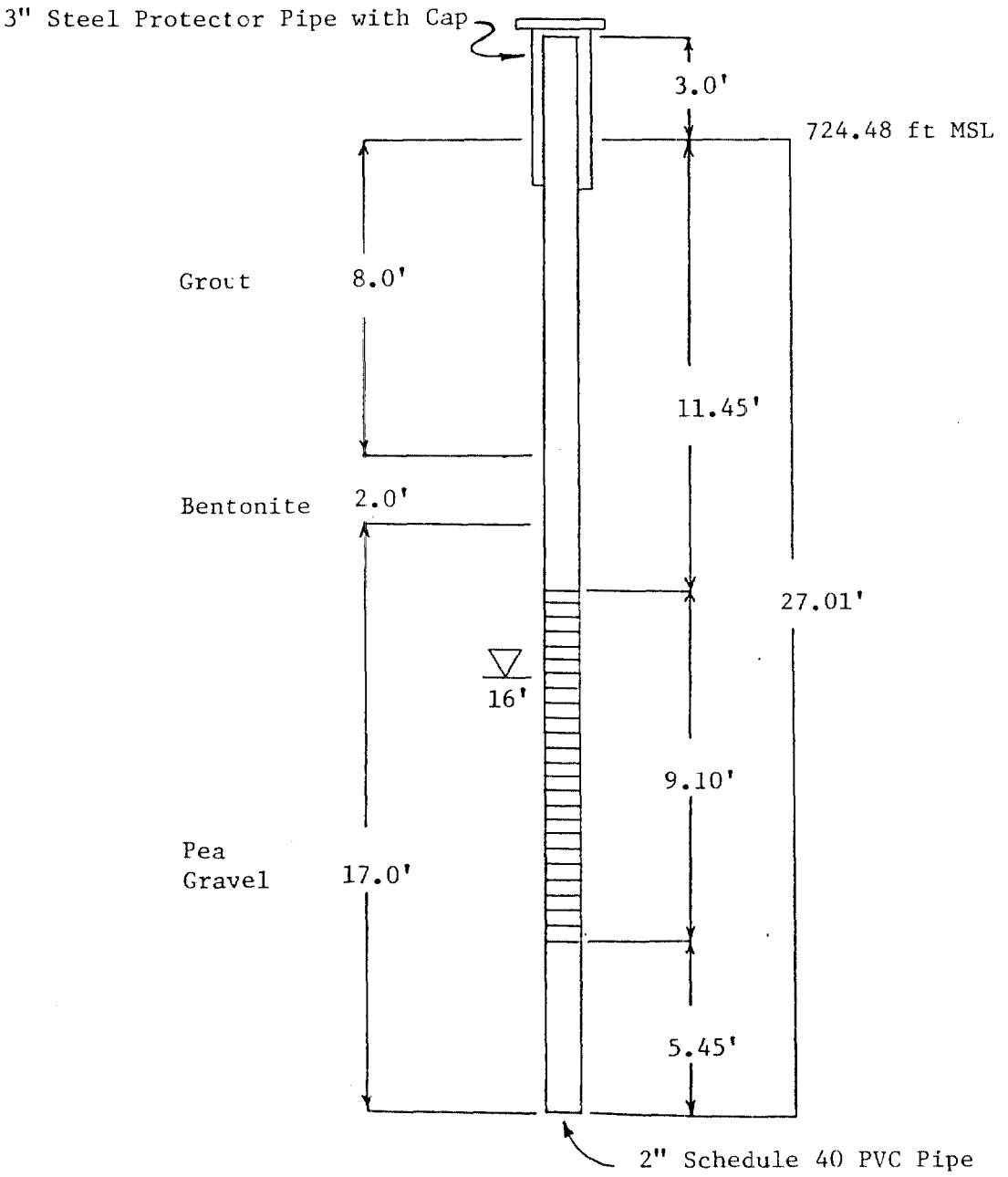
NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Well Completion
Boring Number: WES-1-26-83



Water depth of time of drilling

Well Screen

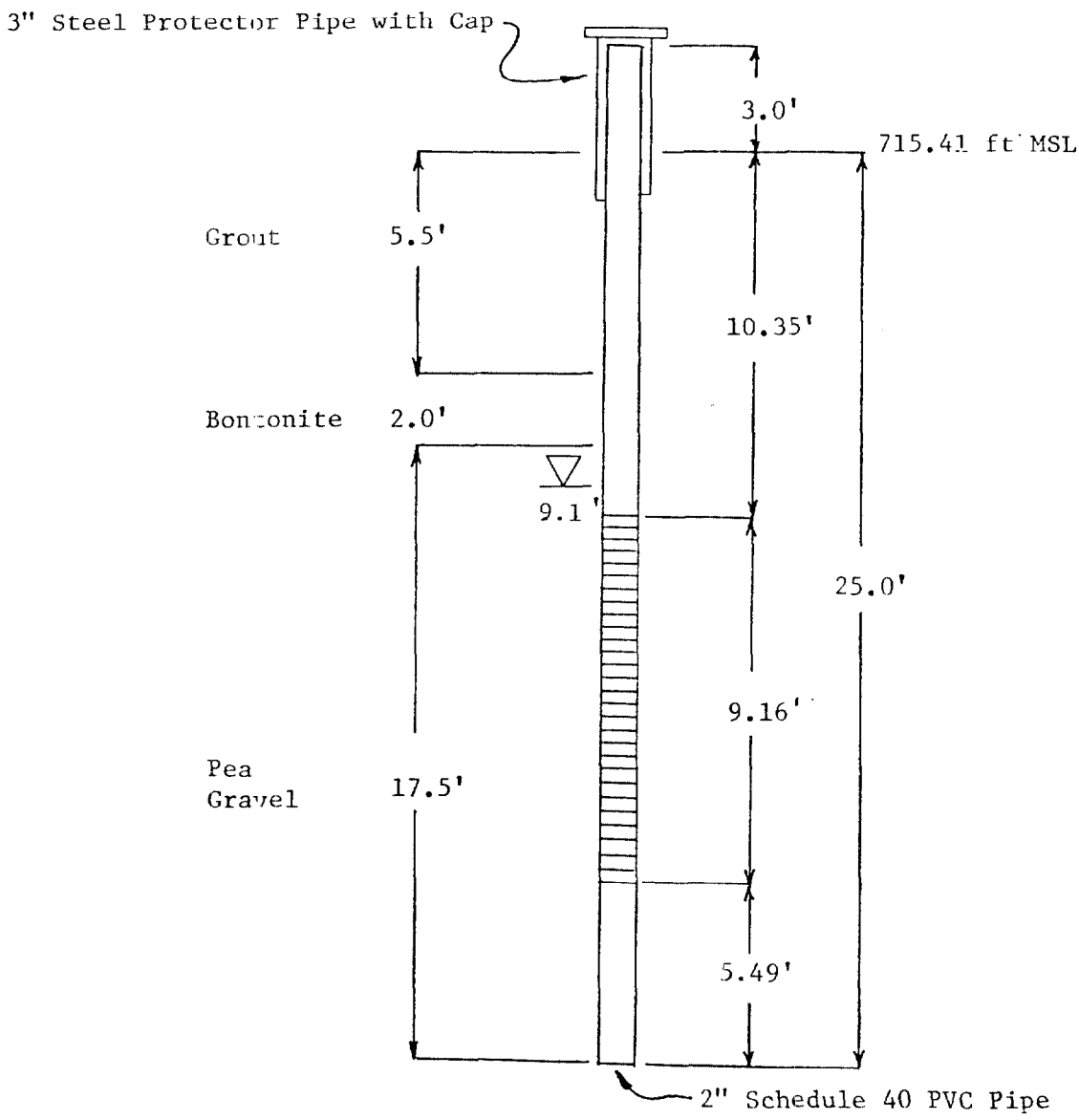
NWSC, Crane, Indiana
Lithology
Well Completion
Boring Number: WES-1-27-83



▽ Water Depth at Time of Drilling

Well Screen

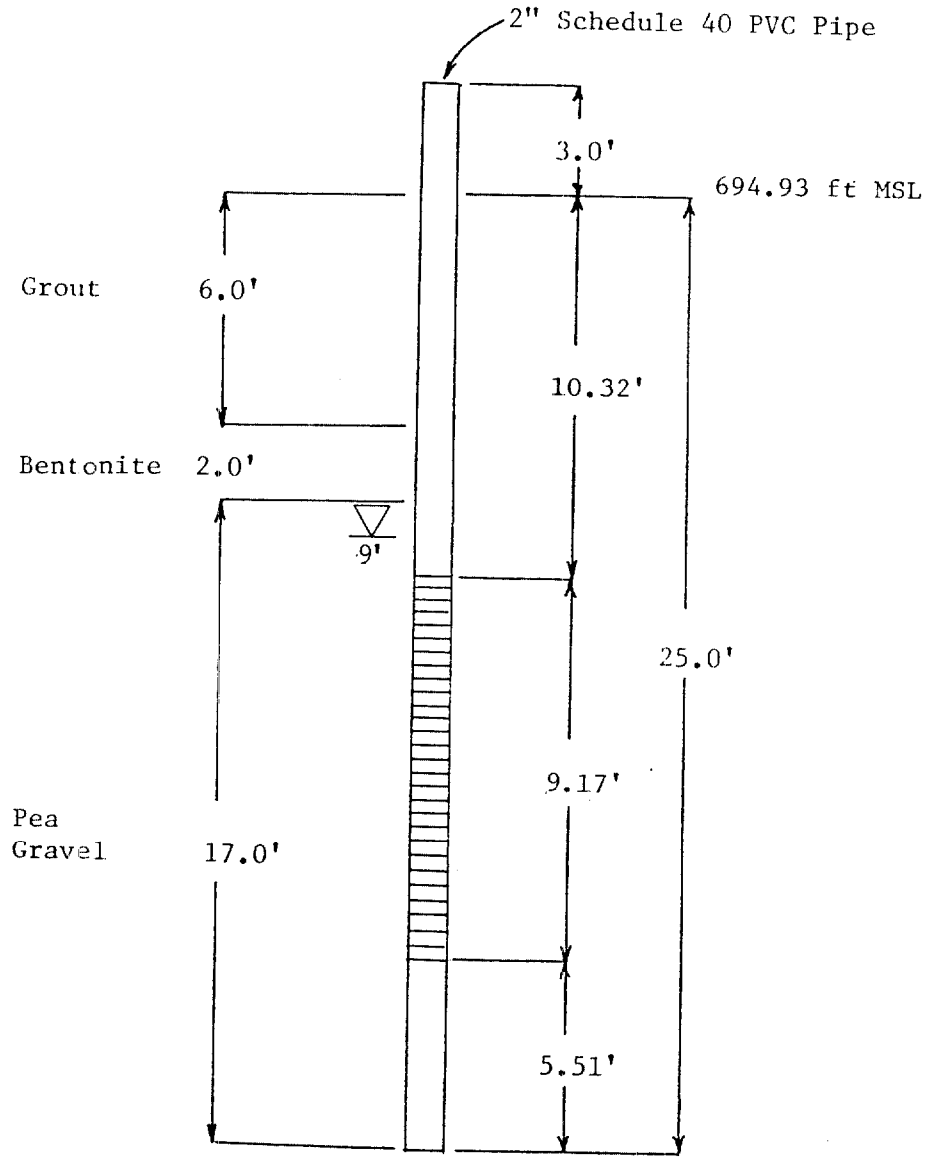
NWSC, Crane, Indiana
Pest Control Area
Well Completion
Boring Number: WES-9-10-83



Water Depth at Time of Drilling

Well Screen

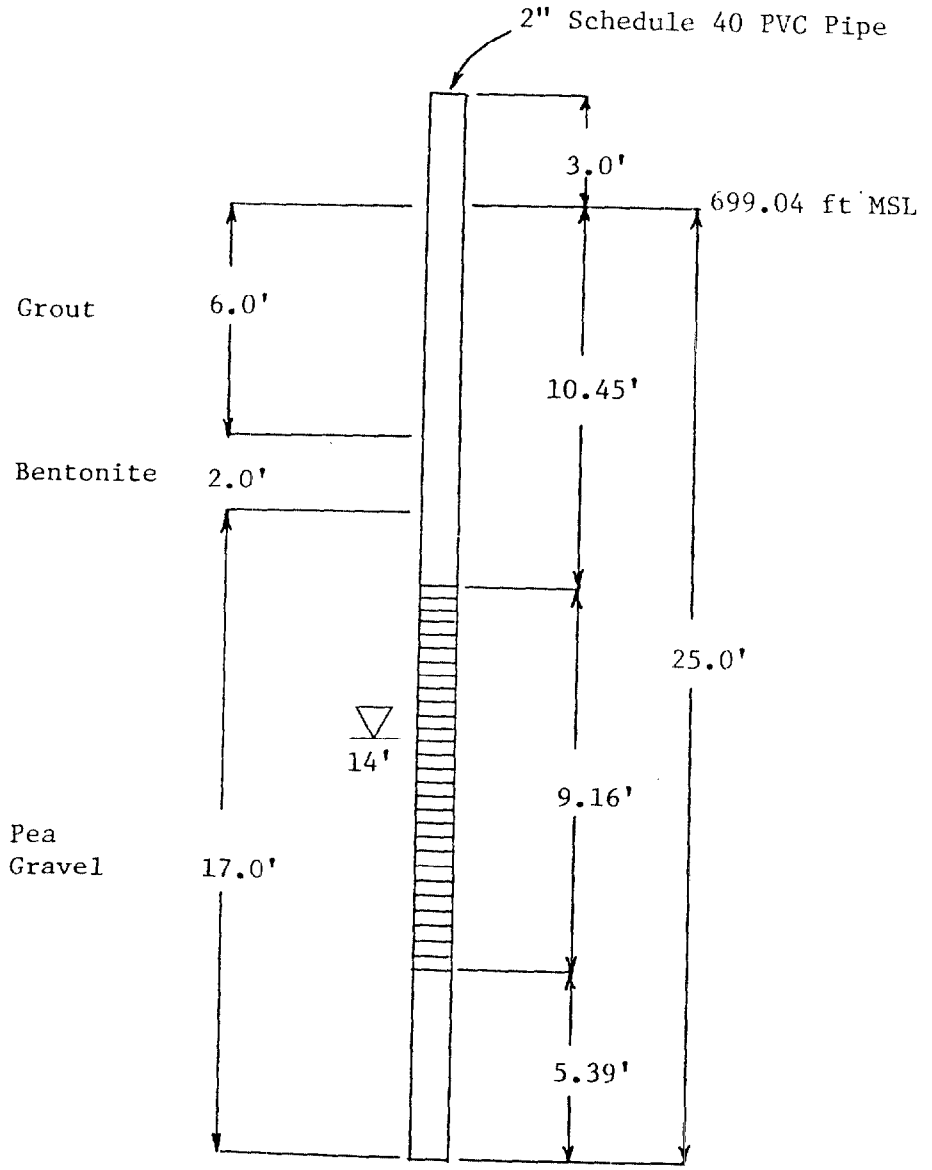
NWSC, Crane, Indiana
Pest Control Area
Well Completion
Boring Number: WES-9-11-83



Water Depth at Time of Drilling

Well Screen

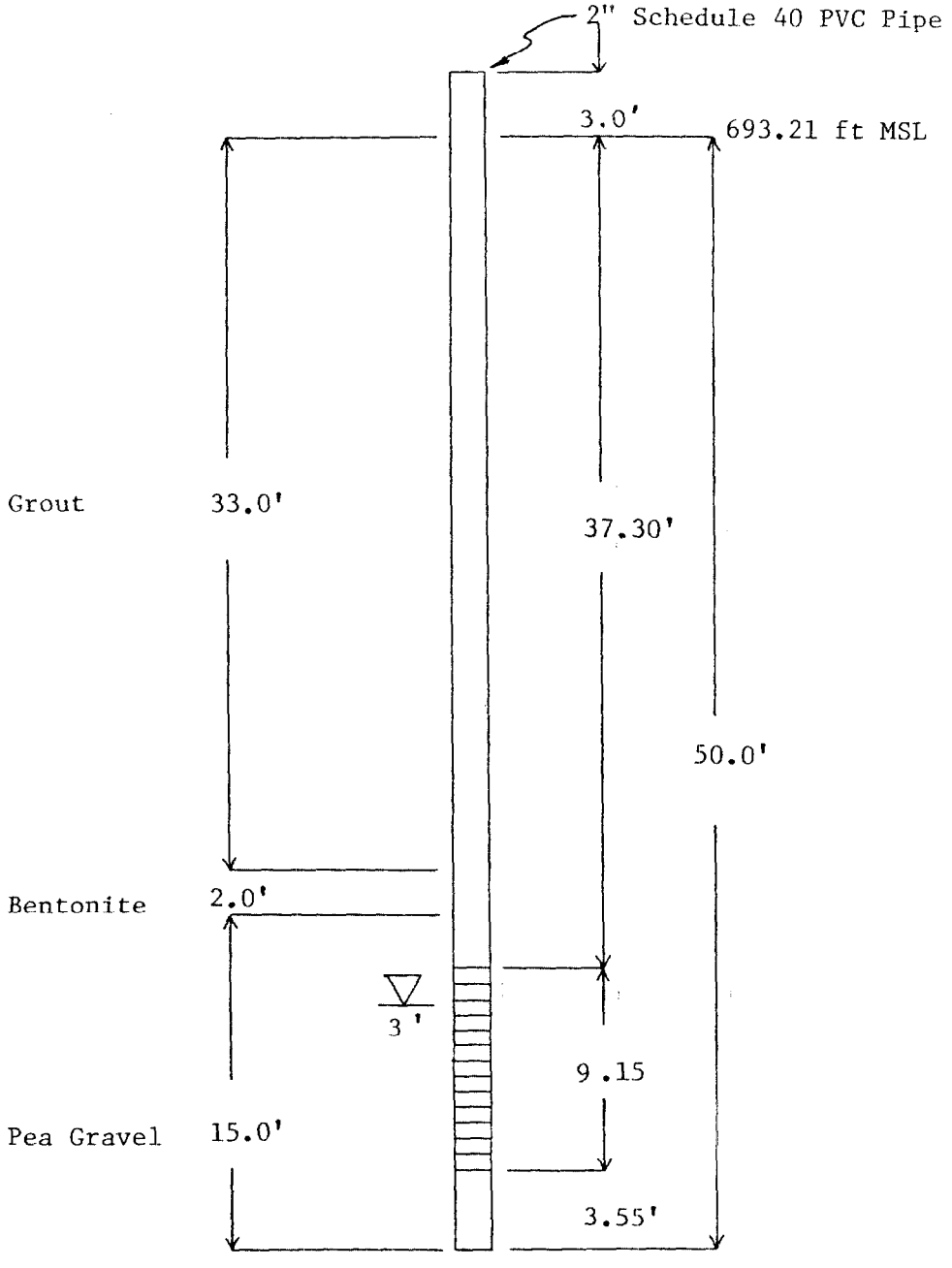
NWSC, Crane, Indiana
Pest Control Area
Well Completion
Boring Number: WES-9-12-83



Water Depth at Time of Drilling

Well Screen

NWSC, Crane, Indiana
Pest Control Area
Well Completion
Boring Number: WES-9-13-83



Water Depth at Time of Drilling

Well Screen

NWSC, Crane, Indiana
Pest Control Area
Well Completion
Boring Number: WES-9-14-83

APPENDIX D

GROUND-WATER ELEVATIONS

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-1-81

Top of Pipe Elevation: 686.14 ft MSL

Screen Interval Elevation: from 650.00 to 640.37 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:51	24.90	661.24	
6 Jul 83	12:08	25.32	660.82	
13 Jul 83	1:45	25.18	660.96	
20 Jul 83	8:13	25.29	660.85	
27 Jul 83	3:15	25.63	660.51	
3 Aug 83	8:51	25.60	660.54	
10 Aug 83	11:17	25.59	660.55	
17 Aug 83	9:11	25.59	660.55	
24 Aug 83	10:43	25.79	660.35	
14 Sep 83	3:52	26.05	660.09	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-2-81

Top of Pipe Elevation: 667.04 ft MSL

Screen Interval Elevation: from 655.80 to 646.44 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:46	11.40	655.64	
6 Jul 83	12:15	12.05	654.99	
13 Jul 83	1:51	12.09	654.95	
20 Jul 83	8:23	12.21	654.83	
27 Jul 83	3:52	12.40	654.64	
3 Aug 83	9:25	12.65	654.39	
10 Aug 83	11:23	12.79	654.25	
17 Aug 83	10:07	12.77	654.27	
24 Aug 83	11:32	13.20	653.84	
14 Sep 83	4:01	13.50	653.54	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-3-81

Top of Pipe Elevation: 670.43 ft MSL

Screen Interval Elevation: from 663.44 to 654.02 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:54	9.37	661.06	
6 Jul 83	12:05	10.25	660.18	
13 Jul 83	1:42	10.62	659.81	
20 Jul 83	8:16	10.68	659.75	
27 Jul 83	3:18	11.25	659.18	
3 Aug 83	8:53	11.22	659.21	
10 Aug 83	11:12	11.55	658.88	
17 Aug 83	9:13	11.48	658.95	
24 Aug 83	10:47	12.00	658.43	
14 Sep 83	3:55	12.53	657.90	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-4-81

Top of Pipe Elevation: 672.95 ft MSL

Screen Interval Elevation: from 653.48 to 644.27 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:49	14.18	658.77	
6 Jul 83	12:11	14.55	658.40	
13 Jul 83	1:47	14.70	658.25	
20 Jul 83	8:20	14.85	658.10	
27 Jul 83	3:48	16.05	656.90	
3 Aug 83	9:23	15.37	657.58	
10 Aug 83	11:20	15.45	657.50	
17 Aug 83	10:04	15.49	657.46	
24 Aug 83	11:28	15.87	657.08	
14 Sep 83	3:58	16.28	656.67	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-5-81

Top of Pipe Elevation: 668.69 ft MSL

Screen Interval Elevation: from 649.51 to 640.39 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:47	13.0	655.69	
6 Jul 83	12:17	13.73	654.96	
13 Jul 83	1:49	13.85	654.84	
20 Jul 83	8:21	14.03	654.66	
27 Jul 83	3:50	15.20	653.49	
3 Aug 83	9:25	14.45	654.24	
10 Aug 83	11:22	14.52	654.17	
17 Aug 83	10:05	14.62	654.07	
24 Aug 83	11:30	15.04	653.65	
14 Sep 83	3:59	15.35	653.34	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-6-82

Top of Pipe Elevation: 599.02 ft MSL

Screen Interval Elevation: from 521.00 to 511.62 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:34	70.45	528.57	
6 Jul 83	12:22	69.58	529.44	
20 Jul 83	3:49	69.70	529.32	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-7-82

Top of Pipe Elevation: 606.45 ft MSL*

Screen Interval Elevation: from 590.84 to 581.46 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
22 Jun 83	11:16	15.85	590.60	
28 Jun 83	3:30	15.98	590.47	
6 Jul 83	12:25	16.53	589.92	
13 Jul 83	1:58	16.24	590.21	
20 Jul 83	8:52	17.10	589.35	
27 Jul 83	3:40	17.18	589.27	
3 Aug 83	9:05	17.46	588.99	
10 Aug 83	10:50	17.51	588.94	
17 Aug 83	9:45	17.77	588.68	
24 Aug 83	11:21	17.80	588.65	
14 Sep 83	4:37	17.94	588.51	

* Change in top of pipe elevation

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-8-82

Top of Pipe Elevation: 604.99 ft MSL

Screen Interval Elevation: from 588.36 to 579.04 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:32	14.33	590.66	
6 Jul 83	12:23	14.72	590.27	
13 Jul 83	1:56	14.90	590.09	
20 Jul 83	8:50	14.91	590.08	
27 Jul 83	3:42	15.15	589.84	
3 Aug 83	9:07	15.08	589.91	
10 Aug 83	10:48	15.17	589.82	
17 Aug 83	9:43	15.37	589.62	
24 Aug 83	11:19	16.31	588.68	
14 Sep 83	4:34	15.67	589.32	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-9-82

Top of Pipe Elevation: 613.18 ft MSL

Screen Interval Elevation: from 592.78 to 583.40 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:36	19.27	593.93	
6 Jul 83	12:19	20.22	592.96	
13 Jul 83	1:55	20.87	592.31	
20 Jul 83	8:47	21.50	591.68	
27 Jul 83	3:44	22.00	591.18	
3 Aug 83	9:09	21.87	591.37	
10 Aug 83	10:46	21.40	591.78	
17 Aug 83	9:41	21.73	591.45	
24 Aug 83	11:17	22.09	591.09	
14 Sep 83	4:32	22.38	590.80	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-10-83

Top of Pipe Elevation: 639.77 ft MSL

Screen Interval Elevation: from 611.52 to 602.12 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:38	23.78	615.99	
6 Jul 83	12:17	24.57	615.20	
13 Jul 83	1:53	24.68	615.09	
20 Jul 83	8:45	25.18	614.59	
27 Jul 83	3:58	25.34	614.43	
3 Aug 83	9:09	25.75	614.02	
10 Aug 83	10:28	25.72	614.05	
17 Aug 83	10:10	25.94	613.83	
24 Aug 83	11:34	26.14	613.63	
14 Sep 83	4:30	26.45	613.32	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-11-83

Top of Pipe Elevation: 659.34 ft MSL

Screen Interval Elevation: from 649.62 to 640.99 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:39	10.00	649.34	
6 Jul 83	12:40	7.57	651.77	
13 Jul 83	2:16	7.97	651.37	
20 Jul 83	8:26	8.00	651.34	
27 Jul 83	3:53	8:23	651.11	
3 Aug 83	9:26	8.33	651.01	
10 Aug 83	11:24	8.28	651.06	
17 Aug 83	10:21	8.44	650.90	
24 Aug 83	11:44	8.56	650.78	
14 Sep 83	4:03	9.04	650.30	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-12-83

Top of Pipe Elevation: 637.05 ft MSL

Screen Interval Elevation: from 610.79 to 601.38 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
28 Jun 83	3:41	23.76	613.29	
6 Jul 83	12:32	24.39	612.66	
13 Jul 83	3:12	24.82	612.23	
20 Jul 83	8:42	24.91	612.14	
27 Jul 83	3:55	25.25	611.80	
3 Aug 83	9:11	25.47	611.58	
10 Aug 83	10:32	25.52	611.53	
17 Aug 83	10:14	25.62	611.43	
24 Aug 83	11:37	26.19	610.86	
14 Sep 83	4:27	25.85	611.20	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-18-83

Top of Pipe Elevation: 661.40 ft MSL

Screen Interval Elevation: from 644.10 to 634.81 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
20 Jun 83	10:40	14.04	644.36	
21 Jun 83	8:58	13.18	648.20	
22 Jun 83	10:58	13.10	648.30	
23 Jun 83	8:29	13.10	648.30	
24 Jun 83	4:25	13.02	648.38	
25 Jun 83	9:16	12.95	648.45	
27 Jun 83	10:30	13.34	648.06	Sampled well
28 Jun 83	3:19	13.32	648.08	
6 Jul 83	12:50	13.62	647.78	
13 Jul 83	2:30	13.55	647.85	
20 Jul 83	8:18	13.74	647.66	
27 Jul 83	3:20	13.85	647.55	
3 Aug 83	8:55	14.14	647.26	
10 Aug 83	11:10	14.08	647.32	
17 Aug 83	9:15	14.00	647.40	
24 Aug 83	10:48	14.37	647.03	
14 Sep 83	4:05	14.58	646.82	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-19-83

Top of Pipe Elevation: 659.79 ft MSL

Screen Interval Elevation: from 641.09 to 632.09 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
20 Jun 83	1:17	19.20	637.59	
21 Jun 83	9:01	20.10	639.69	
22 Jun 83	11:04	20.10	639.69	
23 Jun 83	8:32	20.10	639.69	
24 Jun 83	4:27	19.95	639.84	
25 Jun 83	9:28	19.95	639.84	
27 Jun 83	11:44	19.95	639.84	Sampled well
28 Jun 83	3:23	19.87	639.92	
6 Jul 83	12:47	20.20	639.59	
13 Jul 83	2:24	20.00	639.79	
20 Jul 83	8:33	20.00	639.79	
27 Jul 83	3:28	20.15	639.64	
3 Aug 83	9:15	20.15	639.64	
10 Aug 83	10:53	20.14	639.65	
17 Aug 83	9:25	20.00	639.77	
24 Aug 83	11:01	20.26	639.53	
14 Sep 83	4:17	20.35	639.44	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-20-83

Top of Pipe Elevation: 634.35 ft MSL

Screen Interval Elevation: from 610.00 to 600.66 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
22 Jun 83	11:10	24.55	609.80	
23 Jun 83	8:44	24.50	609.85	
24 Jun 83	4:30	24.50	609.85	
25 Jun 83	9:55	24.52	609.83	
27 Jun 83	11:26	24.55	609.80	Sampled well
28 Jun 83	3:25	24.65	609.70	
6 Jul 83	12:29	25.04	609.31	
13 Jul 83	2:08	25.42	608.93	
20 Jul 83	8:39	25.78	608.57	
27 Jul 83	3:34	26.20	608.15	
3 Aug 83	8:58	26.57	607.78	
10 Aug 83	10:37	26.72	607.63	
17 Aug 83	9:34	27.14	607.21	
24 Aug 83	11:08	27.40	606.95	
14 Sep 83	4:24	28.00	606.35	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-21-83

Top of Pipe Elevation: 606.82 ft MSL

Screen Interval Elevation: from 580.08 to 571.07 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
22 Jun 83	11:14	10.52	596.30	
23 Jun 83	8:50	10.55	596.27	
24 Jun 83	4:33	15.43	591.39	
25 Jun 83	10:20	15.61	591.21	
27 Jun 83	11:05	15.10	591.72	Sampled well
28 Jun 83	3:28	16.10	590.72	
6 Jul 83	12:27	16.53	590.29	
13 Jul 83	2:00	16.95	589.87	
20 Jul 83	8:53	17.05	589.77	
27 Jul 83	3:38	17.28	589.54	
3 Aug 83	9:04	17.59	589.23	
10 Aug 83	10:53	17.57	589.25	
17 Aug 83	9:47	17.63	589.19	
24 Aug 83	11:25	17.98	588.84	
14 Sep 83	4:38	18.24	588.58	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-22-83

Top of Pipe Elevation: 656.55 ft MSL

Screen Interval Elevation: from 633.05 to 623.90 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
9 Jul 83	8:28	16.75	639.80	
11 Jul 83	11:52	17.25	639.30	
12 Jul 83	3:50	17.25	639.30	
13 Jul 83	2:26	17.30	639.25	
14 Jul 83	8:49	17.30	639.25	Sampled well
15 Jul 83	10:05	17.25	639.30	
16 Jul 83	4:18	17.20	639.35	
18 Jul 83	11:08	17.15	639.40	
19 Jul 83	2:53	17.18	639.37	
20 Jul 83	8:35	17.25	639.30	
27 Jul 83	3:29	17.20	639.35	
3 Aug 83	9:16	17.43	639.12	
10 Aug 83	11:00	17.31	639.24	
17 Aug 83	9:24	17.32	639.23	
24 Aug 83	10:59	17.43	639.12	
14 Sep 83	4:16	17.55	639.00	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-23-83

Top of Pipe Elevation: 628.81 ft MSL

Screen Interval Elevation: from 595.30 to 586.23 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
11 Jul 83	8:00	34.00	591.81	Open hole
12 Jul 83	3:55	39.00	589.81	
13 Jul 83	2:07	39.23	589.58	
14 Jul 83	8:30	39.75	589.06	Sampled well
15 Jul 83	10:07	39.87	588.94	
16 Jul 83	4:17	39.75	589.06	
18 Jul 83	11:05	39.90	588.91	
19 Jul 83	2:49	39.90	588.91	
20 Jul 83	8:37	39.95	588.86	
27 Jul 83	3:32	39.90	588.91	
3 Aug 83	8:59	39.95	588.86	
10 Aug 83	10:40	40.00	588.81	
17 Aug 83	9:36	40.03	588.78	
24 Aug 83	11:09	40.00	588.81	
14 Sep 83	4:22	40.05	588.76	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-24-83

Top of Pipe Elevation: 603.57 ft MSL

Screen Interval Elevation: from 584.95 to 575.54 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
11 Jul 83	12:04	13.57	590.00	
12 Jul 83	4:00	13.65	589.92	
13 Jul 83	2:03	13.78	589.79	
14 Jul 83	3:17	13.71	589.86	Sampled well
15 Jul 83	10:10	13.80	589.77	
16 Jul 83	4:15	13.75	589.82	
18 Jul 83	11:00	13.90	589.67	
19 Jul 83	2:50	14.00	589.57	
20 Jul 83	8:55	14.05	589.52	
27 Jul 83	3:37	14.22	589.35	
3 Aug 83	9:01	14.45	589.12	
10 Aug 83	10:43	14.56	589.01	
17 Aug 83	9:38	14.63	588.94	
24 Aug 83	11:14	14.84	588.73	
14 Sep 83	4:40	15.18	588.39	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-25-83

Top of Pipe Elevation: 657.16 ft MSL

Screen Interval Elevation: from 636.74 to 628.37 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
3 Aug 83	3:07	19.86	637.30	
9 Aug 83	3:50	19.91	637.25	
10 Aug 83	1[illegible]:02	19.90	637.26	
11 Aug 83	[illegible]:14	19.68	637.48	
12 Aug 83	8:35	19.92	637.24	
13 Aug 83	9:29	20.00	637.16	
15 Aug 83	3:19	19.59	637.57	
17 Aug 83	9:22	19.88	637.28	
24 Aug 83	10:57	20.13	637.03	
14 Sep 83	4:14	20.10	637.06	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-26-83

Top of Pipe Elevation: 673.21 ft MSL

Screen Interval Elevation: from 629.76 to 620.64 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
8 Aug 83	3:13	34.80	638.41	
9 Aug 83	3:52	34.85	638.36	
10 Aug 83	11:08	34.45	638.76	
11 Aug 83	1:17	34.72	638.49	
12 Aug 83	8:40	34.88	638.33	
13 Aug 83	9:32	35.05	638.16	
15 Aug 83	3:21	34.91	638.30	
17 Aug 83	9:19	34.92	638.29	
24 Aug 83	10:55	35.30	637.91	
14 Sep 83	4:13	35.25	637.96	

Ground-Water Elevations

Mustard Gas Burial Grounds

Boring Number: WES-1-27-83

Top of Pipe Elevation: 662.75 ft MSL

Screen Interval Elevation: from 634.20 to 625.20 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
11 Aug 83	1:20	23.60	639.15	
12 Aug 83	8:43	23.47	639.28	
13 Aug 83	9:35	23.45	639.30	
15 Aug 83	3:23	23.38	639.37	
17 Aug 83	9:17	23.40	639.35	
24 Aug 83	10:52	23.71	639.04	
14 Sep 83	4:11	23.86	638.89	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-1-81

Top of Pipe Elevation: 737.32 ft MSL

Screen Interval Elevation: from 715.77 to 706.62 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
19 Jul 83	10:48	14.90	722.42	Purged well
20 Jul 83	7:45	16.50	720.82	Sampled well
5 Aug 83	2:00	15.90	721.42	
1 Sep 83	1:09	16.45	720.87	
8 Sep 83	12:58	16.90	720.42	
15 Sep 83	9:02	17.14	720.18	
22 Sep 83	3:28	17.26	720.06	
29 Sep 83	10:21	17.54	719.78	
6 Oct 83	11:04	17.63	719.69	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-2-81

Top of Pipe Elevation: 726.80 ft MSL

Screen Interval Elevation: from 718.70 to 710.10 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
19 Jul 83	10:00	9.42	717.38	Purged well
20 Jul 83	7:30	13.80	713.00	Sampled well
5 Aug 83	1:53	11.25	715.55	
1 Sep 83	12:51	12.50	714.30	
8 Sep 83	12:48	12.78	714.02	
15 Sep 83	8:50	13.20	713.60	
22 Sep 83	3:18	13.38	713.42	
29 Sep 83	10:32	13.65	713.15	
6 Oct 83	10:48	13.40	713.40	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-3-81

Top of Pipe Elevation: 709.78 ft MSL

Screen Interval Elevation: from 703.08 to 697.18 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
19 Jul 83	1:30	4.70	705.08	Purged well
20 Jul 83	7:45	5.80	703.98	Sampled well
5 Aug 83	2:23	4.75	705.03	
1 Sep 83	1:29	5.55	704.23	
8 Sep 83	1:18	5.86	703.92	
15 Sep 83	9:22	6.00	703.78	
22 Sep 83	3:39	6.23	703.55	
29 Sep 83	9:44	6.44	703.34	
6 Oct 83	11:15	6.35	703.43	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-4-81

Top of Pipe Elevation: 724.93 ft MSL

Screen Interval Elevation: from 706.13 to 696.81 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
19 Jul 83	11:30	18.50	706.43	Purged well
20 Jul 83	8:00	19.80	705.13	Sampled well
5 Aug 83	2:17	15.46	709.47	
1 Sep 83	1:20	16.42	708.51	
8 Sep 83	1:12	16.45	708.48	
15 Sep 83	9:16	16.78	708.15	
22 Sep 83	3:36	16.89	708.04	
29 Sep 83	10:19	17.03	707.90	
6 Oct 83	11:11	17.03	707.90	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-5-81

Top of Pipe Elevation: 718.52 ft MSL

Screen Interval Elevation: from 706.72 to 697.34 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
19 Jul 83	11:35	9.50	709.02	Purged well
20 Jul 83	8:00	12.30	706.22	Sampled well
5 Aug 83	2:11	11.65	706.87	
1 Sep 83	1:15	11.95	706.57	
8 Sep 83	1:10	12.17	706.35	
15 Sep 83	9:12	12.47	706.05	
22 Sep 83	3:32	12.51	706.01	
29 Sep 83	10:15	12.80	705.72	
6 Oct 83	11:08	12.91	705.61	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-6-81

Top of Pipe Elevation: 722.65 ft MSL

Screen Interval Elevation: from 713.12 to 703.97 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
20 Jul 83	7:45	4.8	717.85	
5 Aug 83	2:03	3.95	718.70	
1 Sep 83	1:11	4.39	718.26	
8 Sep 83	12:56	4.78	717.87	
15 Sep 83	8:59	5.03	717.63	
22 Sep 83	3:26	5.28	717.37	
29 Sep 83	10:24	5.42	717.23	
6 Oct 83	11:01	5.46	717.19	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-7-81

Top of Pipe Elevation: 738.32 ft MSL

Screen Interval Elevation: from 715.78 to 706.76 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
19 Jul 83	10:32	15.55	722.77	Purged well
20 Jul 83	7:00	20.10	718.22	Sampled well
5 Aug 83	1:58	19.30	719.02	
1 Sep 83	1:04	19.82	718.50	
8 Sep 83	12:52	20.24	718.08	
15 Sep 83	8:56	20.37	717.95	
22 Sep 83	3:23	20.48	717.84	
29 Sep 83	10:29	20.65	717.67	
6 Oct 83	10:54	20.68	717.64	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-8-81

Top of Pipe Elevation: 723.19 ft MSL

Screen Interval Elevation: from 709.66 to 700.53 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
19 Jul 83	11:33	11.80	711.39	Purged well
20 Jul 83	8:00	13.25	709.94	Sampled well
5 Aug 83	2:14	12.08	711.11	
1 Sep 83	1:18	12.28	710.91	
8 Sep 83	1:12	12.67	710.52	
15 Sep 83	9:14	13.05	710.14	
22 Sep 83	3:34	13.05	710.14	
29 Sep 83	10:17	13.29	709.90	
6 Oct 83	11:10	13.42	709.77	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-9-81

Top of Pipe Elevation: 726.21 ft MSL

Screen Interval Elevation: from 718.96 to 712.53 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
20 Jul 83	7:30	10.90	715.31	Sampled well
5 Aug 83	1:56	9.26	716.95	
1 Sep 83	1:15	10.96	715.25	
8 Sep 83	12:49	11.15	715.06	
15 Sep 83	9:53	11.39	714.82	
22 Sep 83	3:21	11.64	714.57	
29 Sep 83	10:27	11.77	714.44	
6 Oct 83	10:51	10.24	715.97	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-10-83

Top of Pipe Elevation: 727.48 ft MSL

Screen Interval Elevation: from 713.03 to 703.93 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
19 Aug 83	8:20	8.28	719.20	
20 Aug 83	7:28	6.44	721.04	
22 Aug 83	9:54	6.11	721.37	
23 Aug 83	9:58	6.26	721.22	
24 Aug 83	8:44	6.44	721.04	
25 Aug 83	1:32	6.10	721.38	
26 Aug 83	1:36	6.05	721.43	
29 Aug 83	8:57	5.94	721.54	Sampled well
1 Sep 83	11:50	6.30	721.18	
8 Sep 83	1:02	6.60	720.88	
15 Sep 83	9:05	6.65	720.83	
22 Sep 83	3:30	6.85	720.63	
29 Sep 83	10:12	7.08	720.40	
6 Oct 83	11:06	6.88	720.60	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-11-83

Top of Pipe Elevation: 718.41 ft MSL

Screen Interval Elevation: from 705.06 to 695.90 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
19 Aug 83	8:15	9.10	706.31	Open hole
20 Aug 83	7:31	10.94	707.47	
22 Aug 83	9:56	10.84	707.57	
23 Aug 83	10:02	10.97	707.44	
24 Aug 83	8:38	11.06	707.35	
25 Aug 83	1:38	11.07	707.34	
26 Aug 83	1:34	11.08	707.33	
29 Aug 83	9:26	11.00	707.41	Sampled well
1 Sep 83	11:56	11.15	707.26	
8 Sep 83	1:16	11.17	707.24	
15 Sep 83	9:19	11.67	706.74	
22 Sep 83	3:37	11.65	706.76	
29 Sep 83	10:07	11.87	706.54	
6 Oct 83	11:13	12.00	706.41	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-12-83

Top of Pipe Elevation: 697.93 ft MSL

Screen Interval Elevation: from 684.61 to 675.44 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
20 Aug 83	7:49	3.35	691.58	Open hole
22 Aug 83	2:35	10.55	687.38	Blew well
23 Aug 83	10:07	6.21	691.72	
24 Aug 83	8:34	5.91	692.02	
25 Aug 83	1:45	5.69	692.24	
26 Aug 83	1:32	5.64	692.29	
27 Aug 83	5:57	5.26	692.67	
29 Aug 83	10:18	5.12	692.81	Sampled well
1 Sep 83	1:33	6.23	691.70	
8 Sep 83	1:22	6.31	691.62	
15 Sep 83	9:53	5.35	692.58	
22 Sep 83	3:43	5.43	692.50	
29 Sep 83	9:50	5.55	692.38	
6 Oct 83	11:18	5.40	692.53	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-13-83

Top of Pipe Elevation: 702.04 ft MSL

Screen Interval Elevation: from 688.59 to 679.43 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
22 Aug 83	10:00	5.14	696.90	
23 Aug 83	10:09	6.13	695.91	
24 Aug 83	8:33	6.24	695.80	
25 Aug 83	1:40	6.31	695.73	
26 Aug 83	1:30	6.09	695.95	
27 Aug 83	5:58	6.00	696.04	
29 Aug 83	10:01	6.04	696.00	Sampled well
1 Sep 83	1:31	6.25	695.79	
8 Sep 83	1:20	6.43	695.61	
15 Sep 83	9:51	6.54	695.50	
22 Sep 83	3:41	6.78	695.26	
29 Sep 83	9:49	6.90	695.14	
6 Oct 83	11:17	6.73	695.31	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-14A-83

Top of Pipe Elevation: 696.21 ft MSL

Screen Interval Elevation: from 655.91 to 646.76 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
1 Sep 83	1:45	44.05	650.31	Open hole - Top of casing 694.36
3 Sep 83	9:55	43.25	651.11	Open hole
8 Sep 83	1:30	43.50	650.86	Open hole
15 Sep 83	9:55	40.25	654.11	Open hole
22 Sep 83	3:45	39.70	654.66	Open hole
27 Sep 83	10:13	39.04	655.32	Open hole
28 Sep 83				Installed well
29 Sep 83				Purged well of drilling fluid
30 Sep 83	4:02	50.37	645.84	
1 Oct 83	10:38	50.32	645.89	
3 Oct 83	1:04	50.20	646.01	
4 Oct 83	3:51	50.26	645.95	
6 Oct 83	11:20	50.20	646.01	

Ground-Water Elevations

Pest Control Area

Boring Number: WES-9-14B-83

Top of Casing Elevation: 692.32 ft MSL

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
1 Sep 83	1:45	70.85	621.47	Open hole
3 Sep 83	9:55	69.95	622.37	
8 Sep 83	1:30	68.60	623.72	
15 Sep 83	9:55	25.00	667.32	
22 Sep 83	3:45	36.90	655.42	
27 Sep 83				Grouted boring-installed well into WES 9-14A-83 (located 50 ft SW of WES 9-14B-93).

Ground-Water Elevations

Pest Control Area Hazardous Waste Storage Tank

Boring Number: WT-1--83

Top of Casing Elevation: 727.68 ft MSL

Casing Height: 1.65 ft

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
21 Jul 83	12:45	10.75	716.93	
22 Jul 83	7:22	8.65	719.03	
23 Jul 83	12:21	8.41	719.27	
25 Jul 83	9:55	8.65	719.03	
26 Jul 83	10:45	8.83	718.85	
27 Jul 83	10:22	8.53	719.15	Sampled ground water
28 Jul 83	3:27	8.73	718.95	
29 Jul 83	2:25	9.00	718.68	
1 Sep 83	1:23	7.70	719.98	
8 Sep 83				Caved in
24 Sep 83				Grouted boring

Ground-Water Elevations

Pest Control Area Hazardous Waste Storage Tank

Boring Number: WT-2-83

Top of Casing Elevation: 726.42 ft MSL

Casing Height: 0.75 ft

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
21 Jul 83	12:46	8.90	717.52	
22 Jul 83	7:23	8.45	717.97	
23 Jul 83	12:22	8.39	718.03	
25 Jul 83	9:51	8.66	717.76	
26 Jul 83	10:46	8.81	717.61	
27 Jul 83	10:21	8.56	717.86	Sampled ground water
28 Jul 83	3:26	8.70	717.72	
29 Jul 83	2:26	8.72	717.70	
5 Aug 83	2:07	8.40	718.08	
1 Sep 83	1:24	8.67	717.75	
8 Sep 83	1:05	9.38	717.04	
15 Sep 83	9:07	9.45	716.97	
24 Sep 83				Grouted boring

Ground-Water Elevations

Pest Control Area Hazardous Waste Storage Tank

Boring Number: WT-3-83

Top of Casing Elevation: 726.81 ft MSL

Casing Height: 1.58 ft

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
22 Jul 83	7:25	3.02	722.76	
23 Jul 83	12:22	3.05	722.73	
25 Jul 83	9:58	3.10	722.68	
26 Jul 83	10:48	3.12	722.66	
27 Jul 83	10:20	3.22	722.56	Boring caved in
3 Aug 83	10:19	9.45	717.36	Reamed and removed fall-in
4 Aug 83	3:15	9.00	717.81	
5 Aug 83	2:06	8.75	718.06	
6 Aug 83	4:09	8.73	718.08	
8 Aug 83	2:04	8.60	718.21	
9 Aug 83	8:39	8.97	717.84	
1 Sep 83	1:25	8.80	718.01	
8 Sep 83	1:06	9.08	717.73	
15 Sep 83	9:08	9.20	717.61	
26 Sep 83				Grouted boring

Ground-Water Elevations

Pest Control Area Hazardous Waste Storage Tank

Boring Number: WT-4-83

Top of Casing Elevation: 727.34 ft MSL

Casing Height: 0.8 ft

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
23 Jul 83	12:23	7.33	720.01	
25 Jul 83	9:59	7.48	719.86	
26 Jul 83	10:49	7.52	719.82	
27 Jul 83	10:19	7.60	719.74	Sampled ground water
28 Jul 83	3:25	7.25	720.09	
29 Jul 83	2:28	7.43	719.91	
30 Jul 83	3:30	7.35	719.99	
1 Aug 83	3:30	7.20	720.14	
5 Aug 83	2:06	7.35	719.99	
1 Sep 83	1:27	7.40	719.94	
8 Sep 83	1:08	8.05	719.29	
15 Sep 83	9:09	8.10	719.24	
26 Sep 83				Grouted boring

Ground-Water Elevations

Pest Control Area Hazardous Waste Storage Tank

Top of Inlet Pipe Elevation: 727.28 ft MSL

Casing Height: 0.8 ft

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
25 Jul 83	10:06	17.20	710.08	Tank level measured with 20 ft section of PVC pipe
26 Jul 83	10:51	17.20	710.08	
27 Jul 83	10:27	17.20	710.08	
28 Jul 83	3:30	17.20	710.08	
29 Jul 83	2:34	17.20	710.08	
30 Jul 83	3:34	17.20	710.08	
1 Aug 83	3:32	17.20	710.08	

APPENDIX E

CHEMICAL TEST RESULTS OF WATER SAMPLES

Specific Parameters Tested for in the Chemical Analysis

Parameter	Detection Limit (Parts Per Billion)
Benzene	1
Carbon Tetrachloride	1
Chlorobenzene	1
1, 2-Dichloroethane	1
1, 1, 1-Trichloroethane	1
1, 1-Dichloroethane	1
1, 1, 2-Trichloroethane	1
1, 1, 2, 2-Tetrachloroethane	1
Chloroethane	1
2-Chloroethylvinyl Ether	1
Chloroform	1
1, 2-Dichlorobenzene	1
1, 3-Dichlorobenzene	1
1, 4-Dichlorobenzene	1
1, 1-Dichloroethylene	1
Trans-1, 2-Dichloroethylene	1
1, 2-Dichloropropane	1
1, 3-Dichloropropane	1
Ethylbenzene	1
Methylene Chloride	1
Chloromethane	2
Bromomethane	2
Bromoform	2
Bromodichloromethane	1
Trichlorofluoromethane	1
Dichlorofluoromethane	2
Dibromochloromethane	1
Tetrachloroethylene	1
Toluene	1
Trichloroethylene	1
Vinyl Chloride	1

Chemical Test Results of Water Samples

Mustard Gas Burial Grounds

Well Number	Compound	Concentration (Parts Per Billion)
WES-1-18-83	methylene chloride	6
	1,1,1-trichloroethane	1
	trichloroethylene	2
	benzene	1
WES-1-19-83	trichloroethylene	350
	trichloroflurometh ane	2
	chloroform	15
	1,2-dichloroethane	19
WES-1-20-83	methylene chloride	1
	1,1,1-trichloroethane	1
	trichloroethylene	430
	1,1-dichloroethylene	6
WES-1-21-83	methylene chloride	3
	1,1,1-trichloroethane	1
	benzene	2
WES-1-22-83	1,1,1-trichloroethane	2
	trichloroethylene	80
	benzene	3
	chloroform	4
	1,2-dichloroethane	3
	1,1,2,2-tetrachloroethane	50
WES-1-23-83	methylene chloride	6
	1,1,1-trichloroethane	2
	trichloroethylene	2
	chloroform	2
WES-1-24-83	methylene chloride	2
	1,1,1-trichloroethane	1

Note: Chemical test results for WES-1-18-83 to WES-1-24-83 from US Army Environmental Hygiene Agency letter report, "Ground-water Monitoring Results for Naval Weapons Support Center," dated 16 November 1983.

Chemical Test Results of Water Samples

Mustard Gas Burial Grounds

Well Number	Compound	Concentration (Parts Per Billion)
WES-1-25-83	1,1,2,2-tetrachloroethane	0.05*
	trichloroethene	0.067
	2-propanol	0.1
	tetrahydrofuran	0.8
WES-1-26-83	2-propanol	0.07
	tetrahydrofuran	2
	pentane	4
WES-1-27-83	trichloroethene	0.01
	2-propanol	0.01
	tetrahydrofuran	7
	pentane	7
	cyclohexanoe	0.3

Note: Chemical test results for WES-1-25-83 to WES-1-27-83 from Environmental Research Group letter report dated 9 September 1983.

* Detection limits not specified

Chemical Test Results of Water Samples

Ammunition Burning Grounds

Well Number	Compound	Concentration (Parts Per Billion)
WES-3-24-83	trans-1,2-dichloroethylene	9

Note: Chemical test results from US Army Environmental Hygiene Agency letter report, "Ground-water Monitoring Results for Naval Weapons Support Center," dated 25 July 1983.

Chemical Test Results of Water Samples

Old Burning Pit

Well Number	Compound	Concentration (Parts Per Billion)
WES-5-17-83	trans-1,2-dichloroethylene	22
	trichloroethylene	15

Note: Chemical test results from US Army Environmental Hygiene Agency letter report, "Ground-water Monitoring Results for Naval Weapons Support Center," dated 25 July 1983.

Chemical Test Results of Water Samples

Pest Control Area

Well Number	Compound	Concentration (Parts Per Billion)
WES-9-1-81	methylene chloride	2
	trichlorofluoromethane	1
WES-9-2-81	methylene chloride	2
	trichlorofluoromethane	1
	1,1,2,2-tetrachloroethane	1
	chloroform	1
WES-9-3-81	1,1,1-trichloroethane	40
	trichloroethylene	588
	trans-1,2-dichloroethylene	870
WES-9-4-81	methylene chloride	1
	trichlorofluoromethane	1
	1,1,1-trichloroethane	1
	trichloroethylene	20
	trans-1,2-dichloroethylene	38
	tetrachlaroethylene	1
	benzene	1
WES-9-5-81	methylene chloride	2
	trichlorofluoromethane	1
	1,1,1-trichloroethane	10
	trichloroethylene	24
	trans-1, -dichloroethylene	13
WES-9-6-81	methylene chloride	3
	trichlorofluoromethane	1
	1,1,1-trichloroethane	1
	trichloroethylene	1
	benzene	1
WES-9-7-81	methylene chloride	2
	trichlorofluoromethane	1
	1,1,1-trichloroethane	1
	1,1,2,2-tetrachloroethane	1
	toluene	3
	trichloroethylene	1
	benzene	2

(Continued)

Chemical Test Results of Water Samples

Pest Control Area

Well Number	Compound	Concentration (Parts Per Billion)
WES-9-8-81	methylene chloride	2
	trichlorofluoromethane	1
	1,1,1-trichloroethane	1
	1,1,2,2-tetrachloroethane	2
	trichloroethylene	7
	trans-1, -dichloroethylene	11
WES-9-9-81	methylene chloride	2
	trichlorofluoromethane	1
WES-9-10-83	1,2-dichloroethane	2
	benzene	1
WES-9-11-83	clean well	
WES-9-12-83	clean well	
WES-9-13-83	chloroform	15
WES-9-14-83	clean well	

Note: Chemical test results for WES-9-1-81 to WES-9-9-81 from US Army Environmental Hygiene Agency letter report, "Ground-water Monitoring Results for Naval Weapons Support Center," dated 16 November 1983.

Chemical test results for WES-9-10-83 to WES-9-14-83 reported in telephone conversation with NWSC. Results obtained by NWSC in telephone conversation with US Army Environmental Hygiene Agency, Aberdeen Proving Ground, Maryland.

Chemical Test Results of Water Samples
Pest Control Area
Hazardous Waste Storage Tank

Parameter	Well Concentration (Parts Per Billion)			
	WT-1-83	WT-2-83	WT-2-83**	WT-4-83
Metals				
Lead, total	20	20	9000	10
Chromium, total	29	<5	4000	<5
Copper, total	8	9	5500	ND
Nickel, total	40	50		40
Arsenic, total	3	2		2
Cadmium, total	4	ND	65	ND
Mercury, total	0.3	0.7	<100	0.2
Zinc, total	84	130	20000	96
Barium, total	100	110		100
Silver, total			15	
Iron, total			4200	
PCBs				
Total PCB	ND*	ND	***	ND
PCB 1242	ND	ND	***	ND
PCB 1248	ND	ND	ND	ND
PCB 1254	ND	ND	ND	ND
PCB 1260	ND	ND	ND	ND
Volatiles				
Trichloroethylene	15****	180	2.8	290
Trichloroethane, 1,1,1-	1200	2.4	ND	ND
Methylene chloride	ND	ND		ND

* Not detectable.

** Water samples obtained during drilling process because of color and odor. Water sample taken at 14 ft. Volatile analysis may be unreliable due to improper sample containers.

*** Presence of PCB 1242 or 1248 precludes the determination of the detection limit of the other aroclor.

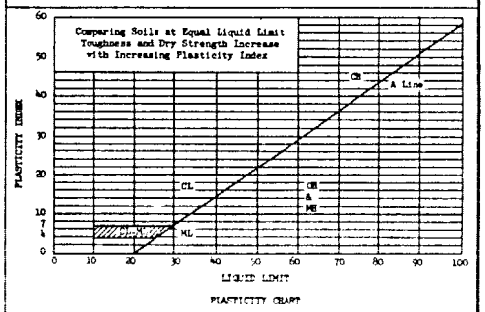
**** Travel blank for volatiles from WT-1-83, WT-2-83, and WT-4-83 had presence of compounds in blank.

NOTE: Chemical test results from Environmental Research Group untitled analytic letter report for Naval Weapons Support Center, dated 31 Aug 83.

UNIFIED SOIL CLASSIFICATION
(Including Identification and Description)

Major Divisions (1)	(2)		Group Symbols (3)	Typical Names (4)	Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights) (5)			Information Required for Describing Soils (6)	Laboratory Classification Criteria (7)
Coarse-grained Soils: More than half of material is larger than No. 200 sieve size.	Gravels: More than half of coarse fraction is larger than No. 4 sieve size. (For visual classification, the 1/4-in. size may be used as equivalent to the No. 4 sieve size.)	Clean Gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.			For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions, and drainage characteristics.	Determine percentages of gravel and sand from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse-grained soils are classified as follows: Less than 5% GW, GP, SW, SP. More than 12% GM, GC, SM, SC. 5% to 12% Borderline cases requiring use of dual symbols. $C_u = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3. Not meeting all gradation requirements for GW.
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.				
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixture.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).			Give typical name; indicate approximate percentages of sand and gravel, maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses.	Atterberg limits below "A" line or PI less than 4. Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below).				Atterberg limits above "A" line with PI greater than 7.
	Sands: More than half of coarse fraction is smaller than No. 4 sieve size.	Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain size and substantial amounts of all intermediate particle sizes.				$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3. Not meeting all gradation requirements for SW.
			SP	Poorly graded sands or gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.			Example: Silty sand, gravelly; about 20% hard, angular gravel particles 1/2-in. maximum size; rounded and subangular sand grains, coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).	
		Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).				Atterberg limits below "A" line or PI less than 4. Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).				Atterberg limits above "A" line with PI greater than 7.
Fine-grained Soils: More than half of material is smaller than No. 200 sieve size. The No. 200 sieve size is about the smallest particle visible to the naked eye.					Identification Procedures on Fraction Smaller than No. 40 Sieve Size				
					Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)		
	Silts and Clays: Liquid limit is less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions.	
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium		
			OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight	Give typical name; indicate degree and character of plasticity; amount and maximum size of coarse grains; color in wet condition; odor, if any; local or geologic name and other pertinent descriptive information; and symbol in parentheses.	
	Silts and Clays: Liquid limit is greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium		
			CH	Inorganic clays of high plasticity, fat clays.	High to very high	None	High		
			OH	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium	Example: Clayey silt, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML).	
Highly Organic Soils			Pt	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.				

Use grain-size curve in identifying the fractions as given under field identification.



PLASTICITY CHART

For laboratory classification of fine-grained soils

(1) Boundary classifications: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder. (2) All sieve sizes on this chart are U. S. standard.

FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (reaction to shaking)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (crushing characteristics)

After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air-drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (consistency near plastic limit)

After particles larger than the No. 40 sieve size are removed, a specimen of soil about one-half inch cube in size, is molded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

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