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HYDROGEOLOGICAL SITE CHARACTERIZATION OF OLD RIFLE RANGE FOR HAZARDOUS WASTE DISPOSAL FACILITY, NAVAL WEAPONS SUPPORT CENTER, CRANE, INDIANA

by

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PREFACE

This report is the fifth of six studies performed by personnel of the Geotechnical Laboratory (GL) of the U. S. Army Engineer Waterways Experiment Station (WES). 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), Engineering Geology and Rock Mechanics Division (EGRMD), 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 assisted in data compilation.

The study was conducted under the direct supervision of Mr. Jerald D. Broughton, Acting Chief, SCU, and 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 extented 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.

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PART I: INTRODUCTION

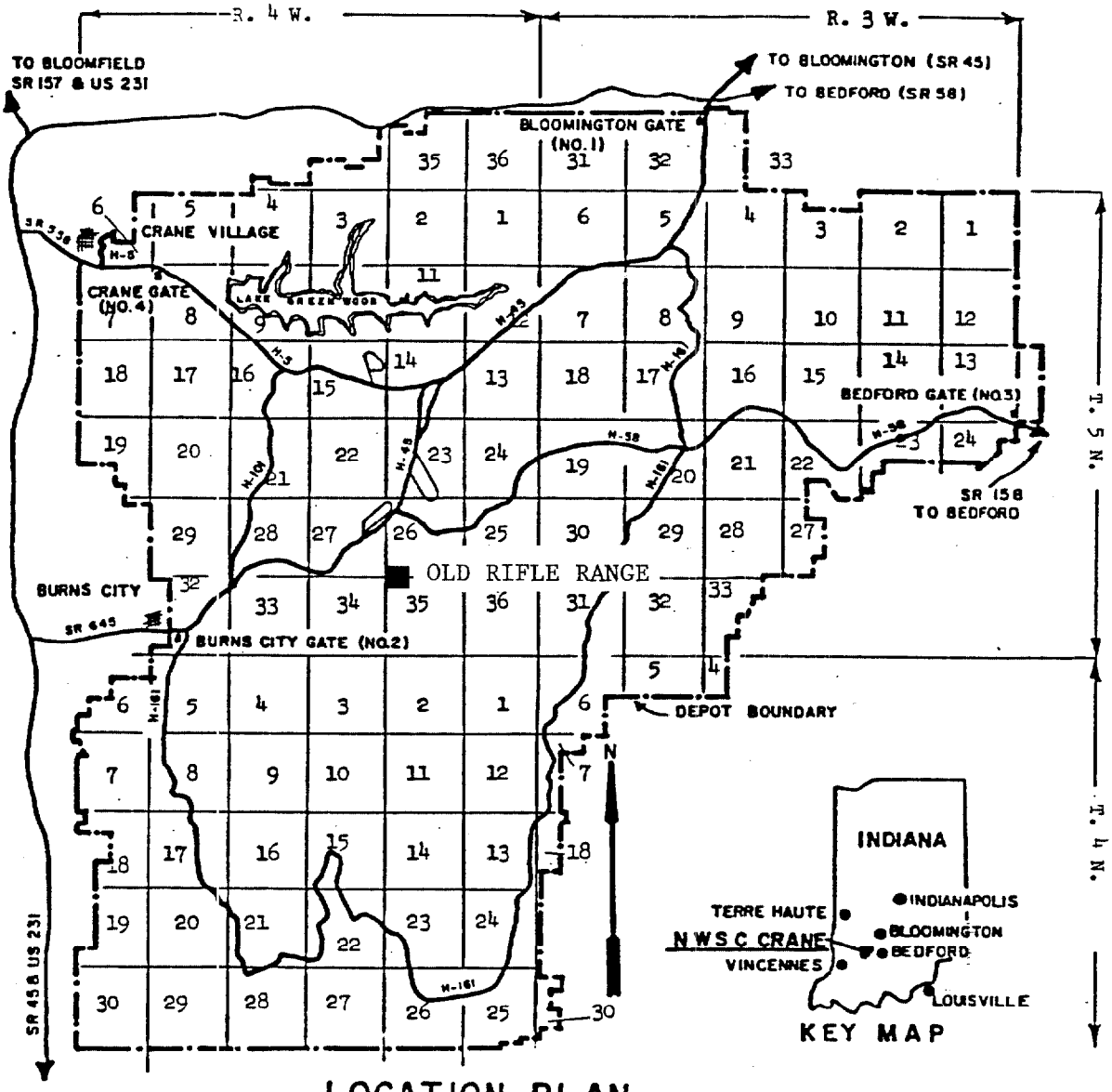
Background

1. The Naval Weapons Support Center (NWSC) plans to construct a permanent hazardous waste flashing facility at the Old Rifle Range (see Figure 1). The facility will recover the explosive-contaminated metal components from various types of military ordnance (e.g., large diameter projectile bodies). The treatment process to eliminate the explosive waste and salvage the metal components is by thermal incineration. The Old Rifle Range (ORR) facility will consist of two separate flashing areas with each area composed of several pits. Disposal of hazardous materials in each area will be dependent on type of explosive-contaminated ordnance; separate areas for flashing of explosive D-contaminated and explosive A-contaminated ordnance.

2. The flashing operation was previously located at the Ammunition Burning Grounds (ABG) along Jeep Trail 25 and was suspended because of possible contamination to the area's ground water and the Little Sulphur Creek. The flashing operation was moved to the ORR because environmental impact permits currently existed (ORR part of Demolition Area) and personnel from the Demolition Area (DEMO) are able to economically conduct DEMO and ORR operations simultaneously. In addition, ground-water monitoring wells had been implaced at the ORR for subsurface monitoring of a similar disposal operation. Seven monitoring wells were installed at the ORR by WES in 1981. The results from this work are presented in the WES draft report "Hydrogeological Investigation of Waste Disposal Sites at the Naval Weapons Support Center, Crane, Indiana" (Dunbar, 1982).

Purpose and Scope

3. The purposes of this investigation were to (a) define the hydrogeology (b) assist in selecting the best site for construction of a hazardous waste flashing facility, and (c) install additional ground-water monitoring wells as required to supplement the existing ground-water monitoring network to determine ground-water quality. Activities during this investigation included a review of existing boring and ground-water data, drilling, selected soil and rock



LOCATION PLAN

SCALE = GRID LINES FORM MILE SQUARES

Figure 1. Location of Naval Weapons Support Center and Old Rifle Range

sampling, well installation, physical soil testing, and data analysis. Information on well installation and physical soil testing are omitted from this report because they are presented in a previous WES NWSC study.

PART II: DATA COLLECTION

Data Review

4. A review of existing geological and ground-water data was conducted to determine the best location for the flashing facility. The source of hydrogeological data was from monitoring wells installed by the WES in 1981. The data review identified a shallow water table at the southern end of the ORR which eliminated this area from consideration. The tentative location for the flashing facility was at the north end of the ORR, adjacent to and upslope from WES-6-20-81, where soil thickness, soil type, topography and depth to the water table were favorable.

Field Exploration

Pit Construction

5. The NWSC construction of a temporary flashing facility was conducted simultaneously with the WES drilling program to accomodate the NWSC time requirements for reduction of ordnance inventories. Three temporary flashing pits (TFP) for explosive D-contaminated ordnance were constructed adjacent to and up slope from monitoring well WES-6-20-81 (see Figure 2). The size of each flashing pit was governed by the dimensions of the temporary impermeable liner which was purchased locally. Each pit is about 120 ft in length with a basal width of about 15 ft and composed of an impermeable liner (4 sheets of 6 mil polyethylene plastic), overlain by 2 ft of compacted clay, 1 ft of coarse limestone gravel, and 10 inches of sand. Flashing pit construction is shown in Figure 3. A 2 ft thick compacted clay layer was omitted from below the impermeable liner, because the existing soil (field classified as a CL), met or exceeded NWSC pit construction requirements. Soil thickness and uniformity of soil type underlying the temporary liner were verified in pits 1 and 2 (see Figure 2 for pit locations) by backhoe excavations in the north and south ends of each pit to a depth of approximately 3.5 feet. Each excavation was backfilled and compacted prior to laying the impermeable liner. Jar samples of the clay underlying the liner were taken at three locations (north end, center, and south end) in flashing pits 1 and 2 for laboratory classification to confirm the field observations. In addition, ground elevations were taken at the base

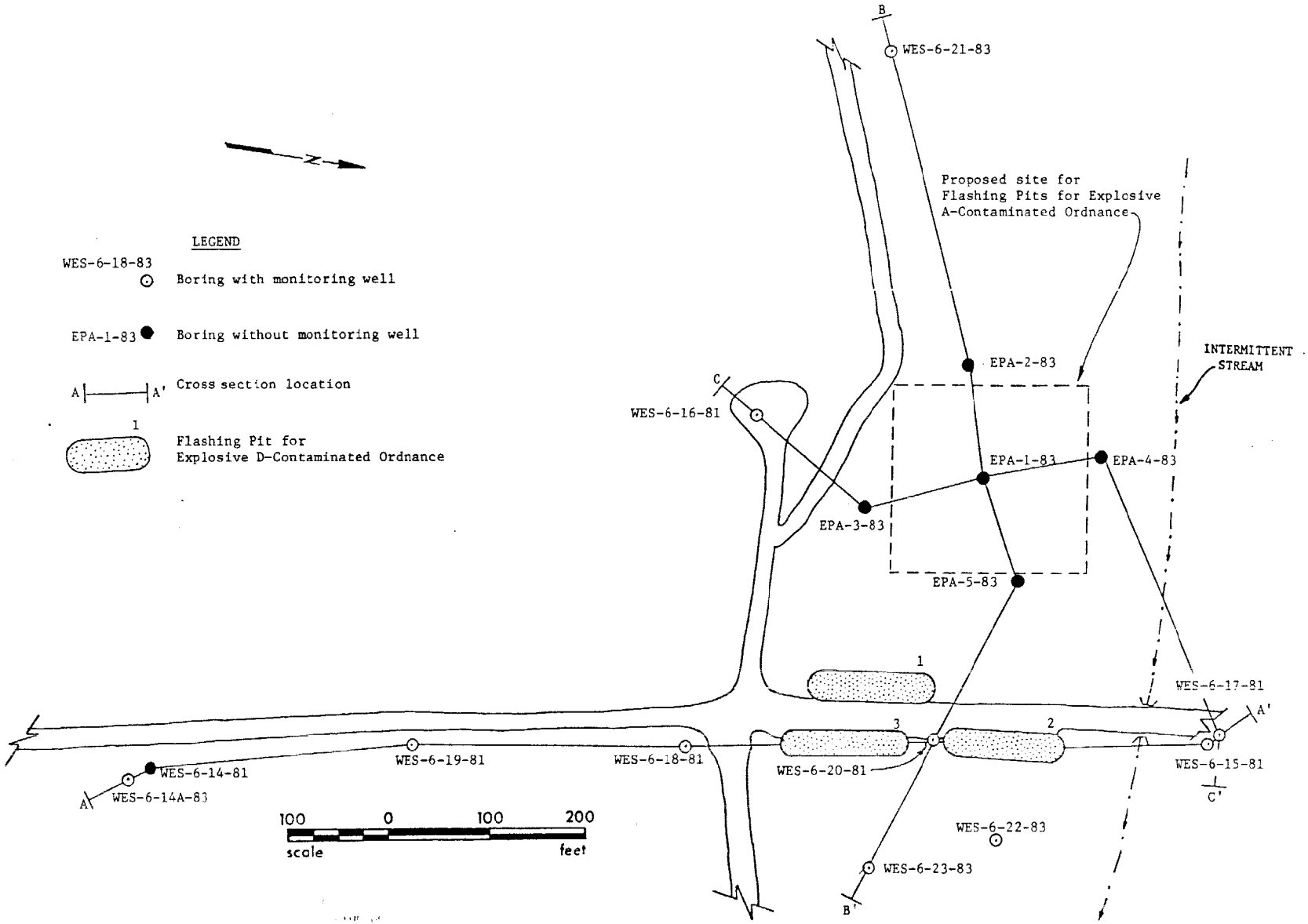


Figure 2. Old Rifle Range Boring, Monitoring Well, Flashing Pit, and Cross Section Locations

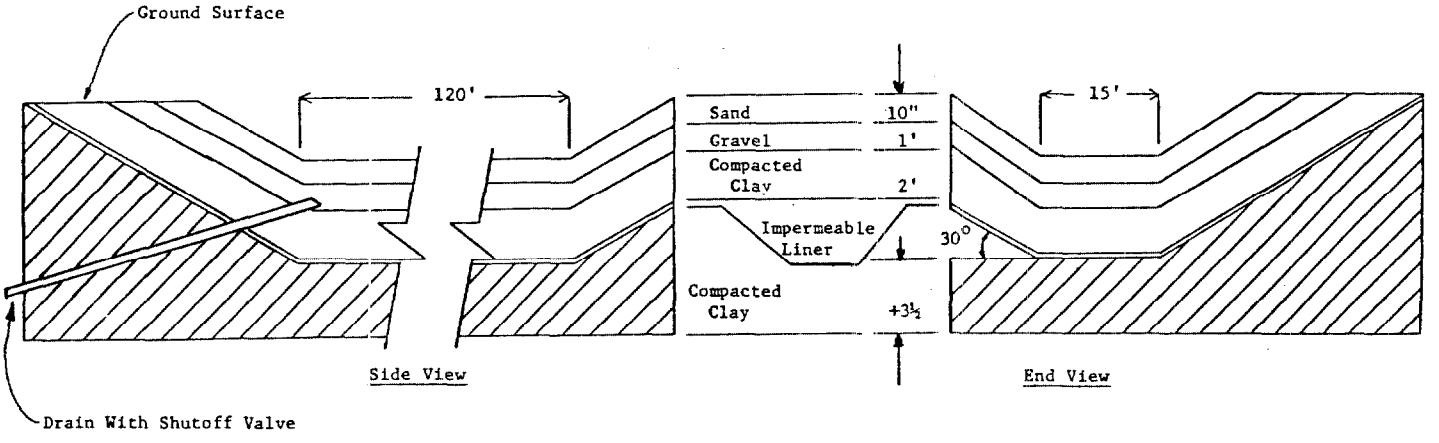


Figure 3. Schematic of Flashing Pit Construction

of the liner at the north and south ends of flashing pits 1 and 2 to establish the exact elevation of the impermeable liner with respect to the water table. A drain with a shutoff valve was installed in each flashing pit to collect precipitation and surface drainage for leachate treatment (see Figure 3).

Drilling and sampling

6. Drilling and sampling were conducted with a truck-mounted Failing 1500 drill rig. Five borings ("Explosive Pit A" borings EPA-1-83 to EPA-5-83) were drilled up slope or west of WES-6-20-81 at the proposed flashing site (PFS) for A-contaminated ordnance (see Figure 2). Borings were drilled on the outside perimeter of the PFS (approximately 200 x 200 ft) which was selected by WES and NWSC environmental and demolition personnel. Three inch undisturbed soil samples were taken in each boring at 5 ft intervals and at stratum changes until rock was encountered. Undisturbed soil samples were taken either with a Hvorslev sampler (fixed piston sampler) or a Pitcher sampler. When sampling with the Pitcher sampler, air was used to remove cuttings. Boring advance between soil samples was with a 5 inch open type or folding auger.

7. In boring EPA-1-83, continuous sampling was conducted in rock with a 4 in. inner diameter x 5-1/2 in. outer diameter x 7 ft long core barrel for detailed rock classification. Rock drilling in borings EPA-2-83 to EPA-5-83 was with a 5-5/8 tricone roller bit. Rock classification in roller bit borings was made from drill cuttings which identified rock type, grain size, and hardness (drilling resistance of the rock). Air was used to remove cuttings during rock drilling. Borings were terminated 10 ft below the water table and were left open for a period of several weeks to monitor the water table elevation before grouting. For a more detailed presentation of the particular sampling and drilling methods employed at the ORR, the reader is referred to the earlier WES report on the ORR.

PART III: GEOLOGY AND GROUND WATER

Geology

8. The geology of the ORR was defined from fifteen borings, field observations, and physical soil test data. The geology of the ORR is composed of residual soils formed by weathering of the underlying parent rock, unconsolidated alluvium, and Pennsylvanian and Mississippian age sedimentary rock. Soil thickness at the ORR ranges from less than 2 ft to a maximum of about 30 ft. The sedimentary rock underlying the two flashing sites is Mississippian age sedimentary rock from the Hardinsburg Formation of the Stephensport Group. West and up slope from the flashing sites (towards DEMO), the Hardinsburg Formation is overlain by the Mississippian age Glen Dean Limestone and by Pennsylvanian age sedimentary rock from the Mansfield Formation of the Raccoon Creek Group (see Table 1). The Glen Limestone and Mansfield Formation are absent under the ORR flashing sites.

9. The geology of the ORR is shown in cross sections A-A', B-B', and C-C' in Figures 4, 5, and 6, respectively (see Figure 2 for locations). Overlying the rock in cross section A-A' is a stiff, brown clay which is approximately 4 ft thick below the impermeable liner in pits 2 and 3. Underlying the clay is a uniform, moderately friable, very fine-grained, massive quartz sandstone that ranges from tan to orange brown in color. South of the temporary flashing pits, between borings WES-6-18-81 and WES-6-19-81 and extending south of boring WES-6-14-81, is a former channel of the ancestral Turkey Creek which is believed to be late Pleistocene or early Holocene in age*. The former stream channel is filled with gravelly clay, sandy clay, clay, and clayey sand for a thickness of at least 20 ft as defined by boring WES-6-19-81.

10. The geology of the PFS and TFS is shown in cross section B-B'. Soils underlying the PFS are predominantly stiff, alluvial clay with minor amounts of sand and sandstone gravel or cobbles which range in thickness from 21 ft (EPA-5-83) to 30 ft (EPA-2-83). Sandstone underlies the ancestral Turkey Creek Channel at the PFS at approximately the 501 ft MSL elevation. Up slope from the PFS, boring WES-6-21-83 encountered a grey, fine-grained, hard limestone at approximately the 537 ft MSL elevation which is approximately 4.5 ft thick.

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* Pleistocene is time period from 2-3 million years ago to 8000 years ago and Holocene is from 8000 years ago to present (Bates and Jackson 1980).

COLUMNAR SECTION SHOWING BEDROCK UNITS

TIME UNIT: PERIOD	TIME UNIT: EPOCH	MAP UNIT	THICKNESS (FEET)	LITHOLOGY	ROCK UNIT * SIGNIFICANT MEMBER	ROCK UNIT * FORMATION		ROCK UNIT * GROUP
PENNSYLVANIAN	CONEMAUGHIAN		175+			MATTOON Fm.	MATTOON Fm. (FORMATIONS MAPPED IN ILLINOIS)	MCLEANSBORO
					MEROM St.			
			150 to 200		LIVINGSTON Ls.	BOND Fm.	BOND Fm.	
					SHOAL CREEK Ls.			
			200 to 350			*PATOKA Fm.*	MODESTO Fm.	
					WEST FRANKLIN Ls.	SHELBURN Fm.		
	ALLEGHENIAN		300 to 400		DANVILLE COAL (VII)	DUGGER Fm.		CARBONDALE
					SPRINGFIELD COAL (V)	PETERSBURG Fm.		
					SURVANT COAL (IV)	LINTON Fm.		
	POTTSVILLIAN		250 to 600		SEELYVILLE COAL (III)	STAUNTON Fm.		*RACCOON CREEK*
					BUFFALOVILLE COAL LOWER BLOCK COAL	BRAZIL Fm.		
						MANSFIELD Fm.		
MISSISSIPPIAN	CHESTERIAN		250 to 300					
			120 to 190					STEPHENSPORT
			70 to 150					WEST BADEN
					LEVIAS ROSICLARE FREDONIA	STE. GENEVIEVE Ls.		BLUE RIVER
	VALMEYERAN		250 to 550			ST. LOUIS Ls.		
			100 to 160			SALEM Ls.		SANDERS
						HARRODSBURG Ls.		
			600+			MULDRAUGH Fm.		BORDEN
						CARWOOD AND LOCUST POINT Fms.		
						NEW PROVIDENCE Sh.		

* ROCK-UNIT NAMES FOR PENNSYLVANIAN ROCKS IN INDIANA FOLLOW THE USAGE PROPOSED BY WIER (IN PREPARATION), STRATIGRAPHY OF MIDDLE AND UPPER PENNSYLVANIAN ROCKS IN SOUTHWESTERN INDIANA. NEW NAMES ARE SHOWN IN ITALICS AND ARE TENTATIVE UNTIL FORMAL PRESENTATION.

Table 1. Stratigraphy of Naval Weapons Support Center

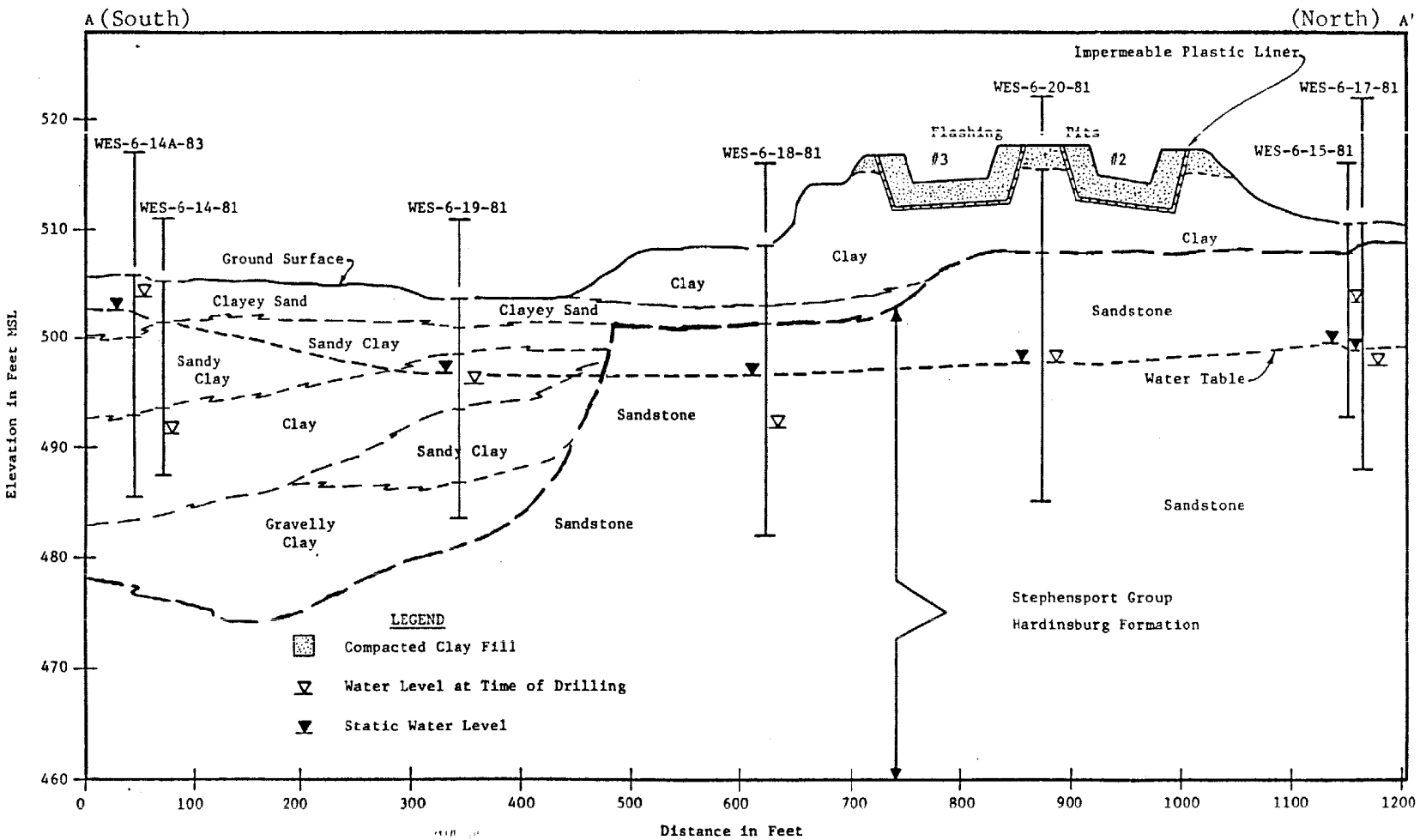


Figure 4. Old Rifle Range Geological Cross Section A-A'

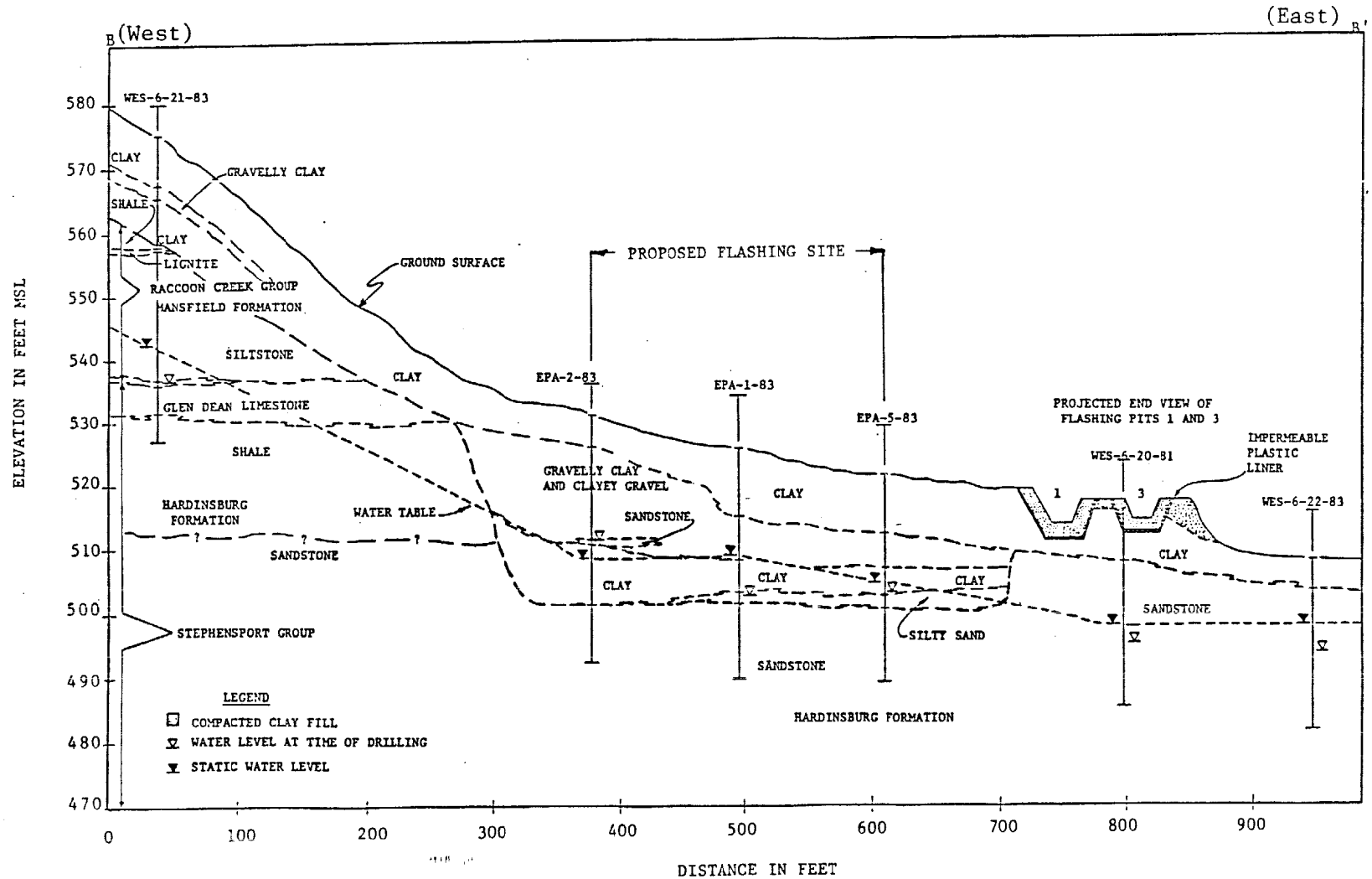


Figure 5. Old Rifle Range Geological Cross Section B-B'

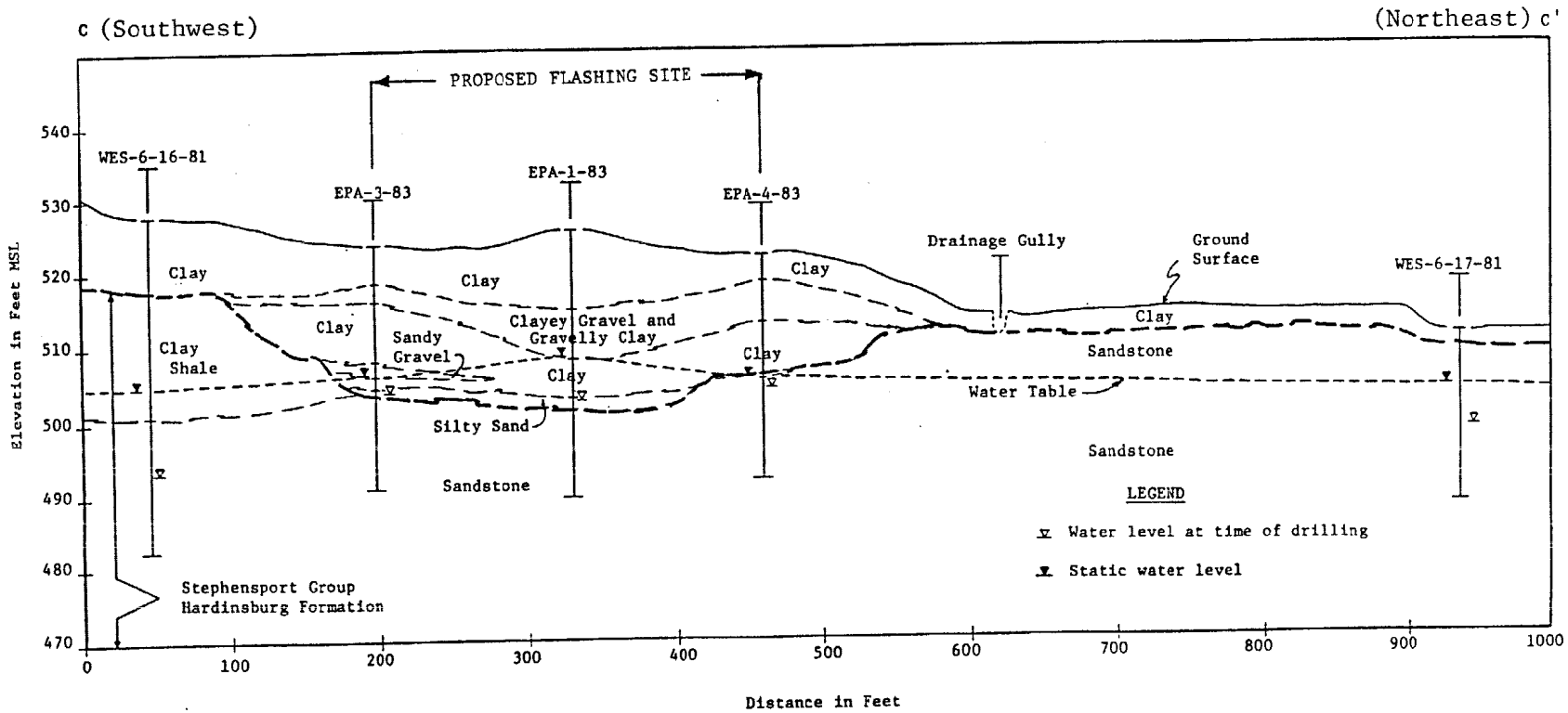


Figure 6. Old Rifle Range Geological Cross Section C-C'

This limestone is the Glen Dean Limestone, the upper most formation of the Stephensport Group. Overlying the Glen Dean Limestone is siltstone, lignite, and shale of the Mansfield formation. Underlying the Glen Dean Limestone is a dark grey, soft shale from the Hardinsburg Formation.

11. In cross section C-C', a predominantly stiff, alluvial clay underlies the PFS and ranges in thickness from 17 ft (EPA-4-83) to 25 ft (EPA-1-83). EPA borings also identify the ancestral Turkey Creek Channel and encountered the Hardinsburg sandstone at approximately the 502 to 508 ft MSL elevation. To the northeast at boring WES-6-17-81, sandstone lies within a few feet of ground surface at approximately the 509 ft MSL elevation. Drilling logs for all ORR borings are presented in Appendix A. Appendix B graphically summarizes the lithology from the field logs.

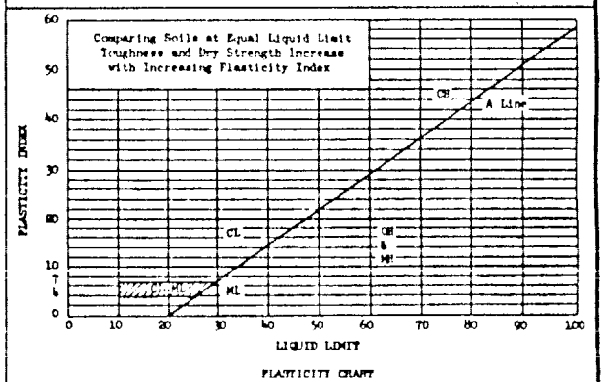
Laboratory Soil Test Results

12. Laboratory classification of NWSC soil samples was according to the Unified Soils Classification System (USCS) as shown by Figure 7. Soil at the ORR is predominantly clay (CL). In fact, from a total of 37 undisturbed and disturbed samples (1981 and 1983 studies), 89 percent were classified as a clay (CL) and the remaining 11 percent were either a clay (CH) or a clayey sand (SC). Laboratory classification of the clay underlying the TFS in flashing pits 1 and 2 was a CL at both sites. Average soil density and water content are 109.5 pounds per cubic foot and 17.7 percent. Average soil permeability from 4 samples (includes 3 samples from PFS was 3.61×10^{-6} centimeters per second (cm/sec) with a range from 3.70×10^{-7} to 9.21×10^{-6} cm/sec. Soil Cation Exchange Capacity (CEC) ranges from 3.71 to 11.20 milliequivalents per 100 grams of material. Soil test results are presented in Appendix C.

Ground Water

13. Four monitoring wells were installed for this study. Monitoring well WES-6-14A-83 was installed adjacent to damaged monitoring well WES-6-14-83 which was later removed and grouted. Monitoring well WES-6-21-83 was installed up gradient from the PFS to replace the existing ground-water monitoring system's up grdient well, WES-6-16-81, which will become a down gradient well after construction of the PFS. Monitoring wells WES-6-22-83 and WES-6-23-83 were installed to supplement the existing monitoring network. Well completion diagrams for all ORR monitoring wells are presented in Appendix D.

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.	$C_u = \frac{D_{60}}{D_{10}}$ 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.
					Identification Procedures on Fraction Smaller than No. 40 Sieve Size				
					Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)		
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.	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.	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.
			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.	Use grain-size curve in identifying the fractions as given under field identification.
	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.				



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 pondering 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.

Figure 7. Unified Soils Classification System

14. Two ground-water contour maps are shown for the ORR; Figure 8 presents a ground-water contour map from EPA borings and previously existing ORR wells for 20 June 1983 and Figure 9 presents a ground-water contour map from previously existing and recently installed monitoring wells for 6 October 1983. EPA borings were grouted prior to drilling monitoring wells WES-6-21-83 through WES-6-23-83 and are consequently not shown in Figure 9. Regional ground-water flow at the ORR is to the east with a component of flow from the southwest and west as shown by Figures 8 and 9. In Figure 8 at the PFS, a third component is indicated by ground-water measurements from EPA borings with flow towards the northeast or towards monitoring wells WES-6-15-81 and WES-6-17-81. Water table elevations for 20 June 1983 range from approximately 508 ft MSL (EPA-2-83) to 500 ft MSL (WES-6-18-81) for a vertical difference of slightly less than 8 ft over a horizontal distance of approximately 500 ft. In Figure 9, the regional ground-water pattern is similar, but the overall water table elevation is lower. Water table elevations on 6 October 1983 are approximately 4 to 5 ft less than for late spring or early summer in Figure 8, where snow melt and higher precipitation rates resulted in a higher water table. Water table elevations for 6 October 1983 range from approximately 499 ft MSL (WES-6-16-81) to 496 ft MSL (WES-6-18-81) for a vertical difference of less than 3 ft over a horizontal distance of approximately 350 ft. The new up gradient monitoring well, WES-6-21-83 which is located approximately 400 ft up slope of WES-6-16-81, has a water table elevation of approximately 542 ft.

15. The water table at the TFS in pit 1 is approximately 9 ft below the impermeable liner during the spring and approximately 13.5 ft below the impermeable liner during the fall. Ground water is flowing in fractures in the sandstone rock beneath the TFS. At the PFS, the water table was approximately 17 ft below ground surface at boring EPA-1-83 during the spring. During the fall, the water table is estimated to decline an additional 4-5 ft at this site. Ground water is flowing through the soil at the PFS. Ground-water measurements from ORR borings and monitoring wells are presented in Appendix E.

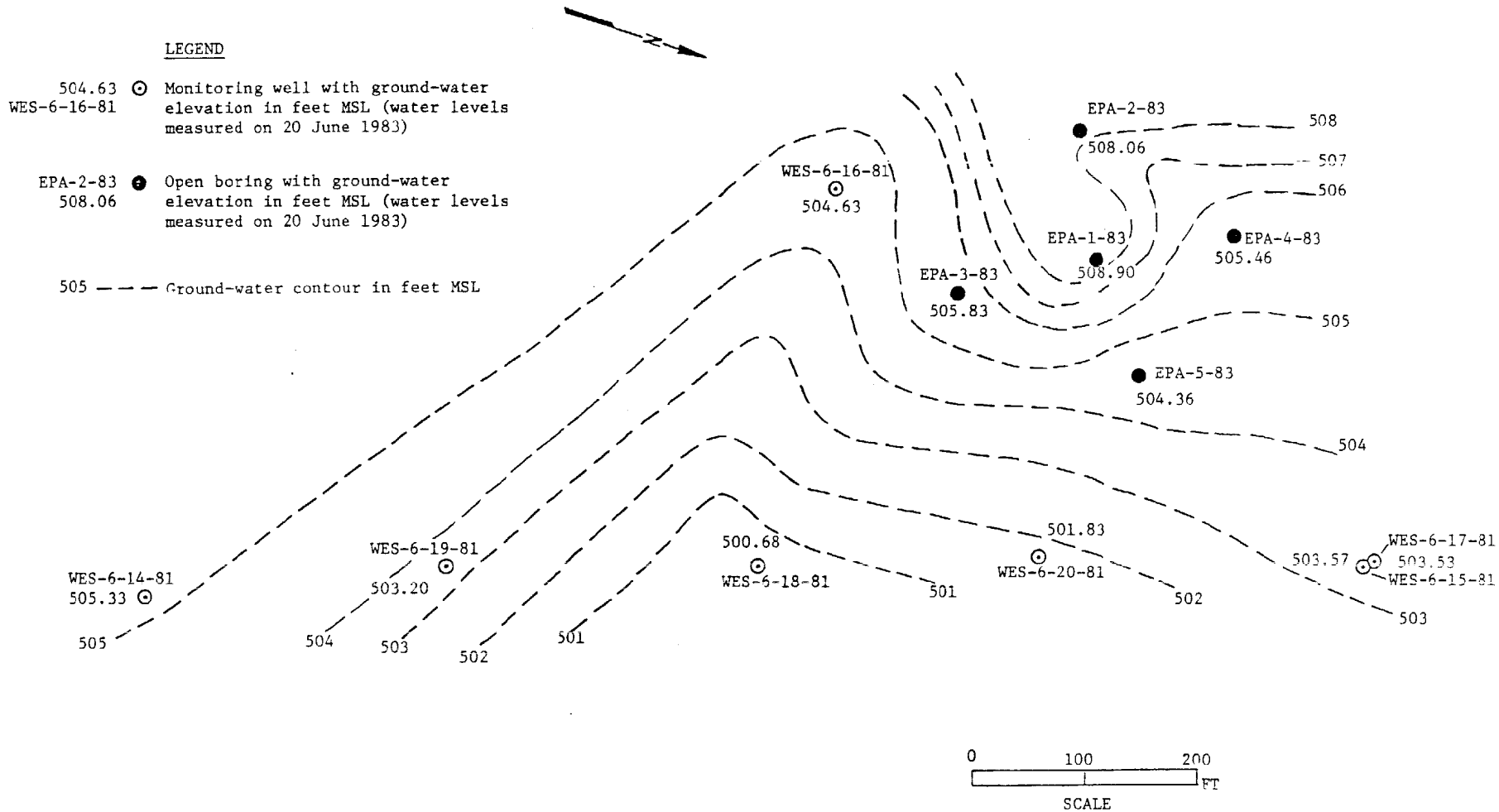


Figure 8. Old Rifle Range Ground-Water Contour Map - 20 June 1983

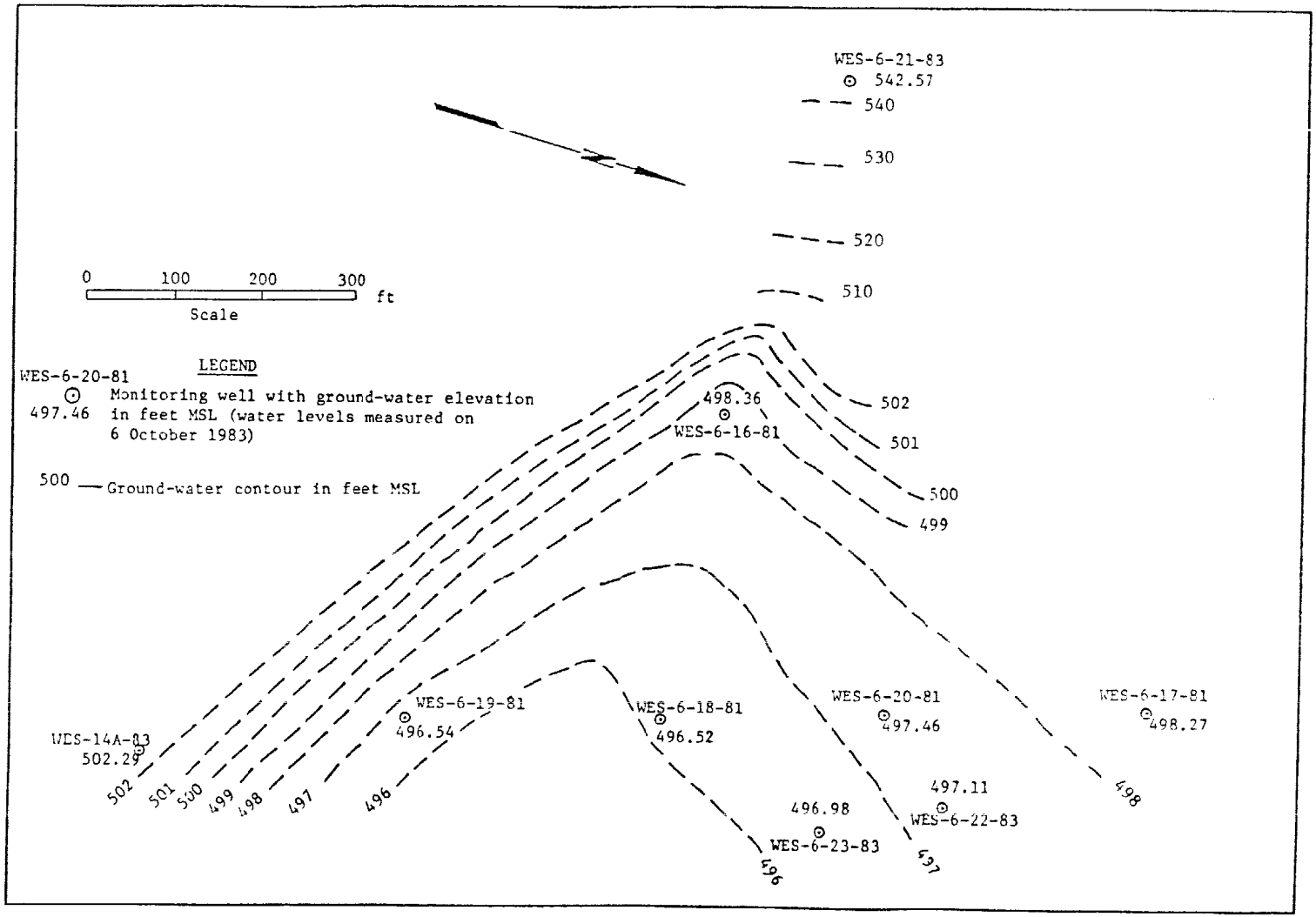


Figure 9. Old Rifle Range Ground-Water Contour Map - 6 October 1983

PART IV: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

16. The conclusions from this study are:

(a) The most favorable siting area for a hazardous waste flashing facility at the ORR is adjacent to and west of monitoring well WES-6-20-81 because soil thickness and depth to the water table are favorable.

(b) Low permeability soils underlying the flashing sites should minimize vertical migration of contaminants to the ground water because about a 3.5 ft thick low permeability soil occurs between rock and the impermeable liner in each flashing pit at the TFS and a 9 to 14 ft (depending on seasonal water table fluctuation) low permeability soil occurs between the estimated position of the impermeable liner and the water table at the PFS.

(c) Ground-water flow parallels the surface drainage and is to the east in rock fractures at the TFS and in soil at the PFS at an average depth below ground surface of about 13 ft. Ground water will fluctuate about 5 ft depending on seasonal precipitation.

(d) Ground-water monitoring wells are located down gradient from both disposal facilities and should enable the NWSC to detect ground-water contamination that may be associated with the disposal operation.

Recommendations

17. In addition to the operational and environmental precautions to minimize the introduction of contaminants at the ORR as defined in the "Environmental Assessment of Explosive-Contaminated Metal Components Flashing Facility at Crane Army Ammunition Activity" (i.e., leachate collection system, covers for flashing pits, vegetation on surface slopes, etc.), the following recommendations are made:

(a) Upon conversion of the TFS to a permanent facility (i.e., replacement of the plastic impermeable liner with a rubber membrane liner in each pit), the effects of thermal incineration on the plastic liners should be determined and appropriate action taken as required.

(b) During construction of the PFS, surveyed elevations from each flashing pit base should be obtained to define exact position of impermeable liner with reference to the water table.

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APPENDIX A

FIELD BORING LOGS

BORING LOG
FIELD DATA

Project NWSC Groundwater Study Site Crane, IN Date 27 Oct. 1981
Location Old Rifle Range Job No. 441-G150.11GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 505.06 Boring No. WES-6-14-81

SAMPLE NUMBER	DATE TAKEN 1981	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd. Press	Cont	CLASSIFICATION AND REMARKS
1	27Oct	0.0		0.0	0.5	0.0	1.61	3" Shelby Tube	0	ST	Sandy clay (CL) and sandstone gravel:
1A				0.5	1.0	1.61	1.89		0	Jar	brown in color, moist, and low
				1.0	1.5				0		plasticity.
				1.5	2.0				0		
				2.0	2.5						Sample length: 1.89 ft
			3.44	0.0	5.0	—	—	7" Folding Auger	—		Cleanout; assumed stratum change
2	27Oct	3.44		5.0	5.5	5.0	7.06	3"Fixed Piston Sampler	0	ST	Sandy clay (CL): grey to brown in
2A				5.5	6.0	7.06	7.30		0	Jar	color, moist, and low plasticity.
				6.0	6.5				0		Water level at 4.0 ft, ten minutes
				6.5	7.0				0		later, water level at 3.4 ft.
				7.0	7.4				10		Sample length: 2.30 ft
				5.0	10.0	—	—	7" Folding Auger	—		Cleanout

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED 3" Fixed Piston Sampler = 3" F.P.S. Sheet 1 of 2 Sheets

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-6-14-81

SAMPLE NUMBER	DATE TAKEN 1981	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd. Press	Cont.	CLASSIFICATION AND REMARKS
3	27 Oct	11.8		10.0	10.5	10.0	11.67	3" F.P.S.	0	ST	Clay (CH): dark grey in color,
3A				10.5	11.0	11.67	11.89		0	Jar	uniform, soft, and high plasticity.
				11.0	11.5				10		
				11.5	12.0				30		
				12.0	12.4				70		Sample length: 1.89 ft
				10.0	15.0			7"Folding Auger			Cleanout
4	27 Oct			15.0	15.5	15.0	17.07	3" F.P.S.	0	ST	Clay (CH): same as above- water
4A				15.5	16.0	17.07	17.32		0	Jar	level rose to 2.6 ft after lunch.
				16.0	16.5				0		
				16.5	17.0				0		
				17.0	17.39				0		Sample length: 2.32 ft
			17.5	15.0	17.5			7" Folding Auger			Cleanout: 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 4 August 1983
Location Old Rifle Range Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 505.87 Boring No. WES-6-14A-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	4 Aug	0.0	5.6	0.0	15.6			5"Folding Auger			Gravelly clay(CL): brown with
				15.6	20.0			6"RockBit			streaks of grey, soft to stiff,
											organic matter to 3 ft, approx.
											5% very fine sandstone gravel.
											Water at 2 ft.
		5.6	12.5								Clay(CL): brown with streaks
											of grey, very thinly bedded,
											soft to stiff, wet.
		12.5	20.0								Clay(CH): grey and dark grey,
											soft, highly plastic.
	5 Aug			0.0	20.0			6"Rock Bit			Required to redrill and flush
				0.0	20.0			4"PVC Casing			mud from boring; used 4 in PVC
											casing to install monitoring well.

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-6-14A-83

SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
											Pulled casing while pouring gravel
											around screen.

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

Sheet 2 of 2 Sheets

BORING LOG
FIELD DATA

Project NWSC Groundwater Study Site Crane, IN Date 30 Oct, 1981
Location Old Rifle Range Job No. 441-G150.11GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 510.42 Boring No. WES-6-15-81

SAMPLE NUMBER	DATE TAKEN 1981	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd. Press	Cont	CLASSIFICATION AND REMARKS
1	30 Oct	0.0		0.0	0.5	0.0	1.35	3"Shelby Tube	0	ST	Sand (SP) and sandstone fragments.
1A				0.5	1.0	1.35	1.55		0	Jar	brown to orange brown in color, very
				1.0	1.5				50		fine to fine-grained, and dry.
				1.5	2.0				120		
			2.4	2.0	2.5				700		Sample length: 1.55 ft
				0.0	2.75			7" Folding Auger			Cleanout; bedrock starts at 2.4 ft
				0.0	2.8			5 5/8" Rock Bit			Cleanout
	31 Oct			2.8				4 x 5 1/2"Core Barrel			See page two for core log.

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

Hole No. WES-6-15-81

DRILLING LOG	DIVISION U.S. Navy	INSTALLATION Crane, IN	SHEET 2 OF 3 SHEETS

1. PROJECT NMSC Groundwater Study	10. SIZE AND TYPE OF BIT 4 x 5 1/2 in. Diamond bit
2. LOCATION (Coordinates or Station) Old Rifle Range	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-6-15-81	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED zero; UNDISTURBED two
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 30 Oct. 81; COMPLETED 31 Oct. 81
7. THICKNESS OF OVERBURDEN 2.75 ft	17. ELEVATION TOP OF HOLE 510.42
8. DEPTH DRILLED INTO ROCK 14.50 ft	18. TOTAL CORE RECOVERY FOR BORING 95.2%
9. TOTAL DEPTH OF HOLE 17.25 ft	19. SIGNATURE OF INSPECTOR Joseph B. Hinshaw

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
510.42	0.0		See page one for overburden information.			
509.42	1.0					
508.42	2.0					
507.42	3.0		Sandstone: brown to rusty brown in color, uniform, fine-grained quartz sand, moderately hard, and oxidized. Bedding ranges from thinly bedded to around one foot maximum thickness and horizontal to sub-horizontal in attitude.			30 Oct. 81 WL - Run 1 Began 2:35 Rec 4.55' End 2:55 Loss - Time 20 min Gain - Drl time 20 min Hyd press 100psi Water press - RPM 50-75 Drl Action Smooth ~~Water~~ ret Brown Remarks Cored with air. Stuck core bbl-drilled 6" Cs around to break out.
506.43	4.0					
505.42	5.0					
504.42	6.0					
			Solution cavity.			
503.42	7.0		Water at end of run. Run 1	100%	-	31 Oct. 81 WL - Run 2 Began 9:42 Rec 3.85 End 10:15 Loss - Time 33 min Gain - Drl time 33 min Hyd press 100psi Water press - RPM 50-75 Drl Action Smooth Water ret Slight return-brown Remarks Stuck core bbl-Drilled 6" Cs around to break out.
502.42	8.0					
501.42	9.0		Sandstone: same			
500.42	10.0					

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PROJECT | HOLE NO.

Hole No. WES-6-15-81

DRILLING LOG	DIVISION	INSTALLATION	SHEET 3 OF 3 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
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	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
500.42	10.0					
499.42	11.0		Run 2			
498.42	12.0					WL - Run 3 Began 1:09 Rec 4.1' End 1:39 Loss - Time 30 min Gain - Drl time 30 min Hyd press 100psi Water press - RPM 50 Drl Action Smooth ~~Water~~ ret Slight-brown Remarks Water more pronounced after second run.
497.42	13.0		Sandstone: same	100%	-	
			small cavity-1/2 x 1/2 x 1 in.			
496.42	14.0					
495.42	15.0		Run 3			
494.42	16.0		Sandstone: same	64.1%	-	WL - Run 4 Began 2:00 Rec 1.25 End 2:30 Loss 0.70 Time 30 min Gain - Drl time 30 min Hyd press 100+ Water press - RPM 50 Drl Action Smooth ~~Water~~ ret Slight-brown Remarks -
			Recovered to 16.55 ft			
493.42	17.0		Hole rodded at 17.25 ft Run 4			
			Blew hole dry and installed well.			

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PROJECT | HOLE NO.

BORING LOG
FIELD DATA

Project NWSC Groundwater Study Site Crane, IN Date 2 Nov, 1981
Location Old Rifle Range Job No. 441-G150.11GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 527.88 Boring No. WES-6-16-81

SAMPLE NUMBER	DATE TAKEN 1981	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd. Press	Cont	CLASSIFICATION AND REMARKS
1	2 Nov	0.0		0.0	0.5	0.0	1.37	3" Shelby Tube	0	ST	Silt (ML): brown in color, uniform,
1A				0.5	1.0	1.37	1.52		0	Jar	dry, and stiff.
				1.0	1.5				200		
				1.5	2.0				480		
				2.0	2.5				620		Sample length: 1.52 ft
				0.0	3.0			7" Folding Auger			Cleanout: very hard
			4.5	3.0	5.0			5 5/8" Rock Bit			Cleanout: softer at 4.5 ft
2A	2 Nov	4.5	10.0	5.0	5.4	5.0	5.4	3"Fixed Piston Sampler	700	Jar	Sandy silt (ML): brown in color,
											dry, low plasticity, and contains
											5-10% fine to medium sand.
		10.0	27.0	5.0	45.15			5 5/8" Rock Bit			Clay shale: brown in color, very
											stiff to hard, weathered, and
											slightly moist in regions.

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BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-6-16-81

SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
		27.0	45.15								Sandstone: brown in color, medium
											hard, and fine-grained.
											Encountered water between 35 and 37ft.
											Meausred water level after 49
											minutes and it rose to 31.97 ft.
											Drilled to 45.15 ft and blew water
											from hole. Rinsed hole three times
											with clean water to remove mud.
											Installed well.

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BORING LOG
FIELD DATA

Project NWSC Groundwater Study Site Crane, IN Date 10 Nov, 1981
Location Old Rifle Range Job No. 441-G150,11GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 510.73 Boring No. WES-6-17-81

SAMPLE NUMBER	DATE TAKEN 1981	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd. Press	Cont	CLASSIFICATION AND REMARKS
1	10 Nov	0.0		0.0	0.5	0.0	1.39	3" Shelby Tube	0	ST	Clay (CL): brown in color, soft,
1A				0.5	1.0	1.39	1.57		0	Jar	slightly moist, and low plasticity.
				1.0	1.5				30		Sample length: 1.57 ft
			2.0	1.5	2.0				700		
	10 Nov	2.0		0.0	17.5	—	—	6 3/4" Rock	Bit	—	Sandstone: brown, fine-grained,
											and medium hard. Checked hole for
											water at 6.8 ft, 10.0 ft, and
											12.4 ft. Moisture at 12.4 ft.
											Water visible from 12.4 to 17.5 ft
											coming in from sidewalls.
	10 Nov		22.5	17.5	22.55	—	—	4 x 5 1/2" Core Barrel		—	Sandstone: see page two for log
											of core.

Sheet 1 of 2 Sheets

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Hole No. WES-6-17-81

DRILLING LOG	DIVISION U.S. Navy	INSTALLATION Crane, IN	SHEET 2 OF 2 SHEETS

1. PROJECT NWSC Groundwater Study	10. SIZE AND TYPE OF BIT 4 x 5 1/2 in Diamond
2. LOCATION (Coordinates or Station) Old Rifle Range	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-6-17-81	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED zero; UNDISTURBED one
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 10 Nov. 81; COMPLETED 10 Nov. 81
7. THICKNESS OF OVERBURDEN 2.0 ft	17. ELEVATION TOP OF HOLE 510.73
8. DEPTH DRILLED INTO ROCK 20.55 ft	18. TOTAL CORE RECOVERY FOR BORING 24.6% %
9. TOTAL DEPTH OF HOLE 22.55 ft	19. SIGNATURE OF INSPECTOR Joseph B. Wenham

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
493.73	17.0					
492.73	18.0		From 17.5 to 18.0 ft, 1/4-3/4 in. alternating layers of rusty brown to dark brown sandstone.			10 Nov. 81 NL - Run 1 Began 1:13 Rec 5:05 End 1:56 Loss - Time 43 min Gain - Drl time 43 min Hyd press 100psi Water press - RPM 50-75 Drl Action Smooth ~~Water~~ ret Brown -
491.73	19.0		Sandstone: brown in color, uniform, fine-grained quartz sand, and medium hard. Pyrite crystals with oxidation rims from 21.65-21.9 ft and at 22.35 ft.			
490.73	20.0					
489.73	21.0					
488.73	22.0					
			Run 1	100%	-	
487.73	23.0		Reamed hole out with 6-3/4 in rock bit and rinsed hole with clean water. Water level came up overnight to 12.7 ft, Blew dry and installed well.			

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PROJECT | HOLE NO.

BORING LOG
FIELD DATA

Project NWSC Groundwater Study Site Crane, IN Date 13 Nov. 1981
Location Old Rifle Range Job No. 441-G150.11GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 508.03 Boring No. WES-6-18-81

SAMPLE NUMBER	DATE TAKEN 1981	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd. Press	Cont	CLASSIFICATION AND REMARKS
1	13 Nov	0.0		0.0	0.5	0.0	1.63	3" Shelby Tube	0	ST	Silty sand (SM): brown to rusty
1A				0.5	1.0	1.63	1.78		0	Jar	brown in color, fine-grained, and
				1.0	1.5				20		little cohesion.
				1.5	2.0				280		
			5.0	2.0	2.5				380		Sample length: 1.78 ft
				0.0	5.0			7" Folding Auger			Cleanout
2	13 Nov	5.0		5.0	5.5	5.0	6.58	3"Fixed Piston Sampler	0	ST	Sand (SP): brown in color, uniform,
2A				5.5	6.0	6.58	6.78		20	Jar	fine-grained quartz sand, and
				6.0	6.5				320		slightly damp.
			6.5	6.5	6.75				720		Sample length: 1.78 ft
		6.5	10.0	5.0	26.6			5 5/8" Rock Bit			Sandstone: brown, weathered, and
											fine-grained
		10.0	11.5								Sandstone with clay/shale lenses,
		11.5	14.4								Sandstone: brown, 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-6-18-81

SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
											and soft.
		14.4	26.6								Sandstone: brown, fine-grained,
											and hard.
											Water at 16.6 ft.
											Jetted hole twice to clear water
											and 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 Groundwater Study Site Crane, IN Date 23 Nov, 1981
Location Old Rifle Range Job No. 441-G150.11GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 503.42 Boring No. WES-6-19-81

SAMPLE NUMBER	DATE TAKEN 1981	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd. Press	Cont	CLASSIFICATION AND REMARKS
		0.0		0.0	5.0			7" Folding Auger			Cleanout: 0.0 to 5.0 ft is disturbed
											from setting up. Had to dump load
			3.0								of gravel to firm up area.
1	23 Nov	3.0		5.0	5.5	5.0	6.88	*3"Fixed Piston Sampler	0	ST	Clay (CH): grey with streaks of
1A				5.5	6.0	6.88	7.13		0	Jar	brown, soft, and high plasticity.
				6.0	6.5				0		Water in hole after cleanout- 8 ft.
				6.5	7.0				0		Sample length: 2.13 ft
				7.0	7.5				10		
			11.75	5.0	10.0			7" Folding Auger			Cleanout: assumed stratum change
2	23 Nov	11.75		10.0	10.5	10.0	11.66	3" F.P.S.	0	ST	Sandy clay (CL): dark grey in color,
2A				10.5	11.0	11.66	11.96		0	Jar	soft, low to medium plasticity, and
				11.0	11.5				0		contains 20% very fine-grained sand.
				11.5	12.0				0		
				12.0	12.39				0		Sample length: 1.96 ft

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* 3" Fixed Piston Sampler = 3"F.P.S.

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-6-19-81

SAMPLE NUMBER	DATE TAKEN 1981	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd. Press	Cont	CLASSIFICATION AND REMARKS
			16.75	10.0	15.0			7" Folding Auger			Cleanout: assumed stratum change
3	23 Nov	16.75		15.0	15.5	15.0	17.06	3" F.P.S.	0	ST	Gravelly clay (CL): brown to grey
3A				15.5	16.0	17.06	17.36		0	Jar	with traces of red and green, fine
				16.0	16.5				0		to medium sized gravel, soft, and
				16.5	17.0				0		low plasticity,
				17.0	17.40				0		Sample length: 2.36 ft
			20.0	15.0	20.0			7" Folding Auger			Went additional few ft to provide
											better seal at surface.

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

Sheet 2 of 2 Sheets

BORING LOG
FIELD DATA

Project NWSC Groundwater Study Site Crane, IN Date 24 Nov, 1981
Location Old Rifle Range Job No. 441-G150.11GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 515.68 Boring No. WES-6-20-81

SAMPLE NUMBER	DATE TAKEN 1981	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd. Press	Cont	CLASSIFICATION AND REMARKS
1	24 Nov	0.0		0.0	0.5	0.0	1.78	3" Shelby Tube	0	ST	Silt (ML), brown in color, soft,
				0.5	1.0	1.78	1.95		0	Jar	low plasticity, and dry.
				1.0	1.5				25		
				1.5	2.0				75		Sample length: 1.95 ft
				2.0	2.5				380		
				0.0	5.0	—	—	7" Folding Auger	—		Cleanout
2	24 Nov			5.0	5.5	5.0	6.75	3"Fixed Piston Sampler	0	ST	Silt (ML): brown in color with
2A				5.5	6.0	6.75	6.95		0	Jar	traces of grey, soft, and low
				6.0	6.5				10		plasticity.
				6.5	7.0				230		Sample length: 1.95 ft- chucks slipped
				7.0	7.5				380		
	25 Nov		8.0	5.0	8.0	—	—	7" Folding Auger	—		Cleanout

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-6-20-81

SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
	25 Nov	8.0	30.5	8.0	30.5			5 5/8" Rock	Bit		Sandstone: brown in color, fine-grained, and weathered. Water encountered around 20.5 ft. 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 16 July 1983
Location Old Rifle Range Job No. 441-G150.13CR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 575.27 Boring No. WES-6-21-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	16 July	0.0	7.6	0.0	18.1			5"Folding Auger			Clay(CL): brown, soft to stiff, dry, sandy.
		7.6	9.6								Gravelly clay: reddish brown, red sandy, gravelly (med. hard ferruginous gravel) stiff to very stiff, dry, massive.
		9.6	10.6								Clay(CH): brown, very stiff, dry, silty, very thinly bedded.
		10.6	11.6								Clay(CH): grey, very stiff, dry, silty, very thinly bedded.
		11.6	16.6								Clay(CH): brown, soft to stiff, silty, slightly damp, very 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-6-21-83

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		16.6	17.0								Shale: grey, soft to stiff, slightly damp.
		17.0	17.6								Lignite: black, earthy, sandy, soft
	18July	17.6	38.5	18.1	48.0			6" Rock Bit			Siltstone: brownish grey, light to dark grey, soft, thinly bedded.
		38.5	39.0								Shale: grey, soft
		39.0	43.5								Limestone: grey, very fine-grained hard-water at 39 ft.
		43.5	48.0								Shale(?): no cuttings, soft
	18July										Installed well-rinsed boring several times to remove mud.

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 25 August 1983
Location Old Rifle Range Job No. 441-C150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 507.64 Boring No. WES-6-22-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	25Aug	0.0	4.6	0.0	4.6			5"Folding Auger			Clayey sand(SM) and sandstone gravel: brown, soft to stiff, very fine-grained sand (25%), sandstone gravel approximately 25%.
		4.6	26.0	4.6	26.0			5-5/8" Rock	Bit		Sandstone: brown, reddish brown, uniform, very fine-grained, weathered soft, water at 14.6 ft
		26.0	--								Shale(?): possible change - no cuttings.
	25Aug										Rinsed boring with water to clear mud. 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 30 September 1983
Location Old Rifle Range Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator B. Harried Surface El 506.41 Boring No. WES-6-23-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	30Sept	0.0	4.3	0.0	27.0			5-5/8"RockBit			Sandy clay(CL): brown, soft to stiff, dry, sandy-very fine grained.
		4.3	27.0								Sandstone: light brown, brown and reddish brown, very fine-grained, uniform, quartz sandstone, soft and weathered to 24 ft water at 16 ft.
	30Sept										Installed well

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

Sheet 1 of 1 Sheets

BORING LOG
FIELD DATA

Project NWSC Disposal Site Characterization Site Crane, IN Date 10 June 1983
Location Old Rifle Range Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 525.62 Boring No. EPA-1-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	HYD PRESS	CONT	CLASSIFICATION AND REMARKS
1	10 June	0.0		0.0	0.5	0.0	2.4	3"Fixed Pist	100	ST	Clay(CL): brown, soft, damp
1A				0.5	1.0	2.4	2.5		150	Jar	Slightly sandy (very fine-grained),
				1.0	1.5				200		soft
				1.5	2.0				400		
				2.0	2.5				400		Sample length: 2.5 ft
				0.0	5.0			5"Folding Auger			Cleanout
2	10 June			5.0	5.5	5.0	7.3	3"Fixed Pist	150	ST	Clay(CL): mottled brown and grey,
2A				5.5	6.0	7.3	7.4		200	Jar	damp, soft, stiff
				6.0	6.5				260		
				6.5	7.0				300		
				7.0	7.4				330		Sample length: 2.4 ft
				5.0	10.0			5"Folding Auger			Cleanout
3	10 June		10.5	10.0	10.5	10.0	10.5	3"Fixed Pist	750	Jar	Clay(CL): grey and brown, sandy

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. EPA-1-83

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	11 June	10.5		10.5	13.8	10.5	13.8	Core 4x5-1/2"Barrel	100-300	Run1	Sandstone and clay(CL): brown,tan and grey, very fine-grained, predominantly quartz sandstone interbedded with brown sandy clay. Recovered approximately 2 ft with sandstone fragments ranging from fine to coarse gravel. Recovered two core pieces approx. 0.4 ft long. Sandstone is weathered, gravel fragments very friable and larger fragments moderately friable, very fine-grained. Drill Time 49 min:

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. EPA-1-83

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	11 June			13.8	19.0	13.8	19.0	Core 4x51/2"Barrel	100-300	Run2	Sandstone and clay(CL): 60% weathered sandstone interbedded with 40% sandy clay(CL); sandstone is brown, and reddish brown, very fine-grained, predominantly quartz sandstone. clay is brown and reddish brown. Sandstone fragments range from fine to coarse gravel. Recovered: approx. 2.0ft Loss: " 3.0ft. Drill Time: 53 min.
	11 June		24.0	19.0	24.0	19.0	24.0	Core 4x51/2"Barrel	100-300	Run3	Sandstone and clay(CL): No recovery except for several gravel sized sandstone fragments. Drill Time: 8 min. Water at 24 ft.

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

Sheet 3 of 6 Sheets

BORING LOG
FIELD DATA

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

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	11 June	24.0		24.0	25.0	24.0	25.0	3" Pitcher Sampler	750		Sandstone: tan, brown, and reddish brown, very fine-grained uniform, quartz, very friable to moderately friable.
				—	25.0			5 5/8" RockBit			Cleanout
	11 June			25.0	29.8			4x5 1/2" Core Barrel		Run4	See Page 5
	11 June			29.8	32.3			" "		Run5	
	11 June		35.9	32.3	35.9			" "		Run6	
											Drilled last three runs with water. Left hole open to obtain water level measurements.

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

Hole No. EPA-1-83

DRILLING LOG	DIVISION U.S. Navy	INSTALLATION NWSC, Crane, IN	SHEET 5 OF 6 SHEETS

1. PROJECT Disposal Site Characterization	10. SIZE AND TYPE OF BIT 4x5" Diamond
2. LOCATION (Coordinates or Station) Old Rifle Range	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY CERES	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title and file number) EPA-1-83	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED Three
5. NAME OF DRILLER C. Drake	14. TOTAL NUMBER CORE BOXES --
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 10 June 1983; COMPLETED 11 June 1983
7. THICKNESS OF OVERBURDEN 24.0	17. ELEVATION TOP OF HOLE 525.62
8. DEPTH DRILLED INTO ROCK 11.9	18. TOTAL CORE RECOVERY FOR BORING 42.9%
9. TOTAL DEPTH OF HOLE 35.9	19. SIGNATURE OF INSPECTOR Joseph B. Fowler

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
500.62	25					WL -- Run 4 Began 2:44 Rec 4.8 End 3:00 Loss -- Time 16 min Gain -- Drl time 16 min Hyd press 100-300 PSI Water press -- RPM 75-100+ Drl Action Smooth Water ret Brown Remarks
499.62	26		Sandstone: tan, reddish brown, oxidized, soft, very fine-grained, uniform, predominantly quartz, weathered, bedding is horizontal and very thinly bedded.			
498.62	27			100%	--	
497.62	28					
496.62	29					
			Run 4 ROD=72.9%			
495.62	30					WL -- Run 5 Began 3:27 Rec 2.5' End 3:37 Loss -- Time 10 min Gain -- Drl time 10 min Hyd press 100-200 PSI Water press -- RPM 75-100+ Drl Action Smooth Water ret Brown Blocked off fractured run.
494.64	31		Sandstone: see above and see remarks.	100%		
493.62	32					
			Run 5 ROD=0.0%			
492.62	33		Sandstone: see above	100%		WL -- Run 6 Began 4:03 Rec 3.6 End 4:18 Loss -- Time 15 min Gain -- Drl time 15 min Hyd press 200 PSI Water press -- RPM 75-100+ Drl Action Smooth Water ret Brown Remarks
491.62	34					
490.62	35					

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PROJECT

HOLE NO.

Hole No. EPA-1-83

DRILLING LOG	DIVISION	INSTALLATION	SHEET 6 OF 6 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
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	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
490.62	35		Sandstone: see above	100%		
			Run 6 RQD=100%			
489.62	36					

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

PROJECT HOLE NO

BORING LOG
FIELD DATA

Project NWSC Disposal Site Characterization Site Crane, IN Date 13 June 1983
Location Old Rifle Range Job No. 441-C 150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 530.91 Boring No. EPA-2-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd Press	Cont	CLASSIFICATION AND REMARKS
1	13June	0.0		0.0	0.5	0.0	2.10	3"Shelby tube	80	ST	Clay(CL): brown with streaks
1A				0.5	1.0	2.10	2.25		160	Jar	of grey, soft, damp, organic matter
				1.0	1.5				200		(roots).
				1.5	2.0				260		Sample length: 2.25 ft
			5.0	2.0	2.5				340		
				0.0	5.0			5"Folding Auger			Cleanout
2	13June	5.0		5.0	5.5	5.0	6.35	3" Fixed Piston	160	ST	Gravelly clay(CL): reddish brown
2A				5.5	6.0	6.35	6.50		260	Jar	clay with decomposed sandstone rock,
				6.0	6.5				400		fine to coarse gravel sized rock
											fragments, clay is soft and slightly
											damp, rock, approx 30%.
											Sample length: 1.50 ft
			8.5	5.0	10.0			5"Folding Auger			Cleanout

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. EPA-2-83

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd Press	Cont	CLASSIFICATION AND REMARKS
3		8.5		10.0	12.5	10.0	11.35	Pitcher 3" Sampler	300	ST	Clayey Gravel(GC): reddish brown,
3A						11.35	11.50			Jar	sandstone from fine to coarse gravel,
											rock approximately 65%, clay approx-
											imately 35%. Sandstone is very
											fine-grained, weathered.
											Sample length 1.5 ft
				10.0	15.0			5 5/8 RockBit			Cleanout
4			19.5	15.0	16.1	15.0	15.95	Pitcher 3" Sampler	300	ST	Clayey Gravel(GC): same as above.
4A						15.95	16.1			Jar	Sample length: 1.1 ft
		19.5	20.2	15.0	38.5			5 5/8 RockBit			Sandstone: reddish brown, soft
		20.2	25.5								Clay: brown, damp water at 20.2 ft
		25.5	27.8								Clay: grey, soft
		27.8	28.5								Clay: brown, soft

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

Sheet 2 of 3 Sheets

BORING LOG
FIELD DATA

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

SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO				
				28.5	29.5						Clay: brown, soft.
				29.5	38.5						Sandstone: brown, reddish brown,
											fine-grained, soft
											Installed 2 ft. piece of casing
											to keep hole open to monitor water
											levels.

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

Sheet 3 of 3 Sheets

BORING LOG
FIELD DATA

Project NWSC Disposal Site Characterization Site Crane, IN Date 14 June 1983
Location Old Rifle Range Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 523.20 Boring No. EPA-3-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd Press	Cont	CLASSIFICATION AND REMARKS
1	14June	0.0		0.0	0.5	0.0	2.25	3"ShelbyTube	80	ST	Clay(CL): brown and grey, soft,
1A				0.5	1.0	2.25	2.40		100	Jar	damp, slightly sandy (5%)
				1.0	1.5				170		
				1.5	2.0				220		
			6.0	2.0	2.5				500		Sample Length: 2.4 ft
				0.0	5.0			5"Folding Auger			Cleanout
2	14June	6.0		5.0	5.5	5.0	6.08	3" Fixed Piston	280	ST	Clayey Gravel(GC): reddish brown,
2A				5.5	6.0	6.08	6.28		550	Jar	fine to medium gravel sized sand-
				6.0	6.5				610		stone fragments with soft, sandy
				6.5	7.0				620		clay.
			7.5	7.0	7.5				640		Sample length: 1.28 ft
				5.0	10.0			5"Folding Auger			Cleanout

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. EPA-3-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd Press	Cont	CLASSIFICATION AND REMARKS
3	14June	7.5		10.0	10.5	10.0	12.12	Fixed 3" Piston	80	ST	Clay(CL and CH): grey and light
3A				10.5	11.0	12.12	12.27		120	Jar	brown, soft, damp, dense, grades
				11.0	11.5				130		from a CH to a CL between 10 and 11
				11.5	12.0				160		ft.
			16.5	12.0	12.45				160		Sample length: 2.27 ft
				10.0	15.0			5"Folding Auger			Cleanout
4		16.5	17.5	15.0	15.5	15.0	16.1	Fixed 3" Piston	190	ST	Sandy Gravel: reddish brown, black
4A				15.5	16.0	16.1	16.3		320	Jar	weathered, very fine-grained
				16.0	16.5				600		sandstone.
				16.5	17.0				450		Sample length: 1.3 ft
				17.0	17.45				430		
		17.5	19.0	15.0	20.0			5"Folding Auger			Clay(CL): brown, reddish brown,
											damp, sandy, gravelly(fine), thinly bedded
		19.0	20.0								Sand(SM): brown, very fine-grained

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

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Job No _____ Boring No. EPA-3-83

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
											damp, silty, clayey(slight binder)
5A	14June			20.0	20.6	20.0	20.6	3" Fixed Piston	750	Jar	Sandy Gravel(GC): reddish brown, brown, dark grey, weathered, very fine-grained sandstone, damp.
		20.0	32.5	20.0	32.5			5-5/8"RockBit			Sandstone: brown, very fine-grained weathered, uniform quartz sandstone.
											Installed 2 ft. piece of casing to keep hole open to monitor water levels.

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

Sheet 3 of 3 Sheets

BORING LOG
FIELD DATA

Project NWSC Disposal Site Characterization Site Crane, IN Date 14 June 1983
Location Old Rifle Range Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 521.89 Boring No. EPA-4-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd Press	Cont	CLASSIFICATION AND REMARKS
1	14June	0.0		0.0	0.5	0.0	1.5	3"ShelbyTube	80	ST	Clay(CL): brown, soft, uniform,
1A				0.5	1.0	1.5	1.7		120	Jar	damp.
				1.0	1.5				160		
				1.5	2.0				180		Sample length: 1.7 ft
			3.5	2.0	2.5				170		
						0.0	5.0	5"Folding Auger			Cleanout
2A	14June	3.5		5.0	5.5	5.0	5.95	3" Fixed Piston	280	Jar	Gravelly clay(CL): reddish brown,
				5.5	5.95				750t		dark brown, brittle, stiff, dry
											with 10 to 20% rock fragments
											(sandstone) ranging from coarse
											sand size to medium gravel, angular
			9.0								fragments.
				5.0	10.0			5"Folding Auger			Cleanout
3	14June	9.0		10.0	10.5	10.0	12.18	3" Fixed Piston	100	ST	Clay(CL): brown with streaks of

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. EPA-4-83

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
3A	14June			10.5	11.0	12.18	12.38		220	Jar	grey, stiff, brittle, slightly moist
4A	14June			11.0	11.5	15.0	16.0		280	Jar	sandy, thinly bedded
				11.5	12.0				260		
			16.0	12.0	12.45				270		Sample length: 2.38 ft
				10.0	16.0	15.0	16.0	5"FoldingAuger			Cleanout- hard at 16 ft
5		16.0	18.0	16.0	18.5	16.0	18.35	3"Pitcher Sampler	700	ST	Sandstone: brown and black, very
5A						18.35	18.50			Jar	weathered, primarily gravel and
											coarse sand fragments.
		18.0	18.5								Shale: greenish grey, brittle dry
											soft, uniform - water in bottom
											of hole.

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

Sheet 2 of 3 Sheets

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. EPA-4-83

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		18.5	21.0	16.0	30.0			5-5/8"RockBit			Sandstone: brown, weathered, soft
		21.0	30.0								Sandstone: tan, light grey, medium
											good rock, very fine-grained, quartz
											sandstone.
											Installed 3.0 ft casing and left
											hole open to monitor water levels.

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

Sheet 3 of 3 Sheets

BORING LOG
FIELD DATA

Project NWSC Disposal Site Characterization Site Crane, IN Date 16 June 1983
Location Old Rifle Range Job No. 441-C150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 521.16 Boring No. EPA-5-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd Press	Cont	CLASSIFICATION AND REMARKS
1	16 June	0.0		0.0	0.5	0.0	2.25	3" Shelby Tube	50	ST	Clay (CL): brown, soft, dry,
1A				0.5	1.0	2.25	2.40		60	Jar	sandy
				1.0	1.5				100		
				1.5	2.0				160		
				2.0	2.5				260		Sample length: 2.40 ft.
				0.0	5.0			5" Folding Auger			Cleanout
2	16 June			5.0	5.5	5.0	6.85	3" Fixed Piston	190	ST	Clay (CL): brown with streaks
2A				5.5	6.0	6.85	7.0		260	Jar	of grey, stiff, soft, damp,
				6.0	6.5				350		slightly sandy.
				6.5	7.0				380		
			9.0	7.0	7.38				400		Sample length: 2.0 ft.
				5.0	10.0			5" Folding Auger			Cleanout
3	16 June	9.0	14.2	10.0	10.5	10.0	11.22	3" Fixed Piston	130	ST	Gravelly clay (CL): reddish brown

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

Sheet 1 of 3 Sheets

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. EPA-5-83

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd Press	Cont	CLASSIFICATION AND REMARKS
3A	16June					10.0	12.0	5" Folding Auger	150	Jar	stiff, brittle, dry; gravel fragments
									320		are angular, fine to coarse sandstone
									520		Sample length: 1.32 ft - tube
									700		stopped and bent on gravel/cobble
				10.0	15.0			5"FoldingAuger			Cleanout
4	16June	14.2		15.0	15.5	15.0	17.15	3" Fixed Piston		ST	Clay(CL): brown and grey, soft,
4A				15.5	16.0	17.15	17.30			Jar	damp.
				16.0	16.5						
				16.5	17.0						
			18.5	17.0	17.45						Sample length: 2.3 ft.
5A		18.5	20.4	15.0	20.0	18.5	19.9	3"Folding Auger		Jar	Silty Sand(SM): brownish grey,
											moist, very fine-grained, uniform.

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

Sheet 2 of 3 Sheets

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____
Location _____ Job No. _____
Drill Rig _____ Inspector _____ Operator _____ Surface El. _____ Boring No. EPA-5-83

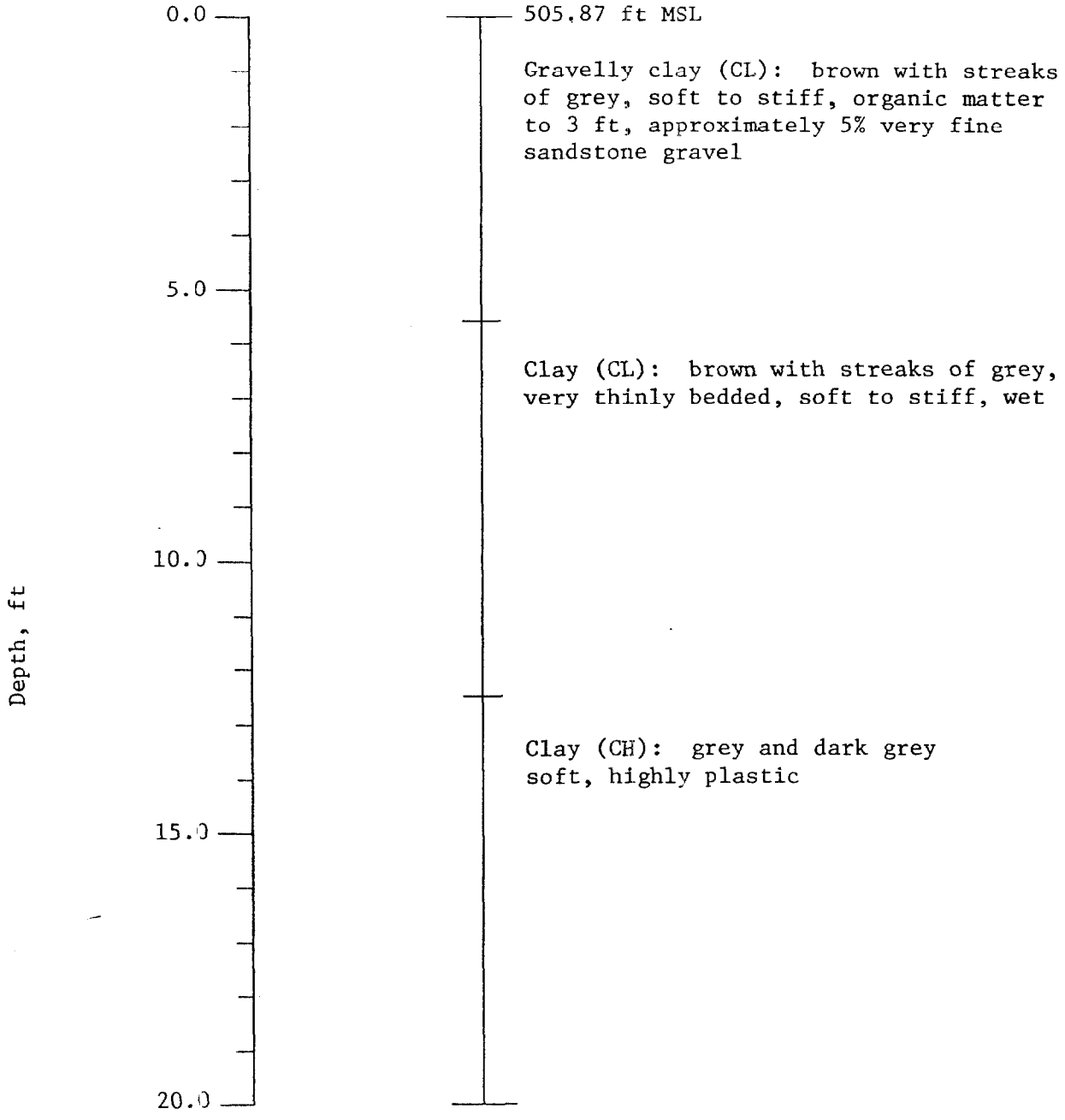
SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER	Hyd Press	Cont	CLASSIFICATION AND REMARKS
6A	16June			20.0	20.4	20.0	20.4	3" Pitcher Sampler	100	Jar	Silty sand(SM): greyish brown, wet, very fine-grained, uniform - hard at 20.4
		20.4	32.0	20.0	32.0			5 5/8" RockBit			Sandstone: light brown, light grey, very fine-grained, slightly weathered.
											Left hole open to obtain water level measurments.
											Installed 2 ft. piece of casing.

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

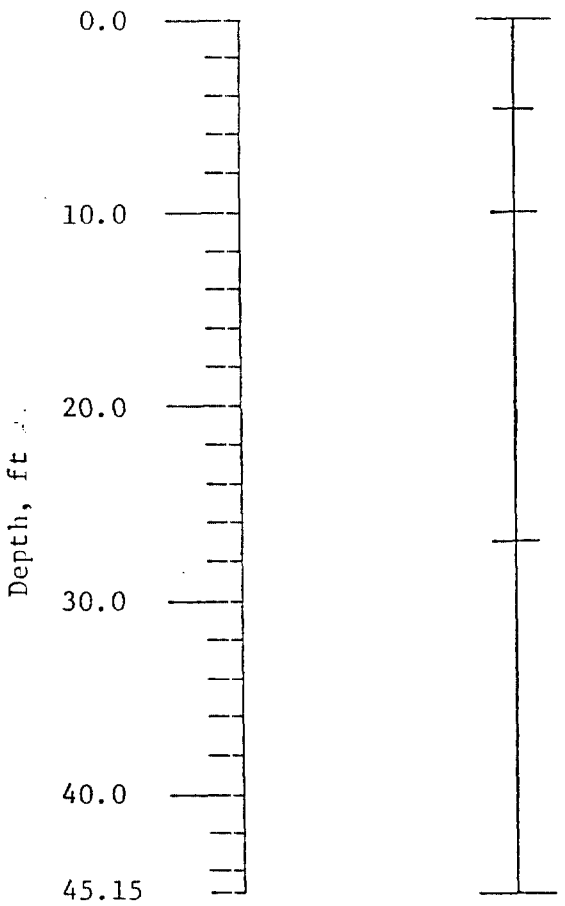
Sheet 3 of 3 Sheets

APPENDIX B

GRAPHIC FIELD LOGS



NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: WES-6-14A-83



527.88' MSL

Silt (ML): brown in color, uniform, dry, and stiff.

Sandy silt (ML): brown in color, dry, and contains 5-10% fine to medium-grained sand.

Clay shale: brown in color, very stiff to hard, weathered, and slightly moist in regions.

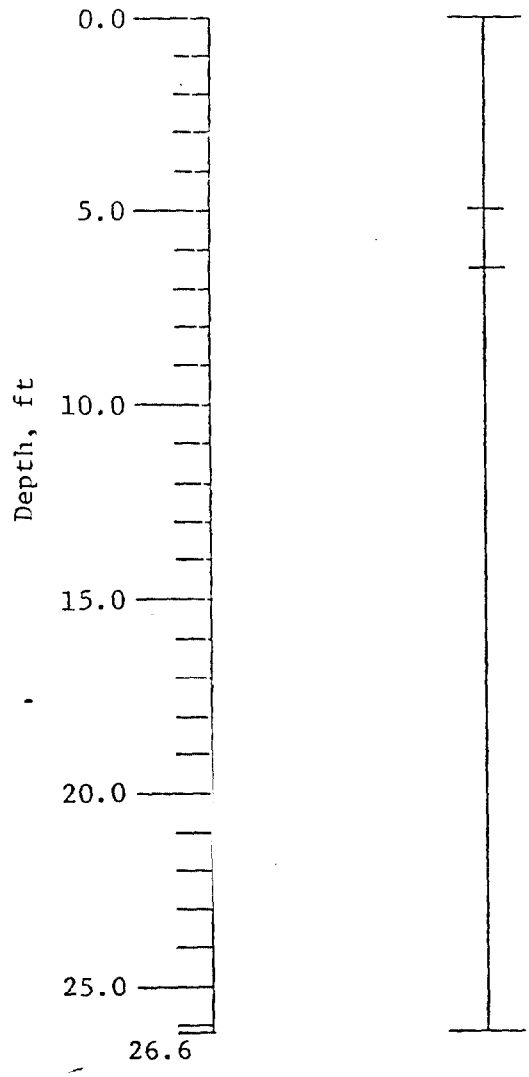
Sandstone: brown in color, medium hard, and fine-grained.

NWSC, Crane, Indiana

Old Rifle Range

Lithology

Boring Number: WES-6-16-81



508.03' MSL

Silty sand (SM): brown to rusty brown in color, fine-grained, and little cohesion.

Sand (SP): brown in color, uniform, fine-grained quartz sand, and slightly moist.

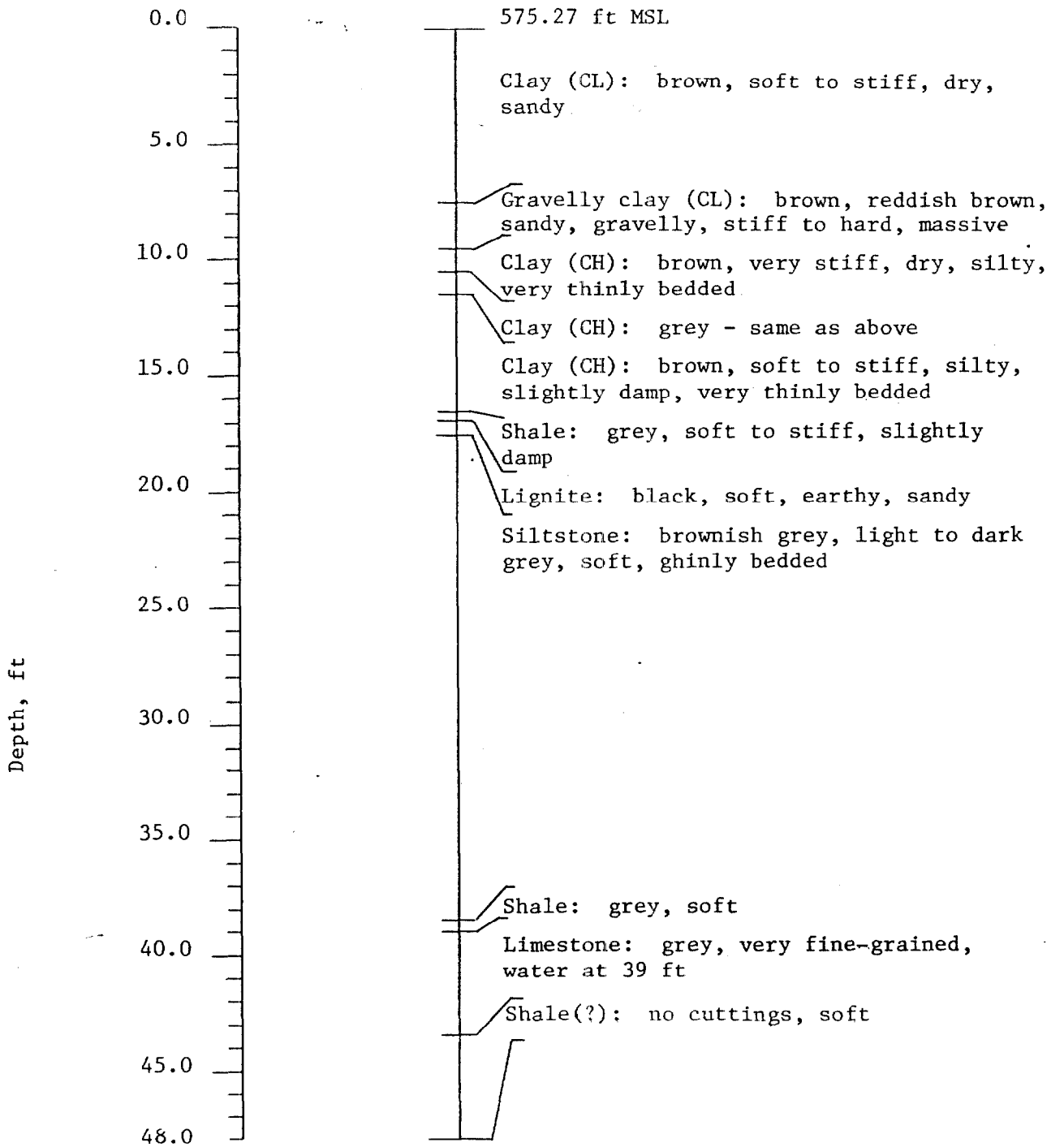
Sandstone: brown, weathered, fine-grained, medium hard to hard, and contains clay or shale lenses from 10 to 11.5 ft .

NWSC, Crane, Indiana

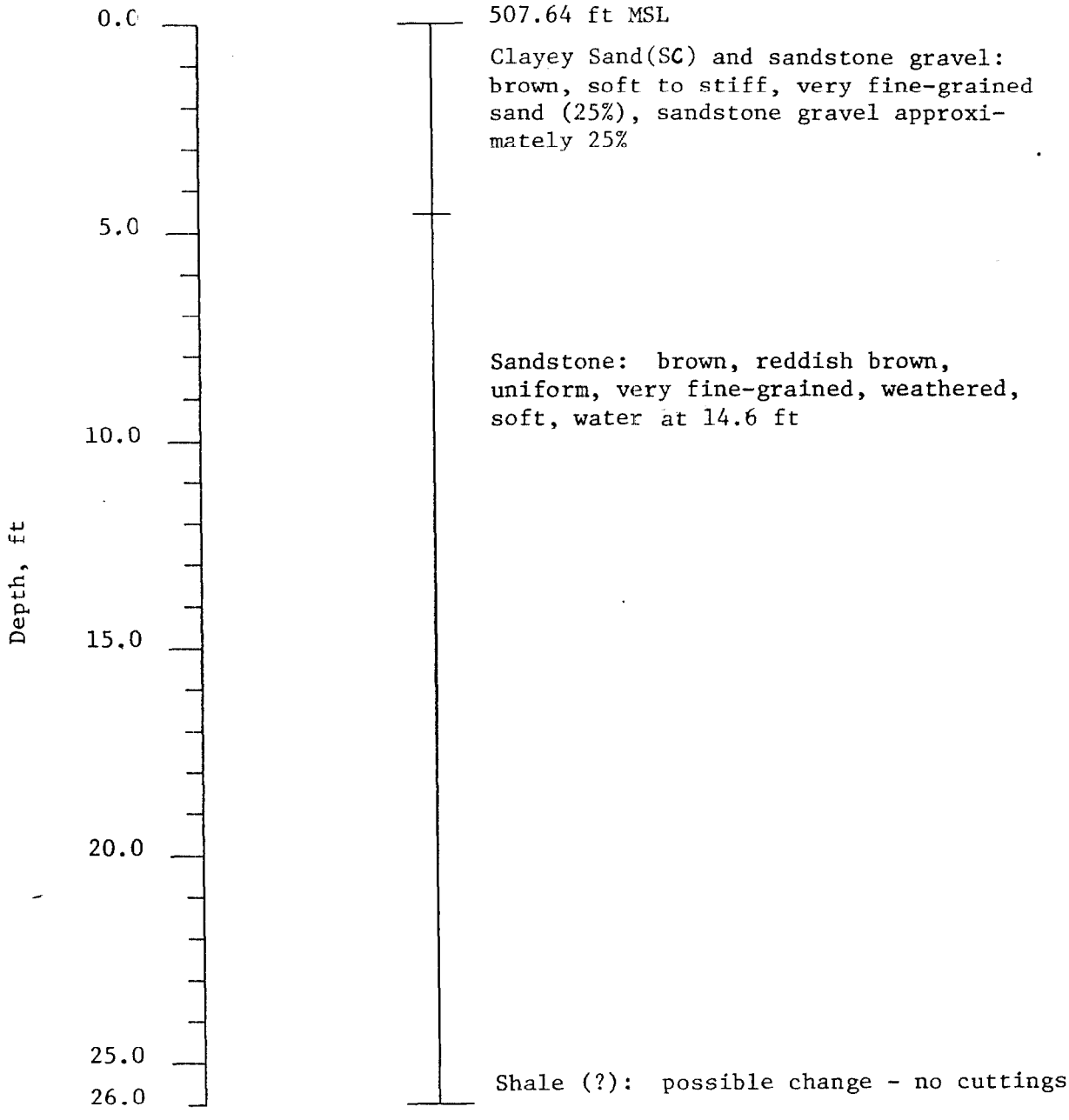
Old Rifle Range

Lithology

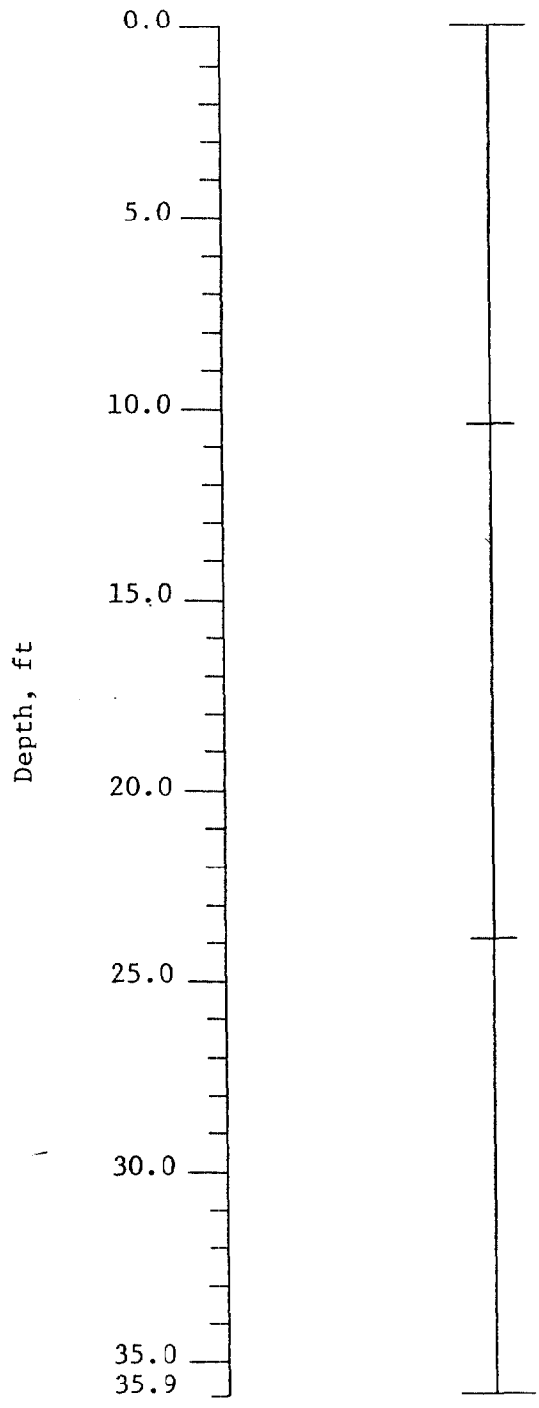
Boring Number: WES-6-18-81



NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: WES-6-21-83



NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: WES-6-22-83



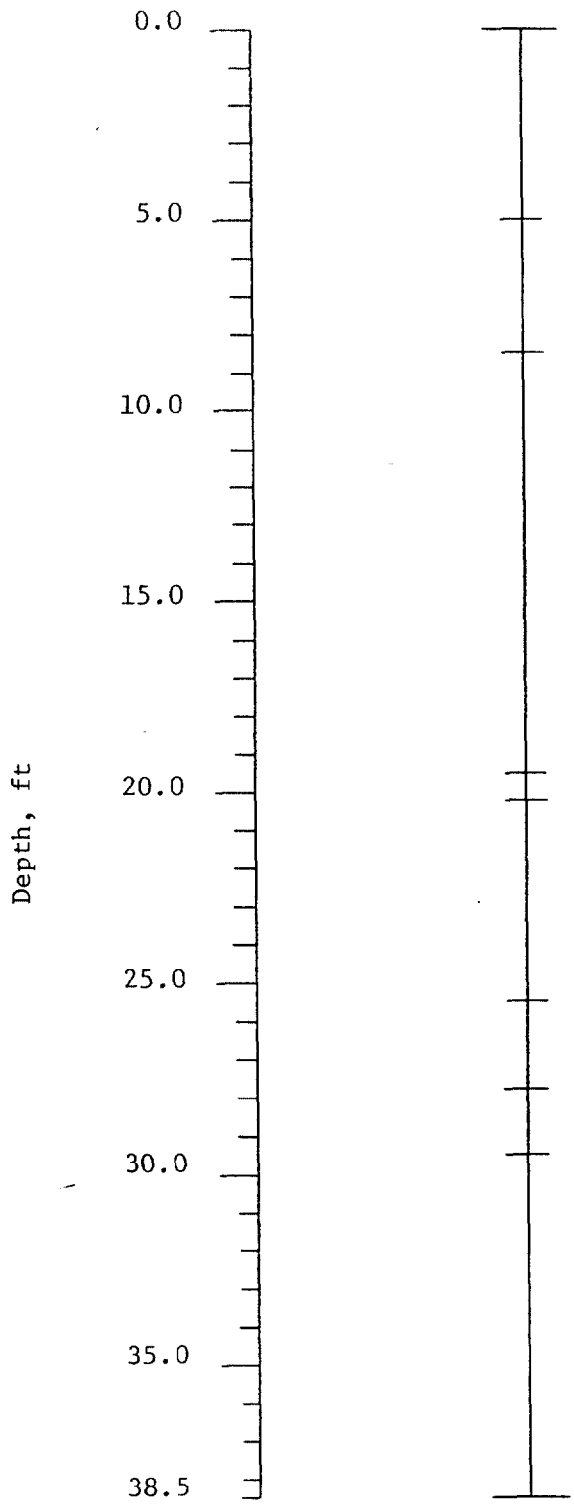
525.62 ft MSL

Clay (CL): brown and grey, soft to stiff, damp, uniform

Sandstone and clay (CL): tan, brown, reddish brown, weathered sandstone interbedded with brown sandy clay; sandstone is very fine-grained, uniform, quartz sand, friable

Sandstone: tan, brown, reddish brown, weathered, very fine-grained, uniform, quartz sandstone, bedding is horizontal and very thinly bedded

NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring No.: EPA-1-83



530.91 ft MSL

Clay (CL): brown with streaks of grey, soft, damp, organic matter (roots)

Gravelly clay (CL): reddish brown clay with weathered fine to coarse gravel sized sandstone fragments

Clayey Gravel (GC): reddish brown, fine to coarse sandstone gravel (65%) and soft clay (35%), sandstone is fine-grained weathered

Sandstone: reddish brown, soft

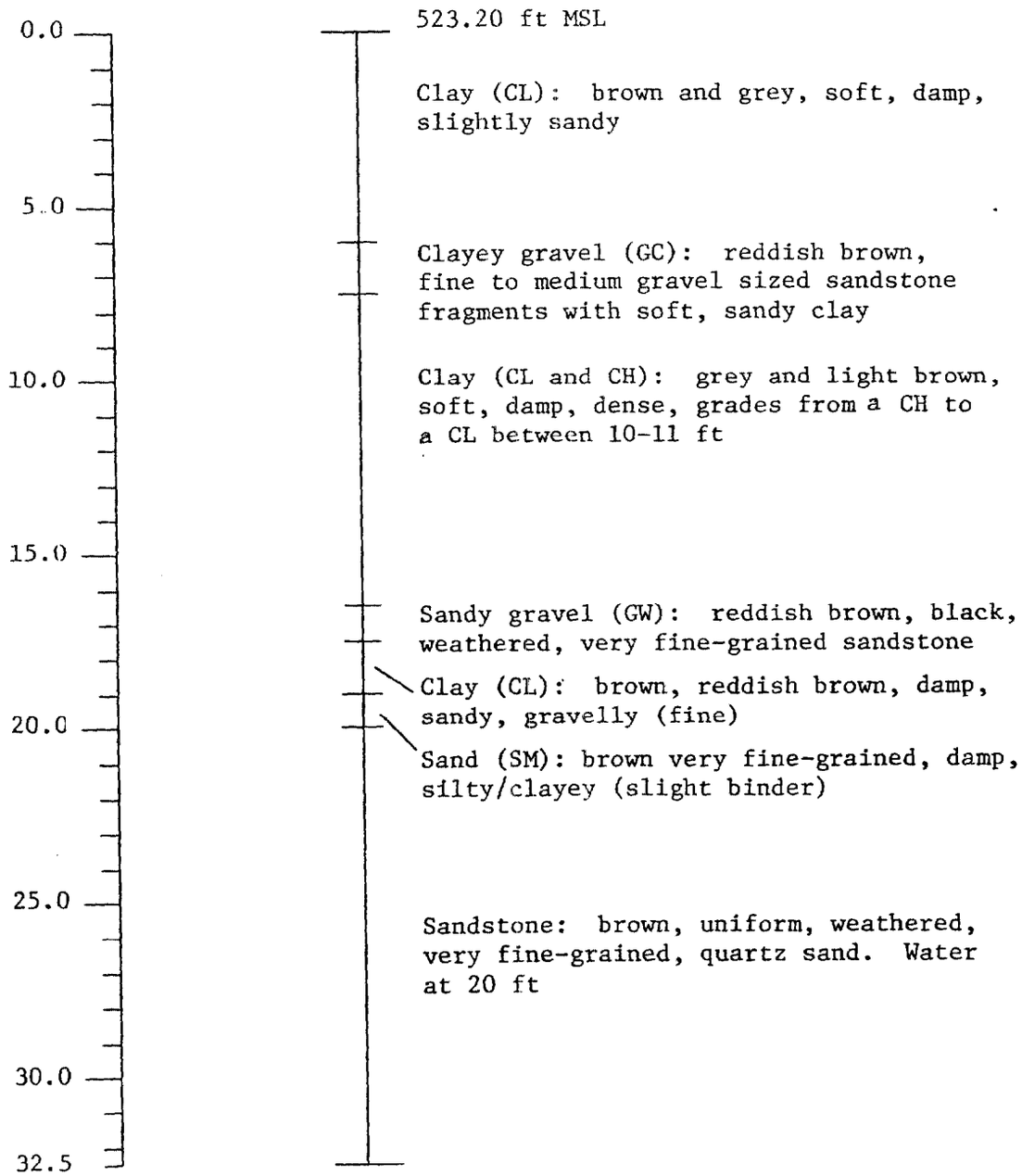
Clay: brown, damp, soft

Clay: grey, damp, soft

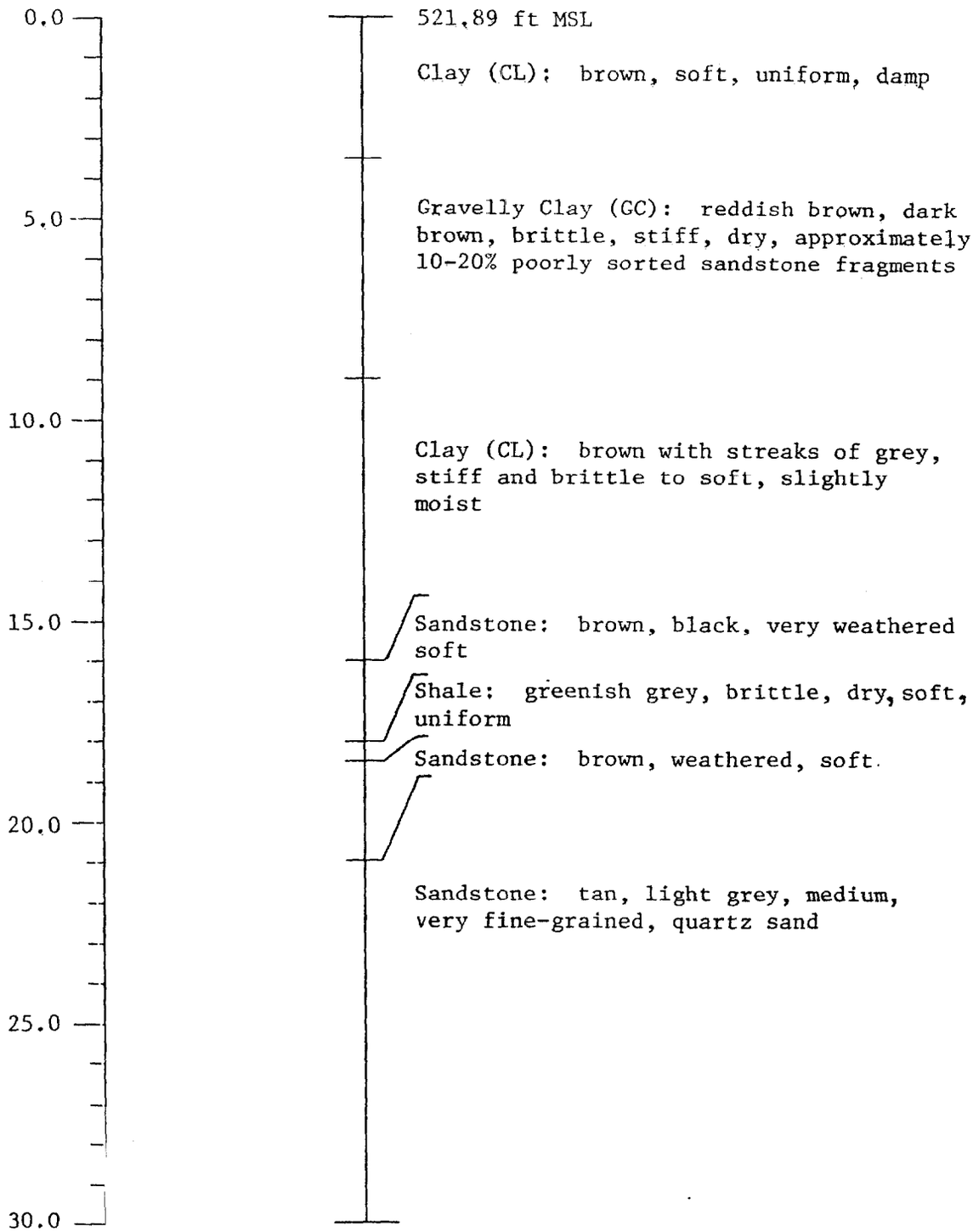
Clay: brown, damp, soft

Sandstone: reddish brown, soft, fine-grained

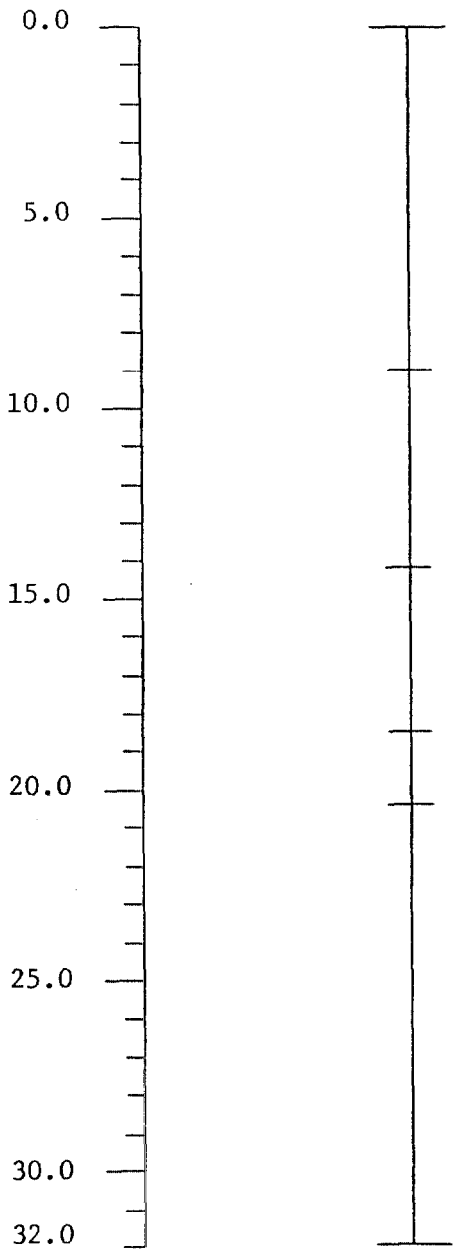
NWSC. Crane, Indiana
Old Rifle Range
Lithology
Boring Number: EPA-2-83



NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: EPA-3-83



NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: EPA-4-83



521.16 ft MSL

Clay (CL): brown with streaks of grey, soft to stiff, sandy, slight cohesion

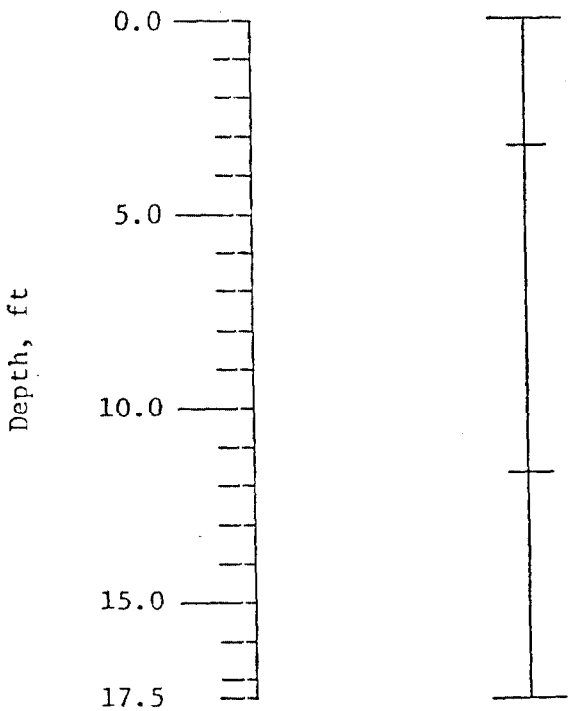
Gravelly Clay (CL): reddish brown, stiff, brittle, dry, gravel fragments angular, fine to coarse, sandstone predominant

Clay (CL): brown and grey, soft, damp, slight cohesion

Silty sand (SM): brownish grey to grey brown, very fine-grained, uniform, wet

Sandstone: light brown, light grey, very fine-grained, uniform

NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: EPA-5-83



505.06' MSL

Sandy clay (CL) and sandstone gravel: brown in color, moist, and low plasticity.

Sandy clay (CL): grey to brown in color, moist, and low plasticity.

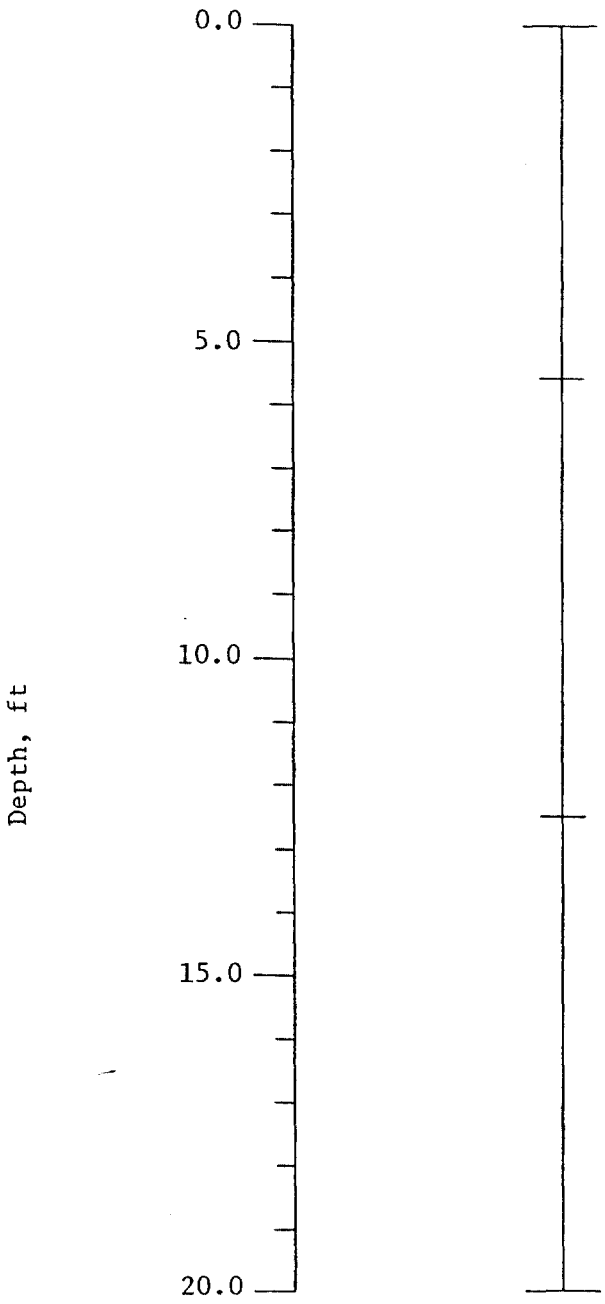
Clay (CH): dark grey in color, uniform, soft, and high plasticity.

NWSC, Crane, Indiana

Old Rifle Range

Lithology

Boring Number: WES-6-14-81



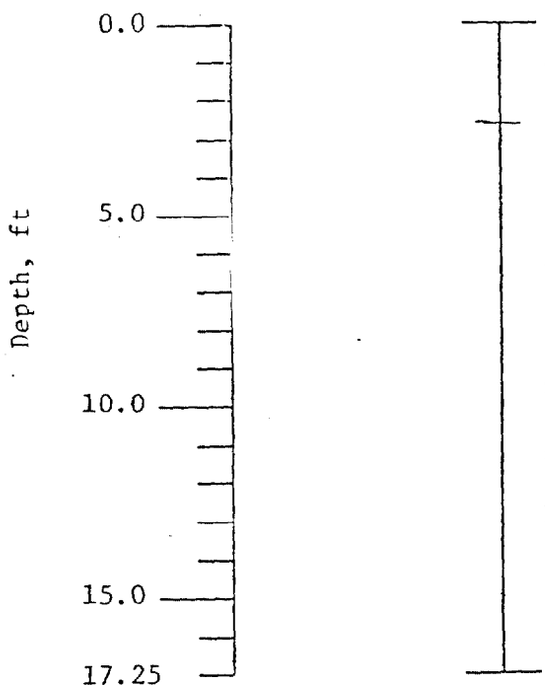
505.87 ft MSL

Gravelly clay (CL): brown with streaks of grey, soft to stiff, organic matter to 3 ft, approximately 5% very fine sandstone gravel

Clay (CL): brown with streaks of grey, very thinly bedded, soft to stiff, wet

Clay (CH): grey and dark grey soft, highly plastic

NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: WES-6-14A-83



510.42' MSL

Sand (SP) and sandstone fragments: brown to orange brown in color, very fine to fine-grained, and dry.

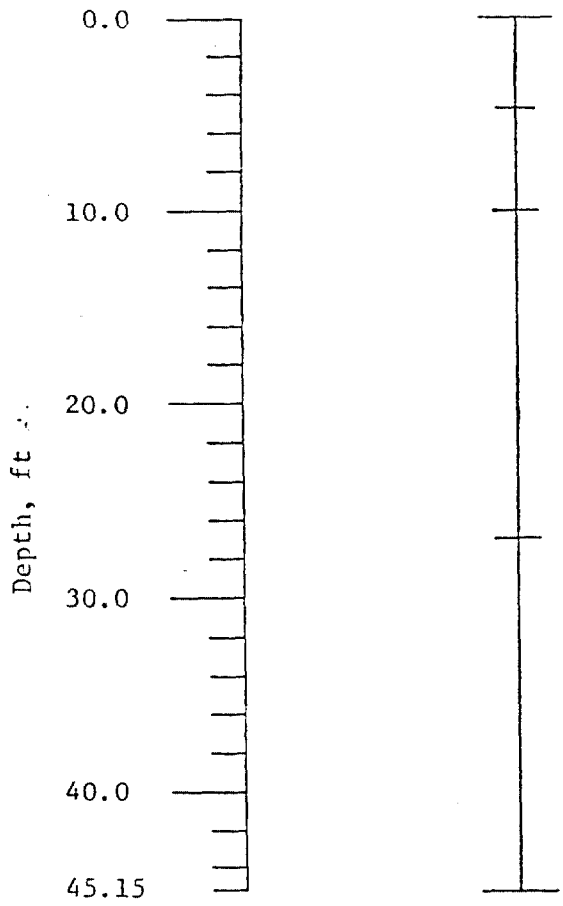
Sandstone: brown to rusty brown in color, uniform, fine-grained quartz sand, moderately hard and oxidized. Bedding ranges from thinly bedded to around one foot maximum and nearly horizontal in attitude.

NWSC, Crane, Indiana

Old Rifle Range

Lithology

Boring Number: WES-6-15-81



527.88' MSL

Silt (ML): brown in color, uniform, dry, and stiff.

Sandy silt (ML): brown in color, dry, and contains 5-10% fine to medium-grained sand.

Clay shale: brown in color, very stiff to hard, weathered, and slightly moist in regions.

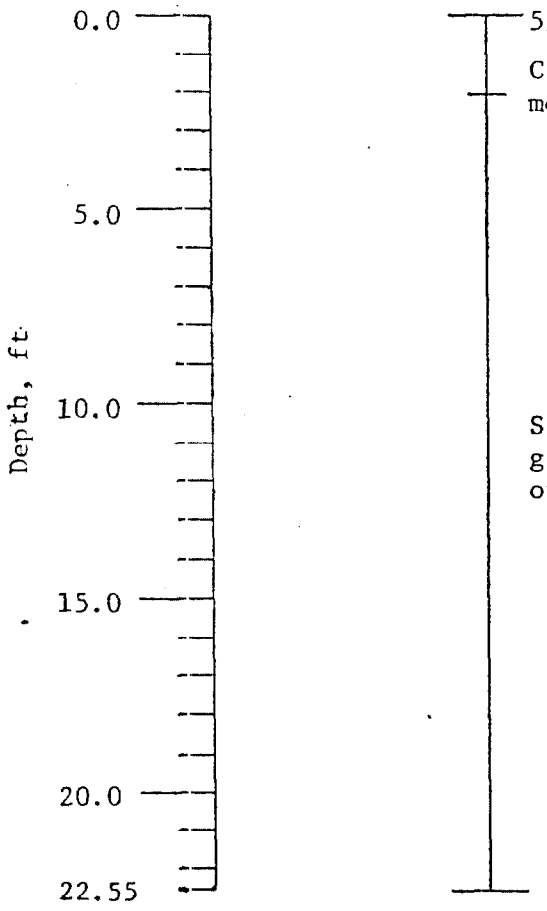
Sandstone: brown in color, medium hard, and fine-grained.

NWSC, Crane, Indiana

Old Rifle Range

Lithology

Boring Number: WES-6-16-81



510.73' MSL

Clay (CL): brown in color, soft, slightly moist, and low plasticity.

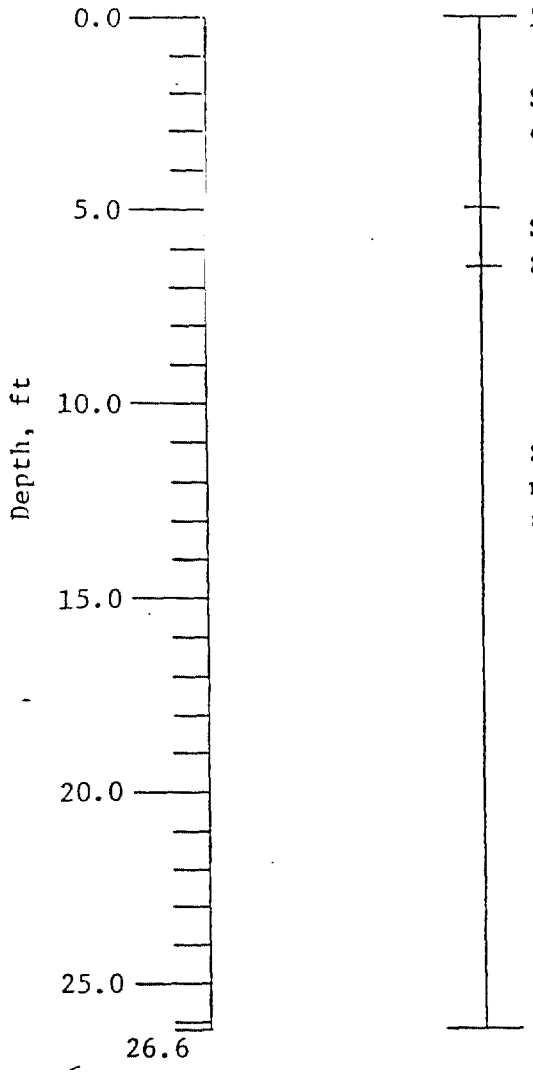
Sandstone: brown in color, uniform, fine-grained quartz sand, medium hard, and oxidized in regions.

NWSC, Crane, Indiana

Old Burning Grounds

Lithology

Boring Number: WES-6-17-81



508.03' MSL

Silty sand (SM): brown to rusty brown in color, fine-grained, and little cohesion.

Sand (SP): brown in color, uniform, fine-grained quartz sand, and slightly moist.

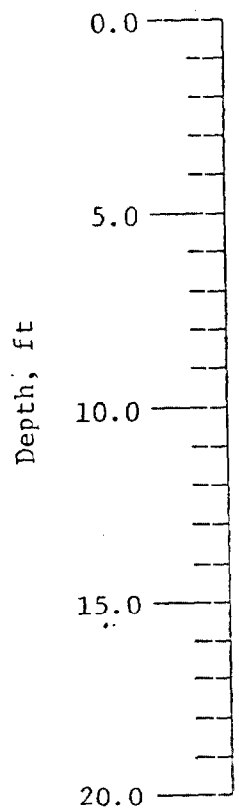
Sandstone: brown, weathered, fine-grained, medium hard to hard, and contains clay or shale lenses from 10 to 11.5 ft .

NWSC, Crane, Indiana

Old Rifle Range

Lithology

Boring Number: WES-6-18-81



503.42' MSL

Fill

Clay (CH): grey with streaks of brown, soft, and high plasticity.

Sandy clay (CL): dark grey in color, soft, low to medium plasticity, and contains 20% very fine-grained sand.

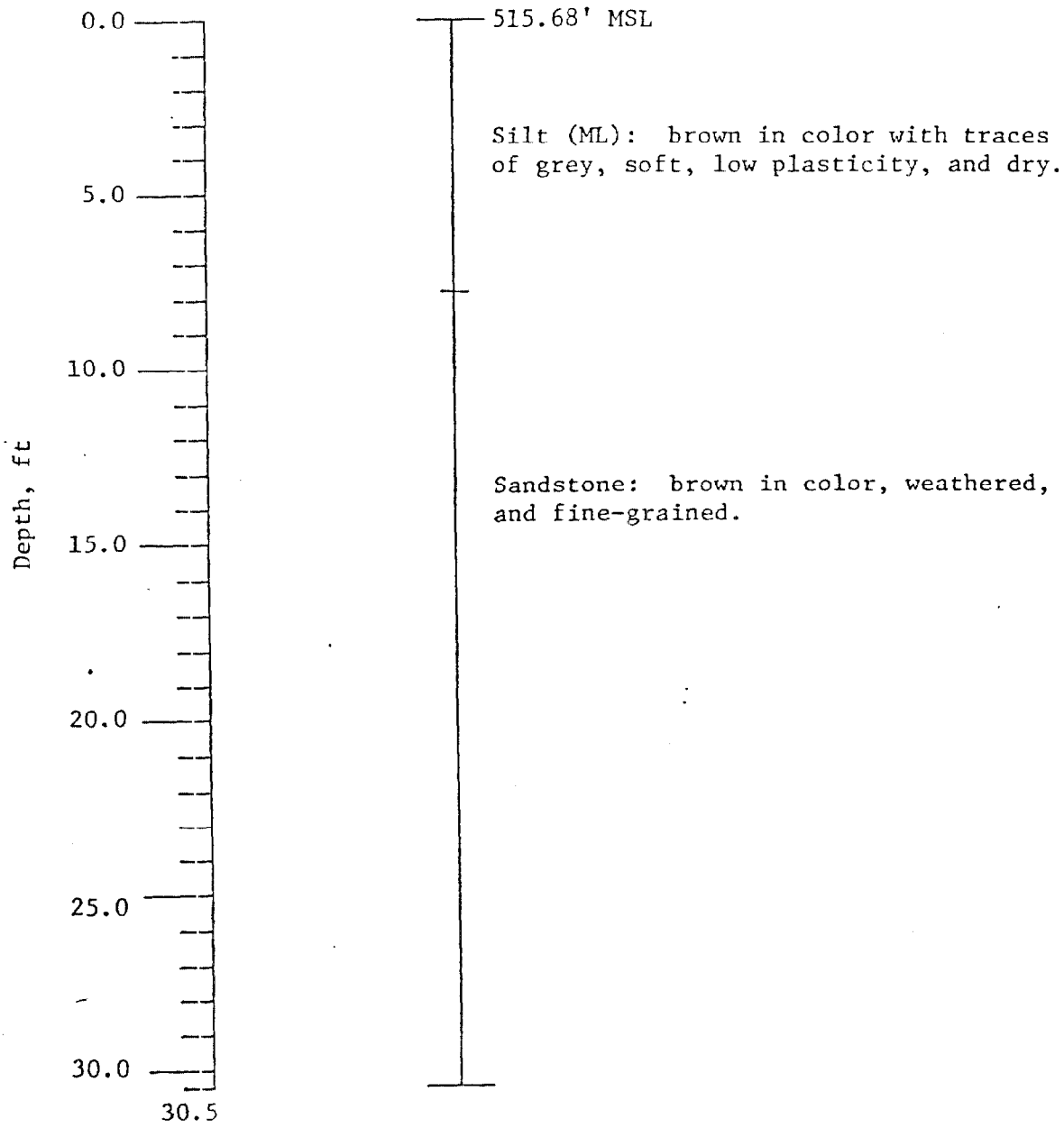
Gravelly clay (CL): brown to grey with traces of red and green, soft, low plasticity, and contains fine to medium sized gravel.

NWSC, Crane, Indiana

Old Burning Grounds

Lithology

Boring Number: WES-6-19-81

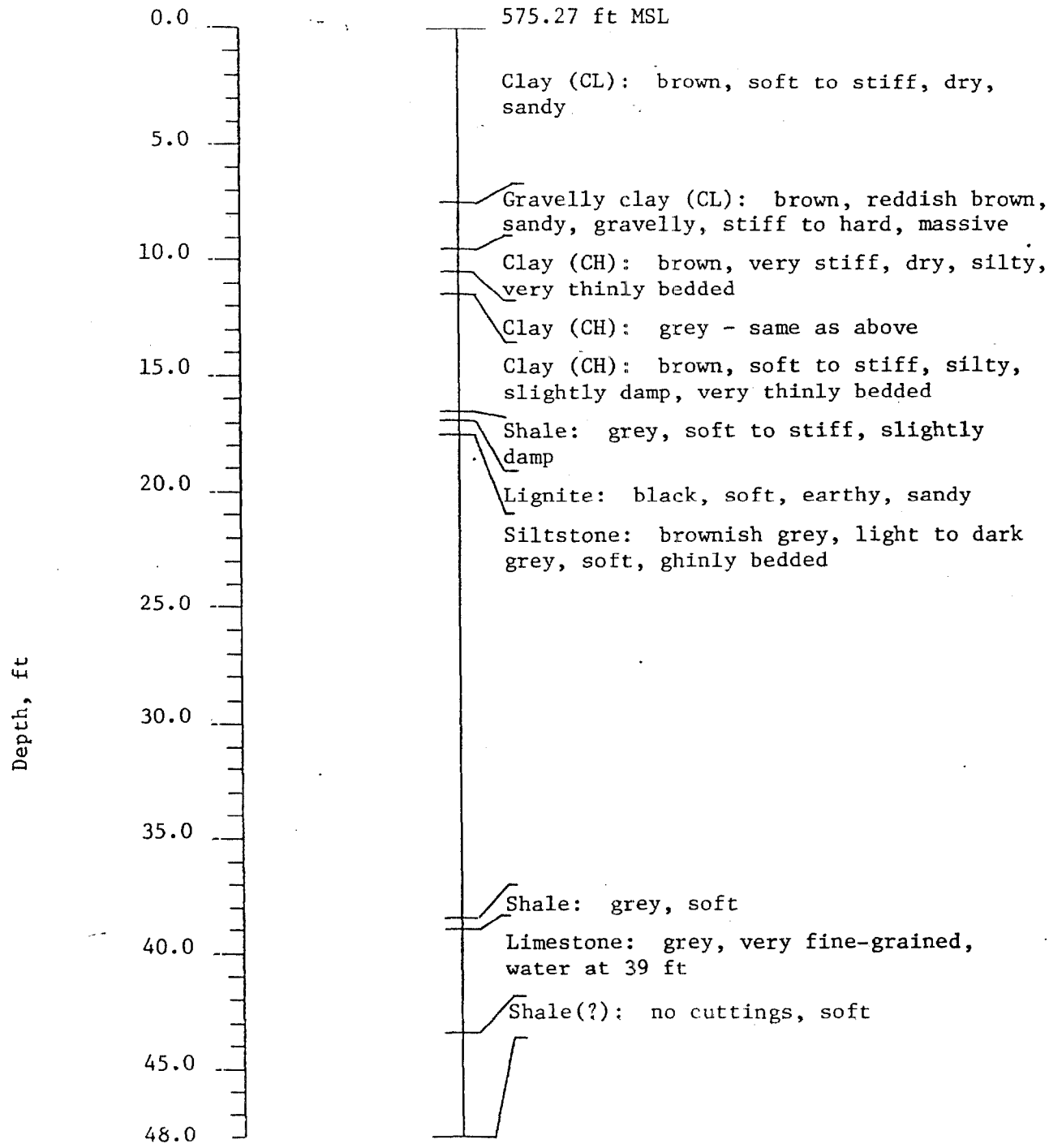


NWSC, Crane, Indiana

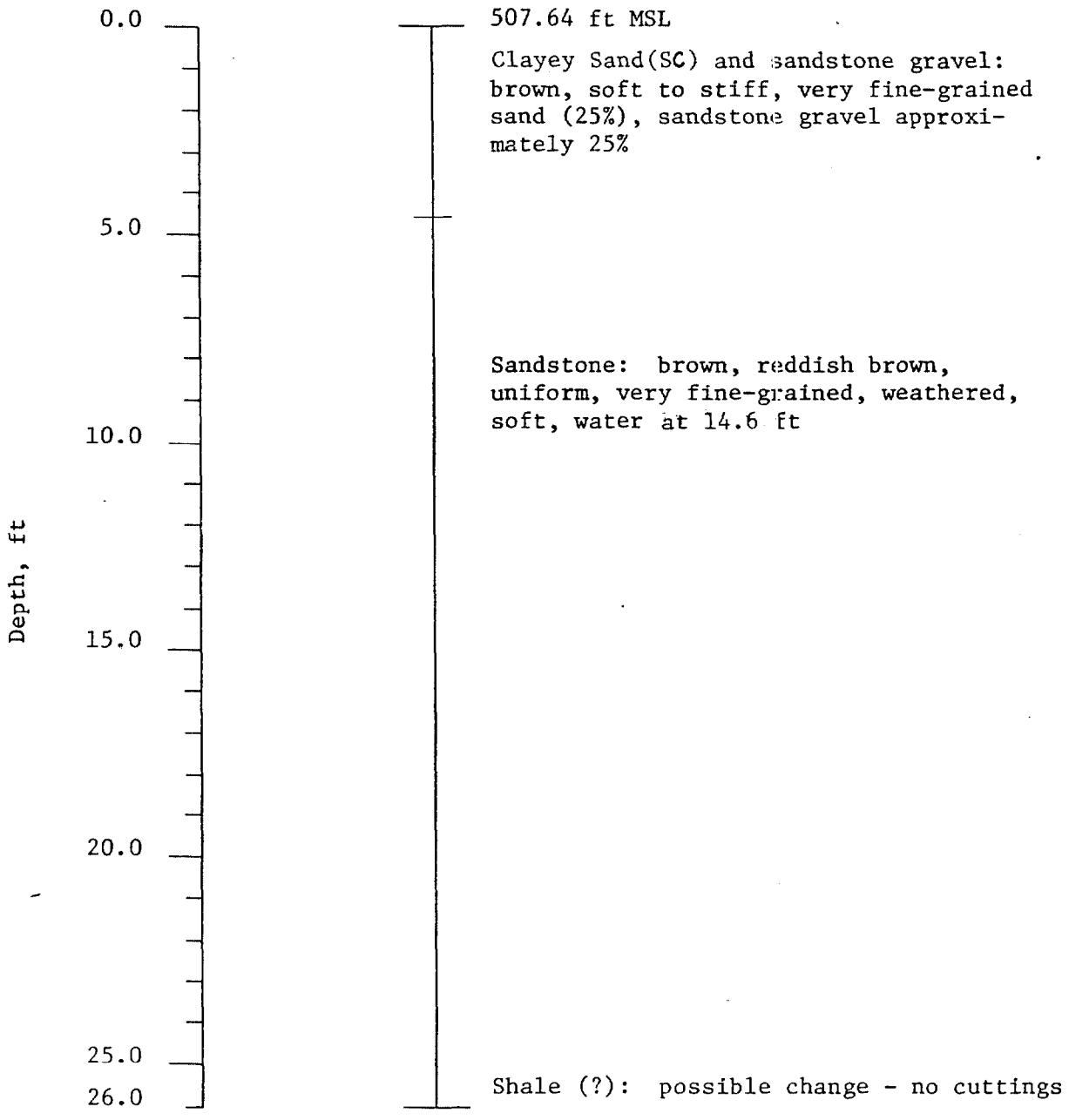
Old Rifle Range

Lithology

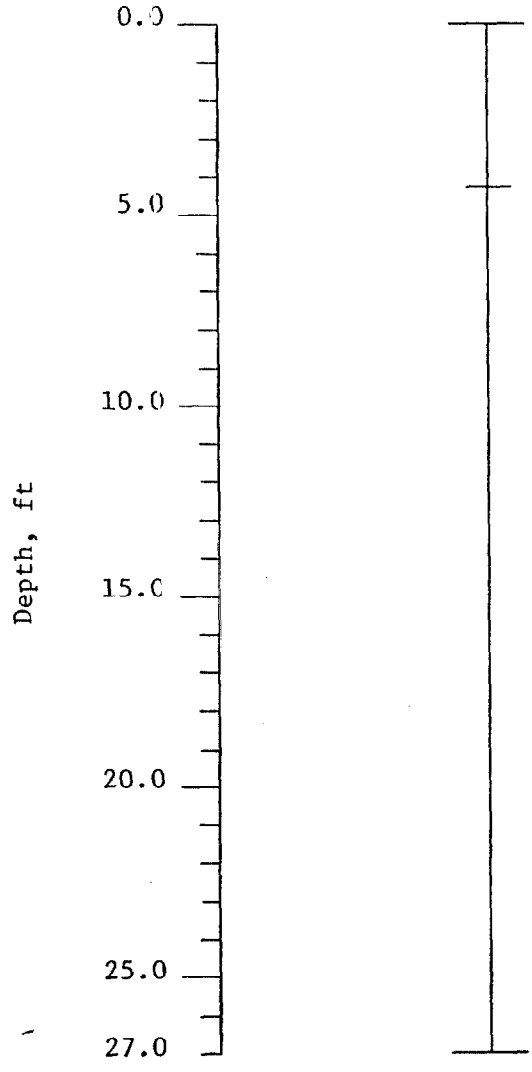
Boring Number: WES-6-20-81



NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: WES-6-21-83



NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: WES-6-22-83

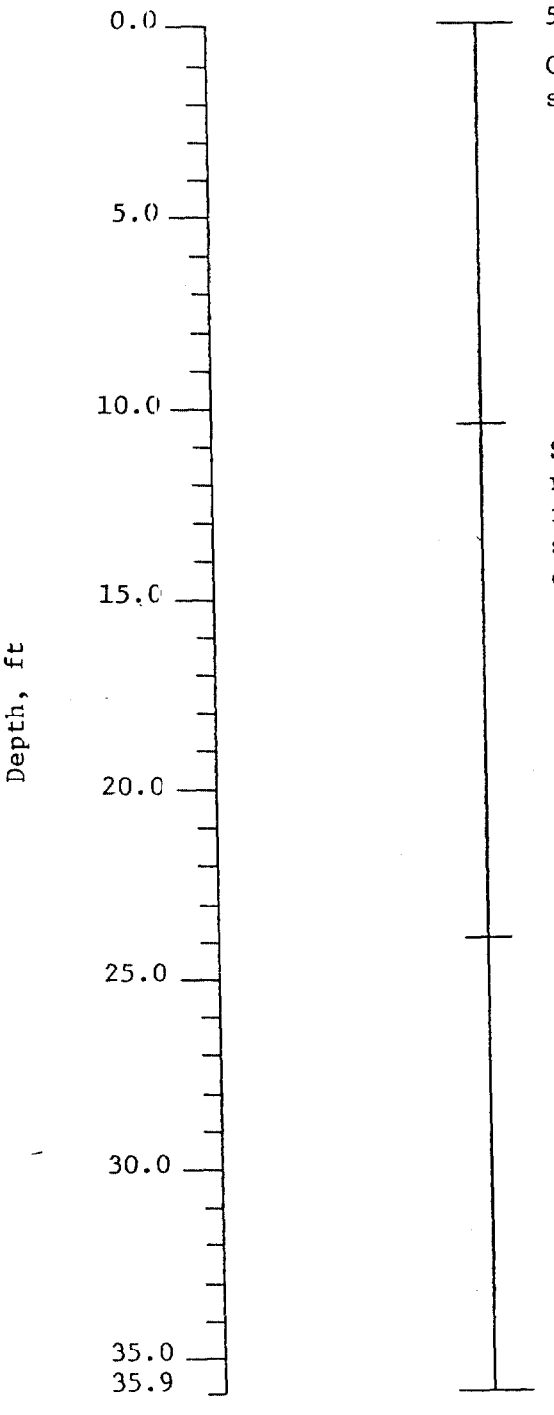


506.41 ft MSL

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

Sandstone: light brown, brown, and reddish brown, very fine-grained, uniform quartz sandstone, soft and weathered to 24 ft. Water at 16 ft

NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: WES-6-23-83



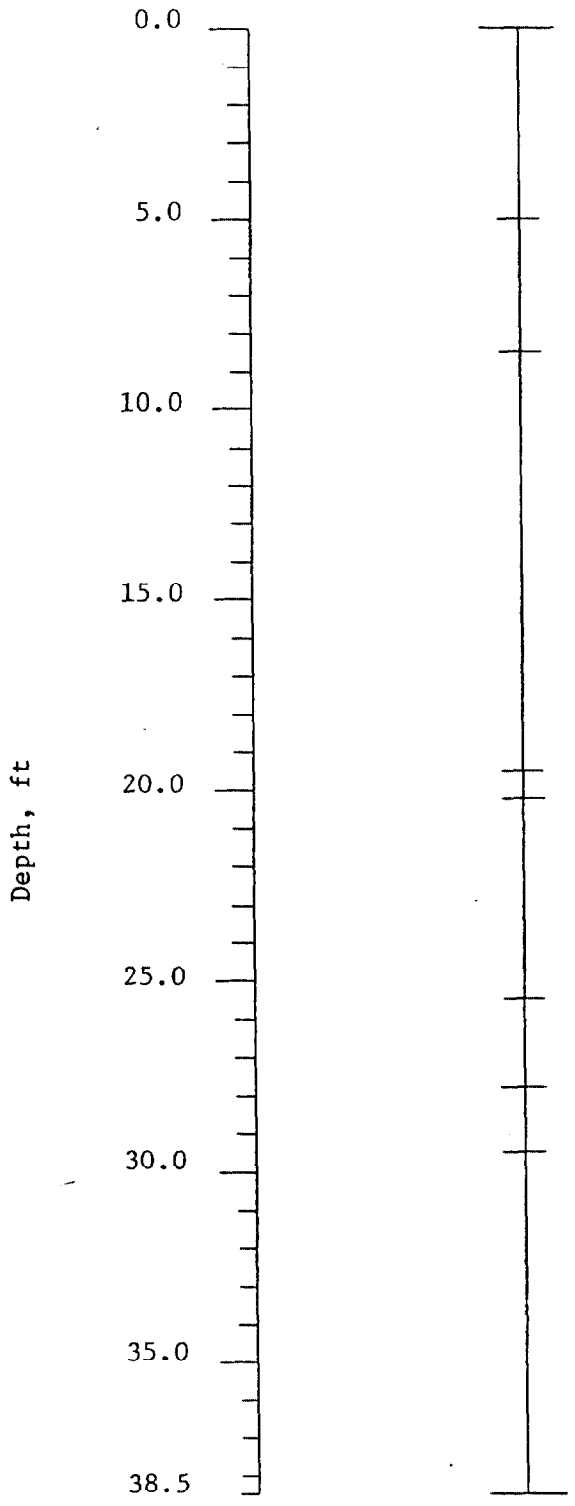
525.62 ft MSL

Clay (CL): brown and grey, soft to stiff, damp, uniform

Sandstone and clay (CL): tan, brown, reddish brown, weathered sandstone interbedded with brown sandy clay; sandstone is very fine-grained, uniform, quartz sand, friable

Sandstone: tan, brown, reddish brown, weathered, very fine-grained, uniform, quartz sandstone, bedding is horizontal and very thinly bedded

NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring No.: EPA-1-83



530.91 ft MSL

Clay (CL): brown with streaks of grey, soft, damp, organic matter (roots)

Gravelly clay (CL): reddish brown clay with weathered fine to coarse gravel sized sandstone fragments

Clayey Gravel (GC): reddish brown, fine to coarse sandstone gravel (65%) and soft clay (35%), sandstone is fine-grained, weathered

Sandstone: reddish brown, soft

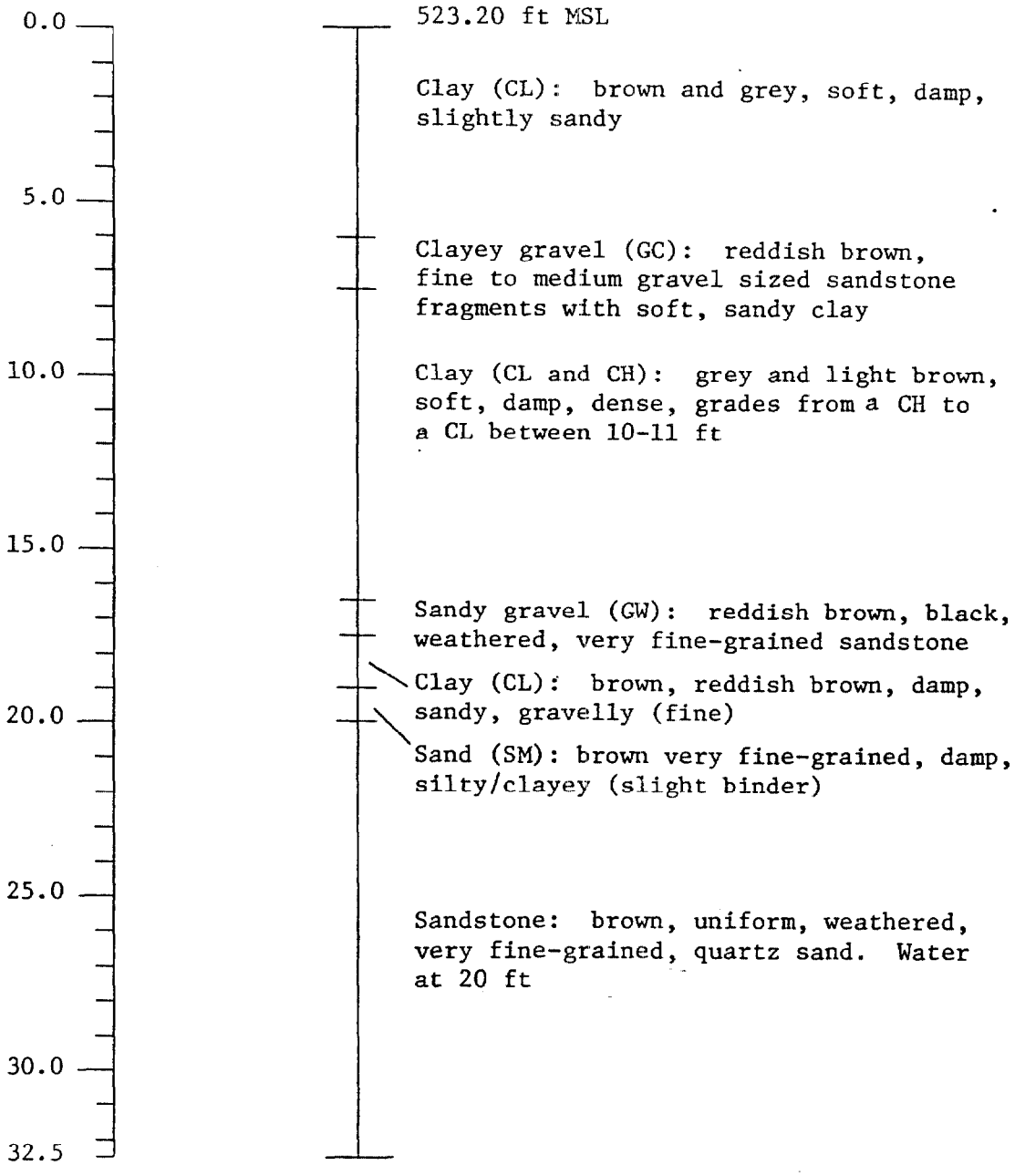
Clay: brown, damp, soft

Clay: grey, damp, soft

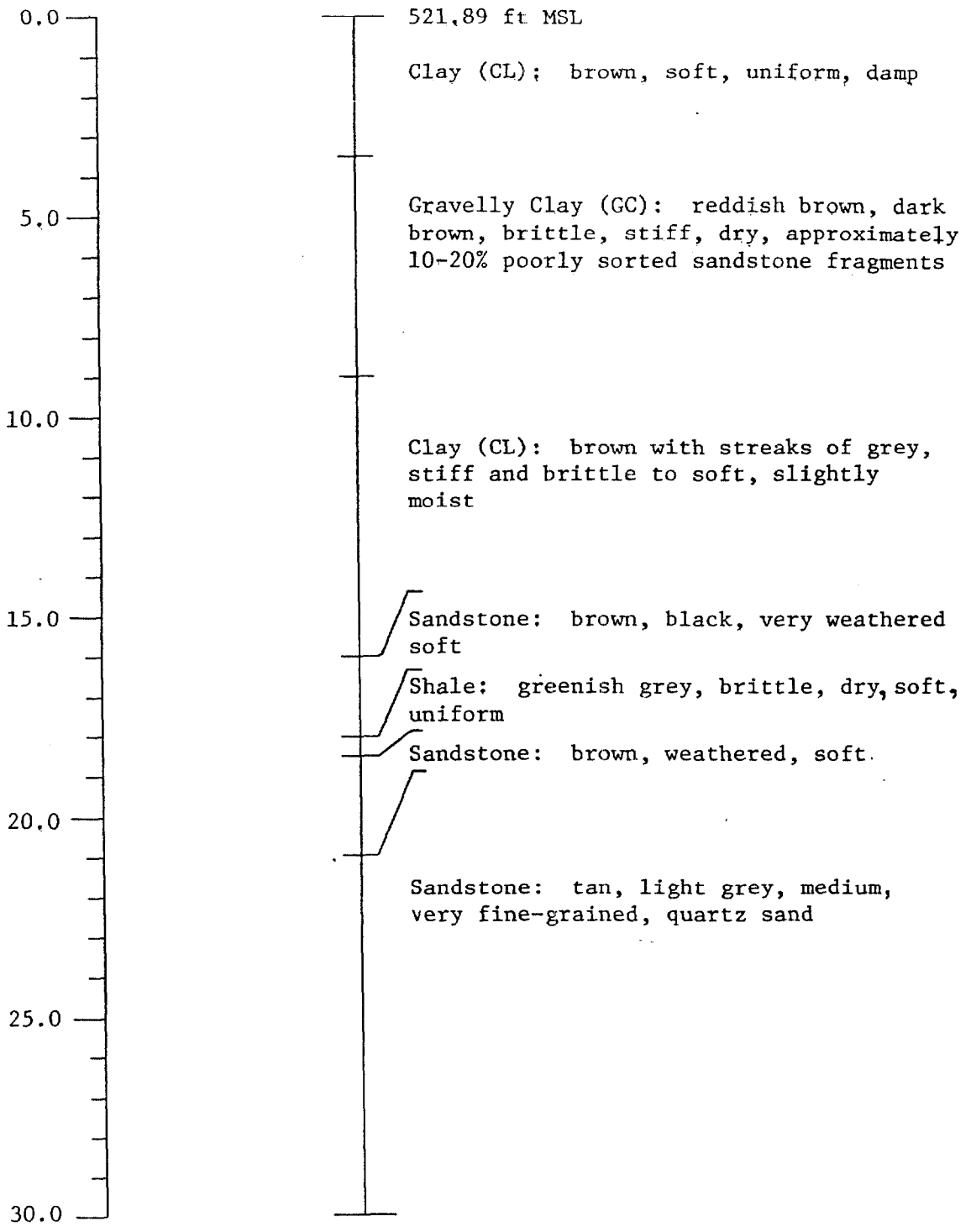
Clay: brown, damp, soft

Sandstone: reddish brown, soft, fine-grained

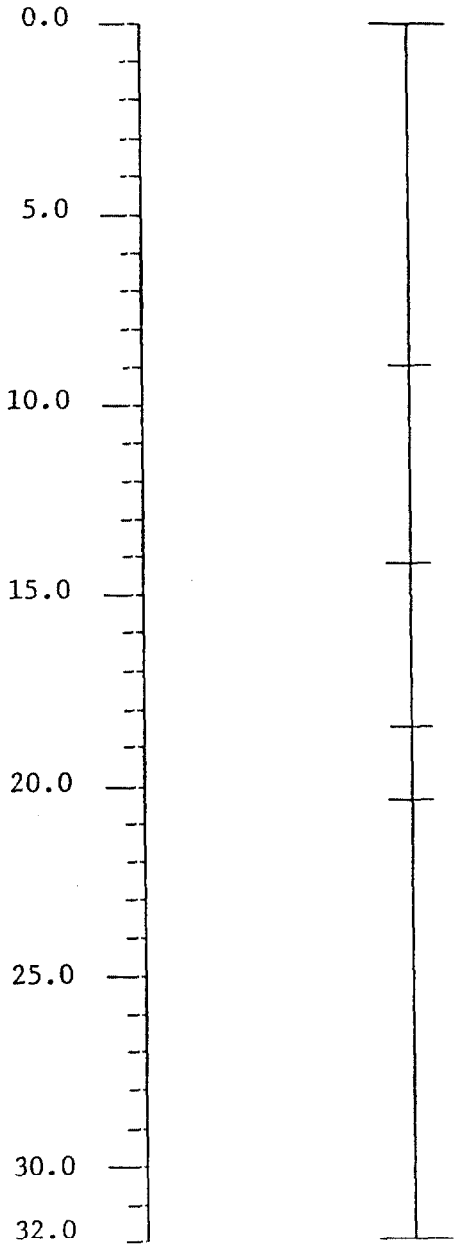
NWSC. Crane, Indiana
Old Rifle Range
Lithology
Boring Number: EPA-2-83



NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: EPA-3-83



NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: EPA-4-83



521.16 ft MSL

Clay (CL): brown with streaks of grey, soft to stiff, sandy, slight cohesion

Gravelly Clay (CL): reddish brown, stiff, brittle, dry, gravel fragments angular, fine to coarse, sandstone predominant

Clay (CL): brown and grey, soft, damp, slight cohesion

Silty sand (SM): brownish grey to grey brown, very fine-grained, uniform, wet

Sandstone: light brown, light grey, very fine-grained, uniform

NWSC, Crane, Indiana
Old Rifle Range
Lithology
Boring Number: EPA-5-83

APPENDIX C

LABORATORY SOIL TEST RESULTS

Laboratory Soil Test Results

Old Rifle Range

Boring Number	Sample Number	Depth ft	Dry Density lbs/cu ft	Water Content Percent	Liquid Limit Percent	Plastic Limit Percent	Plasticity Index Percent	USCS**	Permeability cm/sec	Cation Exchange Capacity meq/100 g
6-14-81	1	0.0-1.61	115.6	15.8	27	16	11	SC		
6-14-81	2	5.0-7.06	98.8	24.0	28	19	9	CL	2.77×10^{-6}	5.65
6-14-81	3	10.0-11.67	101.1	23.5	33	18	15	CL		
6-14-81	4	15.0-17.07	87.0	33.3	61	24	37	CH		
6-15-81	1	0.0-1.35	111.5	16.5	27	17	10	CL		
6-16-81	1	0.0-1.37	102.4	13.8	37	20	17	CL		11.2
6-16-81	2A*	5.0-5.4	--	10.7	29	15	14	CL		
6-17-81	1	0.0-1.39	101.0	22.7	28	17	11	CL		3.71
6-18-81	1	0.0-1.63	117.4	15.0	35	18	17	CL		
6-18-81	2	5.0-6.58	112.9	13.9	24	14	10	SC		
6-19-81	1	5.0-6.88	103.6	23.2	42	18	24	CL		10.2
6-19-81	2	10.0-11.66	99.7	25.2	44	17	27	CL		
6-20-81	1	0.0-1.78	110.8	19.1	27	15	12	CL		4.65
6-20-81	2	5.0-6.75	109.9	18.9	35	14	21	CL		

* Jar sample

** Unified Soils Classification System

Laboratory Soil Test Results

Old Rifle Range

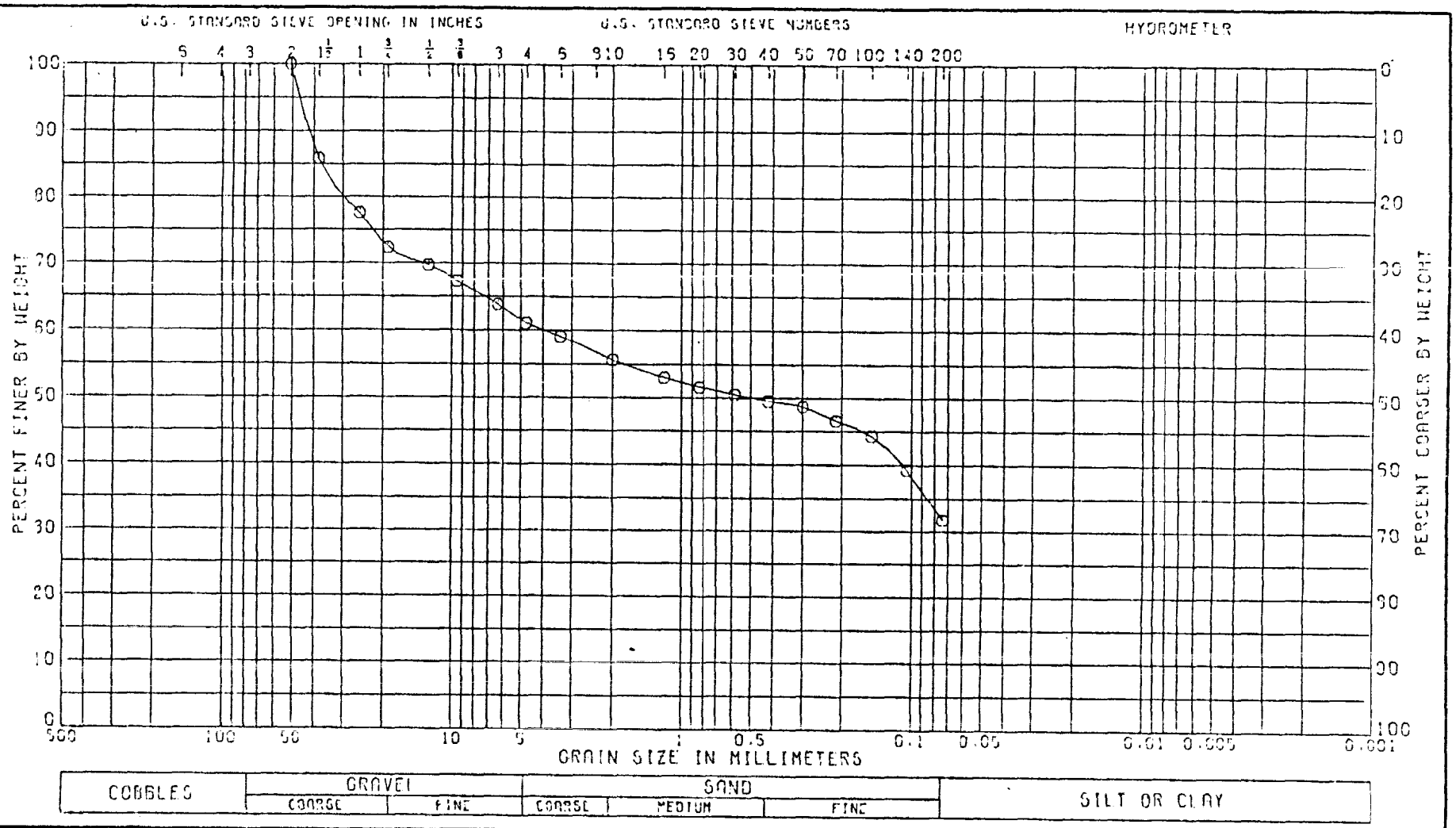
Boring Number	Sample Number	Depth (ft)	Dry Density lbs/cu ft	Water Content Percent	Liquid Limit Percent	Plastic Limit Percent	Plasticity Index Percent	USCS**	Permeability cm/sec	Cation Exchange Capacity meq/100 g
EPA-1-83	1	0.0-2.4	110.7	18.6	34	14	20	CL	$3.3X10^{-7}$	15.7
EPA-1-83	2	5.0-7.3	115.4	15.5	24	13	11	CL		
EPA-2-83	1	0.0-2.1	115.1	16.3	24	15	9	CL		12.8
EPA-2-83	2	5.0-6.35	114.0	16.8	32	14	18	CL		
EPA-2-83	3	10.0-11.35	115.4	13.6	29	13	16	CL		
EPA-2-83	4	15.0-15.95	114.9	9.6	35	16	19	CL		
EPA-3-83	1	0.0-2.25	108.5	19.2	34	15	19	CL		18.4
EPA-3-83	2	5.0-6.08	120.6	13.6	38	18	20	CL		
EPA-3-83	3	10.0-12.12	106.2	20.7	36	14	22	CL	$2.13X10^{-6}$	
EPA-3-83	4	15.0-16.1	123.7	14.0	35	19	16	CL		
EPA-4-83	1	0.0-1.5	105.0	20.4	33	22	11	CL		16.8
EPA-4-83	3	10.0-12.18	109.1	20.2	44	16	28	CL		
EPA-4-83	5	16.0-18.35	113.5	11.2	31	17	14	CL		
EPA-5-83	1	0.0-2.25	106.7	18.9	32	13	19	CL		20.5
EPA-5-83	2	5.0-6.85	109.2	19.1	33	14	19	CL		
EPA-5-83	3	10.0-11.22	110.0	15.6	23	14	9	CL	$9.21X10^{-6}$	
EPA-5-83	4	15.0-17.15	107.6	20.3	38	18	20	CL		
EPD-1-83	1*	BP***	-	-	35	12	23	CL		
EPD-1-83	2*	BP	-	-	32	13	19	CL		
EPD-1-83	3*	BP	-	-	38	16	22	CL		
EPD-2-83	1*	BP	-	-	31	15	16	CL		

Laboratory Soil Test Results

Old Rifle Range (Continued)

Boring Number	Sample Number	Depth (ft)	Dry Density lbs/cu ft	Water Content Percent	Liquid Limit Percent	Plastic Limit Percent	Plasticity Index Percent	USCS**	Permea-bility cm/sec	Cation Exchange Capacity meq/100 g
EPD-2-83	2*	BP	-	-	31	14	17	CL		
EPD-2-83	3	BP	-	-	35	16	19	CL		

* - Jar Sample - #1 (South end of pit), #2 (Center of pit, #3 (North end of pit)
** - Unified Soils Classification System
*** - Bottom of Pit - N end of 1 = 512.20 ft msl; S end of 1 = 510.90 ft msl
N end of 2 = 511.70 ft msl; S end of 2 = 513.10 ft msl



LL	PL	PI	GS	NAT W.%
27	16	11		15.8

CLASSIFICATION

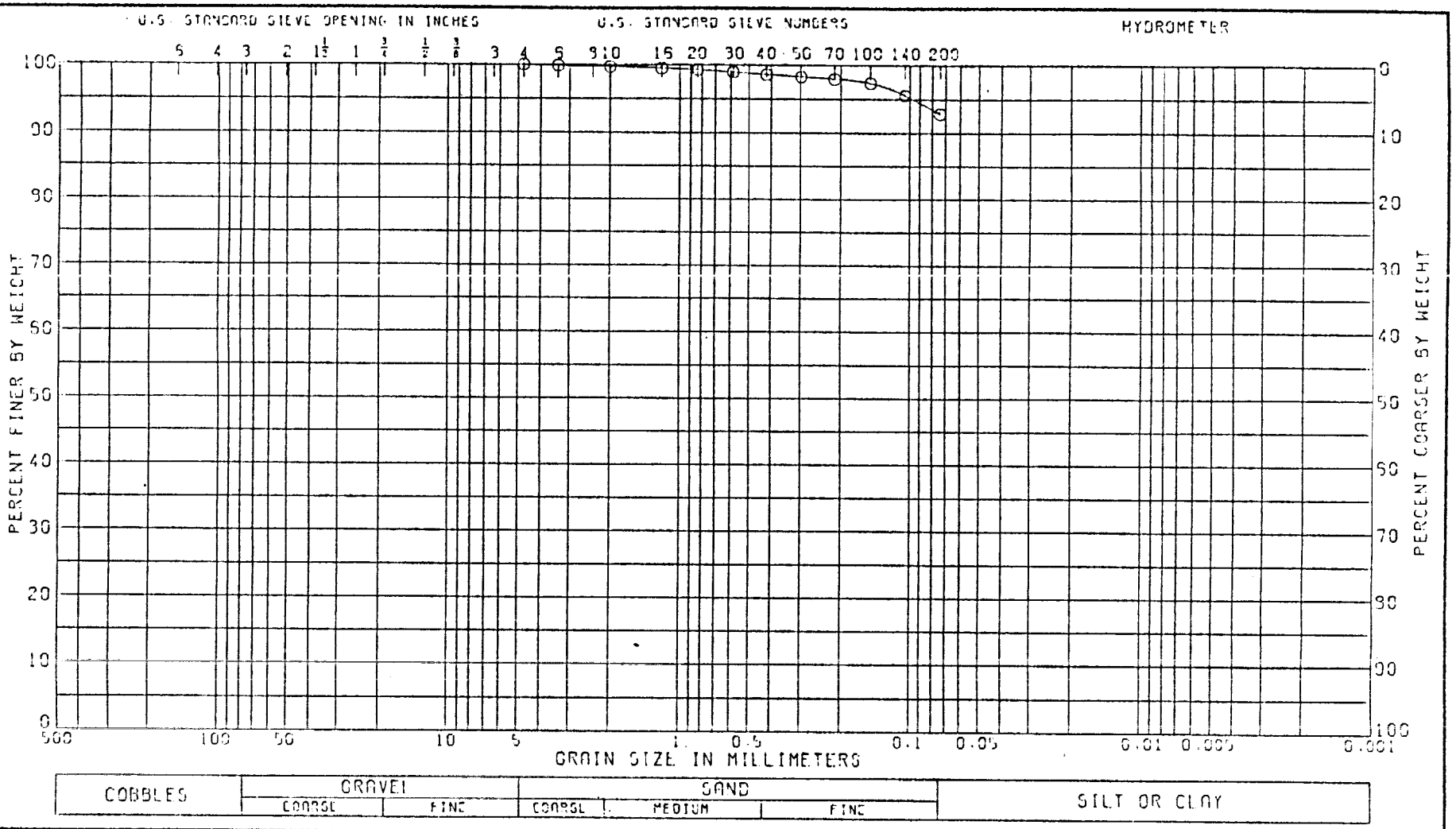
GRAVELLY CLAYEY SAND (SC), REDDISH BROWN
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT CRANE NWSC DEMOLITION AREA

BORING NO. 6-14-81 SAMPLE NO. 1

DEPTH/ELEV 0.0-1.61 DATE 11 FEB 92



LL	PL	PI	CS	NAT W.%
28	19	9		24.0

CLASSIFICATION

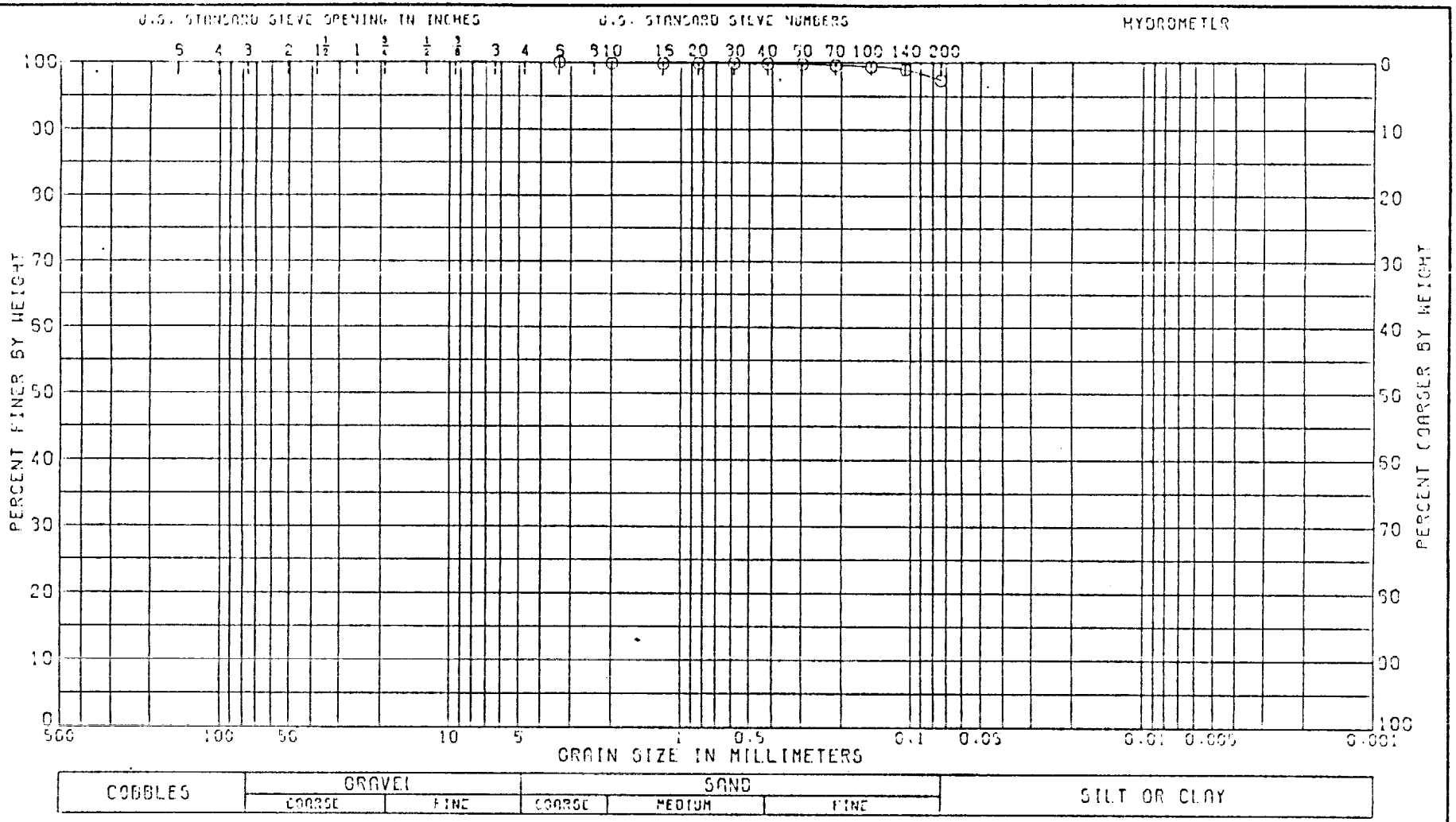
CLAY (CL), BROWN: WITH SAND

GRADATION CURVE

PROJECT: CRANE NWSC
DEMOLITION AREA

BORING NO. 6-14-81 SAMPLE NO. 2

DEPTH/ELEV 5.0-7.05 DATE 31 MAR 82



LL 33	PL 18	PI 15	GS	NAT W.% 23.5	

CLASSIFICATION

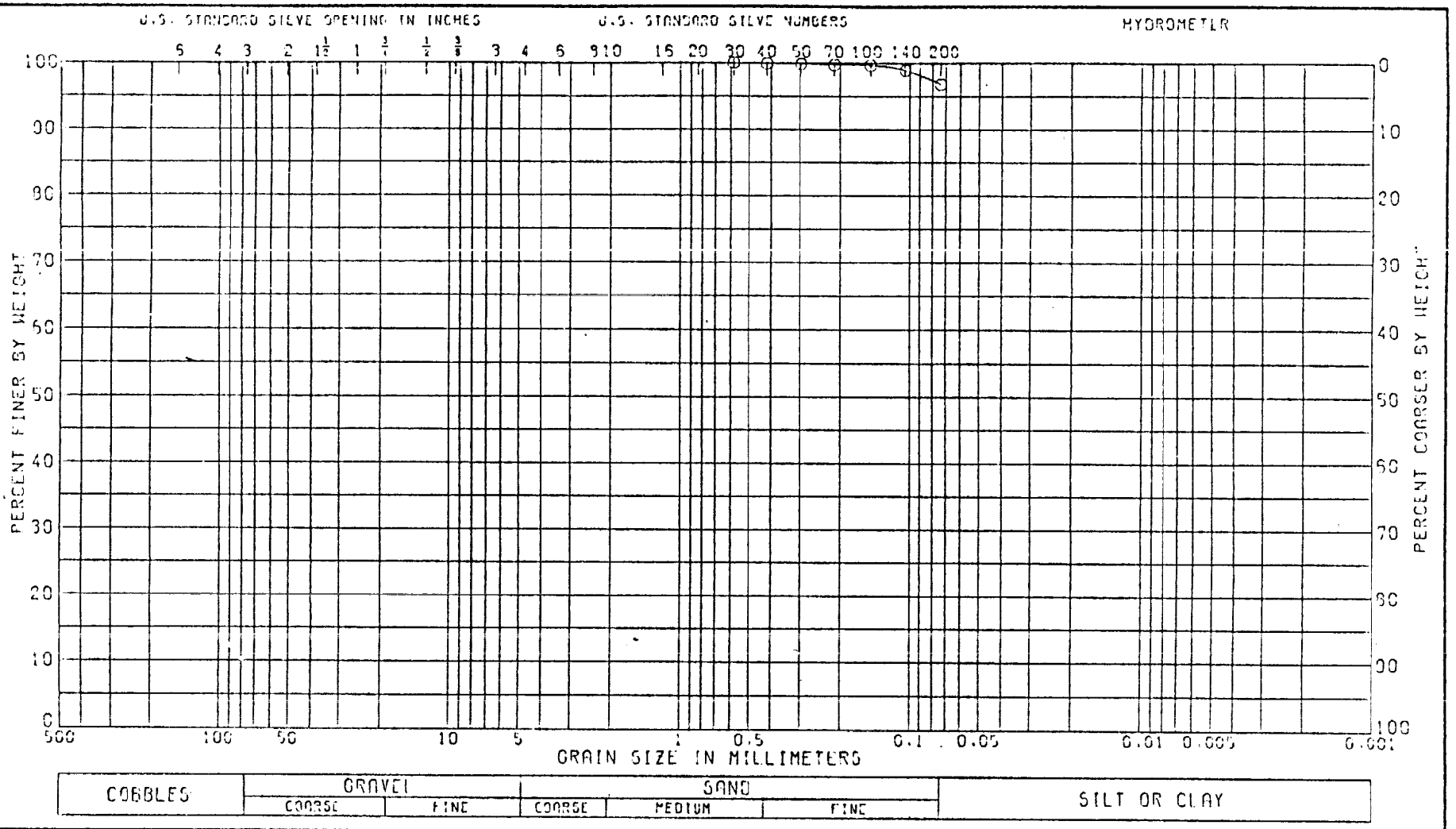
CLAY (CL), GRAY

GRADATION CURVE

PROJECT CRANE NWSC DEMOLITION AREA

BORING NO. G-14-81 SAMPLE NO. 3

DEPTH/ELEV 10.0-11.67 DATE 11 FEB 92



LL 61	PL 24	PI 37	GS	NAT W.% 33.3	

CLASSIFICATION

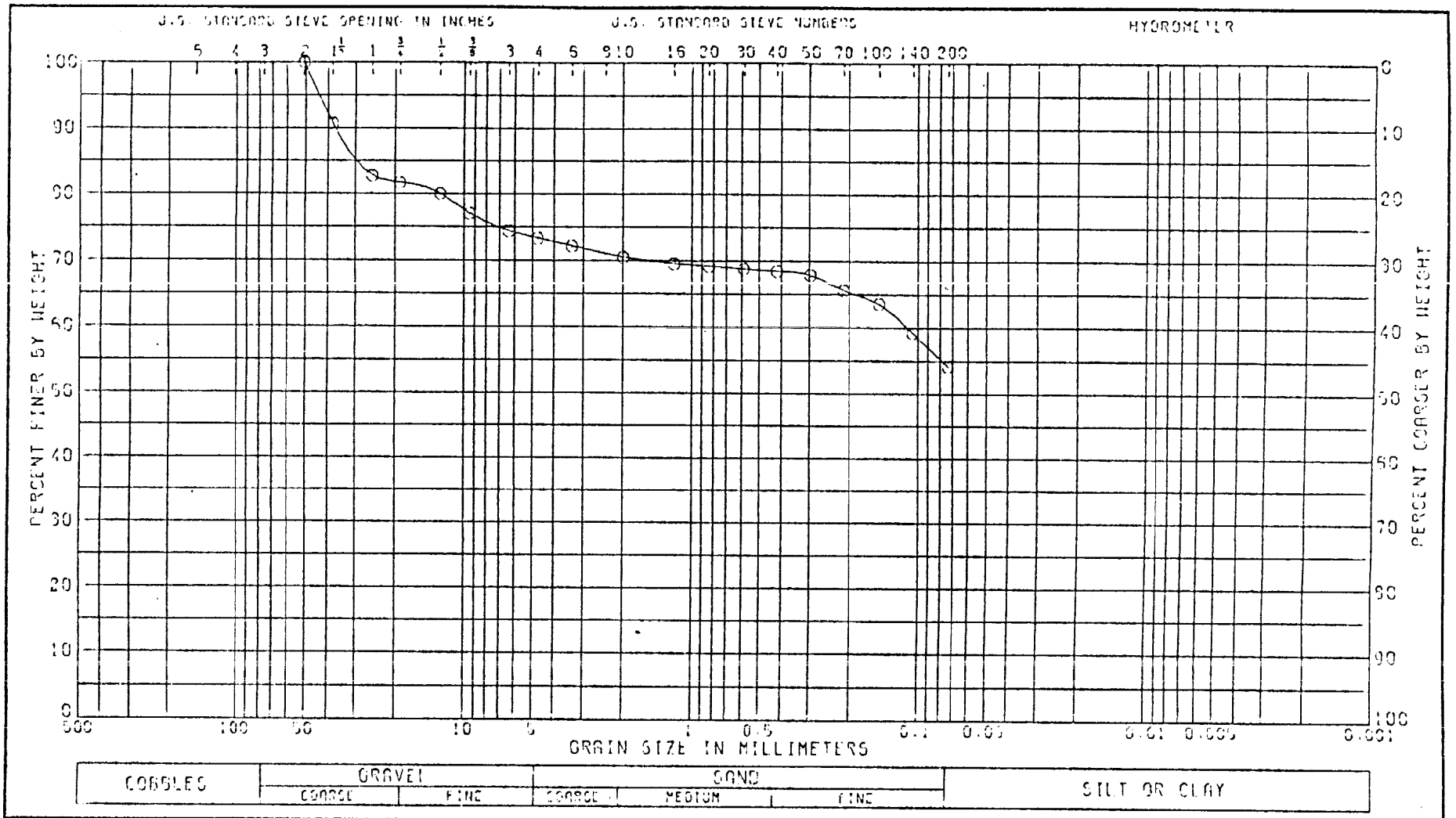
CLAY (CH), DARK BROWN

GRADATION CURVE

PROJECT: CRANE NWSC DEMOLITION AREA

BORING NO. S-14-81 SAMPLE NO. 4

DEPTH/ELEV 15.0-17.07 DATE 11 FEB 82



LL 27	PL 17	PI 10	GS	NAT W.% 16.5	

CLASSIFICATION

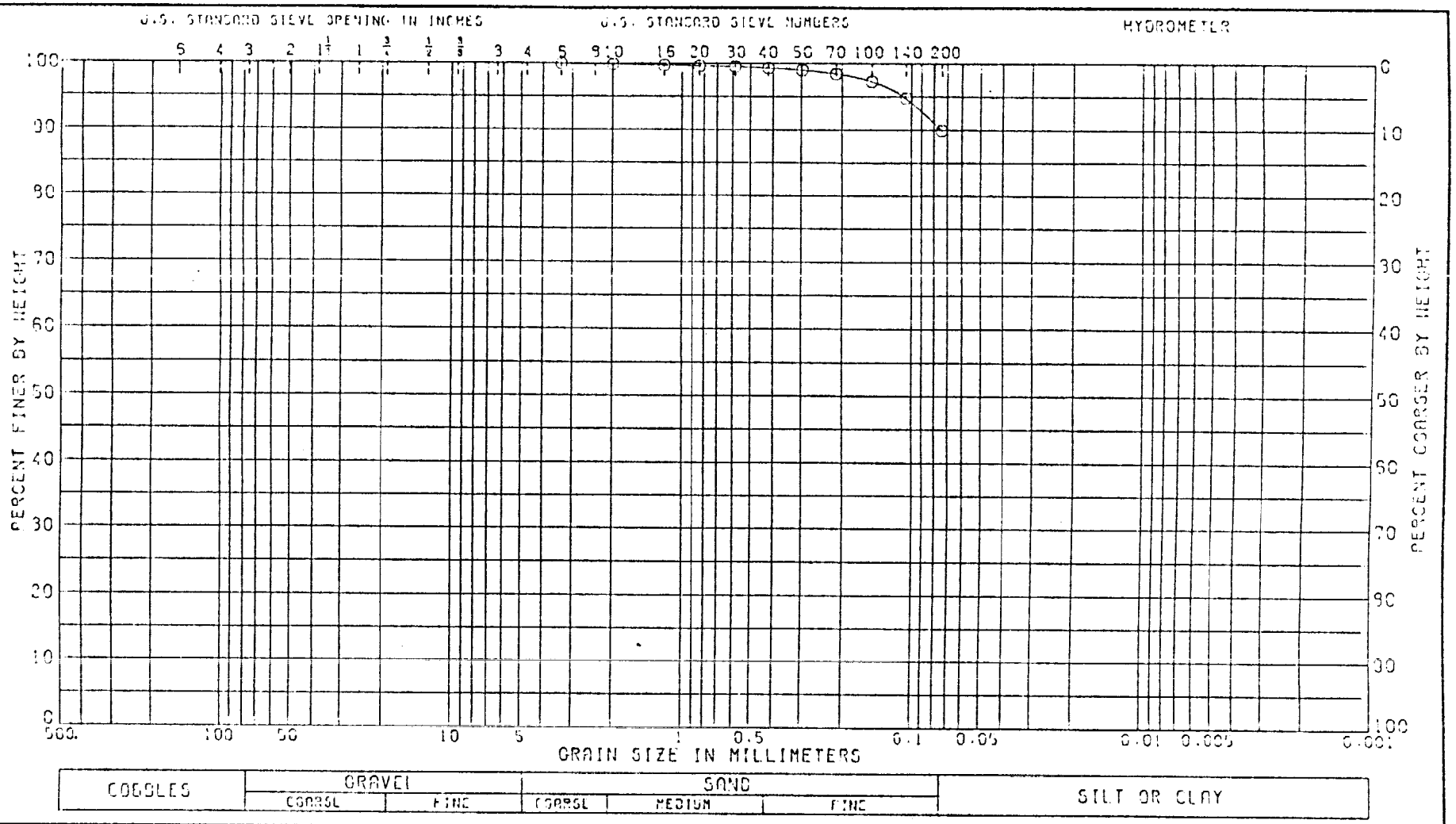
GRAVELLY SANDY CLAY (CL), BROWN
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT CRANE NWSC
OLD BURNING GROUND

BORING NO. 6-15-81 SAMPLE NO. 1

DEPTH/ELEV 0.0-1.35 DATE 26 FEB 82



LL	PL	PI	OS	NAT W.%
37	20	17		13.8

CLASSIFICATION

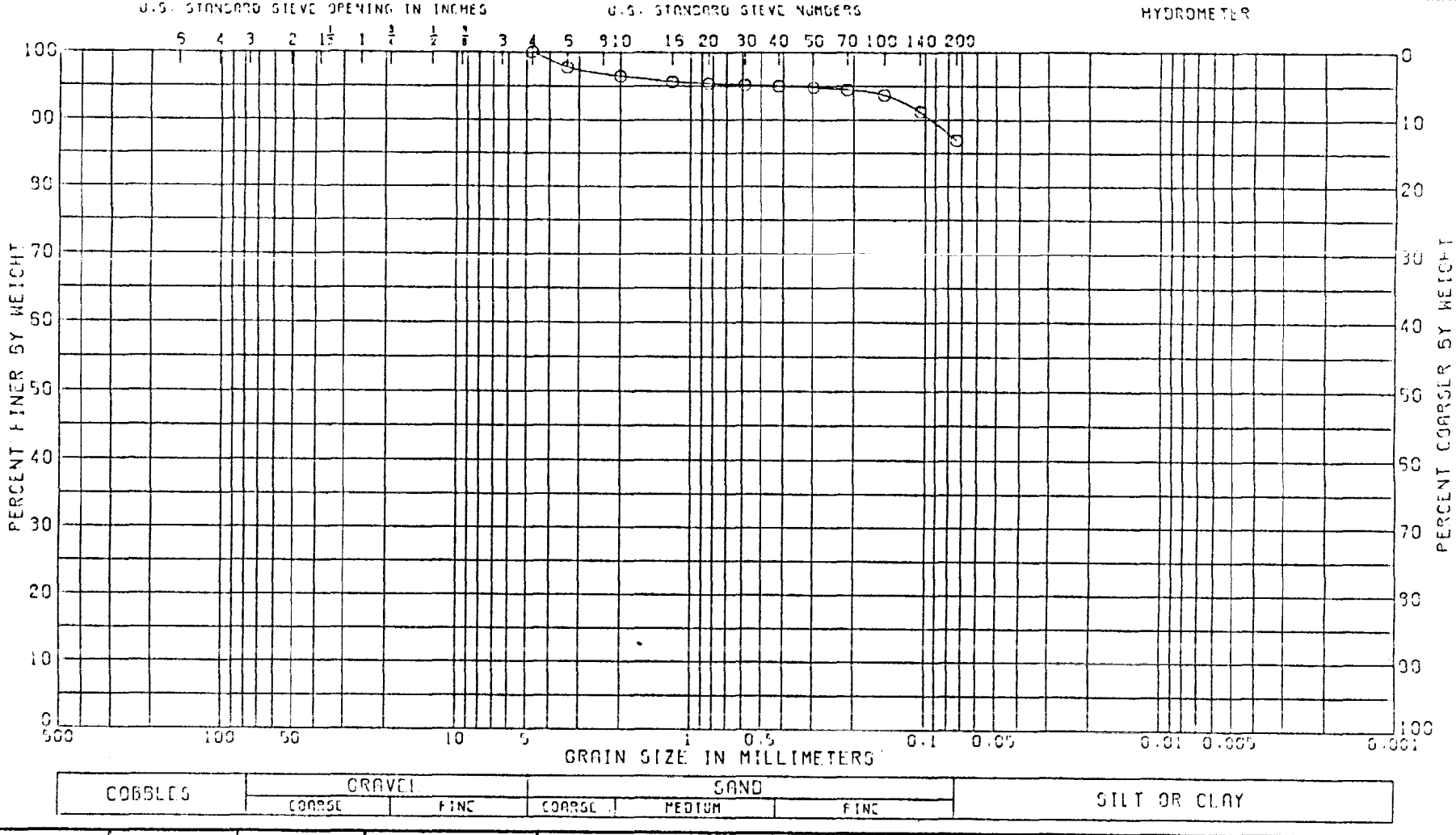
CLAY (CL), BROWN: WITH SAND

GRADATION CURVE

PROJECT: CRANE NWSC DEMOLITION AREA

BORING NO. 6-16-91 SAMPLE NO. 1

DEPTH/ELEV 0.0-1.37 DATE 12 MAR 92



LL	PL	PI	CS	NAT W.%
29	15	14		10.7

CLASSIFICATION

SANDY CLAY (CL), BROWN

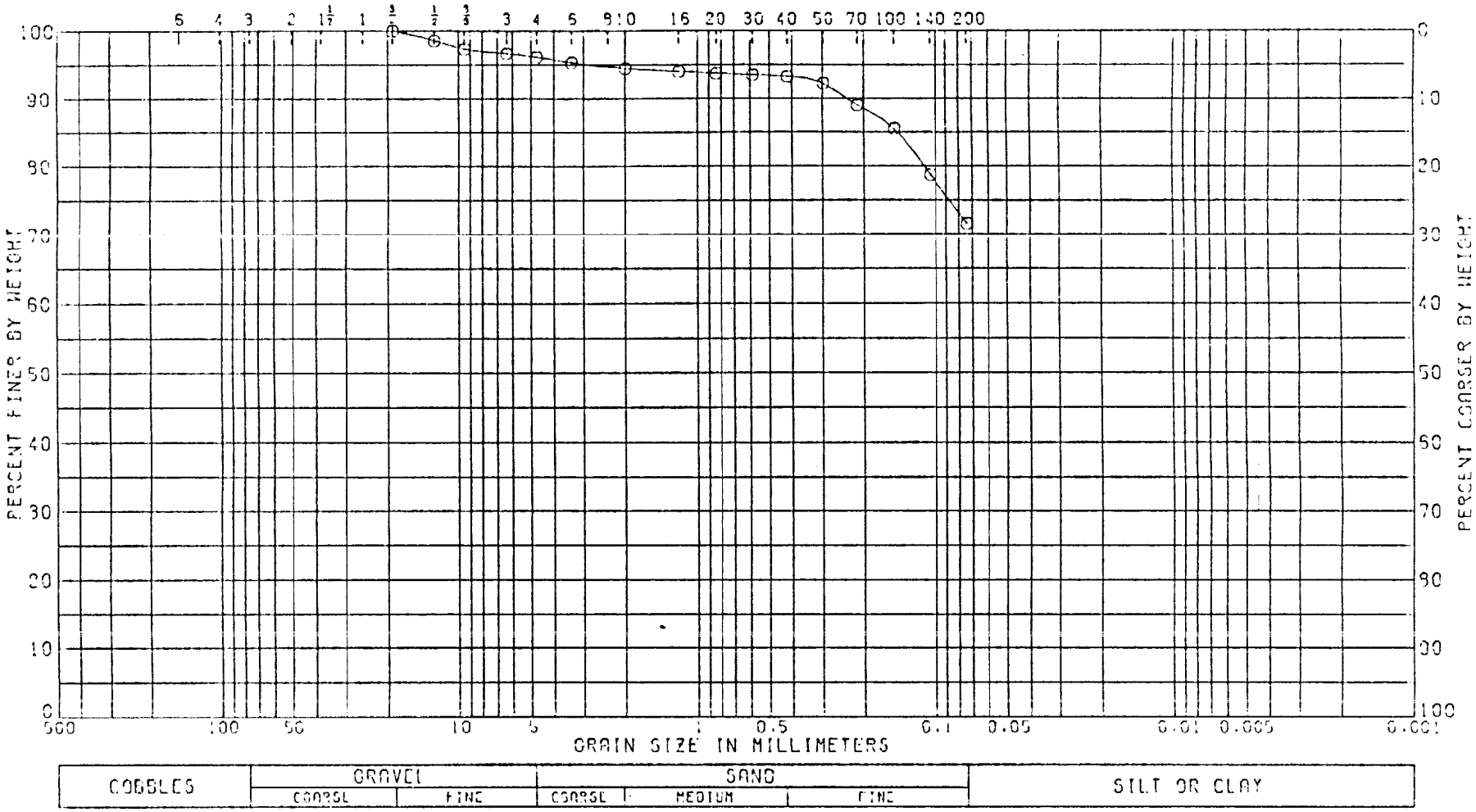
GRADATION CURVE

PROJECT CRANE NWSC

DEMOLITION AREA

BORING NO. 6-15-81 SAMPLE NO. 20

DEPTH/ELEV 5.0-5.4 DATE 31 MAR 82



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

LL	PL	PI	GS	NAT W.%	
28	17	11		22.7	

CLASSIFICATION

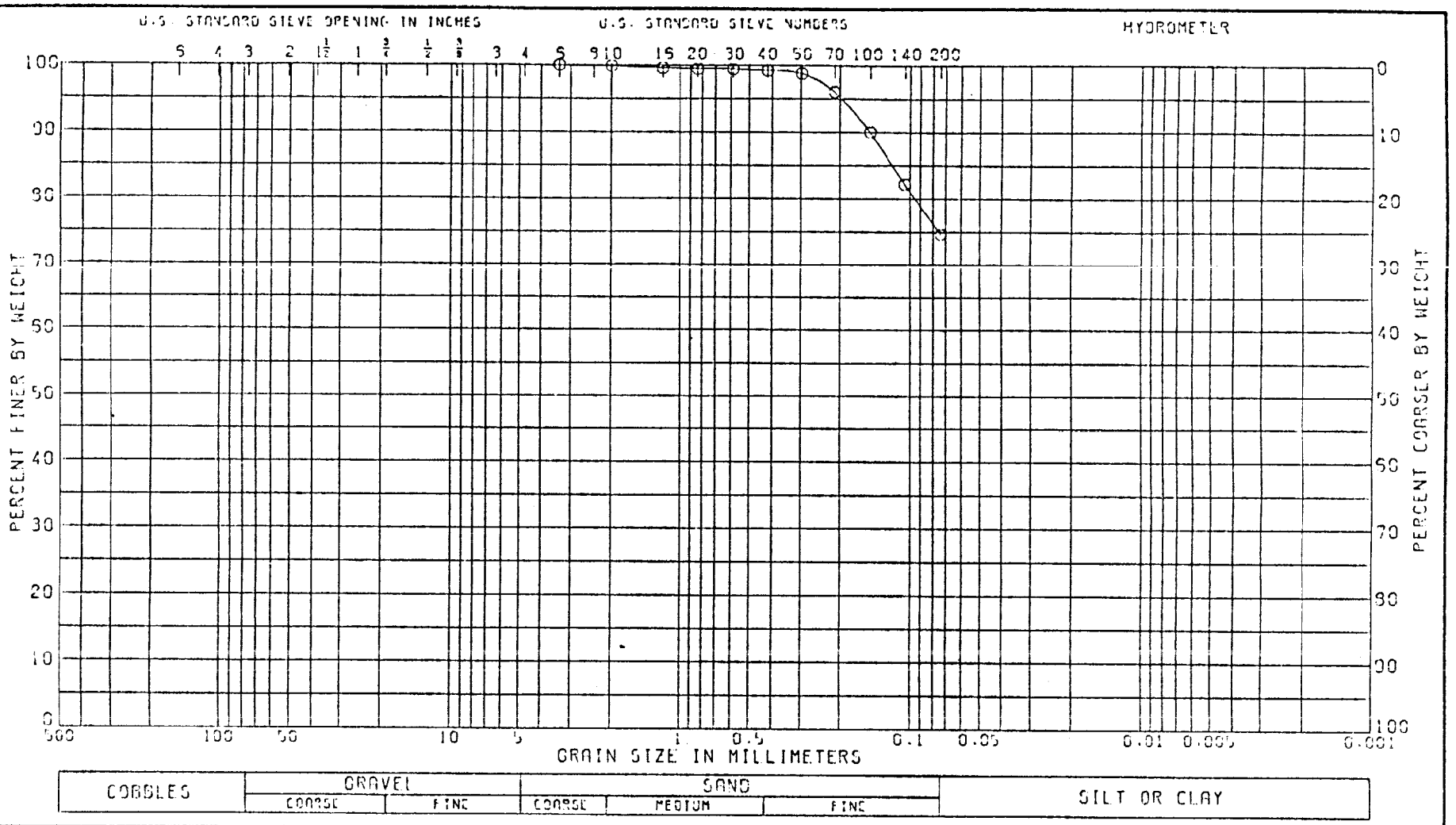
SANDY CLAY (CL), BROWN; TRACE OF GRAVEL

GRADATION CURVE

PROJECT, CRANE NWSC DEMOLITION AREA

BORING NO. S-17-91 SAMPLE NO. 1

DEPTH/ELEV 0.0-1.30 DATE 12 MAR 92



LL	PL	PI	CS	NAT W.%
35	18	17		15.0

CLASSIFICATION

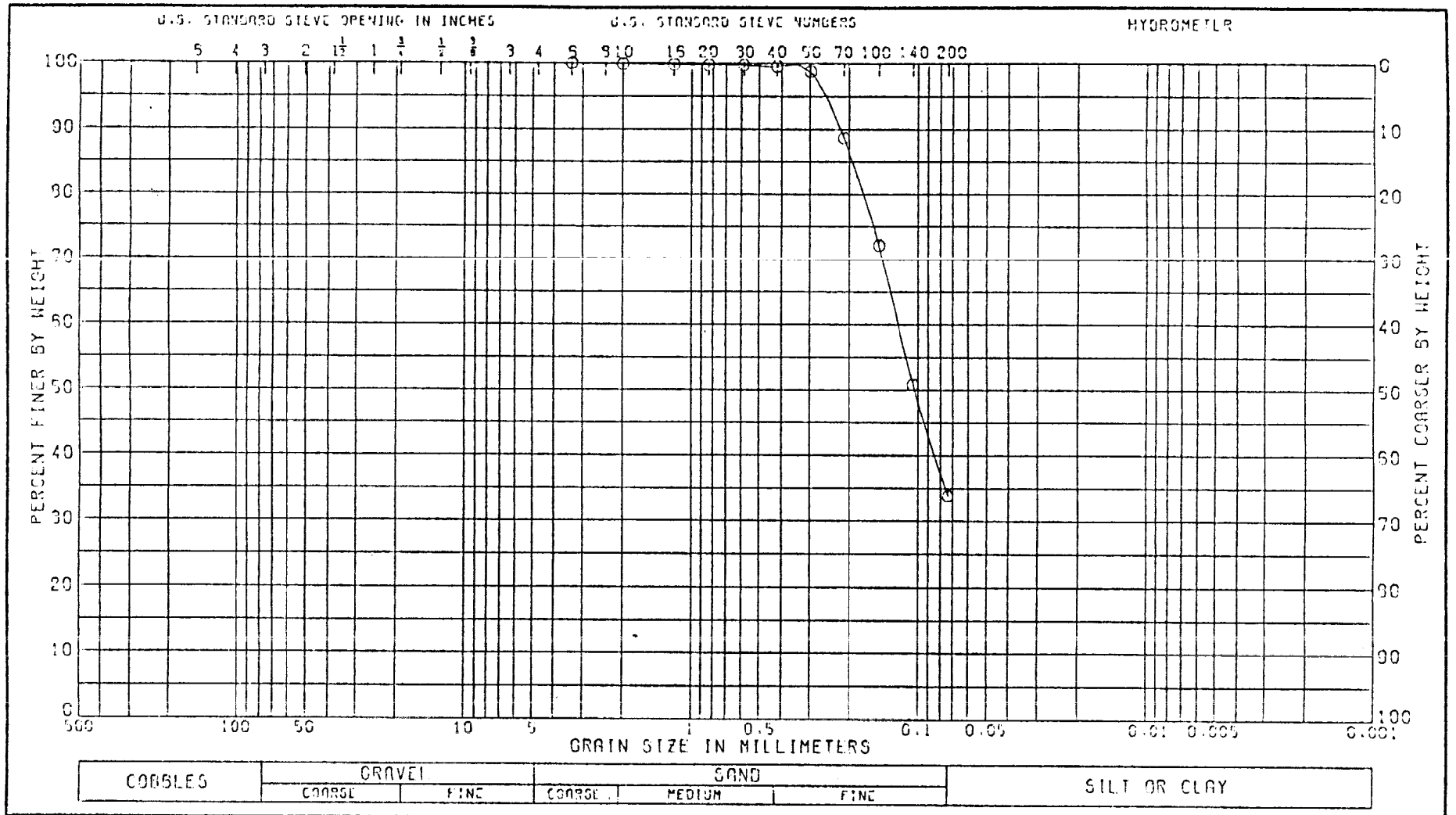
SANDY CLAY (CL), TAN

GRADATION CURVE

PROJECT CRANE NWSC
DEMOLITION AREA

BORING NO. 6-18-91 SAMPLE NO. 1

DEPTH/ELEV 0.0-1.53 DATE 31 MAR 92



LL	PL	PI	GS	NAT W.%
24	14	10		13.9

CLASSIFICATION

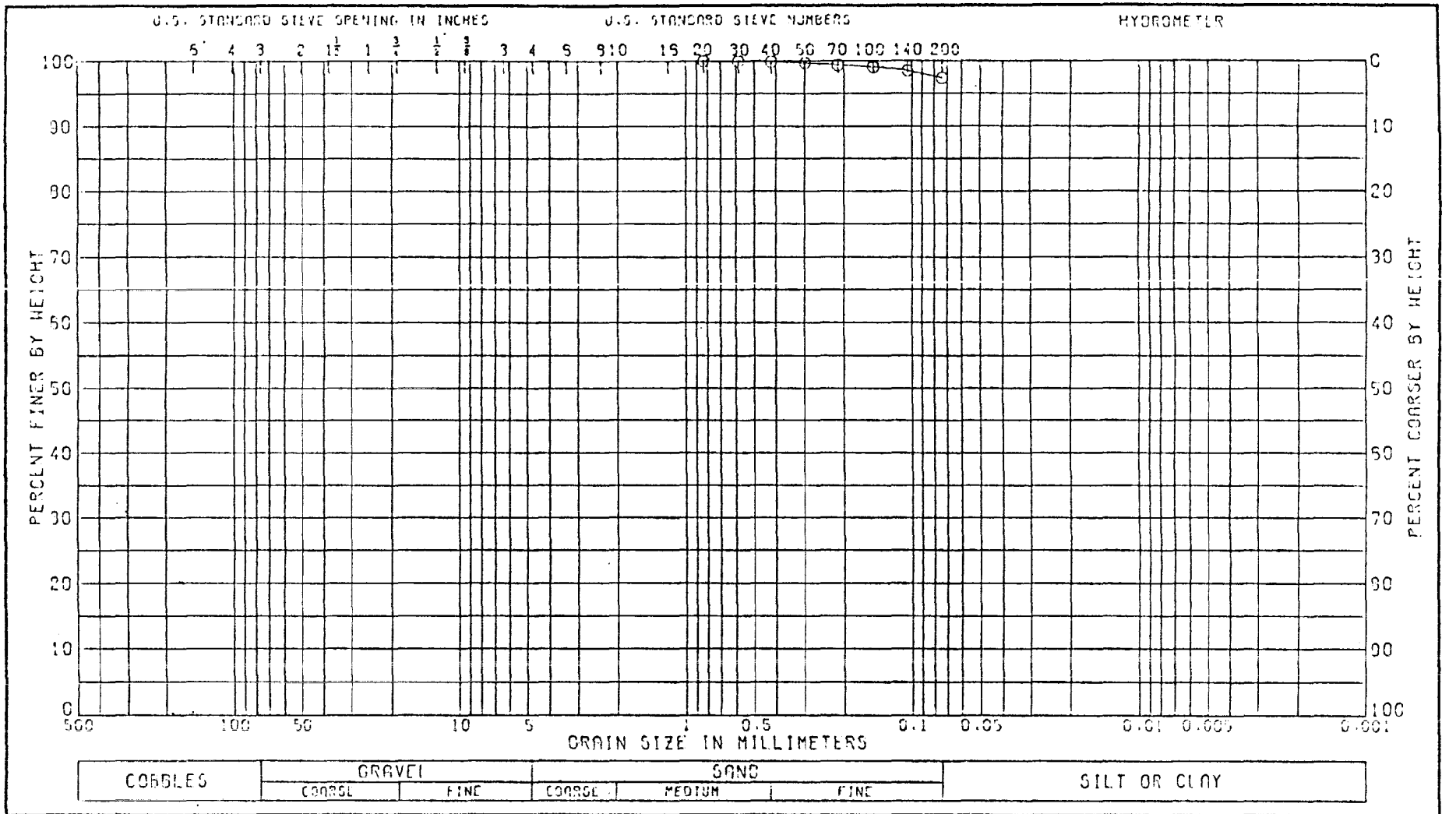
CLAYEY SAND (SC), BROWN

GRADATION CURVE

PROJECT CRANE NWSC DEMOLITION AREA

BORING NO. G-18-81 SAMPLE NO. 2

DEPTH/ELEV 5.0-6.59 DATE 11 FEB 82



LL	PL	PI	CS	NAT W.%
42	18	24		23.2

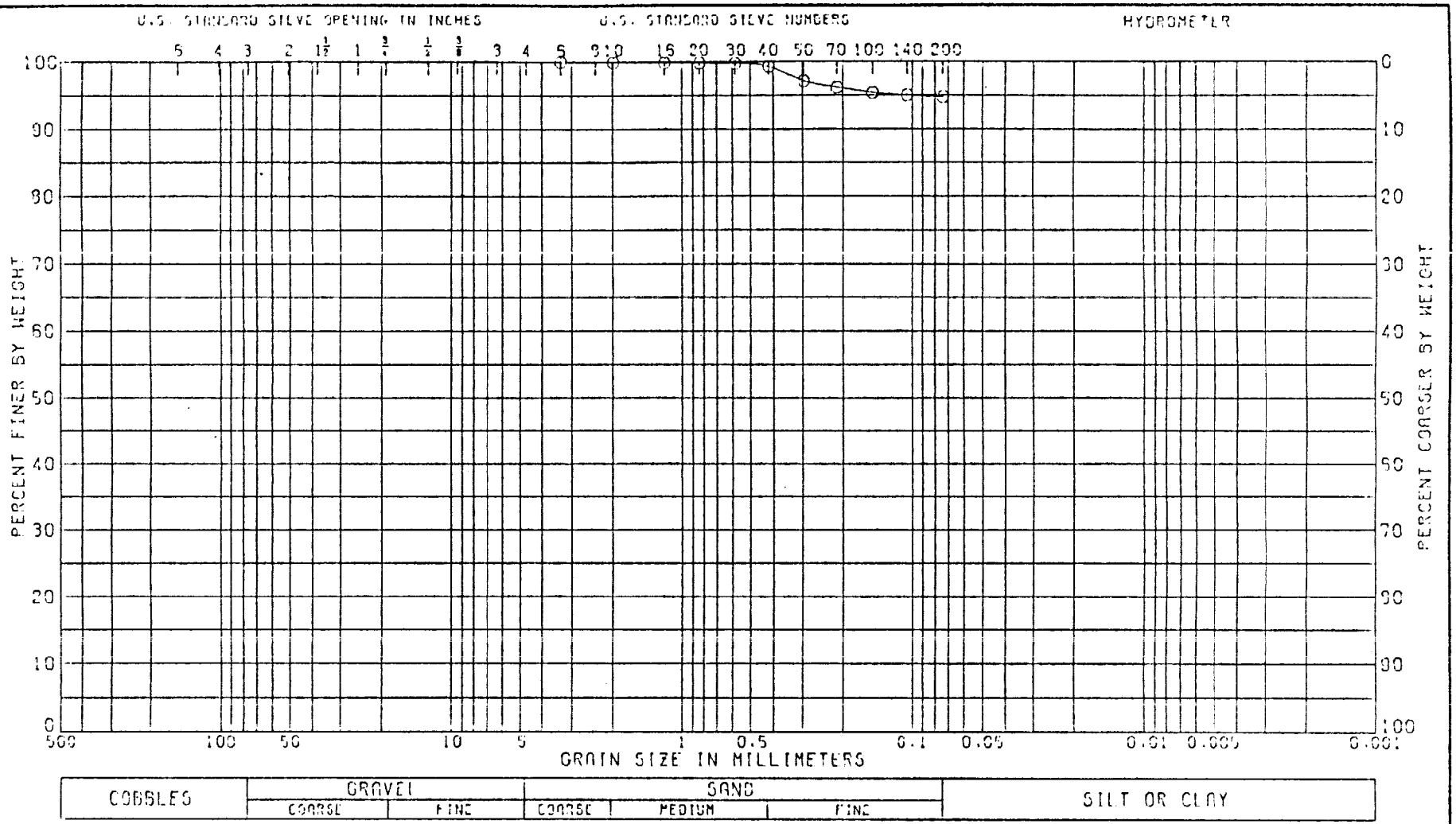
CLASSIFICATION
CLAY (CL), LIGHT BROWN

GRADATION CURVE

PROJECT CRANE NWSC DEMOLITION AREA

BORING NO. 6-10-81 SAMPLE NO. 1

DEPTH/ELEV 5.0-6.09 DATE 11 FEB 82



LL	PL	PI	CS	NAT W.%	
44	17	27		25.2	

CLASSIFICATION

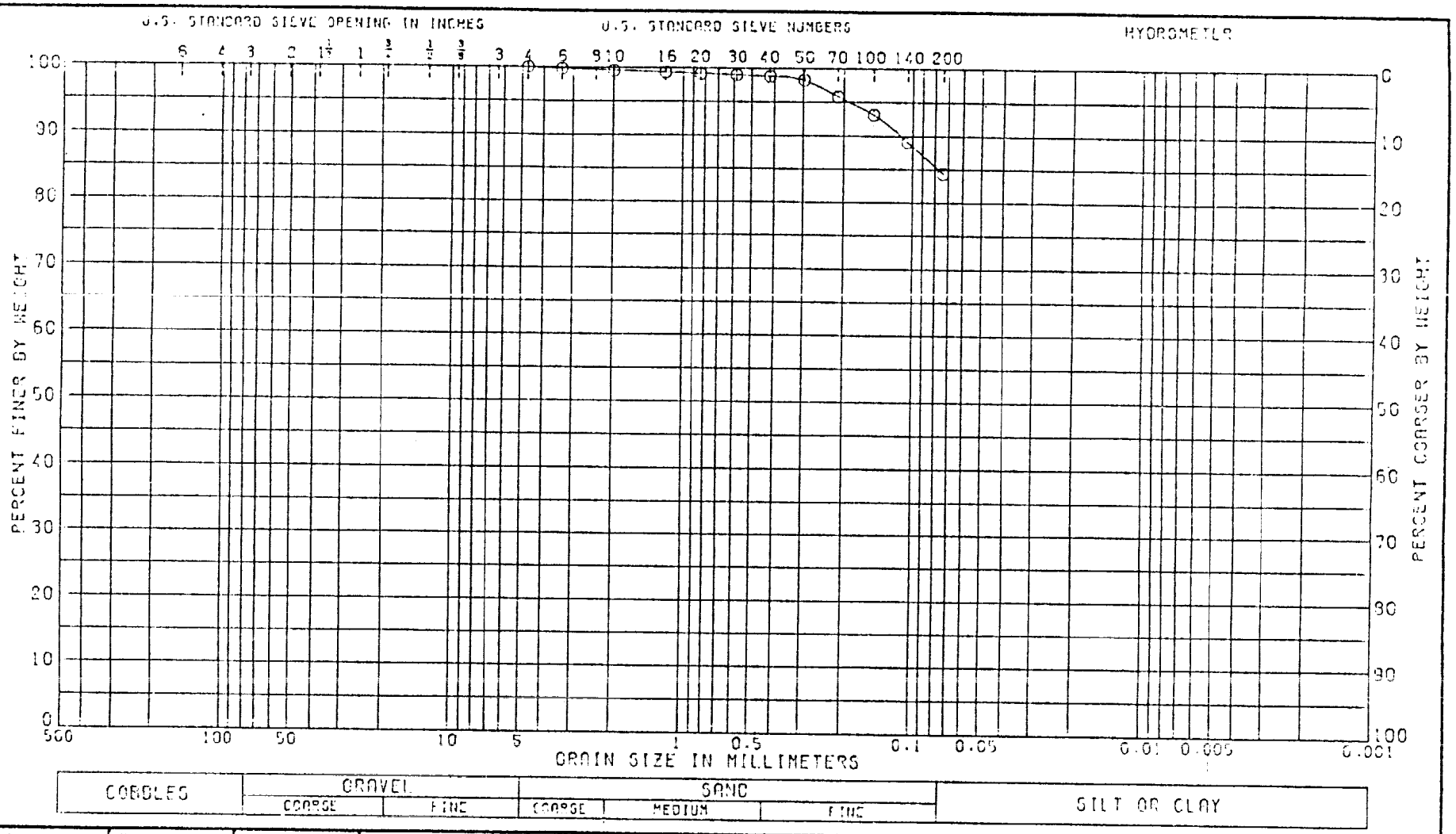
CLAY (CL), BROWNISH GRAY: WITH SAND

GRADATION CURVE

PROJECT CRANE NWSC DEMOLITION AREA

BORING NO. 6-10-91 SAMPLE NO. 2

DEPTH/ELEV 10.0-11.55 DATE 11 FEB 92



LL	PL	PI	GS	NAT W.%
27	15	12		19.1

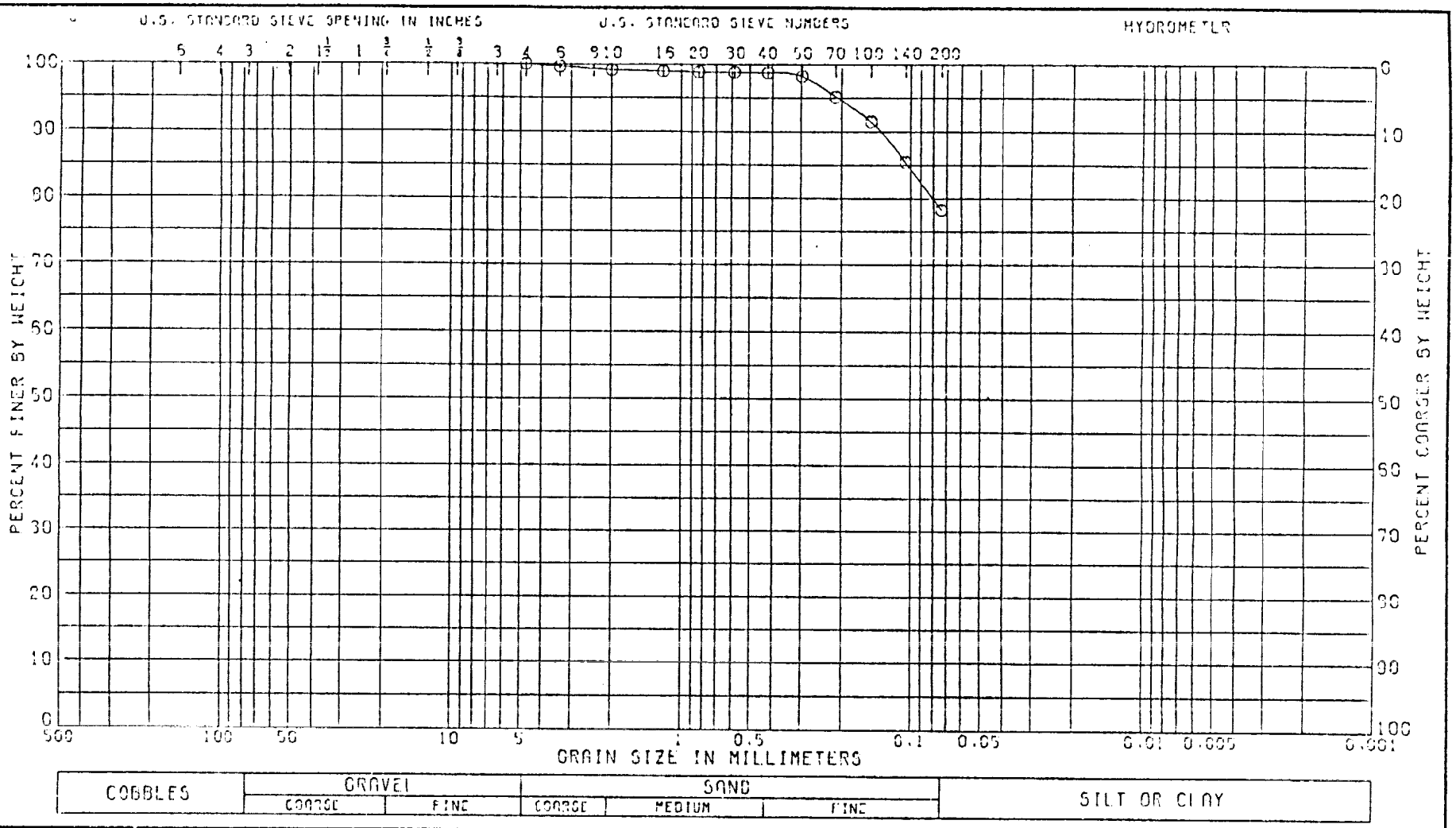
CLASSIFICATION
SANDY CLAY (CL), REDDISH BROWN

GRADATION CURVE

PROJECT CRANE NWSC DEMOLITION AREA

BORING NO. 6-20-81 SAMPLE NO. 1

DEPTH/ELEV 0.0-1.78 DATE 05 FEB 82



LL	PL	PI	GS	NAT W.%	
35	14	21		18.9	

CLASSIFICATION

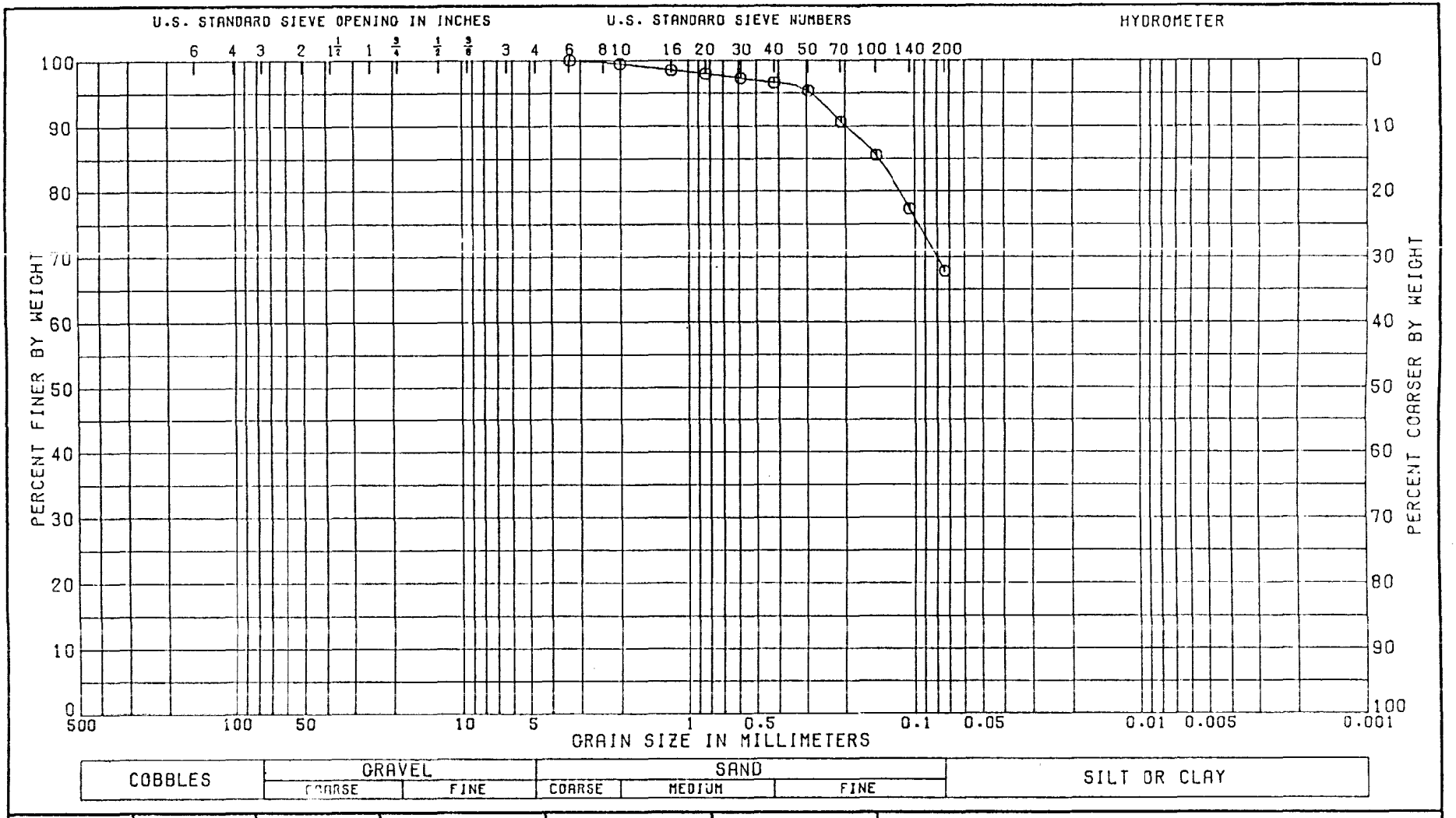
SANDY CLAY (CL), BROWN

GRADATION CURVE

PROJECT CRANE NWSC DEMOLITION AREA

BORING NO. S-20-81 SAMPLE NO. 2

DEPTH/ELEV 5.0-6.75 DATE 11 FEB 82



LL 34	PL 14	PI 20	GS	NAT W.%	

CLASSIFICATION

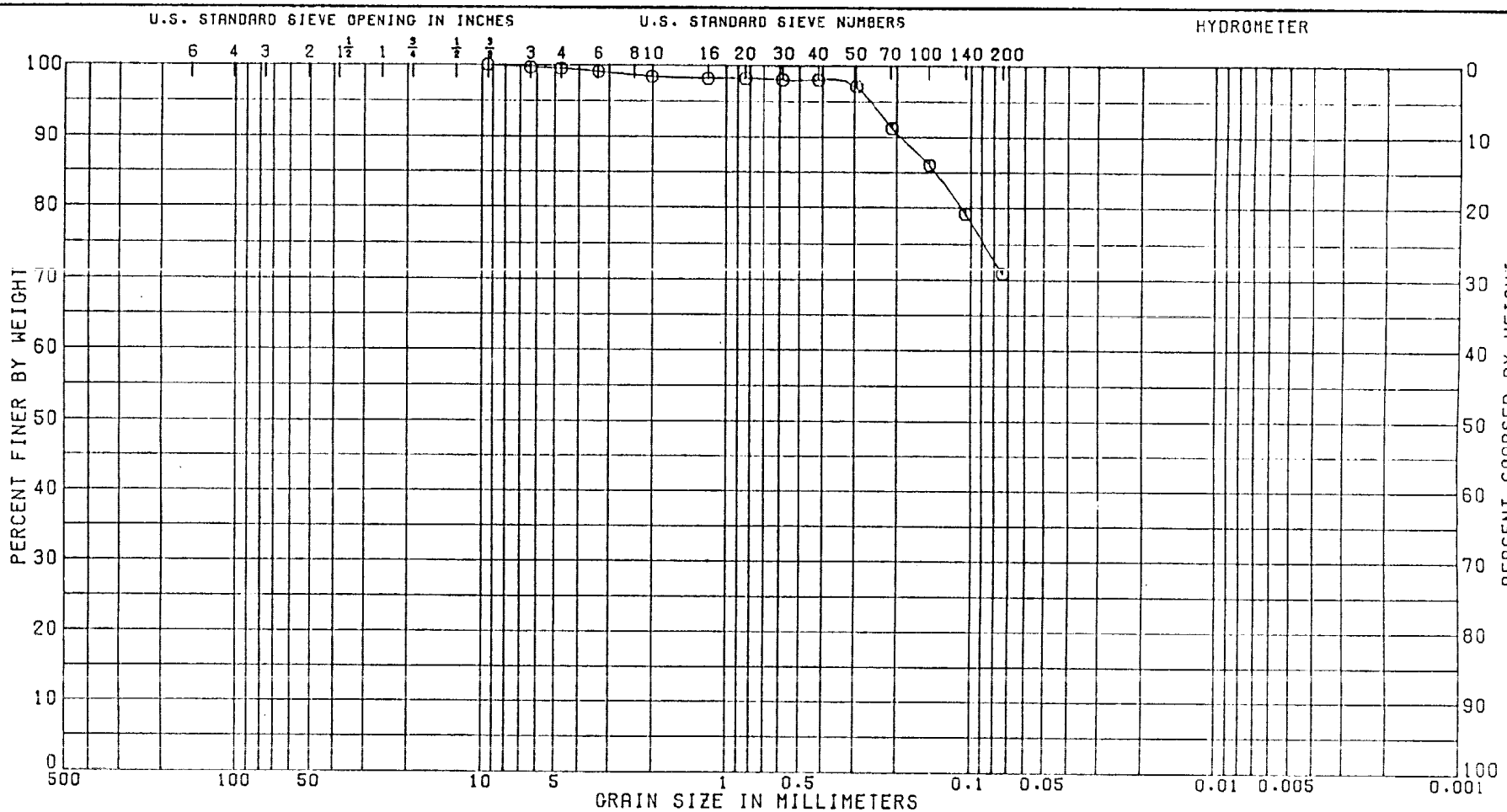
SANDY CLAY (CL), BROWN

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-1-83 SAMPLE NO. 1

DEPTH/ELEV 0.0-2.4 DATE 08 NOV 83



LL 24	PL 13	PI 11	GS	NAT W.%	

CLASSIFICATION

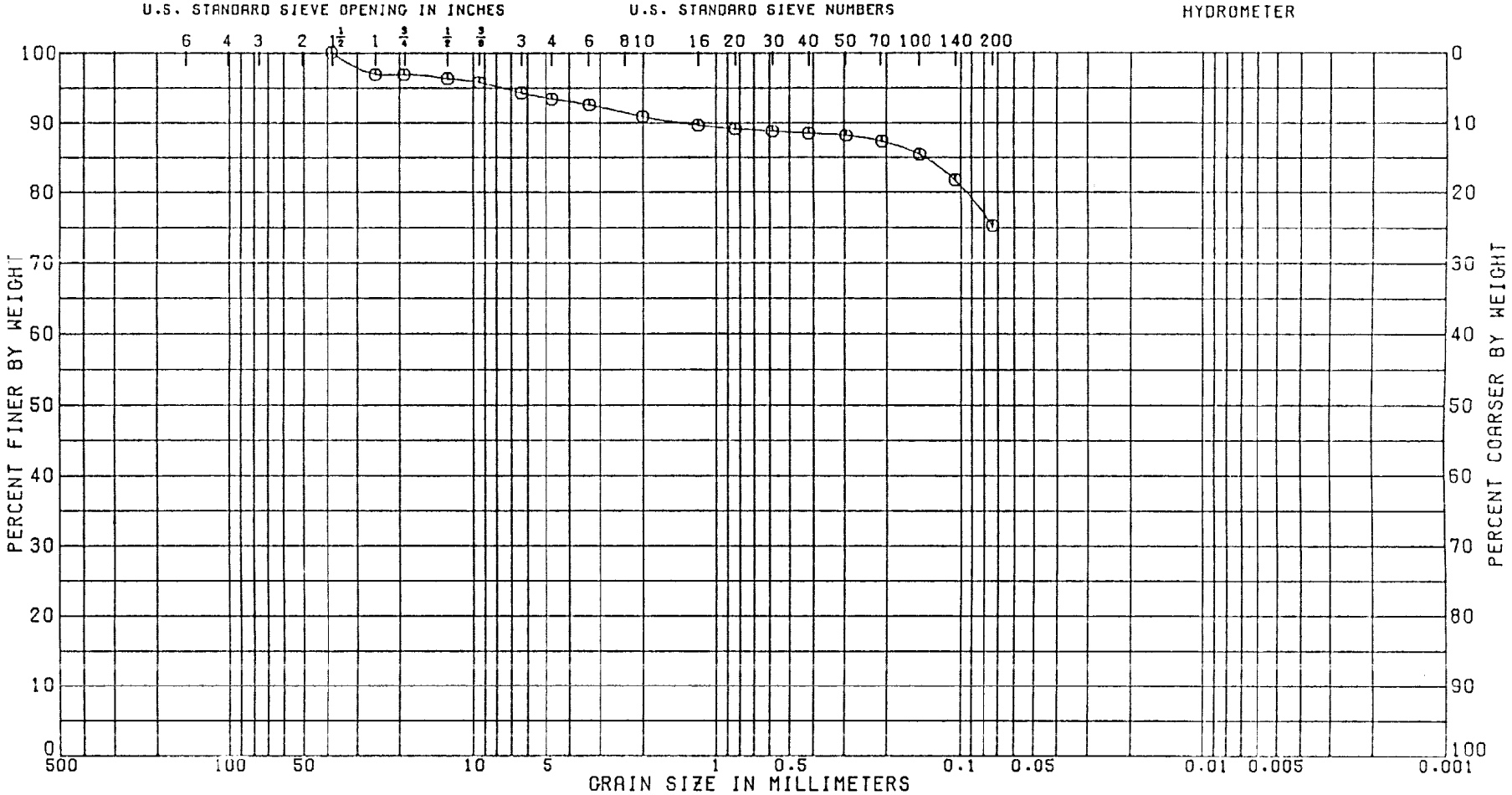
SANDY CLAY (CL), BROWN

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-1-83 SAMPLE NO. 2

DEPTH/ELEV 5.0-7.3 DATE 08 NOV 83



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

LL	PL	PI	GS	NAT W.%
24	15	9		

CLASSIFICATION

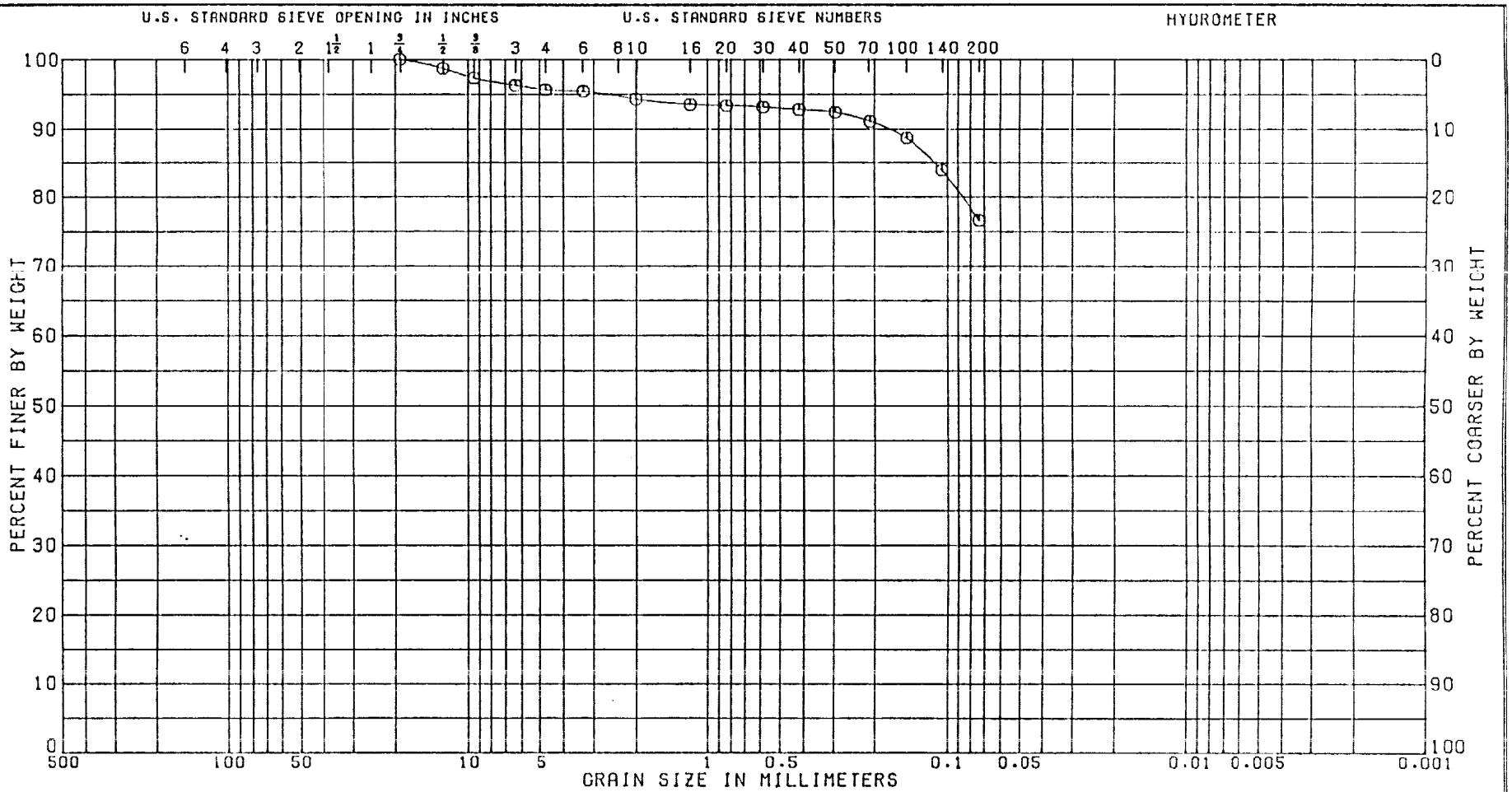
SANDY CLAY (CL), TAN: WITH GRAVEL
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-2-83 SAMPLE NO. 1

DEPTH/ELEV 0.0-2.10 DATE 08 NOV 83



LL	PL	PI	GS	NAT W.%	
32	14	18			

CLASSIFICATION

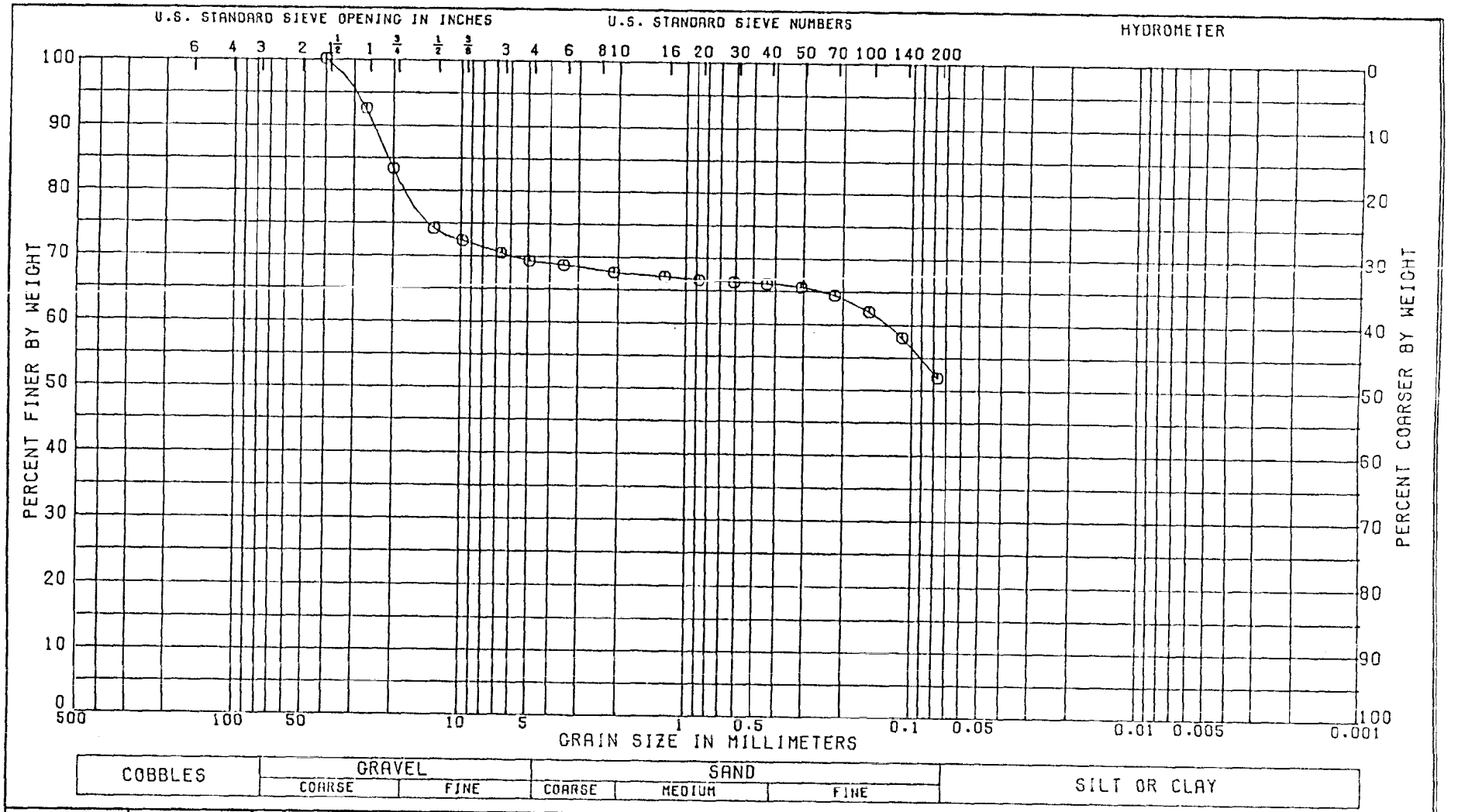
SANDY CLAY (CL), BROWN: TRACE OF GRAVEL
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-2-83 SAMPLE NO. 2

DEPTH/ELEV 5.0-6.35 DATE 08 NOV 83



LL 29	PL 13	PI 16	GS	NAT W.%	

CLASSIFICATION

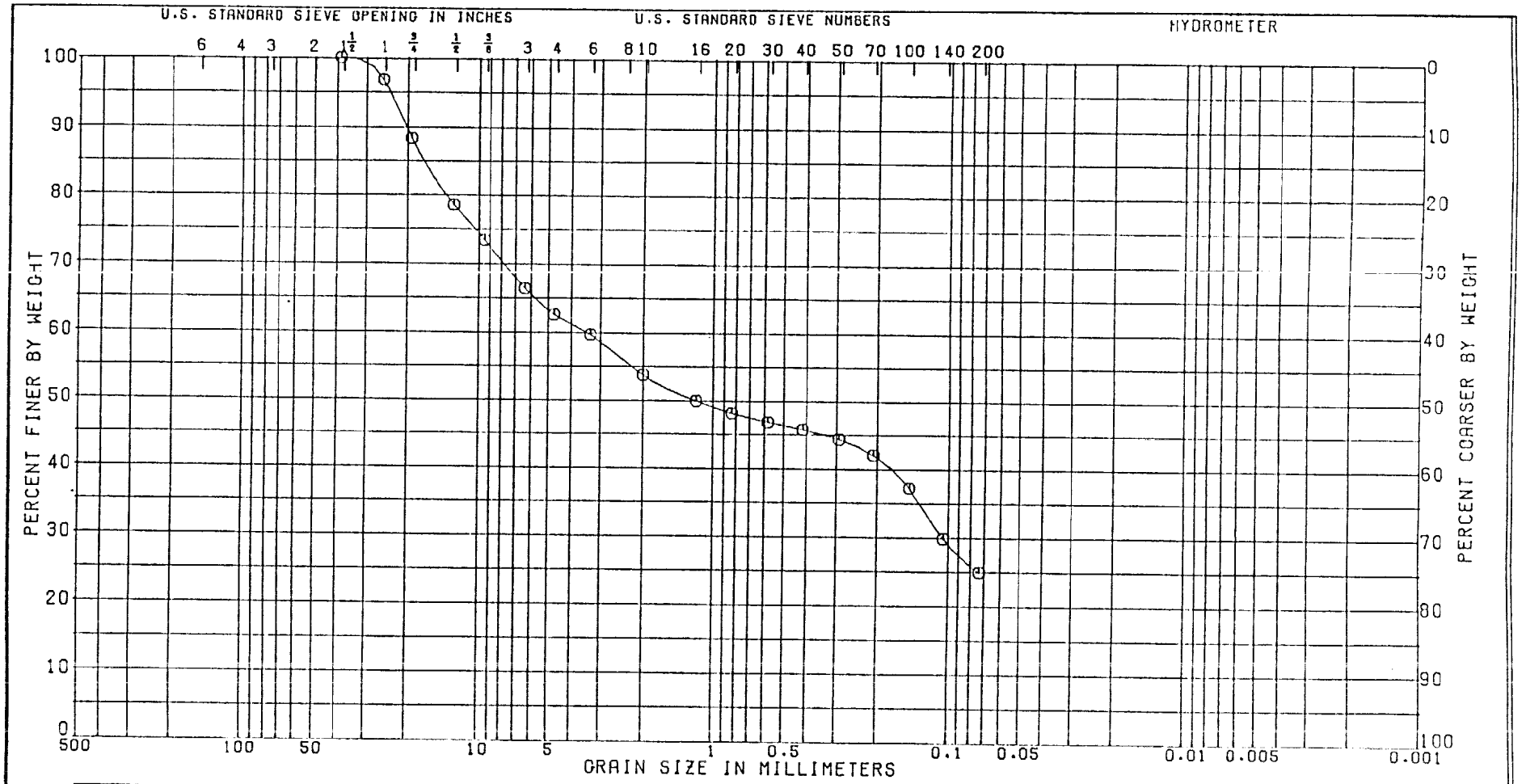
SANDY GRAVELLY CLAY (CL), TAN
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-2-83 SAMPLE NO. 3

DEPTH/ELEV 10.0-11.35 DATE 08 NOV 83



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

LL 35	PL 16	PI 19	GS	NAT W.%	

CLASSIFICATION

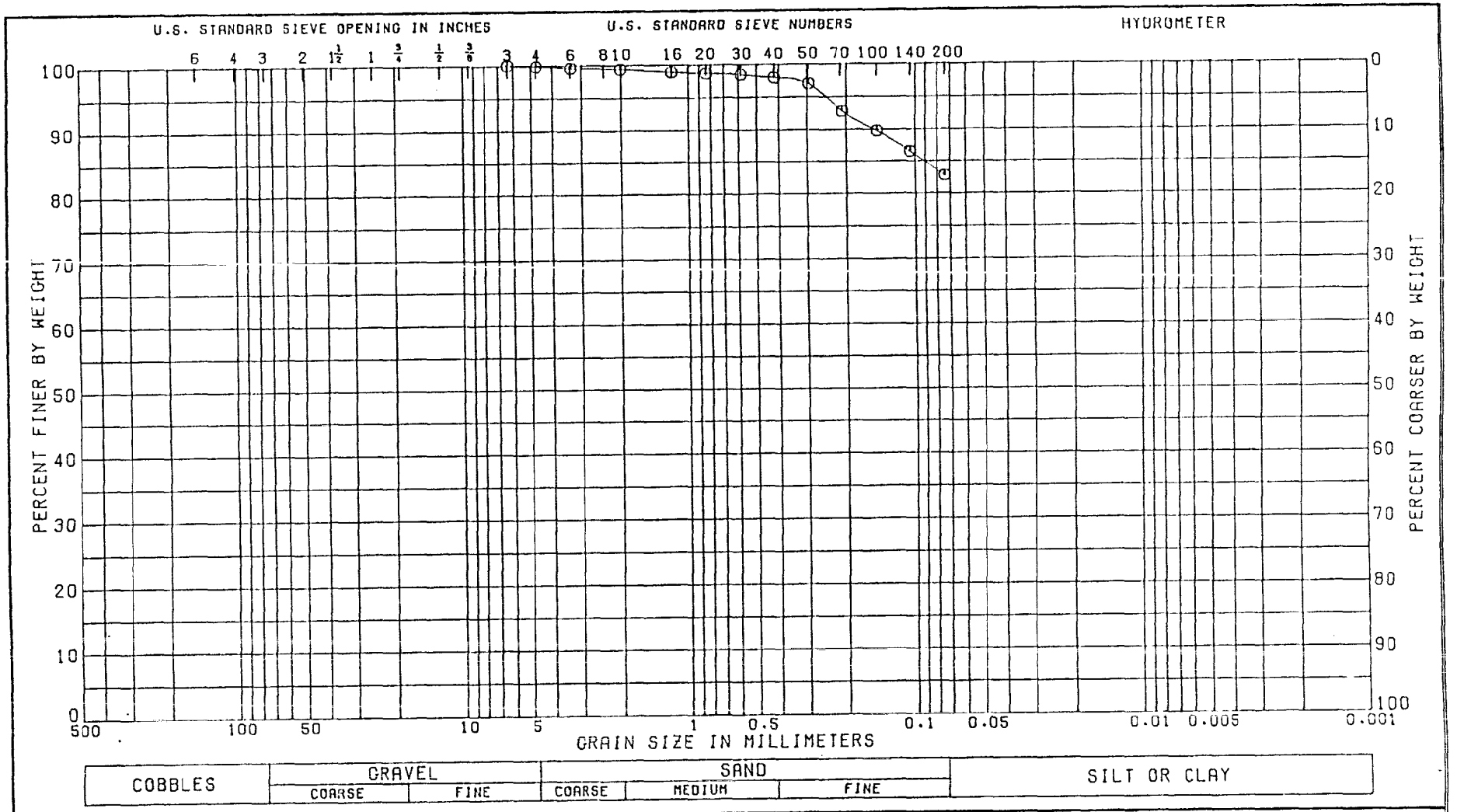
GRAVELLY CLAYEY SAND (SC), BROWN
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-2-83 SAMPLE NO. 4

DEPTH/ELEV 15.0-15.95 DATE 08 NOV 83



LL	PL	PI	GS	NAT W.%	
34	15	19			

CLASSIFICATION

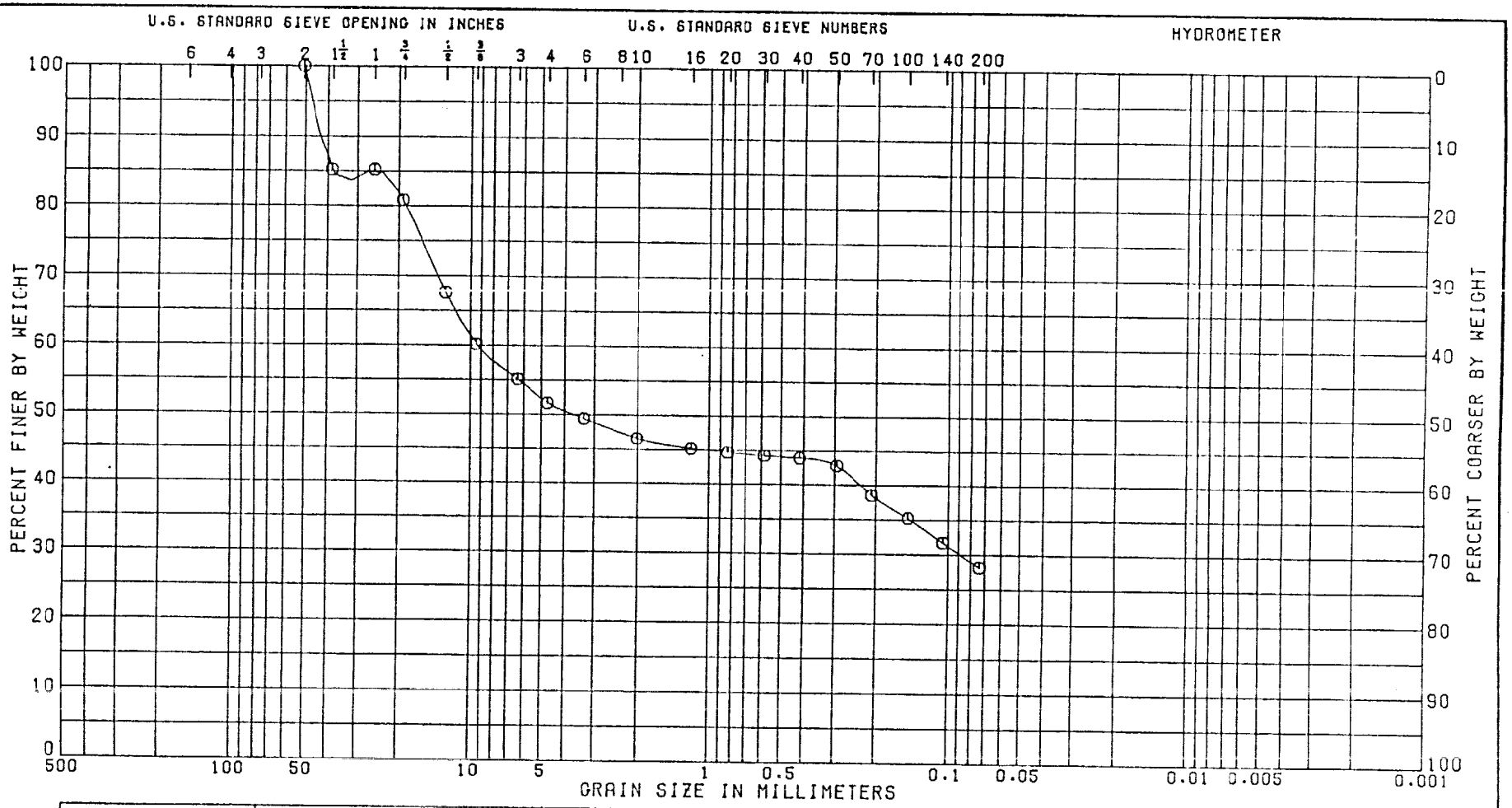
SANDY CLAY (CL), BROWN

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-3-83 SAMPLE NO. 1

DEPTH/ELEV 0.0-2.25 DATE 08 NOV 83



LL	PL	PI	GS	NAT W.%
38	18	20		

CLASSIFICATION

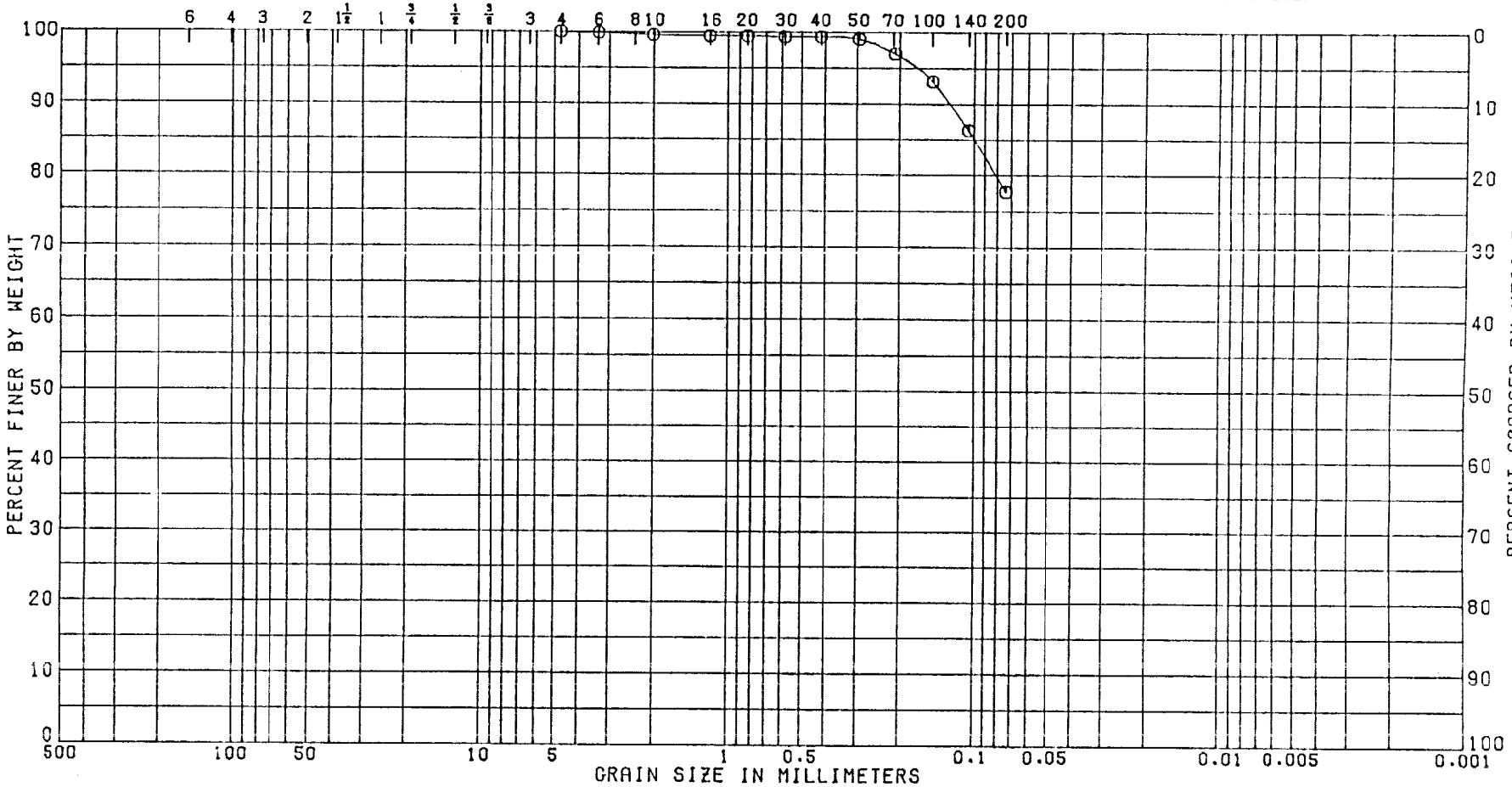
SANDY CLAYEY GRAVEL (GC), REDDISH BROWN
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-3-83 SAMPLE NO. 2

DEPTH/ELEV 5.0-6.08 DATE 08 NOV 83



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

LL	PL	PI	GS	NAT W.%
36	14	22		

CLASSIFICATION

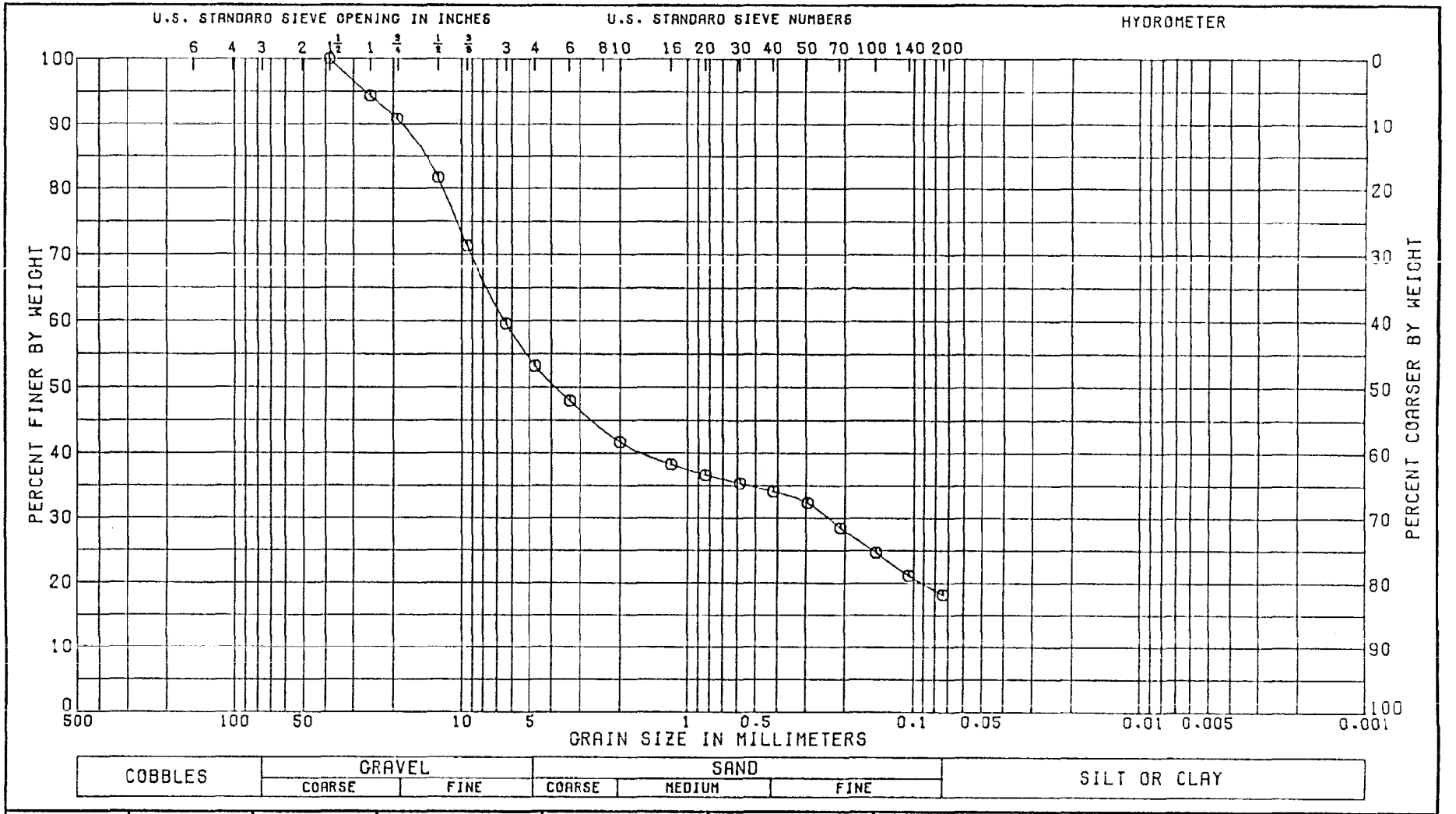
SANDY CLAY (CL), BROWN

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-3-83 SAMPLE NO. 3

DEPTH/ELEV 10.0-12.12 DATE 08 NOV 83



LL	PL	PI	GS	NAT W.%	
35	19	16			

CLASSIFICATION

SANDY CLAYEY GRAVEL (GC), BROWN

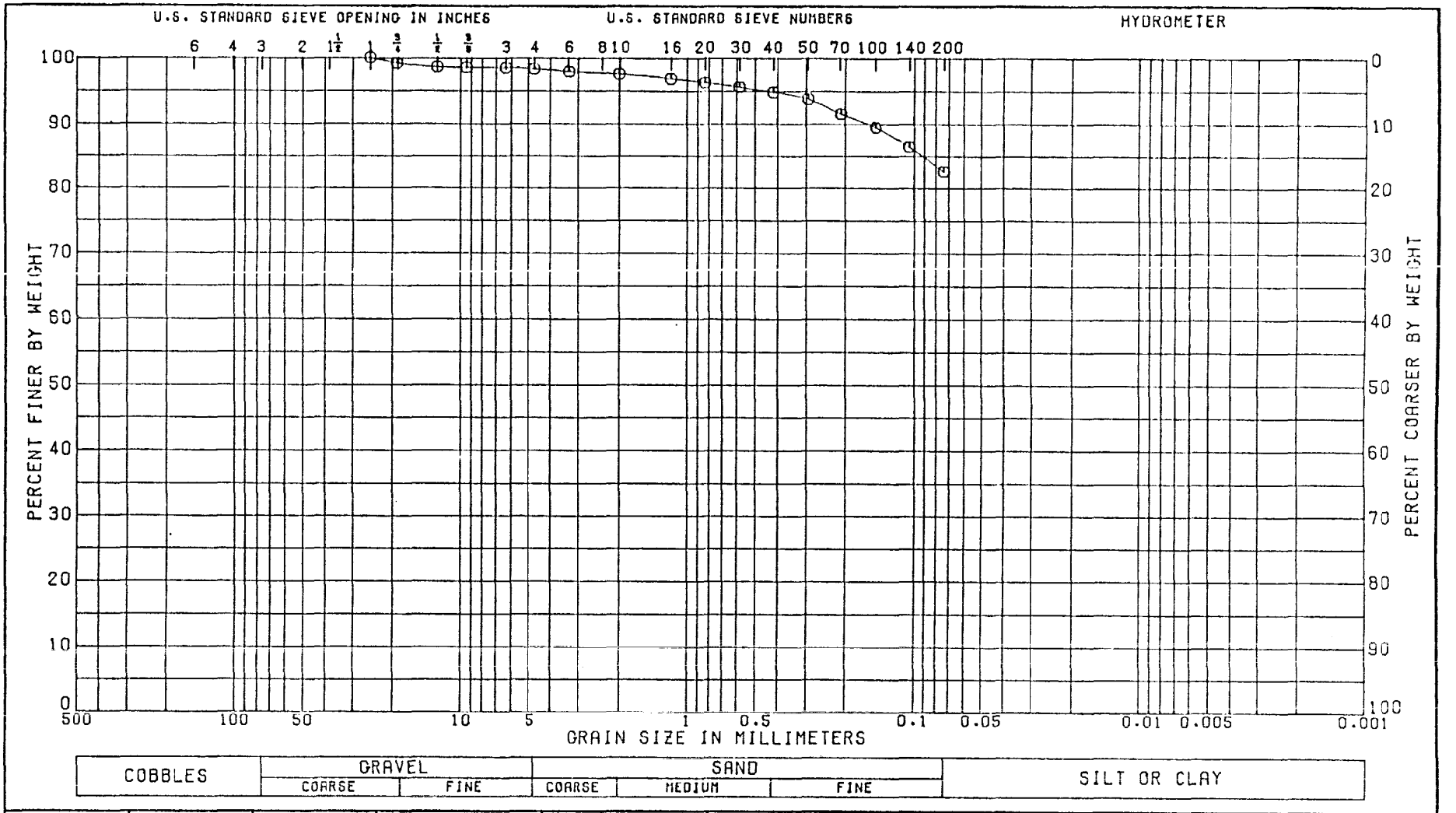
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-3-83 SAMPLE NO. 4

DEPTH/ELEV 15.0-16.1 DATE 08 NOV 83



LL 33	PL 22	PI 11	GS	NAT W.%	

CLASSIFICATION

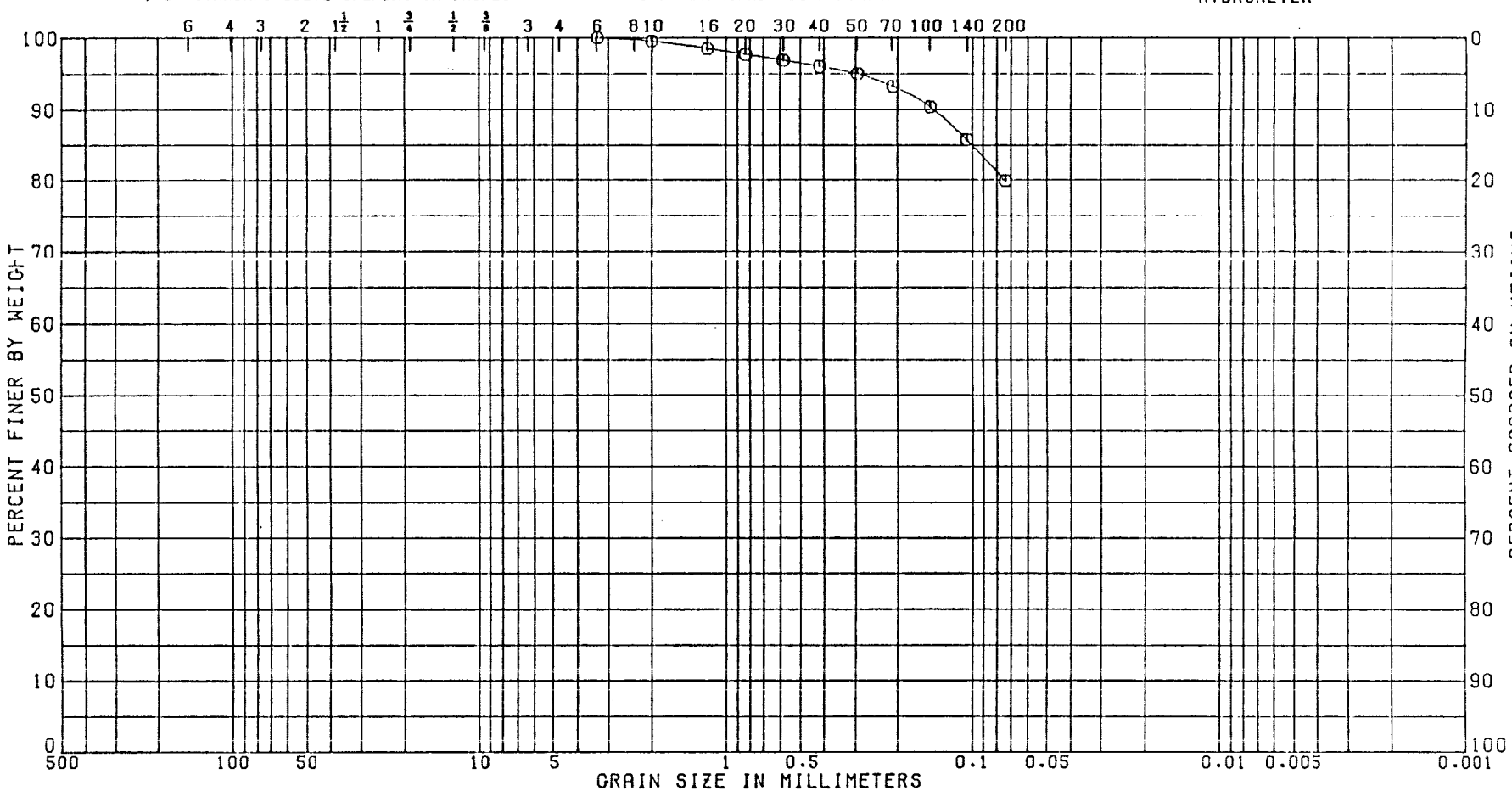
SANDY CLAY (CL), BROWN
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-4-83 SAMPLE NO. 1

DEPTH/ELEV 0.0-1.5 DATE 08 NOV 83



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

LL	PL	PI	GS	NAT W.%	
44	16	28			

CLASSIFICATION

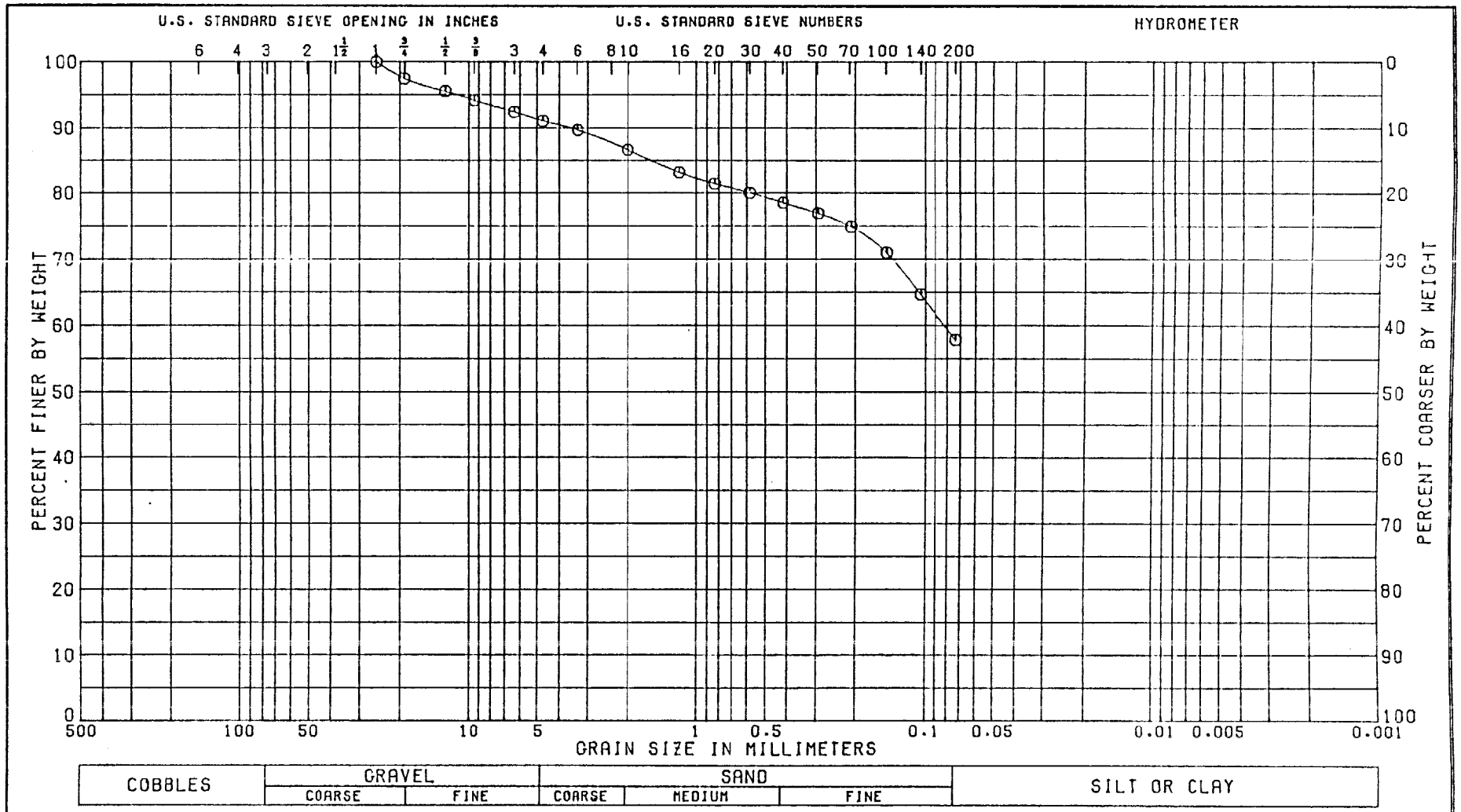
SANDY CLAY (CL), REDDISH TAN

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-4-83 SAMPLE NO. 3

DEPTH/ELEV 10.0-12.18 DATE 08 NOV 83



LL	PL	PI	GS	NAT W.%	
31	17	14			

CLASSIFICATION

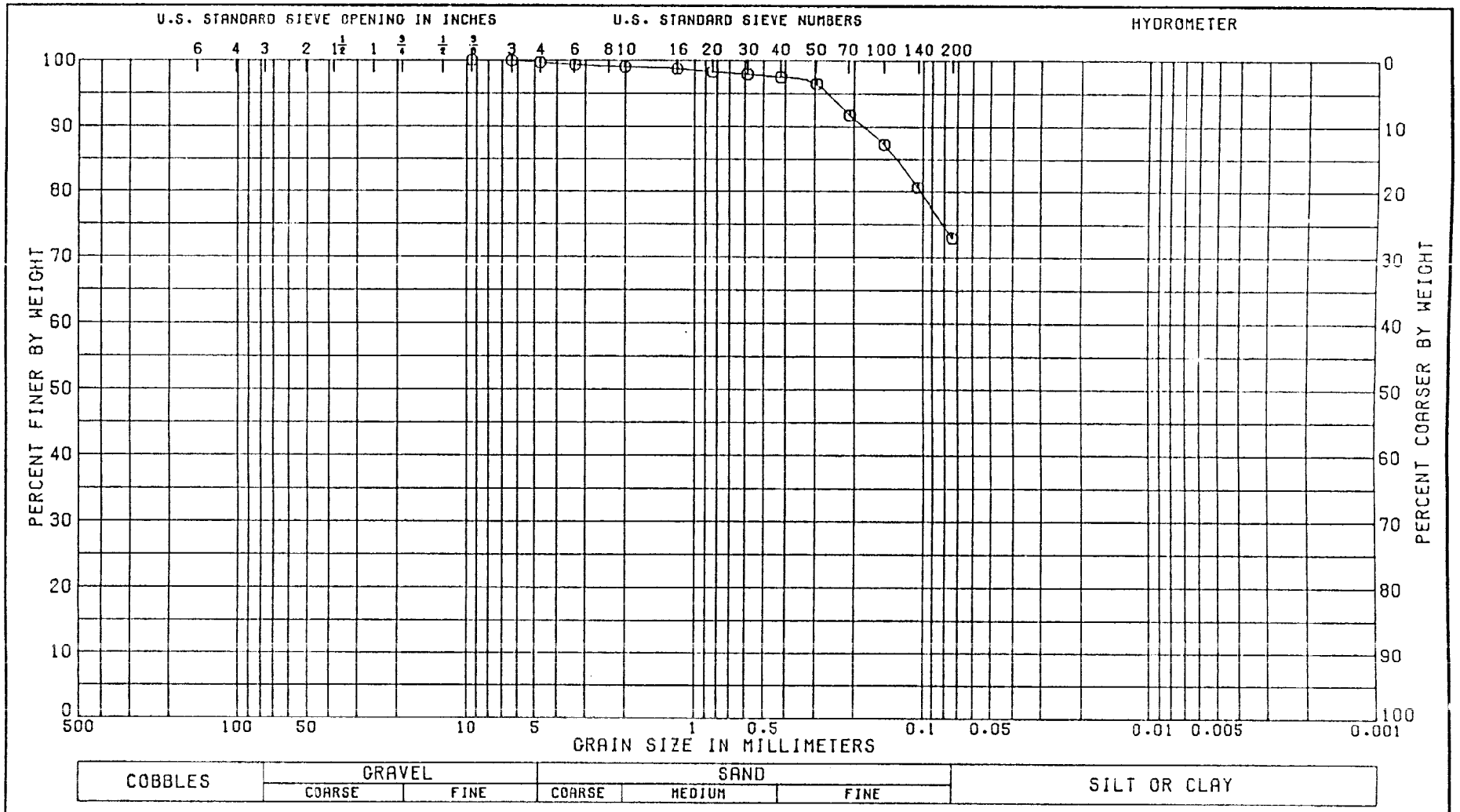
SANDY CLAY (CL), TAN: WITH GRAVEL
INSUFFICIENT SAMPLE FOR ACCURATE GRADATION

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-4-83 SAMPLE NO. 5

DEPTH/ELEV 16.0-18.35 DATE 08 NOV 83



LL	PL	PI	GS	NAT W.%	
32	13	19			

CLASSIFICATION

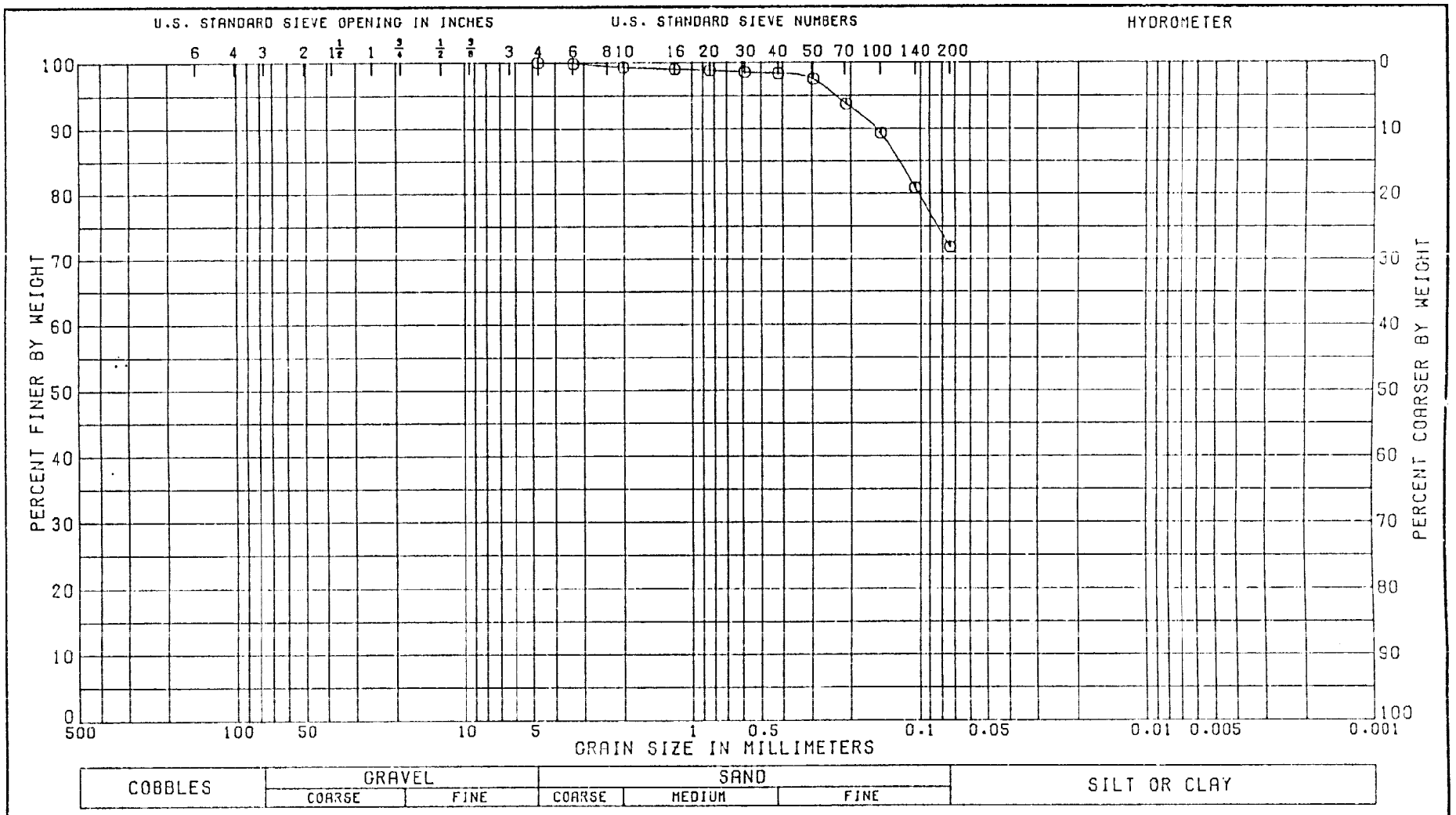
SANDY CLAY (CL), TAN

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-5-83 SAMPLE NO. 1

DEPTH/ELEV 0.0-2.25 DATE 08 NOV 83



LL 33	PL 14	PI 19	GS	NAT W.%	

CLASSIFICATION

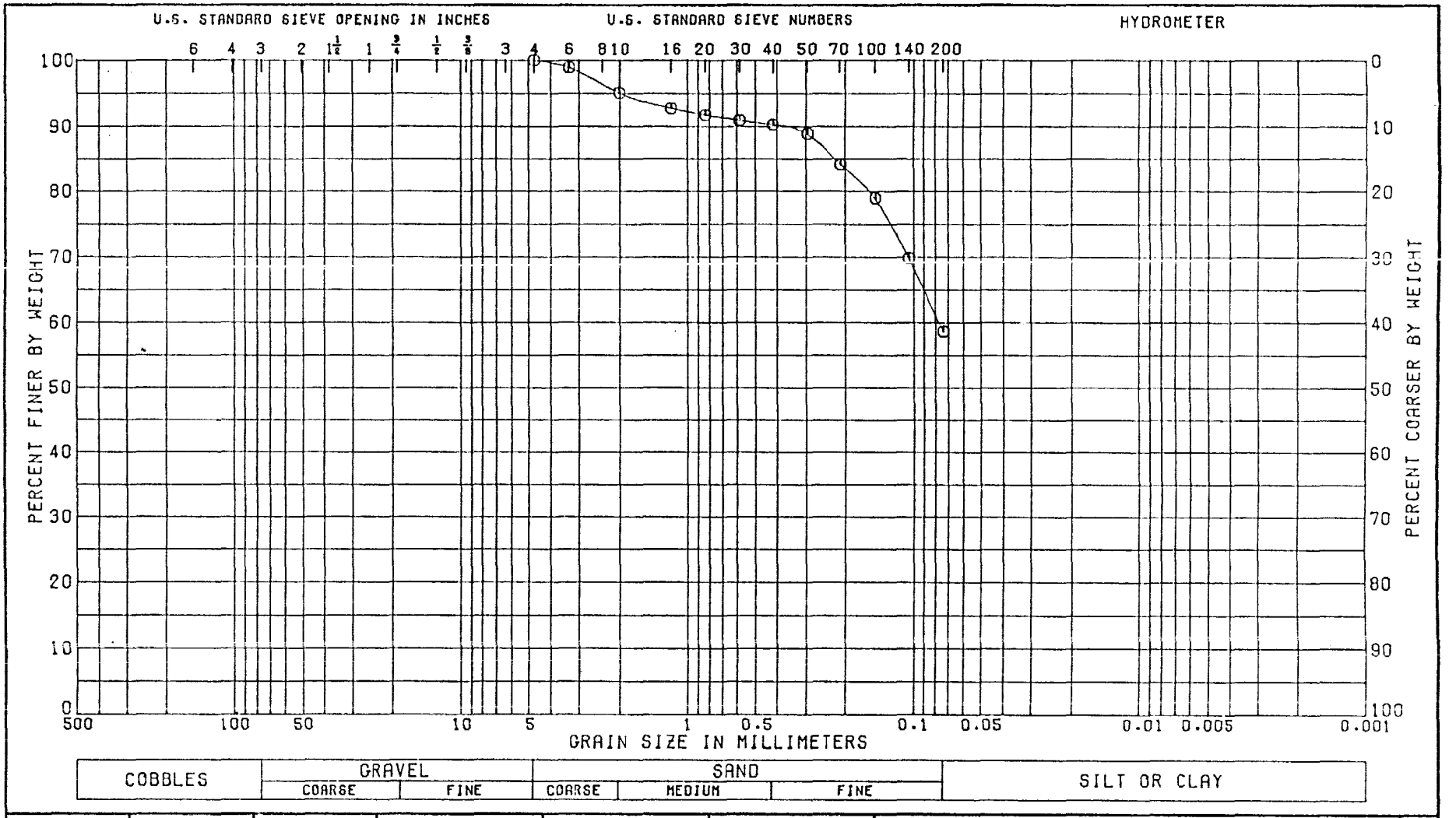
SANDY CLAY (CL), BROWN

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-5-83 SAMPLE NO. 2

DEPTH/ELEV 5.0-6.85 DATE 15 DEC 83



LL	PL	PI	CS	NAT W.%	
23	14	9			

CLASSIFICATION

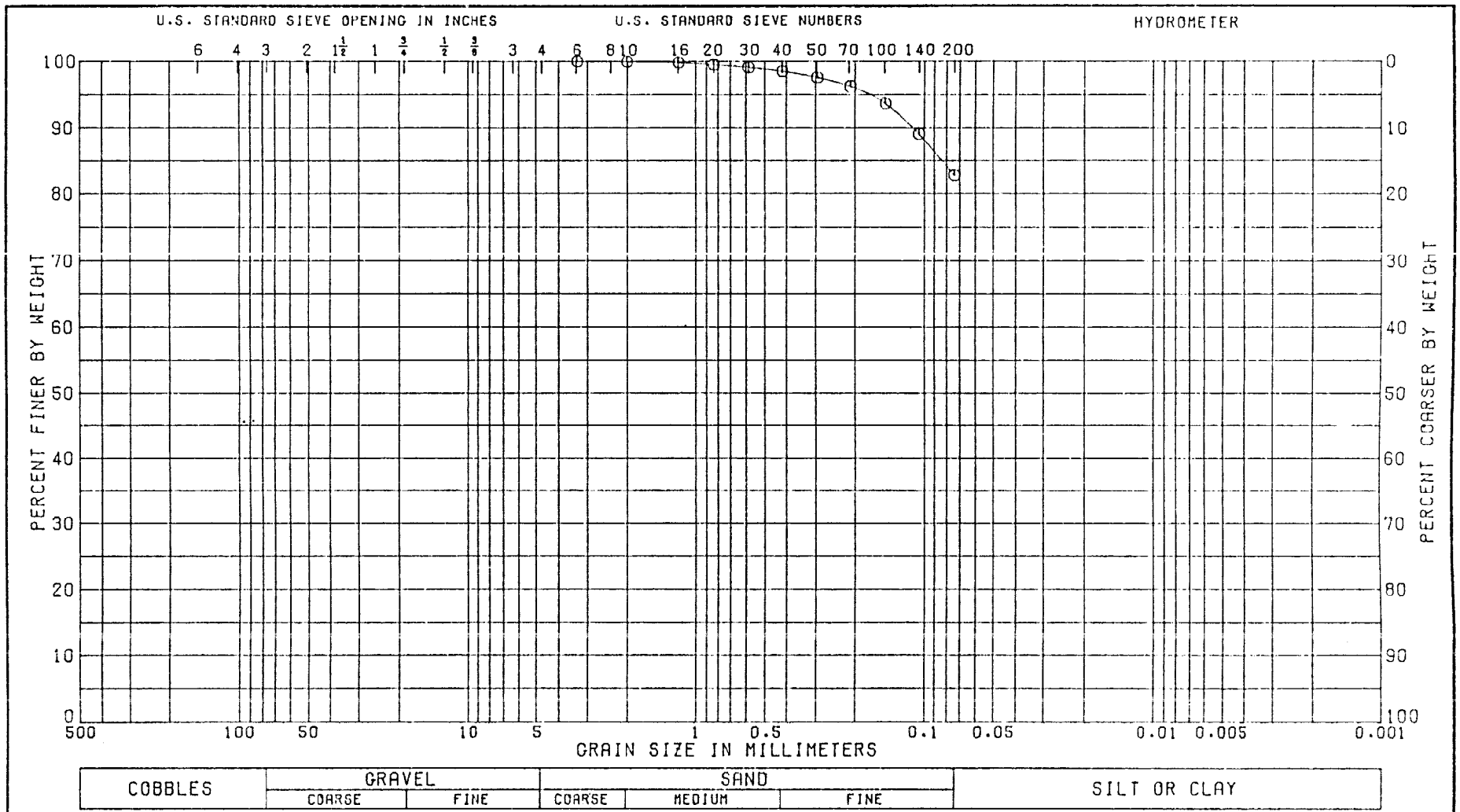
SANDY CLAY (CL), REDDISH BROWN

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-5-83 SAMPLE NO. 3

DEPTH/ELEV 10.0-11.22 DATE 08 NOV 83



LL 38	PL 18	PI 20	GS	NAT W.%	

CLASSIFICATION

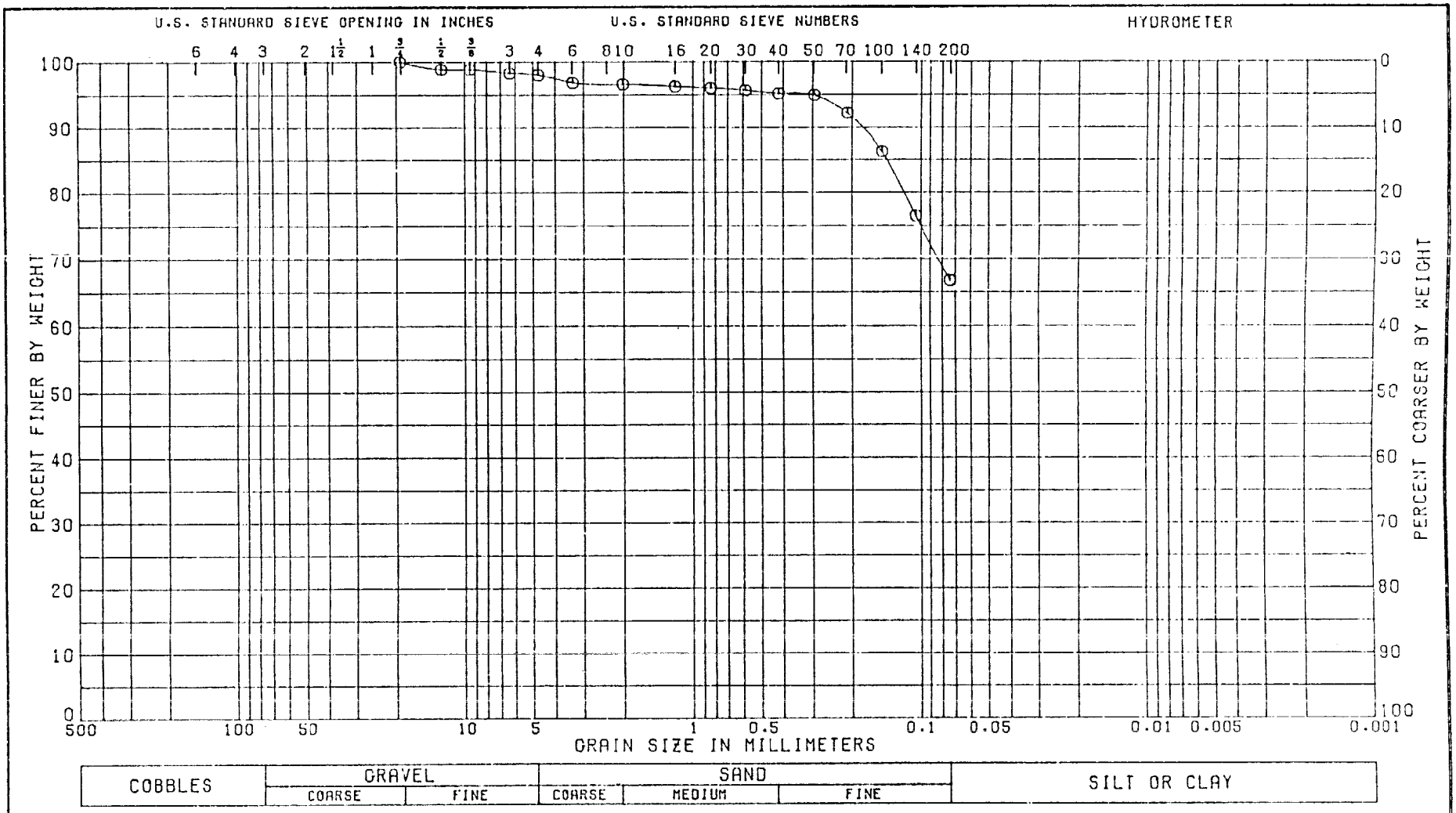
SANDY CLAY (CL), BROWN

GRADATION CURVE

PROJECT CRANE NAVAL WEAPONS SUPPORT CENTER

BORING NO. EPA-5-83 SAMPLE NO. 4

DEPTH/ELEV 15.0-17.15 DATE 15 DEC 83



LL	PL	PI	GS	NAT W.%	
35	12	23			

CLASSIFICATION

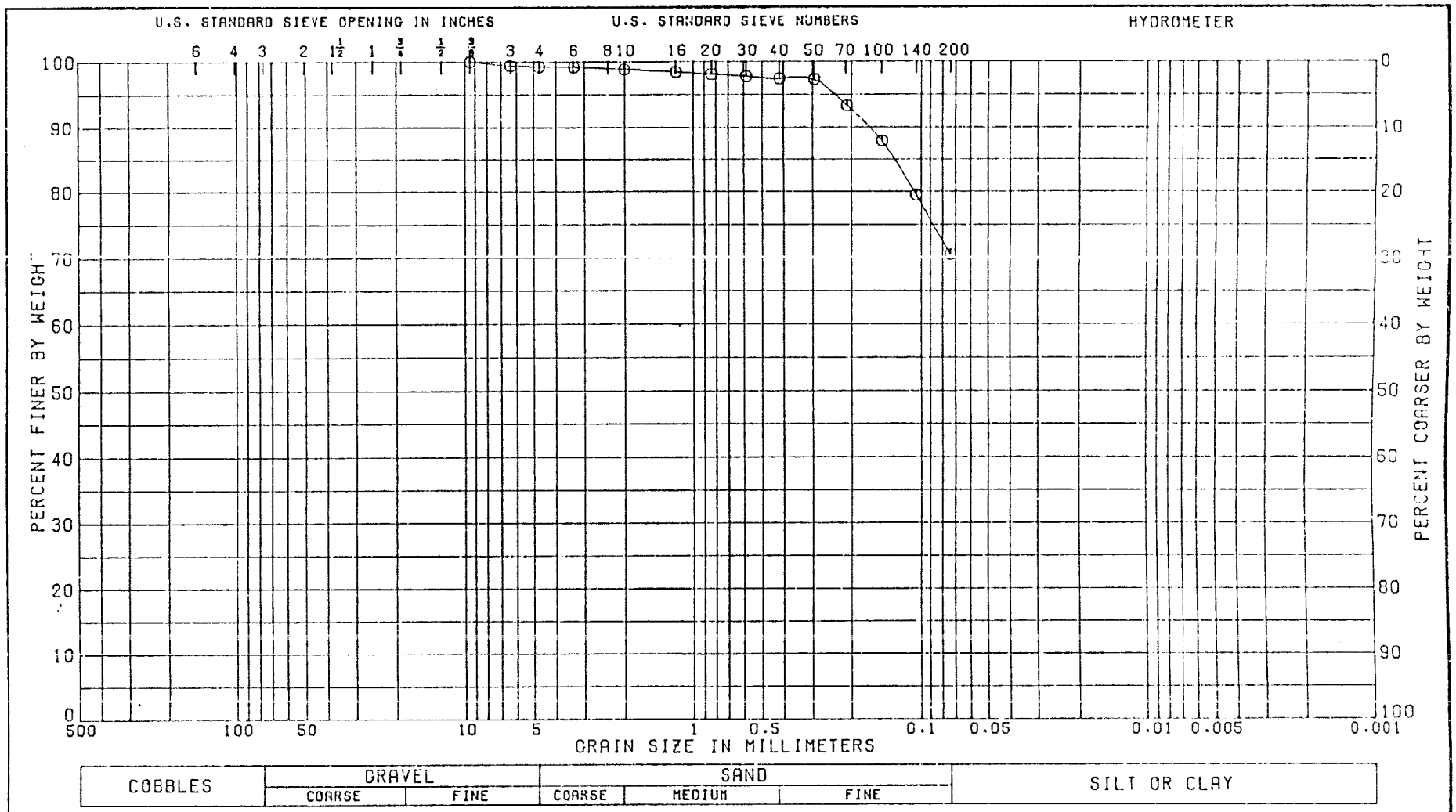
SANDY CLAY (CL), BROWN

GRADATION CURVE

PROJECT NWSC

BORING NO. EPD-1 SAMPLE NO. 1

DEPTH/ELEV BOTTOM-PIT DATE 31 OCT 83



LL	PL	PI	GS	NAT W.%	
32	13	19			

CLASSIFICATION

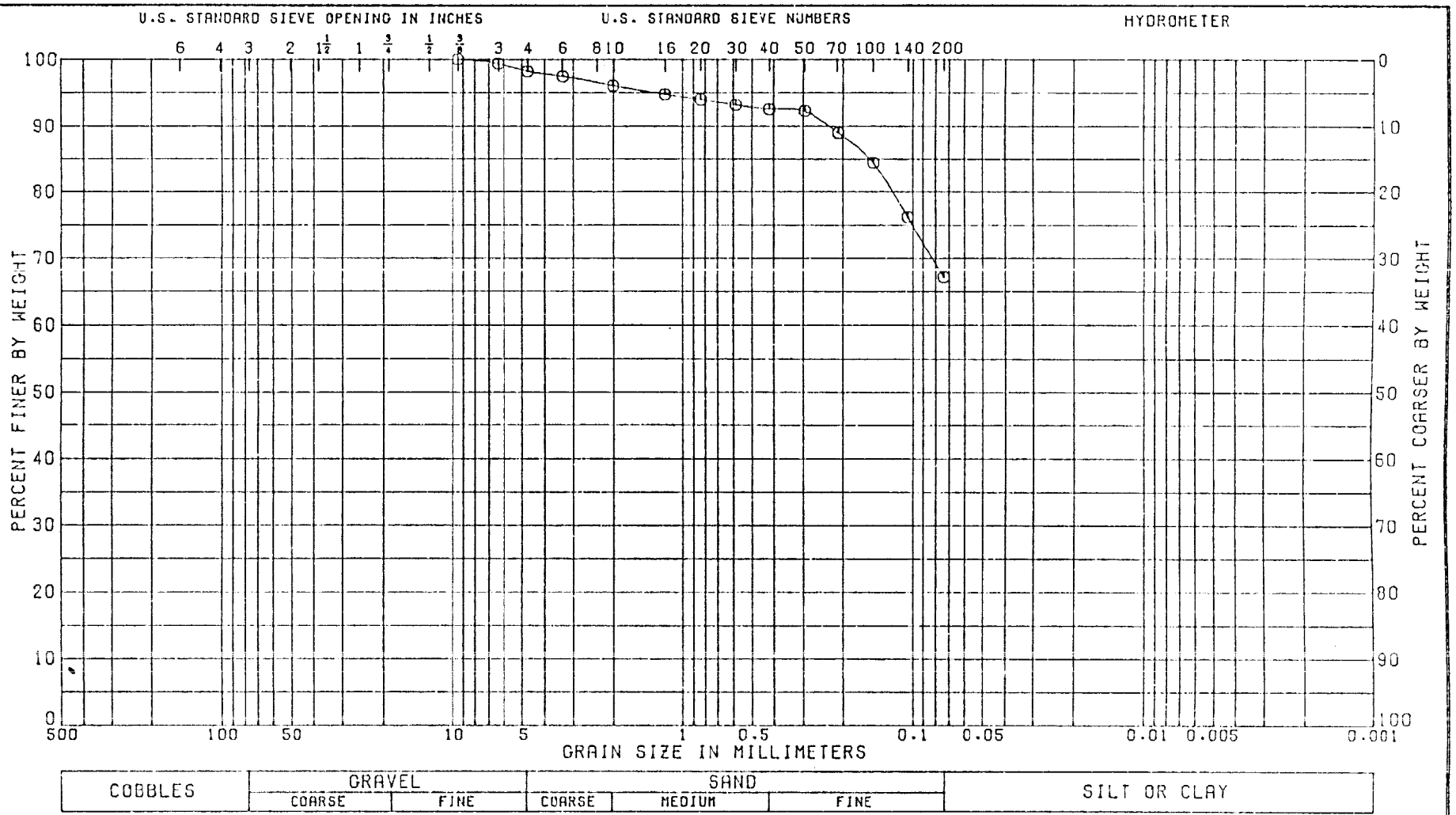
SANDY CLAY (CL), LIGHT BROWN

GRADATION CURVE

PROJECT NWSC

BORING NO. EPD-1 SAMPLE NO. 2

DEPTH/ELEV BOTTOM-PIT DATE 31 OCT 83



LL	PL	PI	GS	NAT W.%
38	16	22		

CLASSIFICATION

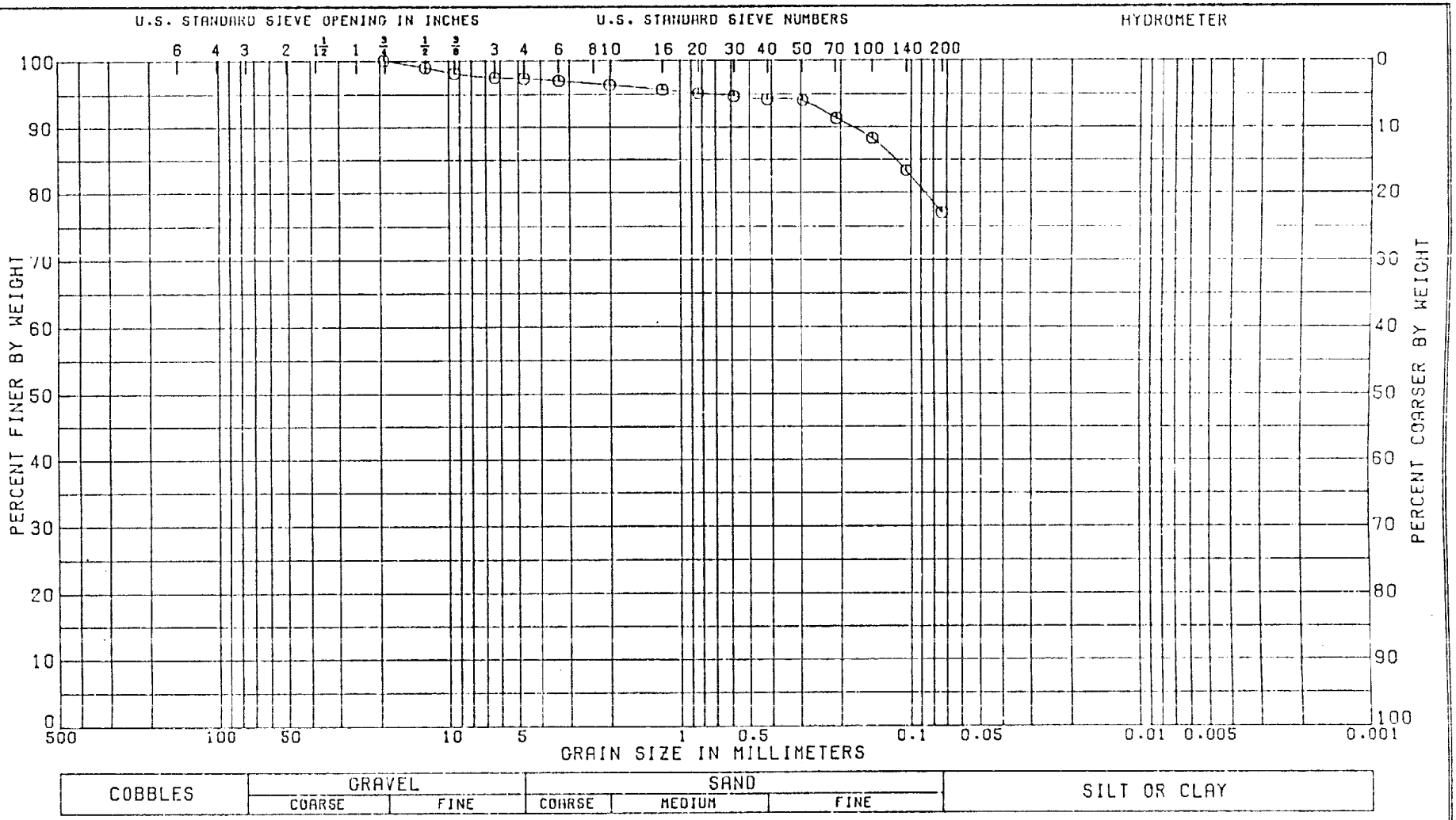
SANDY CLAY (CL), BROWN

GRADATION CURVE

PROJECT NWSC

BORING NO. EPD-1 SAMPLE NO. 3

DEPTH/ELEV BOTTOM-PIT DATE 31 OCT 83



LL	PL	PI	GS	NAT W.%	
31	15	16			

CLASSIFICATION

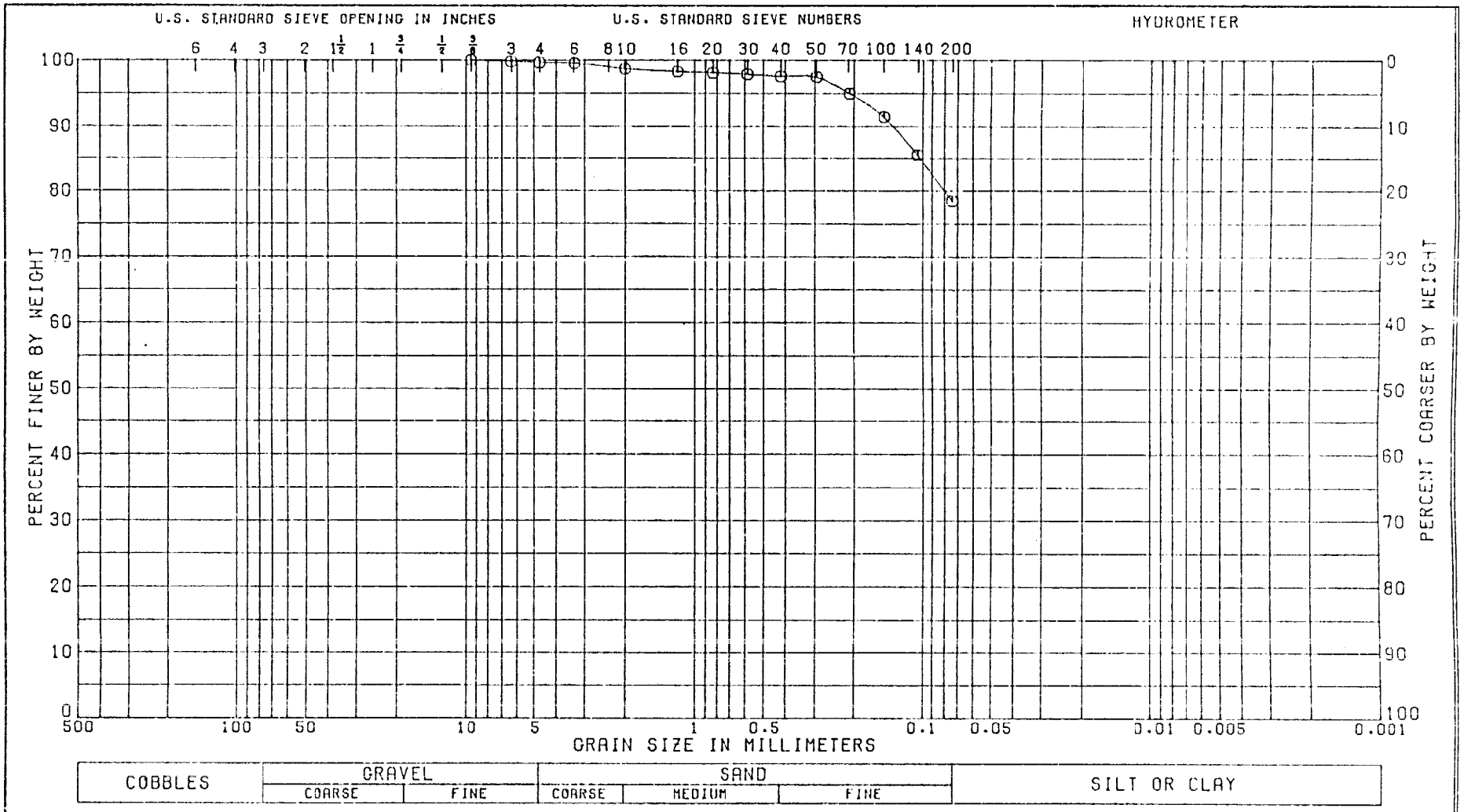
SANDY CLAY (CL), LIGHT BROWN

GRADATION CURVE

PROJECT NWSC

BORING NO. EPD-2 SAMPLE NO. 1

DEPTH/ELEV BOTTOM-PIT DATE 31 OCT 83



LL	PL	PI	GS	NAT W.%	
31	14	17			

CLASSIFICATION

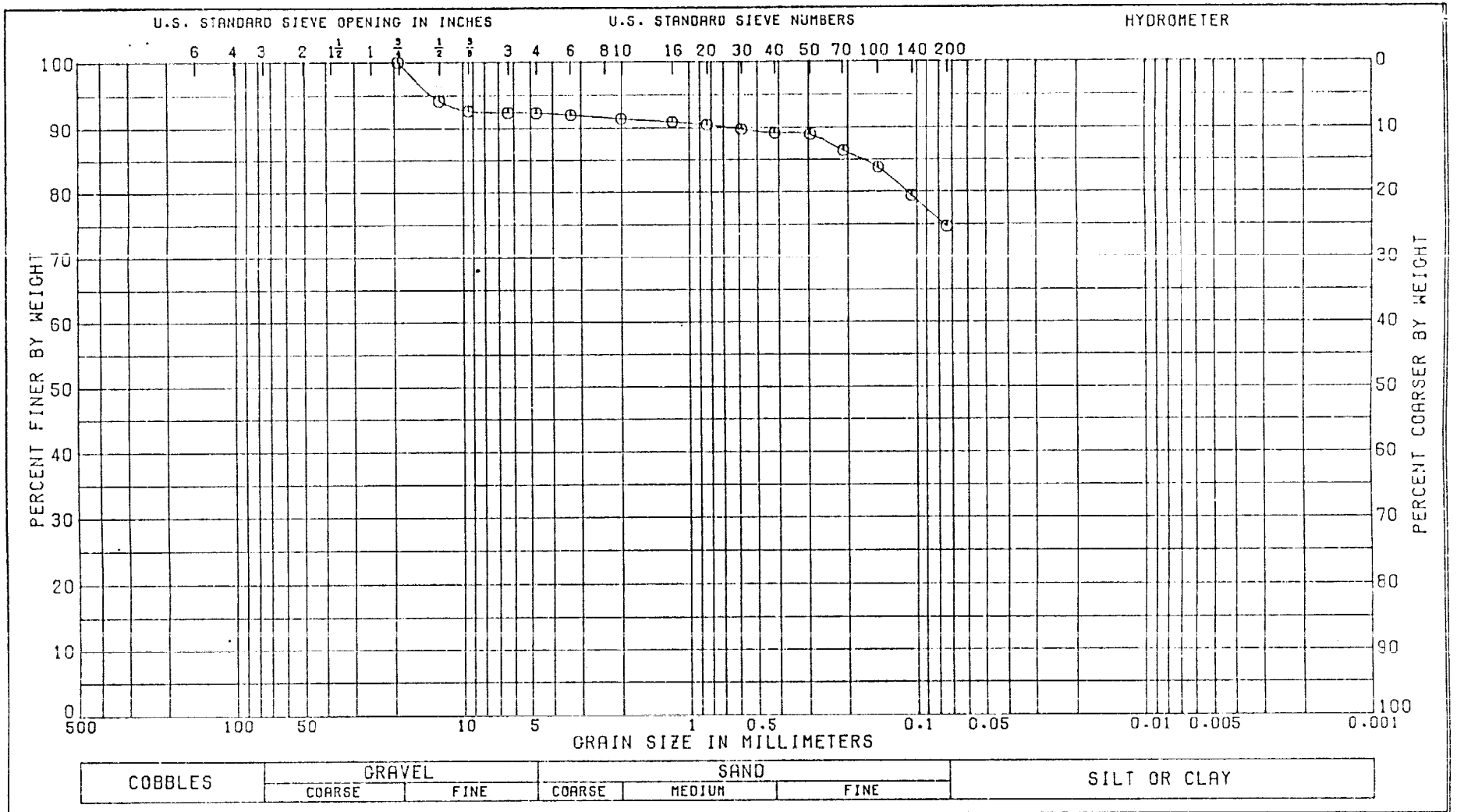
SANDY CLAY (CL), LIGHT BROWN

GRADATION CURVE

PROJECT NWSC

BORING NO. EPD-2 SAMPLE NO. 2

DEPTH/ELEV BOTTOM-PIT DATE 31 OCT 83



LL	PL	PI	GS	NAT W.%	
35	16	19			

CLASSIFICATION

SANDY CLAY (CL), LIGHT BROWN: WITH GRAVEL

GRADATION CURVE

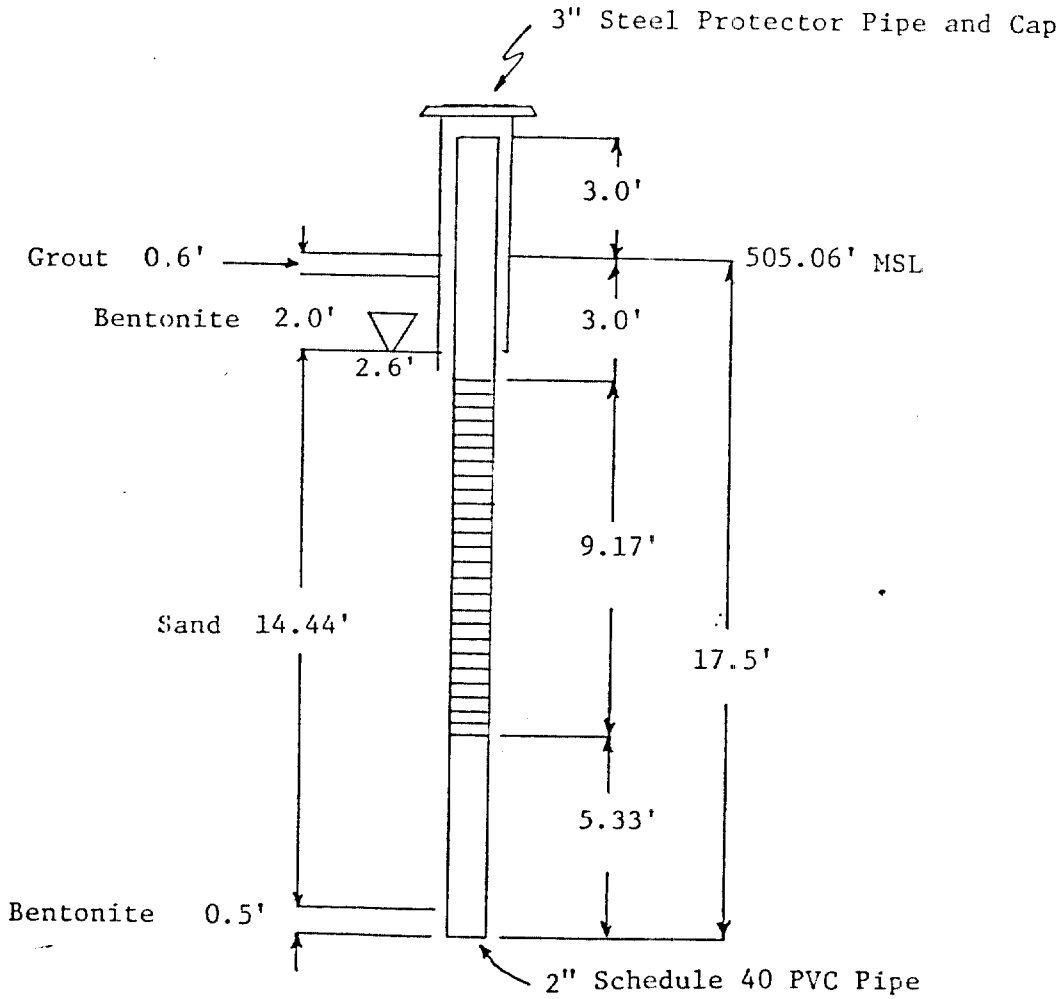
PROJECT NWSC

BORING NO. EPD-2 SAMPLE NO. 3

DEPTH/ELEV BOTTOM-PIT DATE 31 OCT 83

APPENDIX D

WELL COMPLETION DIAGRAMS



Well screen

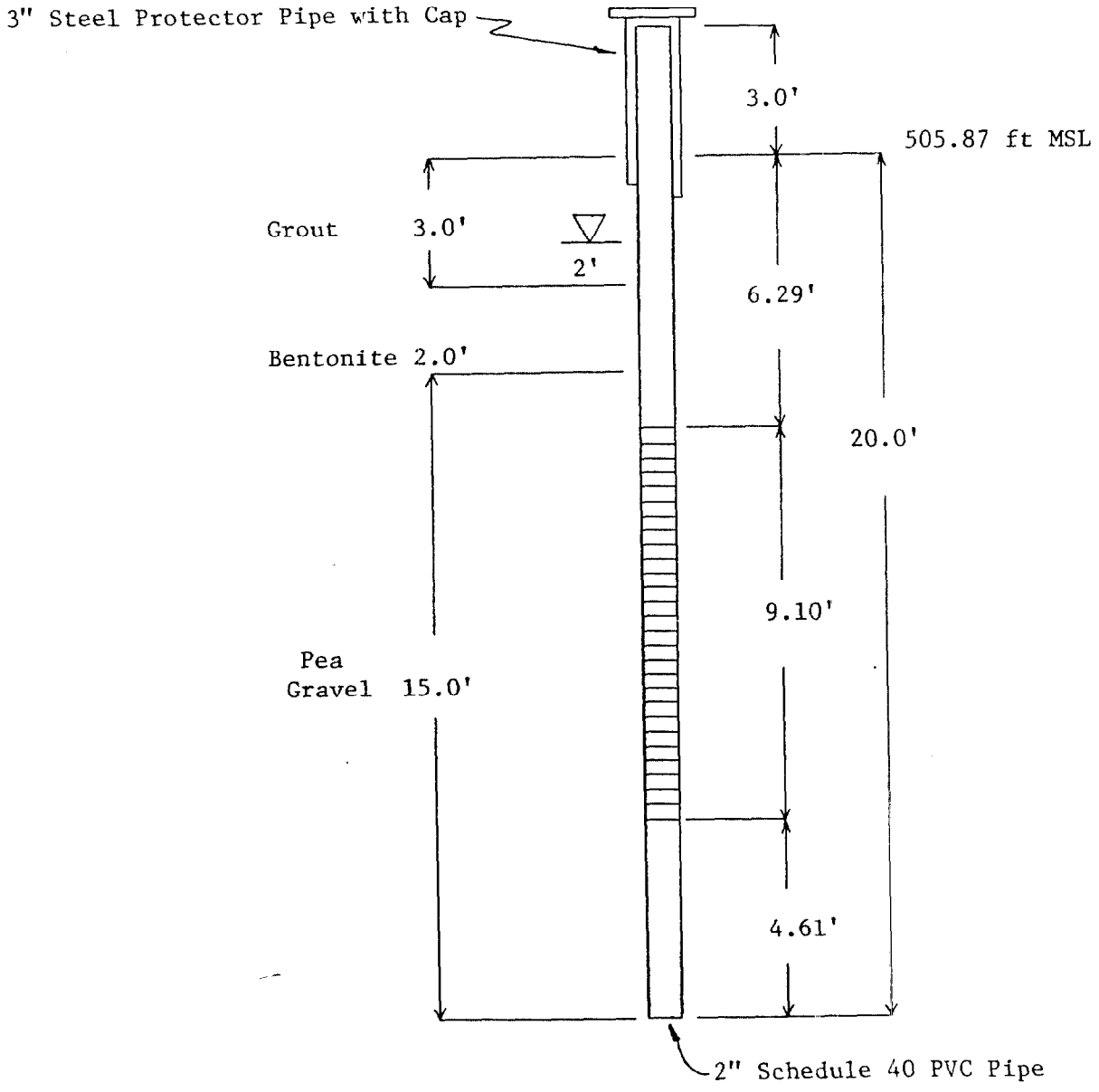
Water depth at time of drilling

NWSC, Crane, Indiana

Rifle Range

Well Completion

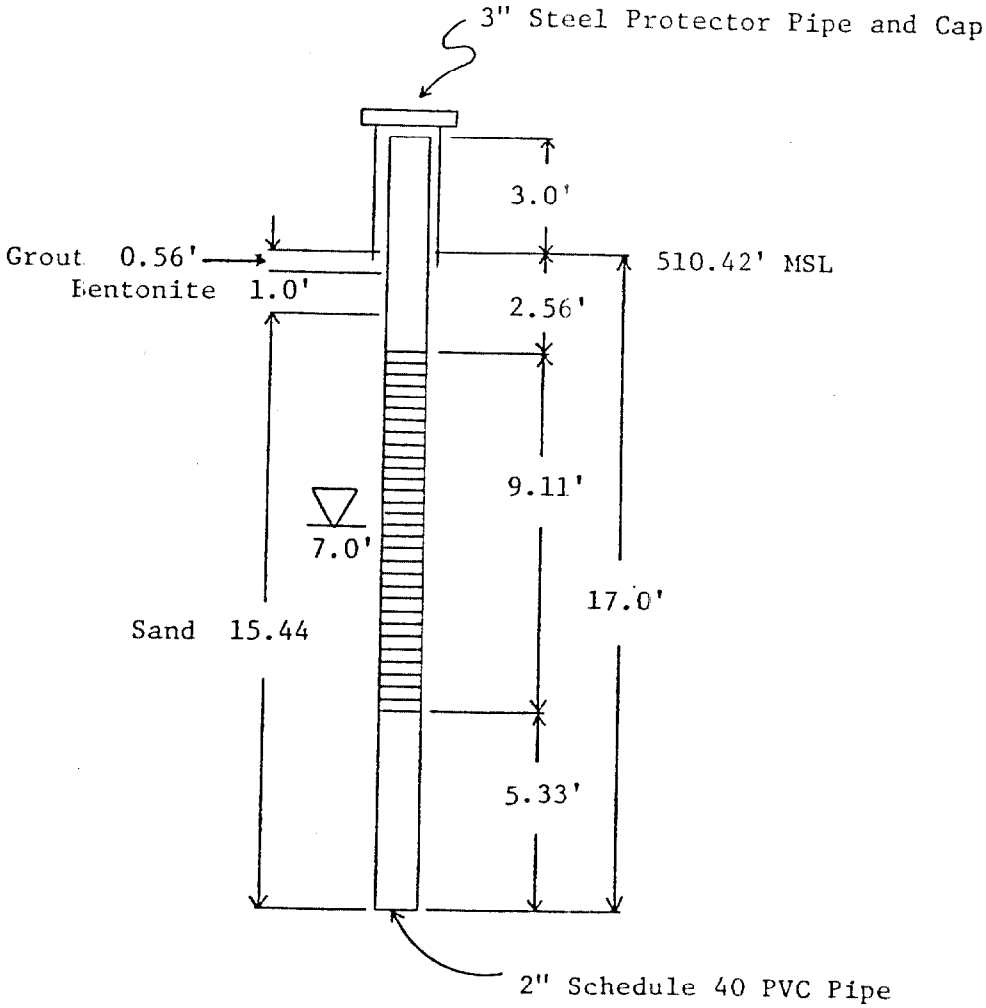
Boring Number: WES-6-14-S1



Water depth at time of drilling

Well Screen

NWSC, Crane, Indiana
Old Rifle Range
Well Completion
Boring Number: WES-6-14A-83



Well screen

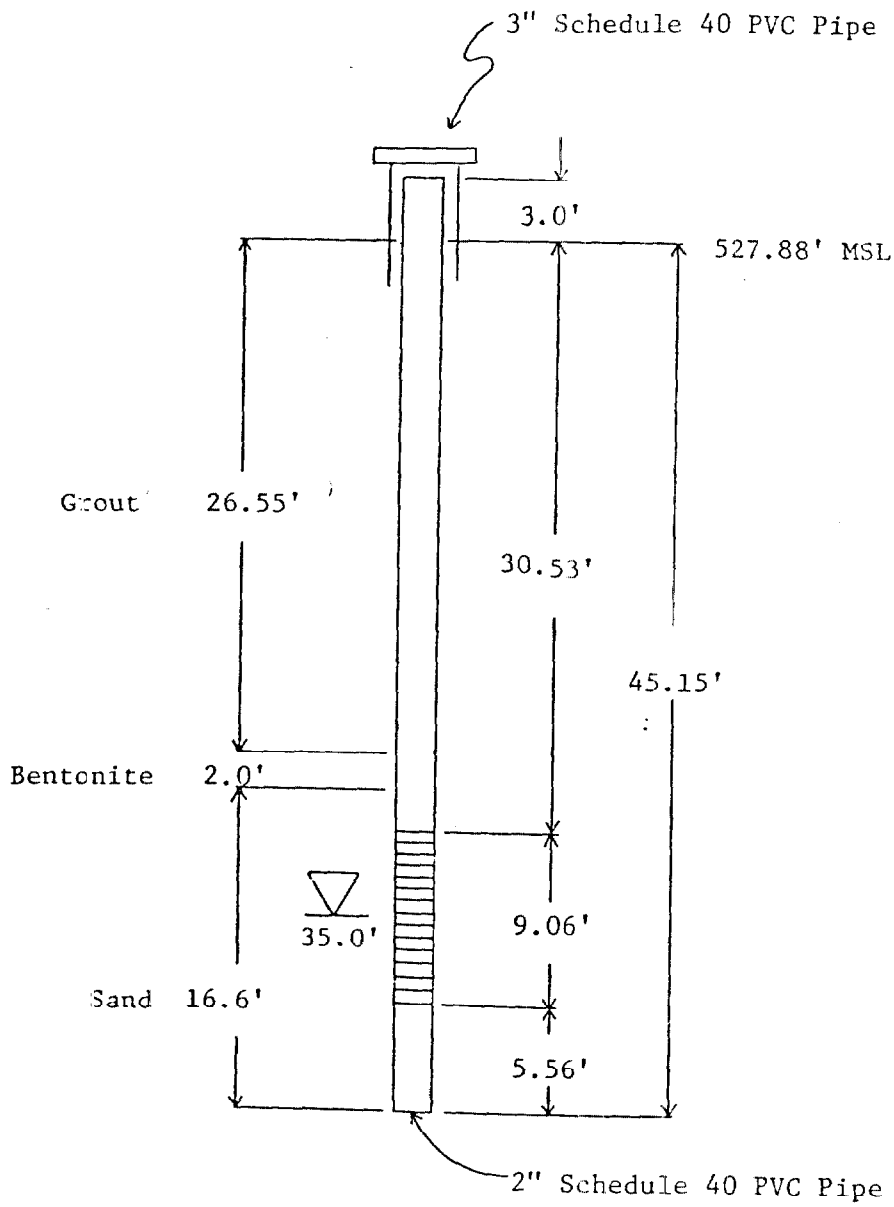
Water depth at time of drilling

NWSC, Crane, Indiana

Rifle Range

Well Completion

Boring Number: WES-6-15-81



Well screen

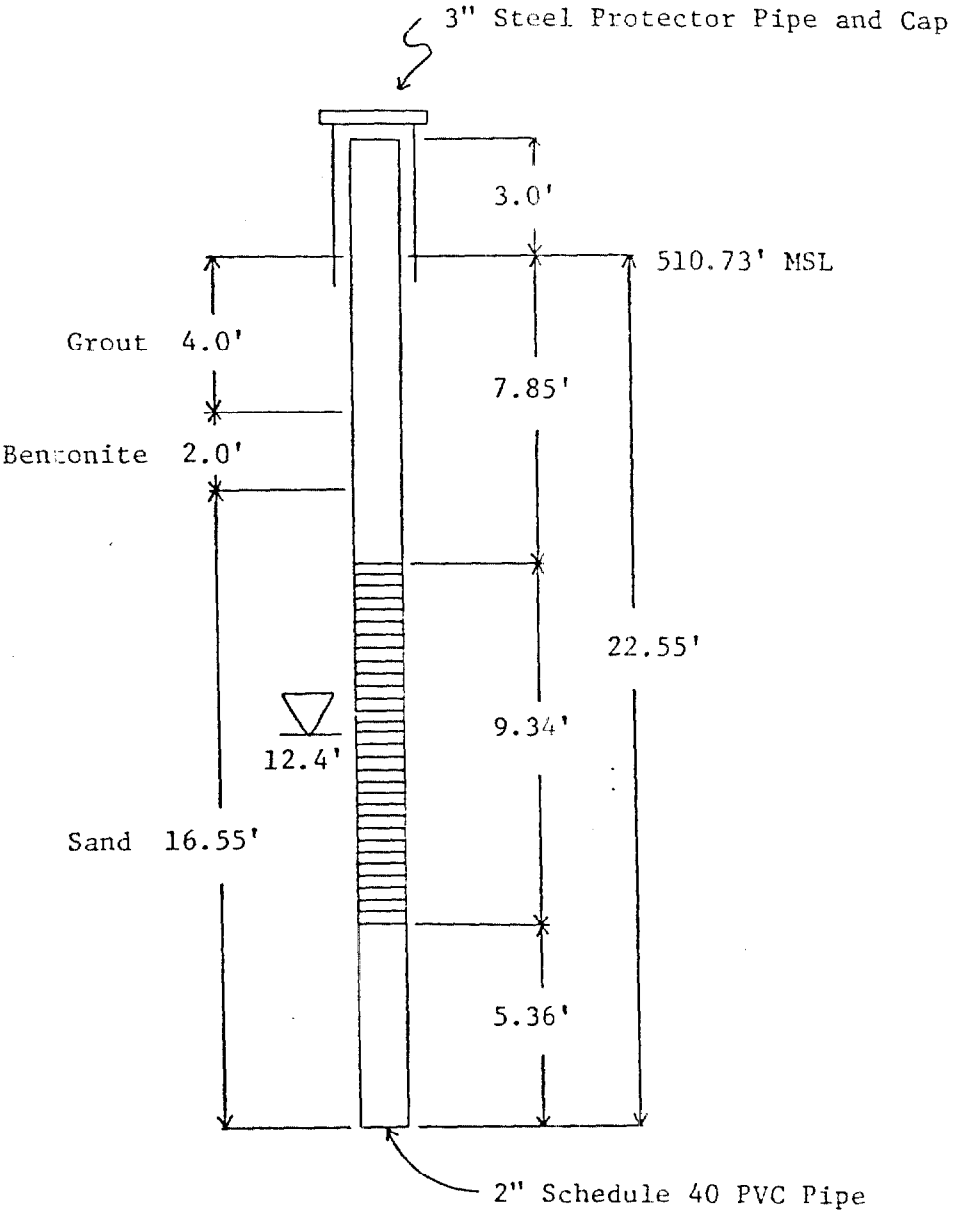
Water depth at time of drilling

NWSC, Crane, Indiana

Rifle Range

Well Completion

Boring Number: WES-6-16-81



Well screen

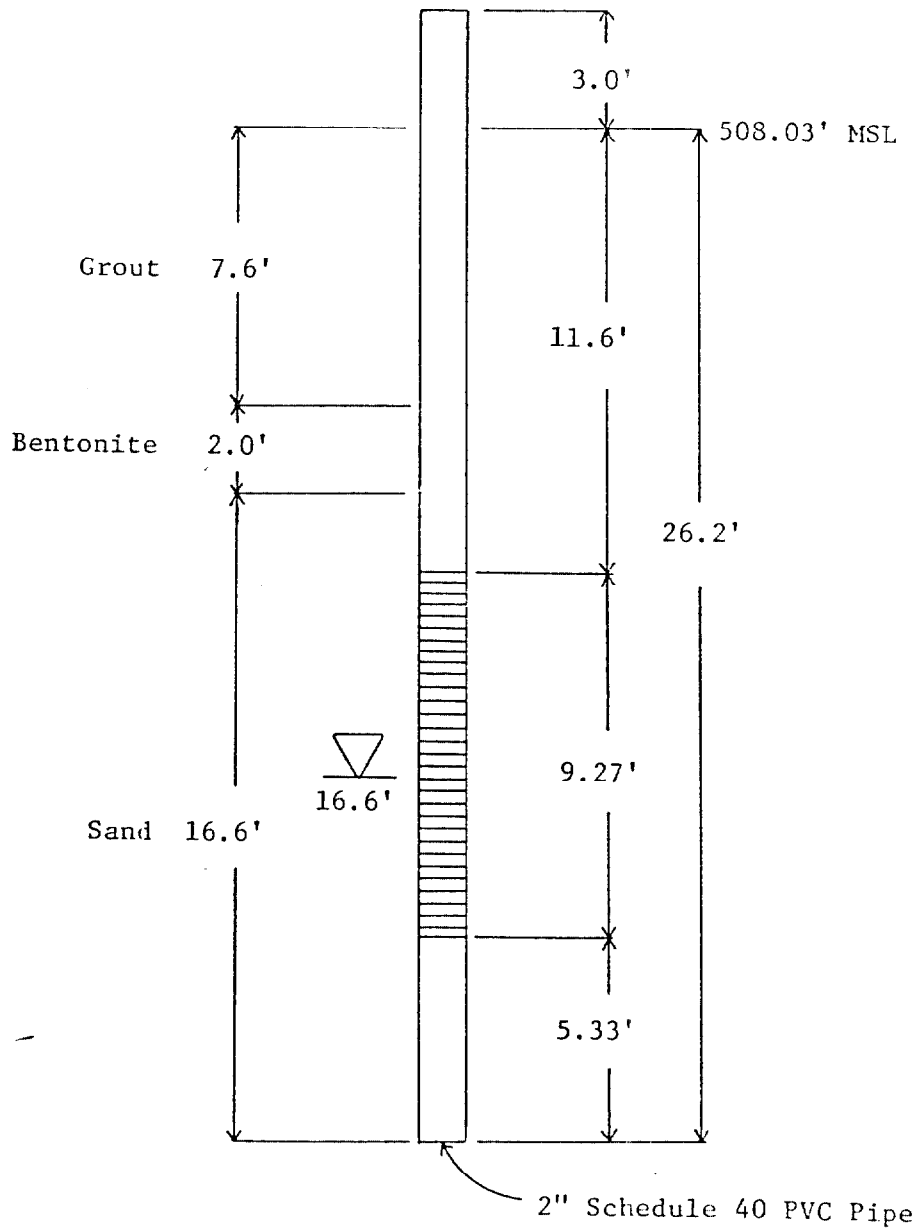
Water depth at time of drilling

NWSC, Crane, Indiana

Rifle Range

Well Completion

Boring Number: WES-6-17-81



Well screen

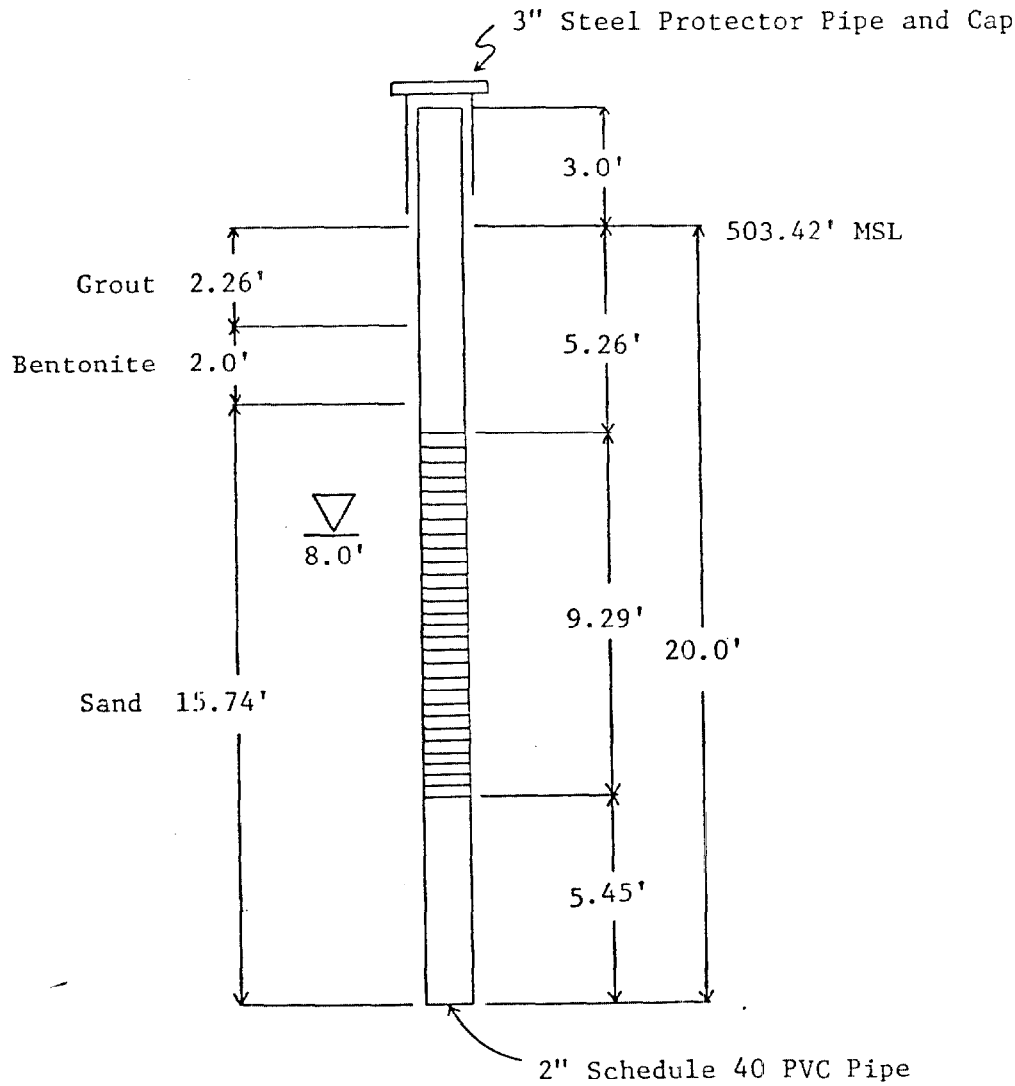
Water depth at time of drilling

NWSC, Crane, Indiana

Rifle Range

Well Completion

Boring Number: WES-6-18-81



Well screen

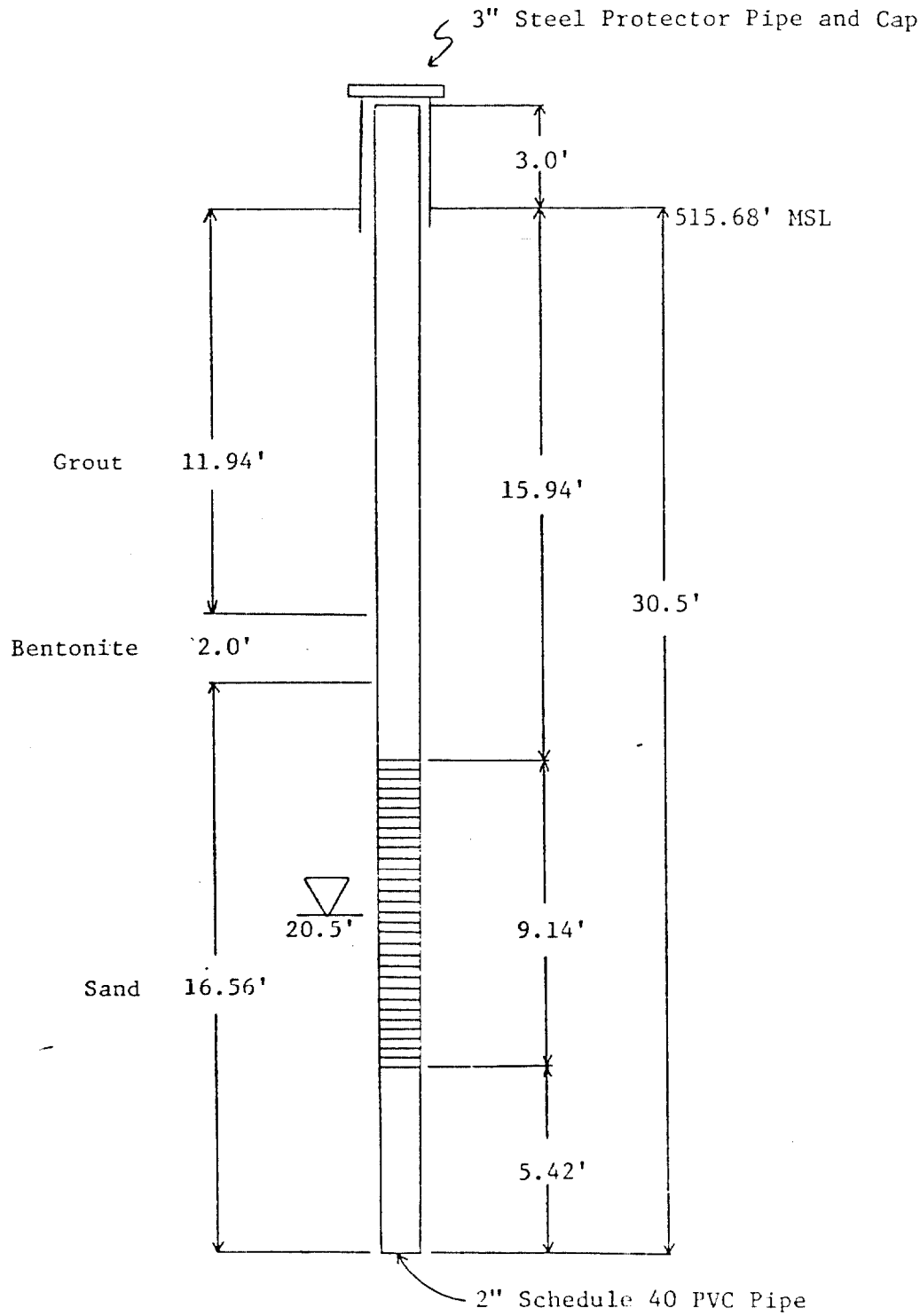
Water depth at time of drilling

NWSC, Crane, Indiana

Rifle Range

Well Completion

Boring Number: WES-6-19-81



Well screen

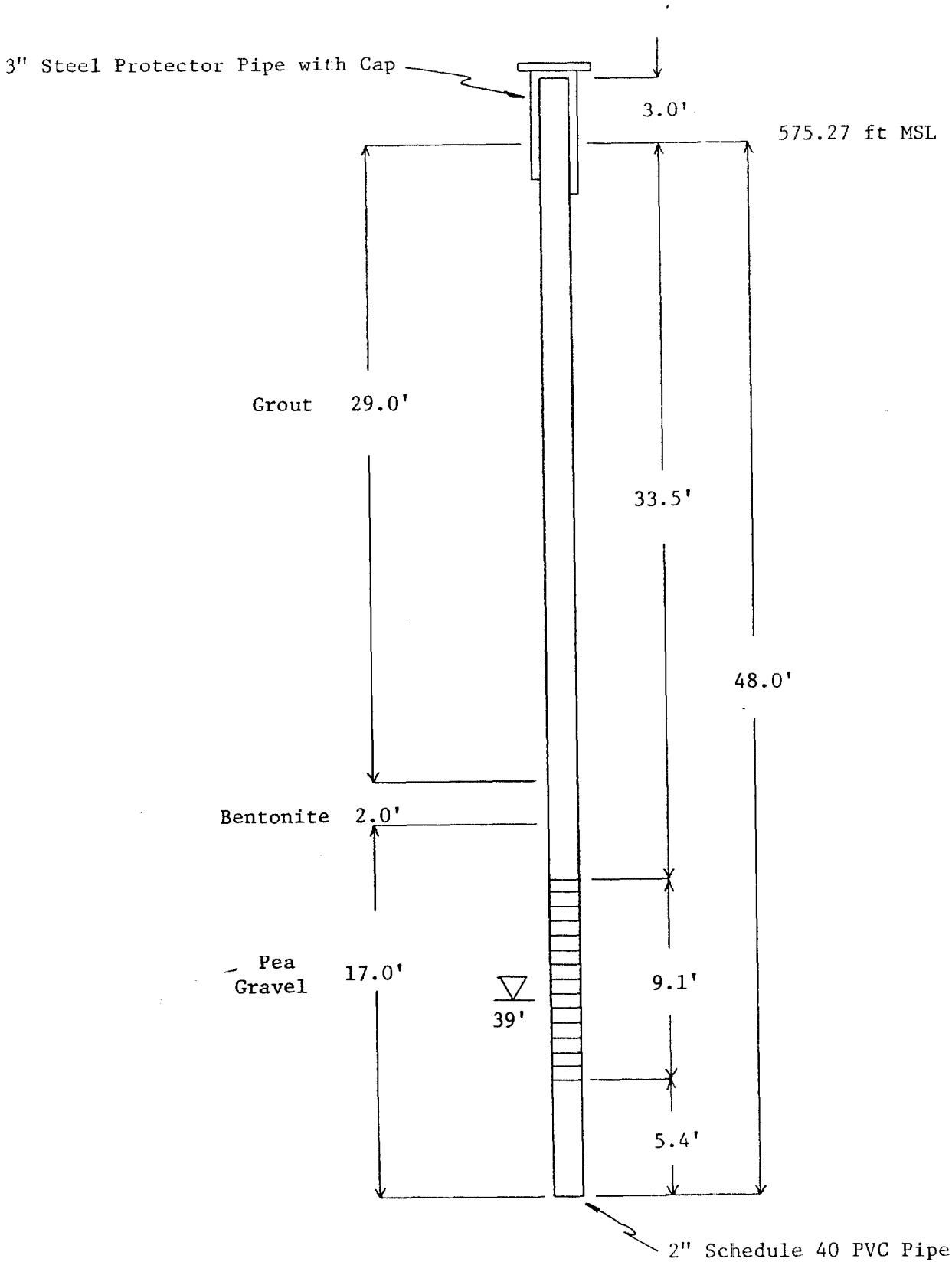
Water depth at time of drilling

NWSC, Crane, Indiana

Rifle Range

Well Completion

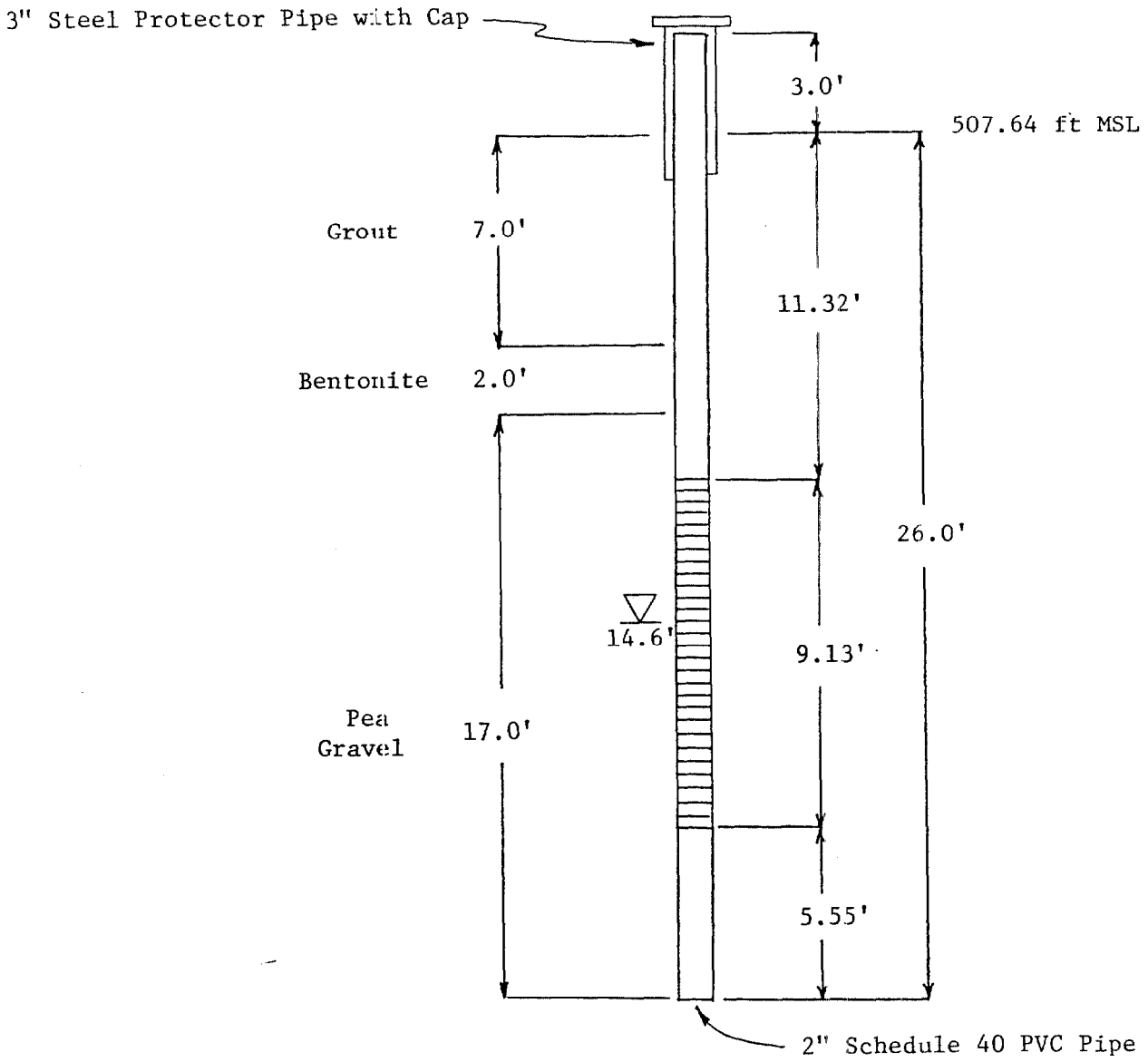
Boring Number: WES-6-20-81



Water depth at time of drilling

Well Screen

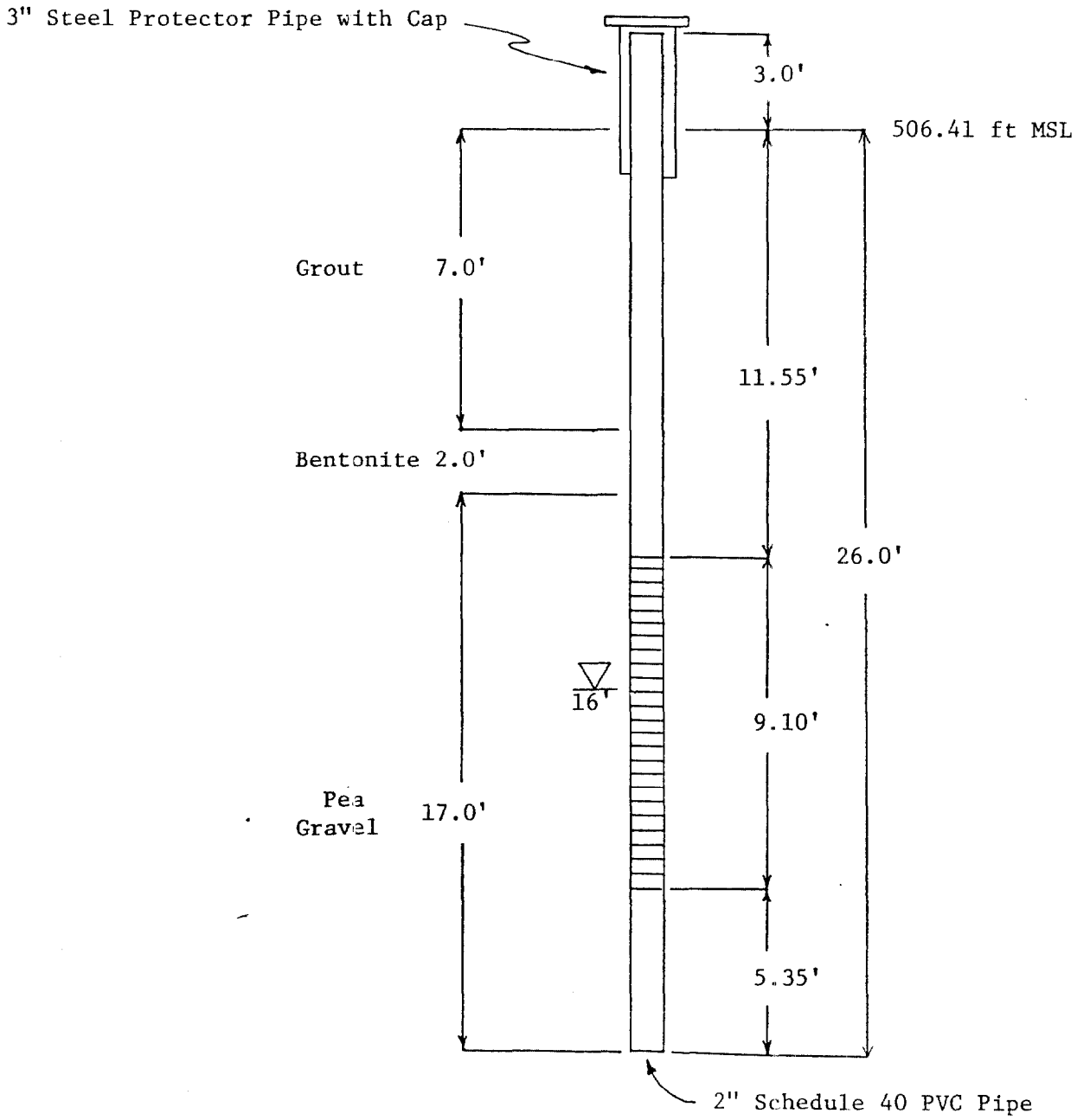
NWSC, Crane, Indiana
Old Rifle Range
Well Completion
Boring Number: WES-6-21-83



Water depth at time of drilling

Well Screen

NWSC, Crane, Indiana
Old Rifle Range
Well Completion
Boring Number: WES-6-22-83



Water depth at time of drilling

Well Screen

NWSC, Crane, Indiana
Old Rifle Range
Well Completion
Boring Number: WES-6-23-83

APPENDIX E

GROUND-WATER ELEVATIONS

Ground-Water Elevations

Old Rifle Range

Boring Number: WES-6-14-81

Top of Pipe Elevation: 508.06 ft MSL

Screen Interval Elevation: from 502.06 to 492.89 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
11 Jun 83	8:03	2.48	505.58	
20 Jun 83	8:41	2.73	505.33	
30 Jun 83	4:50	4.65	503.41	
7 Jul 83	1:08	4.25	503.81	
15 Jul 83	9:08	4.97	503.09	Bentonite in well
18 Jul 83				Blew well-screen is broken
2 Aug 83	3:40	4.50	503.56	
8 Aug 83	2:16	4.73	503.33	
9 Aug 83	8:14	4.76	503.30	
10 Aug 83	1:15	4.80	503.26	
11 Aug 83	2:46	5:00	503.06	
12 Aug 83	9:17	5.09	502.97	
13 Aug 83	9:56	5.12	502.94	
16 Aug 83	8:30	5.48	502.58	
23 Aug 83	9:30	6.03	502.03	
30 Aug 83	10:10	6.38	501.68	
6 Sep 83	2:03	6.75	501.31	
13 Sep 83	4:42	6.89	501.17	
20 Sep 83	8:21	7.07	500.99	
28 Sep 83				Removed well and grouted

Ground-Water Elevations

Old Rifle Range

Boring Number: WES-6-14A-83

Top of Pipe Elevation: 508.87 ft MSL

Screen Interval Elevation: from 499.58 to 490.48 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
8 Aug 83	2:15	5.00	503.87	
9 Aug 83	8:14	5.11	503.76	
10 Aug 83	1:14	5.37	503.50	
11 Aug 83	2:46	5.34	503.53	
12 Aug 83	9:18	5.48	503.39	
13 Aug 83	9:57	5.56	503.31	
16 Aug 83	8:30	5.93	502.94	
23 Aug 83	9:29	6.54	502.33	
30 Aug 83	10:11	6.72	502.15	
6 Sep 83	2:02	7.00	501.87	
13 Sep 83	4:42	7.25	501.62	
20 Sep 83	8:21	7.83	501.04	
6 Oct 83	11:34	6.58	502.29	

Ground-Water Elevations

Old Rifle Range

Boring Number: WES-6-15-81

Top of Pipe Elevation: 513.42 ft MSL

Screen Interval Elevation: from 507.86 to 498.75 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
11 Jun 83	7:51	9.28	504.14	
20 Jun 83	8:49	9.85	503.57	
30 Jun 83	4:40	10.35	503.07	
7 Jul 83	1:21	11.30	502.12	
15 Jul 83	8:53	11.75	501.67	
2 Aug 83	3:10	12.78	500.64	ERG Purged well
9 Aug 83	8:25	12.34	501.08	
16 Aug 83	8:44	13.00	500.42	
23 Aug 83	8:43	13.28	500.14	
30 Aug 81	10:28	13.49	499.93	
6 Sep 83	2:16	13.58	499.84	
13 Sep 83	4:51	13.70	499.72	
20 Sep 83	8:40	14.74	498.68	
6 Oct 83	11:41	13.75	499.67	

Ground-Water Elevations

Old Rifle Range

Boring Number: WES-6-16-81

Top of Pipe Elevation: 530.88 ft MSL

Screen Interval Elevation: from 497.35 to 488.29 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
11 Jun 83	7:45	24.20	506.68	
20 Jun 83	8:15	26.25	504.63	
30 Jun 83	4:56	27.55	503.33	
7 Jul 83	1:01	28.76	502.12	
15 Jul 83	8:56	29.00	501.88	
2 Aug 83	2:56	29.85	501.03	ERG Purged well
9 Aug 83	8:10	29.98	500.90	
16 Aug 83	8:26	30.54	500.34	
23 Aug 83	9:26	31.00	499.88	
30 Aug 83	10:06	31.18	499.70	
6 Sep 83	2:00	31.28	499.60	
13 Sep 83	4:39	31.62	499.26	
20 Sep 83	8:17	31.89	498.99	
6 Oct 83	11:32	32.52	498.36	

Ground-Water Elevations

Old Rifle Range

Boring Number: WES-6-17-81

Top of Pipe Elevation: 513.73 ft MSL

Screen Interval Elevation: from 502.88 to 493.54 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
11 Jun 83	7:49	9.73	504.00	
20 Jun 83	8:49	10.20	503.53	
30 Jun 83	4:39	10.55	503.18	
7 Jul 83	1:21	11.70	502.03	
15 Jul 83	8:51	12.20	501.53	
2 Aug 83	3:10	13.40	500.33	ERG Purged well
9 Aug 83	8:24	12.73	501.00	
16 Aug 83	8:43	13.58	500.15	
23 Aug 83	8:42	13.68	500.05	
30 Aug 83	10:27	13.89	499.84	
6 Sep 83	2:15	14.25	499.48	
13 Sep 83	4:52	15.00	498.73	
20 Sep 83	8:39	14.92	498.81	
6 Oct 83	11:42	15.46	498.27	

Ground-Water Elevations

Old Rifle Range

Boring Number: WES-6-18-81

Top of Pipe Elevation: 511.03 ft MSL

Screen Interval Elevation: from 496.43 to 487.16 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
11 Jun 83	7:57	9.78	501.25	
20 Jun 83	8:36	10.35	500.68	
30 Jun 83	4:46	10.96	500.07	
7 Jul 83	1:15	11.61	499.42	
15 Jul 83	9:00	11.86	499.17	
2 Aug 83	3:34	12.72	498.31	ERG Purged Well
9 Aug 83	8:19	12.42	498.61	
16 Aug 83	8:38	12.76	498.27	
23 Aug 83	9:36	13.30	497.73	
30 Aug 83	10:16	13.42	497.61	
6 Sep 83	2:09	13.63	497.40	
13 Sep 83	4:46	13.90	497.13	
20 Sep 83	8:24	14.10	496.93	
6 Oct 83	11:39	14.51	496.52	

Ground-Water Elevations

Old Rifle Range

Boring Number: WES-6-19-81

Top of Pipe Elevation: 506.42 ft MSL

Screen Interval Elevation: from 498.16 to 488.87 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
11 Jun 83	8:00	4.51	501.91	
20 Jun 83	8:38	3.22	503.20	
30 Jun 83	4:48	5.65	500.77	
7 Jul 83	1:12	6.57	499.85	
15 Jul 83	9:02	6.75	499.67	
2 Aug 83	3:36	10.65	495.77	ERG Purged Well
9 Aug 83	8:16	7.42	499.00	
16 Aug 83	8:34	7.96	498.46	
23 Aug 83	9:33	8.35	498.07	
30 Aug 83	10:33	8.77	497.65	
6 Sep 83	2:07	8.77	497.65	
13 Sep 83	4:45	9.14	497.28	
20 Sep 83	8:27	9.32	497.10	
6 Oct 83	11:36	9.88	496.54	

Ground-Water Elevations

Old Rifle Range

Boring Number: WES-6-20-81

Top of Pipe Elevation: 518.68 ft MSL

Screen Interval Elevation: from 499.74 to 490.60 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
11 Jun 83	7:54	16.23	502.45	
20 Jun 83	8:33	16.85	501.83	
30 Jun 83	4:43	17.34	501.34	
7 Jul 83	1:18	17.97	500.71	
15 Jul 83	8:58	18.00	500.68	
2 Aug 83	3:31	19.40	499.28	ERG Purged Well
9 Aug 83	8:21	18.95	499.73	
16 Aug 83	8:40	19.58	499.10	
23 Aug 83	9:39	19.76	498.92	
30 Aug 83	10:19	19.92	498.76	
6 Sep 83	2:11	20.24	498.44	
13 Sep 83	4:48	20.63	498.05	
20 Sep 83	8:32	20.80	497.88	
6 Oct 83	11:45	21.22	497.46	

Groundwater Elevations

Old Rifle Range

Boring Number: WES-6-21-83

Top of Pipe Elevation: 578.27 ft MSL

Screen Interval Elevation: from 541.77 to 532.67 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
18 Jul 83	10:00	33.28	544.99	
20 Jul 83	9:21	33.42	544.85	
21 Jul 83	3:44	33.50	544.77	
22 Jul 83	3:33	33.51	544.76	
23 Jul 83	12:04	33.52	544.75	
25 Jul 83	10:24	33.62	544.65	
26 Jul 83	11:01	33.65	544.62	
2 Aug 83	2:52	34.08	544.19	
9 Aug 83	8:07	34.23	544.04	
16 Aug 83	8:23	34.34	543.93	
23 Aug 83	9:20	34.71	543.56	
30 Aug 83	10:03	34.90	543.37	
6 Sep 83	1:57	34.98	543.29	
13 Sep 83	4:36	35.22	543.05	
20 Sep 83	8:14	35.39	542.88	
6 Oct 83	11:29	35.70	542.57	

Ground-Water Elevations

Old Rifle Range

Boring Number: WES-6-22-83

Top of Pipe Elevation: 510.64 ft MSL

Screen Interval Elevation: from 496.32 to 487.19 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
26 Aug 83	7:47	11.22	499.42	
29 Aug 83	12:24	12.34	498.30	
30 Aug 83	10:21	12.44	498.20	
31 Aug 83	2:24	12.40	498.24	
1 Sep 83	11:32	12.34	498.30	
2 Sep 83	8:37	12.56	498.08	
3 Sep 83	10:07	12.52	498.12	
6 Sep 83	2:13	12.56	498.08	
13 Sep 83	4:49	12.91	497.73	
20 Sep 83	8:35	13.03	497.61	
6 Oct 83	11:47	13.53	497.11	

Ground-Water Elevations

Old Rifle Range

Boring Number: WES-6-23-83

Top of Pipe Elevation: 509.41 ft MSL

Screen Interval Elevation: from 494.86 to 485.76 ft MSL

Grid Coordinates:

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
1 Oct 83	7:21	12.30	497.11	
3 Oct 83	1:22	12.33	497.08	
4 Oct 83	4:06	12.34	497.07	
5 Oct 83	3:54	12.30	497.11	
6 Oct 83	11:51	12.64	496.77	
10 Oct 83	7:43	12.43	496.98	

Ground-Water Elevations

Old Rifle Range

Boring Number: EPA-1-83

Ground Elevation: 525.62 ft MSL

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
13 Jun 83	10:34	14.3	511.32	
14 Jun 83	1:05	14.6	511.02	
15 Jun 83	1:45	15.2	510.42	
16 Jun 83	11:41	15.50	510.12	
17 Jun 83	10:38	15.68	509.94	
20 Jun 83	8:21	16.72	508.90	
22 Jun 83				Caved In
30 Jul 83				Grouted Boring

Ground-Water Elevations

Old Rifle Range

Boring Number: EPA-2-83

Ground Elevation: 530.91 ft MSL

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
14 Jun 83	1:08	21.70	509.21	
15 Jun 83	1:48	21.74	509.17	
16 Jun 83	11:39	22.14	508.77	
17 Jun 83	10:28	22.30	508.61	
20 Jun 83	8:19	22.85	508.06	
22 Jun 83	11:40	23.15	507.76	
25 Jun 83	1:35	23.32	507.59	
30 Jun 83	4:32	24.05	506.86	
7 Jul 83	12:50	24.75	506.16	
15 Jul 83				Caved In
23 Jul 83				Grouted Boring

Ground-Water Elevations

Old Rifle Range

Boring Number: EPA-3-83

Ground Elevation: 523.20 ft MSL

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
15 Jun 83	1:50	16.0	507.30	
16 Jun 83	11:36	16.34	506.86	
17 Jun 83	10:25	16.70	506.50	
20 Jun 83	8:13	17.37	505.83	
22 Jun 83	11:38	17.70	505.50	
25 Jun 83	1:47	18.08	505.12	
30 Jun 83	4:31	18.80	504.40	
7 Jul 83	12:58	19.60	503.60	
15 Jul 83	8:31	20.70	503.50	
30 Jul 83	8:00	22.00	501.00	
30 Jul 83				Grouted Boring

Ground-Water Elevations

Old Rifle Range

Boring Number: EPA-4-83

Ground Elevation: 521.89 ft MSL

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
16 Jun 83	11:47	14.70	507.19	
17 Jun 83	10:33	14.80	507.09	
20 Jun 83	8:25	16.43	505.46	
22 Jun 83	11:42	15.70	506.19	
25 Jun 83	1:39	15.72	506.17	
30 Jun 83	4:34	16.42	505.47	
7 Jul 83	12:54	18.65	503.24	
15 Jul 83	8:35	17.95	503.94	
23 Jul 83				Grouted Boring

Ground-Water Elevations

Old Rifle Range

Boring Number: EPA-5-83

Ground Elevation: 521.16 ft MSL

Date	Time	Depth to Water, ft	Water Elevation, ft MSL	Remarks
17 Jun 83	10:35	16.50	504.66	
20 Jun 83	8:29	16.80	504.36	
22 Jun 83	11:45	16.50	504.66	
25 Jun 83	1:42	17.05	504.11	
30 Jun 83	4:37	18.35	502.81	
7 Jul 83				Caved In
30 Jul 83				Grouted Boring