GEOHYDROLOGIC INVESTIGATION OF TAILINGS DISPOSAL RHODE RANCH PROSPECT

McMULLEN COUNTY, TEXAS

Prepared For

THE ANACONDA COMPANY

Corpus Christi, Texas

By

ED L. REED AND ASSOCIATES, INC.

Consulting Hydrologists

Midland and Corpus Christi, Texas

April 1980

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GEOHYDROLOGIC INVESTIGATION OF TAILINGS DISPOSAL

RHODE RANCH PROSPECT

MC MULLEN COUNTY, TEXAS

INTRODUCTION

Camp Dresser and McKee Inc. has submitted a report on behalf of The Anaconda Company outlining the justification for waiver of ownership requirement for the uranium mill tailings generated on the Rhode Ranch Prospect. This report addresses the geohydrologic framework of the Rhode Ranch Prospect and evaluates the tailings disposal as it fits into this framework.

The Rhode Ranch Prospect lies in southeastern McMullen County, Texas, approximately five miles north of the Duval County line and five miles west of the Live Oak County line. Rhode Ranch is in a sparsely populated portion of South Texas lying approximately 20 miles southwest of George West and 30 miles northwest of Alice, the two largest towns nearby.

TOPOGRAPHY AND DRAINAGE

The Rhode Ranch lies on gently undulating terrain that regionally slopes northward toward the Nueces River (figures 1 and 2). A northeast trending topographic divide across the southeast corner of McMullen County separates northwestward drainage into the Nueces River from southeastward drainage into Lagarto Creek. Both the Nueces River and Lagarto Creek drain into Lake Mathis. Most of the Rhode Ranch surface is drained toward Hill Creek and thence into the Nueces River (figure 2).

Following mining and subsequent reclamation, the surface topography will be restored as closely as possible to the present drainage. Two minor drainage ways transect the proposed mining area, one on the south end and one on the north end (figure 2). These drainage ways will also be restored to their pre-mining configuration.

GEOLOGY

The mineralized sand from which the uranium will be extracted lies within two sand beds in the Miocene-age Oakville Sandstone. The Oakville is largely exposed at the surface of the Rhode Ranch Prospect, although small outliers of Goliad sand have been mapped on top of the Oakville (figure 3). The Oakville Sandstone has locally been subdivided into three members. From oldest to youngest they are the Rincon, the Manuel and the Magnolia. Uranium mineralization occurs in sands of the lower Manuel and the lower Rincon as illustrated in the CDM report. Three cross-sections accompanied by lithologic descriptions are presented in figure 4. The Magnolia member consists of alternating beds of clay, silt and very fine sand. An examination of the exploration pit wall shows that the lower part of the Magnolia consists largely of cross-bedded fine sands. The underlying Manuel member which is approximately 40 feet thick consists predominantly of yellow, virtually silt-free, clay in the upper part and a calcareous, very fine to medium grained, gray sand in the lower part. The Rincon member which is about 40 feet thick in the northeast and absent in the southwest consists predominantly of clay in the upper portion and fine to medium grained gray sand in the lower portion. On the east side of Rhode Ranch the lower sand of the Rincon member resides directly upon the Catahoula clay. On the western portion of Rhode Ranch the Rincon member has pinched out and the Manuel member rests directly on the Catahoula.

The clays in the Oakville are predominantly montmorillonitic; sands are predominantly quartzose (TWC 6520). The sand is usually loose, but can be tightly cemented as in the upper part of the Manuel sand. Sieve analyses of the sands and clays show that on the average 95 percent of the clay zone material is finer than a 200 mesh sieve. The sand ranges from fine to coarse.

The western limit of the Oakville lies approximately 2 miles west of the mine site. The Oakville thickens to about 500 feet in the vicinity of the McMullen-Live Oak County line.

The Catahoula consists principally of tuffaceous clays and tuff with alternating fine to medium tuffaceous sand and sandy clay. The Catahoula which yields minor amounts of slightly to moderately saline water extends to a depth of approximately 1400 feet. In southeastern McMullen County there are no fresh water aquifers which lie beneath the Catahoula. The Eocene-age Carrizo sand which even at considerable depths often carries fresh to moderately saline water, here is in excess of 7,000 feet below the surface and probably contains water that is quite saline. The Eocene-age Queen City, Yegua, and Jackson which are fresh water aquifers in western McMullen and LaSalle Counties are deeply buried in southeastern McMullen County and contain saline water (TWC Bull. 6520).

The Gulf Coast Region is underlain by a gentle, southeasterly dipping monocline wherein the older formations dip coastward at a rate of 60 to 90 feet per mile and the younger formations dip less steeply, at a rate of 20 to 50 feet per mile.

In the vicnity of the Rhode Ranch Prospect the Catahoula dips to the east at a rate of approximately 35 feet per mile (figure 5).

A northeast trending normal fault lies about a mile southeast of the proposed mine area. This fault which has a displacement of approximately 60 feet is downthrown on the southeast side. Two minor splinter faults are recognized at the northeast end of this fault. East of the fault the Catahoula dips toward the east at a rate of approximately 80 feet per mile.

HYDROLOGY

An inventory was made of the water wells in the vicinity of the Rhode Ranch in late 1977. This inventory has been updated for the current study. The results of this inventory are presented in figure 6.

Catahoula

Figure 6 shows that the Oakville-Catahoula contact lies approximately two miles west of the mine area. Thus, the western edge of the Oakville is expected to be thin and unsaturated. Exploration drilling and the construction of the bulk sample pit has indeed shown that the Oakville in the area west of the northeast trending fault is unsaturated. Therefore, in the area west of the fault (the upthrown side) the wells are completed in the sands of the Catahoula.

The quality of the Catahoula water is rather poor with chlorides generally exceeding 1,000 milligrams per liter (mg/l). The easternmost Catahoula wells produce water with chlorides in excess of 2,000 mg/l. The sulfate in the water produced from the Catahoula usually exceeds 500 mg/l although sulfate concentrations as low as 236 mg/l are present. In the vicinity of the mine, the shallowest Catahoula sand lies 500 feet below the Catahoula/Oakville contact (figure 7). This 500 foot interval is comprised principally of clay. Thus the

Oakville in the area of the prospect is hydraulically separate from the Catahoula aquifers. The piezometric surface in the Catahoula is approximately 60 feet per mile toward the southeast.

Oakville Sandstone

A few wells are completed in the Oakville on the east (downthrown) side of the fault (figure 8). The nearest of these wells is about 1.5 miles east of the mine. Water produced from the Oakville is somewhat better quality than that produced from the underlying Catahoula although some poor quality water does exist. Chloride concentration in the Oakville is as low as 500 mg/l (Well D-1) and can be in excess of 4,900 mg/l. The piezometric surface in the Oakville also dips toward the southeast but has a flatter gradient than the Catahoula at about 30 feet per mile.

Hydrologic data such as permeability, transmissivity, and porosity are scant for the aquifers in southeast McMullen County. This sparsity of data is due to the low interest in the local aquifers which generally have low yields of poor quality water. Pumping tests conducted by Anaconda for wells completed in the Oakville near the Live Oak-McMullen County line indicate that the Oakville in this area has a low transmissivity of only about 100 gallons per day per foot (gpd/ft). Throughout much of Live Oak County the Oakville is a major aquifer, with transmissivities ranging from 1,000 or 2,000 to over 50,000 gpd/ft (TBWE Bull. 6105). The aquifer is artesian with storage coefficients generally in the range of 10^{-4}. No data are available on the transmissivity of the Catahoula sands in southeastern McMullen County.

The uranium mineralization as described in the CDM report lies within the middle and lower Oakville sands. The Oakville Sandstone which is a major aquifer in Live Oak County is unsaturated in the vicinity of the Rhode Ranch mine prospect. The 12-mile wide Oakville Sandstone outcrop, however, is the primary recharge area for the Oakville. Therefore, even though by all appearances the Oakville is unsaturated in the vicinity of the mine, this is not to say that ground water does not intermittently percolate through this otherwise unsaturated sand. In the vicinity of the mine, the Oakville sands are so shallow that they remain drained of the recharge waters. Southeast of the fault, however, the Oakville sands are apparently displaced to depths where they are allowed to remain saturated (figure 8). The fault, it appears, approximates the westward limit of Oakville saturation.

TAILINGS DISP AL

Primary Method

As described in the CDM report, the method of tailings disposal considered most desirable is one where the tailings can be re-emplaced into the open pit from whence they were derived. We believe that the high clay content of the overburden will enable utilization of this disposal method. The procedures for encapsulating the tailings are described below and illustrated in figure 9.

Appendix A shows the grain size distribution and permeability of the Catahoula clay which underlies the lowest sand to be mined. The permeability of the Catahoula ranges from 1.7×10^{-7} to 2.5×10^{-11} centimeters per second (cm/sec) indicating that these clays are practically impervious. These low permeabilities are the result of the high percentage of fine-grained material as indicated by the sieve analyses which show that 95-100 percent of the material passes a 200 mesh sieve (.074 mm). These impervious clays of the Catahoula will effectively restrict downward migration of fluids from the tailings.

The overburden which was stockpiled during the excavation of the bulk sample pit (figures 5 and 6) was sampled and analyzed for grain size distribution and permeability (Appendix B). It can be seen from these analyses that the material is generally quite fine grained and has a low permeability. The permeability of this material averages 5×10^{-8} cm/sec. The silt-clay content of the overburden is quite high as seen in the size distribution analyses. On examination of the samples (see boring logs, Appendix B) only small pockets, generally less than 2 or 3 inches of sand, were apparent. This indicates that mixing is effective during overburden excavation. The uppermost 2 to 5 feet of the overburden pile contained largely sand. This sand was derived from the layers just above the ore zone and hence the percentage of clay is lower than the rest of the overburden pile. This sand on top of the mineralized zone will be buried with the tailings.

Both the Manuel sand and the Rincon sand (figure 9) contain ore. In the northeast part of the mine area only the Manuel sand is mineralized. The Manuel in this area is separated from the Rincon sand by approximately 20 feet of clay. In the middle portion of the mine area (figure 4) both the Manuel and Rincon are mineralized and the intervening Rincon clay is thin. In the southwest part of the mine area, the entire Rincon member is absent and the Manuel rests directly on the Catahoula. Tailings disposal, therefore, will be treated somewhat differently in the northeast than in the middle or southwest areas.

In the northeast area, it is proposed that following removal of the ore in the Manuel sand a bulldozer-width trench be constructed along the inside periphery of the pit and that this trench be cut into the Rincon clay. This trench will be backfilled with compacted overburden which we have demonstrated will have a permeability in the range of 5×10^{-8} cm/sec. This compacted layer will essentially line the wall of the pit as shown in figure 9. Once all of the tailings have been emplaced in the pit, a 3-foot minimum compacted overburden layer will be placed on top of the tailings. This method of disposal will totally encapsulate the tailings by low permeability overburden material.

A similar method of disposal will be used in the middle area where both the Rincon and Manuel are mineralized. After the removal of the Rincon ore, the trench will be cut into the Catahoula and subsequently backfilled with compacted overburden as seen in the middle diagram in figure 9. In the southwestern area, the Rincon member is absent and the Manuel rests directly on the Catahoula. Upon mining the Manuel ore, the trenches will be cut into the Catahoula and filled with compacted overburden.

It can be seen in figure 9 that we propose to construct the compacted pit wall liner only opposite those portions of the geologic section which contain predominantly sand. Three Shelby tube samples collected from the pit wall (Appendix A) show permeabilities ranging from 3.8×10^{-7} to 6.0×10^{-9} cm/sec for the clays and sandy clays that lie between 32 and 48 feet from the surface (36 to 20 feet above the ore zone). These materials are considered adequate for tailings containment. In the event that tailings are placed opposite the Manuel clay as shown in the right diagram in figure 9, the compacted sidewall will only be extended up into the basal part of the Manuel clay. Once all the tailings have been emplaced, a compacted overburden cap will be installed.

During the period of time that the tailings are being emplaced in the pit, the drainable water will be diverted to low areas in the pit floor and pumped back into the mill circuit. Thus the encapsulated tailings will have a moisture content less than saturation.

Following the emplacement of the compacted overburden cap, the balance of the overburden can be placed in the pit with little heed to the manner of emplacement. It is our opinion that the proposed encapsulation will prevent water which might at times percolate through the Oakville from encountering the tailings. Thus no leaching of the tailings is anticipated.

Alternative Proposal

It is our opinion that the tailings disposal outlined above represents the best method of tailings disposal. A secondary alternative which we consider less environmentally sound is outlined below. This alternative essentially consists of constructing a below ground tailings pond (figure 10) which would be located in the southeast corner of Section 58. As proposed, the bottom of the tailings pond would be approximately 1440 feet on a side and the surrounding dike comprised of the excavated material would be approximately 30 feet high. The depth of the pit would range from approximately 30 feet on the northwest corner to about 50 feet in the southeast half of the pit.

Three borings were completed in the vicinity of the proposed tailings pond location (figure 10). These borings which range in depth from 25 to 43 feet were sampled for permeability and sieve analyses. The permeability of these samples ranges from 1.4×10^{-7} to 3.1×10^{-9} cm/sec with the exception of one sample at a depth of

16 feet which has a permeability of 6.3×10^{-6} cm/sec. Between 41 and 95 percent of the material passes the 200 mesh sieve.

Logs of nearby exploration holes (figure 11) indicate that in the northwest portion of the location, material consisting predominantly of clay extends from near the surface to a depth of about 50 feet. In the southeast portion of the area, material consisting predominantly of clay extends to a depth on only about 30 feet and silty or sandy material is present between 30 and 50 feet. Below a depth of 50 feet the material is predominantly sand. It is anticipated, therefore, that the floor of the southeast half of the pond which will be excavated to a maximum depth of 50 feet would have to be lined with a minimum of 3 feet of compacted clay which had been previously excavated (figure 12). This clay liner would retard fluid movement from the pond.

The tailings and waste would be placed into the pond to a depth of about 10 feet. Upon closure of the pond a 10-foot minimum cover would be placed on top of the tailings. Figure 12 illustrates that this cover would lie entirely below ground level. The remainder of the excavated material would be mounded over the pond and seeded.

SUMMARY

In our opinion the most environmentally sound method for the disposal of the tailings generated on the Rhode Ranch Prospect is emplacement into the mined-out pi[illegible]. This scheme is considered practical in the Rhode Ranch area because the mining activity will be above the level of ground water saturation. Additionally, the high clay content in the overburden enables its use as a pit wall liner. The Oakville Sandstone in the mine area, although unsaturated, is part of the recharge area for the Oakville in Live

Oak County. It is important, therefore, to encapsulate the tailings such that no recharge water encounters and thereby leaches the tailings. Permeability tests run on samples collected from the bulk sample pit overburden stockpile indicates that the permeability of the overburden is quite low. It is evident, therefore, that the compacted overburden material will provide an excellent means of encapsulating the tailings and thus prohibiting leaching by recharge water.

Alternatively, we have considered disposal of the tailings into a below ground tailings pond. We consider this alternative to be less environmentally sound for three reasons.

(1) The disposed tailings will be nearer the surface.

(2) The tailings would be emplaced into virgin formations that otherwise would not have been contaminated.

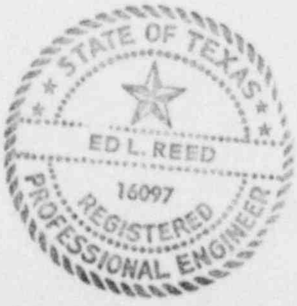
(3) Standing water which would be impounded in the tailings pond throughout the entire mill life would increase the risk for fluid migration away from the tailings pond.

For these reasons we feel that the concept of re-emplacement of the tailings into the open pit represents the best practical disposal.

Respectfully submitted,

V. Steve Reed

Ed L. Reed, P.E.



REFERENCES

Texas Board of Water Engineers Bulletin 6105, Ground Water Geology of Live Oak County, Texas, 1961.

Texas Water Commission Bulletin 6520, Ground Water Resources of LaSalle and McMullen Counties, Texas, 1965.

Bureau of Economic Geology, University of Texas at Austin. Geologic Atlas of Texas, Crystal City-Eagle Pass Sheet, 1976.

APPENDIX A

APPENDIX A

CATAHOULA PERMEABILITY

(SAMPLE LOCATIONS FIGURE 2)

Shilstone ENGINEERING TESTING LABORATORY. INC.

BEAUMONT, TEXAS, 2276 PARK STREET 77701 713-838-1694
FREEPORT, TEXAS, 415 NORTH AVENUE F. 77541 713-233-6366
HOUSTON, TEXAS, 1714 MEMORIAL DRIVE 77007 713-224-2047

February 14, 1980

The Anaconda Company
Mineral Resources Group
1400 Bank and Trust Tower
Corpus Christi, Texas 78477

Attn: Mr. R.B. Hill

Re: Permeability Test
File No. 205-05011

Gentlemen:

In compliance with your instructions, we have conducted permeability tests, moisture content and density determinations on the soil samples supplied by your office.

The results of our tests are listed below.

Boring ID	Depth (ft.)	Moisture Content (%)	Dry Unit Weight (pcf)	Permeability at 20°C (cm/sec)
17-9-36CC	118	28	98.0	$7.0x10^{-11}$
	123	26	96.0	$3.5x10^{-11}$
	132	24	100.9	$1.5x10^{-9}$
77-8-23CC	121	27	98.8	$1.3x10^{-8}$
	121A			$1.8x10^{-8}$ *
	128	27	95.0	$7.7x10^{-10}$
	137	23	106.8	$4.2x10^{-10}$
81-23.5-1.5CC	149	28	95.9	$1.7x10^{-7}$ **
	155	22	104.8	$8.7x10^{-9}$
	155A			$1.1x10^{-8}$ *
	161	24	99.4	$1.1x10^{-9}$
81-52.5-16.5CC	119	27	99.9	$2.4x10^{-9}$
	125	24	105.5	$1.1x10^{-9}$
	132	27	94.1	$.4x10^{-10}$

86-4.5-39.5CC	141	30	96.2	$1.1x10^{-9}$
	146	28	95.7	$2.0x10^{-9}$
	153	21	104.4	$8.3x10^{-10}$

* Indicates the results of a second permeability test to verify relatively high permeability valves as compared to values obtained from the other samples tested.

** Upon completion of the permeability test and extraction of this sample from the testing device it was observed that large voids between the sample and the testing ring were present. These voids will have an increasing effect on the permeability values. A second attempt was made to prepare a suitable sample but was unsuccessful due to the quantity of calcareous nodules present in the sample.

The permeability testing device utilizes a testing ring of 1.50" inside diameter and 1.0" height. The samples were hand trimed to a size slightly larger than the testing ring. The testing ring along with its matching cutting blade was then pushed into the soil sample. This ensures a tight fit between the soil sample and the ring while minimizing any disturbance of the sample. The test ring with the sample was inserted into the permeability test device with precautions taken so that no volume change of the sample would occur during the test. A vacuum pump was used to evacuate and saturate the sample and test apparatus. The flow of demineralized water through the sample was kept in a steady state by use of a high pressure water supply tank (constant head). For the samples submitted the pressure in the water supply tank was maintained at 125 pounds per square inch.

Using the valves obtained from the tests the coefficient of permeability was computed using the following equation.

$$K = \frac{QL}{thA}$$

Where K= coefficient of permeability
Q= total quantity of water which flowed through the sample in elapsed time t.
t= elapsed time
h= total head
A= area of sample
L= Thickness of sample

The coefficient of permeability was corrected to 20C by multiplying K by the ratio of the viscosity of water at test temperature to the viscosity of water at 20C.

$$K_{20C} = K \frac{U_T}{U_{20C}}$$

If you have any further questions or if we can be of further assistance in this matter please contact us at your convenience.

Respectfully submitted,

SHILSTONE ENGINEERING TESTING
LABORATORY, INC.

Gerald E. Henderson
Staff Engineer

Thomas F. Mullin
Branch Manager

TFM/GEH/ds

SIEVE ANALYSES

(SEE FIGURE 2 FOR CORE HOLE LOCATIONS)

CORE #81-28-7.5C

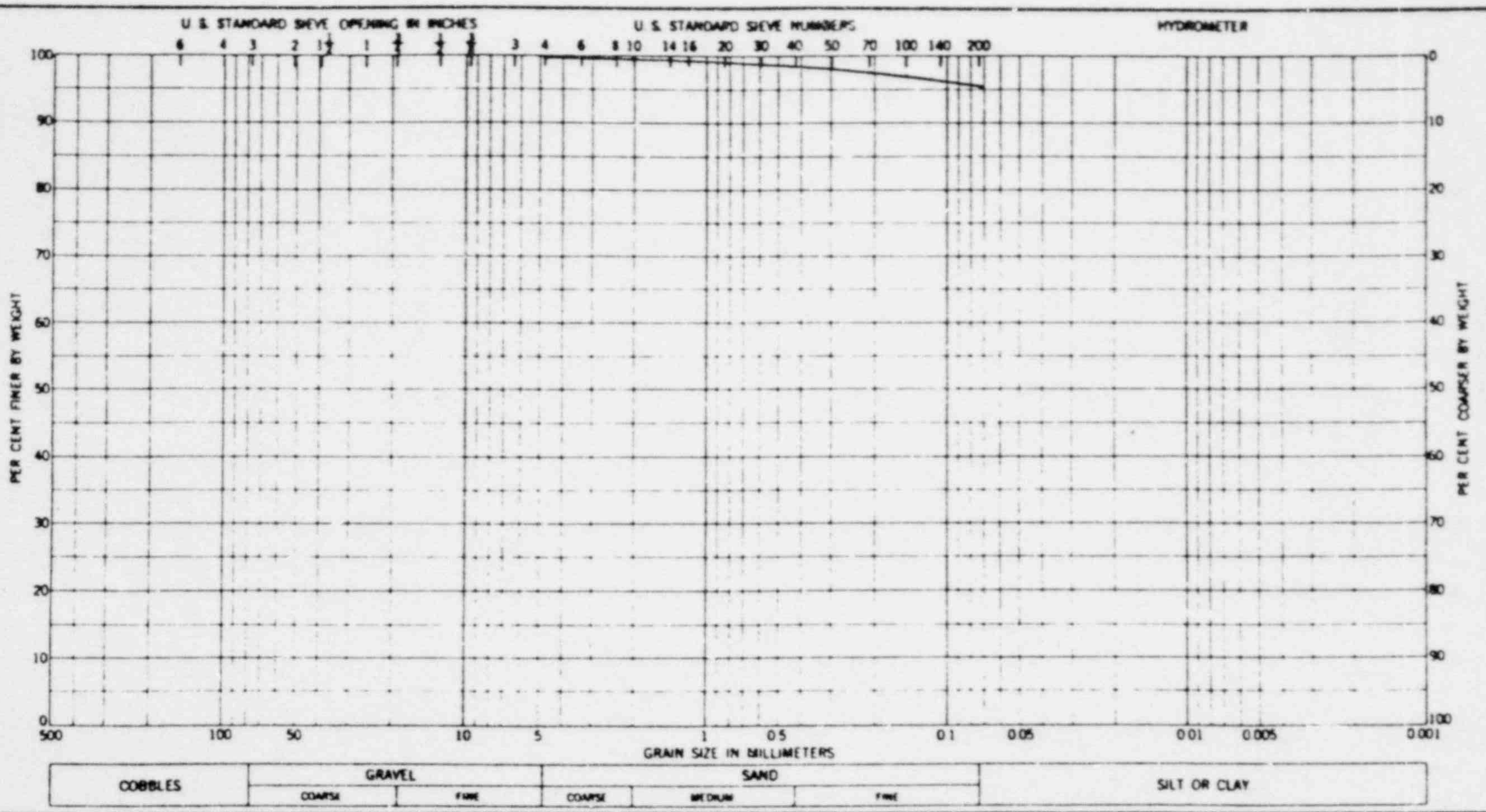
Sample Depth	Sieve Size	% Passing
163'	# 4	100.0
	# 16	98.3
	# 30	97.9
	# 60	97.7
	# 100	96.9
	# 200	95.2

Classification: Gray clay (CH)

CORE #78-3-15.5C

Sample Depth	Sieve Size	% Passing
146'	# 200	100

Classification: Gray clay (CH)



Boring No	Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
81		163'	Gray clay (CH)				

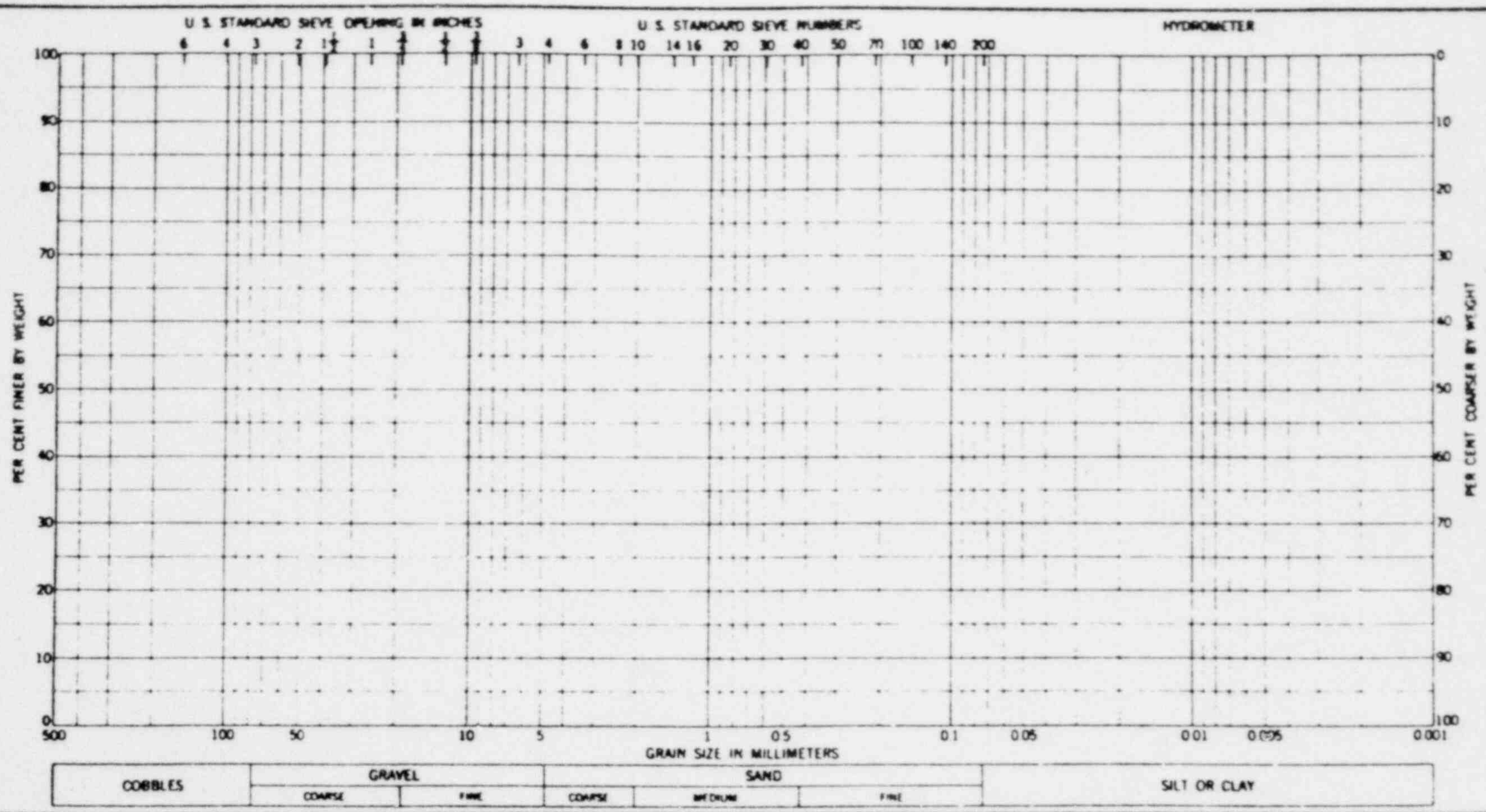
Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M



Boring No	Sample No	Elev. or Depth	Classification	Nat w %	LL	PL	PI
78		146'	Gray clay (CH)				

Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M

APPENDIX B

APPENDIX B

OVERBURDEN PERMEABILITY

SUBSURFACE EXPLORATION

OVERBURDEN PILE AND PIT AREA

RHODE RANCH SITE

MCMULLEN COUNTY, TEXAS

FOR

ED L. REED AND ASSOCIATES, INC.

SUITE 315 OIL INDUSTRIES BLDG.

UPPER NORTH BROADWAY

326-05028

SUBSURFACE EXPLORATION

OVERBURDEN PILE AND PIT AREA

RHODE RANCH SITE

MCMULLEN COUNTY, TEXAS

INTRODUCTION

General

A study of subsurface conditions in the area of the Anaconda Copper Company - Rhode Ranch site was authorized by Mr. G.R. Davis of Anaconda Copper Company on February 17, 1980. The purpose of this investigation has been to determine subsurface materials and conditions in the referenced area.

Scope of Work

The following anlaysis was performed in connection with the preparation of this report.

1) Core borings were drilled in order to:

   a. Determine subsurface materials present at this site.
   b. Obtain samples of subsurface materials for laboratory analysis.

2) Samples of subsurface materials from the borings were analyzed in the laboratory by:

   a. Visual examination and classification.
   b. Atterberg limits tests.
   c. Minus No. 200-mesh sieve tests.
   d. Unit dry weight and moisture content tests.
   e. Falling head permeability tests.

SUBSURFACE EXPLORATION

Subsurface materials at the site were explored by three soil borings located on the overburden pile and by four samples taken directly from the pit. The borings taken on the overburden pile range in depth from 16.0 to 19.0 feet below the ground surface. Samples taken inside the pit range in depth from 32.0 to 48.0 feet below the ground surface. Boring locations were directed in the field by Mr. Bob Hill of Anaconda Copper Company. An approximate boring location sketch as well as a general site plan has been included in the Appendix of this report.

The soil borings were performed with a drilling rig equipped with a rotary head. Conventional hollow stem augers were used to advance the holes. Undisturbed samples of the subsurface materials were obtained from the borings by thin-wall, seamless steel, [illegible] tube samplers. All samplers of subsurface materials were extracted and classified in the field. Samples were identified according to boring number and depth and wrapped in aluminum foil. The samples were coated with paraffin in order to minimize moisture changes. All samples were then placed in core boxes and transported to the laboratory for tests and further study.

LABORATORY TESTING

Selected samples of subsurface materials from the borings were examined and classified in the laboratory. Atterberg limits tests and minus No. 200 mesh sieve test were performed on these samples to establish index properties and grain size characteristics and to aid in proper classification of the materials. Results of the classification tests are shown by the summary on attached Plate

III. These classifications refer to the "Unified Soil Classification System".

Existing conditions of the soils were investigated by moisture content test and unit dry weight on the selected samples. Results of these tests are shown on the attached Logs of Borings.

The permeabilities of selected samples of subsurface materials were investigated by falling head permeability tests in the laboratory. The samples were placed in a confining ring in the permeameters and subjected to a confining pressure to seal off the contact plane between the sample and the ring. The sample was allowed to saturate before the test was performed. Upon saturation, water was allowed to flow through the sample and measurements were taken periodically until an average permeability coefficient was obtained. Depending on the permeability of the sample, the head on the water was generally increased using a closely controlled air pressure in order to reduce the test time and get a measurable flow of water through the sample and a small diameter precisely marked pipette. Details regarding the moistures and densities of the samples, and the permeability coefficients are shown on attached Plate IV.

SUBSURFACE MATERIALS AND CONDITIONS

Specific types and depths of subsurface materials encountered in the sample locations are shown on the attached Logs of Borings. In the overburden pile, subsurface materials encountered from the ground surface down generally consisted of 2.5 to 5.0 feet of yellow sand, 11.0 to 14.0 feet of yellow green clay and .0 to 3.0 of sand and caliche.

In the pit area, samples No. 1 and 2 consisted of a yellow-green clay while No. 3 contained a yellow sandy clay. No groundwater was encountered in any of the borings.

Results of the permeability tests indicated that all soil types encountered in the borings had permeability coefficients ranging from a low of 4.8×10^{-9} cm/sec to a high of 2.4×10^{-7} cm/sec.

Results of all tests performed are included on the following pages.

Respectfully submitted,

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

Dexter Bacon, E.I.T.
Geotechnical Branch Manager

Garland Burch, P.E.
Regional Engineer

STATE OF TEXAS
GARLAND L. BURCH
38126
REGISTERED
PROFESSIONAL ENGINEER

DB:GB/ic

APPENDIX

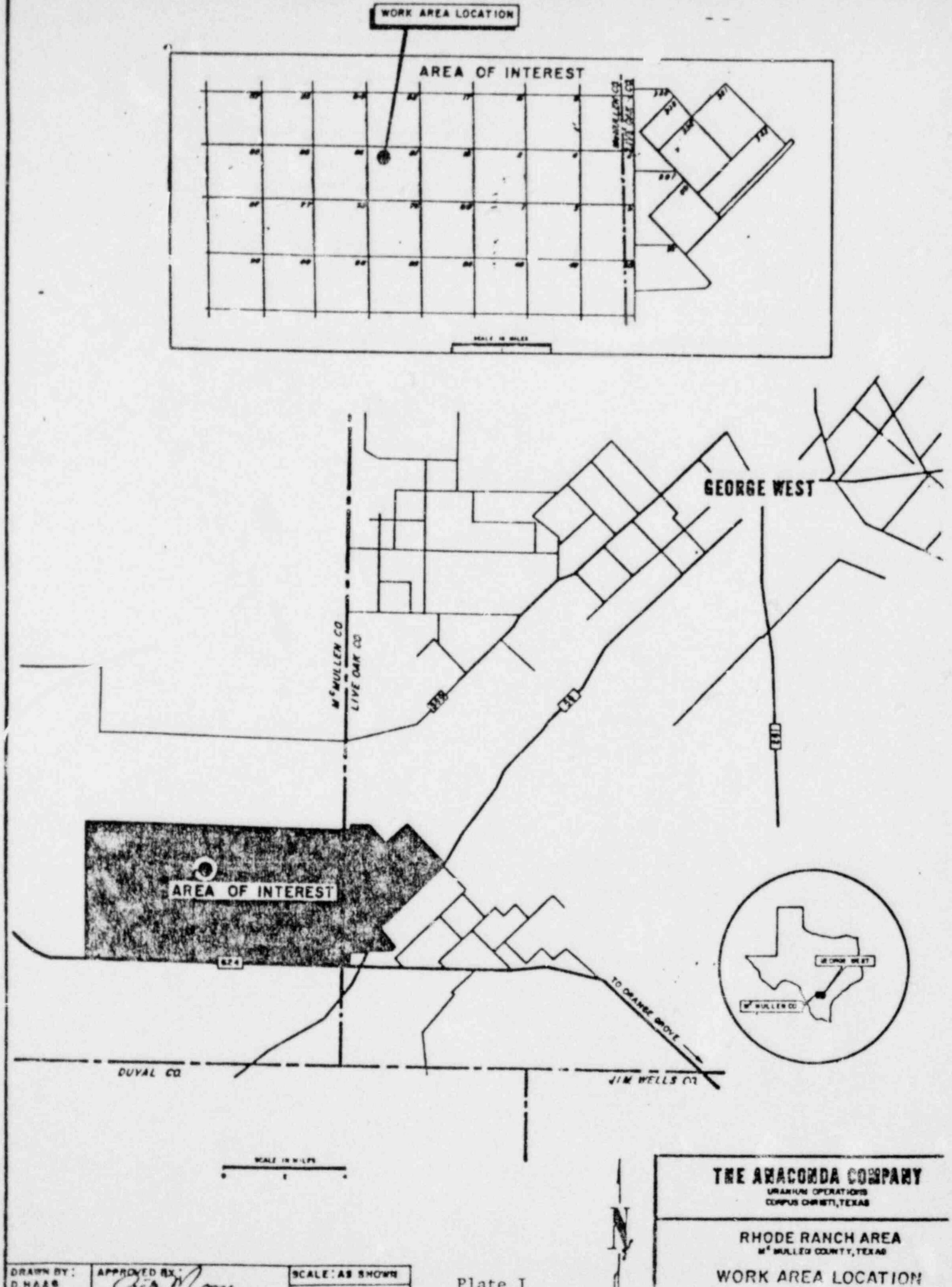

WORK AREA LOCATION
AREA OF INTEREST
GEORGE WEST
McMULLEN CO
LIVE OAK CO
AREA OF INTEREST
624
TO ORANGE GROVE
DUVAL CO.
JIM WELLS CO.
GEORGE WEST
McMULLEN CO
THE ANACONDA COMPANY
URANIUM OPERATIONS
CORPUS CHRISTI, TEXAS
RHODE RANCH AREA
McMULLEN COUNTY, TEXAS
WORK AREA LOCATION
DRAWN BY: D.HAAS
APPROVED BY:
SCALE: AS SHOWN
N

Plate I

APPROXIMATE BORING LOCATIONS

RHODE RANCH SITE
OVERBURDEN PILE AND PIT AREA

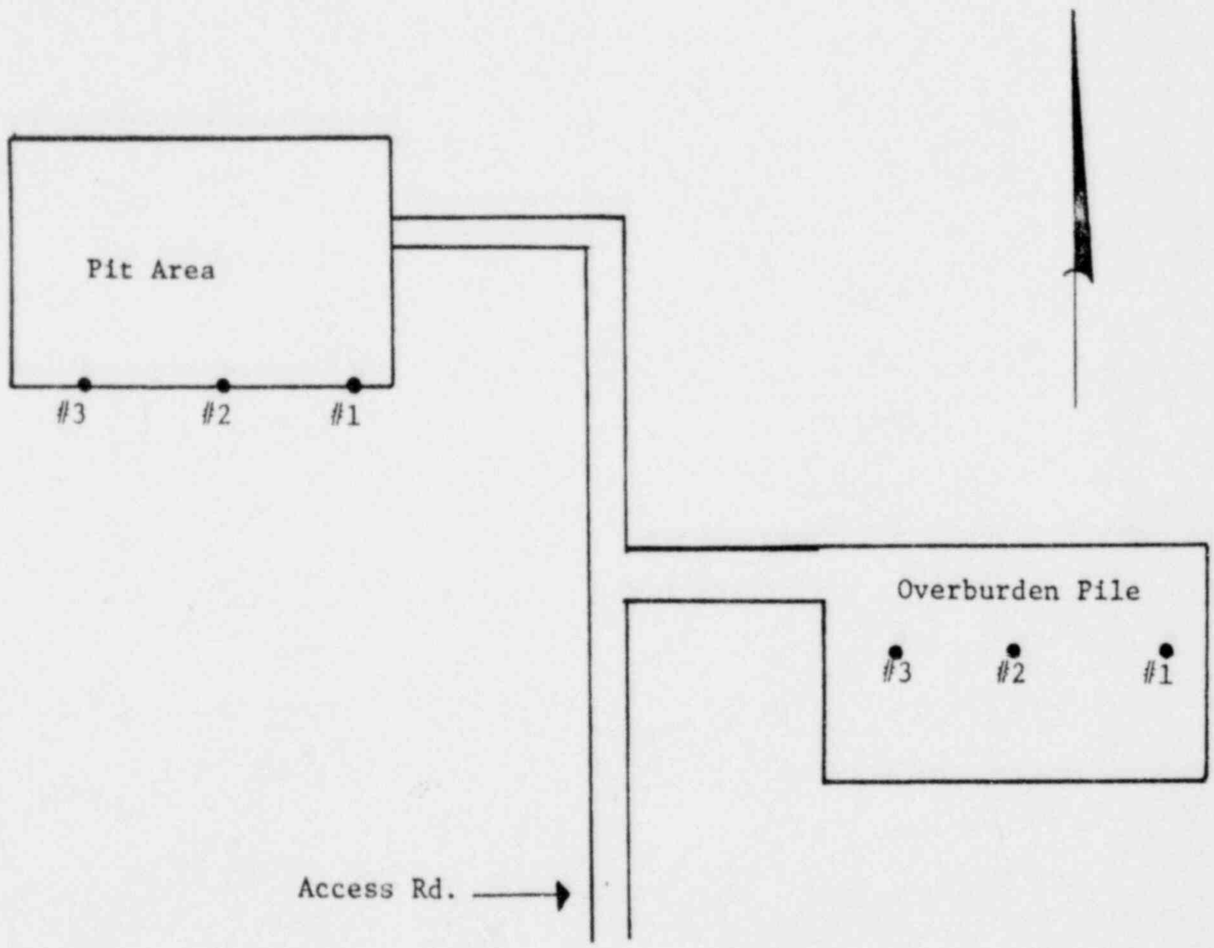


Plate II

OVERBURDEN PILE AND PIT AREA

RHODE RANCH SITE

MCMULLEN COUNTY TEXAS

SUMMARY OF CLASSIFICATION TESTS

Boring No.	Depth in Feet	Liquid Limit %	Plasticity Index %	% Passing #200 Mesh Sieve	Unified Soil Classification	Description
1	4.5 - 6.0	74	50	71.6	CH	Tan clay
1	9.0 - 10.5	47	29	74.7	CL	Tan sandy clay
2	6.0 - 7.0	93	64	96.1	CH	Tan clay
2	10.0 - 11.0	58	35	86.5	CH	Tan clay
3	5.0 - 6.0	56	32	77.8	CH	Tan clay
3	10.0 - 11.0	60	40	79.2	CH	Tan clay
Pit #1	0 - 1.0	57	35	84.6	CH	Yellow-green clay
Pit #1	1.0 - 1.5	65	38	89.6	CH	Yellow-green clay
Pit #2	0 - 1.0	65	43	79.8	CH	Yellow-green clay
Pit #3	0 - 1.0	27	13	51.0	CL	Yellow sandy clay
3	4.0 - 5.0	33	18	42.0	SC	Yellow clayey sand

326-05028

OVERBURDEN PILE AND PIT AREA

RHODE RANCH SITE

MCMULLEN COUNTY TEXAS .

SUMMARY OF FALLING HEAD PERMEABILITY RESULTS

Boring No.	Depth(ft)	% Moisture Before	Moisture After	Unit Dry Weight(p.c.f.)	Average Permeability(cm/sec)
1	4.5 - 6.0	23.4	31.7	99.8	1.9×10^{-9}
1	9.0 - 10.5	12.8	18.6	113.3	2.8×10^{-9}
2	6.0 - 7.0	26.3	29.4	100.2	4.8×10^{-9}
2	10.0 - 11.0	17.5	25.7	111.3	2.8×10^{-9}
3	5.0 - 6.0	25.0	--	116.0	----
3	10.0 - 11.0	17.4	--	108.0	2.4×10^{-7}
Pit# 1	0 - 1.0	24.8	--	97.0	1.1×10^{-8}
Pit# 1	1.0 - 1.5	24.3	--	101.1	3.1×10^{-8}
Pit# 2	0 - 1.0	24.5	--	--	6.0×10^{-9}
Pit# 3	0 - 1.0	9.9	--	119.0	3.8×10^{-7}
3	4.0 - 5.0	14.8	17.5	111.0	4.0×10^{-8}

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

326-05028

LOG OF BORING
FOR
Overburden Pile and Pit Area
Rhode Ranch Site
McMullen County, Texas

BORING NO Overburden#1 DATE 3-5-80

ELEV FEET	SOIL DESCRIPTION	DEPTH FEET	SAMPLE TYPE	N BLOWS PER FOOT	UNC. COMP STRENGTH T.S.F.	MOISTURE %	UNIT DRY WEIGHT P.C.F.
	SURFACE						
	Yellow sand with clay pockets		ST				
	Yelow clay and sandy clay		ST				
	Yellow-green clay with intermittent thin sand lenses and caliche		ST				
		5				23.4	99.8
			ST				
			ST				
			ST				
	*Encountered boulder @ 10.5 feet	10	ST			12.8	113.3
			*				
	Caliche becoming more prevalent		ST				
			ST				
		15	ST				
	Boring terminated @ 16.0 feet.						
		20					

TYPE OF SAMPLE
D. — DISTURBED
S.T. — SHELBY TUBE
S.S. — SPLIT SPOON
R.C. — ROCK CORE
( ) — PENETROMETER

REMARKS:
All samples are fill materials.
Groundwater not encountered

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT FT
G.W. AFTER COMPLETION FT
G.W. AFTER HRS. FT

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

326-05028

LOG OF BORING
FOR

Overbuden Pile and Pit Area
Rhode Ranch Site
McMullen County, Texas

BORING NO Overburden#2 DATE 3-5-80

ELEV. FEET	SOIL DESCRIPTION	DEPTH FEET	SAMPLE TYPE	N BLOWS PER FOOT	UNC. COMP. STRENGTH T.S.F.	MOISTURE %	UNIT DRY WEIGHT P.C.F.
	SURFACE						
	Yellow clayey sand with clay pockets and lenses		ST				
			ST				
	Green and yellow clay with intermittent sand lenses, gypsum, and caliche		ST				
			ST				
			ST				
		5	ST				
			ST			26.3	100.2
			ST				
			ST				
		10	ST				
			ST			17.5	111.3
			ST				
			ST				
			ST				
		15	ST				
			ST				
			ST				
	Gray sand, with green clay and caliche		ST				
			ST				
	Boring terminated @ 19.0 ft.	20	ST				

TYPE OF SAMPLE
D. — DISTURBED
S.T. — SHELBY TUBE
S.S. — SPLIT SPOON
R.C. — ROCK CORE
( ) — PENETROMETER

REMARKS:

All samples are fill material.
No groundwater encountered

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT FT
G.W. AFTER COMPLETION FT
G.W. AFTER HRS FT

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

326-05028

LOG OF BORING
FOR

Overburden Pile and Pit Area
Rhode Ranch Site
McMullen, County, Texas

BORING NO. Overburden#3 DATE 3-5-80

ELEV. FEET	SOIL DESCRIPTION	DEPTH FEET	SAMPLE TYPE	N BLOWS PER FOOT	UNC. COMP STRENGTH T.S.F.	MOISTURE %	UNIT DRY WEIGHT P.C.F.
	SURFACE						
	Yellow medium to coarse clayey sand, small yellow green clay pockets		ST				
			ST				
			ST				
			ST				
		5	ST				
	Yellow-green clay with intermittent sand lenses, traces of gypsum		ST			25.0	116.0
			ST				
			ST				
			ST				
	Sand lens @ 9 to 10 feet	10	ST				
			ST			17.4	108.0
			ST				
			ST				
			ST				
		15	ST				
			ST				
	Brown sand, same clay and gypsum		ST				
	Sandy caliche, same clay and sandy clay		ST				
	Virgin soil		ST				
	Boring terminated @ 19.0 feet	20					

TYPE OF SAMPLE
D. — DISTURBED
S.T. — SHELBY TUBE
S.S. — SPLIT SPOON
R.C. — ROCK CORE
( ) — PENETROMETER

REMARKS:

End of fill @ 18.5 feet depths.
No groundwater ecountered

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT FT.
G.W. AFTER COMPLETION FT.
G.W. AFTER HRS. FT.

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

326-05028

LOG OF BORING
FOR

Overburden Pile and Pit Area
Rhode Ranch Site
McMullen, County, Texas

BORING NO Pit Samples DATE 3-5-80

ELEV. FEET	SOIL DESCRIPTION	DEPTH FEET	SAMPLE TYPE	N BLOWS PER FOOT	UNC. COMP. STRENGTH T.S.F.	MOISTURE %	UNIT DRY WEIGHT P.C.F.
	SURFACE						
	Pit Sample #1 (32 feet below surface)						
	Yellow-green clay	0	ST			24.8	97.0
		2	ST			24.3	[illegible]1.0
	Pit Sample #2 (41 feet below surface)						
	Yellow -green clay	0 1	ST			24.5	
	Pit sample #3 (48 feet below surface)						
	Yellow sandy clay	0 1	ST			9.9	119.0

TYPE OF SAMPLE
D. — DISTURBED
S.T. — SHELBY TUBE
S.S. — SPLIT SPOON
R.C. — ROCK CORE
( ) — PENETROMETER

REMARKS:

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT FT.
G.W. AFTER COMPLETION FT.
G.W. AFTER HRS. FT.

SAMPLE DESCRIPTION

CLIENT Anaconda

LOCATION Rhode Ranch

DATE March 6, 1980

WELL NUMBER

ELEVATION

S.W.L.

CASING

PERFORATIONS

DRILLER

INTERVAL	DESCRIPTION by V.S. Reed	POROSITY
Pit #1		
0-1	32' below surface. Yellow-green clay.	
1-2	Yellow-green clay.	
Pit #2		
0-1	41' below surface. Yellow-green clay.	
Pit #3		
0-1	48' below surface. Yellow clayey sand and sandy clay.	

ED L. REED & ASSOCIATES, INC.
CONSULTING HYDROLOGISTS
MIDLAND-CORPUS CHRISTI, TEXAS

CLIENT Anaconda

LOCATION Rhode Ranch

DATE March 5, 1980

WELL NUMBER Overburden #1

ELEVATION

S.W.L.

CASING

PERFORATIONS

DRILLER

INTERVAL	DESCRIPTION by V.S. Reed	POROSITY
0-1 1/2	Yellow sand with yellow clay near 0, 8" Rec.	
1 1/2 -3	Top yellow clay, bottom sandy clay 1' Rec.	
3-4 1/2	3-4 yellow-green clay, moist, 4-4 1/2 yellow medium sand w/green clay rind 12" Rec.	
4 1/2-6	4 1/2 - 5 1/2 mostly yellow-green clay, some sand, 5 1/2 - 6 green clay, minor sand, caliche	
6-7 1/2	6-7 yellow silty clay, some sand, 7 - 7 1/2 gray clay, dry	
7 1/2-9	7 1/2 - 8 1/2 yellow-green clay, little silt, 8 1/2 - 9 gray silty clay	
9-10 1/2	9-10 yellow green clay, silty, 10-10 1/2 gray silty clay	
10 1/2-12	Lost sample	
12-13	11" Rec. 12-12 1/2 yellow green silty clay, 12 1/2 - 13 gray sand and sandy clay	
13-14	10" Rec. 13-13 1/2 green-yellow clay, 13 1/2-14 gray sand with caliche, silty	
14-15	10" Rec. yellow-green clay and silty clay with caliche at 15	
15-16	Gray-green clay with caliche	

SAMPLE DESCRIPTION

CLIENT Anaconda

LOCATION Rhode Ranch

DATE March 5, 1980

WELL NUMBER Overburden #2

ELEVATION

S.W.L.

CASING

PERFORATIONS

DRILLER

INTERVAL	DESCRIPTION by V.S. Reed	POROSITY
0-1	Yellow clayey sand with pockets of clay 10" Rec.	
1-2	10" Rec. yellow clayey medium sand	
2-3	12" Rec. 2-2 1/2 as above, 2 1/2-3 yellow clay	
3-4	11" Rec. 3-3 1/4 medium yellow sand, 3 1/4-4 green-yellow clay, minor gypsum	
4-5	9" Rec. 4-4 1/2 yellow clayey sand to sandy clay, 4 1/2-5 yellow gray clay	
5-6	9" Rec. 5-5 1/4 yellow green clay, 5 1/4-6 yellow medium sand	
6-7	10" Rec. yellow green clay*, 1" medium sand at 7	
7-8	12" Rec. 7-7 1/2 yellow green clay with gypsum, 1" medium sand at 7 1/2, 7 1/2-8 yellow green clay, small sand pockets (1")	
8-9	10" Rec. 8-8 1/2 yellow green clay, 8 1/2-9 mottled yellow and gray clay with gypsum, minor silt	
9-10	11" Rec. yellow-green clay with gypsum and small sand pockets	
10-11	10" Rec. 10-10 3/4 yellow green clay, 10 3/4 - 11 yellow and gray silty clay with gypsum	
11-12	10" Rec. yellow green clay, 1" gray medium sand at 12	
12-13	10" Rec. 12 - 12 3/4 yellow green clay, 12 3/3-13 gray clayey sand	
13-14	11" Rec. 13-13 1/2 gray sand and yellow clay, 13 1/2-14 gray-green clay, some sand	
14-15	11" Rec. gray clayey sand	
15-16	11" Rec. 15-15 1/2 gray-green clay, 15 1/2-16 gray-green clay and gray sand	
16-17	11" Rec. gray & yellow-green clay, minor sand pockets*	
17-18	10" Rec. gray sand, with green clay and caliche	
18-19	12" Rec. 18-18 1/2 green-yellow clay, 18 1/2-19 sandy caliche	

SAMPLE DESCRIPTION

CLIENT Anaconda

LOCATION Rhode Ranch

DATE March 5, 1980

WELL NUMBER Overburden #3

ELEVATION

S.W.L.

CASING

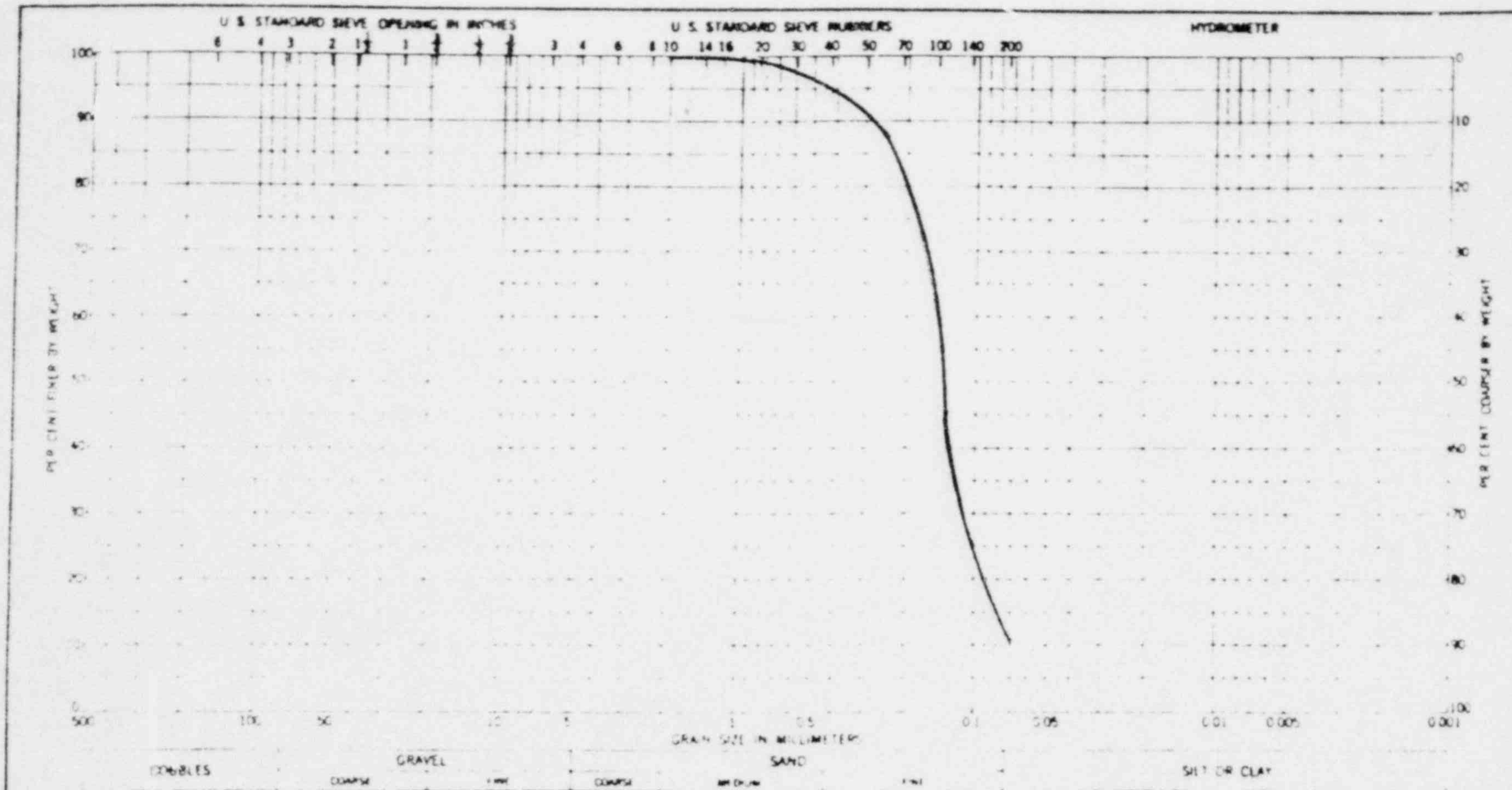
PERFORATIONS

DRILLER

INTERVAL	DESCRIPTION by V.S. Reed	POROSITY
0-1	Medium-coarse clayey sand, yellow, 13" Rec.	
1-2	As above, 12" Rec.	
2-3	As above, 13" Rec.	
3-4	13" Rec. as above with small yellow-green clay pockets	
4-5	13" Rec. 4 - 4 1/2 clayey eyllow sand, 4 1/2 - 5 yellow and gray clay, minor gypsum	
5-6	10" Rec. yellow-green clay	
6-7	12" Rec. 6-6 3/4 clayey yellow sand, 6 3/4 - 7 yellow green clay with gypsum	
7-8	12" Rec. yellow-green clay with abundant gypsum, gray sand 7-7 1/4	
8-9	10" Rec. yellow sandy clay 8-8 3/4, 8 3/4 - 9 yellow green clay with gypsum	
9-10	12" Rec. gray clayey sand with gypsum. Pockets gray green clay	
10-11	10" Rec. yellow-green clay and sandy clay. Hard gray sand at 11	
11-12	12" Rec. yellow-green clay 11-11 3/4, gray sand 11 3/4 - 12	
12-13	11" Rec. yellow-green clay and sandy clay with gypsum, gray sand at 13	
13-14	11" Rec. as above, abundant gypsum	
14-15	10" Rec. yellow-green clay with gypsum near 15	
15-16	12" gray-yellow clay and sandy clay with gypsum	
16-17	11" as above 16-16 1/2, 16 1/2 - 17 brown sand, green-yellow clay and gypsum	
17-18	11" gray sandy caliche with pockets yellow-green gypy clay and sandy clay	
18-19	12" yellow sandy clay, clayey sand 18-18 1/2, 18 1/2 - 19 soil	

SIEVE ANALYSES

(SEE FIGURE 2 FOR CORE HOLE LOCATIONS)



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w	LL	PL	PI
Pit #3			Fine sand (SP)				

REPORT OF SOIL ANALYSIS

Project: Overburden
Pile and Pit Area

File No. 326-05028

Date

378 1M

Plate III

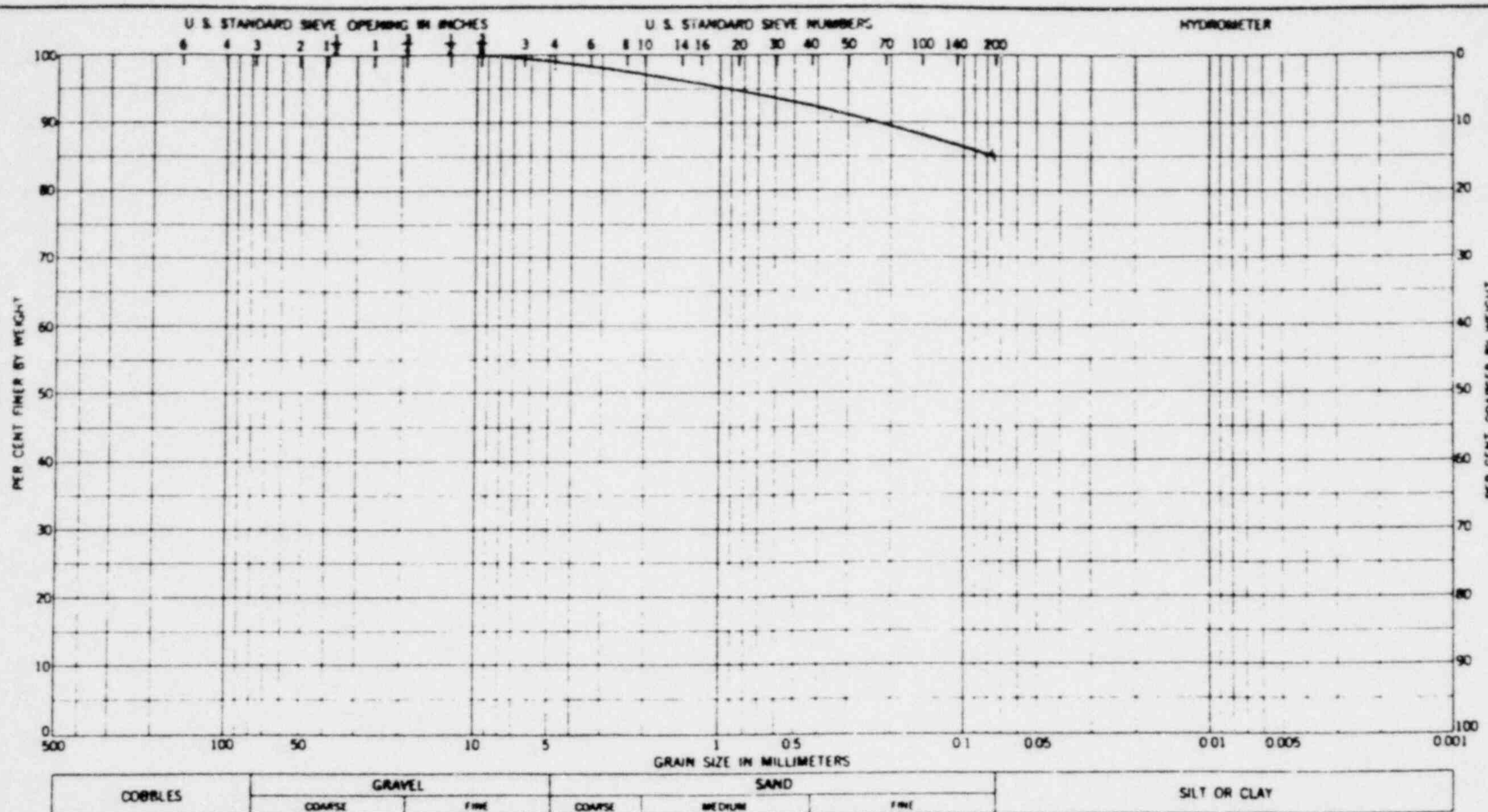
OVERBURDEN PILE

Boring No.	Depth	Sieve Size	% Passing
#1	6-7.5	3/8"	100.0
		# 4	98.1
		# 10	95.5
		# 30	92.2
		# 60	90.2
		# 100	88.8
		# 200	84.9

Classification: Brown clay (CH)

Boring No.	Depth	Sieve Size	% Passing
#1	9.0-9.5	1 1/2"	100.0
		1"	96.0
		3/8"	94.5
		# 10	90.0
		# 30	85.2
		# 60	81.4
		# 100	78.1
		# 200	68.8

Classification: Brown clay with sand lenses (CH)



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
No. 1		6-7.5	Brown clay (CH)				

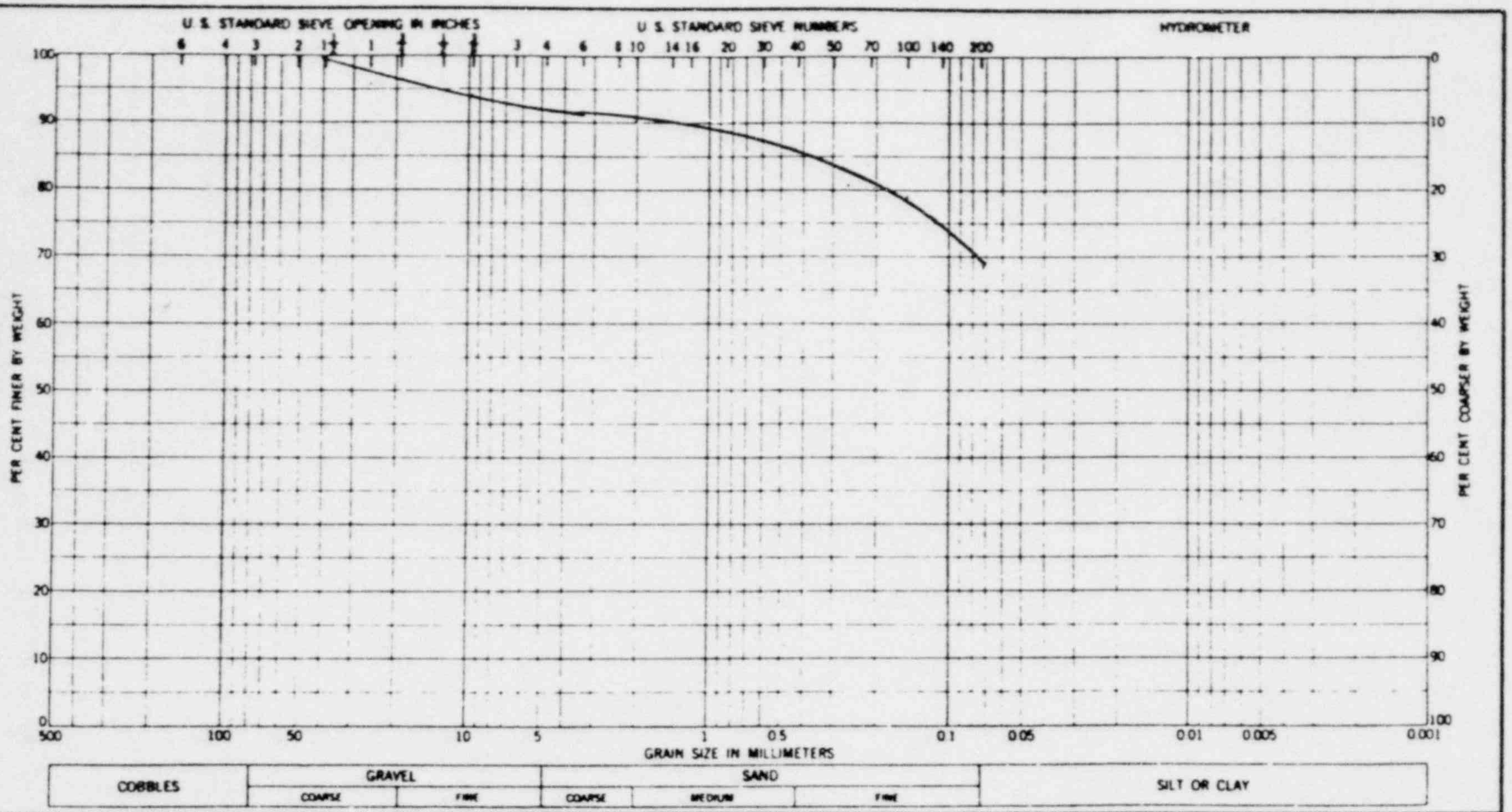
Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
No. 1		9.0-9.5	Brown clay with sand lenses (CH)				

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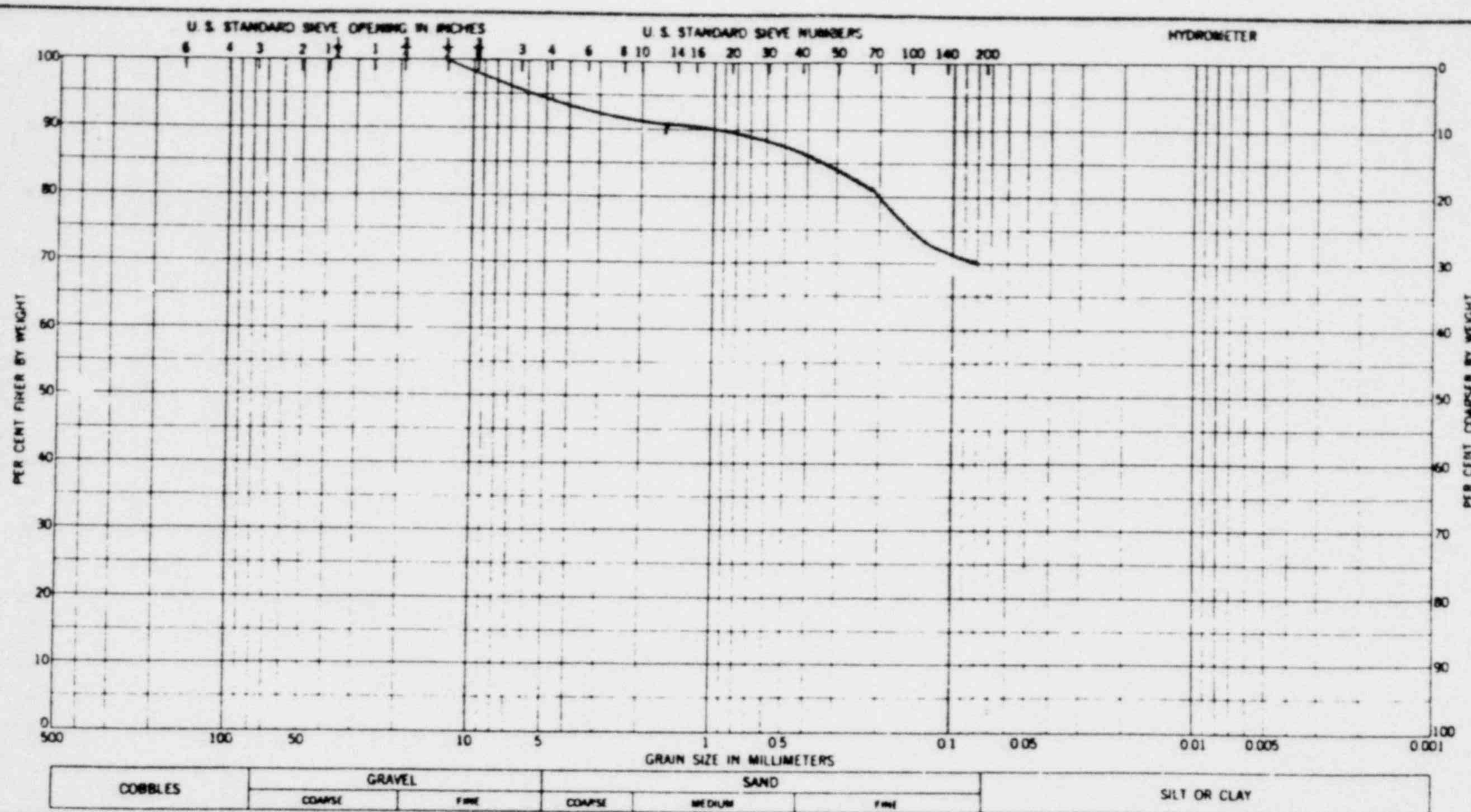
OVERBURDEN PILE

Boring No.	Depth	Sieve Size	% Passing
#2	5.5-6.0	1/2"	100.0
		3/8"	98.9
		# 4	94.6
		# 10	91.7
		# 30	88.4
		# 60	82.6
		# 100	74.4
		# 200	70.1

Classification: Brown clay with sand lenses (CH)

Boring No.	Depth	Sieve Size	% Passing
#2	11-12	1"	100.0
		3/4"	95.4
		# 4	92.6
		# 10	90.3
		# 30	87.9
		# 60	86.4
		# 100	84.4
		# 200	79.5

Classification: Brown clay (CH)



Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
No. 2		5.5-6.0	Brown clay with sand lenses (CH)				

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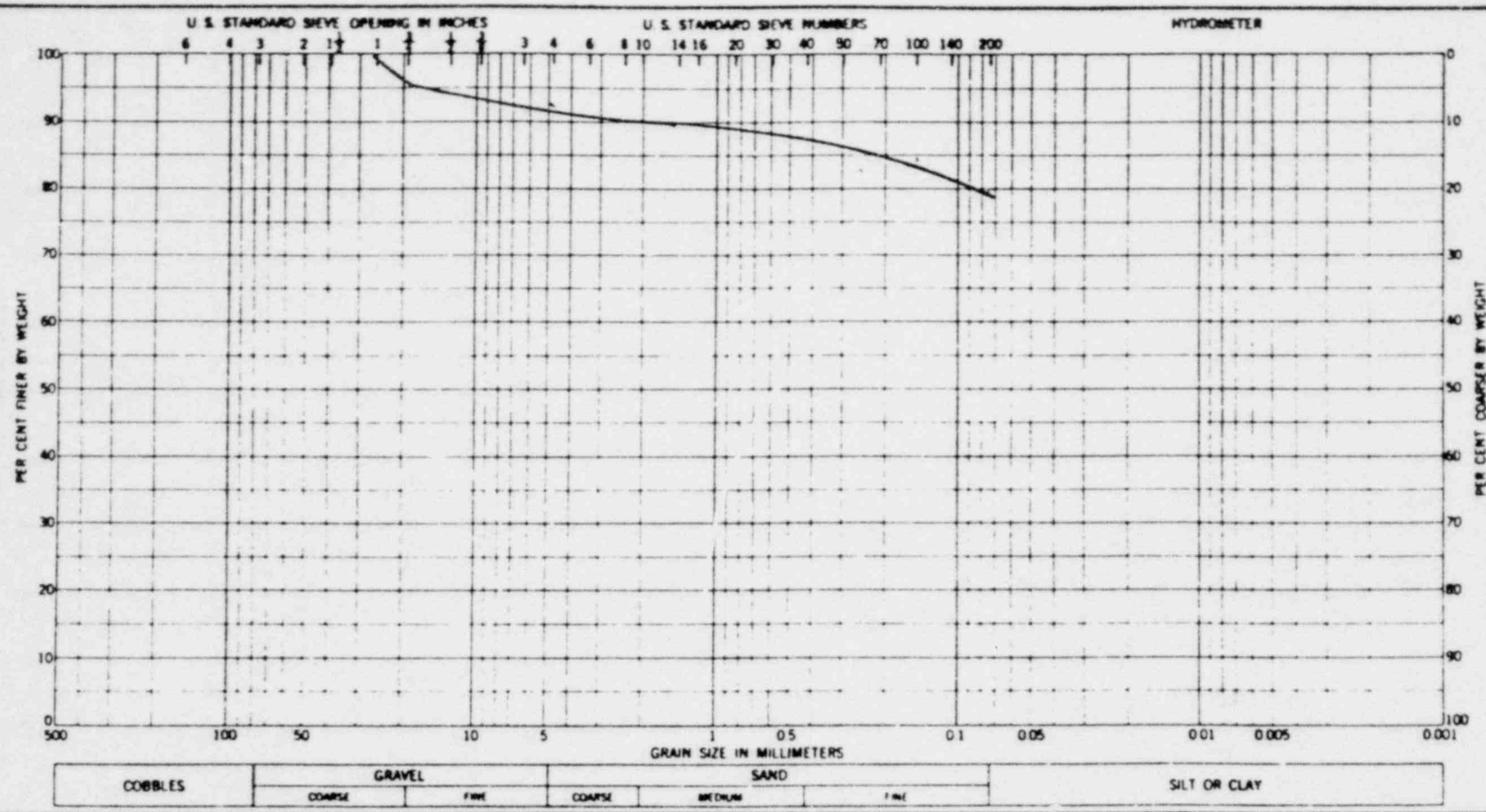

Boring No	Sample No	Elev. or Depth	Classification	Nat w %	LL	PL	PI
No. 2		11-12	Brown clay (CH)				

Project

File No. 326-05053

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REPORT OF SOIL ANALYSIS

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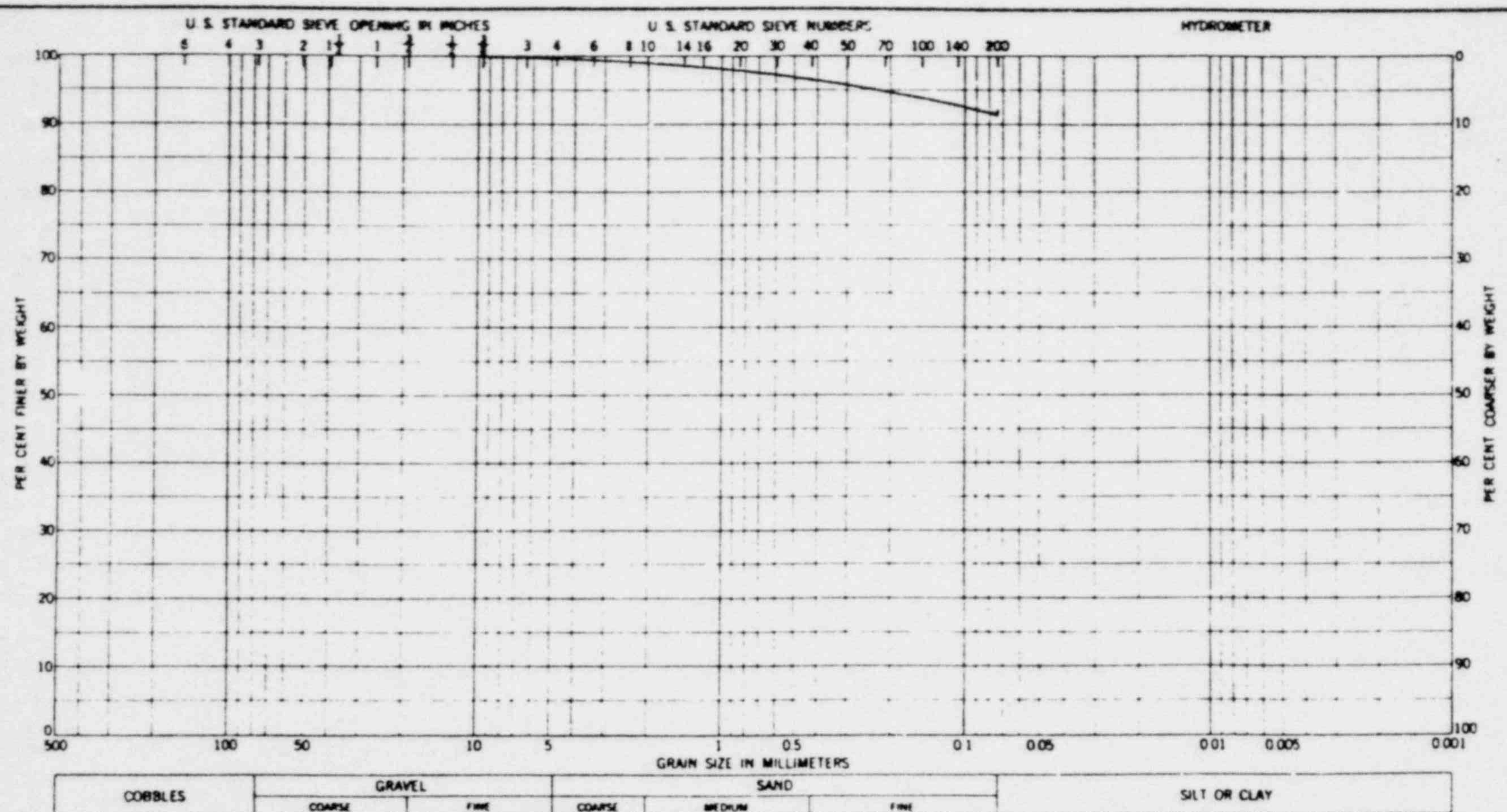
OVERBURDEN PILE

Boring No.	Depth	Sieve Size	% Passing
#3	6-7	3/8"	100.0
		# 4	99.0
		# 16	95.4
		# 30	94.9
		# 200	92.2

Classification: Brown to orange clay (CH)

Boring No.	Depth	Sieve Size	% Passing
#3	9-10	3/8"	100.0
		# 4	97.5
		# 16	93.7
		# 30	92.0
		# 60	89.7
		# 200	85.3

Classification: Light brown clay (CH)



Boring No	Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
No. 3		6-7	Brown to orange clay (CH)				

Project

File No. 26-05053

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REPORT OF SOIL ANALYSIS

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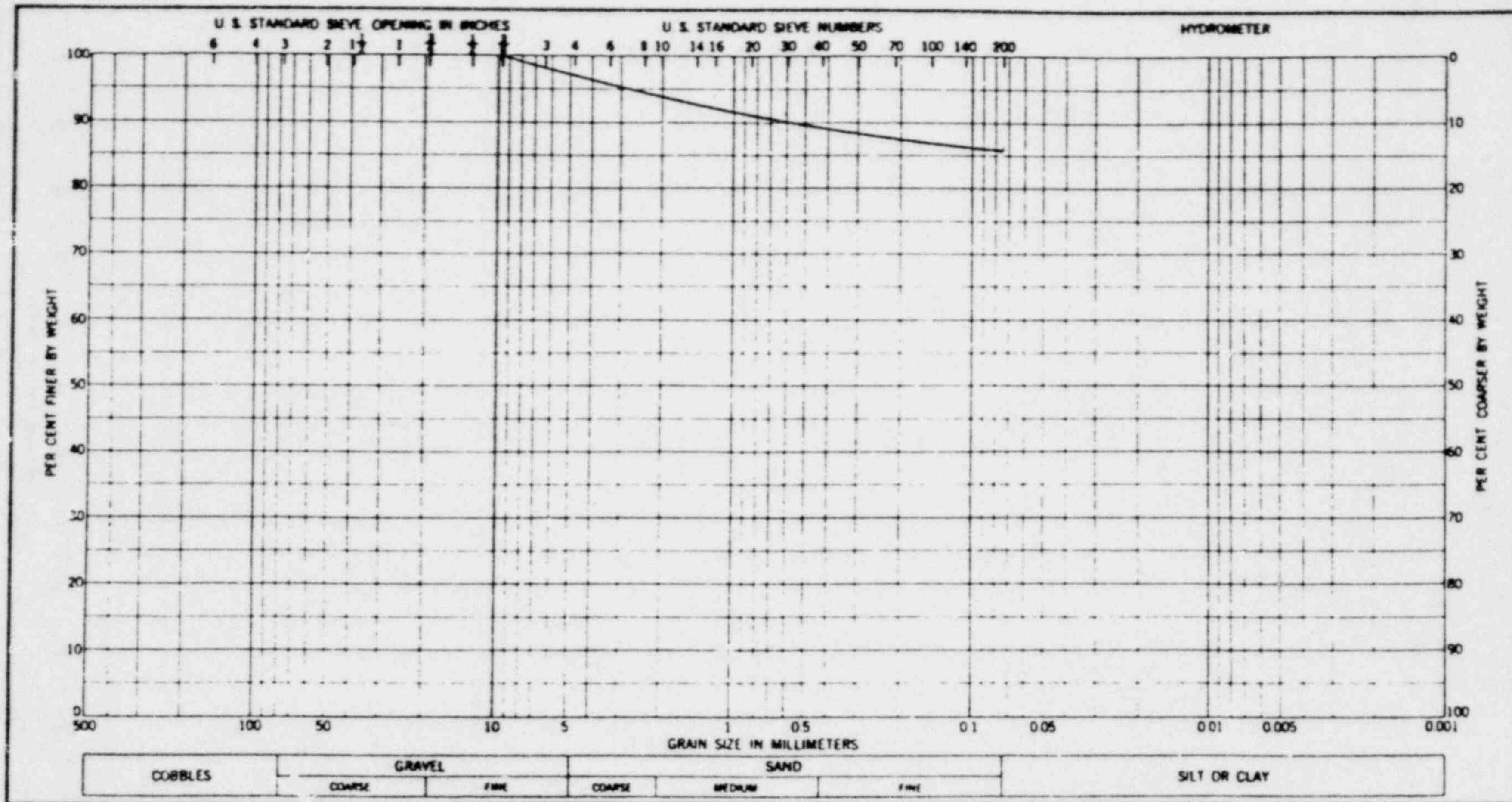

Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
No. 3		9-10	Light brown clay				

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REPORT OF SOIL ANALYSIS

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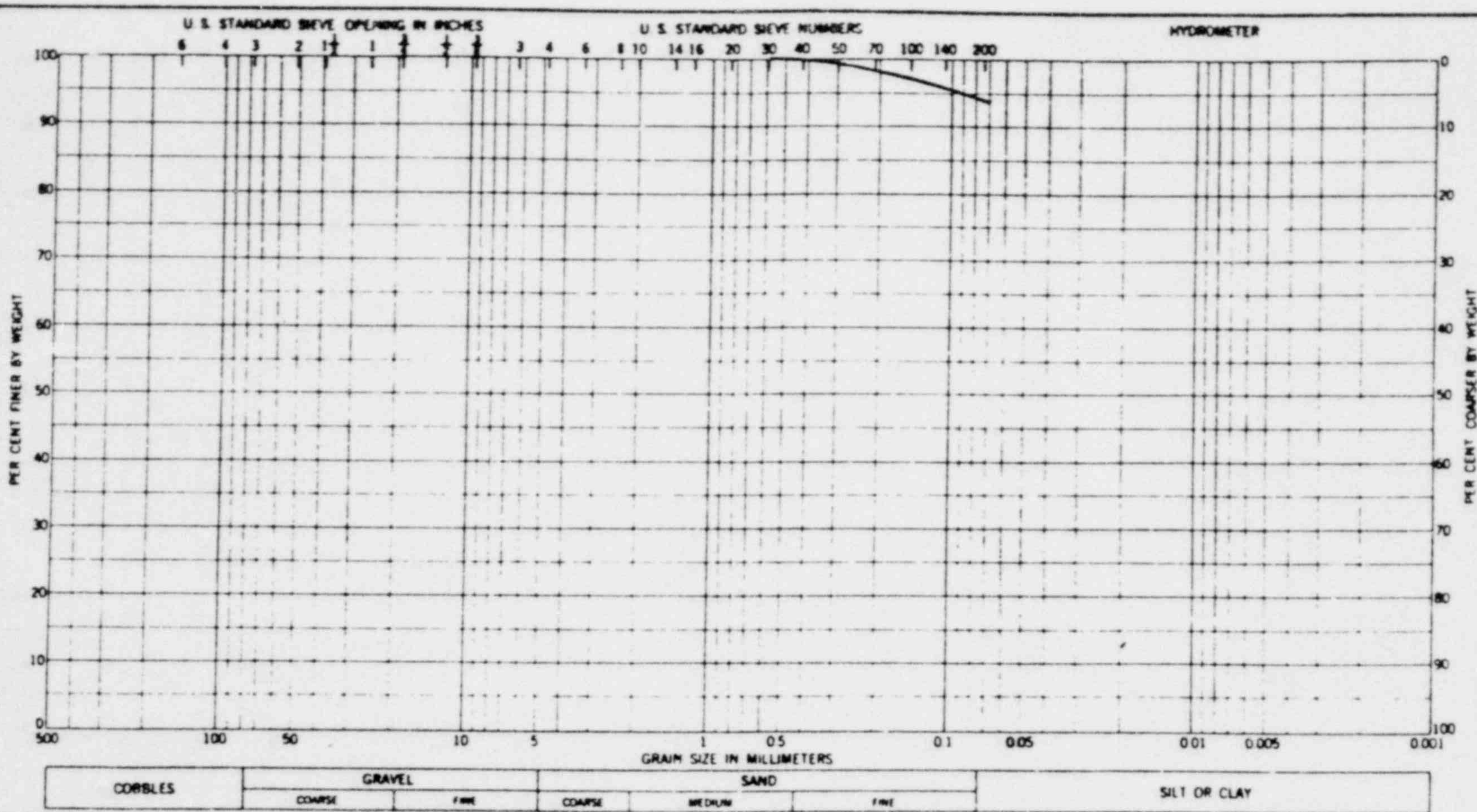
CORE #78-3-15.5C

Sample Depth	Sieve Size	% Passing
15'	# 30	100.0
	# 60	98.6
	# 100	96.8
	# 200	94.1

Classification: Tan clay (CH)

Sample Depth	Sieve Size	% Passing
30'	# 3/8"	100.0
	# 4	97.8
	# 16	96.0
	# 30	95.5
	# 60	94.5
	# 100	92.5
	# 200	89.7

Classification: Tan clay (CH)



Boring No	Sample No	Elev. or Depth	Classification	Nat w %	LL	PL	PI
78		15'	Tan clay (CH)				

Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

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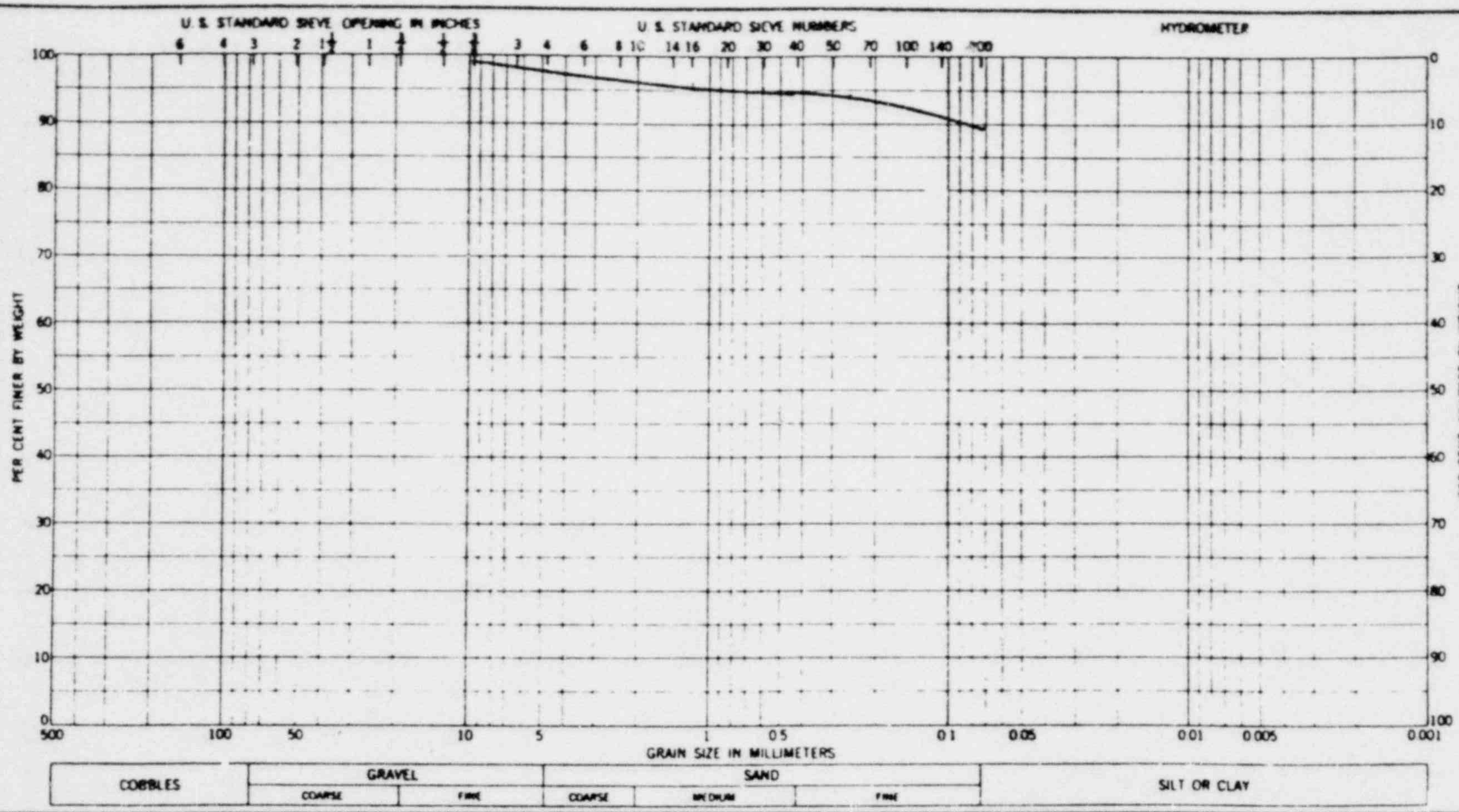

Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
78		30'	Tan clay (CH)				

Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

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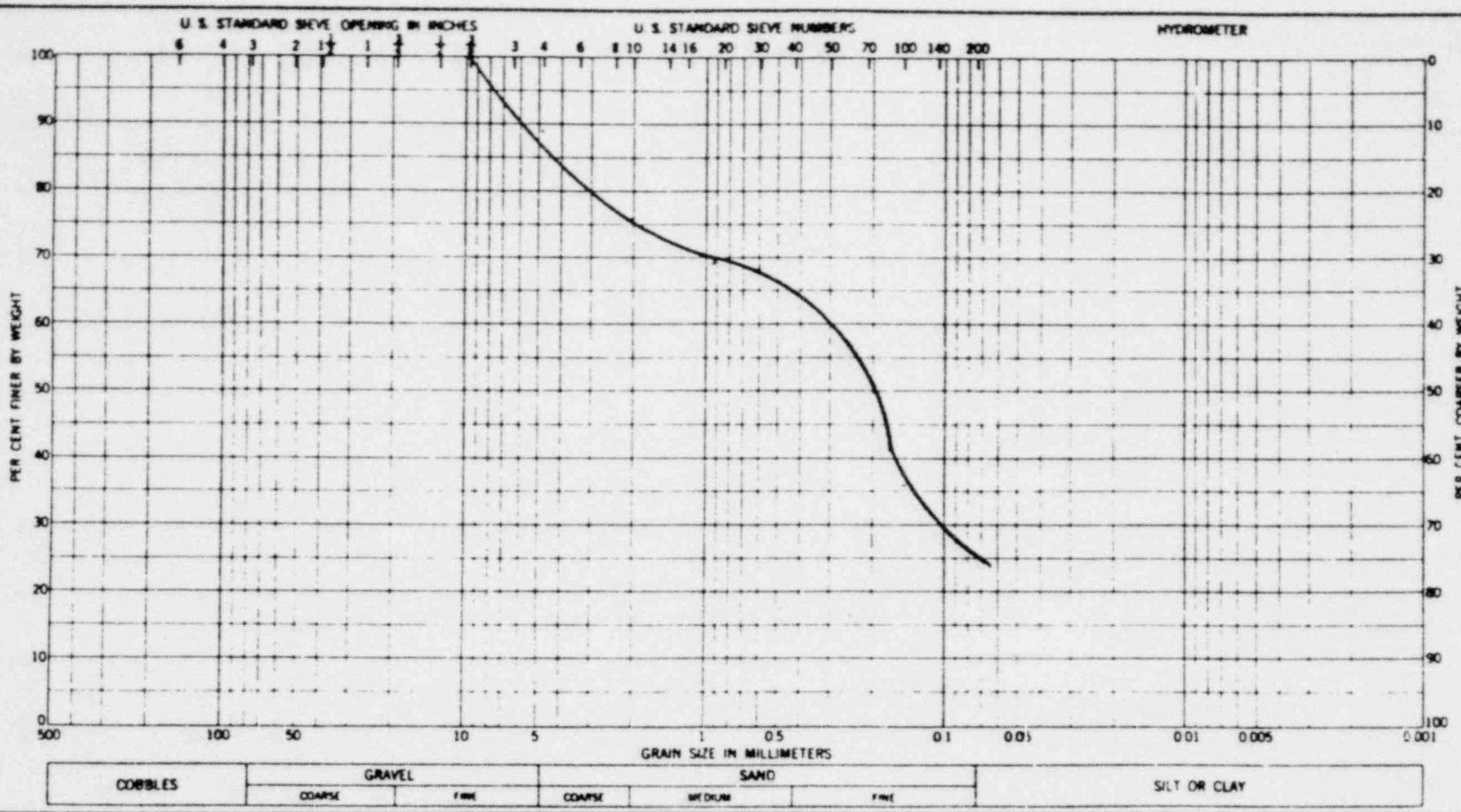
CORE #78-3-15.5C

Sample Depth	Sieve Size	% Passing
45'	3/8"	100.0
	# 4	88.4
	# 10	75.7
	# 30	68.3
	# 60	56.8
	# 100	35.9
	# 200	24.2

Classification: Tan clayey sand (SC)

Sample Depth	Sieve Size	% Passing
60'	1 1/2"	100.0
	3/4"	85.5
	3/8"	75.2
	# 4	63.4
	# 16	56.0
	# 30	52.4
	# 60	49.8
	# 100	46.0
	# 200	37.9

Classification: Clayey gravelly sand (SC)



Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
78		45'	Tan clayey sand(SC)				

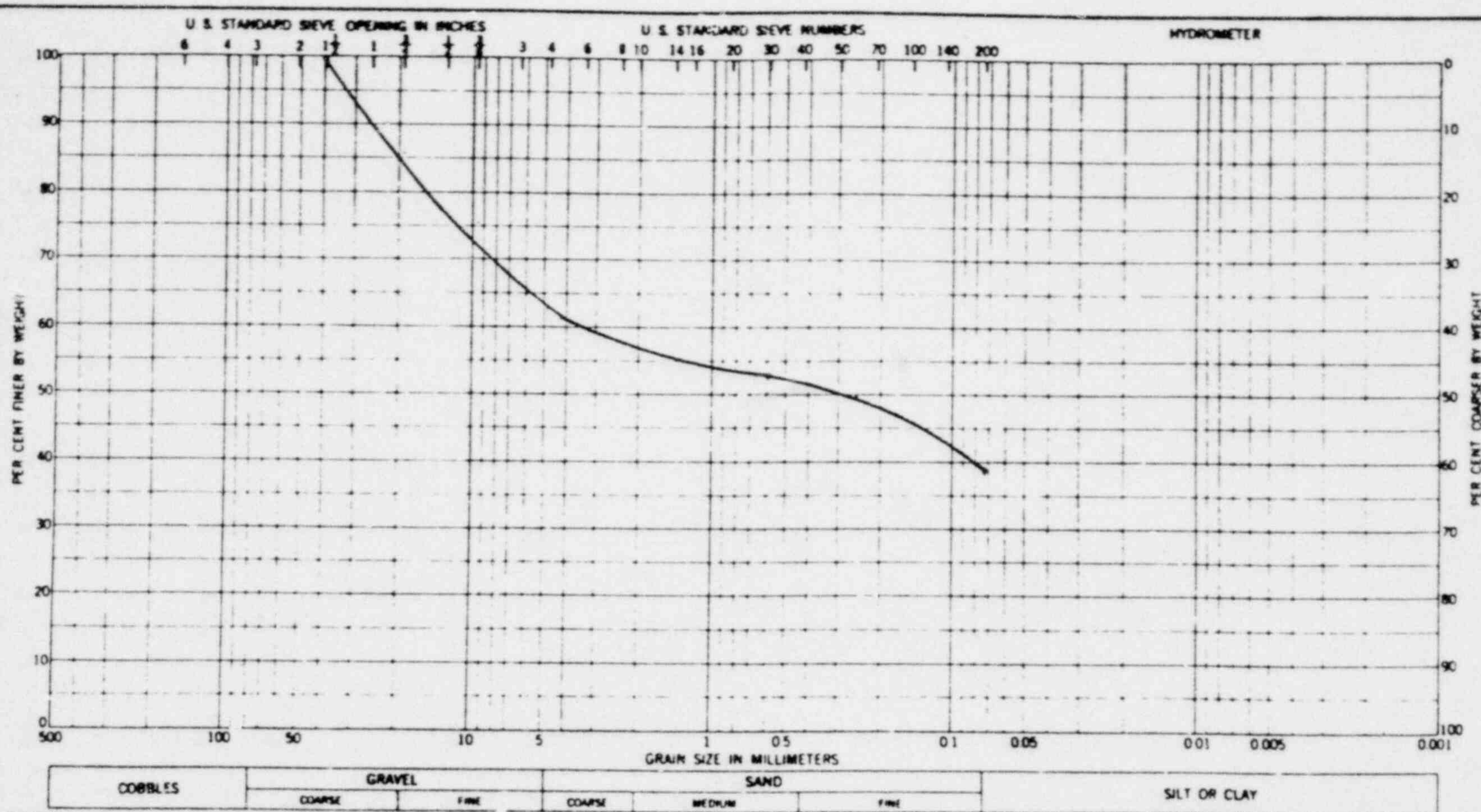
Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M



Boring No	Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
78		60'	Clayey gravelly sand (SC)				

Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M

CORE #78-3-15.5C

Sample Depth	Sieve Size	% Passing
75'	3/8"	100
	# 4	98.8
	# 10	94.2
	# 30	86.2
	# 60	33.4
	# 100	25.4
	# 200	20.0

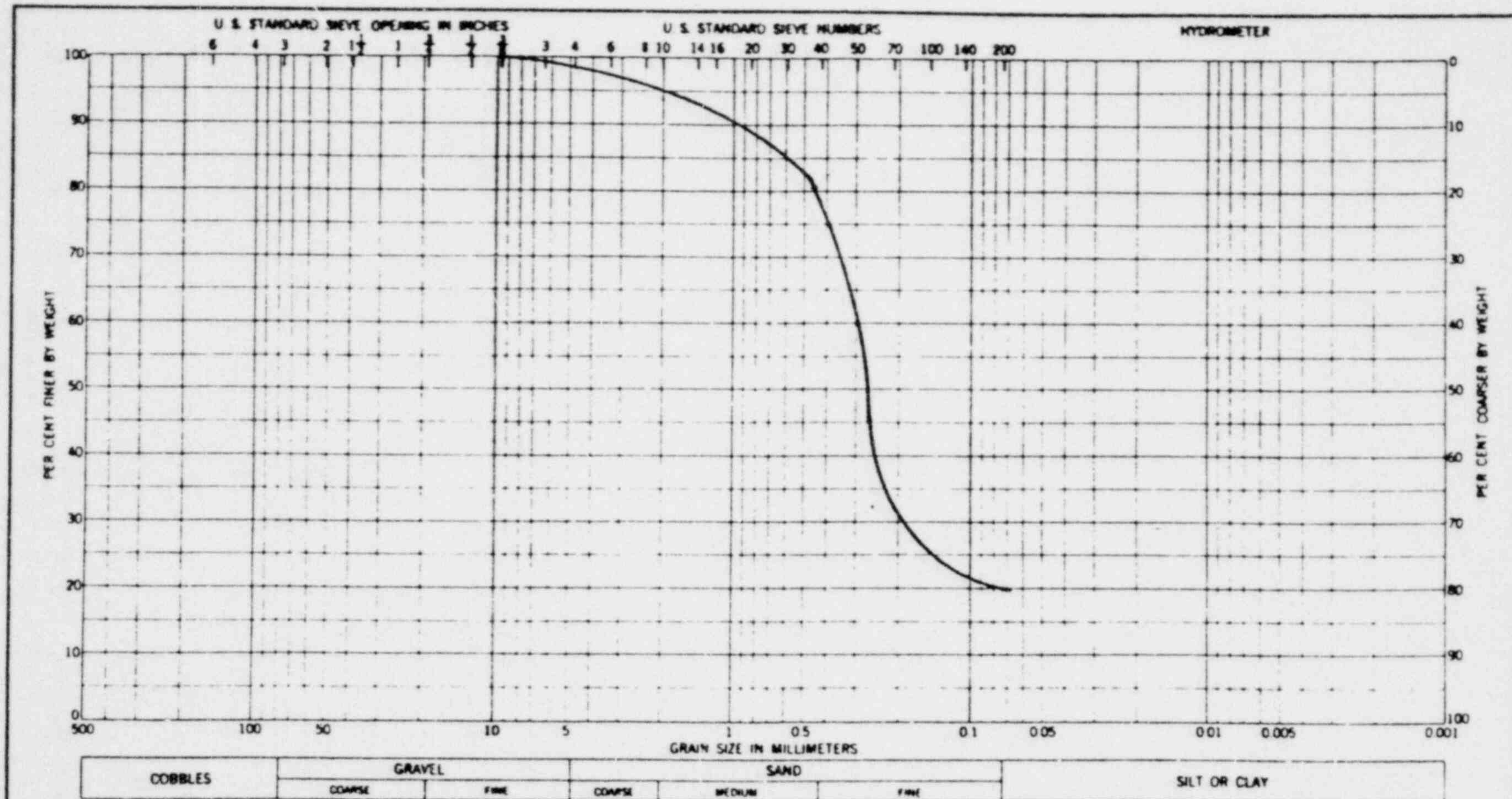
Classification: Fine to medium gray clayey sand (SC)

Sample Depth	Sieve Size	% Passing
90'	# 60	100
	# 100	98.2
	# 200	97.4

Classification: Gray clay (CH)

Sample Depth	Sieve Size	% Passing
105'	# 30	100.0
	# 60	98.7
	# 100	97.9
	# 200	95.6

Classification: Gray clay (CH)



Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
78		75'	Fine to medium gray clayey sand (SC)				

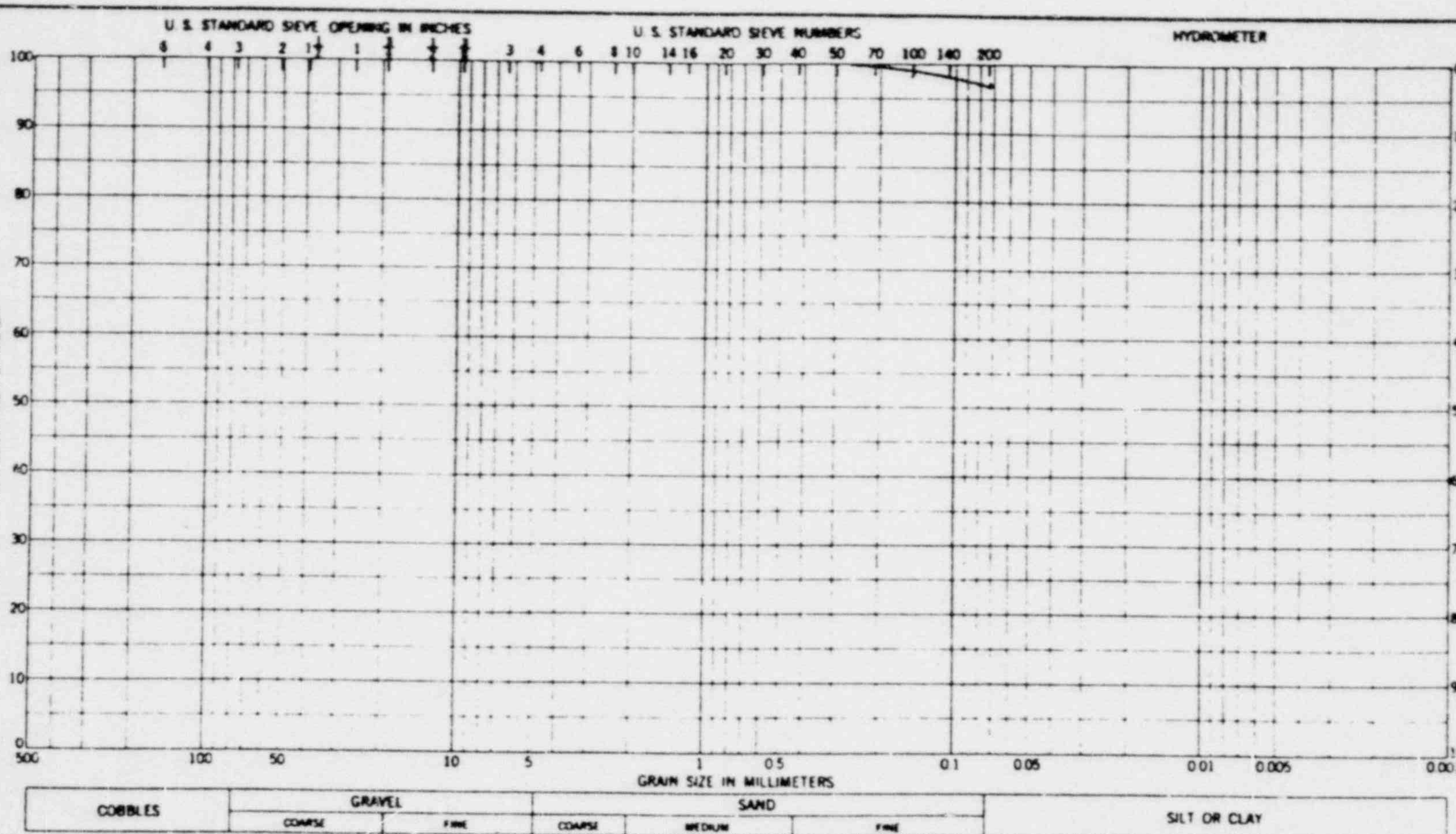
Project

File No 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M



Boring No	Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
78		90'	Gray clay (CH)				

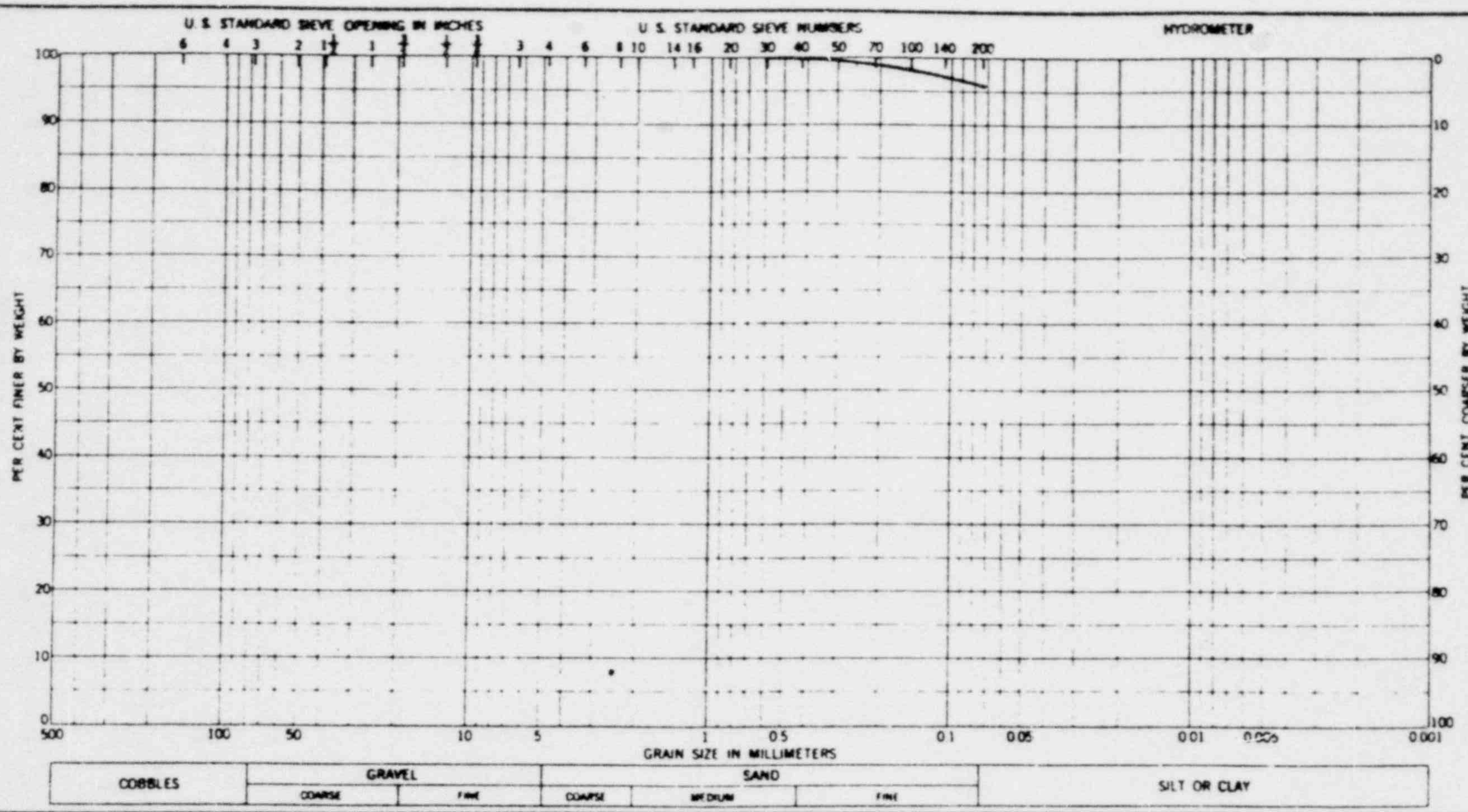
Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
78		105'	Gray clay (CH)				

Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M

CORE #78-3-15.5C

Sample Depth	Sieve Size	% Passing
120'	# 10	100.0
	# 30	99.6
	# 100	99.4
	# 200	99.3

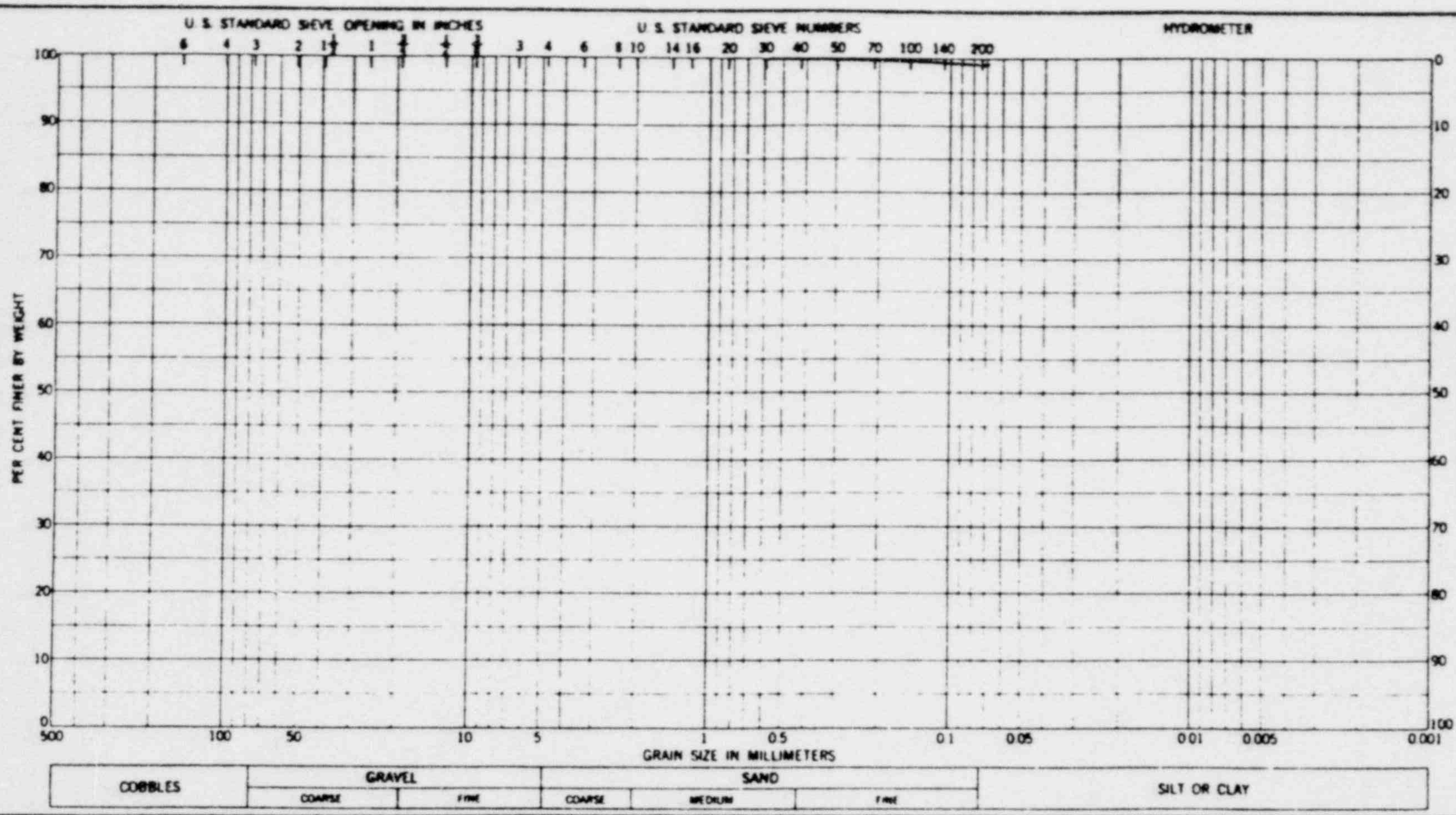
Classification: Gray clay (CH)

Sample Depth	Sieve Size	% Passing
135'	3/8"	100.0
	# 10	79.5
	# 16	67.8
	# 30	53.2
	# 60	31.1
	# 100	10.3
	# 200	6.3

Classification: Gray fine to coarse sand (SW)

Sample Depth	Sieve Size	% Passing
146'	# 200	100

Classification: Gray clay (CH)



Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
78		120'	Gray clay (CH)				

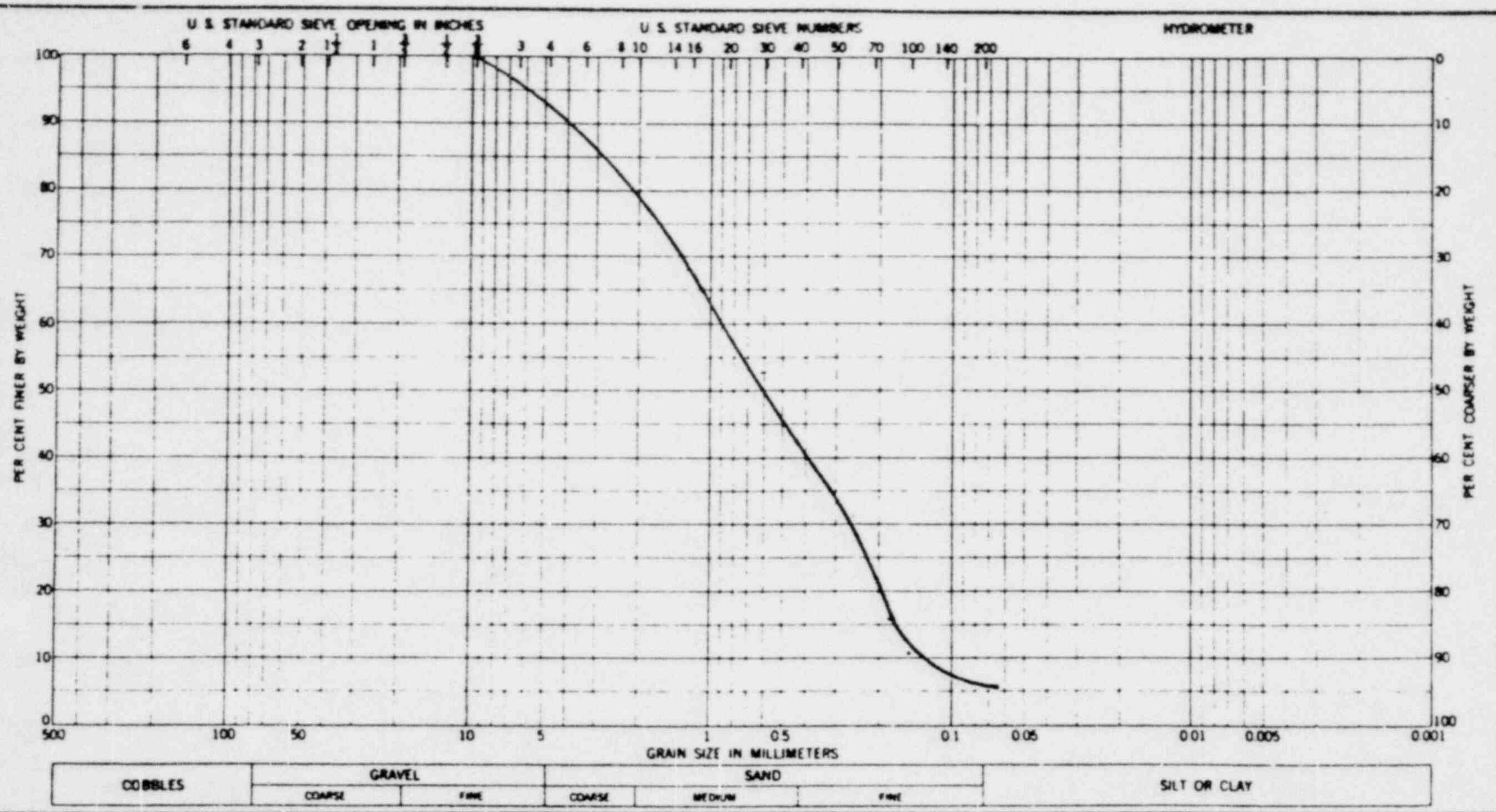
Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M



Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
78		135'	Gray fine to coarse sand (SW)				

Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M

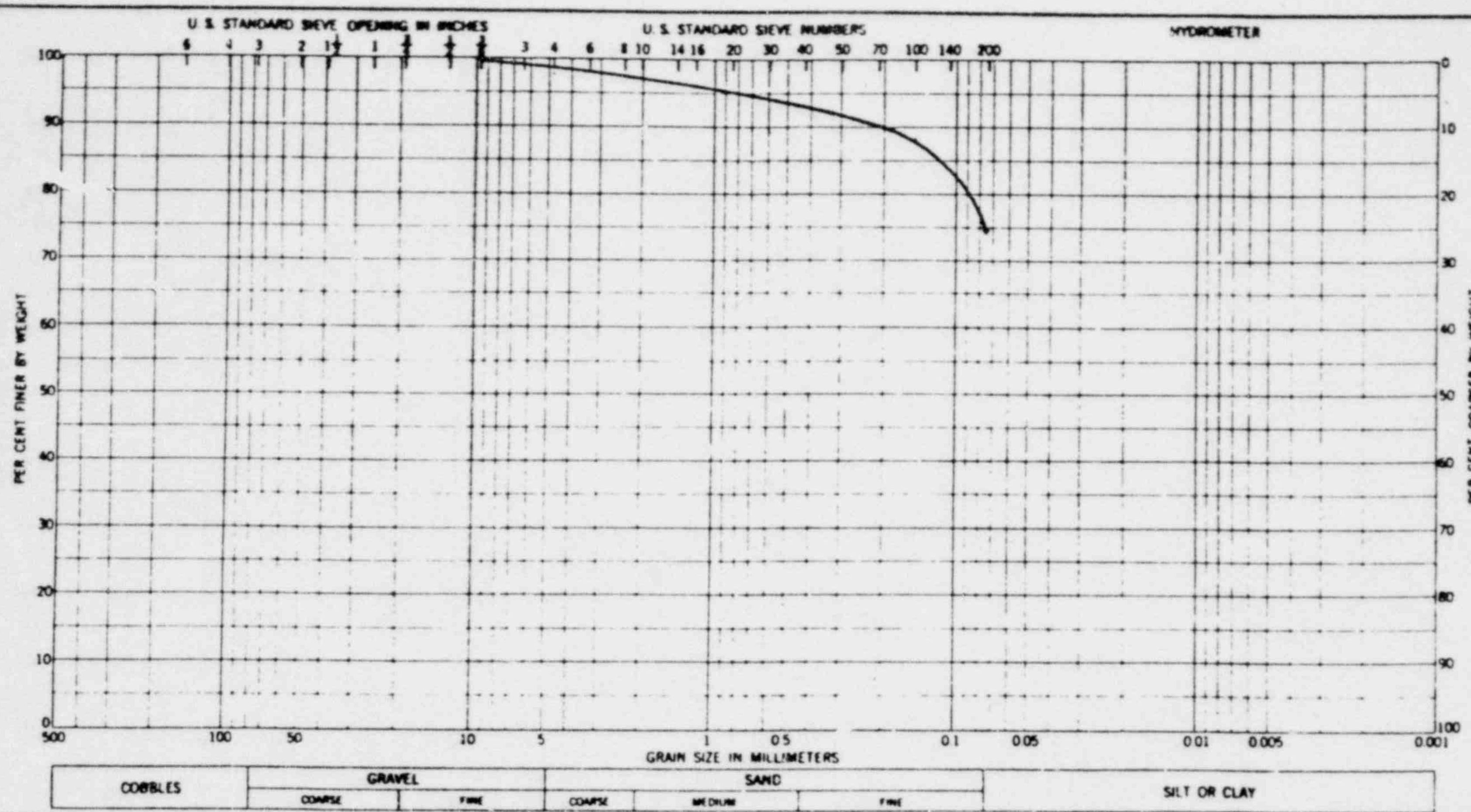
CORE #81-28-7.5C

Sample Depth	Sieve Size	% Passing
15'	3/8"	100.0
	# 4	97.6
	# 16	95.2
	# 30	94.4
	# 60	91.2
	# 100	87.6
	# 200	74.8

Classification: Light gray clay, (CH)

Sample Depth	Sieve Size	% Passing
30'	3/8"	100.0
	# 10	95.1
	# 30	88.2
	# 60	58.2
	# 100	45.4
	# 200	24.5

Classification: Tan fine clayey sand (SC)



Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
81		15'	Light gray clay, (CH)				

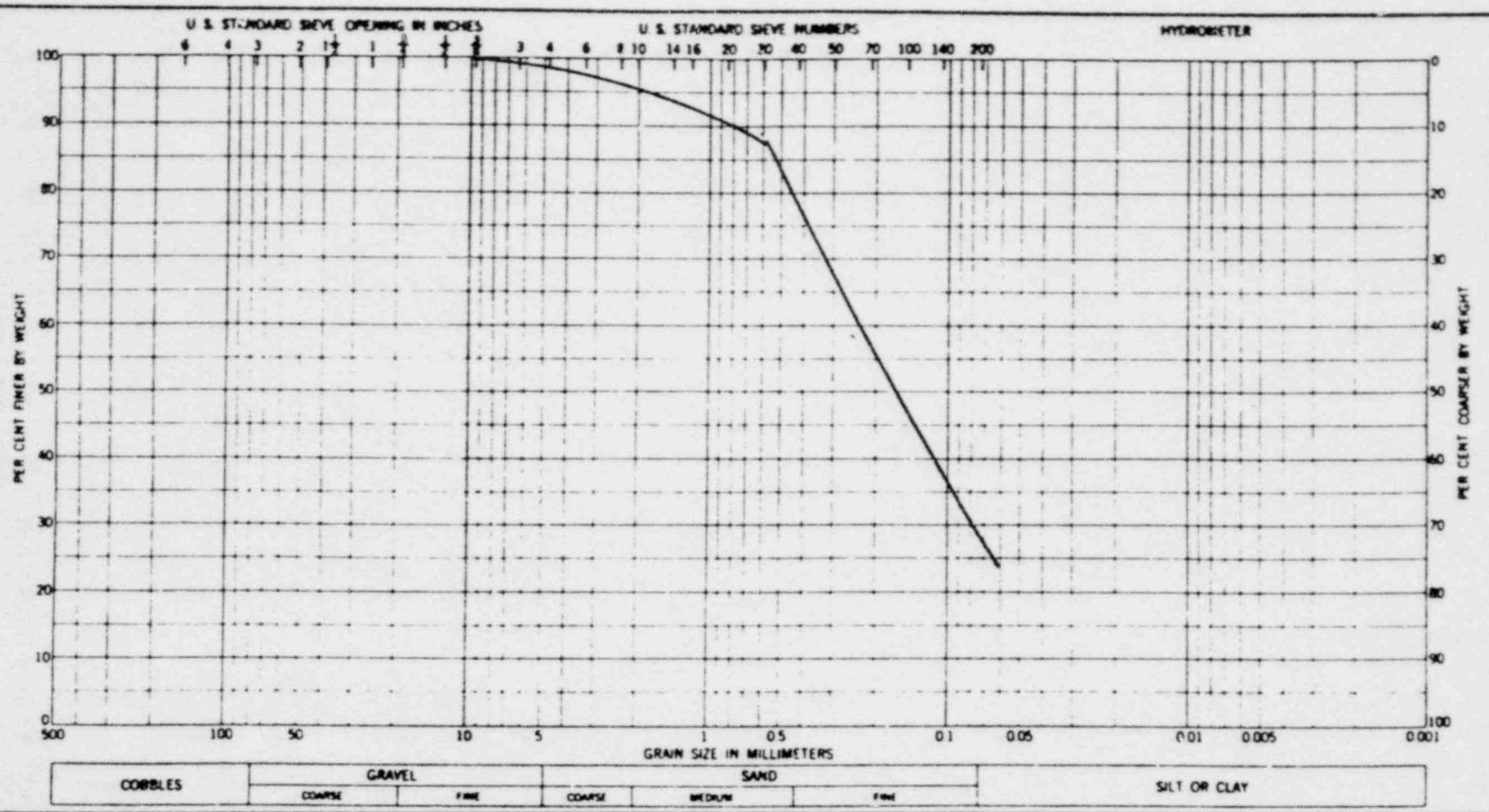
Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
81		30'	Tan fine clayey sand (SC)				

Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M

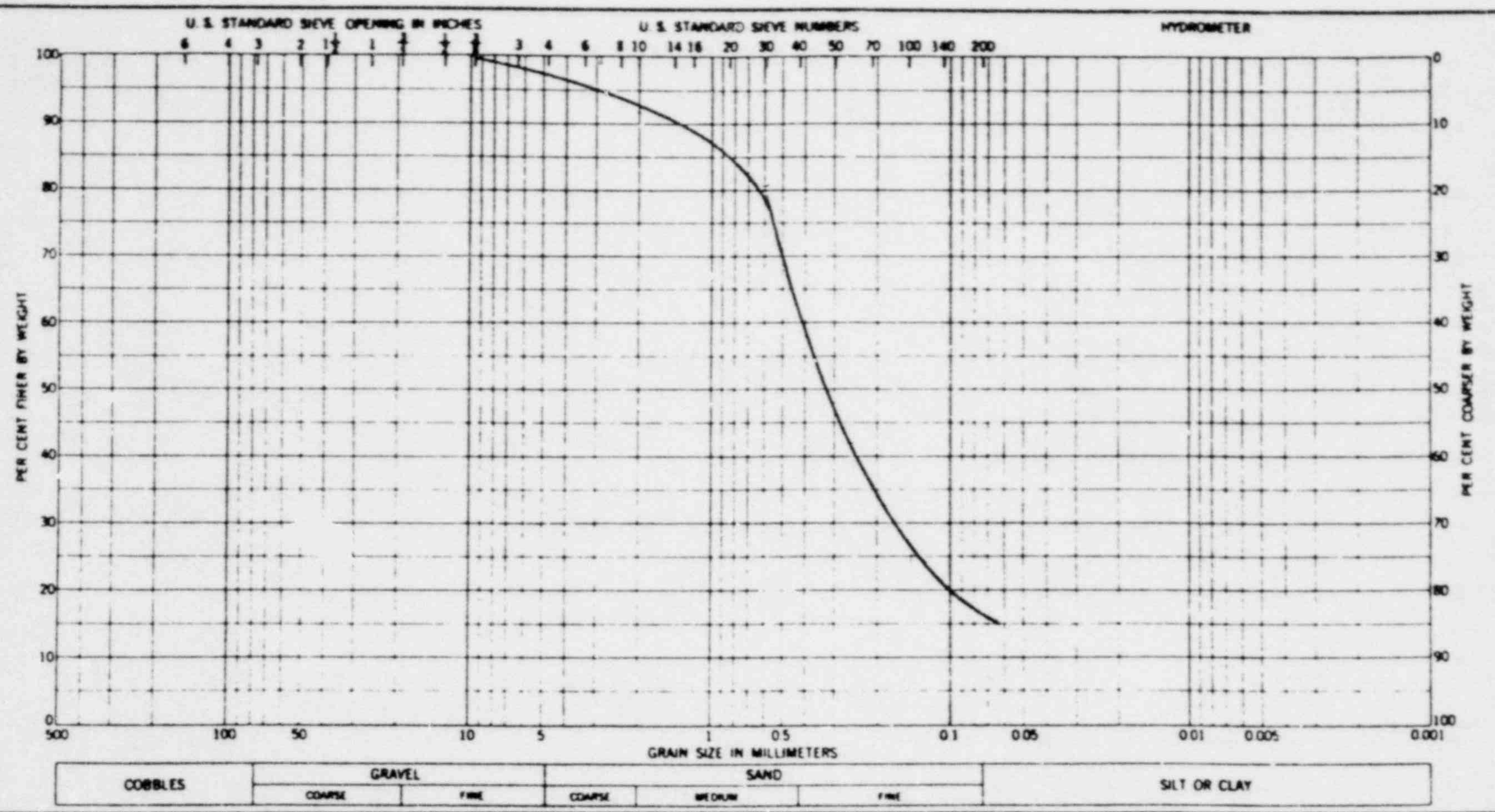
CORE #81-28-7.5C

Sample Depth	Sieve Size	% Passing
45'	3/8"	100.0
	# 10	92.6
	# 30	80.6
	# 60	42.2
	# 100	25.0
	# 200	16.0

Classification: Brown fine clayey sand (SC)

Sample Depth	Sieve Size	% Passing
60'	3/8"	100.0
	# 4	91.6
	# 10	82.6
	# 30	66.6
	# 60	54.0
	# 100	28.7
	# 200	17.7

Classification: Light brown fine to medium sand (SC)



Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
81		45'	Brown fine clayey sand (SC)				

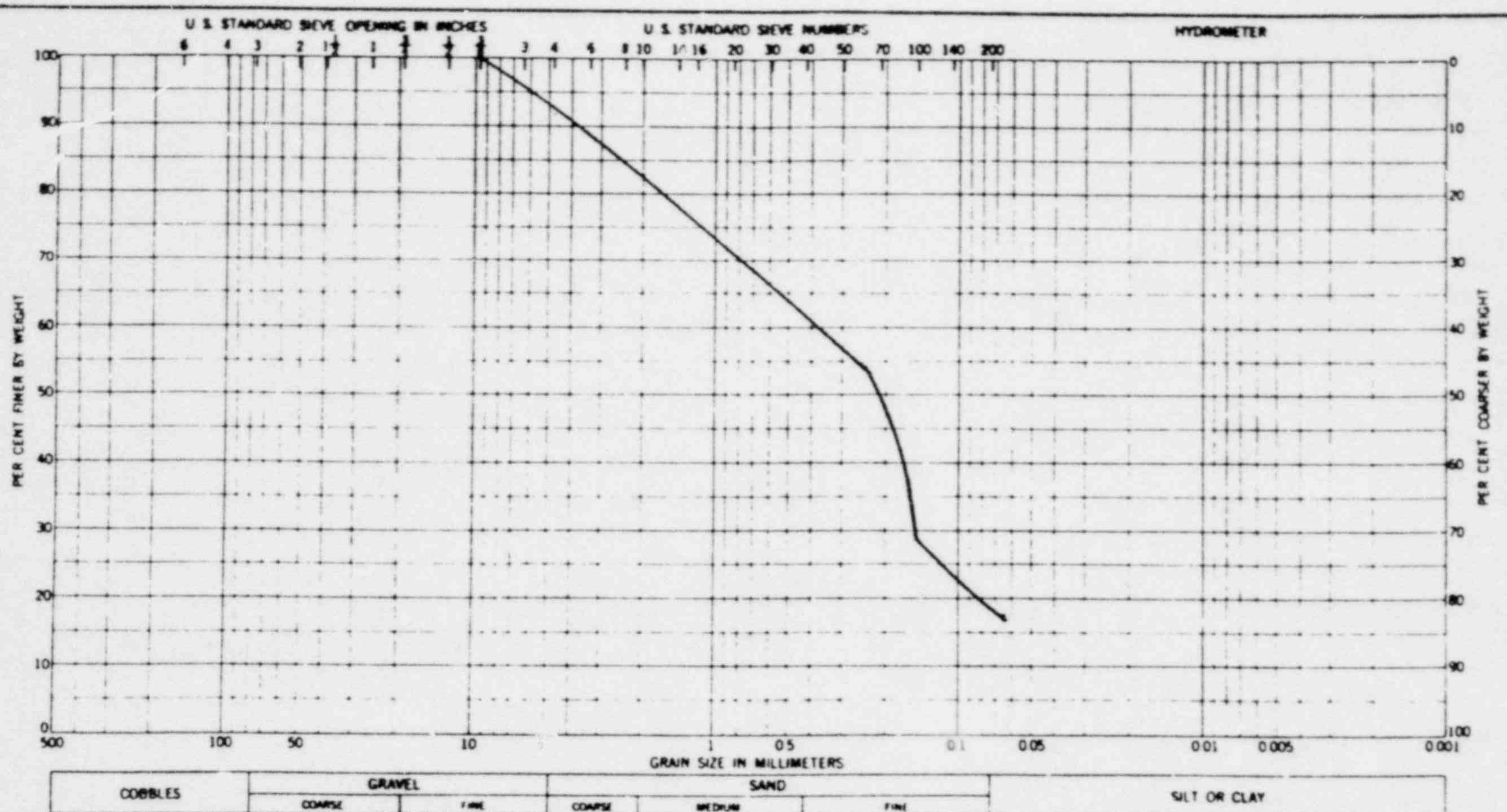
Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
81		60'	Light brown fine to medium sand (SC)				

Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M

CORE #81-28-7.5C

Sample Depth	Sieve Size	% Passing
75'	# 30	100.0
	# 60	99.2
	# 200	93.4

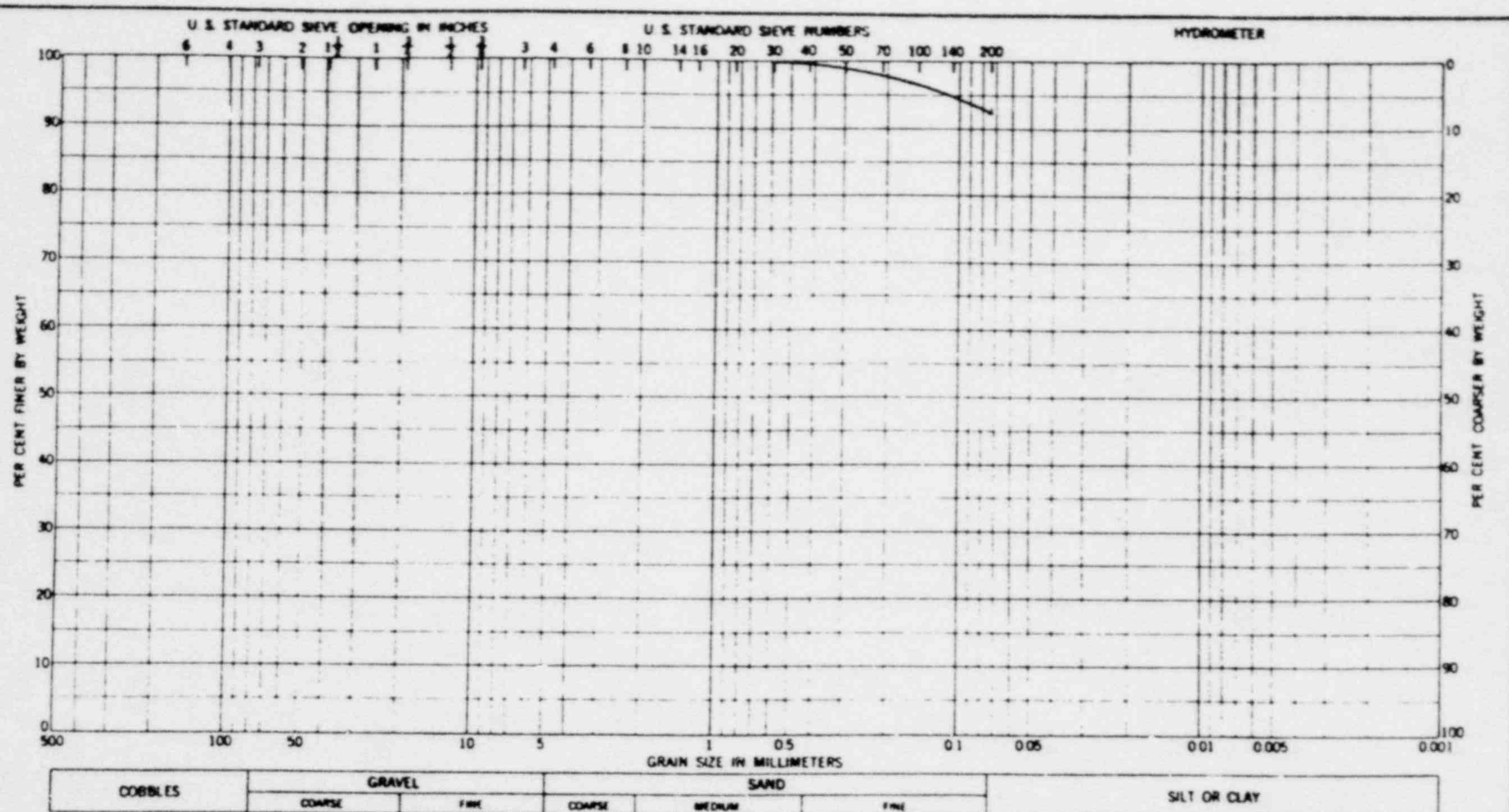
Classification: Gray clay (CH)

Sample Depth	Sieve Size	% Passing
90'	# 30	100.0
	# 60	95.6
	# 100	92.5
	# 200	90.5

Classification: Gray clay (CH)

Sample Depth	Sieve Size	% Passing
105'	3/8"	100.0
	# 4	86.5
	# 10	69.6
	# 30	56.4
	# 60	36.4
	# 100	22.8
	# 200	11.4

Classification: Fine to coarse silty sand, (SW-SM)



Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
81		75'	Gray clay (CH)				

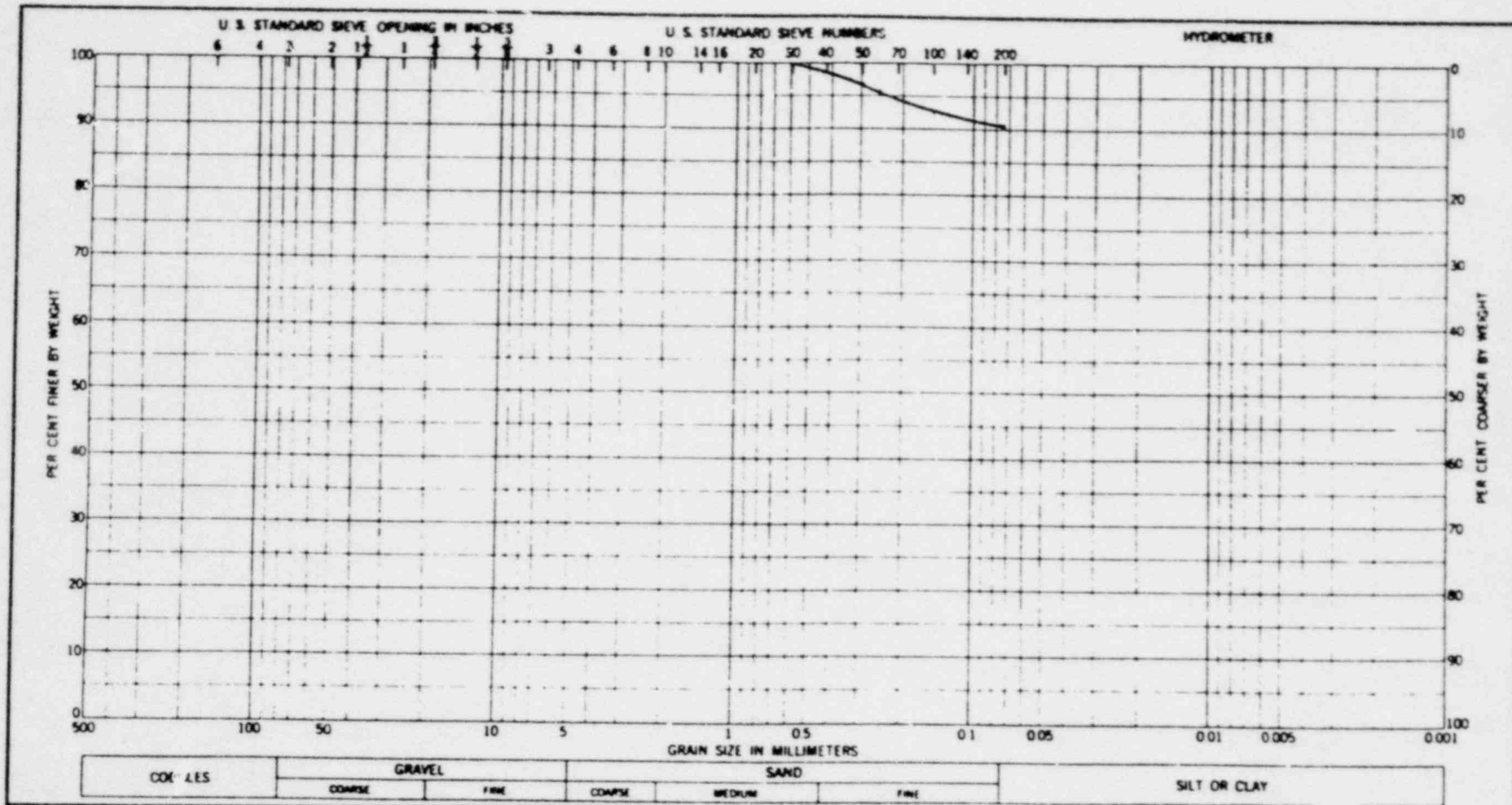
Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M



Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
81		90'	gray clay (CH)				

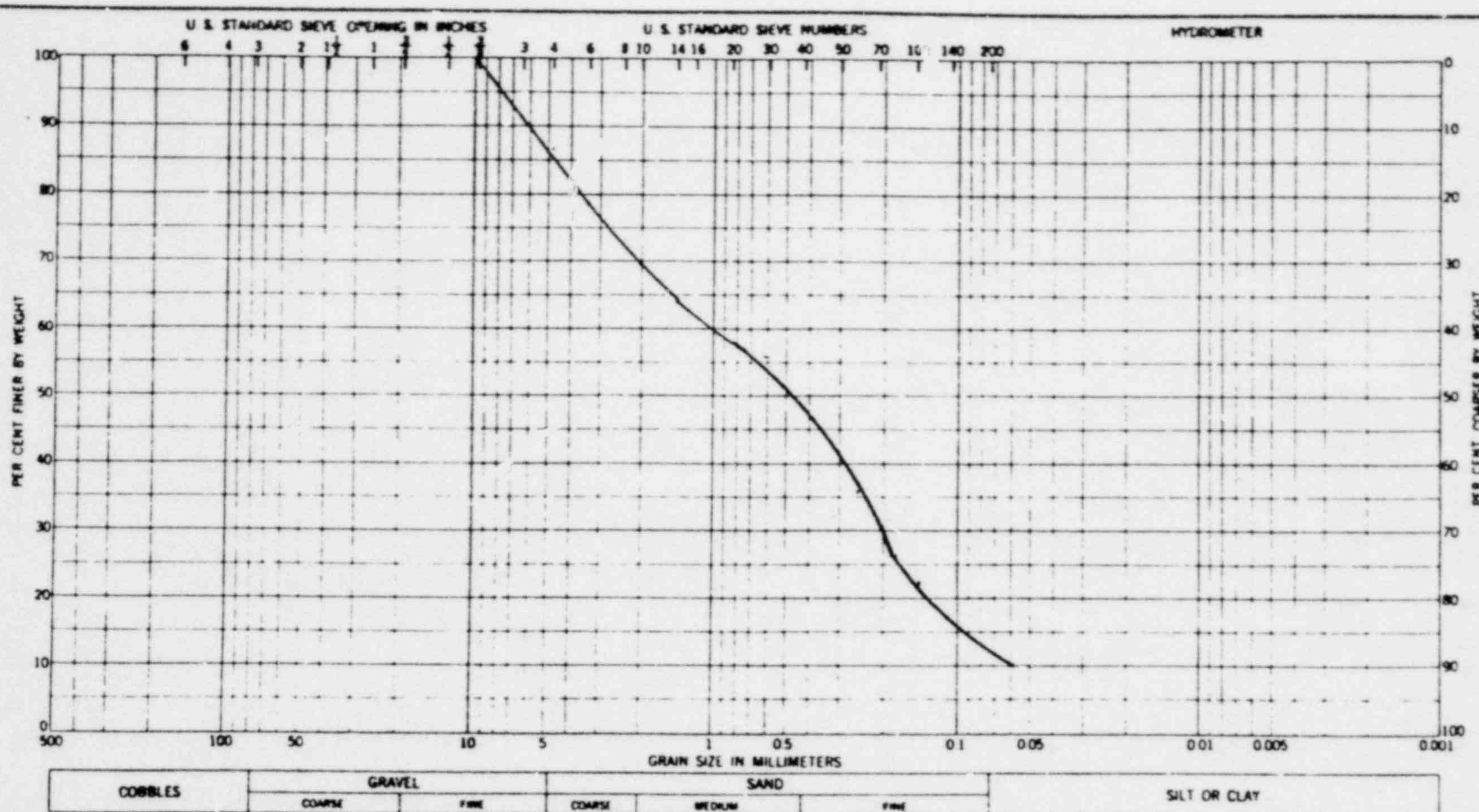
Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M



Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
81		105'	Fine to coarse silty sand. (SW-SM)				

Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M

CORE #81-28-7.5C

Sample Depth	Sieve Size	% Passing
120'	# 4	100.0
	# 10	96.7
	# 30	89.1
	# 60	64.3
	# 100	24.3
	# 200	7.1

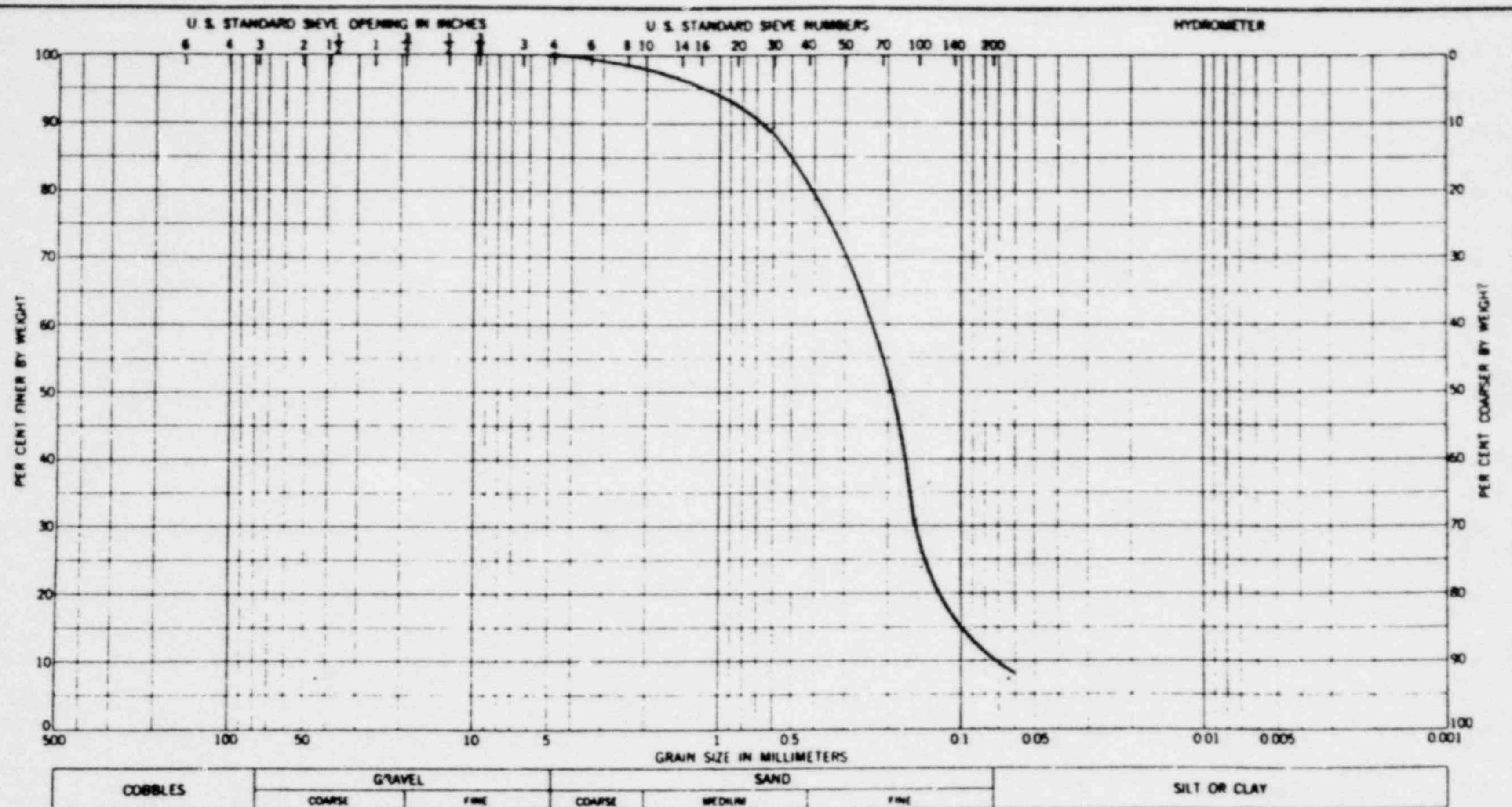
Classification: Fine sand (SP-SM)

Sample Depth	Sieve Size	% Passing
135'	# 100	100.0
	# 200	99.2

Classification: Gray clay (CH)

Sample Depth	Sieve Size	% Passing
150'	# 10	100
	# 30	97.9
	# 60	54.0
	# 100	18.0
	# 200	6.5

Classification: Fine to medium sand (SP-SM)



Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
81		120'	Fine sand (SP-SM)				

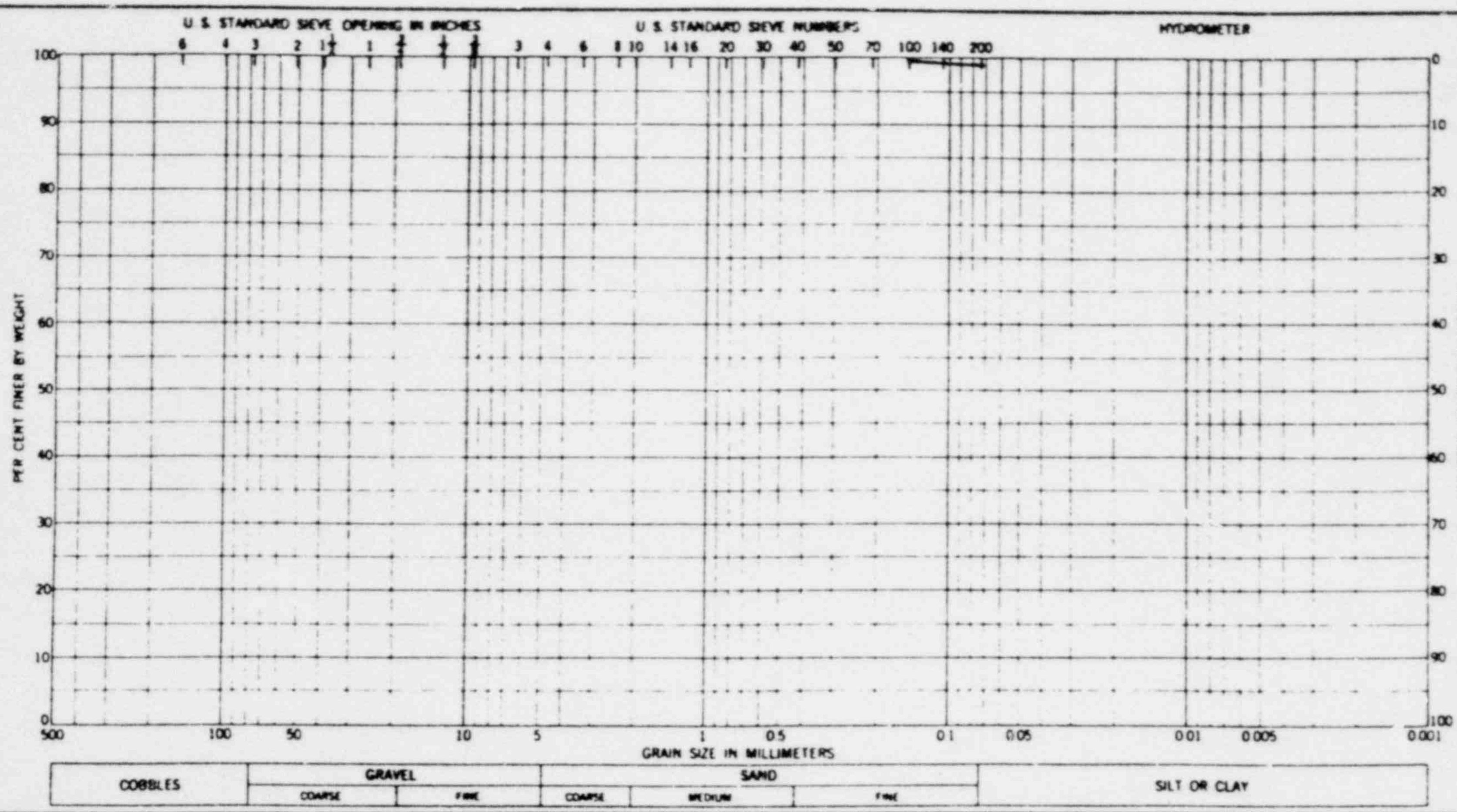
Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M



Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
81		135'	Gray clay (CH)				

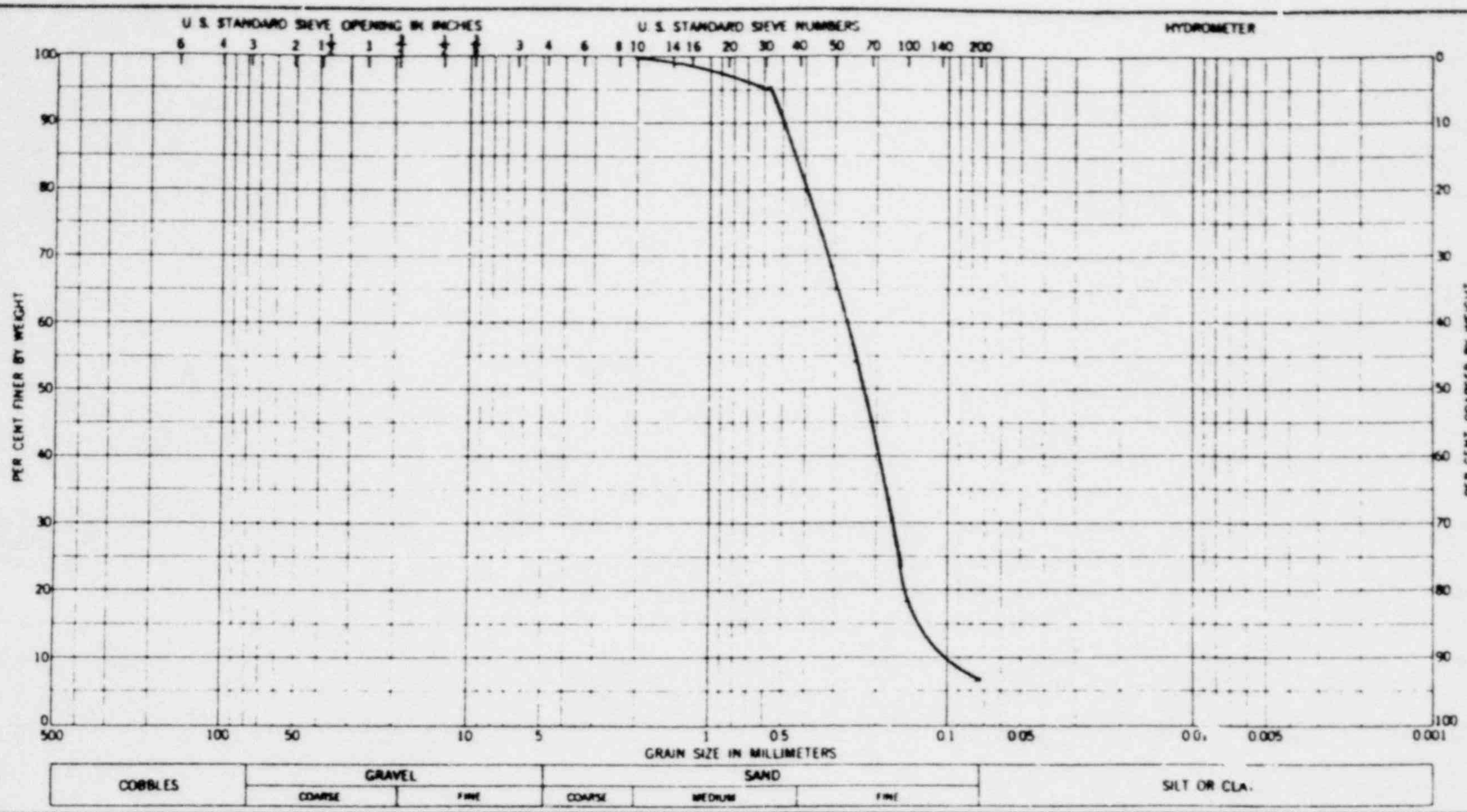
Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M



Boring No	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI
81		150'	Fine to medium sand (SP-SM)				

Project

File No. 326-05053

Date 4-28-80

REPORT OF SOIL ANALYSIS

3781M

APPENDIX C

APPENDIX C

TAILINGS POND PERMEABILITY

SHILSTONE ENGINEERING TESTING LABORATORY, INC.
810 South Padre Island Drive, Corpus Christi, TX 78416

ATLANTA, GEORGIA 404-872-0795
MONROE, LOUISIANA 318-387-2327
NEW ORLEANS, LOUISIANA 504-524-8395
AUSTIN, TEXAS 512-477-3738
BEAUMONT, TEXAS 713-842-1020
CORPUS CHRISTI, TEXAS 512-854-4801
FREEPORT, TEXAS 713-233-6366
HARLINGEN, TEXAS 512-423-6826
HOUSTON, TEXAS 713-224-2047
LAREDO, TEXAS 512-727-3702
SAN ANTONIO, TEXAS 512-342-9377
VICTORIA, TEXAS 512-575-0281

April 9, 1980

Ed L. Reed & Associates, Inc.
Suite 315 - Oil Industries Bldg.
723 Upper North Broadway
Corpus Christi, TX 78401

Attention: Mr. Steve Reed

Reference: Rhode Ranch
Section 58 - Tailings Proposed
McMullen County, Texas
File No. 326-05040

Gentlemen:

Enclosed are the results of the laboratory tests performed on samples retrieved from the reference site. Along with the laboratory tests results, visual classification data has been included on the enclosed Logs of Boring.

Field and laboratory procedures were performed in accordance with those procedures outlined in our previous report on the Overburden Pile and Pit Area (Report No. 326-05028). Also included in this report, is the grain size curve for sample Pit #3 from the previous report.

The borings were located in the field by Mr. Bob Hill of Anaconda Copper Company.

Subsurface conditions encountered at this site generally consisted of 12.5 to 14.0 feet of sand and caliche overlying a brown or gray clay to a depth of 42 feet. Sandstone was encountered at the 42 foot depth.

As can be seen from the Atterberg Limits results, the clays encountered have very high expansive properities.

Results of the permeability tests indicate of range of permeability coefficients ranging from a low of 3.6×10^{-9} cm/sec to a high of 6.3×10^{-6} c/sec.

If you have any questions regarding our analysis, or if we can be of further service, please feel free to contact us at your convenience.

Sincerely,

Dexter Bacon

Dexter Bacon, E.I.T.
Geotechnical Branch Manager

DB/ic

326-05040

RHODE RANCH SECTION 58-TAILING PROPOSED

MCMULLEN CO., TEXAS

SUMMARY OF CLASSIFICATION TESTS

Boring No.	Depth in Feet	Liquid Limit %	Plasticity Index %	% Passing #200 Mesh Sieve	Unified Soil Classification	
B-1	12-1[illegible]	89	49	---	CH	Brown clay
B-1	15-16	106	67	94.9	CH	Brown clay
B-1	21-22	108	72	94.7	CH	Brown clay
B-2	12-13	58	35	57.3	CH	Brown sandy clay
B-2	15-16	57	38	52.9	CH	Brown clay
B-2	24-25	77	42	--	CH	Gray clay
B-2	33-34	95	29	90.8	CH	Blue-gray clay
Ref 2	9-10	44	29	56.7	CL	Brown sandy clay
Ref 2	15-16	38	24	41.0	SC	Brown clayey sand
Ref 2	18-19	101	37	91.0	CH	Tan clay

326-05040

RHODE RANCH SECTION 58-TAILINGS PROPOSED

MCMULLEN CO., TEXAS

SUMMARY OF FALLING HEAD PERMEABILITY TESTS

Boring No.	Depth (ft.)	%Moisture Before	%Moisture After	Unit Dry Weight (p.c.f.)	Average Permeability (cm/sec)
B-1	12-13	28.4	47.5	92.0	3.1×10^{-9}
B-1	15-16	28.4	46.4	87.5	1.7×10^{-8}
B-1	21-22	25.2	40.2	94.2	1.4×10^{-8}
B-2	12-13	15.5	20.6	114.0	1.1×10^{-8}
B-2	15-16	17.0	33.7	111.4	3.6×10^{-9}
B-2	24-25	19.4	25.6	105.3	1.2×10^{-8}
B-2	33-34	32.9	40.1	89.1	3.1×10^{-9}
Ref 2	9-10	10.4	17.7	115.4	1.4×10^{-7}
Ref 2	15-16	8.0	13.2	122.8	6.3×10^{-6}
Ref 2	18-19	30.8	34.2	91.4	2.0×10^{-8}

Plate II

SUMMARY OF PERMEABILITY AND CLASSIFICATION RESULTS

RHODE RANCH SITE

MCMULLEN CO., TEXAS

Boring No.	Depth	% Moisture Before	% Moisture After	Weight (p.c.f.)	Average Permeability(cm/sec)
Ref 2	24-25.5	27.8	34.6	96.2	4.7×10^{-9}

Liquid Limit(%)	Plastic Index	% Passing #200 Sieve	Unified Soil Classification
77	43	92.5	CH

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

326-05040

LOG OF BORING FOR

Rhode Ranch Section 58-
Tailings Proposed
McMullen Co., Texas

BORING NO B-1 DATE 3/18/80

ELEV FEET	SOIL DESCRIPTION	DEPTH FEET	SAMPLE TYPE	N BLOWS PER FOOT	UNC COMP STRENGTH T.S.F.	MOISTURE %	UNIT DRY WEIGHT P.C.F.
	SURFACE						
	Brown clay and caliche	0–6	ST				
	Brown sand with caliche	6–12	ST				
			ST				
	Gray-green clay with gypsum	12–25	ST		15.5		114.0
			ST		17.0		111.4
			ST				
			ST				
		25	ST		19.4		105.3
	Boring terminated @ 25.0 feet.						

TYPE OF SAMPLE
D — DISTURBED
ST — SHELBY TUBE
SS — SPLIT SPOON
RC — ROCK CORE
( ) — PENETROMETER

REMARKS:
No groundwater encountered

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT FT.
G.W. AFTER COMPLETION FT.
G.W. AFTER HRS FT.

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

326-05040

LOG OF BORING
FOR

Rhode Ranch Section 58-
Tailings Proposed
McMullen Co., Texas

BORING NO. B-2 DATE 3-18-80

ELEV FEET	SOIL DESCRIPTION	DEPTH FEET	SAMPLE TYPE	N BLOWS PER FOOT	UNC. COMP. STRENGTH T.S.F.	MOISTURE %	UNIT DRY WEIGHT P.C.F.
	SURFACE						
	Dark brown silty clay						
			ST				
		5					
			ST				
	Same with gravel	10	ST				
	Brown sandy clay		ST			15.5	114.0
		15	ST			17.0	111.4
	Gray clay with gypsum		ST				
		20					
			ST				
		25	ST			19.4	105.3
			ST				
		30	ST				
			ST			32.9	89.1
		35					

Continued on next page

TYPE OF SAMPLE
D. — DISTURBED
S.T. — SHELBY TUBE
S.S. — SPLIT SPOON
R.C. — ROCK CORE
( ) — PENETROMETER

REMARKS:
No groundwater encountered

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT FT.
G.W. AFTER COMPLETION FT.
G.W. AFTER HRS. FT.

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

326-05040

LOG OF BORING
FOR
Rhode Ranch Section 58-
Tailings Proposed
McMullen Co., Texas

BORING NO B-2 DATE 3-18-80

ELEV. FEET	SOIL DESCRIPTION	DEPTH FEET	SAMPLE TYPE	N-BLOWS PER FOOT	UNC. COMP STRENGTH T.S.F.	MOISTURE %	UNIT DRY WEIGHT P.C.F.
	SURFACE						
	Gray and yellow clay with gypsum						
		40	ST				
	Gray sandstone		ST				
	Boring terminated @ 43.0 feet						
		45					

TYPE OF SAMPLE
D — DISTURBED
S.T. — SHELBY TUBE
S.S. — SPLIT SPOON
R.C. — ROCK CORE
( ) — PENETROMETER

REMARKS:

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT FT.
G.W. AFTER COMPLETION FT.
G.W. AFTER HRS. FT.

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

326-05040

LOG OF BORING
FOR
Rhode Ranch Section 58-
Tailings Proposed
McMullen Co., Texas

BORING NO. Ref-2 DATE 3-17-80

ELEV. FEET	SOIL DESCRIPTION	DEPTH FEET	SAMPLE TYPE	N BLOWS PER FOOT	UNC. COMP. STRENGTH T.S.F.	MOISTURE %	UNIT DRY WEIGHT P.C.F.
	SURFACE						
	Silty clay with streaks of caliche		ST				
	Caliche and sand, some clay	5	ST				
	Clay lens @ 10 feet	10	ST			10.4	115.4
			ST				
		15	ST			8.0	122.8
	Tan clay		ST			30.8	91.4
		20	ST				
		25	ST				
	Boring terminated @ 25.0 feet						

TYPE OF SAMPLE
D — DISTURBED
S.T. — SHELBY TUBE
S.S. — SPLIT SPOON
R.C. — ROCK CORE
( ) — PENETROMETER

REMARKS:

No groundwater encountered

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT FT.
G.W. AFTER COMPLETION FT.
G.W. AFTER HRS FT.

FIGURES 1-12

FIGURE 1

TOPOGRAPHIC MAP

Scale: 1:250,000

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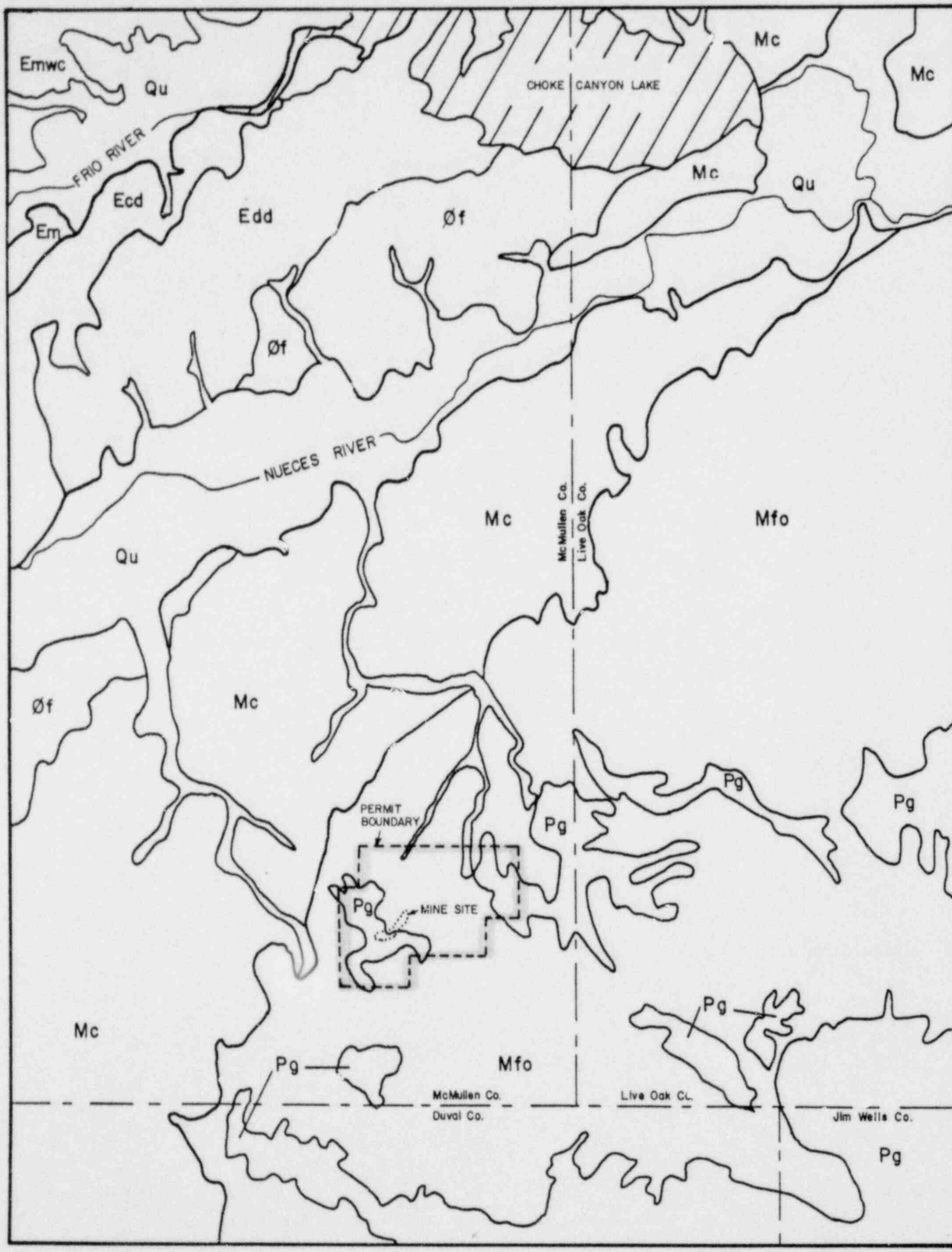

0 1 2 3 4 5 miles

N

SOURCE: BEG 1976

FIGURE 3
GEOLOGIC MAP

LEGEND FOR FIGURE 3

Epoch	Group	Symbol	Unit
PLIESTOCENE-HOLOCENE		Qu	Quaternary, undifferentiated
PLIOCENE		Pg	Goliad Formation
MIOCENE		Mfo	Fleming Formation & Oakville Sandstone
MIOCENE		Mc	Catahoula Formation
OLIGOCENE		Of	Frio Formation
EOCENE	JACKSON GROUP	Edd	DeWeesville Sandstone
EOCENE	JACKSON GROUP	Ecd	Conquista Clay & Dilworth Sandstone
EOCENE	JACKSON GROUP	Em	Manning Formation
EOCENE	JACKSON GROUP	Emwc	Wellborn & Caddell, undifferentiated

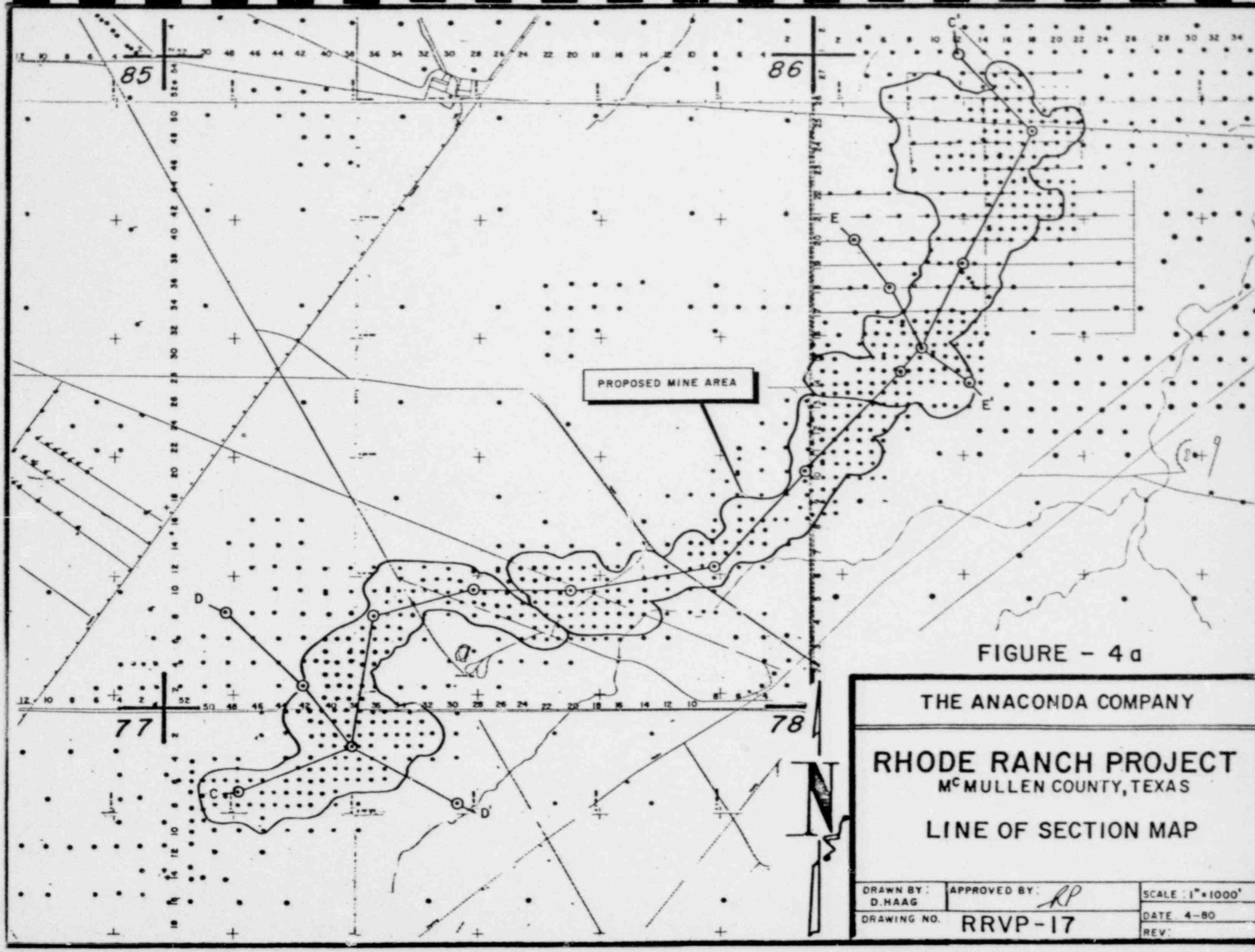

FIGURE - 4a

THE ANACONDA COMPANY

RHODE RANCH PROJECT

M^C MULLEN COUNTY, TEXAS

LINE OF SECTION MAP

DRAWN BY: D.HAAG	APPROVED BY: RP	SCALE: 1" = 1000'
DRAWING NO.	RRVP-17	DATE 4-80
		REV:

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ANO. 8006060147

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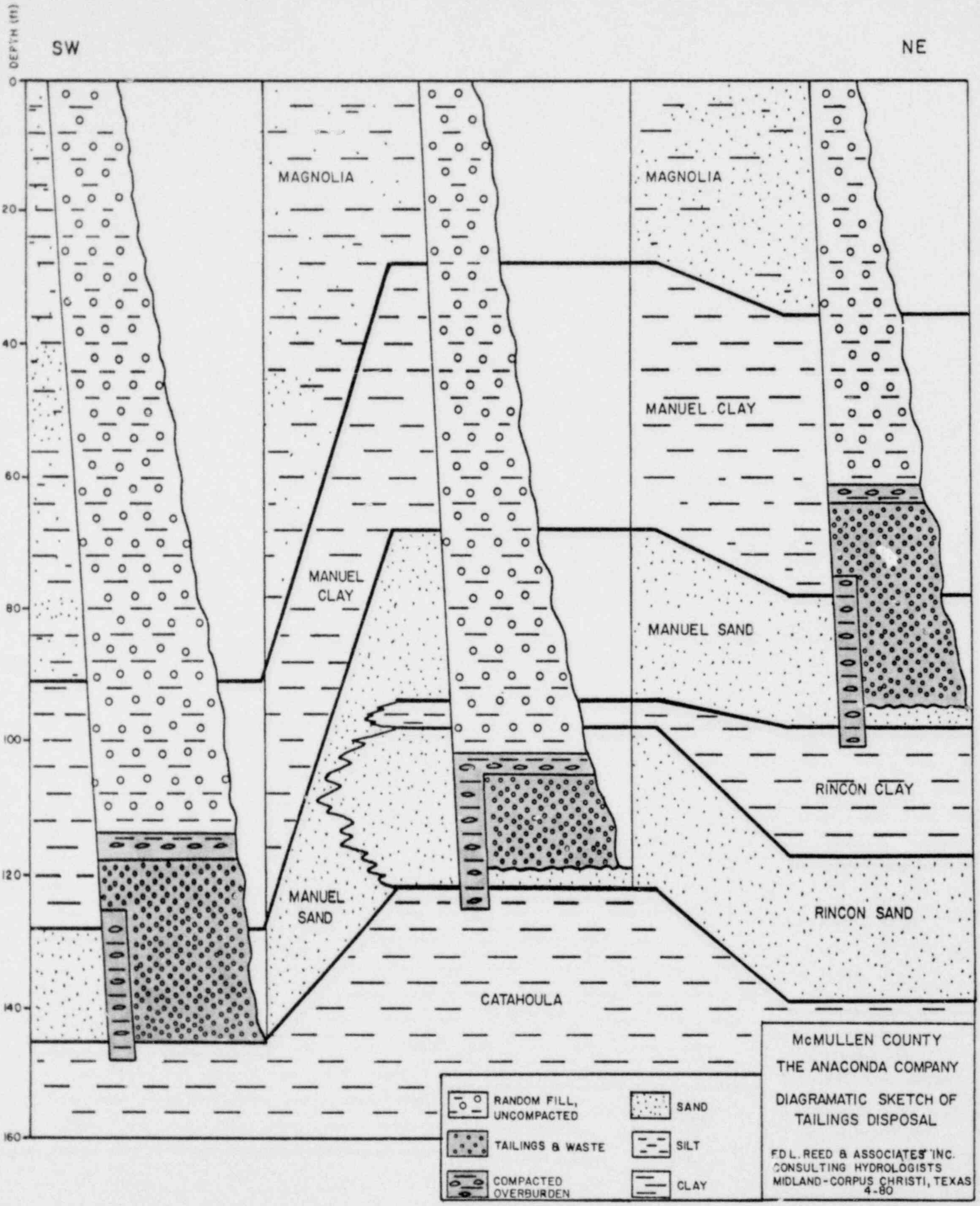
DEPTH (ft)
SW
NE
0
20
40
60
80
100
120
140
160
MAGNOLIA
MAGNOLIA
MANUEL CLAY
MANUEL CLAY
MANUEL SAND
MANUEL SAND
RINCON CLAY
RINCON SAND
CATAHOULA
RANDOM FILL, UNCOMPACTED
TAILINGS & WASTE
COMPACTED OVERBURDEN
SAND
SILT
CLAY
McMULLEN COUNTY
THE ANACONDA COMPANY
DIAGRAMATIC SKETCH OF TAILINGS DISPOSAL
ED L. REED & ASSOCIATES INC.
CONSULTING HYDROLOGISTS
MIDLAND-CORPUS CHRISTI, TEXAS
4-80

FIGURE 9

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ANO. 8006060147

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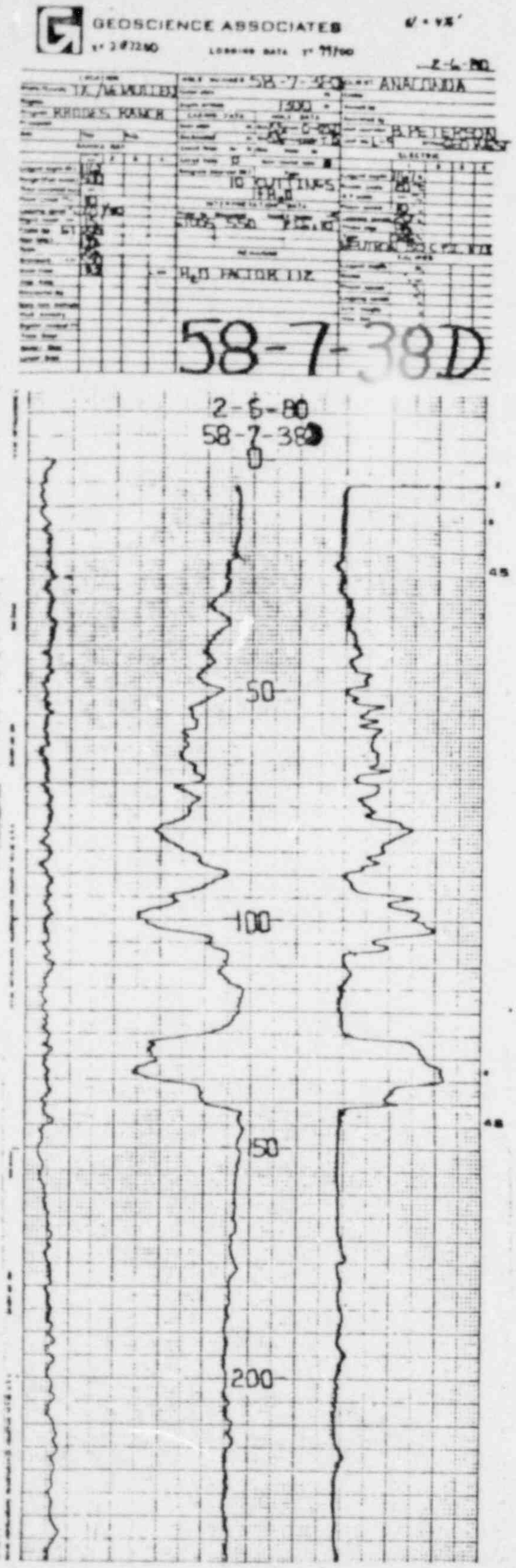


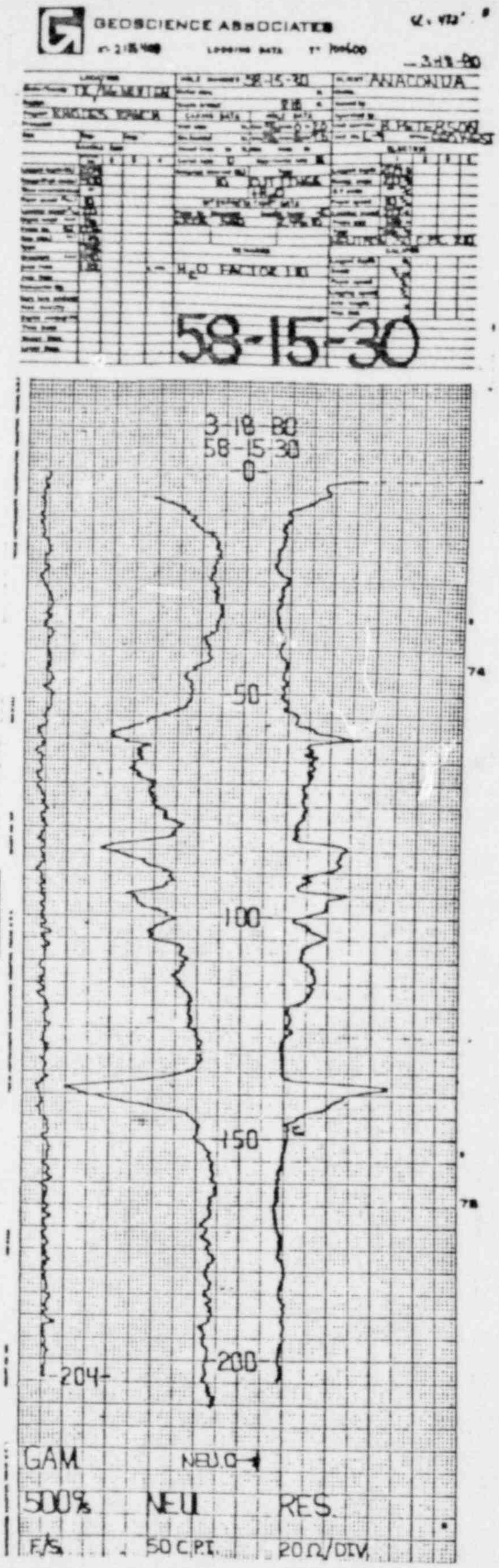
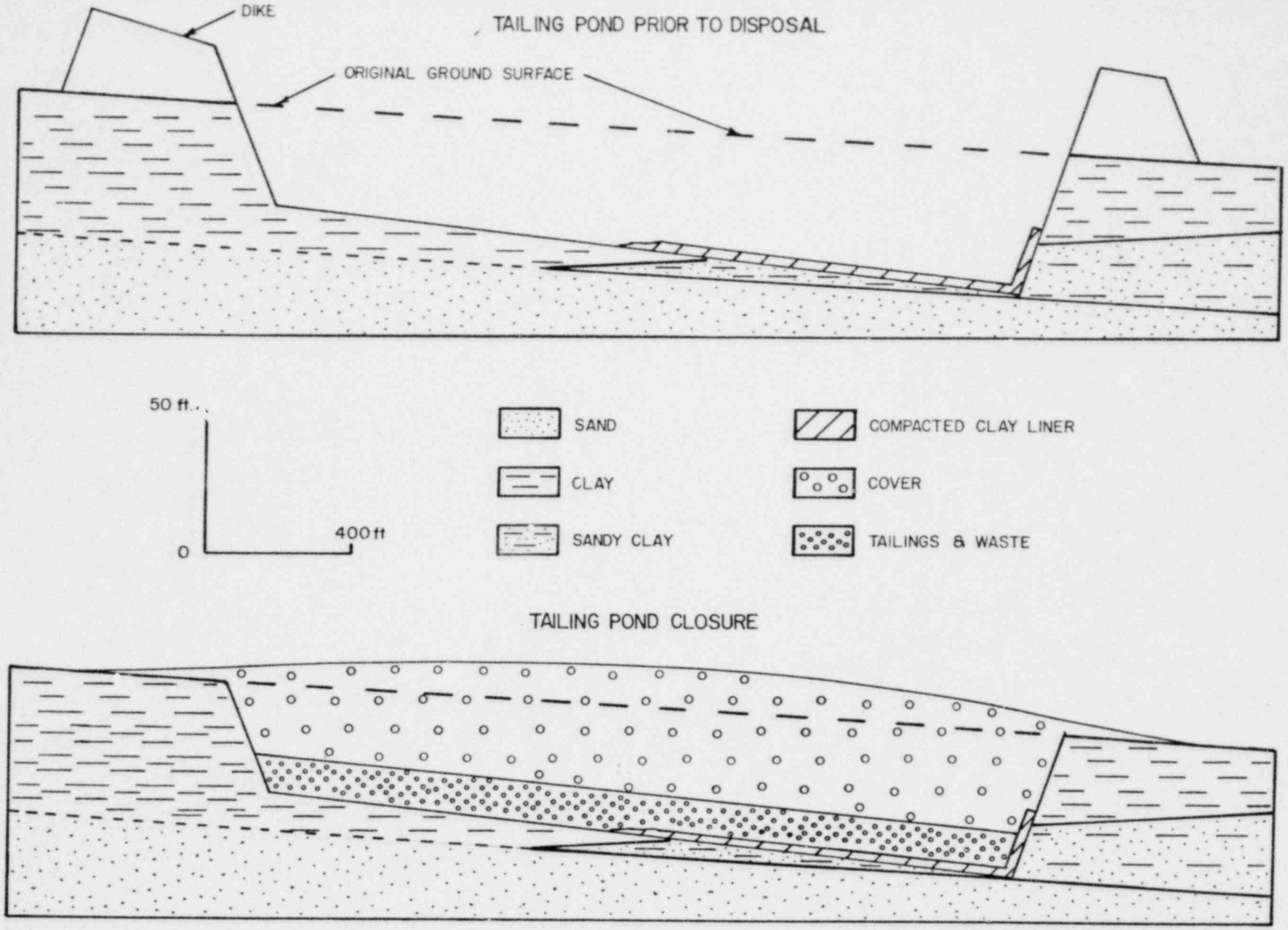


FIGURE 11

THE ANACONDA COMPANY
RHODE RANCH PROJECT
M^C MULLEN COUNTY, TEXAS

DRAWING NO.	APPROVED BY: R. Pugh	SCALE: 1" = 40' V
RRVP-22	DRAWN BY: D. HAAG	DATE: 4-80
		REVISED



McMULLEN COUNTY, TEXAS

THE ANACONDA COMPANY

SCHEMATIC DIAGRAM OF TAILING POND

FIGURE 12

ED L. REED & ASSOCIATES, INC
CONSULTING HYDROLOGISTS
MIDLAND, CORPUS CHRISTI, TEXAS

4-80