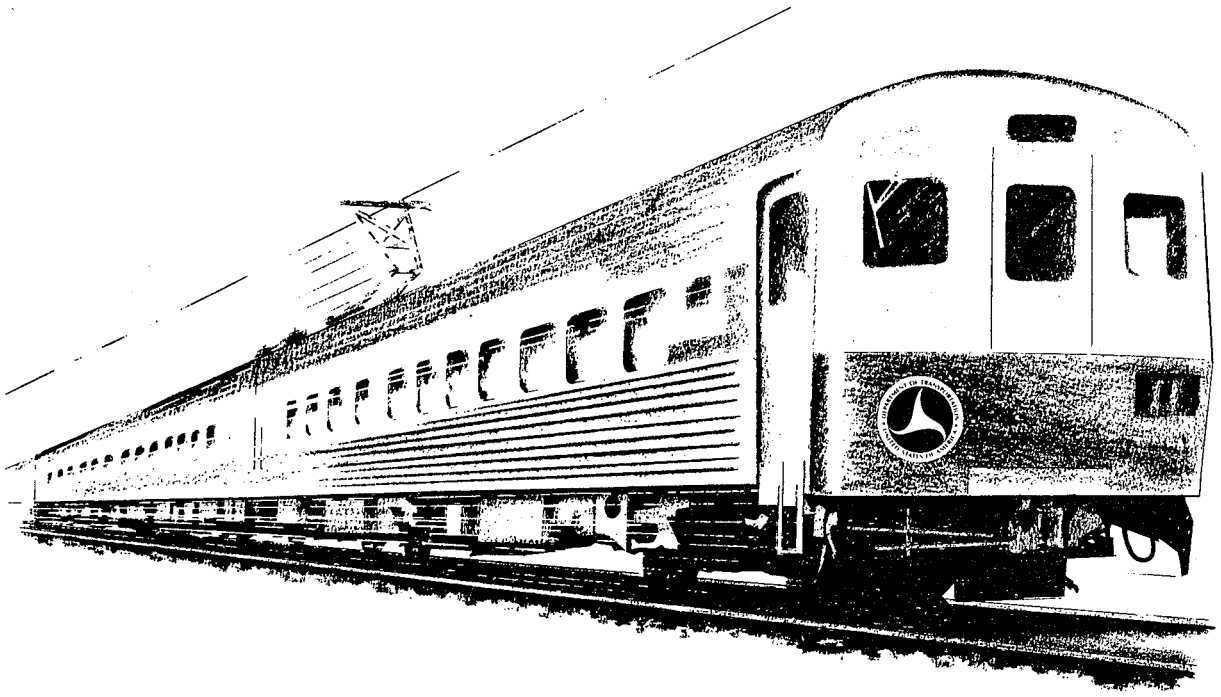
PER

EXPLORATORY SOIL BORINGS AT TWO LOCATIONS FOR THE U.S. DEPARTMENT OF TRANSPORTATION

DESIGN STUDIES



FINAL REPORT

AUGUST 1971

FEDERAL RAILROAD ADMINISTRATION

OFFICE OF HIGH-SPEED GROUND TRANSPORTATION

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15. Supplementary Notes

16. Abstract

Exploratory borings and soil classification studies are reported on for two locations; southeast Kansas and northeast New Mexico.

The objective of the work was the revelation of sufficient sub-soil information to enable a decision on the part of the sponsoring agency as to where to most appropriately install a railroad test track.

Duplication of physical conditions most representative of present railroad track support conditions and economics of construction were important considerations.

17. Key Words	18. Distribution Statement
Geological evaluation, soil classifications, engineering analysis, laboratory soil tests, core descriptions	Availability is unlimited. Copies may be purchased from the National Technical Information Service, Springfield, Va. 22151, for $3.00 a copy.

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KANSAS AREA

REPORT FOR
U. S. DEPARTMENT OF TRANSPORTATION
TEST TRACK
KANSAS

I - Introduction

A. Purpose of Survey

The purpose of the survey was to examine the proposed U. S. Department of Transportation test track site in Kansas from a geological and laboratory testing investigation through the use of samples obtained from prescribed test borings taken along its center-line.

B. Location of Site

The test track site is located 30 feet west of the center-line of the existing Santa Fe track between mile posts 161 and 163, approximately 11.3 miles northeast of El Dorado, Kansas on Highway 177, or 7.2 miles southwest of the small community of Cassoday, Kansas. The terrain of the site area is rolling with two hill areas necessitating excavation.

C. Test Borings

The following 16 test borings were augered, drilled and cored on April 16, 17, 23, 24, 1969 by means of a 750 Failing truck mounted core drill:

Boring Number	Station Number	Description	Depth
#1	8513+00	Embankment	6.0'
#2	8514+62	Embankment	6.0'
#3	8517+00	Embankment	6.0'
#4	8523+00	Excavation	16.2'
#5	8535+22	Excavation	13.0'
#6	8542+00	Embankment	6.0'
#7	8549+39	Embankment	6.0'

Boring Number	Station Number	Description	Depth
#8	8560+00	Embankment	6.0'
#9	8563+06	Embankment	6.0'
#10	8568+76	Embankment	6.0'
#11	8575+42	Embankment	7.8'
#12	8582+00	Excavation	13.0'
#13	8587+00	Excavation	18.0'
#14	8590+00	Embankment	6.0'
#15	8594+00	Embankment	6.0'
#16	8598+40	Embankment	6.0'
		Total	134.0'

II - Geological Survey

A. Type Soils

Three representative soils were found to be present in the overburden section above the bed rock between Santa Fe mile posts 161 and 163, Kansas.

The uppermost of these three soils is best described as a clay, silty, black, moist and plastic varying in thickness from total absence in borings Nos. 8 and 16 to a maximum thickness of 3.8 feet in boring No. 11. Average thickness of this upper soil where present is 1.3 feet.

The next lower soil type beneath that of above when present is a clay, slightly silty, reddish brown, moist and plastic. It varies in thickness from total absence in boring Nos. 1, 2, 7, 8, 9, 11, 15 to a maximum of 5.3 feet in boring No. 12. The average thickness where present is 1.0 foot. In boring No. 11, 3 feet of this particular clay was used as a fill and noted immediately at the surface.

The third and lowest soil type where present is described as a gradational clay, mottled gray, yellow, tan, moist to wet (due to rainfall drainage at this time of year from ditching adjacent

to present track), plastic, grading into this same colored clay-shale which is refusal to the penetrometer. This type was found to be absent in boring Nos. 1, 7, and 8 and reached a maximum thickness of 4.0 feet in boring No. 5. Average thickness of the unit where present was found to be 0.8 foot, wherein approximately half of this total thickness can be considered clay and the bottom half clay-shale or refusal.

B. Bed Rock

Bed rock as herein described will denote the top of the Fort Riley limestone of Permian Geologic Age. However, in most of the borings actual refusal occurs a few inches above the top of the limestone in a weathered form of shale that appears to be more of a clay-shale as mentioned above. The weathered and soft condition of the shale was evident from the poor core recovery in this thin interval immediately on top of the limestone.

The Fort Riley limestone in the borings was characterized by being mostly dense, buff to gray and of medium hardness in its pure state while in a number of instances it appeared shaley, interbedded with thin clay-shale to shale layers, and in some instances only minute shale laminae. Vugular openings due to solution in this near surface carbonate section occurred in borings Nos. 3, 7, 12 and 16. Less common than the vugs were vertical fractures found in boring Nos. 2, 13, and 14. According to the Kansas State Geological Survey, fractures or jointing occur quite common in the Fort Riley limestone.

Due to the affects of erosion on top the surface of the Fort Riley limestone and its interbedded shale layers, it would appear that its grade approximates 0.5 foot per 100 feet or expressed as 28 feet per mile or 0.3 degree of dip in a southwest direction. Less than one degree dip to the southwest is likewise accepted by the State Geological Survey.

C. Surface Ground Water

Although several drainage patterns cross through the two-mile area of the present and test track area, the general pattern of drainage for the area is to the southwest or parallel to the direction of the track.

Only drainage water was encountered in several of the borings, this being due to their nearness to present ditching carrying or holding water after heavy rainfall this time of year. The water table for the area is reported at approximately 180 feet by a water well drilling firm active in the area.

III - Engineering Analysis

Conditions existing at proposed site location in Kansas offers a much more variable soil profile than those existing in New Mexico. There exist three basic types of soil at this location which may be used as fill or embankment material. Because of topography there may exist fills of approximately 6 feet. The silty clay uppermost soil has a remolded modified proctor compacted dry unit weight of 105.7 pounds per cubic foot with an optimum moisture content of 17%. Undisturbed samples obtained for this material indicate an average unconfined compressive strength of 2.0 ksf. Upon remolding the unconfined compressive strength was found to be an average of 6.0 ksf. The large increase in strength in the remolded state, compacted to 95% modified proctor density, results from the relatively large increase in dry unit weight of the material.

The next underlying material is a CH material with an undisturbed compressive strength averaging about 2.5 ksf. Remolded strength of this material compacted to 95% modified proctor density averaged about 6.0 ksf which was the same as overlying soil. The strength gain here again is contributed to the increased unit dry weight of the remolded compacted soil. Remolded unit dry weight of modified proctor for this material was 106 pounds per cubic foot with an optimum moisture content of 19%.

Soil lying just above the limestone and shale was a silty clay of good remolded unconfined compressive strength (averaging about 6 ksf). The modified proctor unit dry weight of this material was found to be 109 pounds per cubic foot with an optimum moisture content of 16.6%. This material might be classified as a CL material.

Since segregation of this material will be almost impossible during excavation, the resulting borrow will be a mixture of all three types of soil. No foreseen difficulties should arise from mixing these soils. Before placing and compacting these soils they should be thoroughly mixed if they are to be used together.

Lime stabilization of this material would not be recommendable except for possibly the top six inches of the road bed to provide a tight durable surface on which to construct tracks. The lime content used in this layer should be sufficient to obtain a strength gain and not a percentage that sould reduce plasticity only. In this case as well as with the cement content additional tests would be necessary to recommend a percentage. This information could be made available upon request.

A detailed slope stability study of this material was not attempted since testing was conducted in accordance with specifications issued for bidding, and we do not feel that we have sufficient information from the investigation to make a detailed study.

The problem present at the Kansas site location which should arouse some discussion is the possibility of differential movement between sections of track that will be located on bed rock and those sections which will be placed on embankments. To prevent this occurrence it would be advisable to undercut bed rock at transition sections to allow at least 4.0 feet of fill to be placed. This would allow for a more uniform depth of fill; thus, more uniform compacted soil behavior.

HEMPHILL CORPORATION

John T. Eidt

John T. Eidt, Geologist

B. D. Marks, III, B.S.C.E., M.S.C.E.
Soils Consultant

Jack F. Stewart, Engineer

UNCONFINED COMPRESSION TEST

DATE: April 22, 1969

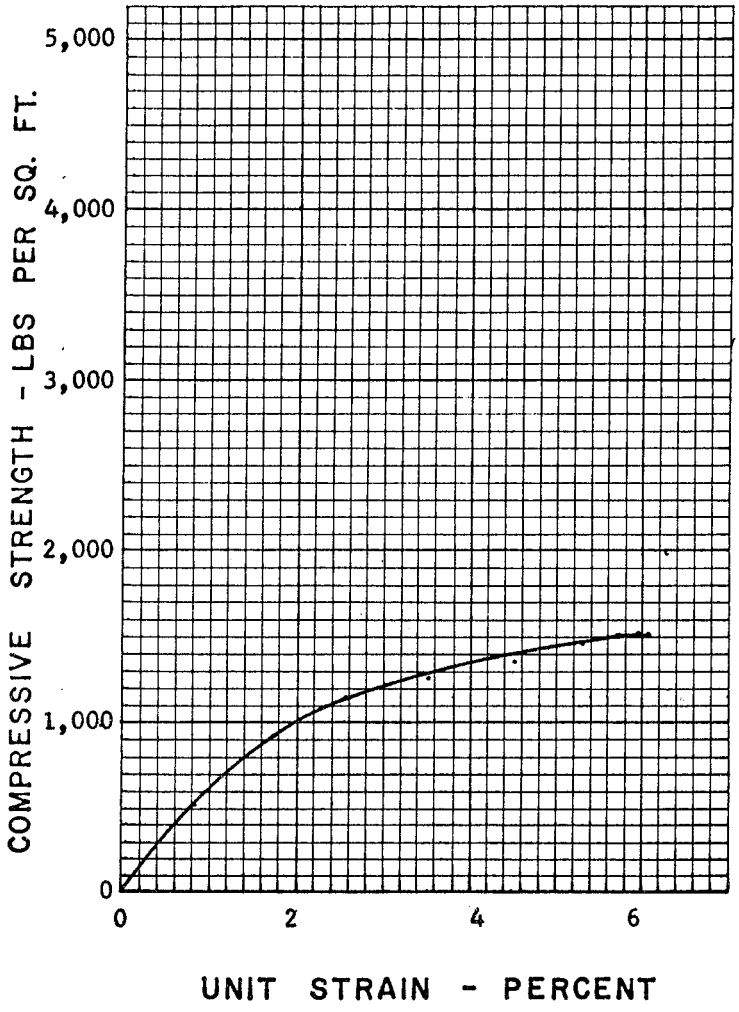
CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

TEST RESULTS

HOLE NO. 1 SAMPLE NO. _____ FROM 1.0 TO 2.0

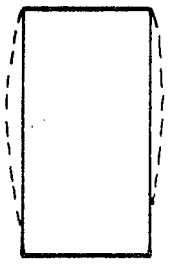
MATERIAL DESCRIPTION: Black Silty Clay - Moist, Plastic



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	1,516.32
PERCENT STRAIN	5.93
PERCENT MOISTURE	35.9
DRY DENSITY LBS PER CU. FT.	83.4
LIQUID LIMIT	
PLASTIC LIMIT	
PLASTICITY INDEX	
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



HEMPHILL CORPORATION

4834 S. 83RD E. AVE. TULSA, OKLAHOMA

UNCONFINED COMPRESSION TEST

DATE: April 22, 1969

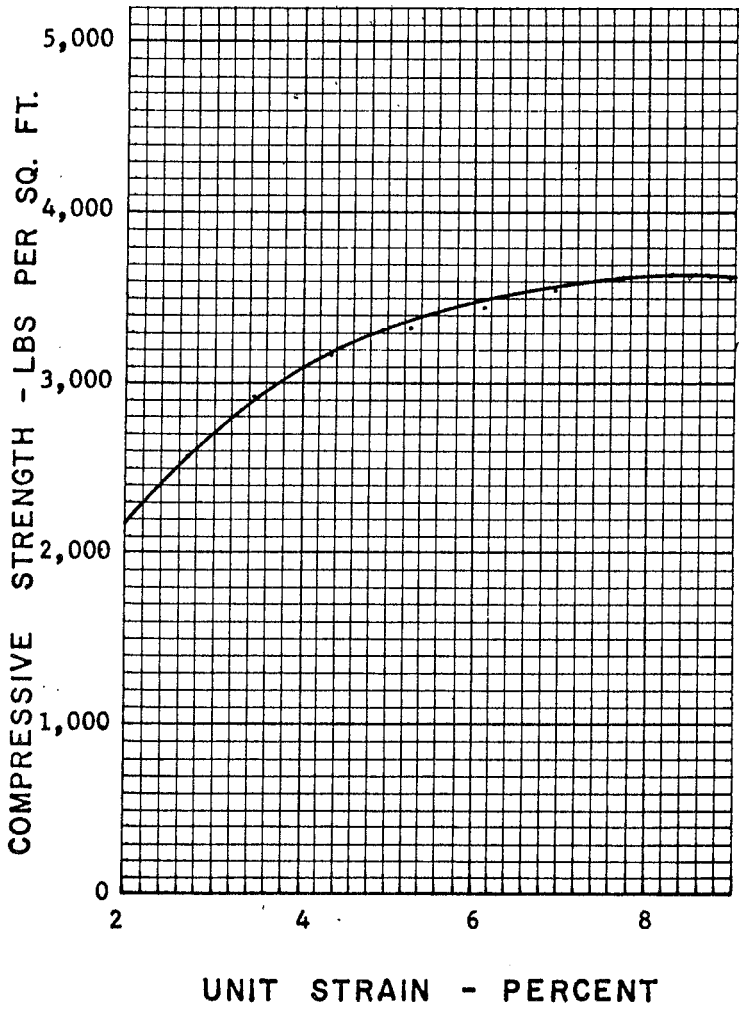
CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

TEST RESULTS

HOLE NO. 2 SAMPLE NO. _____ FROM 0.5 TO 1.5

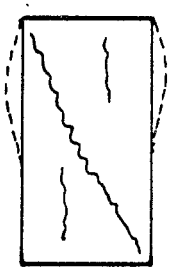
MATERIAL DESCRIPTION: Black Silty Clay - Moist, Plastic



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	3,650.40
PERCENT STRAIN	8.55
PERCENT MOISTURE	30.5
DRY DENSITY LBS PER CU. FT.	92.3
LIQUID LIMIT	
PLASTIC LIMIT	
PLASTICITY INDEX	
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



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4834 S. 83RD E. AVE. TULSA, OKLAHOMA

UNCONFINED COMPRESSION TEST

DATE: April 22, 1969

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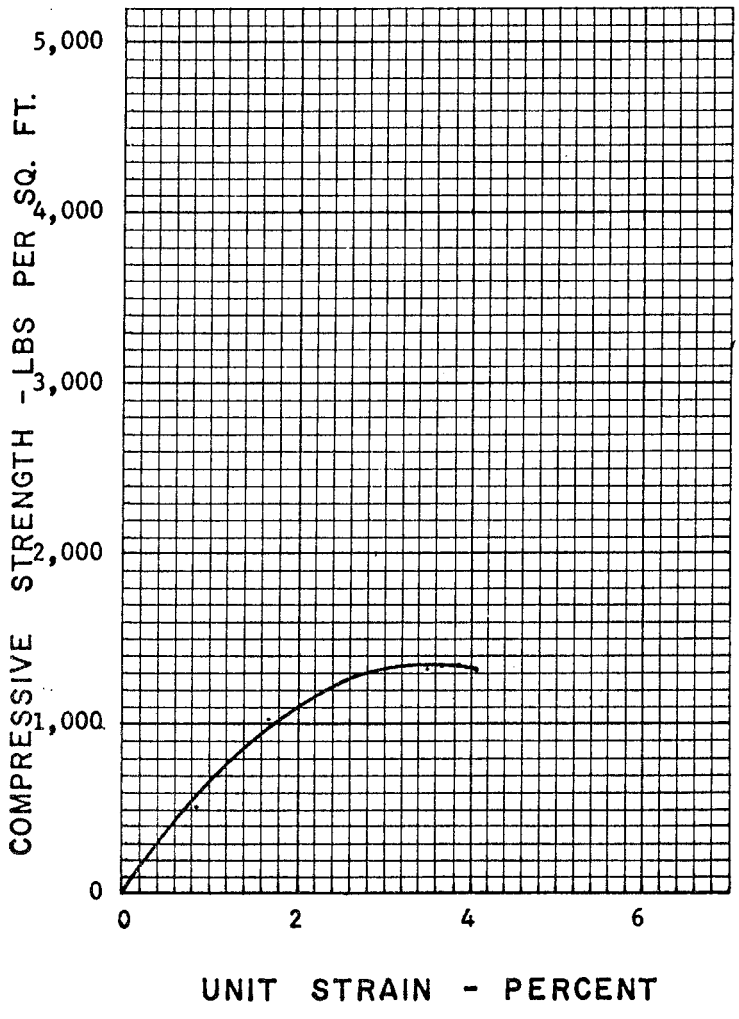
PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

TEST RESULTS

HOLE NO. 3 SAMPLE NO. _____ FROM 1.5 TO 2.5

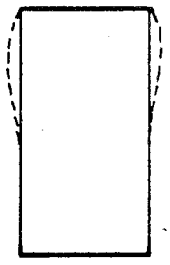
MATERIAL DESCRIPTION: Reddish Brown Clay, Slightly Silty - Moist, Plastic



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	1,352.16
PERCENT STRAIN	3.84
PERCENT MOISTURE	29.5
DRY DENSITY LBS PER CU. FT.	88.8
LIQUID LIMIT	
PLASTIC LIMIT	
PLASTICITY INDEX	
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



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UNCONFINED COMPRESSION TEST

DATE: April 22, 1969

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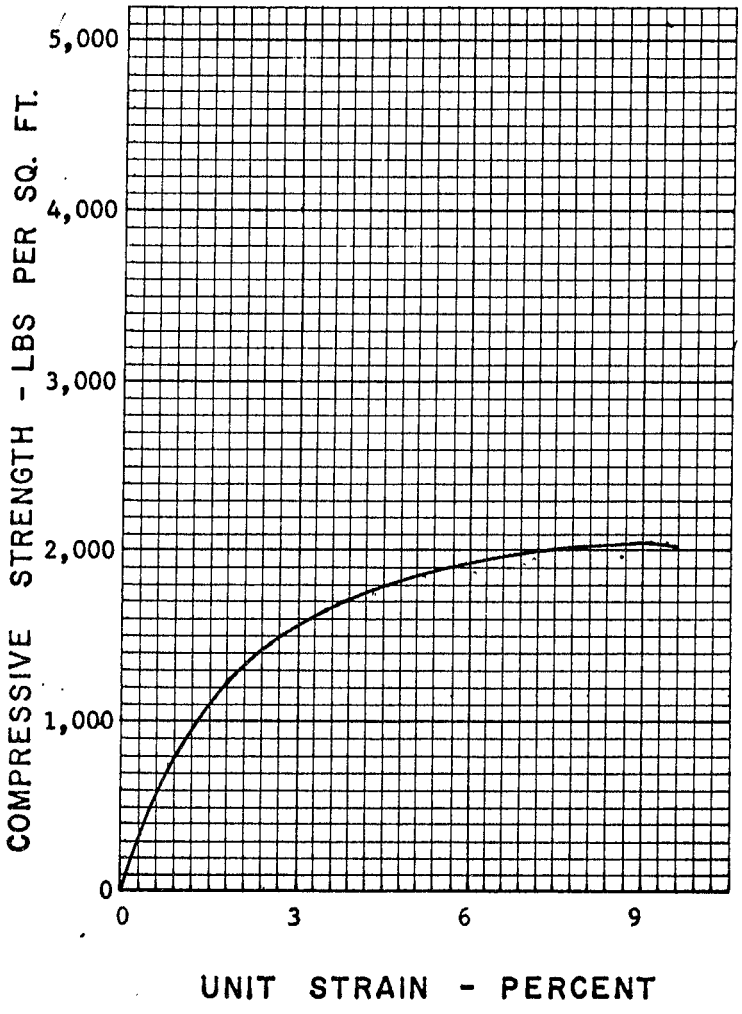
PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

TEST RESULTS

HOLE NO. 4 SAMPLE NO. _____ FROM 0.0 TO 1.0

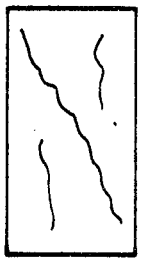
MATERIAL DESCRIPTION: Black Silty Clay, Moist, Plastic



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	2,044.80
PERCENT STRAIN	9.25
PERCENT MOISTURE	31.2
DRY DENSITY LBS PER CU. FT.	86.4
LIQUID LIMIT	
PLASTIC LIMIT	
PLASTICITY INDEX	
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



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4834 S. 83RD E. AVE. TULSA, OKLAHOMA

UNCONFINED COMPRESSION TEST

DATE: April 22, 1969

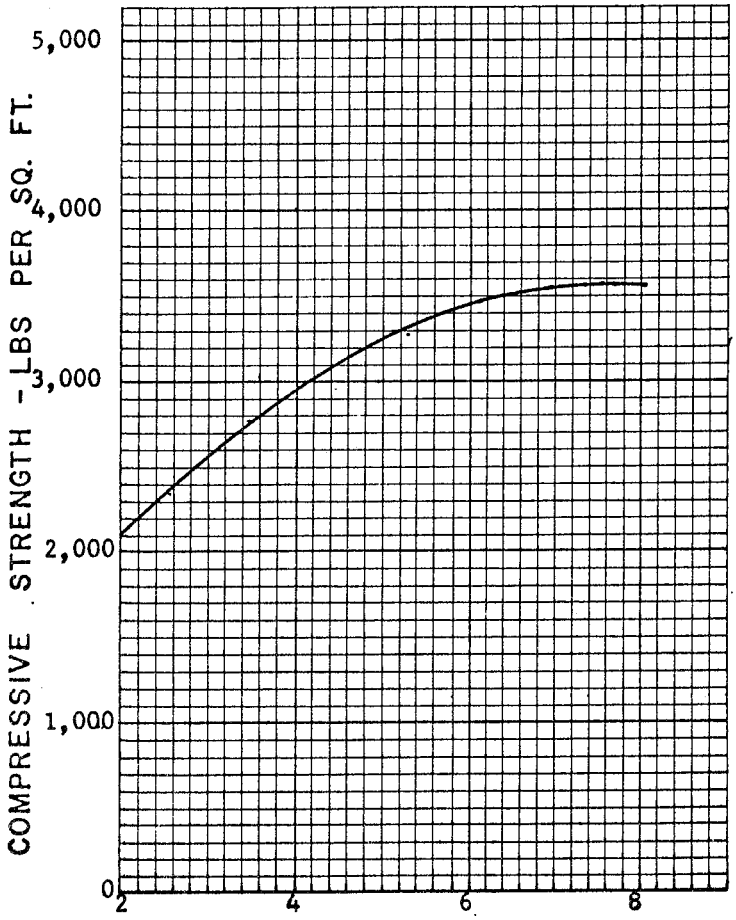
CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

TEST RESULTS

HOLE NO. 6 SAMPLE NO. _____ FROM 2.0 TO 3.0

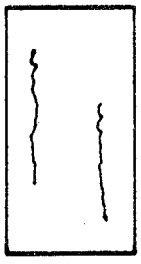
MATERIAL DESCRIPTION: Reddish Brown Clay - Moist, Plastic



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	3,587.04
PERCENT STRAIN	7.68
PERCENT MOISTURE	25.5
DRY DENSITY LBS PER CU. FT.	94.1
LIQUID LIMIT	39.8
PLASTIC LIMIT	25.8
PLASTICITY INDEX	14.0
SHRINKAGE LIMIT	17.41
SHRINKAGE RATIO	1.787
CLASSIFICATION	CL
-#200 Sieve	58.8%

FAILURE CONDITIONS



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UNCONFINED COMPRESSION TEST

DATE: April 22, 1969

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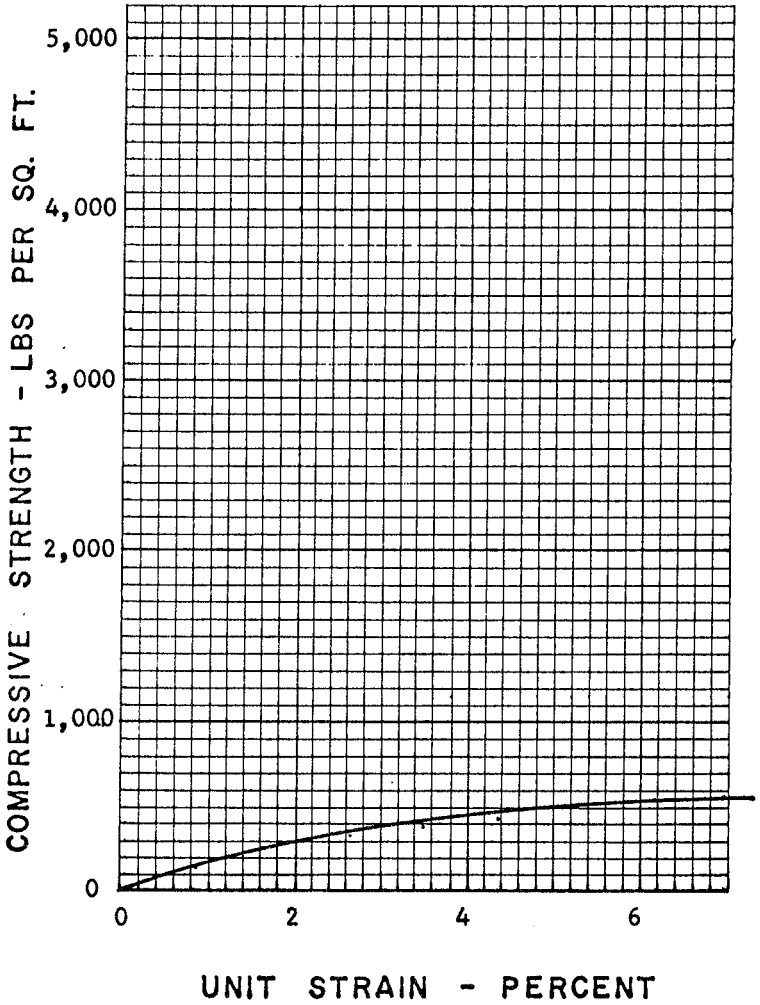
PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

TEST RESULTS

HOLE NO. 9 SAMPLE NO. _____ FROM 0.0 TO 1.0

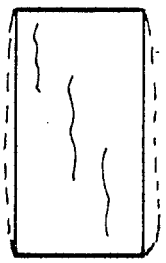
MATERIAL DESCRIPTION: Black Silty Clay - Moist, Plastic



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	577.44
PERCENT STRAIN	6.98
PERCENT MOISTURE	34.8
DRY DENSITY LBS PER CU. FT.	82.0
LIQUID LIMIT	
PLASTIC LIMIT	
PLASTICITY INDEX	
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



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UNCONFINED COMPRESSION TEST

DATE: April 22, 1969

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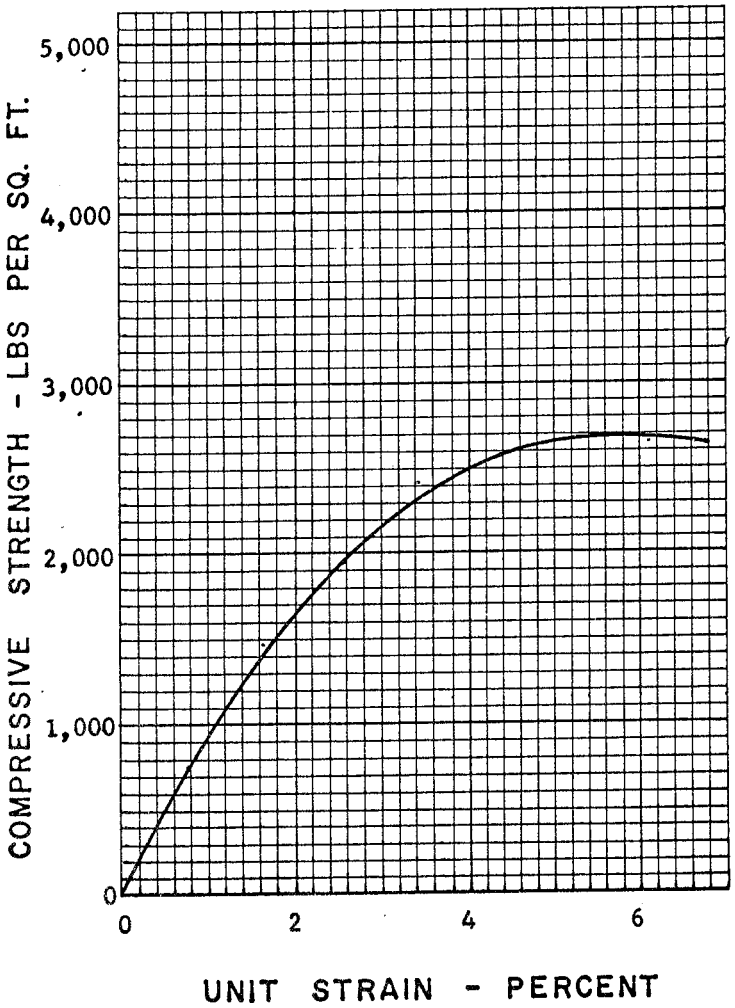
PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

TEST RESULTS

HOLE NO. 10 SAMPLE NO. _____ FROM 0.0 TO 1.0

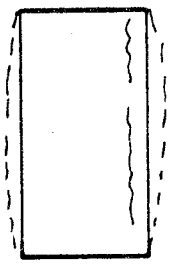
MATERIAL DESCRIPTION: Black Silty Clay - Moist, Plastic



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	2,748.96
PERCENT STRAIN	6.98
PERCENT MOISTURE	26.4
DRY DENSITY LBS PER CU. FT.	94.4
LIQUID LIMIT	
PLASTIC LIMIT	
PLASTICITY INDEX	
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



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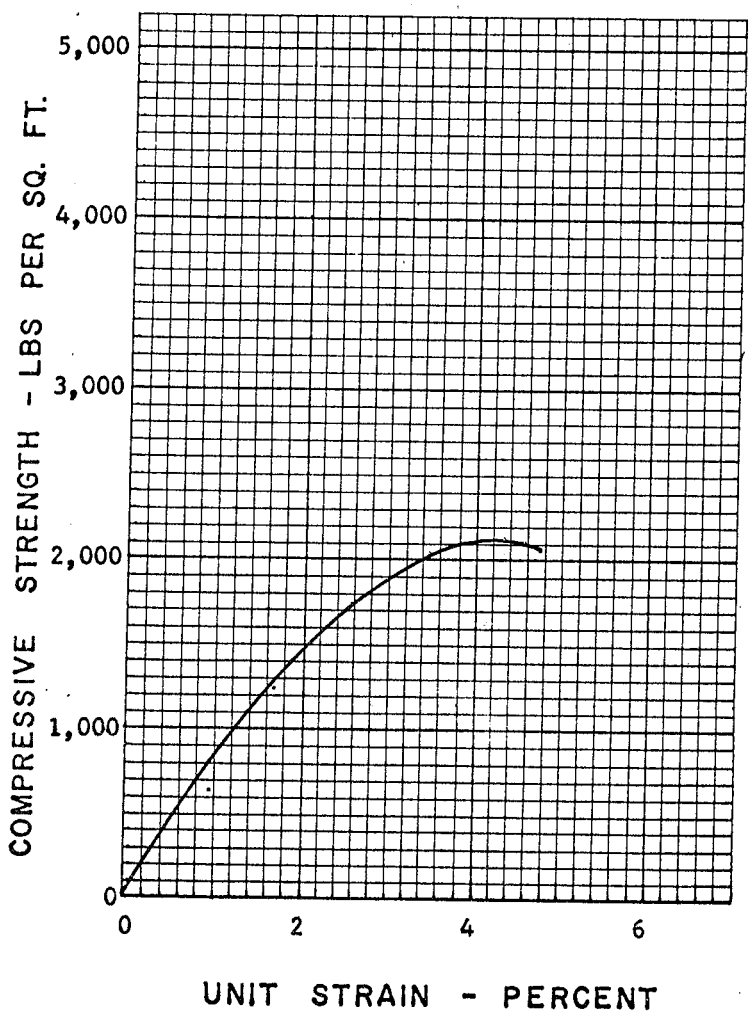
TEST RESULTS

HOLE NO. 15 SAMPLE NO. _____ FROM 0.5 TO 1.5

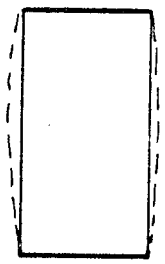
MATERIAL DESCRIPTION: Black to Brown Silty Clay - Moist, Plastic



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	2,113.92
PERCENT STRAIN	4.36
PERCENT MOISTURE	29.3
DRY DENSITY LBS PER CU. FT.	88.0
LIQUID LIMIT	
PLASTIC LIMIT	
PLASTICITY INDEX	
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



HEMPHILL CORPORATION

4834 S. 83RD E. AVE. TULSA, OKLAHOMA

MOISTURE - DENSITY CURVE

DATE: April 29, 1969

CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

MATERIAL: Black Silty Clay Topsoil

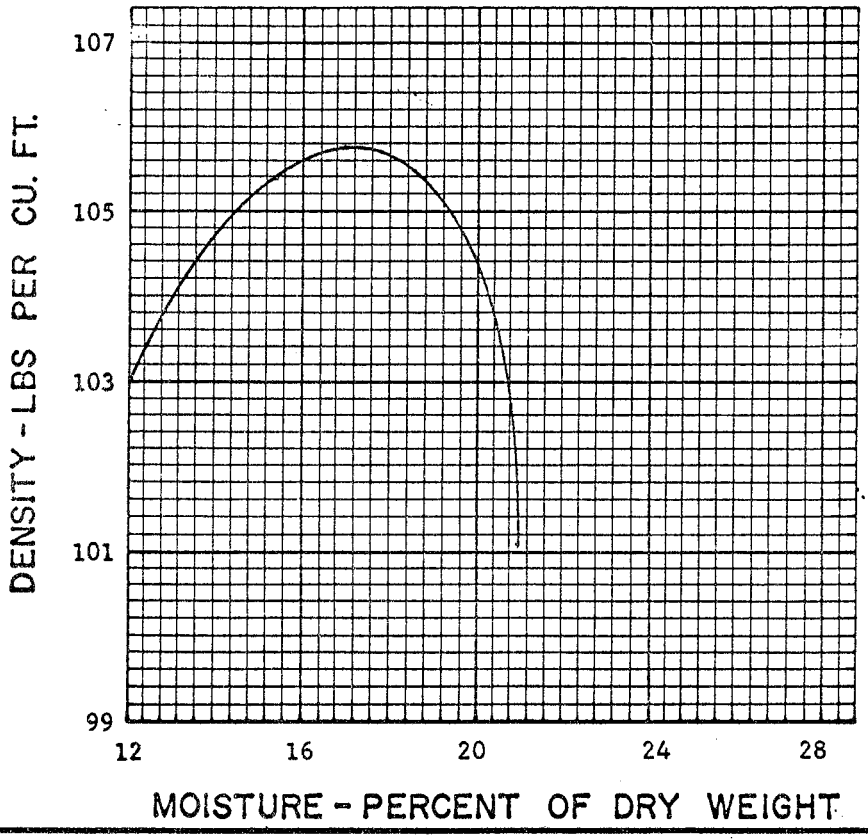
MATERIAL SOURCE: Approximate depth 0.0' - 1.3'

METHOD OF TEST: A.S.T.M. D 1557, Method A

TEST RESULTS

MAXIMUM DRY DENSITY = 105.7 LBS PER CU. FT.

OPTIMUM MOISTURE CONTENT = 17.0 %



PHYSICAL PROPERTIES

LIQUID LIMIT = ____ %

PLASTIC LIMIT = ____ %

PLASTICITY INDEX = ____ %

SHRINKAGE LIMIT = ____ %

HEMPHILL CORPORATION

UNCONFINED COMPRESSION TEST

DATE: April 29, 1969

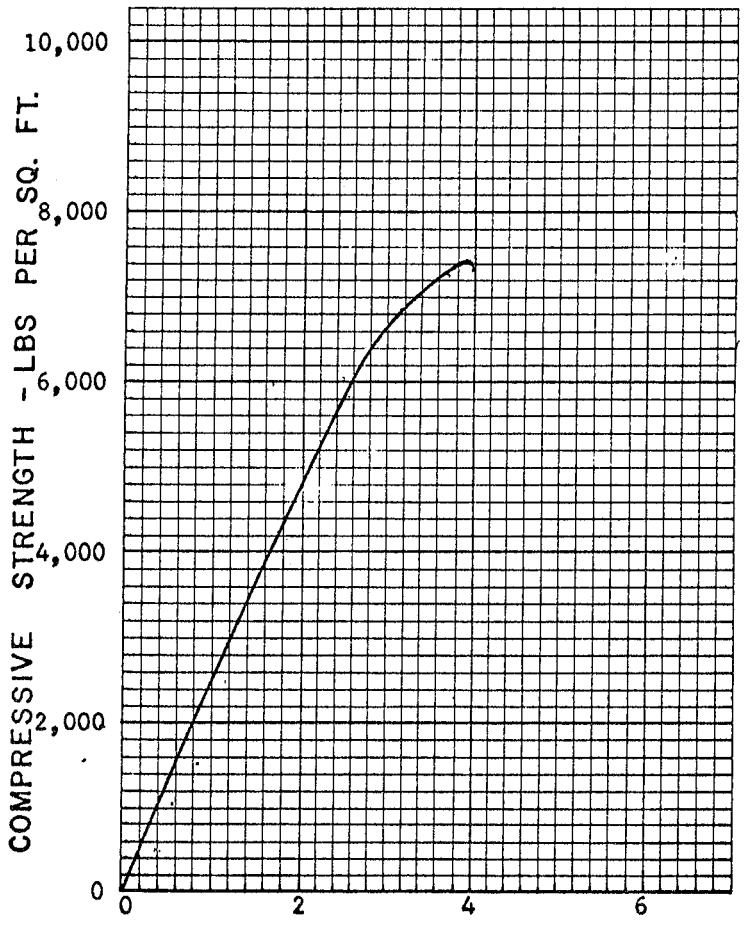
CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

TEST RESULTS

HOLE NO. Remolded SAMPLE NO. one (1) FROM 0.0 TO 1.3

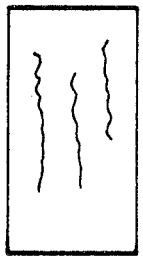
MATERIAL DESCRIPTION: Black Silty Clay Topsoil



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	7,454.88
PERCENT STRAIN	3.90
PERCENT MOISTURE	16.8
DRY DENSITY LBS PER CU. FT.	95% Max.
LIQUID LIMIT	
PLASTIC LIMIT	
PLASTICITY INDEX	
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



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4834 S. 83RD E. AVE. TULSA, OKLAHOMA

UNCONFINED COMPRESSION TEST

DATE: April 29, 1969

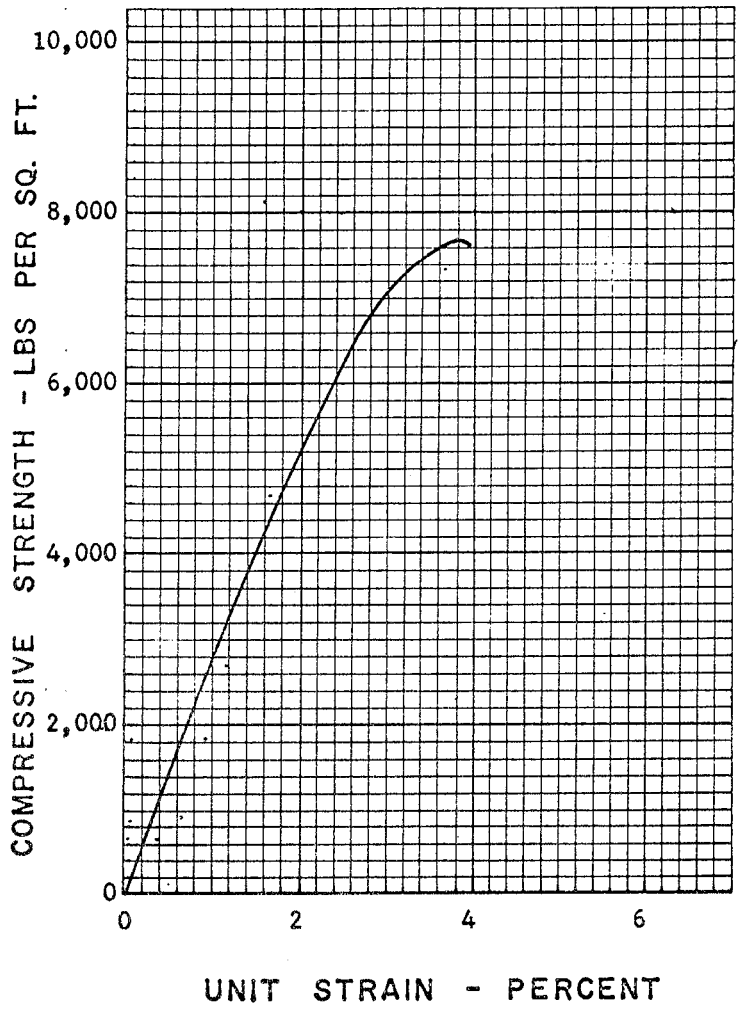
CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

TEST RESULTS

HOLE NO. Remolded SAMPLE NO. Two (2) FROM 0.0 TO 1.3

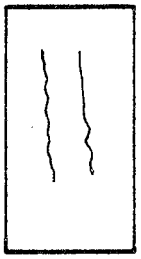
MATERIAL DESCRIPTION: Black Silty Clay Topsoil



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	7,737.12
PERCENT STRAIN	3.78
PERCENT MOISTURE	18.9
DRY DENSITY LBS PER CU. FT.	95% Max.
LIQUID LIMIT	
PLASTIC LIMIT	
PLASTICITY INDEX	
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



HEMPHILL CORPORATION

4834 S. 83RD E. AVE. TULSA, OKLAHOMA

MOISTURE - DENSITY CURVE

DATE: April 29, 1969

CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

MATERIAL: Reddish Brown Clay, slightly silty

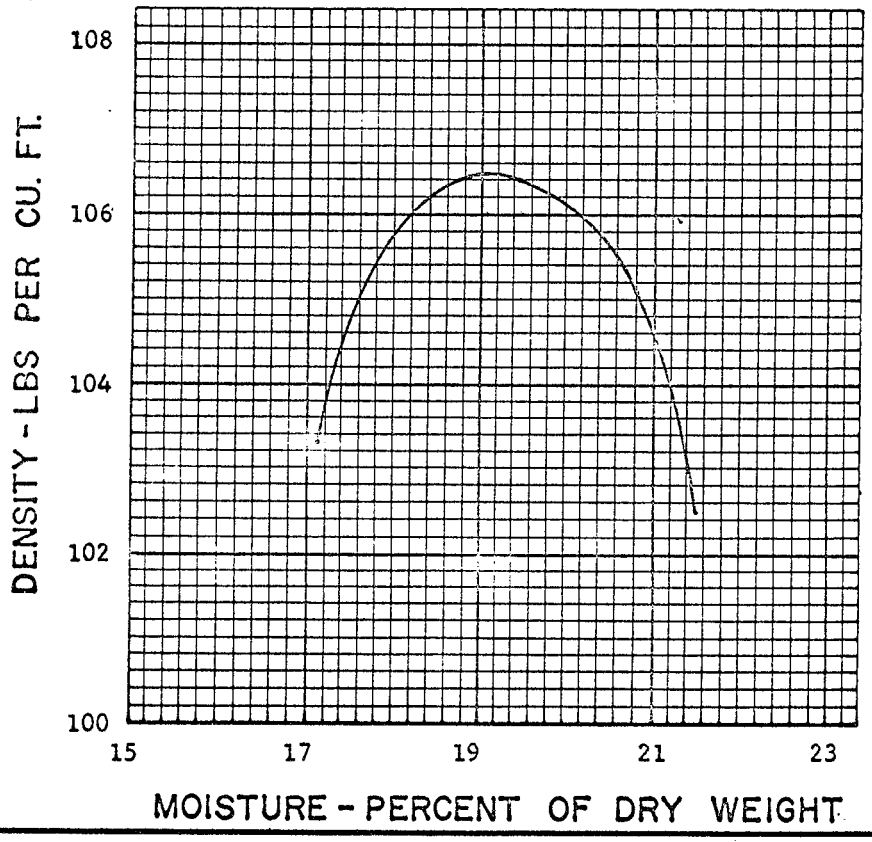
MATERIAL SOURCE: Approximate depth 1.5' - 3.0'

METHOD OF TEST: A.S.T.M. D 1557, Method A

TEST RESULTS

MAXIMUM DRY DENSITY = 106.4 LBS PER CU. FT.

OPTIMUM MOISTURE CONTENT = 19.1 %



PHYSICAL PROPERTIES

LIQUID LIMIT = 47.3 %

PLASTIC LIMIT = 18.7 %

PLASTICITY INDEX = 28.6 %

SHRINKAGE LIMIT = ____ %

HEMPHILL CORPORATION

UNCONFINED COMPRESSION TEST

DATE: April 29, 1969

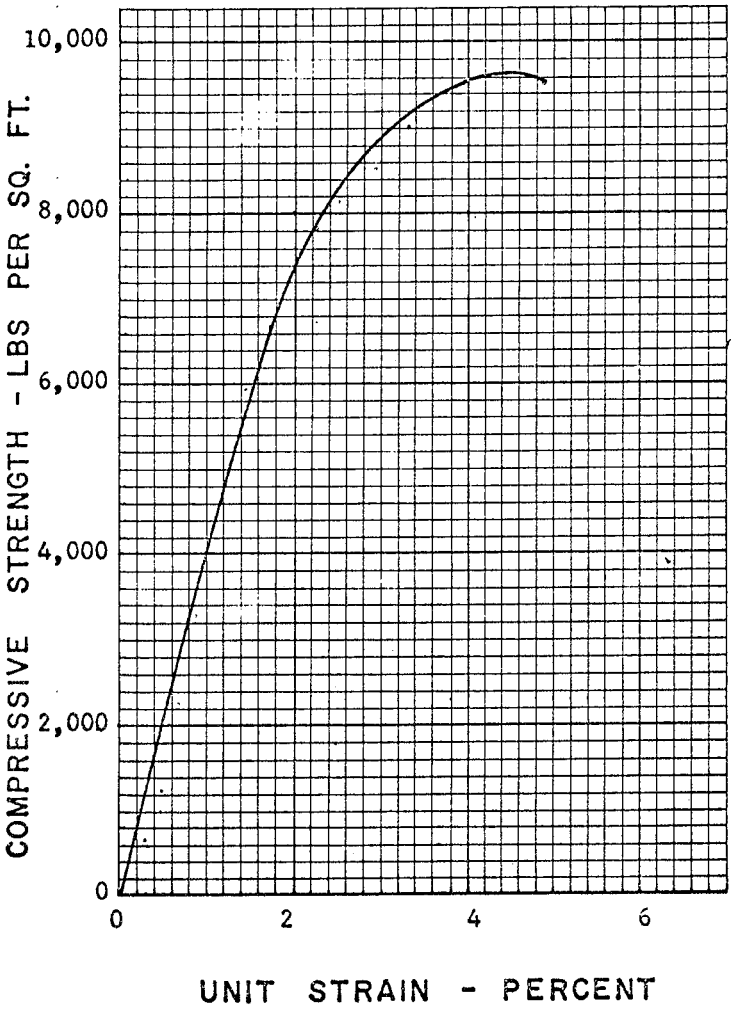
CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for Kansas Area Test Track

TEST RESULTS

HOLE NO. Remolded SAMPLE NO. one (1) FROM 1.5' TO 3.0'

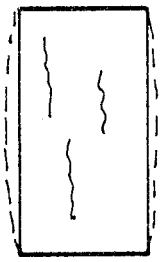
MATERIAL DESCRIPTION: Reddish Brown Clay, slightly silty



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	9,672.48
PERCENT STRAIN	4.43
PERCENT MOISTURE	20.1
DRY DENSITY LBS PER CU. FT.	95% Max.
LIQUID LIMIT	47.3
PLASTIC LIMIT	18.7
PLASTICITY INDEX	28.6
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



HEMPHILL CORPORATION

4834 S. 83RD E. AVE. TULSA, OKLAHOMA

UNCONFINED COMPRESSION TEST

DATE: April 29, 1969

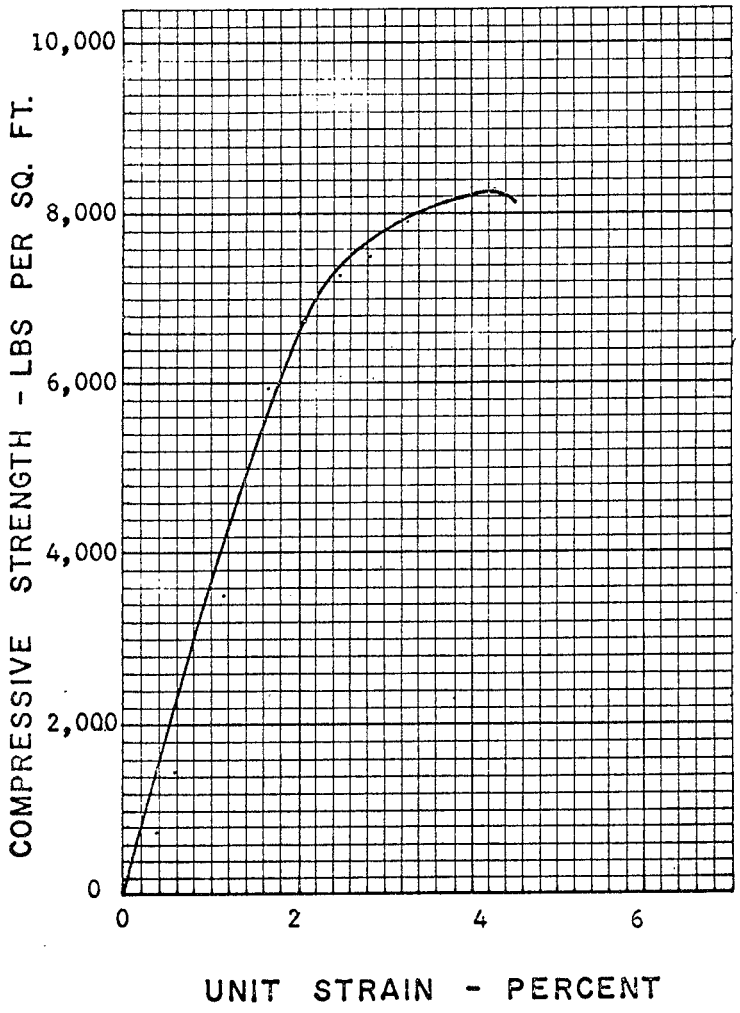
CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for Kansas Area Test Track

TEST RESULTS

HOLE NO. Remolded SAMPLE NO. two (2) FROM 1.5' TO 3.0'

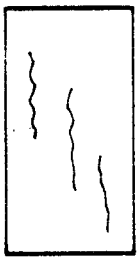
MATERIAL DESCRIPTION: Reddish Brown Clay, slightly silty



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	8,271.36
PERCENT STRAIN	4.20
PERCENT MOISTURE	20.8
DRY DENSITY LBS PER CU. FT.	95% Max.
LIQUID LIMIT	47.3
PLASTIC LIMIT	18.7
PLASTICITY INDEX	28.6
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



HEMPHILL CORPORATION

4834 S. 83RD E. AVE. TULSA, OKLAHOMA

MOISTURE - DENSITY CURVE

DATE: April 29, 1969

CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

MATERIAL: Mottled gray, yellow, tan clay with shale particles

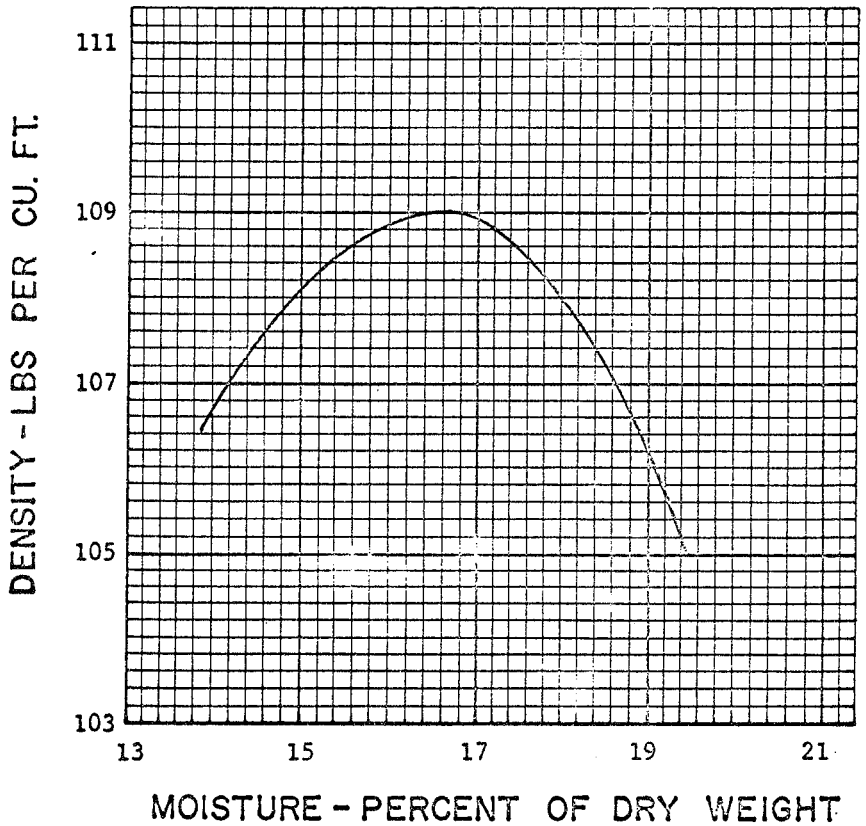
MATERIAL SOURCE: Approximate depth 3.0' - 3.7'

METHOD OF TEST: A.S.T.M. D 1557, Method A

TEST RESULTS

MAXIMUM DRY DENSITY = 109.0 LBS PER CU. FT.

OPTIMUM MOISTURE CONTENT = 16.6 %



PHYSICAL PROPERTIES

LIQUID LIMIT = 31.5 %

PLASTIC LIMIT = 20.5 %

PLASTICITY INDEX = 11.0 %

SHRINKAGE LIMIT = ____ %

HEMPHILL CORPORATION

UNCONFINED COMPRESSION TEST

DATE: April 29, 1969

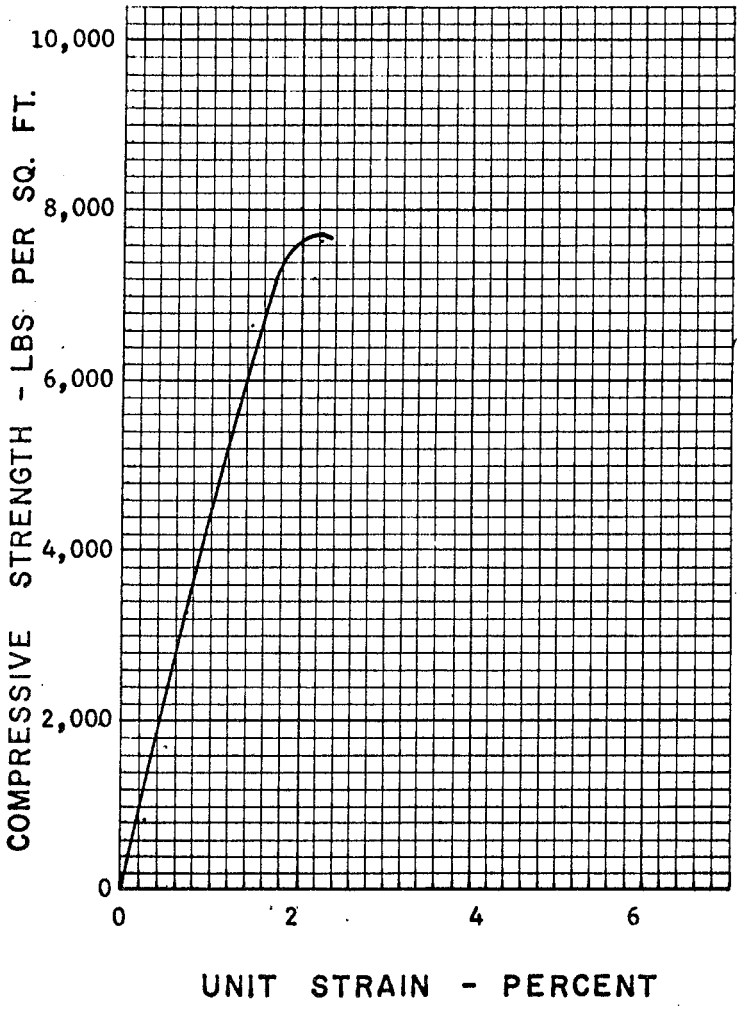
CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for Kansas Area Test Track

TEST RESULTS

HOLE NO. Remolded SAMPLE NO. One (1) FROM 3.0 TO 3.7

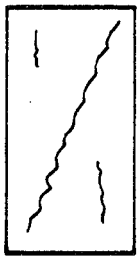
MATERIAL DESCRIPTION: Mottled gray, yellow, tan clay with shale particles



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	7,704.00
PERCENT STRAIN	2.17
PERCENT MOISTURE	17.1
DRY DENSITY LBS PER CU. FT.	95% Max
LIQUID LIMIT	31.5
PLASTIC LIMIT	20.5
PLASTICITY INDEX	11.0
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



HEMPHILL CORPORATION

4834 S. 83RD E. AVE. TULSA, OKLAHOMA

UNCONFINED COMPRESSION TEST

DATE: April 29, 1969

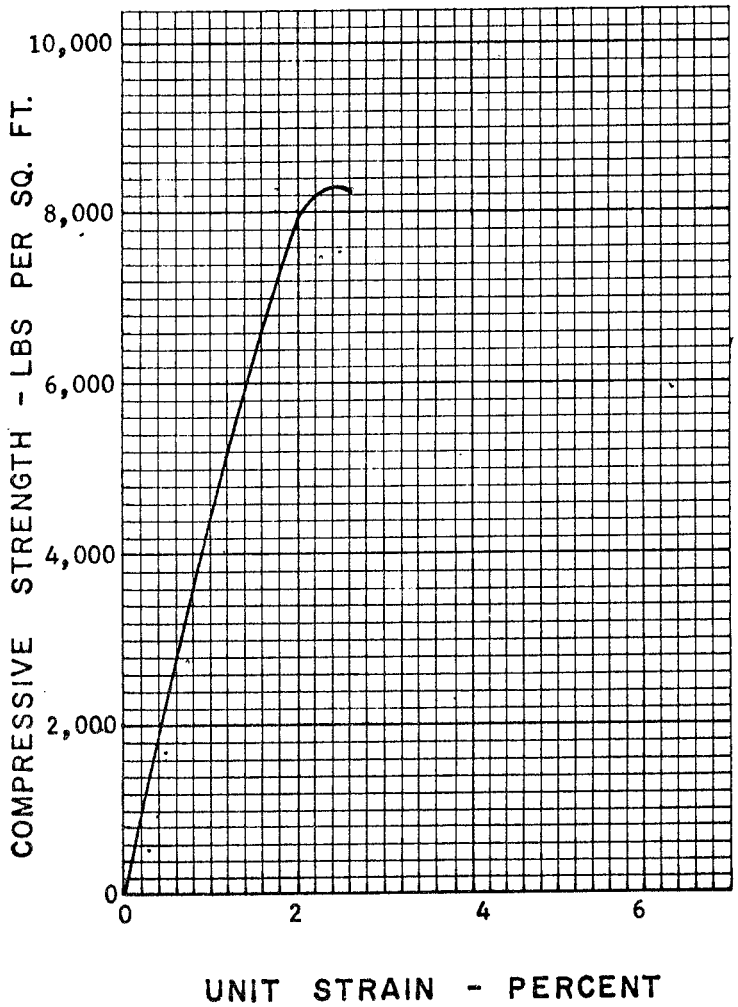
CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for Kansas Area, Test Track

TEST RESULTS

HOLE NO. Remolded SAMPLE NO. Two (2) FROM 3.0 TO 3.7

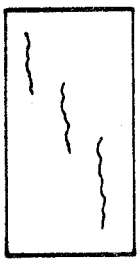
MATERIAL DESCRIPTION: Mottled gray, yellow, tan clay with shale particles



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	8,228.16
PERCENT STRAIN	2.43
PERCENT MOISTURE	16.4
DRY DENSITY LBS PER CU. FT.	95% Max
LIQUID LIMIT	31.5
PLASTIC LIMIT	20.5
PLASTICITY INDEX	11.0
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	CL

FAILURE CONDITIONS



HEMPHILL CORPORATION

4834 S. 83RD E. AVE. TULSA, OKLAHOMA

BORING LOG

HOLE NO. 1

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8513+00 See Boring Location Plan — DATE 4-16-69

GND. ELEV. 1417.2' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1417.2	0.0						
	1.0			Clay, Silty, Black, Plastic, Moist			Air Drilling
			1½/2⅝				
1415.2	2.0			Limestone, Tan to Gray, Dense, Medium Hard w/Very Thin Interbedded Tan Shale Layers. Refusal: Permian Age - Ft. Riley member.			Coring 4.2
					38%		
1411.2	6.0						6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 1

BORING LOG

HOLE NO. 2

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8514+62 — DATE 4-16-69

GND. ELEV. 1416.7' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA NX Heavy Duty

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1416.7	0.0			Clay, Silty, Black Grading into Reddish Brown, Plastic, Moist			Air Drilling 0.5
							Shelby Tube 1.5
	2.0		3/5				
1413.8	2.9			Gradational Clay, Silty, to Clay-Shale, Mottled Yellow, Tan, Brown, Slightly Moist. Refusal: Permian Age - Ft. Riley member			
1412.9	3.8						Coring 4.0
				Limestone, Gray, Dense, Medium Hard w/Thin Layers of Interbedded Tan Shale Note: Natural Vertical Fractures from 4.5 - 5.3.	100%		
1410.7	6.0						6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 2

BORING LOG

HOLE NO. 3

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8517+00 See Boring Location Plan — DATE 4-17-69

GND. ELEV. 1417.5' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA NX Heavy Duty

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1417.5	0.0						
1416.5	1.0			Clay, Silty, Black, Moist, Plastic			Air Drilling
1415.0	2.5			Clay, Slightly Silty, Reddish Brown, Moist, Plastic			1.5 Shelby Tube 2.5
1414.5	3.0			Clay, to Clay-Shale, Yellow Refusal: Permian Age - Ft. Riley member			
1411.5	6.0			Limestone, Buff, Shaley, Dense, Medium Soft, Vugular from 4.1 to 4.6 Note: Drainage or seepage water at 3.2'	100%		Coring 4.0 6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 3

BORING LOG

HOLE NO. 4

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8523+00 — DATE 4-24-69

GND. ELEV. 1422.4' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA NX Heavy Duty

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	CORE % RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1422.4	0.0						Air Drilling 0.0
1421.3	1.1			Clay, Silty, Black, Moist, Plastic			Shelby Tube 1.0
	1.5			Clay, Slightly Silty, Reddish Brown			Air Drilling
	2.5		2/3				
1418.4	4.0			Gradation Clay - Clay-Shale Gray Tan, Slightly Moist and Slightly Plastic in Upper Part Only Refusal: Permian Age - Ft. Riley member			
1417.1	5.3			Limestone, Buff to Gray, Dense, Medium Hard w/Interbedded Thin Tan, Medium Soft Shale Laminae and Becoming Shaley Limestone From 14.7 - 16.2			Coring 6.0
					100%		
1406.2	16.2						16.2
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 4

BORING LOG

HOLE NO. 5

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8535+22 — DATE 4-24-69

GND. ELEV. 1416.1' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA NX Heavy Duty

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1416.1	0.0						
1415.7	0.4			Clay, Silty, Black, Slightly Moist w/Chunks of Free Limestone on Surface			Air Drilling
1413.9	2.2			Clay, Slightly Silty, Reddish Brown, Moist, Plastic			
	3.0			Gradational Clay - Clay Shale, Gray Tan, Slightly Moist and Plastic From 2.2 - 3.0			
	4.0		14/23	Refusal: Permian Age - Ft. Riley member			
1409.9	6.2			Limestone, Buff to Gray, Shaley From 6.2 to 11.5 (Rather than interbedded) Medium Soft Where Shaley and Then Grading into Dense Medium Hard Limestone			Coring 7.5
					87%		
1403.1	13.0						13.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 5

BORING LOG

HOLE NO. 6

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 854+00 See Boring Location Plan — DATE 4-17-69

GND. ELEV. 1410.4' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA NX Heavy Duty

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1410.4	0.0						
1409.2	1.2			Clay, Silty, Black, Plastic, Moist			Air Drilling
				Clay, Reddish Brown, Plastic, Moist			2.0
1407.6	2.8						Shelby Tube 3.0
1407.1	3.3			Clay Grading into a Clay-Shale, Mottled Gray, Yellow Tan, With a Few Fine Gravels, Slightly Moist Refusal: Permian Age - Ft. Riley member			
				Limestone, Buff to Gray, Dense, Medium Hard w/Interbedded Thin Layers of Tan to Yellow Shale			Coring 4.0
1404.4	6.0				100%		6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 6

BORING LOG

HOLE NO. 7

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8549+39 See Boring Location Plan — DATE 4-17-69

GND. ELEV. 1400.0' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA Heavy Duty NX

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT (0 6 12 18 24)	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
0.0	0.0						
				Clay, Silty, Black, Plastic, Moist			Air Drilling
1398.3	1.7						(Attempted Penetration @ 1.5')
				Limestone, Gray to Tan, Medium Soft, Shaley			
1397.5	2.5						
				Clay-Shale, Yellow, Moist (Saved Jar Sample) Refusal: Permian Age - Ft. Riley member			
1396.2	3.8						
				Limestone, Buff-Gray, Dense, Medium Hard w/Vugs From 4.4 - 4.5			Coring 4.2
					100%		
1394.0	6.0						6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 7

BORING LOG

HOLE NO. 8

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8560+00 See Boring Location Plan — DATE 4-23-69

GND. ELEV. 1398.3' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA Heavy Duty NX

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	CORE % RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1398.3	0.0			Mixture of Limestone Boulders, Clay and Clay-Shale at Surface			Air Drilling
1397.8	0.5			Refusal: Permian Age - Ft. Riley member			
				Limestone, Buff to Gray, Dense, Medium Hard to Hard w/Limey Shale in Core From 2.0 - 2.2' and Several Very Thin Slightly Weathered Shale Layers Below	92.5%		Coring 2.0
1392.3	6.0						6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 8

BORING LOG

HOLE NO. 9

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Sta. 8563+06 See Boring Location Plan — DATE 4-17-69

GND. ELEV. 1394.0' — G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA Heavy Duty NX

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Field Log, Coring Data, Etc.)
1394.0	0.0						Air Drilling
1392.8	1.2			Clay, Silty, Black, Plastic Moist			Shelby Tube 1.0
1392.6	1.4			Clay-Shale, Mottled Yellow Tan, Brown, Slightly Moist Refusal:: Permian Age - Ft. Riley member			
1390.6	3.4			Limestone, Buff to Gray, Dense, Medium Soft to Medium Soft to Medium Hard w/Interbedded Tan, Medium Soft Shale Layers	100%		Coring 2.0
1390.4	3.6			Clay-Shale, Mottled Yellow Tan, Medium Soft, Slightly Moist			
1388.0	6.0			Limestone, Gray, Dense, Medium Hard w/Interbedded Thin Laminae of Tan, Medium Soft Shale			6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 9

BORING LOG

HOLE NO. 10

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8568+76 See Boring Location Plan — DATE 4-23-69

GND. ELEV. 1393.9' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA Heavy Duty NX

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Field Log, Coring Data, Etc.)
1393.9	0.0						Air Drilling
1392.8	1.1			Clay, Silty, Black, Moist Plastic			Shelby Tube 1.0
1391.4	1.3			Clay, Reddish Brown, Slightly Silty, Moist Plastic			
				Gradational From Clay-Shale, Yellow Tan, Medium Hard to Shale, Tan, Limey, Medium Hard w/Interbedded Dense, Medium Hard, Limestone			Coring 1.7
1391.4	2.5			Refusal: Permian Age - Ft. Riley member	100%		
1387.9	6.0			Limestone, Dense, Buff to Gray, Medium Hard w/Very Thin Layers of Tan, Medium Soft Shale			6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 10

BORING LOG

HOLE NO. 11

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8575+42 See Boring Location Plan — DATE 4-24-69

GND. ELEV. 1397.8' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT (0 / 25 / 50 / 75 / 100)	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1397.8	0.0			Clay, Slightly Silty, Reddish Brown, Moist, Plastic (All Fill)			Air Drilling
1394.8	3.0			Clay, Silty, Black, Wet From Adjacent Ditch Drainage, Plastic			(Attempted Penetration from 6.5-6.8 total 5 blows)
	6.8			Clay, Yellow Gray Grading into Clay-Shale @ 6.8' Refusal: Permian Age - Ft. Riley member			
	7.8			Bottom of Hole			7.8

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 11

BORING LOG

HOLE NO. 12

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8582+00 See Boring Location Plan — DATE 4-23-69

GND. ELEV. 1399.2' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA — WT. OF HAMMER — FALL OF HAMMER

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA Heavy Duty NX

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1398.2	0.0						Air Drilling
1393.7	0.5			Clay, Silty, Black, Moist, Plastic			
				Clay, Slightly Silty, Reddish-Brown, Moist, Plastic			
1393.4	5.8						
				Clay, Yellow Gray, Moist Plastic (Carrying drainage water from present railroad ditch) Grading into Clay-Shale from 6.8-7.0' Refusal: Permian Age - Ft. Riley member			
1392.2	7.0						Coring 7.5
				Limestone, Buff to Gray, Dense, Medium Hard w/Thin Layers of Tan, Medium Soft, Limey Shale from 8.0-8.2, 9.9-10.4, and Vugs Noted in Limestone from 10.4-10.8'	96.4%		
1386.2	13.0						13.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 12

BORING LOG

HOLE NO. 13

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8587+00 See Boring Location Plan — DATE 4-23-69

GND. ELEV. 1396.7' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA — WT. OF HAMMER — FALL OF HAMMER

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA Heavy Duty NX

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1396.7	0.0						
1396.2	0.5			Clay, Silty, Black, Moist, Plastic			Air Drilling
				Clay, Slightly Silty, Reddish-Brown, Moist, Plastic			
1393.2	3.5						
				Clay, Tan Gray, More Moist Than Above Clay, Plastic w/Trace of Gravel Grading into a Clay-Shale from 4.3-4.5			
392.2	4.5			Refusal: Permian Age - Ft. Riley member			Coring 4.5
				Limestone, Buff to Gray, Dense, Medium Soft to Medium Hard w/Vertical Fracture from 4.5-5.5; Shale, Tan, Limey, Medium Soft from 5.7-6.1, from 7.5-7.9, from 11.4-11.6, and 13.4-13.6 and 15.3-15.4; Open Vertical Fracturing from 15.4 to 16.7; Also Closed Cross-Vertical Fractures Noted from 8.0-9.0'			
1378.7	18.0						18.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 13

BORING LOG

HOLE NO. 14

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8590+00 See Boring Location Plan — DATE 4-23-69

GND. ELEV. 1392.0' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA Heavy Duty NX

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1392.0	0.0						
				Clay, Silty, Black, Moist, Plastic			Air Drilling
1391.0	1.0						
			3/5	Clay, Slightly Silty, Red, Moist, Plastic			
	2.0						
1389.2	2.8						2.9
				Clay, Yellowish-Gray, Slightly Moist, Grading into Clay-Shale			Shelby Tube 3.2
1388.7	3.3			Refusal: Permian Age - Ft. Riley member			Coring 3.5
				Limestone, Buff to Gray, Dense, Shaley from 3.3 to 3.7 and Containing a Vertical Fracture from 3.3 to 4.5	92%		6.0
1386.0	6.0			Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 14

BORING LOG

HOLE NO. 15

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8594+00 See Boring Location Plan — DATE 4-23-69

GND. ELEV. 1386.0' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA Heavy Duty NX

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1386.0	0.0			Clay, Silty, Black to Brown Moist, Plastic			Air Drilling 0.5
							Shelby Tube 1.5
1383.5	2.5						(Attempted Shelby Tube @ 2.5' but obtained jar sample only) 3.0
1382.8	3.2			Clay-Shale, Mottled Yellow Brown Gray, Medium Hard (Note: Too Hard to Push and too Soft to Recover Core) Refusal: Permian Age - Ft. Riley member			Coring
				Limestone, Buff to Gray, Dense, Medium Hard w/ a Few Very Thin Laminae of Shale, Tan, Medium Hard	93%		
1380.0	6.0			Bottom of Hole			6.0

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 15

BORING LOG

HOLE NO. 16

PROJECT U. S. Department of Transportation - Test Track - Kansas — SHEET NO. 1 OF 1

HOLE LOCATION Station 8598+40 See Boring Location Plan — DATE 4-23-69

GND. ELEV. 1382.8' G.W. ELEV. — BORED BY Risenhoover — LOGGED BY John Eidt

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA Heavy Duty NX

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
1382.8	0.0						
	0.3			Clay, Slightly Silty, Reddish Brown, Moist, Plastic			Air Drilling
1381.6	1.2		8				Coring 1.3
				Gradational Clay-Shale, Medium Soft, Tan to Tan Shale w/Interbedded Dense Limestone Refusal: Permian Age - Ft. Riley member			
1380.7	2.1			Limestone, Buff to Gray, Dense, Medium Hard w/ an Occassional Thin Laminae of Tan, Medium Soft Shale also a Vug Noted at 5.3 and Shale, Tan, Medium Soft from 5.5 to 5.7	82.9%		
1376.8	6.0			Bottom of Hole			6.0

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 16

NEW MEXICO AREA

REPORT FOR
U. S. DEPARTMENT OF TRANSPORTATION
TEST TRACK
NEW MEXICO

I - Introduction

A. Purpose of Survey

The purpose of the survey was to examine the proposed U. S. Department of Transportation test track site in New Mexico from a geological and laboratory testing investigation through the use of samples obtained from prescribed test borings taken along its center-line and potential borrow areas.

B. Location of Site

The test track site is located 30 feet south of the center-line of the existing Santa Fe track between mile posts 684 and 686, between Melrose and Cantara, New Mexico, while the borrow borings were taken 60 feet south of the existing track. The natural terrain of the site is relatively flat.

C. Test Borings

The following 17 test borings were augered and drilled on April 23, 24, 1969 by means of a 1500 Failing truck mounted core drill:

Boring Number	Station Number	Description	Depth
#1 (30' south of center-line of existing track)	1950+00	Embankment	6.0'
#2	1958+00	Embankment	6.0'
#3	1966+00	Embankment	6.0'
#4	1974+00	Embankment	6.0'
#5	1982+00	Embankment	6.0'
#6	1990+00	Embankment	6.0'

Boring Number		Station Number	Description	Depth
#7		1998+00	Embankment	6.0'
#8		2006+00	Embankment	6.0'
#9		2014+00	Embankment	6.0'
#10		2022+00	Embankment	6.0'
#11		2030+00	Embankment	6.0'
#8-12	(60' south of center-line of existing track)	1950+00	Borrow	6.0'
#8-13		1965+00	Borrow	6.0'
#8-14		1980+00	Borrow	6.0'
#8-15		1995+00	Borrow	6.0'
#8-16		2010+00	Borrow	6.0'
#8-17		2025+00	Borrow	6.0'
			Total	102.0'

II - Geological Survey

A. Type Soils

Only two representative soils were found to be present in the 6 feet of subsurface investigation throughout the two mile test track site between Santa Fe mile posts 684 and 686, New Mexico.

The upper soil consisted of brown silt, very little if any moisture, having a very slight amount of clay. The thickness in the eleven center line borings ranged from as little as 0.5 foot to a maximum of 2.0 feet. The average thickness was 1.2 feet. That in the six borrow borings ranged from 1.8 to 2.5 feet, with an average of 2.2 feet.

The lower soil consisted of sand, very silty and very fine grained, multicolored white-reddish white to tan, very limey with a trace of clay and varying amounts of caliche particles. Larger

sizes of caliche were noted in the western half of the test track site commencing with boring No. 7 thru 11. The sand is of Tertiary Geologic Age and is referred to as the Ogallala Formation, with the caliche characterizing the nearby terrace deposits of Recent Geologic Age.

B. Bed Rock

6.0'feet being the maximum depth of investigation, bed rock was not encountered anywhere in the test track site.

C. Surface Ground Water

No moisture or drainage water was encountered in any of the borings and it is reported the static water level is at a considerable depth in the area.

III - Engineering Analysis

The uppermost soil existing at the New Mexico site could be classified as a CL material with a compacted modified proctor of 118 pounds per cubic foot at an optimum moisture content of 11.4%. Unconfined compressive strength of a remolded sample compacted to 95 per cent modified proctor was 3.0 ksf. The low unconfined compressive strength in this case results from lack of clay sufficient to contribute cohesive strength.

The underlying soil, a very fine grained sand of medium density, was completely lacking in plasticity and may be classified as a SF material. This material yielded a modified proctor compacted unit weight of 118 pounds per cubic foot at an optimum moisture content of 11%. Thus, the compaction properties of the two existing natural soils is very similar.

The New Mexico site offers ideal conditions for construction of a uniformly conditioned test site. Since soil conditions are uniform throughout the section and very little excavation or embankment would be necessary; differential settlements of the track bed might be expected to be negligible. Environmental conditions existing at this site would also be a most ideal situation for controlled research.

Based on topography at the site and existing soils, the following may be considered an adequate subgrade design. Excavation to an elevation of 3998 feet would expose the sandy, non-plastic

material throughout the test section. A one to two foot base for track foundation could be constructed above this material by using silty clay material (excavated) stabilized with Portland cement. The one to two foot of soil-cement base would offer an ideal track bed foundation. The existing material promises to respond to cement stabilization very favorably since it is a very friable low plasticity material. After treatment it would be unexpected to find unconfined compressive strengths greatly in excess of those obtained on raw soil. Additional tests would be required to find optiment cement content required for this particular material. If such information is required in the future planning and design of the test section, it could be made available on request.

HEMPHILL CORPORATION

John T. Eidt, Geologist

B. D. Marks, III, B.S.C.E., M.S.C.E.
Soils Consultant

Jack F. Stewart, Engineer

MOISTURE - DENSITY CURVE

DATE: April 29, 1969

CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for New Mexico Area, Test Track

MATERIAL: Brown Silt Topsoil

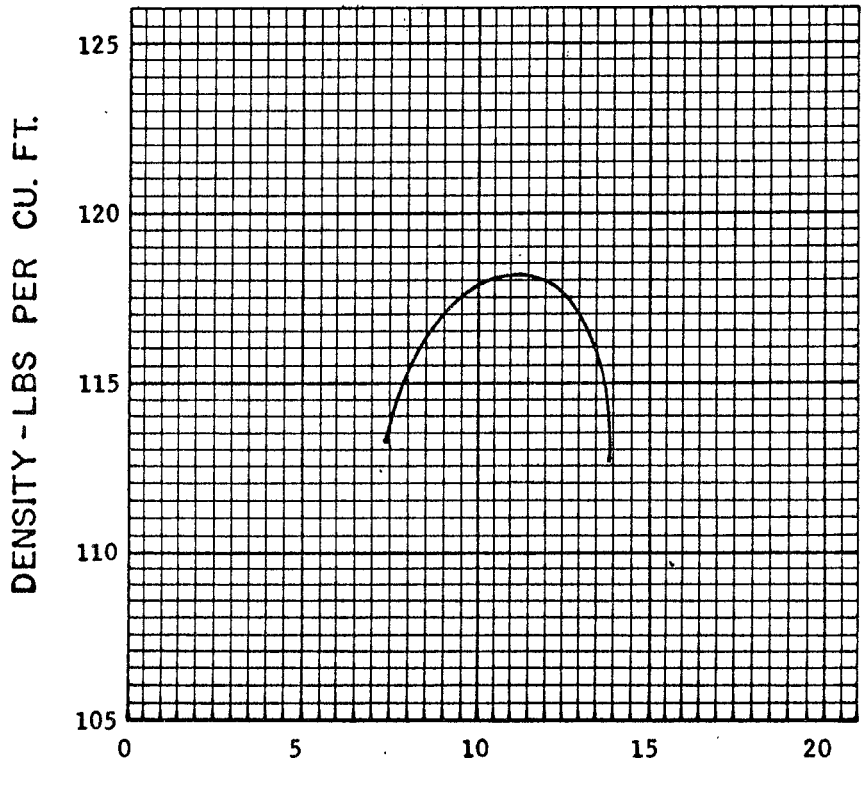
MATERIAL SOURCE:

METHOD OF TEST: ASTM D 1557, Method A

TEST RESULTS

MAXIMUM DRY DENSITY = 118.4 LBS PER CU. FT.

OPTIMUM MOISTURE CONTENT = 11.4 %



PHYSICAL PROPERTIES

LIQUID LIMIT = ____ %

PLASTIC LIMIT = ____ %

PLASTICITY INDEX = NP %

SHRINKAGE LIMIT = ____ %

HEMPHILL CORPORATION

UNCONFINED COMPRESSION TEST

DATE: May 5, 1969

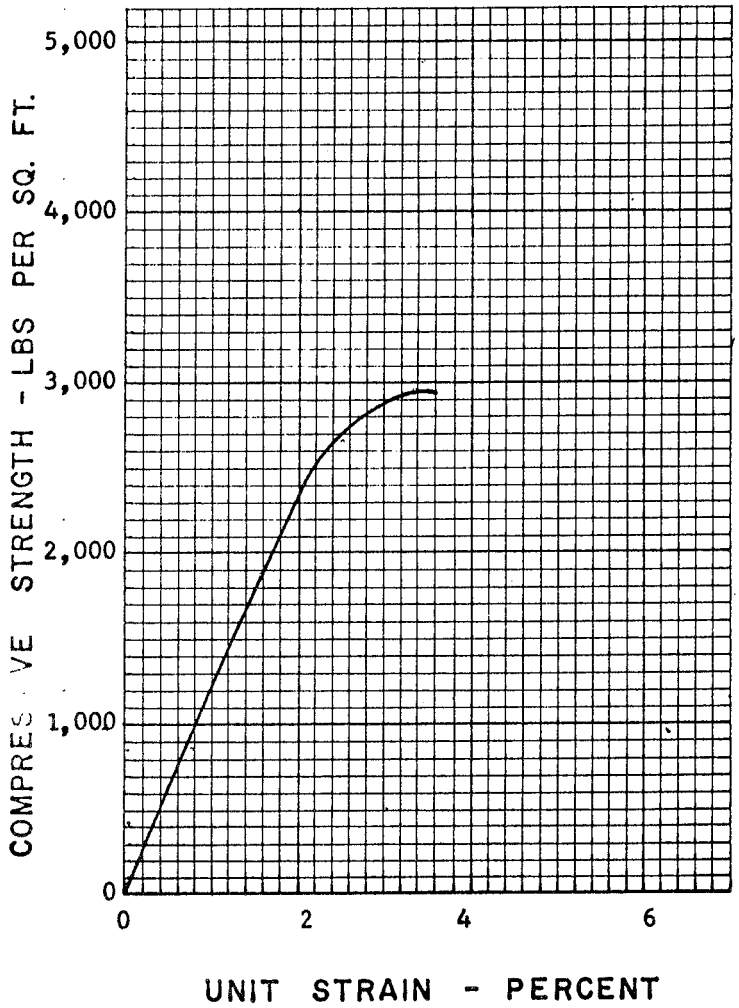
CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for New Mexico Area, Test Track

TEST RESULTS

HOLE NO. Remolded SAMPLE NO. One (1) FROM _____ TO _____

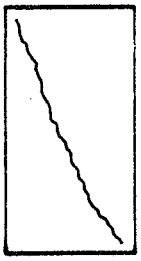
MATERIAL DESCRIPTION: Brown Silt Topsoil



PHYSICAL PROPERTIES

UNCONFINED COMPRESSIVE STRENGTH LBS PER SQ. FT.	2,966.40
PERCENT STRAIN	3.33
PERCENT MOISTURE	12.0
DRY DENSITY LBS PER CU. FT.	95% Max.
LIQUID LIMIT	
PLASTIC LIMIT	
PLASTICITY INDEX	N.P.
SHRINKAGE LIMIT	
SHRINKAGE RATIO	
CLASSIFICATION	OL

FAILURE CONDITIONS



HEMPHILL CORPORATION

4834 S. 83RD E. AVE. TULSA, OKLAHOMA

MOISTURE - DENSITY CURVE

DATE: April 29, 1969

CLIENT: The Atchinson, Topeka and Santa Fe Railway System

PROJECT: U. S. Department of Transportation for New Mexico Area, Test Track

MATERIAL: Caliche with silt and fine grain sand

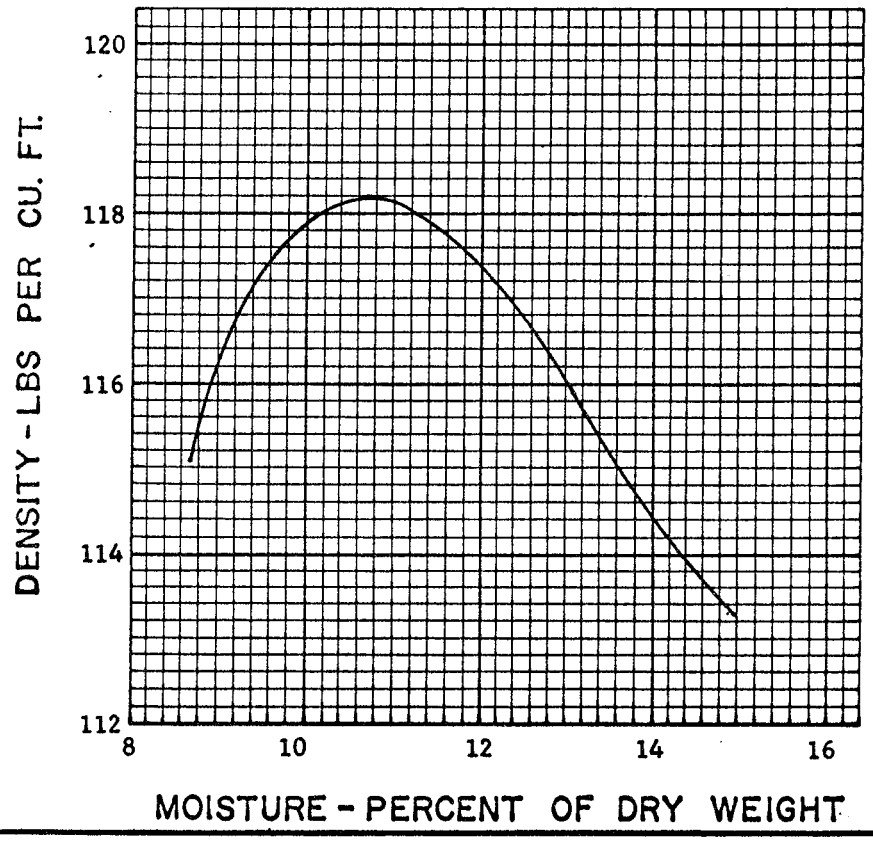
MATERIAL SOURCE:

METHOD OF TEST: ASTM D 1557, Method A

TEST RESULTS

MAXIMUM DRY DENSITY = 118.2 LBS PER CU. FT.

OPTIMUM MOISTURE CONTENT = 10.5 %



PHYSICAL PROPERTIES

LIQUID LIMIT = 25.2 %

PLASTIC LIMIT = 15.9 %

PLASTICITY INDEX = 9.3 %

SHRINKAGE LIMIT = ____ %

HEMPHILL CORPORATION

BORING LOG

HOLE NO. 1

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 1950+00 See Boring Location Plan — DATE 4-24-69

GND. ELEV. 4401.5' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4401.5	0.0						
4400.9	0.6			Silt, Very Slight Amount of Clay, Brown			Air Drilling
	1.5			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Variable Amounts of Caliche Particles Tertiary Age - Ogallala Formation			
	3.0		7/5/4				
	4.5						
			12/20/15				
4395.5	6.0						6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 1

BORING LOG

HOLE NO. 2

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 1958+00 See Boring Location Plan — DATE 4-24-69

GND. ELEV. 4400.4' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT (0 6" 12" 18" 24")	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4400.4	0.0						
				Silt, Very Slight Amount of Clay, Brown			Air Drilling
4398.9	1.5						
			2/3/7	Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Variable Amounts of Caliche Particles Tertiary Age - Ogallala Formation			
	3.0						
	4.5		8/9/10				
4394.4	6.0						6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 2

BORING LOG

HOLE NO. 3

PROJECT U. S. Department of Transportation - Test Track - New Mexico SHEET NO. 1 OF 1

HOLE LOCATION Station 1966+00 See Boring Location Plan DATE 4-24-69

GND. ELEV. 4398.1' G.W. ELEV. BORED BY Woodall LOGGED BY Same

SAMPLER DATA 2" Split Spoon WT. OF HAMMER 140# FALL OF HAMMER 30"

PENETROMETER DATA WT. OF HAMMER FALL OF HAMMER

AUGER DATA CORE BARREL & BIT DATA

ELEV. 4398.1	DEPTH AND SCALE 0.0	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4398.0	1.1			Silt, Very Slight Amount of Clay, Brown			Air Drilling
	1.5			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Variable Amounts of Caliche Particles Tertiary Age - Ogallala Formation			
	3.0		19/10/11				
	4.0						
	5.5		8/9/9				
4392.1	6.0						6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 3

BORING LOG

HOLE NO. 4

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 1974+00 See Boring Location Plan — DATE 4-24-69

GND. ELEV. 4399.3' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4399.3	0.0						
4398.3	1.0			Silt, Very Slight Amount of Clay, Brown			Air Drilling
	1.5			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Variable Amounts of Caliche Particles Tertiary Age - Ogallala Formation			
	3.0		5/6/4				
	4.5						
4393.3	6.0		6/15/18				6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 4

BORING LOG

HOLE NO. 5

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 1982+00 See Boring Location Plan — DATE 4-24-69

GND. ELEV. 4398.2' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4398.2	0.0						
	0.5			Silt, Very Slight Amount of Clay, Brown			Air Drilling
4397.2	1.0						
			5/11/13	Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Variable Amounts of Caliche Particles Tertiary Age - Ogallala Formation			
	2.0						
	4.5		9/11/12				
4392.2	6.0						6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 5

BORING LOG

HOLE NO. 6

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 1990+00 See Boring Location Plan — DATE 4-24-69

GND. ELEV. 4398.4' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4398.4	0.0						Air Drilling
4396.4	2.0			Silt, Very Slight Amount of Clay, Brown w/Increasing Clay Content			
	3.0		42/58	Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Variable Amounts of Caliche Particles Tertiary Age - Ogallala Formation			
	4.5						
4392.4	6.0		10/11/12				6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 6

BORING LOG

HOLE NO. 7

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 1998+00 See Boring Location Plan — DATE 4-23-69

GND. ELEV. 4400.2' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

CASING DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV. 4400.2	DEPTH AND SCALE 0.0	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4399.2	1.0			Silt, Very Slight Amount of Clay, Brown			Air Drilling
	2.0			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Varying Amounts and Sizes of Caliche Tertiary Age - Ogallala Formation			
	4.0		11/21/31				
	4.4						
4394.2	6.0		7/7/7				6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 7

BORING LOG

HOLE NO. 8

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 2006+00 See Boring Location Plan — DATE 4-23-69

GND. ELEV. 4401.2' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETRATION DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4401.2	0.0						
4400.7	0.5			Silt, Very Slight Amount of Clay, Brown			Air Drilling
	1.5			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Varying Amounts and Sizes of Caliche Tertiary Age - Ogallala Formation			
	3.0		5/11/18				
	4.5						
4395.2	6.0		8/23/13				6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 8

BORING LOG

HOLE NO. 9

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 2014+00 See Boring Location Plan — DATE 4-23-69

GND. ELEV. 4401.5' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

CASING DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT (6" / 6" / 6")	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4401.5	0.0						Air Drilling
4400.5	1.0			Silt, Very Slight Amount of Clay, Brown w/Increasing Clay Content			
	2.5			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Varying Amounts and Sizes of Caliche Tertiary Age - Ogallala Formation			
	4.0		22/36/63				
	4.5						
	5.8		16/50/70				
4395.5	6.0						6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 9

BORING LOG

HOLE NO. 10

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 2022+00 See Boring Location Plan — DATE 4-23-69

GND. ELEV. 4403.9' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA 2" Split Spoon — WT. OF HAMMER 140# — FALL OF HAMMER 30"

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT (0 / 25 / 50 / 75 / 100)	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4403.9	0.0						
	0.5		4/10/16	Silt, Very Slight Amount of Clay, Brown w/Increasing Clay Content			Air Drilling
4402.2	1.7						
	2.0			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Varying Amounts and Sizes of Caliche Tertiary Age - Ogallala Formation			
	4.5		3/8/9				
4397.9	6.0			Bottom of Hole			6.0

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 10

BORING LOG

HOLE NO. 11

PROJECT U. S. Department of Transportation - Test Track - New Mexico SHEET NO. 1 OF 1

HOLE LOCATION Station 2030+00 See Boring Location Plan DATE 4-23-69

GND. ELEV. 4403.4' G.W. ELEV. BORED BY Woodall LOGGED BY Same

SAMPLER DATA 2" Split Spoon WT. OF HAMMER 140# FALL OF HAMMER 30"

CORE BARREL DATA WT. OF HAMMER FALL OF HAMMER

CASING DATA CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
403.4	0.0						
				Silt, Very Slight Amount of Clay, Brown			Air Drilling
402.2	1.2						
	1.5			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Varying Amounts and Sizes of Caliche Tertiary Age - Ogallala Formation			
			50/4.5				
	2.5						
	3.0						
			10/21/22				
	4.5						
			10/11/12				
397.4	6.0						6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. 11

BORING LOG

HOLE NO. B-12

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 1950+00 See Boring Location Plan — DATE 4-24-69

GND. ELEV. 4402.0' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA — WT. OF HAMMER — FALL OF HAMMER

CASING DATA — WT. OF HAMMER — FALL OF HAMMER

CASING DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT (0 / 6 / 12 / 18 / 24 / 30 / 36)	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4402.0	0.0			Silt, Very Slight Amount of Clay, Brown			Air Drilling
4400.0	2.0			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Varying Amounts of Caliche Particles Tertiary Age - Ogallala Formation			
4396.0	6.0			Bottom of Hole			6.0

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. B-12

BORING LOG

HOLE NO. B-13

PROJECT U. S. Department of Transportation - Test Track - New Mexico SHEET NO. 1 OF 1

HOLE LOCATION Station 1965+00 See Boring Location Plan DATE 4-24-69

GND. ELEV. 4399.3' G.W. ELEV. BORED BY Woodall LOGGED BY Same

SAMPLER DATA WT. OF HAMMER FALL OF HAMMER

CASING DATA WT. OF HAMMER FALL OF HAMMER

WATER DATA CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4399.3	0.0						
				Silt, Very Slight Amount of Clay, Brown			Air Drilling
4397.3	2.0						
				Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Varying Amounts of Caliche Particles Tertiary Age - Ogallala Formation			
4393.3	6.0						6.0
				Bottom of Hole			

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. B-13

BORING LOG

HOLE NO. B-14

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 1980+00 See Boring Location Plan — DATE 4-24-69

GND. ELEV. 4399.4' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

CASING DATA — WT. OF HAMMER — FALL OF HAMMER

SAMPLER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4397.3	0.0			Silt, Very Slight Amount of Clay, Brown			Air Drilling
4397.3	2.1			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Varying Amounts of Caliche Particles Tertiary Age - Ogallala Formation			
4393.4	6.0			Bottom of Hole			6.0

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. B-14

BORING LOG

HOLE NO. B-15

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 1995+00 See Boring Location Plan — DATE 4-24-69

GND. ELEV. 4400.8' — G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA — WT. OF HAMMER — FALL OF HAMMER

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	CASING	NO. OF BLOWS PER FOOT (0 25 50 75 100)	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4400.8	0.0			Silt, Very Slight Amount of Clay, Brown			Air Drilling
4397.8	3.0			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Varying Amounts of Caliche Particles Tertiary Age - Ogallala Formation			
4394.8	6.0			Bottom of Hole			6.0

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. B-15

BORING LOG

HOLE NO. B-16

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 2010+00 See Boring Location Plan — DATE 4-24-69

GND. ELEV. 4402.0' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA — WT. OF HAMMER — FALL OF HAMMER

PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

AUGER DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Fluid Loss, Casing Data, Etc.)
4402.0	0.0			Silt, Very Slight Amount of Clay, Brown			Air Drilling
4400.2	1.8			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Varying Amounts of Caliche Particles Tertiary Age - Ogallala Formation			
4396.0	6.0			Bottom of Hole			6.0

HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. B-16

BORING LOG

HOLE NO. B-17

PROJECT U. S. Department of Transportation - Test Track - New Mexico — SHEET NO. 1 OF 1

HOLE LOCATION Station 2025 See Boring Location Plan — DATE 4-24-69

TOP ELEV. 4402.8' G.W. ELEV. — BORED BY Woodall — LOGGED BY Same

SAMPLER DATA — WT. OF HAMMER — FALL OF HAMMER

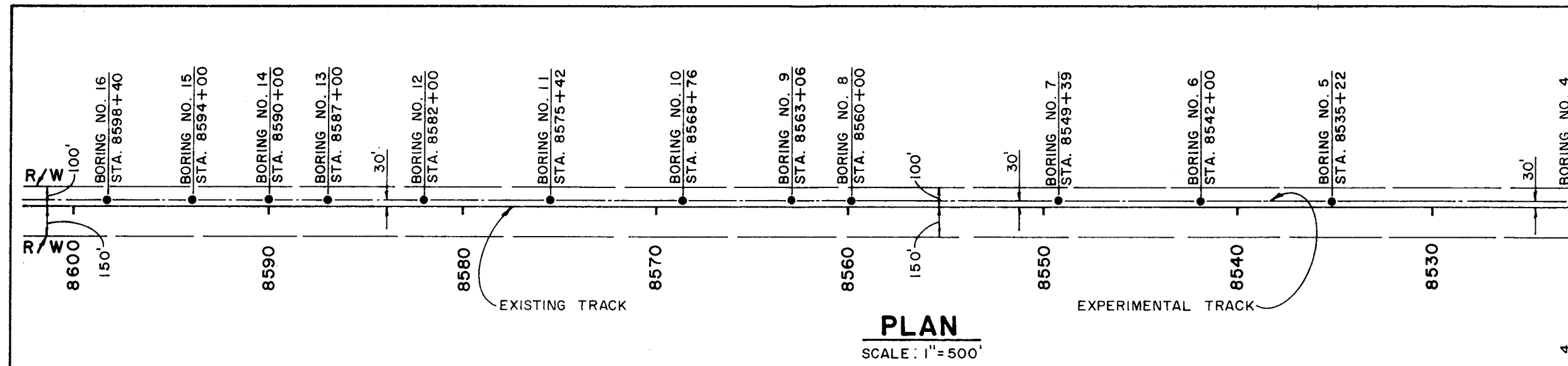
PENETROMETER DATA — WT. OF HAMMER — FALL OF HAMMER

CASING DATA — CORE BARREL & BIT DATA

ELEV.	DEPTH AND SCALE	LEGEND	NO. OF BLOWS PER FOOT (0 / 20 / 40 / 60 / 80 / 100)	DESCRIPTION OF MATERIALS (Type, Color, Texture, Consistency)	% CORE RECOVERY	SAMPLE NO.	REMARKS (Drilling Characteristics, Drilling Field Logs, Casing Data, Etc.)
4402.8	0.0			Silt, Very Slight Amount of Clay, Brown			Air Drilling
4400.3	2.5			Sand, Very Silty, Very Fine Grained, Reddish White to Tan, Limey, w/Trace of Clay and Varying Amounts of Caliche Particles Tertiary Age - Ogallala Formation			
4396.8	6.0			Bottom of Hole			6.0

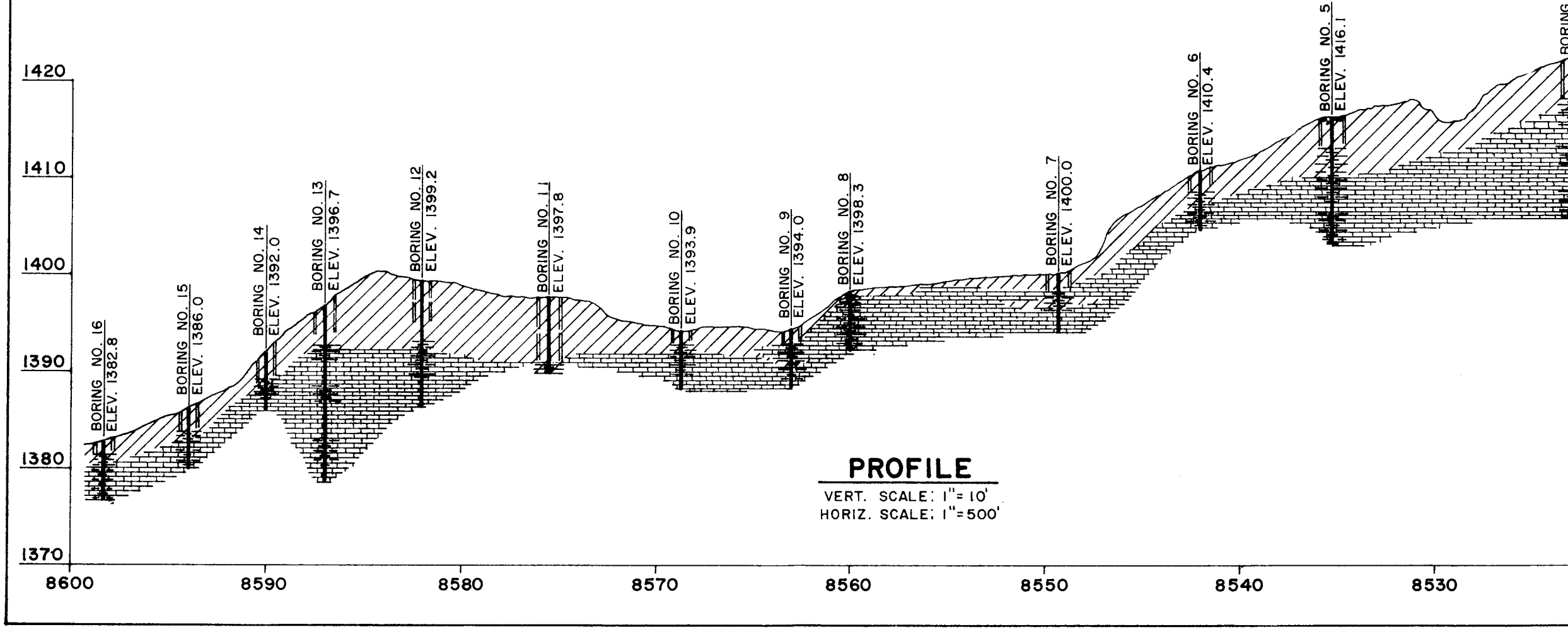
HEMPHILL & SHELBY DRILLING COMPANY
TULSA, OKLAHOMA

HOLE NO. B-17



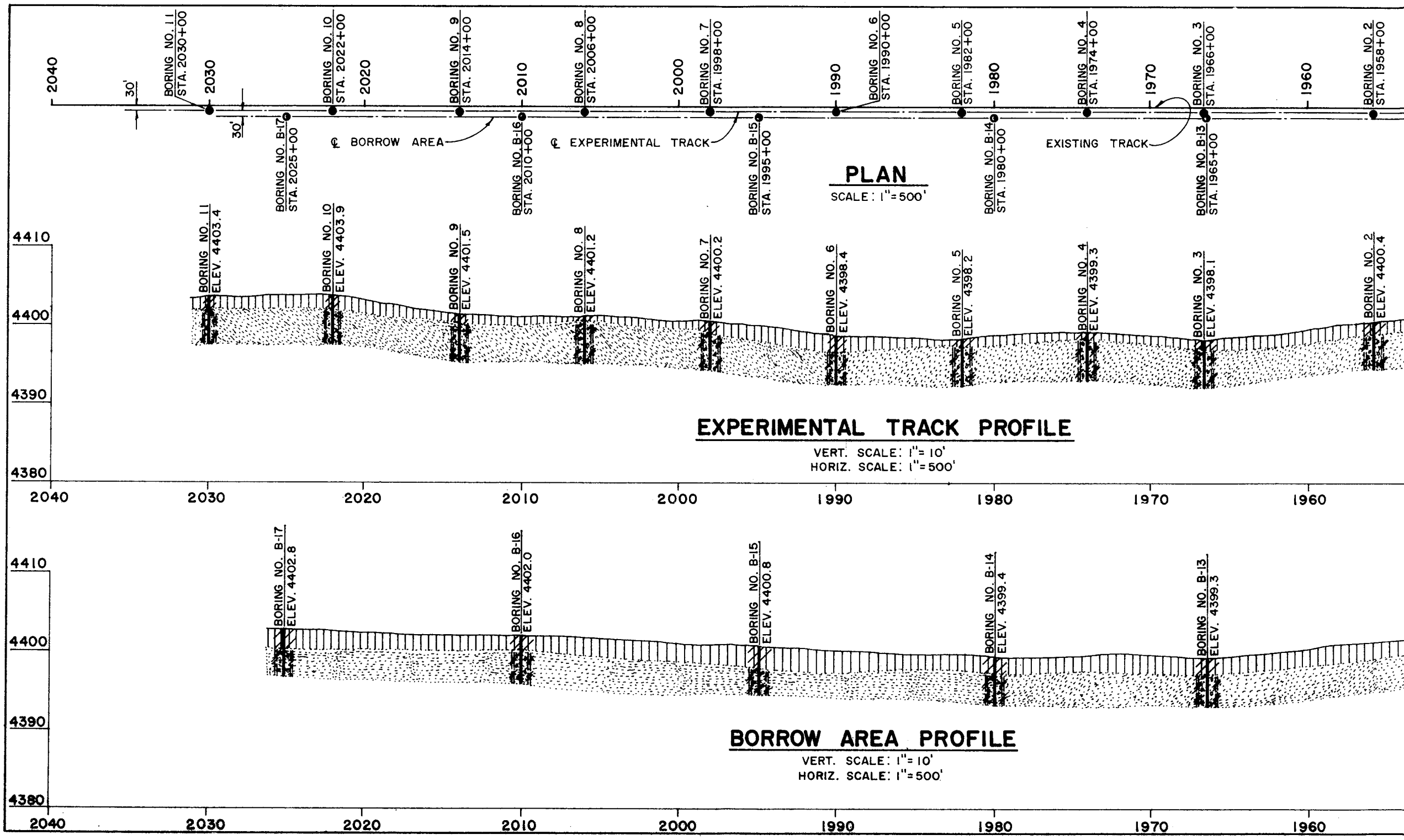
PLAN

SCALE: 1"=500'



PROFILE

VERT. SCALE: 1"= 10'
HORIZ. SCALE: 1"=500'


2040
2030
2020
2010
2000
1990
1980
1970
1960
30'
30'
BORING NO. 11 STA. 2030+00
BORING NO. 10 STA. 2022+00
BORING NO. 9 STA. 2014+00
BORING NO. 8 STA. 2006+00
BORING NO. 7 STA. 1998+00
BORING NO. 6 STA. 1990+00
BORING NO. 5 STA. 1982+00
BORING NO. 4 STA. 1974+00
BORING NO. 3 STA. 1966+00
BORING NO. 2 STA. 1958+00
BORING NO. B-17 STA. 2025+00
BORING NO. B-16 STA. 2010+00
BORING NO. B-15 STA. 1995+00
BORING NO. B-14 STA. 1980+00
BORING NO. B-13 STA. 1965+00
℄ BORROW AREA
℄ EXPERIMENTAL TRACK
EXISTING TRACK
PLAN
SCALE: 1"=500'
4410
4400
4390
4380
BORING NO. 11 ELEV. 4403.4
BORING NO. 10 ELEV. 4403.9
BORING NO. 9 ELEV. 4401.5
BORING NO. 8 ELEV. 4401.2
BORING NO. 7 ELEV. 4400.2
BORING NO. 6 ELEV. 4398.4
BORING NO. 5 ELEV. 4398.2
BORING NO. 4 ELEV. 4399.3
BORING NO. 3 ELEV. 4398.1
BORING NO. 2 ELEV. 4400.4
EXPERIMENTAL TRACK PROFILE
VERT. SCALE: 1"= 10'
HORIZ. SCALE: 1"=500'
BORING NO. B-17 ELEV. 4402.8
BORING NO. B-16 ELEV. 4402.0
BORING NO. B-15 ELEV. 4400.8
BORING NO. B-14 ELEV. 4399.4
BORING NO. B-13 ELEV. 4399.3
BORROW AREA PROFILE
VERT. SCALE: 1"= 10'
HORIZ. SCALE: 1"=500'