TVA 64 (C-5-9-65)

UNITED STATES GOVERNMENT

Memorandum

TENNESSEE VALLEY AUTHORITY

11-7-69

TO : F. P. Lacy, Chief, Civil Design Branch, 405 UB, Knoxville (3)

FROM : J. C. McCraw, Chief, Construction Services Branch, 709 UB, Knoxville

DATE : September 17, 1969

SUBJECT: JOHNSONVILLE STEAM PLANT - ASH POND - SOIL AND FOUNDATION EXPLORATION

The soil investigation on the above project, authorized July 3, 1969, by W. N. Calvert, was carried out during the period of July 7-24, 1969, and included six undisturbed sample borings and 14 auger holes.

The stratigraphy of this site indicates the presence of a surficial river alluvium, of Pleistocene to recent age, consisting of silts or clays, which grade into sand and gravel. The recent alluvium, according to a 1948 exploration, is up to 70 feet thick in the flood plain, and bedrock is the Camden chert, which consists of blocks of chert parted by clay seams.

Dike Foundation and Partial Embankment

Six undisturbed borings, US-1 through US-6, were drilled along the centerline and lakeside of the dike between stations 30+00 and 75+00, on approximately 900-foot centers. The plan of the soils investigation is shown on laboratory drawing 605-B-143. At the time of the exploration, fill was placed to about elevation 366, and original soil was encountered between elevations 355 and 358. Laboratory drawing 605-B-144 shows the profile of the foundation and that of partial fill. Only one of these borings, US-1, extended into the sand gravel layer at elevation 354. In boring US-2, a one-foot layer of non-plastic, silty gravel, representing surface material above the original soil, exists between elevations 357 and 358. With the exception of a fully saturated silt layer of low plasticity, ML, in boring US-1, practically all soils according to the Unified System classified lean clay, CL, of tan to medium gray color. By particle size distribution, these are clayey silts with liquid limits from 34 to 45 percent and plastic indices averaging about 17 percent. The sand fraction is as low as 4 percent and as high as 21 percent. Dry densities range from about 90 pcf to 107 pcf. Void ratios vary from 0.6 to 0.9.

The lake level during July fluctuated from elevation 356.5 to 358.1, with an average of 357.2. A water table in the dike foundation was not encountered but was expected between elevations 350 and 355.

30

Selected samples obtained from both the foundation and completed portions of the dike embankment were tested for shear strength. Results of unconsolidated-undrained Q and saturated consolidated-undrained R tests show a fairly wide range of friction angles and cohesion. Overall, there is a similarity of index and engineering properties of fill and foundation soils, despite slightly higher density-compaction of the fill. Under Q-test conditions, foundation soils are of moderately low to medium strength; under R-test conditions, medium shear strength is indicated.

Laboratory testing of index and engineering properties of foundation and embankment soils is tabulated in the attached "Summary of Laboratory Test Data - Ash Dike Foundation."

Borrow Soils

Of primary interest are soils from borrow area A in the settlement pond area within the dike, comprising approximately 88 acres. Moderately high moisture contents were encountered in soils from the south and west portions, as established in borings AHP-1, -2, -3, -4, and -14. In the northeastern sector of the area, which is boggy in places, the water table is shallow, and high natural moisture contents are common. These are gray to blue, lean clays, as found in AHP-8 through AHP-12. The borrow soil profile is shown in laboratory drawing 605-FF-145.

To date most of the borrowing is concentrated on the southern end and along the western edge of the pond area. Surface elevations at the time of the exploration ranged from 345 to 355, and the water table was established between elevations 335 and 346, indicating the availability of about 10 additional feet of suitable soils in the immediate area. Suitable soils from the south end, comprising 40 acres, will yield about 550,000 cubic yards. The wet northeastern half of the area will require special attention to reduce moisture contents to within acceptable limits. Upon careful drying, this area can produce about 0.5 million cubic yards.

The two classes of borrow soils determined have very similar characteristics in particle size distribution, plasticity, and compactibility except that class I is somewhat leaner and therefore has a maximum density two pounds higher than class II soils. A slight increase in the friction angle under triaxial R test conditions is also noted. About 80 percent of the borrow will be of class I. A minor discrepancy exists in the comparison of the penetration resistance of the two soil

classes at optimum moisture. The leaner class I soils have about 100 psi less resistance than class II soils.

A substitute borrow area, B, was located in the vicinity of the old campground and would entail a hauling distance of about 7,000 feet. Twelve acres of soils yielding 300,000 cubic yards are available. These soils are generally dry of optimum and consist of lean to medium clays. The soil profile of borrow area B is shown in laboratory drawing 605-B-146.

Laboratory testing of the two borrow classes included consolidated-undrained R test at two percent moisture above optimum. Shear test results show friction angles within less than two degrees of each other and of similar values for cohesion.

Laboratory testing of index and engineering properties of borrow soils are tabulated in the attached "Summary of Laboratory Test Data - Borrow Soil Classes."

Evaluation

The soil foundation of the dike for the ash settlement pond presently under construction is composed of alluvial, lean clay of medium plasticity and low permeability, grading into sand and gravel of undetermined depth.

The scope of this exploration only warranted drilling to shallow depth to compare properties of the original subsoil with those of the already placed and compacted fill. Limited testing indicates adequate and equal strength of both foundation and fill, with the foundation being slightly weaker. Isolated pockets of subsoils of pronounced weakness which were noted had been excavated by construction crews prior to the exploration. This investigation did not reveal any particular unstable foundation conditions.

The area inside the dike and the old campground area will yield well over one million cubic yards of additional fill. Portions of the borrow material, especially from the northeast section of the pond, will require considerable drying before they can be compacted to the required density.

A laboratory approximation of the stability of 1 on 2 embankment inside slope, based on the critical circle through the toe, resulted in $F_S = 1.6$. Below elevation 365, the outside slope of six horizontal to one vertical is considered adequate.

F. P. Lacy
September 17, 1969

JOHNSONVILLE STEAM PLANT - ASH POND - SOIL AND FOUNDATION EXPLORATION

Proposed design values are as follows:

Foundation

Density		Triaxial Q Strength	Triaxial R Strength Saturated
γ_w	123 pcf	4° friction	14° friction
γ_s	126 pcf	0.40 tsf cohesion	0.40 tsf cohesion

Embankment

γ_w	123 pcf	4° friction	12° friction
γ_s	126 pcf	0.50 tsf cohesion	0.50 tsf cohesion

J. C. McCraw

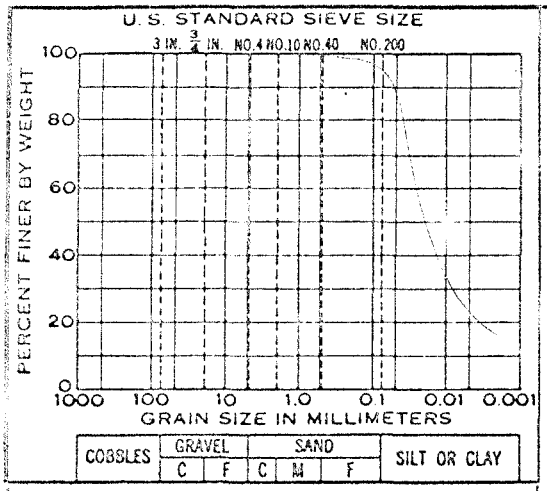
ROL:ARC
Attachments
CC (Attachments):
R. O. Lane, SMW-K
H. H. Mull, 603 UB-K

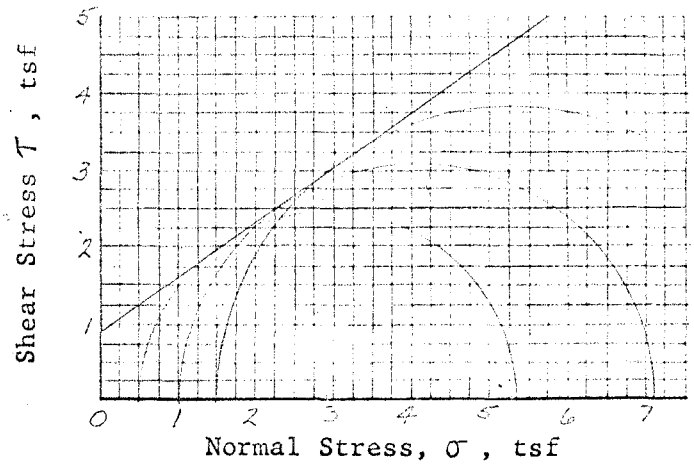
JOHNSONVILLE STEAM PLANT - ASH DIKE FOUNDATION*

SUMMARY OF LABORATORY TEST DATA

Elevation	Soil Symbol	Natural Moisture %	Grain Size Analysis Gravel %	Sand %	Silt %	Clay %	D_{10} mm	Atterberg Limits Liquid Limit %	Plasticity Index %	Density pcf	Void Ratio	Triaxial Q Ø Deg.	Triaxial Q C tsf	Triaxial R Ø Deg.	Triaxial R C tsf
Boring US-1, Station 75+00 Ł, Surface Elevation 365.0															
362.0-359.7	CL	19.6	9	37	34	20	--	28.8	9.3	108.2	0.535				
357.0-355.0	ML	28.7	0	1	79	20	--	31.0	5.5	93.3	0.805			35.6	0.91
Boring US-2, Station 67+00 Ł, Surface Elevation 366.0															
364.0-361.6	CL	21.3	0	6	50	44	--	43.3	18.2	97.9	0.727			23.3	0.25
358.0-356.3	GM	14.6	45	31	22	9	.006	NP	NP	--	--				
356.3-355.8	CL	21.6	0	12	47	41	--	37.7	17.3	107.1	0.598				
354.0-351.6	CL	24.8	0	8	48	44	--	38.1	17.2	98.1	0.732	3.3	0.90		
Boring US-3, Station 59+50, 8 Ft. Left, Surface Elevation 366.0															
364.0-362.1	CL	19.1	0	8	50	42	--	40.3	16.4	102.1	0.651				
360.0-357.8	CL	24.6	0	15	44	41	--	38.3	15.7	97.4	0.737			16.7	0.35
356.0-355.5	CL	24.4	0	31	35	34	--	30.3	12.5	97.7	0.720	2.7	0.44		
355.5-353.6	CL	21.0	0	21	43	36	--	34.6	17.4	102.7	0.641			9.6	0.74
352.0-351.0	CL	26.5	0	10	45	45	--	42.7	19.1	96.6	0.762	7.5	0.38		
351.0-349.6	CL	25.0	0	6	50	44	--	46.1	22.6	98.8	0.719				
Boring US-4, Station 50+00 Ł, Surface Elevation 366.5															
363.5-362.4	CL	21.7	0	14	44	42	--	38.0	16.0	104.8	0.617				
358.5-356.1	CL	26.3	0	11	49	40	--	39.2	16.3	96.2	0.763	2.7	0.38	15.7	0.40
354.5-352.2	CL	23.8	0	5	52	43	--	40.7	18.7	102.1	0.676				
Boring US-5, Station 39+00 Ł, Surface Elevation 367.5															
364.5-363.1	CL	21.8	0	8	51	41	--	43.4	17.5	97.7	0.739	22.0	0.80	6.7	0.94
359.5-357.1	CL	27.3	0	10	45	45	--	40.5	19.2	94.2	0.802	9.1	0.17		
355.5-354.0	CL	22.1	0	16	42	42	--	39.8	16.5	104.6	0.611				
Boring US-6, Station 30+00 Ł, Surface Elevation 365.5															
362.5-361.0	CL	22.4	0	11	53	36	--	38.8	15.2	98.4	0.726			16.5	0.26
357.5-355.3	CL	22.3	0	16	39	45	--	35.2	16.3	102.7	0.634			15.2	0.58
353.5-352.2	CL	27.0	0	4	52	44	--	45.3	19.7	89.6	0.904				

*Foundation soils below average elevation 356.

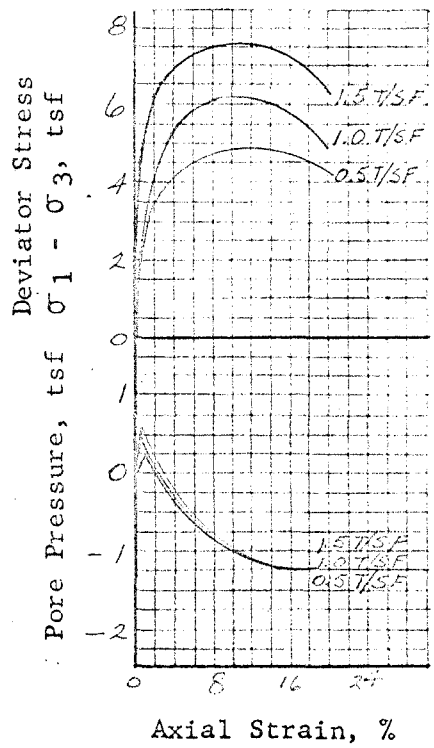




Type of Specimen	UNDISTURBED
Classification	ML
LL. 31.0	G 2.70
PI. 5.5	D10 —

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	35.6	.72	0.91
Effective	31.0	.60	0.45

Specimen Number		1	2	3	4
Initial	Moisture Content, %	29.1	28.0	29.1	
	Dry Density, pcf	[illegible]	[illegible]	[illegible]	
	Void Ratio	[illegible]	.787	.821	
	Saturation, %	97.4	96.0	[illegible]	
Before Shearing	Moisture Content after Saturation, %	29.9	29.1	30.4	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	28.1	27.5	26.8	
	Void Ratio after Consolidation	.765	.743	.723	
Final Moisture Content, %		28.1	27.5	26.8	
Minor Principal Stress, σ_3, tsf		0.50	1.00	1.50	
Major Principal Stress, σ_1, tsf		[illegible]	3.10	[illegible]	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		1.57	2.09	2.77	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		6.41	8.19	10.25	
Time to Failure, min.		60	40	50	
Rate of Strain, %/min.		0.2	0.2	0.2	
Specimen Height, in.		3.18	3.18	3.18	
Specimen Diameter, in.		1.40	1.40	1.40	



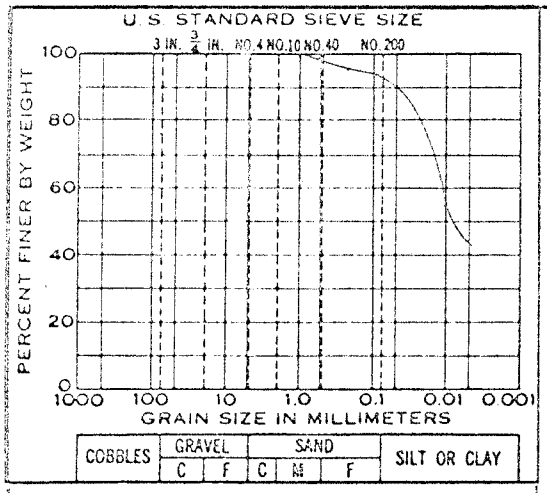
Remarks:

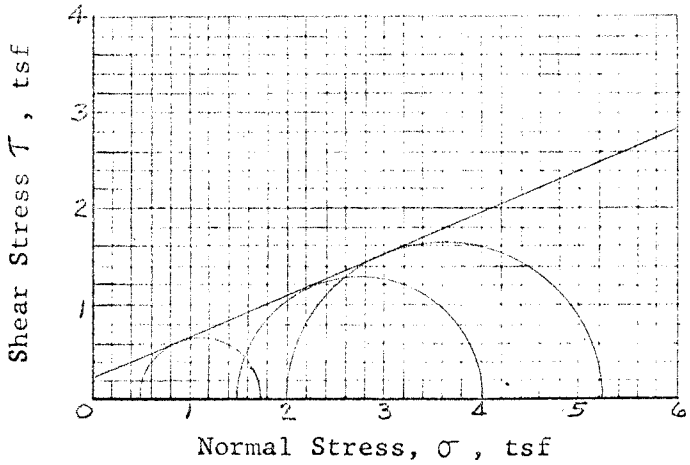
Project: JOHNSONVILLE S.P.

Feature ASH DIKE

Boring No. US-1	Sample No. 2
Station 75+00	Offset ℄
Date 8-21-69	Elev. 357.7-357.2

TRIAXIAL COMPRESSION TEST (R)

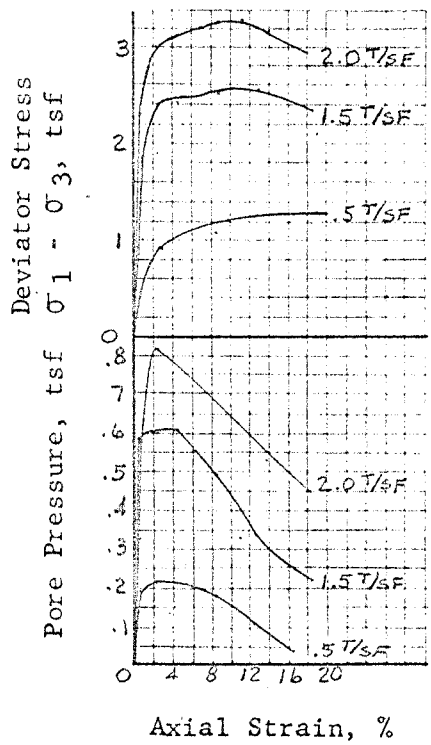




Type of Specimen	UNDISTURBED
Classification	CL
LL. 43.3	G 2.71
PI. 18.2	D10 —

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	23.3°	0.43	0.25
Effective	32.0°	0.62	0.05

Specimen Number		1	2	3	4
Initial	Moisture Content, %	21.0	21.0	22.0	
	Dry Density, pcf	96.5	99.1	98.3	
	Void Ratio	0.753	0.708	0.721	
	Saturation, %	75.5	80.4	82.7	
Before Shearing	Moisture Content after Saturation, %	27.8	26.1	26.6	
	Saturation, %	100.0	100.0	100.0	
	Moisture Content after Consolidation, %	25.9	24.5	25.6	
	Void Ratio after Consolidation	0.720	0.668	0.670	
Final Moisture Content, %		25.9	24.5	25.6	
Minor Principal Stress, σ_3, tsf		0.50	1.50	2.00	
Major Principal Stress, σ_1, tsf		1.76	4.06	5.23	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		0.50	1.16	1.37	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		1.76	3.68	4.60	
Time to Failure, min.		100	60	50	
Rate of Strain, %/min.		0.2	0.2	0.2	
Specimen Height, in.		3.18	3.18	3.18	
Specimen Diameter, in.		1.41	1.41	1.41	



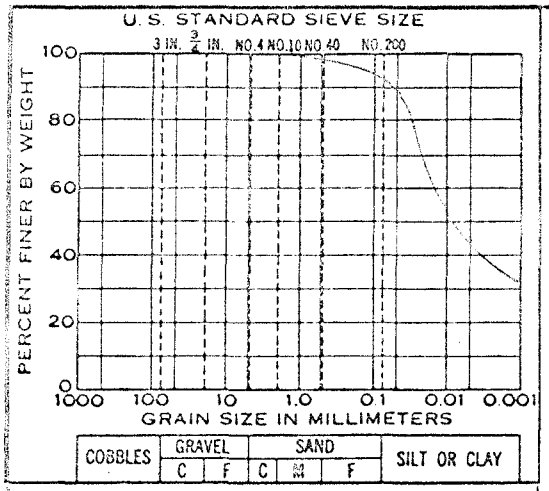
Remarks:

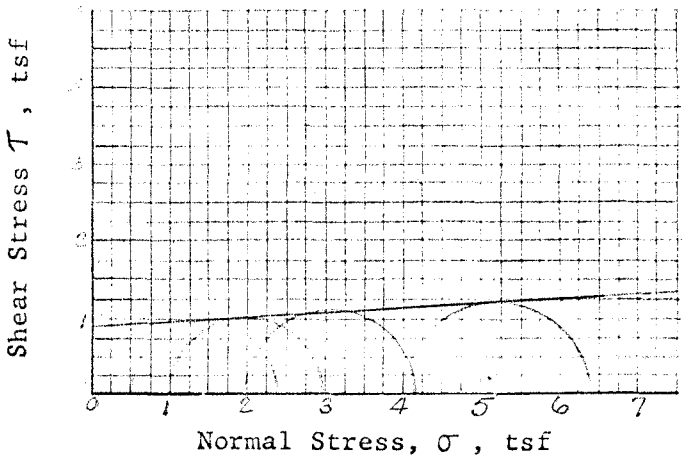
Project: JOHNSONVILLE STEAM PLANT

Feature ASH DIKE

Boring No. 2	Sample No. 1
Station 67+00	Offset ℄
Date 9-8-69	Elev. 363.5-363.0

TRIAXIAL COMPRESSION TEST (R)

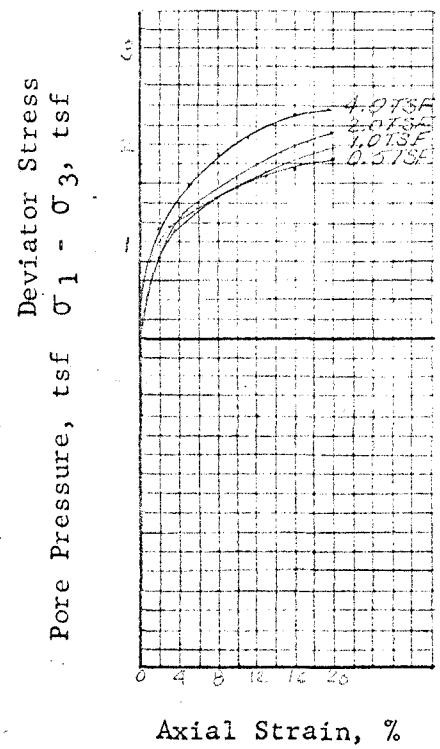




Type of Specimen	UNDISTURBED
Classification	CL
LL. 38.1	G 2.72
PI. 17.2	D10 —

Specimen Number		1	2	3	4
Initial	Moisture Content, %	24.6	25.[illegible]	25.6	24.9
	Dry Density, pcf	99.0	[illegible]	[illegible]	[illegible]
	Void Ratio	0.7[illegible]	[illegible]	[illegible]	[illegible]
	Saturation, %	[illegible]	91.0	[illegible]	[illegible]
Before Shearing	Moisture Content after Saturation, %	—	—	—	—
	Saturation, %	—	—	—	—
	Moisture Content after Consolidation, %	—	—	—	—
	Void Ratio after Consolidation	—	—	—	—
Final Moisture Content, %		24.5	24.6	24.5	24.2
Minor Principal Stress, σ_3, tsf		1.00	1.00	2.00	4.00
Major Principal Stress, σ_1, tsf		2.24	[illegible]	4.14	[illegible]
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		—	—	—	—
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		—	—	—	—
Time to Failure, min.		20	20	[illegible]	20
Rate of Strain, %/min.		1.0	[illegible]	[illegible]	1.0
Specimen Height, in.		[illegible]	3.142	3.142	[illegible]
Specimen Diameter, in.		1.398	1.398	1.398	1.398

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	3.3°	.058	0.90
Effective	—	—	—



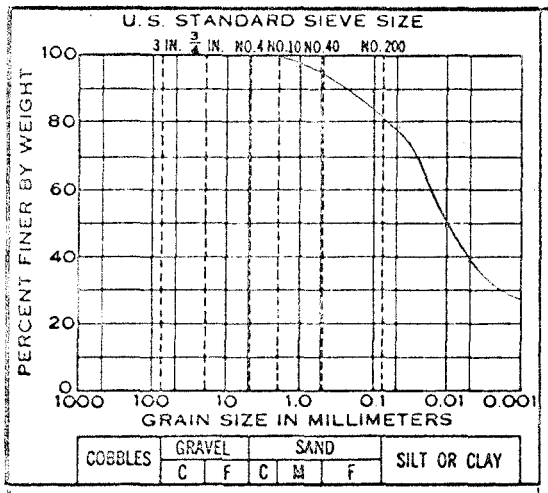
Remarks:

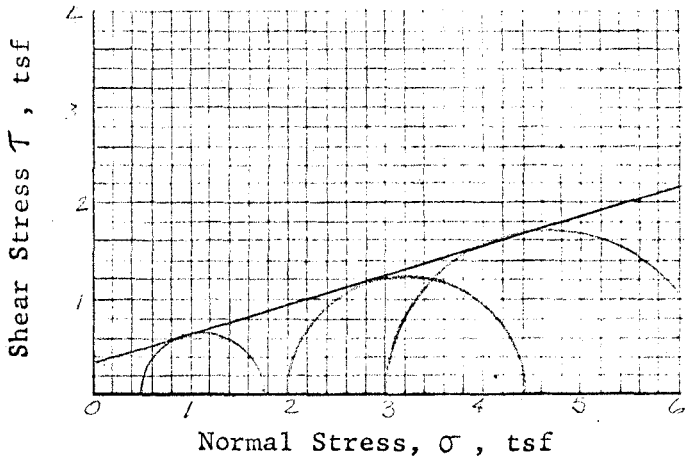
Project: JOHNSONVILLE SP

Feature ASH DIKE

Boring No. US-2	Sample No. 3
Station [illegible]	Offset [illegible]
Date 8/7/69	Elev. [illegible]

TRIAXIAL COMPRESSION TEST (Q)

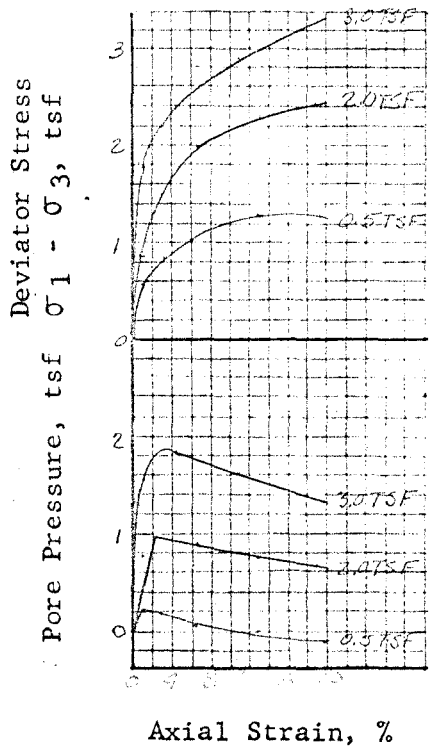




Type of Specimen UNDISTURBED	
Classification CL	
LL. 29.3	G 2.71
PI. 15.7	D_{10} —

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	16.7°	0.30	0.35
Effective	28.5°	0.54	0.00

Specimen Number		1	2	3	4
Initial	Moisture Content, %	25.3	23.9	24.7	
	Dry Density, pcf	96.2	98.6	97.4	
	Void Ratio	0.759	[illegible]	0.722	
	Saturation, %	90.3	[illegible]	[illegible]	
Before Shearing	Moisture Content after Saturation, %	27.9	[illegible]	27.2	
	Saturation, %	100.0	100.0	100.0	
	Moisture Content after Consolidation, %	[illegible]	[illegible]	23.1	
	Void Ratio after Consolidation	[illegible]	[illegible]	0.745	
Final Moisture Content, %		[illegible]	[illegible]	23.1	
Minor Principal Stress, σ_3, tsf		0.50	[illegible]	3.00	
Major Principal Stress, σ_1, tsf		1.76	[illegible]	6.33	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		[illegible]	[illegible]	1.47	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		[illegible]	[illegible]	5.00	
Time to Failure, min.		[illegible]	[illegible]	[illegible]	
Rate of Strain, %/min.		0.2	[illegible]	[illegible]	
Specimen Height, in.		3.14	[illegible]	3.12	
Specimen Diameter, in.		1.41	[illegible]	1.40	



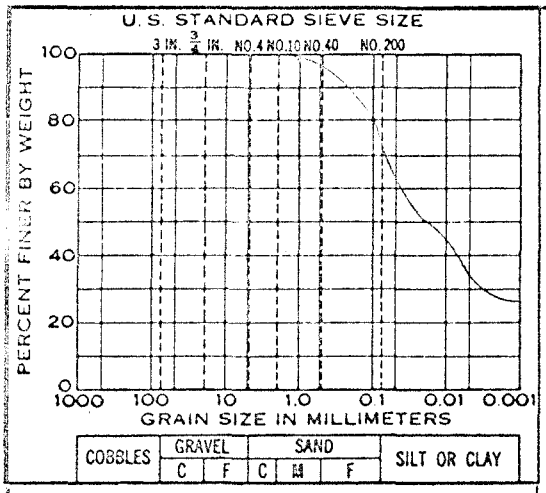
Remarks:

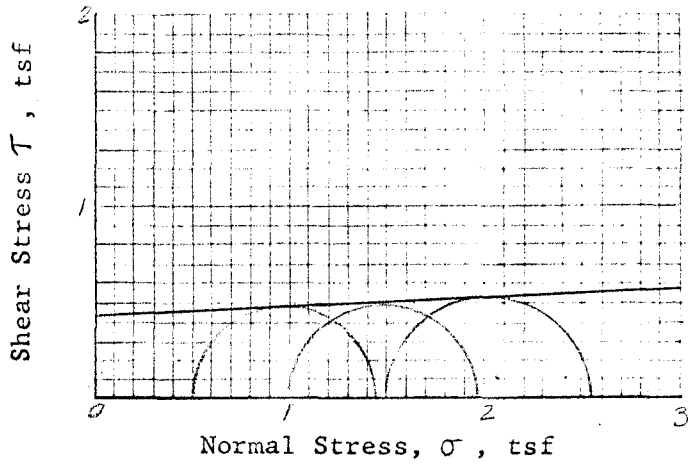
Project: JOHNSONVILLE [illegible]

Feature ASH DIKE

Boring No. [illegible]	Sample No. [illegible]
Station [illegible]	Offset [illegible]
Date [illegible]	Elev. [illegible]

TRIAXIAL COMPRESSION TEST (R)

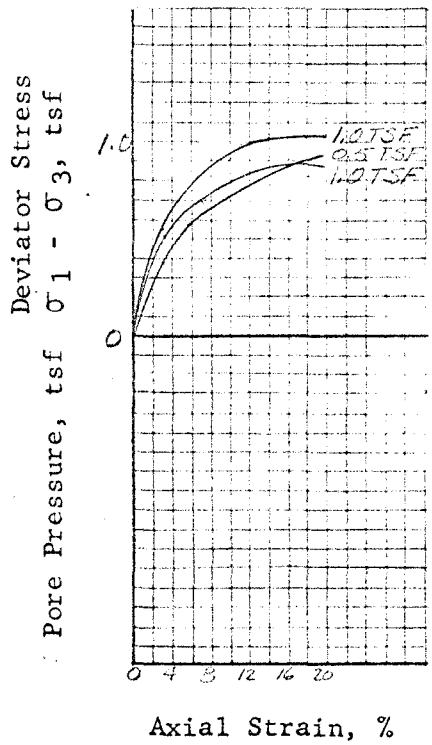




Type of Specimen	UNDISTURBED
Classification	CL
LL. 30.3	G 2.69
PI. 12.5	D_{10} —

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	27°	.046	0.44
Effective			

Specimen Number		1	2	3	4
Initial	Moisture Content, %	23.9	23.5	22.3	
	Dry Density, pcf	97.9	96.3	98	
	Void Ratio	0.72	0.74	[illegible]	
	Saturation, %	89.9	92.0	116	
Before Shearing	Moisture Content after Saturation, %	—	—	—	
	Saturation, %	—	—	—	
	Moisture Content after Consolidation, %	—	—	—	
	Void Ratio after Consolidation	—	—	—	
Final Moisture Content, %		23.4	25.0	[illegible]	
Minor Principal Stress, σ_3, tsf		0.50	1.00	1.50	
Major Principal Stress, σ_1, tsf		1.43	1.94	[illegible]	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		—	—	—	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		—	—	—	
Time to Failure, min.		19	14	14	
Rate of Strain, %/min.		1.0	1.0	1.0	
Specimen Height, in.		3.142	[illegible]	3.142	
Specimen Diameter, in.		1.398	[illegible]	1.398	



Remarks:

Project: JOHNSONVILLE S.P.

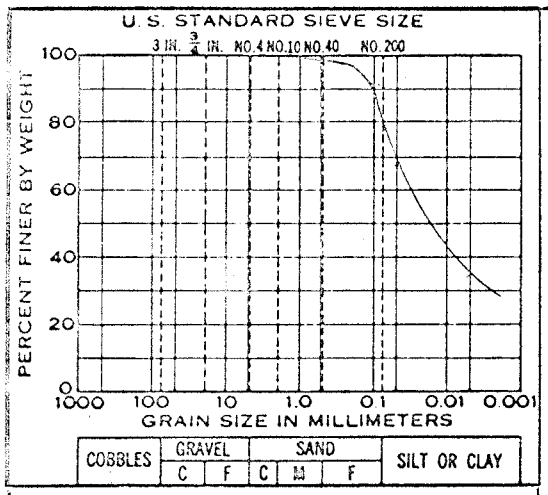
Feature ASH DIKE

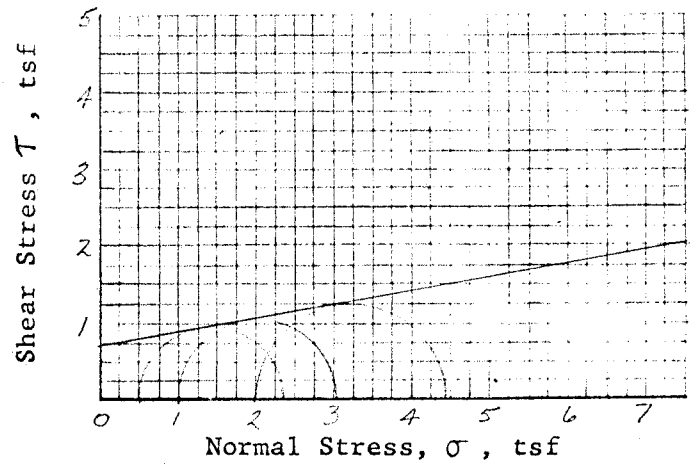
Boring No. US-3 | Sample No. 3

Station [illegible] | Offset 8' LT

Date 8/7/69 | Elev. [illegible]

TRIAXIAL COMPRESSION TEST (Q)

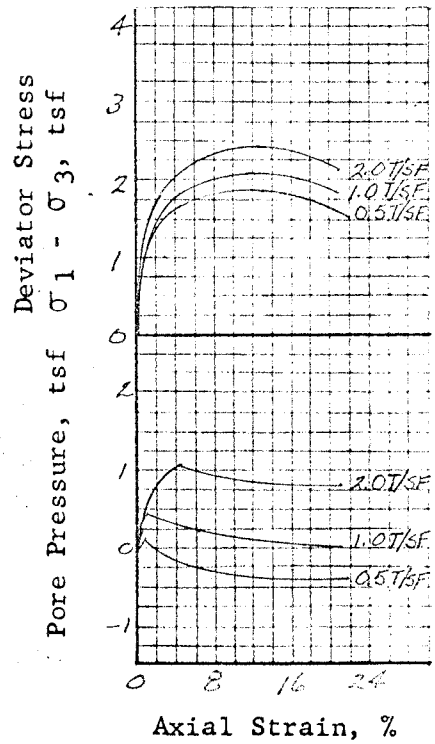




Type of Specimen	UNDISTURBED
Classification	CL
LL. 34.6	G 2.70
PI. 17.4	D10 ———

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	9.6	.17	0.74
Effective	28.4	.54	0.14

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	21.1	20.5	21.5	
	Dry Density, pcf	103.2	103.4	101.6	
	Void Ratio	.633	.631	.640	
	Saturation, %	99.9	87.1	89.9	
Before Shearing	Moisture Content after Saturation, %	22.5	23.4	24.4	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	22.5	22.6	22.8	
	Void Ratio after Consolidation	.594	.575	.567	
Final Moisture Content, %		22.5	22.6	22.8	
Minor Principal Stress, σ_3, tsf		0.50	1.00	2.00	
Major Principal Stress, σ_1, tsf		2.34	3.02	4.44	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		0.79	0.99	1.11	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		2.63	2.92	3.55	
Time to Failure, min.		60	50	60	
Rate of Strain, %/min.		0.2	0.2	0.2	
Specimen Height, in.		3.18	3.18	3.18	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

Project: JOHNSONVILLE S.P.

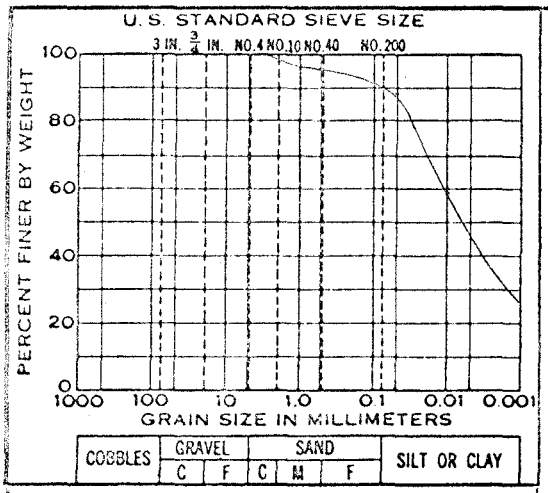
Feature ASH DIKE

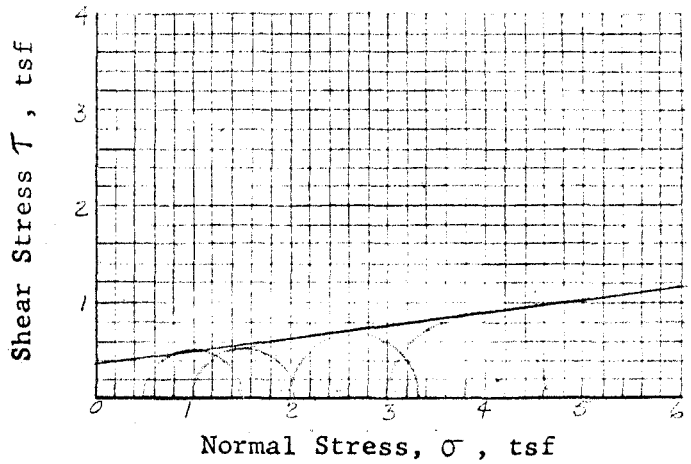
Boring No. US-3 | Sample No. 3

Station 59+50 | Offset 8' LT

Date 8-19-69 | Elev. 3545-3540

TRIAXIAL COMPRESSION TEST (R)

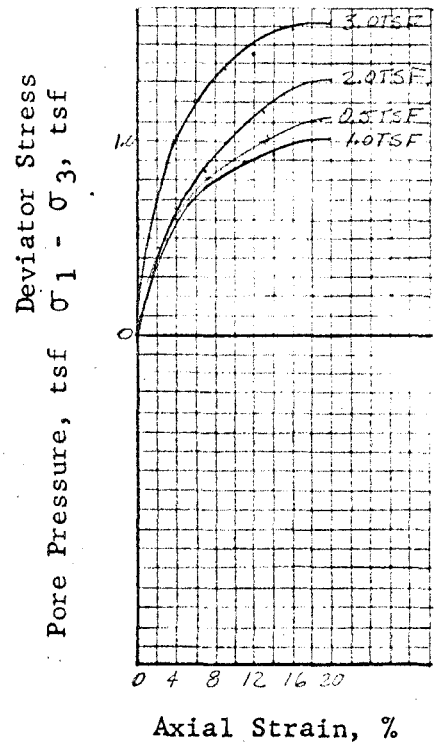




Type of Specimen	UNDISTURBED
Classification	CL
LL. 42.1	G 2.72
PI. 19.1	D10 —

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	7.5°	0.13	0.38
Effective	—	—	—

Specimen Number		1	2	3	4
Initial	Moisture Content, %	26.2	27.5	27.4	24.7
	Dry Density, pcf	97.2	[illegible]	95.9	98.0
	Void Ratio	0.724	[illegible]	0.771	0.733
	Saturation, %	94.8	95.3	96.3	91.8
Before Shearing	Moisture Content after Saturation, %	—	—	—	—
	Saturation, %	—	—	—	—
	Moisture Content after Consolidation, %	—	—	—	—
	Void Ratio after Consolidation	—	—	—	—
Final Moisture Content, %		26.4	27.4	27.5	24.9
Minor Principal Stress, σ_3, tsf		0.50	1.00	2.00	3.00
Major Principal Stress, σ_1, tsf		1.49	2.05	[illegible]	[illegible]
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		—	—	—	—
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		—	—	—	—
Time to Failure, min.		13	20	19	20
Rate of Strain, %/min.		1.0	1.0	1.0	1.0
Specimen Height, in.		2.14	2.14	2.14	2.14
Specimen Diameter, in.		1.40	1.40	1.40	1.40



Remarks:

Project: JOHNSONVILLE S.P.

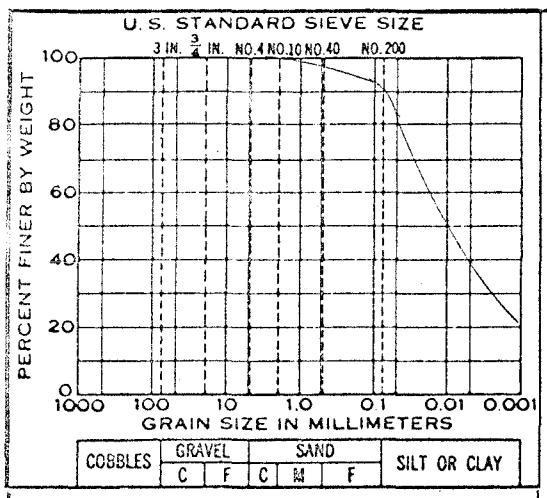
Feature [illegible]

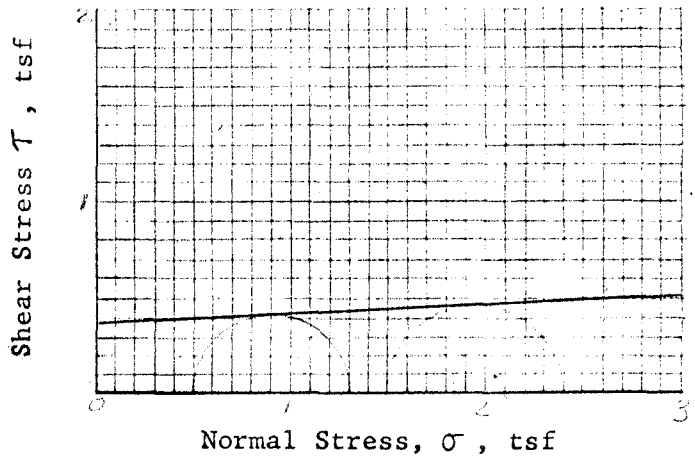
Boring No. US-3 | Sample No. 4

Station 59+50 | Offset 8' Lt

Date 9/3/69 | Elev. 352.0 - 354.0

TRIAXIAL COMPRESSION TEST

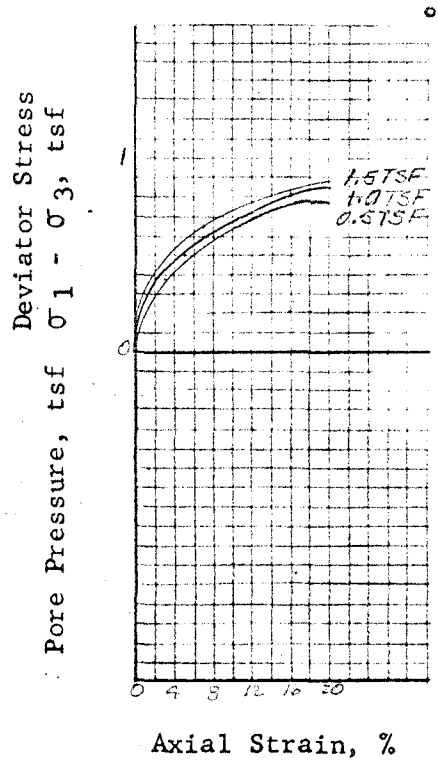




Type of Specimen	UNDISTURBED
Classification	CL
LL. 30.2	G 2.71
PI. [illegible]	D_{10} —

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	2.7°	0.05	0.38
Effective	—	—	—

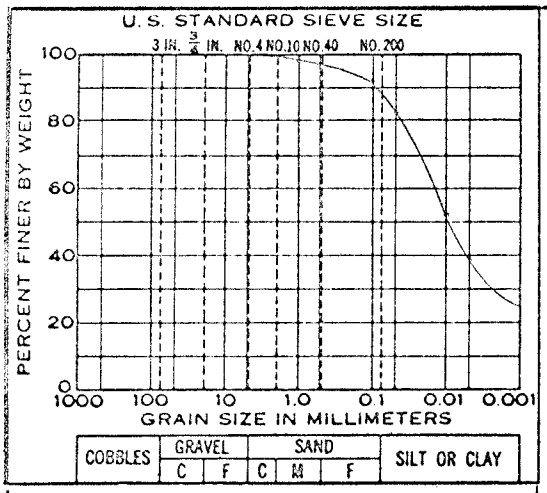
Specimen Number		1	2	3	4
Initial	Moisture Content, %	30.1	29.2	23.3	
	Dry Density, pcf	90.9	92.4	93.3	
	Void Ratio	[illegible]	0.831	0.816	
	Saturation, %	[illegible]	95.1	95.5	
Before Shearing	Moisture Content after Saturation, %	—	—	—	
	Saturation, %	—	—	—	
	Moisture Content after Consolidation, %	—	—	—	
	Void Ratio after Consolidation	—	—	—	
Final Moisture Content, %		32.0	29.0	[illegible]	
Minor Principal Stress, σ_3, tsf		0.50	1.00	1.50	
Major Principal Stress, σ_1, tsf		1.30	1.84	[illegible]	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		—	—	—	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		—	—	—	
Time to Failure, min.		17	17	[illegible]	
Rate of Strain, %/min.		1.0	1.0	1.0	
Specimen Height, in.		3.142	3.140	3.142	
Specimen Diameter, in.		1.40	1.40	1.40	

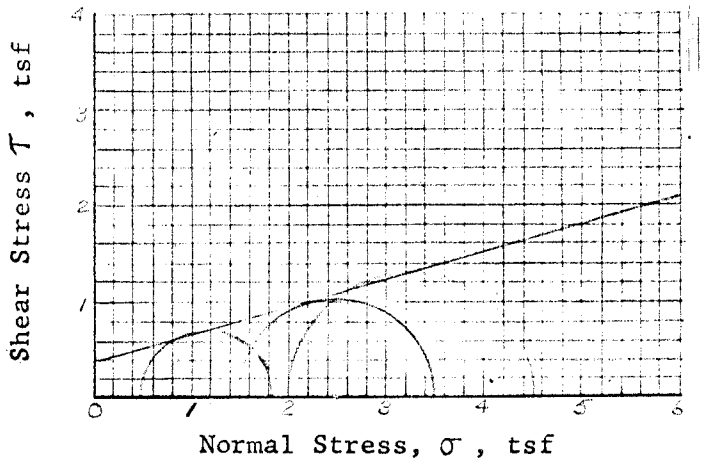


Remarks:

Project: JOHNSONVILLE S P	
Feature ASH DIKE	
Boring No. US-4	Sample No. 2
Station 504+00	Offset 1
Date 9/18/69	Elev. [illegible]

TRIAXIAL COMPRESSION TEST (Q)

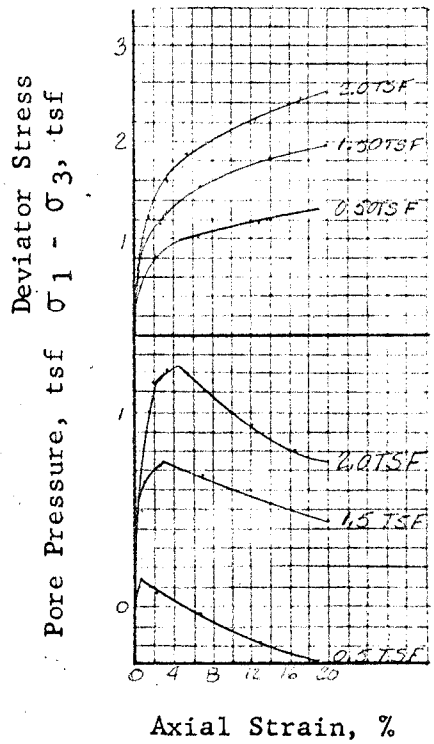




Type of Specimen UNDISTURBED	
Classification CL	
LL. 39.2	G 2.71
PI. 16.3	D_{10} ——

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	15.7°	0.28	0.40
Effective	29.7°	0.57	0.0

Specimen Number		1	2	3	4
Initial	Moisture Content, %	23.8	23.6	22.1	
	Dry Density, pcf	98.2	99.9	102.3	
	Void Ratio	0.72	0.694	0.653	
	Saturation, %	89.7	92.0	91.8	
Before Shearing	Moisture Content after Saturation, %	26.7	25.6	24.1	
	Saturation, %	100.0	100.0	100.0	
	Moisture Content after Consolidation, %	23.8	23.1	22.1	
	Void Ratio after Consolidation	0.710	0.624	0.575	
Final Moisture Content, %		23.8	23.1	22.1	
Minor Principal Stress, σ_3, tsf		0.50	1.50	2.00	
Major Principal Stress, σ_1, tsf		1.83	2.48	3.53	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		[illegible]	1.07	1.39	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		[illegible]	[illegible]	[illegible]	
Time to Failure, min.		90	100	90	
Rate of Strain, %/min.		0.2	0.2	0.2	
Specimen Height, in.		2.143	2.143	2.143	
Specimen Diameter, in.		1.40	1.40	1.40	



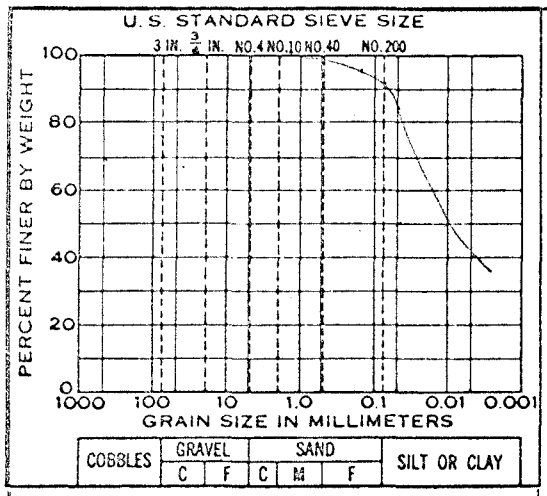
Remarks:

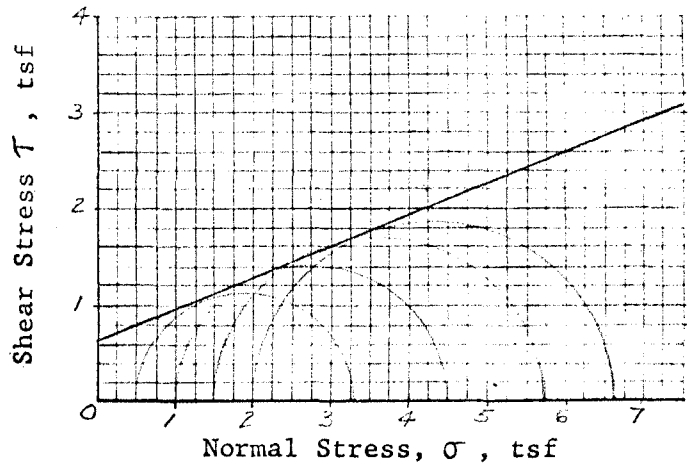
Project: JOHNSONVILLE

Feature HIGH DIKE

Boring No. US-4	Sample No. 2
Station 50+00	Offset ℄
Date 8/14/69	Elev. 357.5

TRIAXIAL COMPRESSION TEST (R)

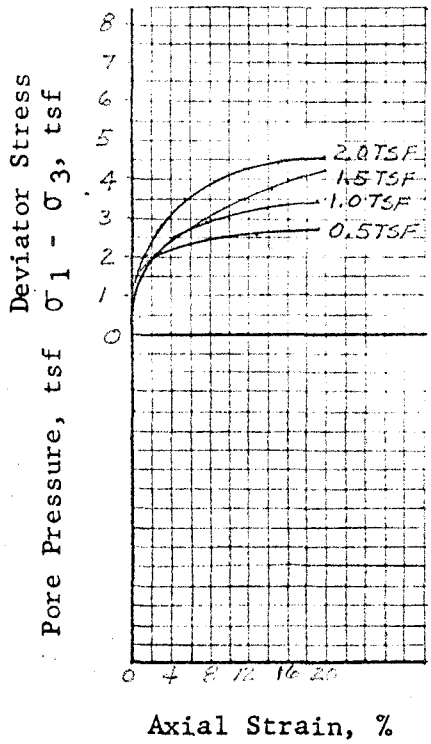




Type of Specimen UNDISTURBED	
Classification CL	
LL. 43.4	G 2.72
PI. 17.5	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	22.0	.40	0.80
Effective	—	—	—

Specimen Number		1	2	3	4
Initial	Moisture Content, %	22.4	21.8	22.2	21.4
	Dry Density, pcf	95.5	95.8	95.5	96.5
	Void Ratio	.778	.772	.778	.759
	Saturation, %	78.2	76.8	77.6	76.6
Before Shearing	Moisture Content after Saturation, %	—	—	—	—
	Saturation, %	—	—	—	—
	Moisture Content after Consolidation, %	—	—	—	—
	Void Ratio after Consolidation	—	—	—	—
Final Moisture Content, %		22.2	21.6	22.3	21.3
Minor Principal Stress, σ_3, tsf		0.50	1.00	1.50	2.00
Major Principal Stress, σ_1, tsf		3.28	4.48	5.74	6.60
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		—	—	—	—
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		—	—	—	—
Time to Failure, min.		19	19	21	20
Rate of Strain, %/min.		1.0	1.0	1.0	1.0
Specimen Height, in.		3.14	3.14	3.14	3.14
Specimen Diameter, in.		1.40	1.40	1.40	1.40



Remarks:

Project: JOHNSONVILLE S.P.

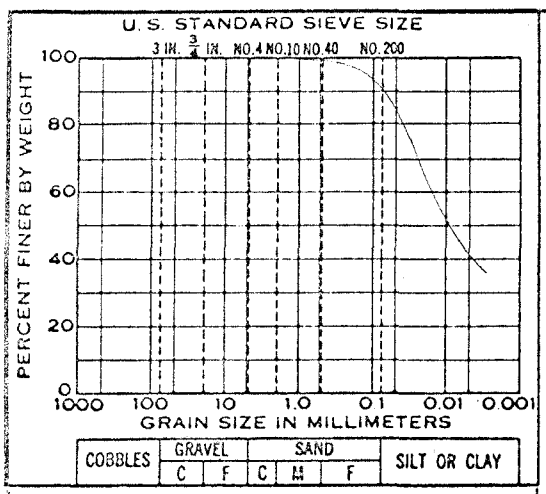
Feature ASH DIKE

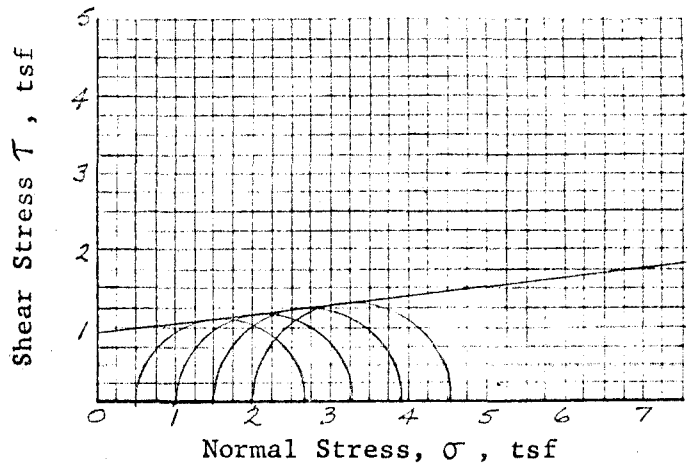
Boring No. US-5 | Sample No. 1

Station 39+00 | Offset ℄

Date AUG. 20, 1969 | Elev. 364.0-363.5

TRIAXIAL COMPRESSION TEST (Q)

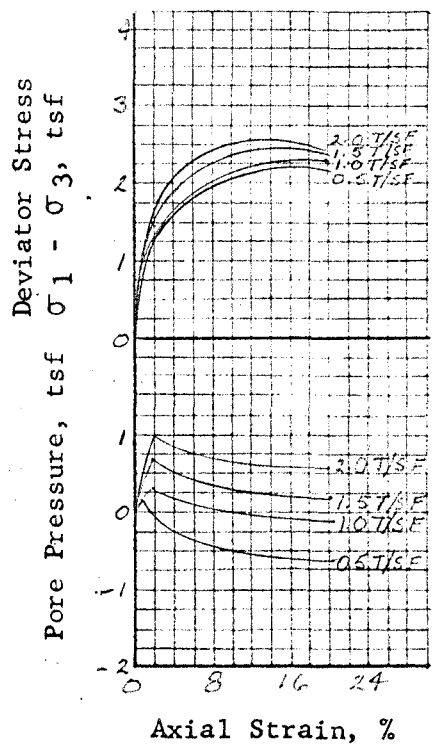




Type of Specimen	UNDISTURBED		
Classification	CL		
LL.	42.4	G	2.72
PI.	17.5	D_{10}	—

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	6.7	.12	0.94
Effective	20.3	.37	0.38

Specimen Number		1	2	3	4
Initial	Moisture Content, %	22.2	21.6	22.3	20.8
	Dry Density, pcf	98.7	99.3	99.3	101.0
	Void Ratio	.721	.710	.710	.682
	Saturation, %	83.6	82.9	85.2	83.1
Before Shearing	Moisture Content after Saturation, %	26.5	26.1	26.1	25.1
	Saturation, %	100	100	100	100
	Moisture Content after Consolidation, %	26.3	24.7	25.3	24.0
	Void Ratio after Consolidation	.706	.687	.691	.643
Final Moisture Content, %		26.3	24.7	25.3	24.0
Minor Principal Stress, σ_3, tsf		0.50	1.00	1.50	2.00
Major Principal Stress, σ_1, tsf		2.69	3.27	3.91	4.52
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		1.04	1.13	1.20	1.28
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		3.23	3.40	3.61	3.80
Time to Failure, min.		80	100	70	60
Rate of Strain, %/min.		0.2	0.2	0.2	0.2
Specimen Height, in.		3.18	3.18	3.18	3.18
Specimen Diameter, in.		1.40	1.40	1.40	1.40



Remarks:

Project: JOHNSONVILLE S. P.

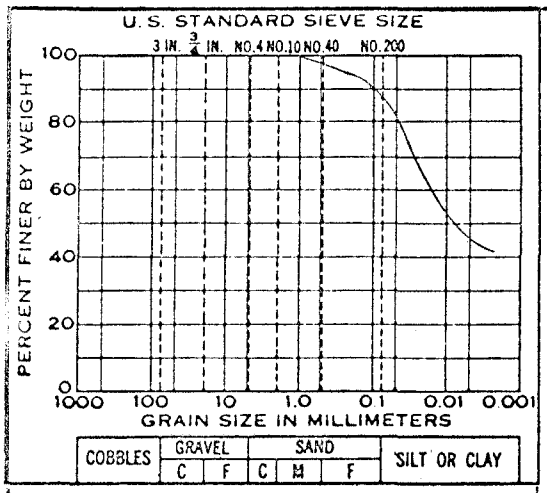
Feature ASH DIKE

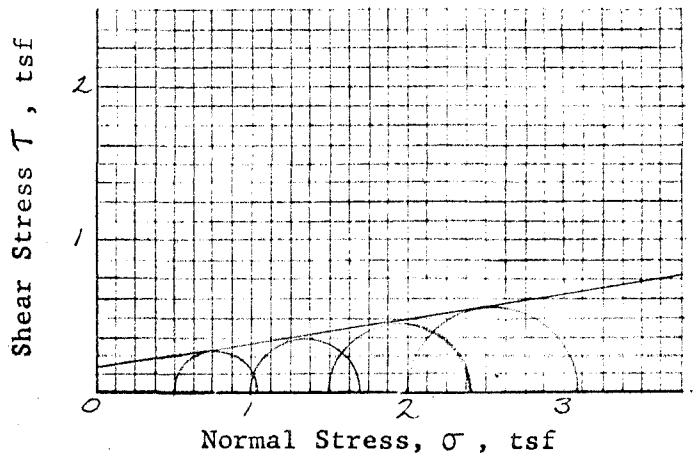
Boring No. US-5 | Sample No. 1

Station 39+00 | Offset ℄

Date 8-21-69 | Elev. 363.5-363.1

TRIAXIAL COMPRESSION TEST (R)

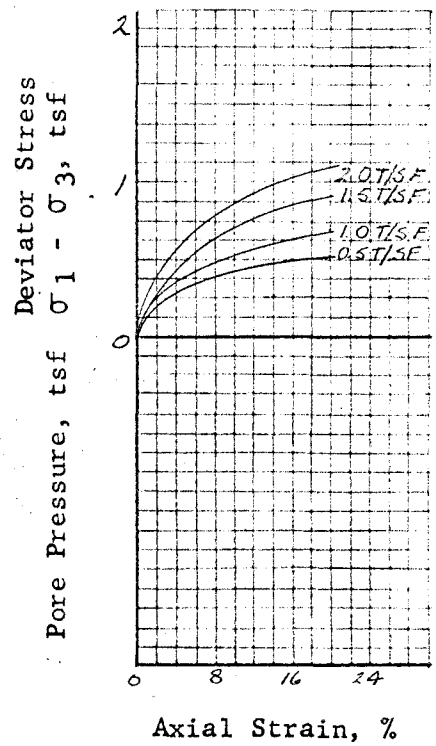




Type of Specimen	UNDISTURBED		
Classification	CL		
LL.	40.5	G	2.72
PI.	19.2	D10	—

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	9.1	.16	0.17
Effective	—	—	—

Specimen Number		1	2	3	4
Initial	Moisture Content, %	28.2	27.3	27.6	26.1
	Dry Density, pcf	94.1	95.1	93.3	94.4
	Void Ratio	.805	.786	.814	.799
	Saturation, %	95.4	94.7	91.7	88.9
Before Shearing	Moisture Content after Saturation, %	—	—	—	—
	Saturation, %	—	—	—	—
	Moisture Content after Consolidation, %	—	—	—	—
	Void Ratio after Consolidation	—	—	—	—
Final Moisture Content, %		27.6	26.9	26.9	25.6
Minor Principal Stress, σ_3, tsf		0.50	1.00	1.50	2.00
Major Principal Stress, σ_1, tsf		1.03	1.70	2.41	3.09
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		—	—	—	—
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		—	—	—	—
Time to Failure, min.		20	20	20	20
Rate of Strain, %/min.		1.0	1.0	1.0	1.0
Specimen Height, in.		3.14	3.14	3.14	3.14
Specimen Diameter, in.		1.40	1.40	1.40	1.40



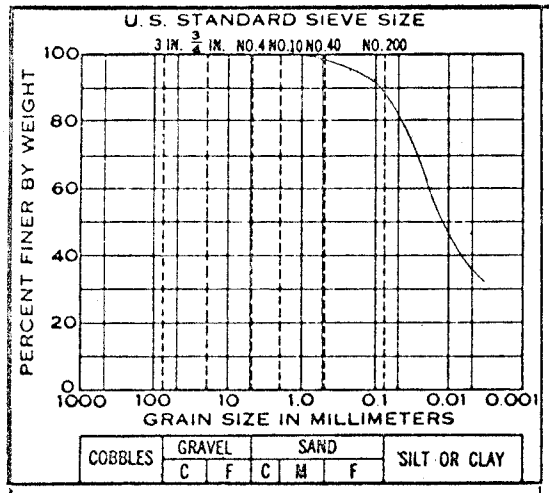
Remarks:

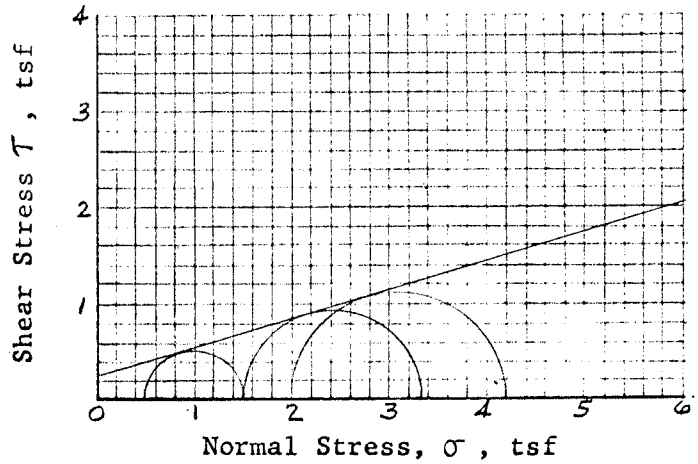
Project: JOHNSONVILLE S.P.

Feature ASH DIKE

Boring No. US-5	Sample No. 2
Station 39+00	Offset ℄
Date 8-18-69	Elev. 358.7 - 359.5

TRIAXIAL COMPRESSION TEST (Q)

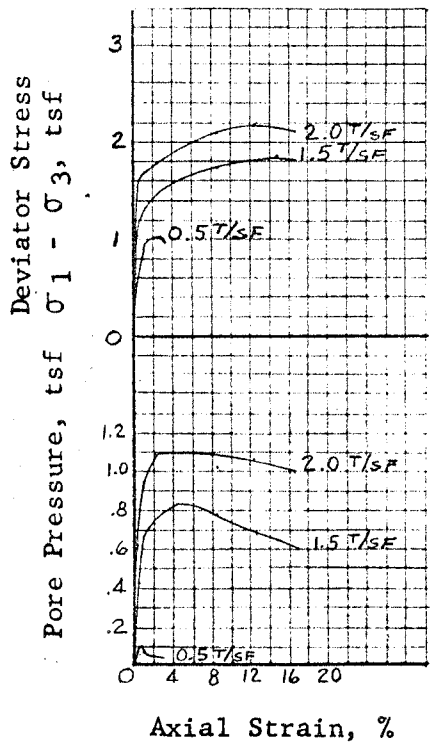




Type of Specimen UNDISTURBED	
Classification CL	
LL. 38.8	G 2.72
PI. 15.2	D_{10} –

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	16.5	0.30	0.26
Effective	29.8	0.58	0.04

Specimen Number		1	2	3	4
Initial	Moisture Content, %	22.7	22.2	22.3	
	Dry Density, pcf	98.1	98.9	98.2	
	Void Ratio	0.732	0.718	0.729	
	Saturation, %	84.5	84.0	83.1	
Before Shearing	Moisture Content after Saturation, %	26.9	26.4	26.8	
	Saturation, %	100.0	100.0	100.0	
	Moisture Content after Consolidation, %	26.0	24.2	24.2	
	Void Ratio after Consolidation	0.697	0.665	0.653	
Final Moisture Content, %		26.0	24.2	24.2	
Minor Principal Stress, σ_3, tsf		0.50	1.50	2.00	
Major Principal Stress, σ_1, tsf		1.50	3.33	4.19	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		0.46	0.85	0.93	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		1.46	2.68	3.26	
Time to Failure, min.		10	70	60	
Rate of Strain, %/min.		0.2	0.2	0.2	
Specimen Height, in.		3.18	3.18	3.18	
Specimen Diameter, in.		1.41	1.41	1.41	



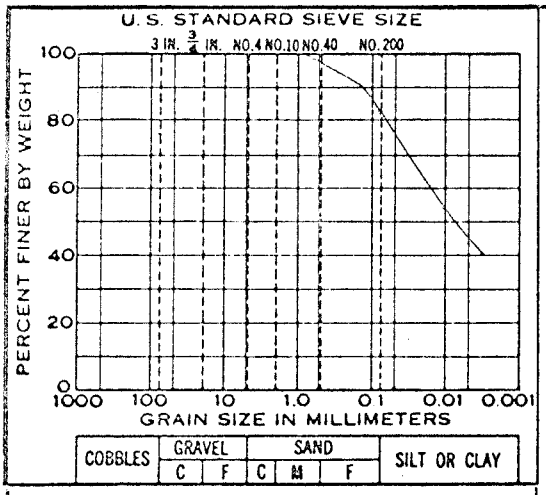
Remarks:

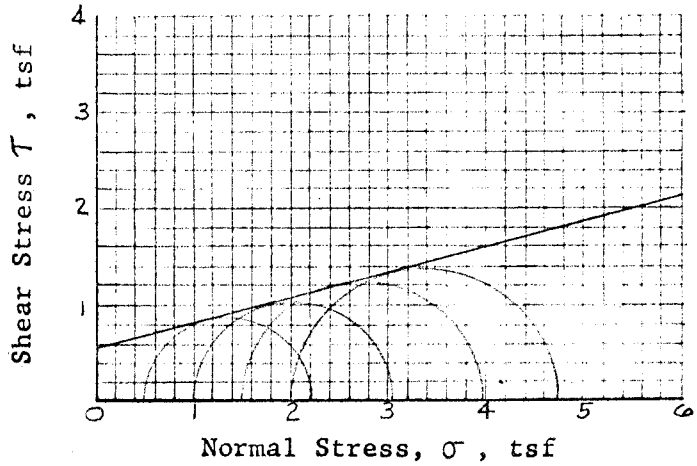
Project: JOHNSONVILLE SP

Feature ASH DIKE

Boring No. 6	Sample No. 1
Station 30+00	Offset ℄
Date 9-3-69	Elev. 362.0-361.5

TRIAXIAL COMPRESSION TEST (R)

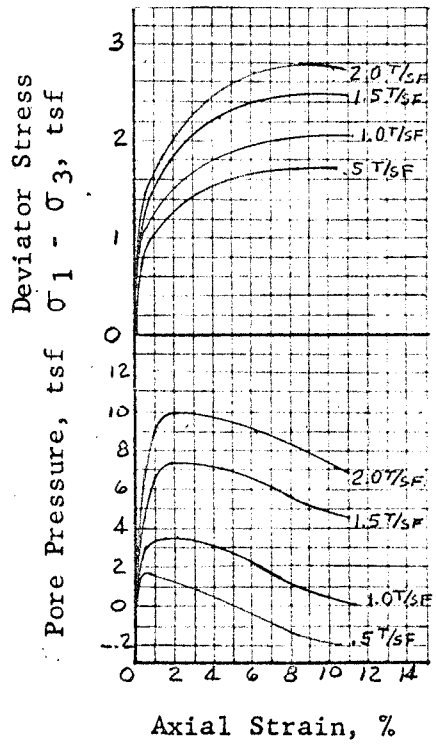




Type of Specimen UNDISTURBED	
Classification CL	
LL. 35.2	G 2.68
PI. 16.3	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	15.2	0.27	0.58
Effective	28.0	0.53	0.18

Specimen Number		1	2	3	4
Initial	Moisture Content, %	22.7	22.3	22.4	22.1
	Dry Density, pcf	101.8	102.7	103.5	102.8
	Void Ratio	0.664	0.628	0.617	0.628
	Saturation, %	94.4	95.2	97.2	94.3
Before Shearing	Moisture Content after Saturation, %	24.0	23.4	23.0	23.4
	Saturation, %	100.0	100.0	100.0	100.0
	Moisture Content after Consolidation, %	23.5	23.3	23.3	22.4
	Void Ratio after Consolidation	0.618	0.602	0.555	0.577
Final Moisture Content, %		23.5	23.3	23.3	22.4
Minor Principal Stress, σ_3, tsf		0.50	1.00	1.50	2.00
Major Principal Stress, σ_1, tsf		2.21	3.04	3.98	4.75
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		0.64	1.00	0.97	1.29
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		2.35	3.03	3.45	4.04
Time to Failure, min.		40	50	40	
Rate of Strain, %/min.		0.2	0.2	0.2	0.2
Specimen Height, in.		3.18	3.18	3.18	3.18
Specimen Diameter, in.		1.41	1.41	1.41	1.41



Remarks:

Project: JOHNSONVILLE S P

Feature ASH DIKE

Boring No. 6	Sample No. 2
Station 30+00	Offset ℄
Date 8-27-69	Elev. 355.8-355.3

TRIAXIAL COMPRESSION TEST (R)

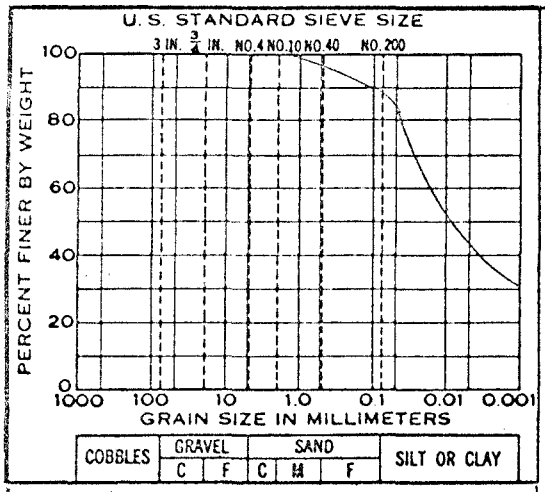
JOHNSONVILLE STEAM PLANT

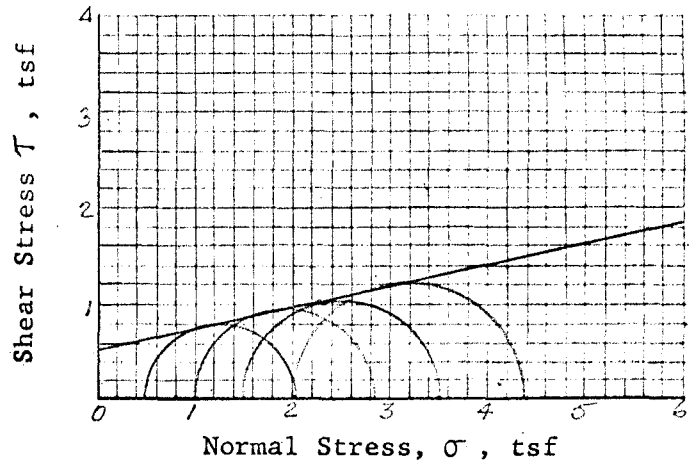
ASH POND DIKE

SUMMARY OF LABORATORY TEST DATA

BORROW SOIL CLASSES

Class	I	II
Symbol	CL	CL
Mechanical and hydrometer analysis		
Gravel, percent	0	0
Sand, percent	13	13
Silt, percent	43	35
Clay, percent	44	52
Atterberg Limits		
Liquid limit, percent	40.9	42.9
Plastic limit, percent	21.1	22.1
Plasticity index, percent	19.8	20.8
Shrinkage limit, percent	16.7	16.4
Standard Proctor Compaction		
Optimum Moisture, percent	19.8	20.8
Maximum Density, pcf	104.5	102.4
Penetration Resistance, psi	360	475
Shear strength at 2 percent above optimum		
Triaxial R: Ø, degrees	12.5	10.8
C, tsf	0.53	0.50

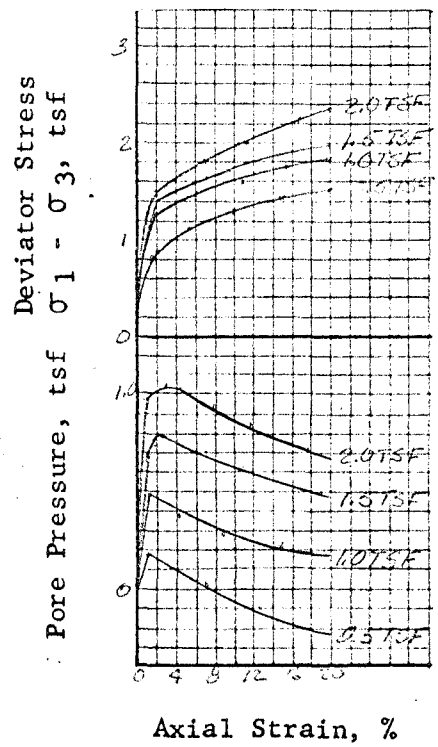




Type of Specimen	REMOLDED
Classification	CL
LL. 40.9	G 2.73
PI. 19.8	D_{10} —

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	12.5°	0.22	0.53
Effective	23.8°	0.41	0.25

Specimen Number		1	2	3	4
Initial	Moisture Content, %	22.0	22.3	21.7	21.7
	Dry Density, pcf	102.4	102.3	103.0	102.9
	Void Ratio	0.624	[illegible]	0.605	[illegible]
	Saturation, %	90.5	91.3	90.3	90.2
Before Shearing	Moisture Content after Saturation, %	24.3	24.4	24.0	24.0
	Saturation, %	100.0	100.0	100.0	100.0
	Moisture Content after Consolidation, %	22.9	22.5	22.9	[illegible]
	Void Ratio after Consolidation	0.631	[illegible]	0.60[illegible]	[illegible]
Final Moisture Content, %		22.9	22.5	22.9	[illegible]
Minor Principal Stress, σ_3, tsf		[illegible]	[illegible]	1.04	[illegible]
Major Principal Stress, σ_1, tsf		2.01	2.21	3.50	4.28
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		0.72	0.82	1.02	1.40
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		2.23	[illegible]	3.02	3.78
Time to Failure, min.		80	100	100	100
Rate of Strain, %/min.		[illegible]	[illegible]	[illegible]	[illegible]
Specimen Height, in.		[illegible]	[illegible]	[illegible]	[illegible]
Specimen Diameter, in.		[illegible]	[illegible]	[illegible]	[illegible]



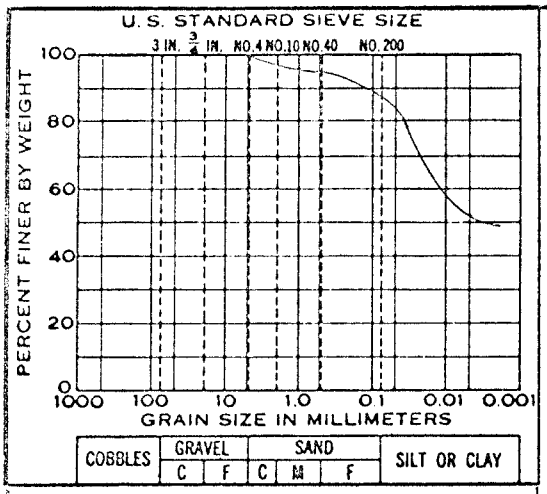
Remarks: REMOLDED AT 2% ABOVE OPTIMUM MOISTURE CONTENT STANDARD PROCTOR [illegible]

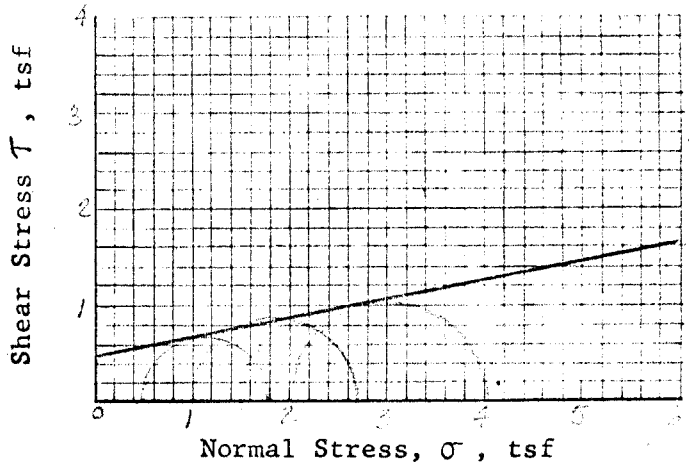
Project: JOHNSONVILLE SP BORROW AREA

Feature ASH DIKE

Boring No.	Sample No. [illegible]
Station	Offset
Date 9/2/69	Elev.

TRIAXIAL COMPRESSION TEST (R)

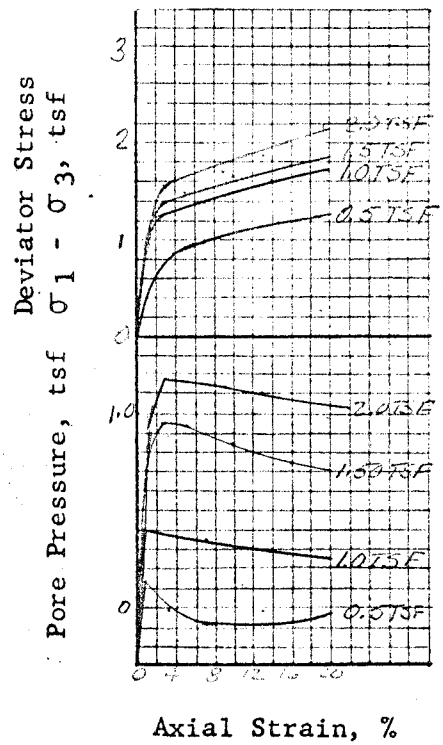




Type of Specimen	REMOLDED
Classification	CL
LL. 42.9	G 2.75
PI. 22.8	D10 —

Specimen Number		1	2	3	4
Initial	Moisture Content, %	22.6	22.7	22.7	22.9
	Dry Density, pcf	100.8	100.8	100.8	100.6
	Void Ratio	0.703	0.703	0.703	0.706
	Saturation, %	88.3	88.6	88.6	89.4
Before Shearing	Moisture Content after Saturation, %	25.6	25.6	[illegible]	25.7
	Saturation, %	100.0	100.0	[illegible]	[illegible]
	Moisture Content after Consolidation, %	25.0	24.1	24.4	24.0
	Void Ratio after Consolidation	0.697	0.671	0.683	0.667
Final Moisture Content, %		25.0	24.1	24.4	24.0
Minor Principal Stress, σ_3, tsf		0.50	1.00	1.50	2.00
Major Principal Stress, σ_1, tsf		1.79	2.10	3.32	4.05
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		0.53	[illegible]	0.83	[illegible]
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		1.53	2.45	[illegible]	[illegible]
Time to Failure, min.		100	90	[illegible]	[illegible]
Rate of Strain, %/min.		0.2	0.2	[illegible]	0.2
Specimen Height, in.		3.17	3.17	3.19	3.17
Specimen Diameter, in.		1.40	1.40	1.40	1.40

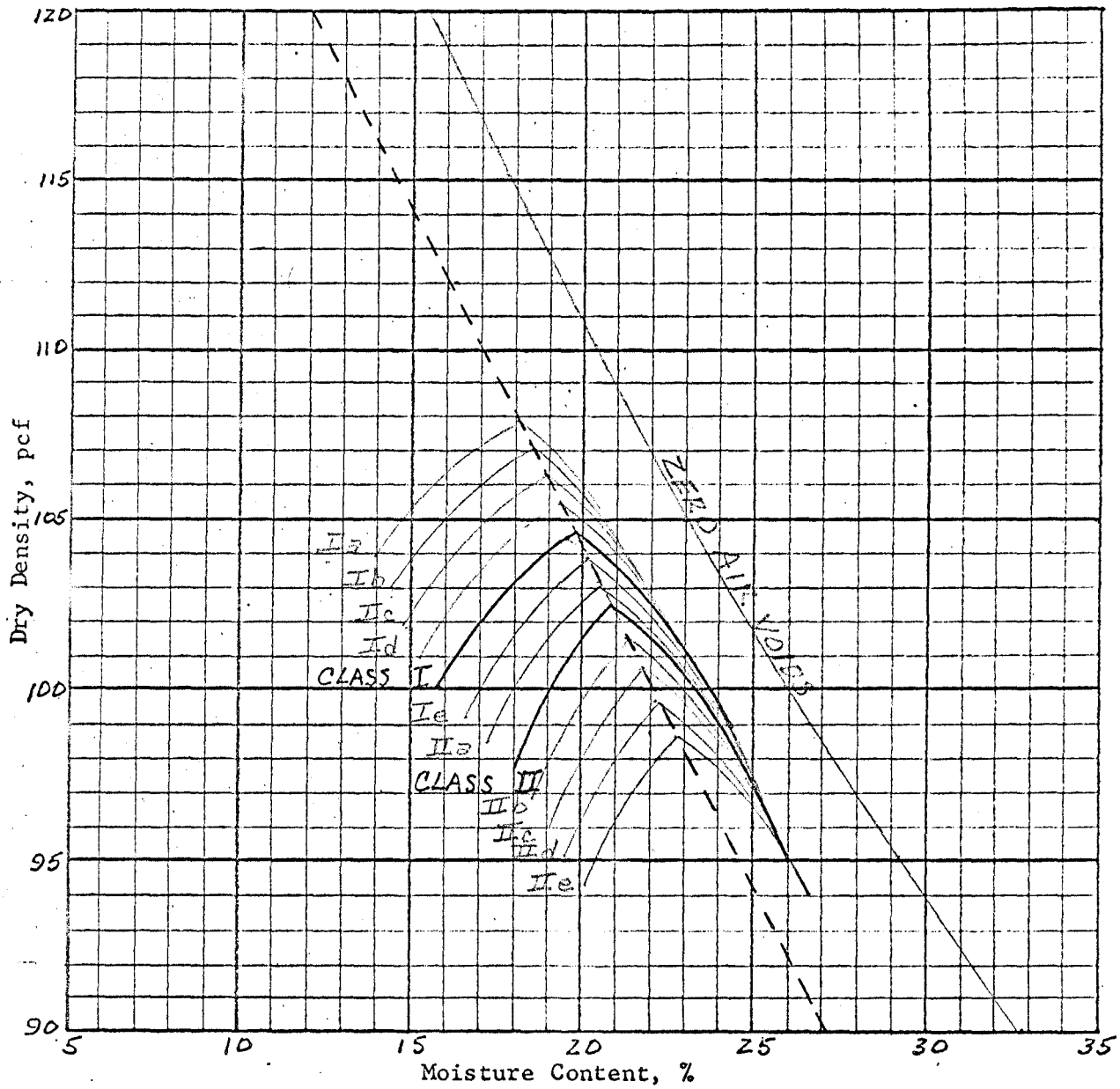
Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	10.8°	0.19	0.50
Effective	29.3	0.49	0.18



Remarks: REMOLDED AT 2% ABOVE OPTIMUM MOISTURE CONTENT STANDARD PROCTOR DENSITY

Project: JOHNSONVILLE SP	
BORROW AREA	
Feature ASH DIKE	
Boring No.	Sample No. CLASS I
Station	Offset
Date 8/27/69	Elev.

TRIAXIAL COMPRESSION TEST (R)



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
I CL	0	13	43	44	2.73	40.9	19.8	19.8	104.5
II CL	0	13	35	52	2.75	42.9	20.8	20.8	102.4

Plus No. 4 Specific Gravity, SSD	
Plus No. 4 Absorption, %	

Remarks:

Project JOHNSONVILLE ASH DIKE

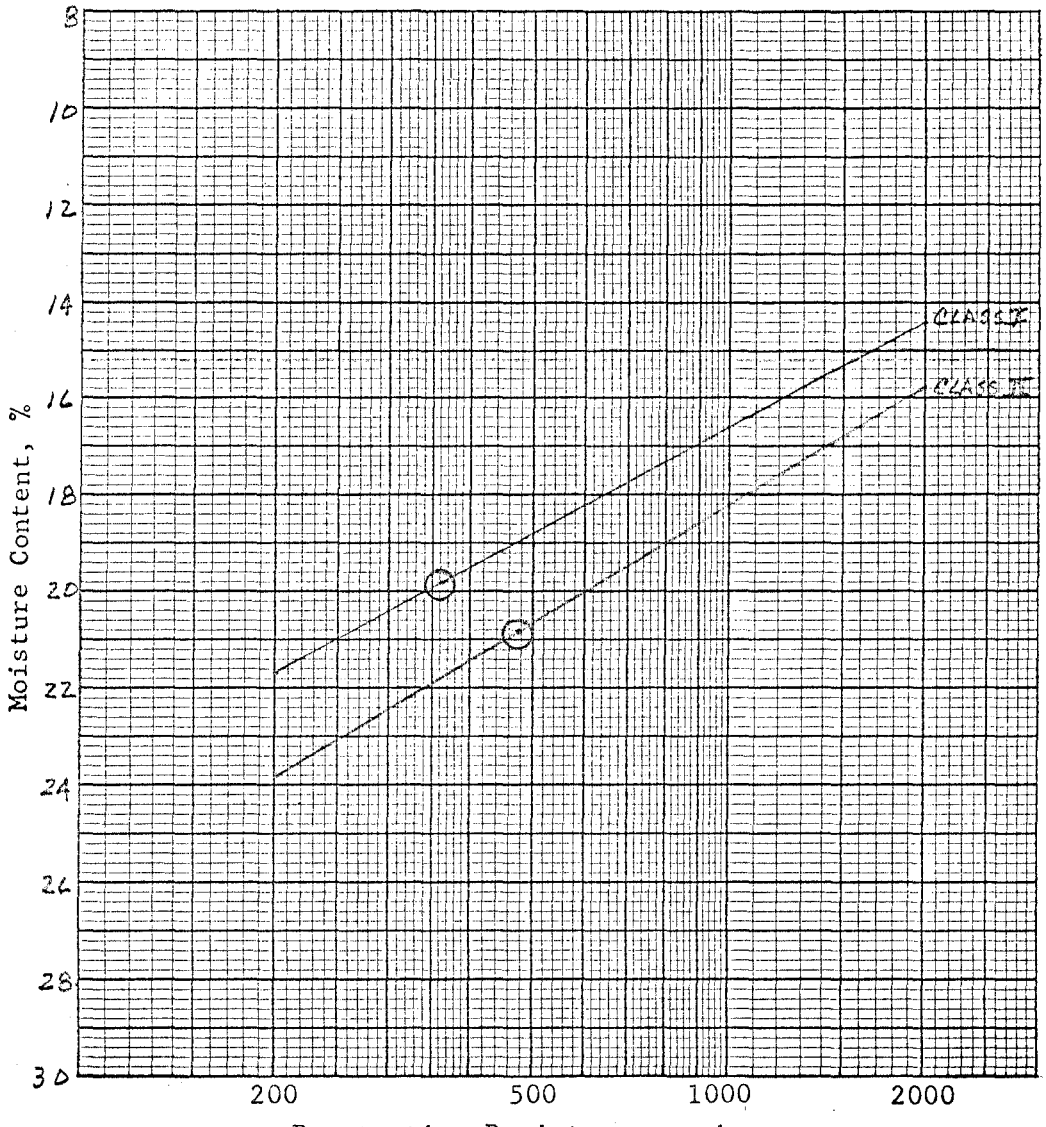
Feature BORROW AREA

ASTM Designation D698-66T

Date Tested 7-31-69

COMPACTION TEST (FAMILY OF CURVES)

Soil Form 14



Soil Class	Optimum Moisture, %	Maximum Density, pcf	Penetration Resistance, psi
I	19.8	104.5	360
II	20.8	102.4	475

Remarks:

Denotes Optimum Moisture

Project JOHNSONVILLE ASH DIKE

Feature BORROW AREA

ASTM Designation

Date Tested 7-31-69

MOISTURE-PENETRATION TEST

Soil Form 15

SCALE: 1" = 100'

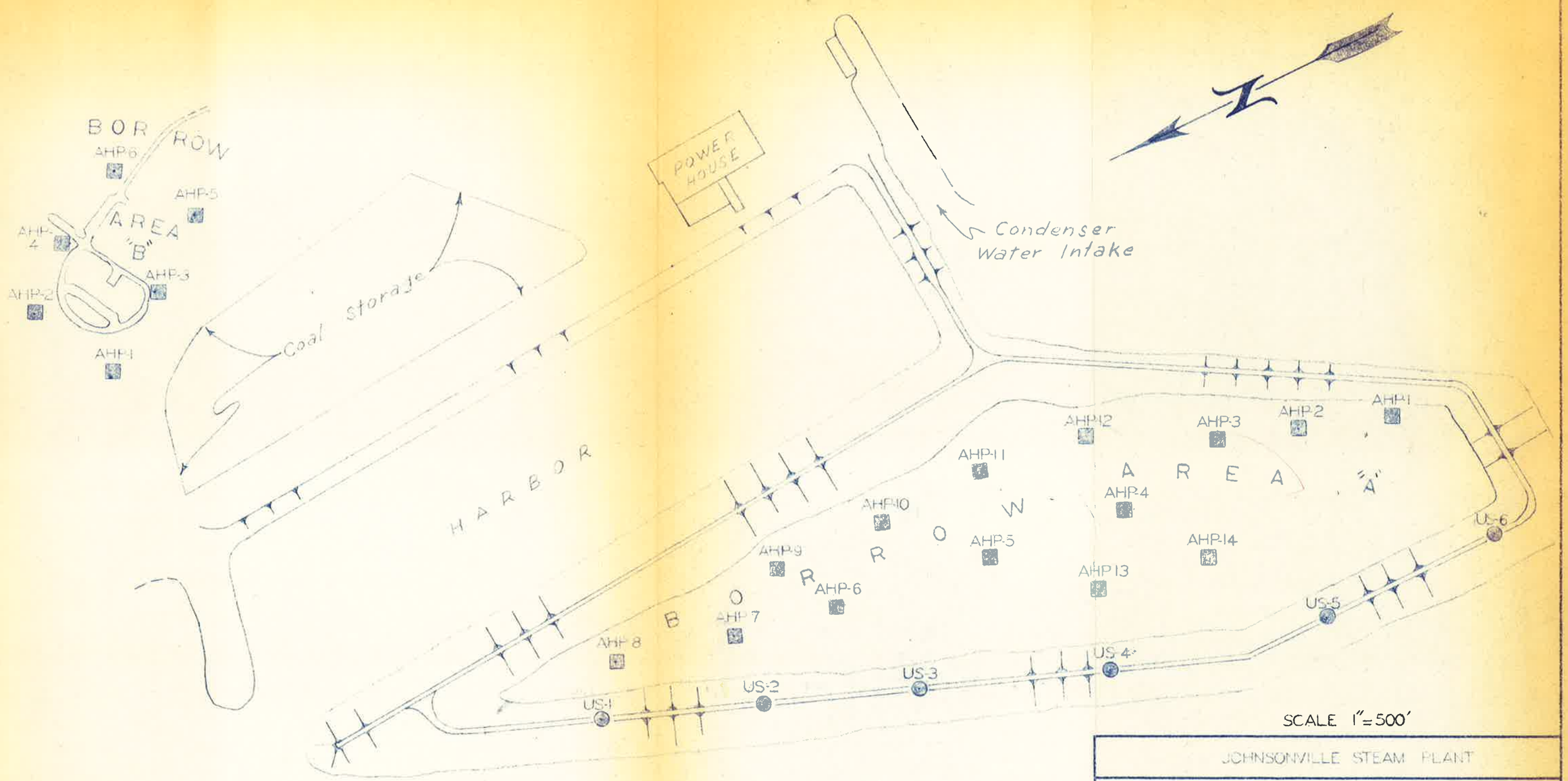
ASH DISPOSAL AREA

PLAN OF SOIL EVALUATION

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED	APPROVED

KNOXVILLE	9	2	68	30	0	2	[illegible]



SYMBOLS

● UNDISTURBED SAMPLING HOLES

▣ AUGER HOLES

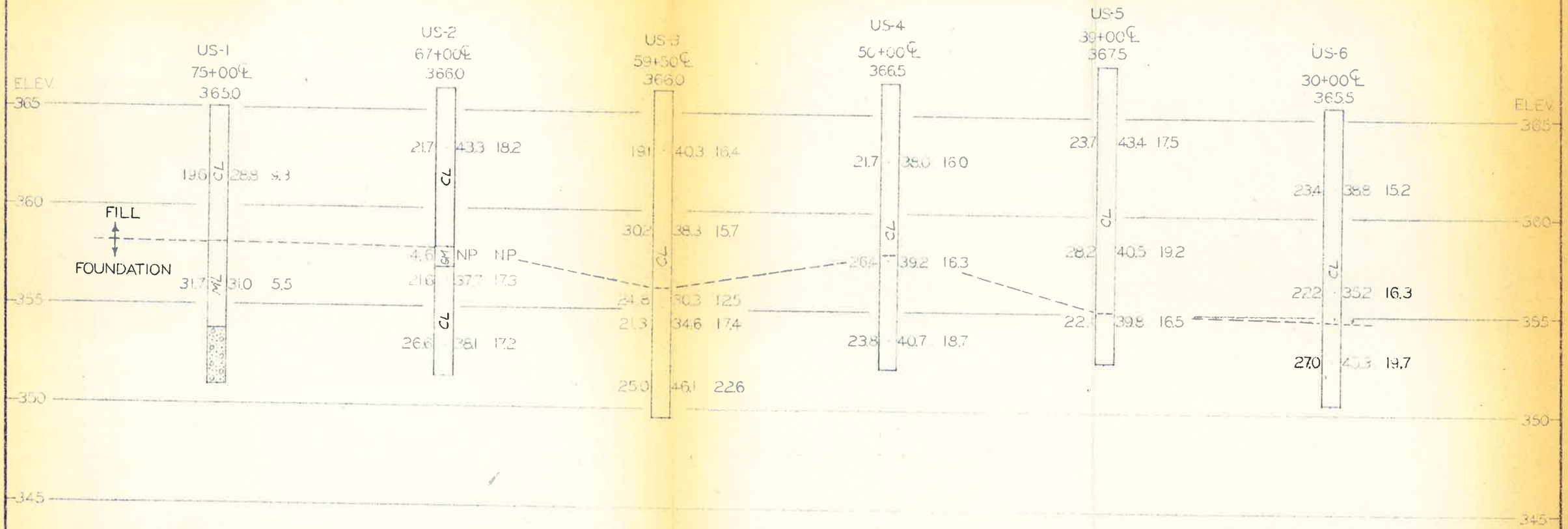
JOHNSONVILLE STEAM PLANT

ASH DISPOSAL AREA

PLAN OF SOILS INVESTIGATION

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED			APPROVED
HPM				ROL
KNOXVILLE	9-2-69	30	CS	3	605B143 RO



LEGEND

HOLE NO.
LOCATION
ELEV.

NATURAL MOISTURE CONTENT | CLASSIFICATION | LIQUID LIMIT | PLASTICITY INDEX

SYMBOLS

UNCLASSIFIED SAND AND GRAVEL

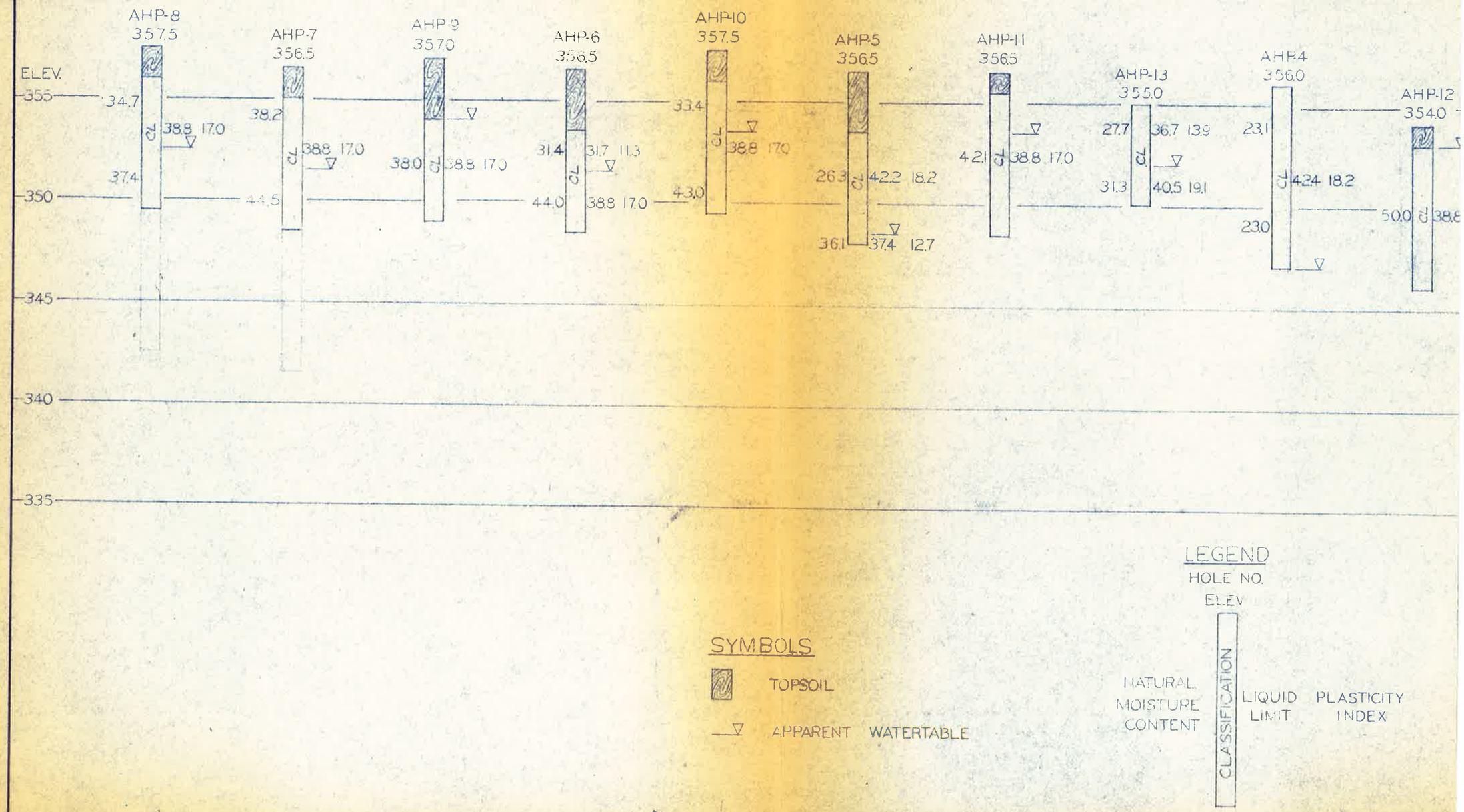
SCALE 1" = 5'

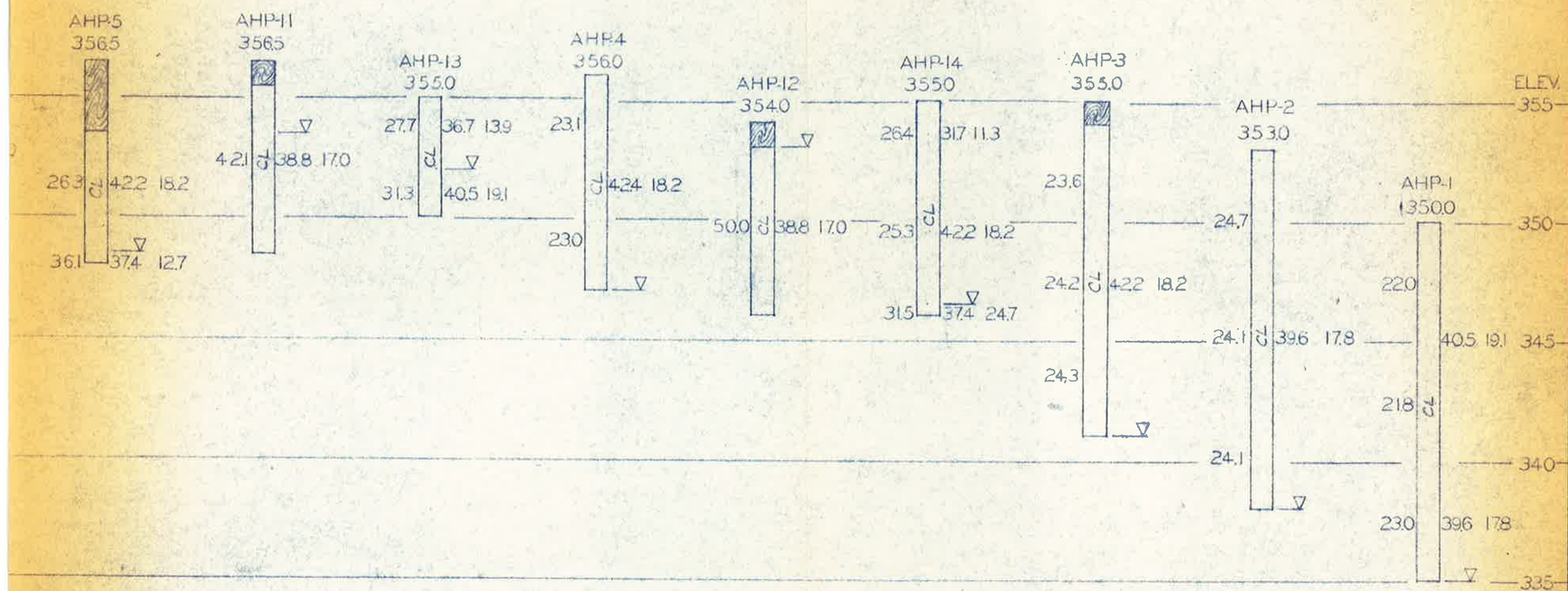
JOHNSONVILLE STEAM PLANT

ASH DISPOSAL AREA
DIKE FOUNDATION
SOILS PROFILE

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED				APPROVED
HPM					RDL
KNOXVILLE	9-2-69	30	CS	3	605B144 RO


ELEV.
355
350
345
340
335
AHP-8
357.5
34.7
38.8 17.0
37.4
AHP-7
356.5
38.2
38.8 17.0
44.5
AHP-9
357.0
38.8 17.0
38.0
AHP-6
356.5
31.4
31.7 11.3
38.8 17.0
44.0
AHP-10
357.5
33.4
38.8 17.0
43.0
AHP-5
356.5
26.3
42.2 18.2
37.4 12.7
36.1
AHP-11
356.5
42.1
38.8 17.0
AHP-13
355.0
27.7
36.7 13.9
40.5 19.1
31.3
AHP-4
356.0
23.1
42.4 18.2
23.0
AHP-12
354.0
50.0
38.8
CL
SYMBOLS
TOPSOIL
APPARENT WATERTABLE
LEGEND
HOLE NO.
ELEV
NATURAL MOISTURE CONTENT
CLASSIFICATION
LIQUID LIMIT
PLASTICITY INDEX



LEGEND

HOLE NO.

ELEV

CLASSIFICATION

NATURAL MOISTURE CONTENT

LIQUID LIMIT

PLASTICITY INDEX

LS

OPSOIL

PPARENT WATERTABLE

SCALE 1=5

JOHNSONVILLE STEAM PLANT

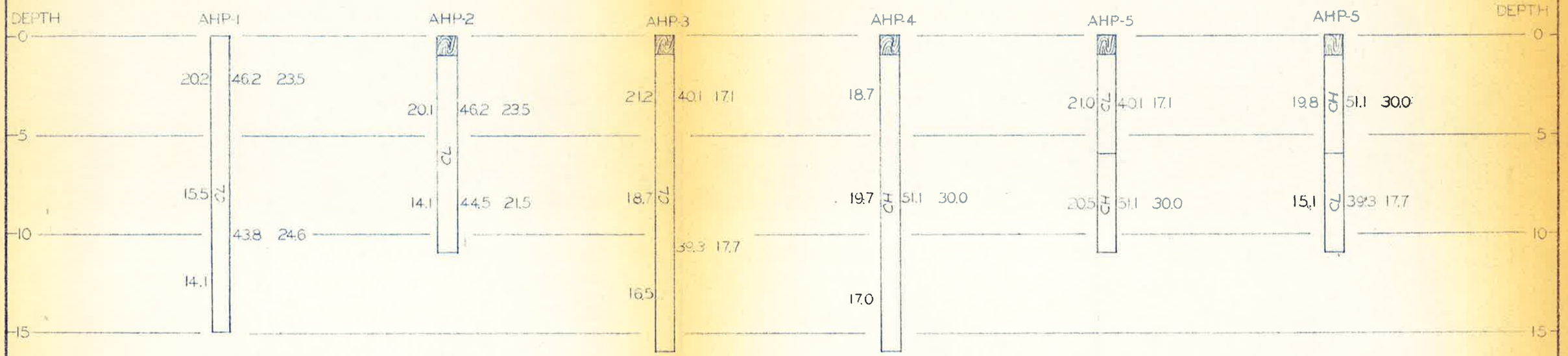
BORROW AREA A

SOILS PROFILE

TENNESSEE VALLEY AUTHORITY

MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED			APPROVED
HPM				ROL
KNOXVILLE	9-2-69	30	CS	3	605FF145 RO



SYMBOLS

TOPSOIL

LEGEND

HOLE NO.

NATURAL MOISTURE CONTENT

CLASSIFICATION

LIQUID LIMIT

PLASTICITY INDEX

SCALE 1" = 5'

JOHNSONVILLE STEAM PLANT

BORROW AREA B
SOILS PROFILE

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED			APPROVED	
HPM				ROL	
KNOXVILLE	9-2-69	30	CS	3	605B146 R0