ATTACHMENT J.4.61

OU4 GEOTECHNICAL DESIGN INVESTIGATION SUMMARY REPORT

FOR SILO SUPERSTRUCTURES

Operable Unit 4
Geotechnical Design Investigation
Summary Report
for Silo Superstructure

Operable Unit 4
Project Order 161
Project No. 40200

May 1996
Revision 0

Environmental Remedial Action Project
Fernald Environmental Management Project
Fernald, Ohio
FERMCO Subcontract No. 2-21487

PARSONS

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Operable Unit 4
Geotechnical Design Investigation
Summary Report for Silo Superstructure

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LIST OF ACRONYMS AND ABBREVIATIONS

ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
ATT	Advanced Terra Testing, Inc.
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Corporation
FOS	Factor of Safety
GMA	Great Miami Aquifer
OU	Operable Unit
psf	pounds per square foot
SAIC	Science Applications International Corporation

SECTION 1

INTRODUCTION

This report summarizes geotechnical field and laboratory test data collected for geotechnical design of silo superstructure foundations associated with the Operable Unit 4 (OU-4) Fernald Residue Vitrification Plant (FRVP) at the Fernald Environmental Management Project (FEMP) . As part of the Final Record of Decision, vitrification has been selected as the desired remediation method for residues currently stored in Silos 1, 2, and 3. Residue Retrieval systems will be designed and constructed to remove the residues for subsequent treatment at the FRVP. Residue in Silos 1 and 2 will be accessed through the top of the silo dome from superstructures while residue in Silo 3 will be accessed through the silo side wall.

In support of PARSONS Project Order (PO) 161 "Silo Superstructure Design for the FRVP", geotechnical soil samples were collected in the silo area and laboratory testing of the samples was conducted to provide geotechnical data for the design of both the Silo 1 and 2 superstructure foundations and Silo 3 equipment foundations. This report summarizes the results of the field activities, laboratory testing, and associated geotechnical engineering evaluation.

SECTION 2

FIELD ACTIVITIES SUMMARY

This section summarizes the field activities implemented per the *Project-Specific Plan for Silo Superstructure Design Investigation, Phase 1* (FERMCO 1996).

2.1 Geotechnical Test Borings

Eight geotechnical test borings were advanced in the vicinity of Silos 1, 2, and 3. Figure 2-1 shows the test boring locations. Drilling and sampling operations were conducted from January 3 to 16, 1996. The drilling and sampling was performed by the Fernald Environmental Restoration Management Corporation's (FERMCO's) drilling subcontractor, Alliance Environmental, Inc. A PARSONS Engineering Geologist prepared the field lithologic log, oversaw sampling operations, and selected the soil samples to be sent to the geotechnical laboratory for testing. FERMCO Environmental Field Operation personnel provided sample management and logistical support for the field activities. A drill rig with hollow stem augers was used to advance the borings to the planned depths. Appendix A lists the geotechnical test boring coordinates and their total depth. The coordinates are from a survey conducted by FERMCO. Appendix B contains the field lithologic logs.

Soil samples were collected continuously using split-spoon and thin-walled tube samplers (ASTM D 1587). Standard penetration tests (ASTM D 1586) were conducted in conjunction with sampling. Bulk samples of auger cuttings were collected for compaction tests. The soil samples were shipped to Advanced Terra Testing, Inc. (ATT), Lakewood, Colorado for geotechnical testing.

2.2 Water Level Measurements

Water level measurements at existing monitoring wells in the vicinity of OU-4 were taken by FERMCO on January 19, 1996. Appendix C contains the water level measurements. Figure 2-2 provides a summary of the water elevations at specific well locations.

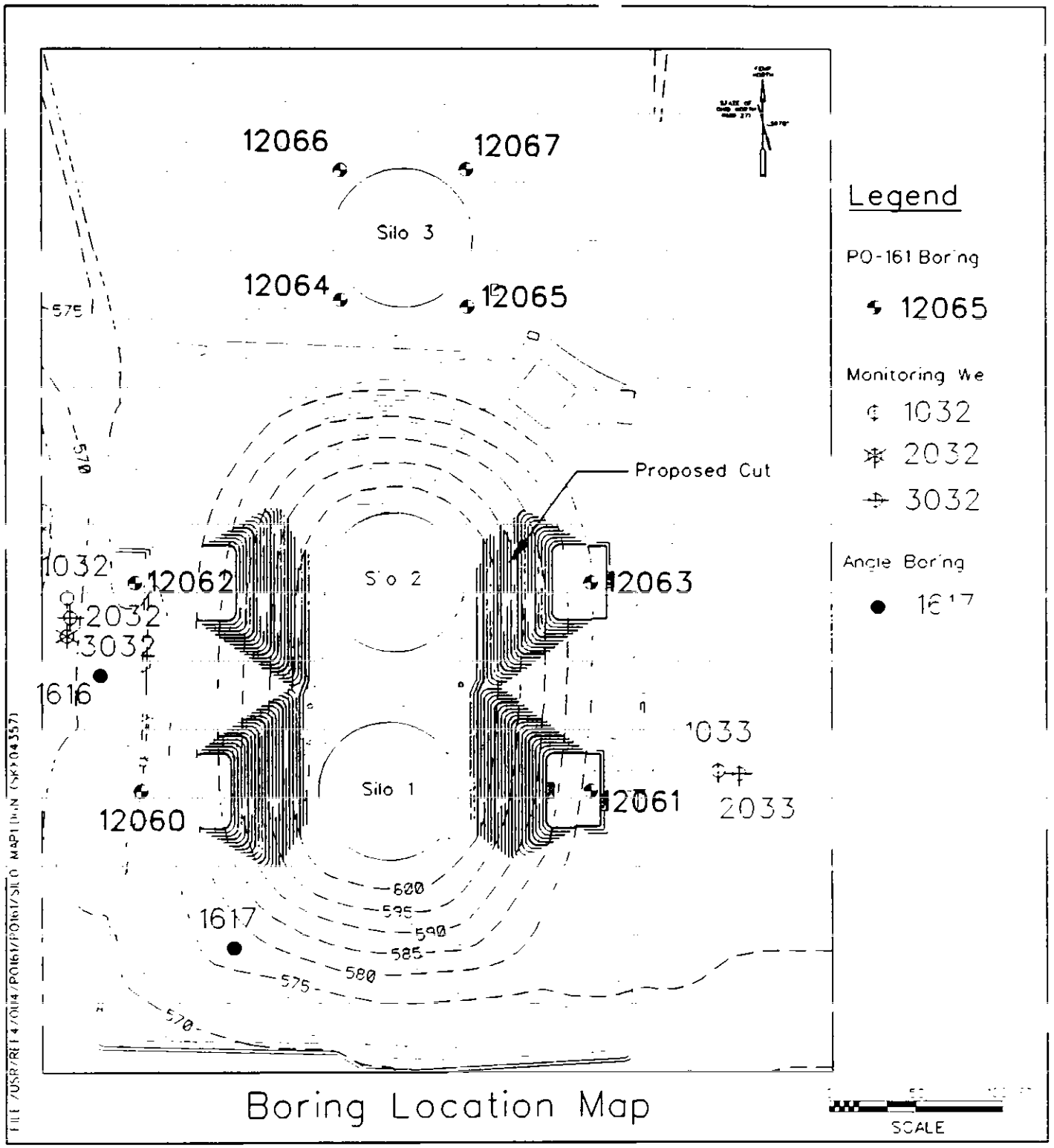

Figure 2-1 - Boring Location Map

SECTION 3

LABORATORY DATA SUMMARY

This section summarizes the results of geotechnical laboratory testing performed by ATT during February and March 1996. The laboratory data sheets from the testing are contained in *Silo Superstructure Geotechnical Design Investigation, Geotechnical Laboratory Data Report* (SAIC 1996).

3.1 Test Methods

The geotechnical tests performed by ATT are listed in Table 3-1.

Table 3-1 - Geotechnical Test Methods

Test Method	Title
ASTM D 2216-92	Standard Test Method for Determination of Water (Moisture) Content of Soil and Rock
ASTM D 4318-93	Standard Test Method for Liquid Limit, and Plasticity Index of Soils
ASTM D 422-63	Standard Test Method for Particle-Size Analysis of Soils
ASTM D 854-92	Standard Test Method for Specific Gravity of Soils
ASTM D 698-91	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM 2435-90	Standard Test Method for One-Dimensional Consolidation Properties of Soils
ASTM D 4767-88	Standard Test Method for Consolidated-Undrained Triaxial Compression Test on Cohesive Soils
Reference: *Annual Book of Standards, Volume 4.08, Soil and Rock* (ASTM 1995)	

3.2 Index Properties

Table 3-2 summarizes the results of index properties testing of disturbed (split-spoon and bulk samples) and undisturbed (Shelby tube samples) soil samples collected during the field investigation. Table 3-3 summarizes unit weight measurements from testing of undisturbed samples.

Table 3 2 Summary of Index Properties, Disturbed and Undisturbed Samples

On Site Location	Boring No	Sample No	Sample Type	Top Depth (feet)	Bottom Depth (feet)	Color (from field log)	General Stratum	USCS Group Name [5]	USCS Group Symbol	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Gravel (%)	Sand (%)	Grain Size Silt and Clay (%)	Clay (0.002 mm) (%)	Specific Gravity	Data Source
Site 1	12060	411304	ST	7 0	9 5	Yellowish Brown	Fill	Sandy Silty Clay	CL-ML	17 5	19 0	12.5	6 6	2.5	37 9	59 6	14 0	2.79	PO 161
Site 1	12060	411306	ST	11 0	13 5	Dark Gray	Gray Till	Sandy Silty Clay	CL ML	13 0	20 4	13 8	6 5	8 9	27.7	63.4	15.4	2.77	PO 161
Site 1	12060	411308	SS	15 0	17 0	Dark Olive Gray	Gray Till	Lean Clay (V)	NT	15 3	NT	NT	NT	NT	NT	NT	NT	NT	PO 161
Site 1	12060	411310	Bulk	0 0	10 0	Yellowish Brown	Fill	Clayey Sand with Gravel	SC	15 1	21 4	13 6	7 8	27 3	34.8	37.9	10.2	2 79	PO 161
Site 1	12061	411331	ST	2 5	5 0	Dark Yellowish Brown	Loess	Lean Clay (V)	NT	24 4	NT	NT	NT	NT	NT	NT	NT	NT	PO 161
Site 1	12061	411333	ST	6 5	9 0	Yellowish Brown	Loess	Lean Clay	CL	23 2	27 8	15.5	12 3	0 0	6.5	93.5	22 5	2.79	PO 161
Site 1	12061	411335	ST	10 5	13 0	Yellowish Brown	Stratified Glacial Deposits	Sandy Silt	ML	13 5	16 8	13 6	3 3	3 4	38 2	58.4	11.9	2.76	PO 161
Site 2	12062	411312	ST	2 5	5 0	Dark Yellowish Brown	Brown Till	Sandy Lean Clay with Gravel (V)	NT	32 5	NT	NT	NT	NT	NT	NT	NT	NT	PO 161
Site 2	12062	411315	SS	9 0	10 5	Dark Yellowish Brown	Brown Till	Silty Sand	SM	12 7	NP	NP	NP	6 8	44.8	48.4	4.4	2 75	PO 161
Site 2	12062	411316	ST	10 5	13 0	Yellowish Brown	Brown Till	Silty Sand with Gravel	SM	13 8	16 4	13 7	2 8	23 2	33.6	43.2	8.9	2.79	PO 161
Site 2	12062	411318	ST	15 0	17 0	Olive Brown	Gray Till	Sandy Silt	ML	14 6	NP	NP	NP	3 7	35 2	61.1	8.2	2 84	PO 161
Site 2	12063	411322	ST	4 0	6 0	Olive Brown	Stratified Glacial Deposits	Lean Clay	CL	23 8	45 2	16 3	28 9	0 0	11 1	88 9	32 9	2.74	PO 161
Site 2	12063	411324	ST	8 0	10.5	Dark Yellowish Brown	Stratified Glacial Deposits	Silty Clay with Sand	CL-ML	21 6	21 9	15 6	6 3	0 0	15.1	84 9	21 4	2 79	PO 161
Site 2	12063	411325	Bulk	0 0	10 0	Dark Yellowish Brown	Stratified Glacial Deposits	Sandy Lean Clay	CL	24 2	28 4	17.1	11 4	7 0	25.6	67.4	19.3	2 72	PO 161
Site 2	12063	411327	ST	12 0	14 5	Gray	Stratified Glacial Deposits	Lean Clay	CL	20 9	26 8	16 2	10 7	0 5	6 1	93 4	25 9	2.81	PO 161
Site 2	12063	411328	SS	14 5	16 5	Dark Yellowish Brown	Brown Till	Well Graded Sand with Gravel (V)	NT	25 7	NT	NT	NT	NT	NT	NT	NT	NT	PO 161
Site 3	12064	411363	ST	3 5	6 0	Olive Brown	Stratified Glacial Deposits	Lean Clay (V)	NT	23 2	NT	NT	NT	NT	NT	NT	NT	NT	PO 161
Site 3	12064	411372	ST	21 5	24 0	Dark Grayish Brown	Stratified Glacial Deposits	Lean Clay with Sand	CL	15 3	22 6	13 2	9 3	3 6	21 5	74 9	19 8	2.78	PO 161
Site 3	12064	411365	ST	7 5	10 0	Olive Brown	Stratified Glacial Deposits	Silty Sand with Gravel	SM	25 6	NP	NP	NP	18 0	52 9	31.1	6 7	2.77	PO 161
Site 3	12064	411370	ST	17 5	20 0	Dark Grayish Brown	Stratified Glacial Deposits	Lean Clay with Sand	CL	14 3	22 9	13 5	9 3	1 2	20 9	77 9	22.7	2 80	PO 161
Site 3	12065	411383	ST	6 0	8 0	Light Olive Brown	Stratified Glacial Deposits	Lean Clay	CL	22 2	24 9	16 6	8.4	0 0	6 1	93 9	22 3	2.78	PO 161
Site 3	12065	411387	ST	13 0	15 0	Dark Grayish Brown	Brown Till	Sandy Lean Clay	CL	12 9	22 2	13 7	8 6	8 7	22.9	68.4	19 9	2 82	PO 161
Site 3	12065	411389	ST	16 5	18 5	Gray	Brown Till	Sandy Lean Clay with Gravel (V)	NT	9 9	NT	NT	NT	NT	NT	NT	NT	NT	PO 161
Site 3	12065	411385	Bulk	0 0	10 0	Light Olive Brown	Stratified Glacial Deposits	Lean Clay	CL	24 7	27 0	16 4	10 5	1 4	6 6	92 0	24 4	2 78	PO 161
Site 3	12066	411352	ST	3 5	6 0	Light Olive Brown	Stratified Glacial Deposits	Lean Clay	CL	20 3	34 8	19 1	15 4	0 0	1 0	99.0	37 7	2.76	PO 161
Site 3	12066	411357	ST	11 5	14 0	Olive Brown	Stratified Glacial Deposits	Lean Clay with Sand	CL	15 0	25 4	14 4	11 0	7.4	18.1	73 5	22.2	2 80	PO 161
Site 3	12066	411355	Bulk	0 0	10 0	Yellowish Brown	Stratified Glacial Deposits	Lean Clay	CL	19 6	35 8	18 3	17 5	0 8	3 0	96 2	36 0	2 83	PO 161
Site 3	12066	411359	SS	16 0	18 0	Dark Grayish Brown	Brown Till	Sandy Lean Clay	CL	15 9	20 7	13 3	7.3	9 5	23.7	66.8	16.7	2.78	PO 161
Site 3	12067	411343	ST	7 5	10 0	Olive Brown	Stratified Glacial Deposits	Lean Clay	CL	20 1	36 4	16.9	19 6	0 0	0 6	99.4	38.2	2.76	PO 161
Site 3	12067	411345	ST	11 5	14.0	Dark Gray	Brown Till	Lean Clay	CL	25.8	33.2	17 9	15 3	0.0	0 4	99.6	39.3	2.78	PO 161
Site 3	12067	411347	SS	15 5	17 5	Dark Gray	Gray Till	Sandy Lean Clay with Gravel (V)	NT	13 7	NT	NT	NT	NT	NT	NT	NT	NT	PO 161

Notes

1 On-Site Location. OU 4, Sites 1 3

2 Sample Type
- Bulk Bulk Sample
- SS Split Spoon Sample
- ST Shelby Tube Sample (ASTM D 1587)

3 Moisture Content determined by ASTM D 2216, Plasticity Indicies by ASTM D 4318, Grain Size by ASTM D 422, Specific Gravity by ASTM D 854

4 NP - Reported as non plastic from laboratory plasticity test (ASTM D 4318)
NT - Not Tested

5 USCS Group Name (V) Visual Classification, not classified from oratory test data

6 Data Source PO 161 Site Superstructure Geotechnical Design tigation, Geotechnical Laboratory Data Report, April 12, 1996 by SAIC Golden, CO, PARSONS Project Order 161

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Table 3-3 - Summary of Unit Weight and Percent Saturation, Undisturbed Specimens

On-Site Location	Boring No.	Sample No.	Sample Type	Top Depth (feet)	Bottom Depth (feet)	Color (from field log)	General Stratum	USCS Group Name	USCS Group Symbol	Specimen ID	Test Type	Moisture Content Specimen (%)	Moisture Content Average (%)	Wet Density Specimen (pcf)	Wet Density Average (pcf)	Dry Density Specimen (pcf)	Dry Density Average (pcf)	Percent Saturation Specimen (%)	Percent Saturation Average (%)	Specific Gravity	Data Source
Silo 1	12060	411304	ST	7.0	9.5	Yellowish Brown	Fill	Sandy Silty Clay	CL-ML	411304	CON_s	13.5		138.8		122.2		89		2.79	PO 161
										411304A	CU	14.1		144.8		126.9		100		2.79	PO 161
										411304B	CU	17.5		136.5		116.2		96		2.79	PO 161
										411304C	CU	19.1		133.5		112.1		96		2.79	PO 161
													16.1		138.4		119.4		96		Average
Silo 1	12060	411306	ST	11.0	13.5	Dark Gray	Gray Till	Sandy Silty Clay	CL-ML	411306A	CU	12.2		145.4		129.5		100		2.77	PO 161
										411306B	CU	13.0		142.8		126.4		98		2.77	PO 161
										411306C	CU	11.1		144.9		130.4		95		2.77	PO 161
													12.1		144.4		129.8		97		Average
Silo 1	12061	411333	ST	6.5	9.0	Yellowish Brown	Loess	Lean Clay	CL	411333	CON_s	19.9		132.6		110.7		97		2.79	PO 161
										411333A	CU	23.4		131.2		106.3		100		2.79	PO 161
										411333B	CU	23.2		130.9		106.2		100		2.79	PO 161
										411333C	CU	21.6		130.8		107.5		97		2.79	PO 161
													22.0		131.4		107.7		98		Average
Silo 1	12061	411335	ST	10.5	13.0	Yellowish Brown	Stratified Glacial Deposits	Sandy Silt	ML	411335	CON_s	12.8		141.5		125.5		95		2.76	PO 161
										411335A	CU	15.6		133.6		115.6		88		2.76	PO 161
										411335B	CU	13.5		143.5		126.5		100		2.76	PO 161
										411335C	CU	15.9		137.9		119.0		98		2.76	PO 161
													14.5		139.1		121.7		95		Average
Silo 2	12062	411316	ST	15.0	17.0	Olive Brown	Gray Till	Sandy Silt	ML	411316	CON_s	14.9		139.8		121.7		93		2.84	PO 161
Silo 2	12063	411322	ST	4.0	6.0	Olive Brown	Stratified Glacial Deposits	Lean Clay	CL	411322	CON_s	20.3		128.3		106.7		92		2.74	PO 161
										411322B	CU	23.8		125.9		101.8		96		2.74	PO 161
										411322C	CU	25.2		125.5		100.3		96		2.74	PO 161
													23.1		126.6		102.9		95		Average
Silo 2	12063	411324	ST	8.0	10.5	Dark Yellowish Brown	Stratified Glacial Deposits	Silty Clay with Sand	CL-ML	411324A	CU	21.5		128.1		105.5		92		2.79	PO 161
										411324B	CU	21.6		130.5		107.3		97		2.79	PO 161
										411324C	CU	21.0		129.8		107.3		94		2.79	PO 161
													21.4		129.5		106.7		94		Average
Silo 2	12063	411327	ST	12.0	14.5	Gray	Stratified Glacial Deposits	Lean Clay	CL	411327A	CU	20.2		130.1		108.2		92		2.81	PO 161
										411327B	CU	20.9		131.7		109.0		96		2.81	PO 161
										411327C	CU	21.2		132.4		109.3		98		2.81	PO 161
													20.8		131.4		108.6		95		Average
Silo 3	12064	411372	ST	21.5	24.0	Dark Grayish Brown	Stratified Glacial Deposits	Lean Clay with Sand	CL	411372A	CU	14.8		142.1		123.8		100		2.78	PO 161
										411372B	CU	15.3		141.7		122.9		100		2.78	PO 161
										411372C	CU	15.1		141.1		122.6		100		2.78	PO 161
													15.1		141.6		123.1		100		Average
Silo 3	12064	411370	ST	17.5	20.0	Dark Grayish Brown	Stratified Glacial Deposits	Lean Clay with Sand	CL	411370	CON_s	14.2		140.7		123.2		95		2.80	PO 161
Silo 3	12065	411383	ST	6.0	8.5	Light Olive Brown	Stratified Glacial Deposits	Lean Clay	CL	411383	CON_s	19.8		133.2		111.2		98		2.78	PO 161
										411383A	CU	21.7		131.6		108.2		100		2.78	PO 161
										411383B	CU	22.2		131.1		107.2		100		2.78	PO 161
										411383C	CU	21.1		133.6		110.4		100		2.78	PO 161
													21.2		132.4		109.3		99		Average
Silo 3	12066	411357	ST	11.5	14.0	Olive Brown	Stratified Glacial Deposits	Lean Clay with Sand	CL	411357A	CU	14.7		140.9		122.8		98		2.80	PO 161
										411357B	CU	15.0		141.1		122.7		99		2.80	PO 161
										411357C	CU	15.4		140.5		121.7		99		2.80	PO 161
													15.0		140.8		122.4		98		Average
Silo 3	12067	411345	ST	11.5	14.0	Dark Gray	Brown Till	Lean Clay	CL	411345	CON_s	23.2		130.3		105.8		100		2.78	PO 161
										411345A	CU	25.0		129.2		103.3		100		2.78	PO 161
										411345B	CU	25.6		128.3		102.2		100		2.78	PO 161
										411345C	CU	26.5		127.2		100.6		100		2.78	PO 161
													25.1		128.8		103.0		100		Average

Notes:

1. On-Site Location: OU-4, Silos 1 - 3
2. Sample Type: ST Shelby Tube Sample (ASTM D 1587)
3. Test Type: CON_s Consolidation with time readings, (ASTM D 2435), specimen at saturated conditions
   CU Triaxial Shear, Consolidated, Undrained with Pore Pressure Measurements (ASTM D 4767)
4. Data Source: PO 161 Silo Superstructure Geotechnical Design Investigation, Geotechnical Laboratory Data Report, April 12, 1996 by SAIC Golden, CO, PARSONS Project Order 161.

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3.3 Compaction Characteristics

Table 3-4 summarizes the results of Standard Proctor compaction tests performed on bulk samples of auger cuttings. Appendix D contains the compaction curves.

3.4 Consolidation Parameters

Table 3-5 summarizes the results of consolidation tests performed on undisturbed soil samples. The consolidation parameters (c_c, c_r, c_v, and OCR) come from PARSONS' evaluation of consolidation test data from the *Silo Superstructure Geotechnical Design Investigation, Geotechnical Laboratory Data Report* (SAIC 1996). Taylor's Square Root of Time Method was used to estimate the time rate of consolidation parameters. These consolidation parameters are used by design engineers to evaluate potential settlement of structures resulting from consolidation of underlying cohesive soils.

3.5 Strength Parameters

Table 3-6 summarizes the strength parameters from evaluation of consolidated, undrained triaxial compression test results. Appendix E contain the Mohr circle strength envelopes PARSONS constructed to establish the strength parameters (cohesion and friction angle). These strength parameters are used by design engineers to estimate the bearing capacity of soils.

Table 3-4 - Summary of Index Properties and Standard Proctor Compaction Tests of Bulk Samples

On-Site Location	Boring No.	Sample No.	Sample Type	Top Depth (feet)	Bottom Depth (feet)	General Stratum	USCS Group Name	USCS Group Symbol	Natural Moisture Content	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Grain Size Gravel (%)	Sand (%)	Silt and Clay (%)	Clay (.002mm) (%)	Specific Gravity	Compaction Method	Opt. Moisture Content (%)	Maximum Dry Density (pcf)	Data Source
Silo 1	12060	411310	Bulk	0.0	10.0	Fill	Clayey Sand with Gravel	SC	15.1	21.4	13.6	7.8	27.3	34.8	37.9	10.2	2.78	Standard	8.2	135.5	PO 161
Silo 2	12063	411325	Bulk	0.0	10.0	Stratified Glacial Deposits	Sandy Lean Clay	CL	24.2	28.4	17.1	11.4	7.0	25.6	67.4	19.3	2.72	Standard	14.7	114.7	PO 161
Silo 3	12065	411385	Bulk	0.0	10.0	Stratified Glacial Deposits	Lean Clay	CL	24.7	27.0	16.4	10.5	1.4	6.6	92.0	24.4	2.78	Standard	14.9	116.8	PO 161
Silo 3	12066	411355	Bulk	0.0	10.0	Stratified Glacial Deposits	Lean Clay	CL	19.6	35.8	18.3	17.5	0.8	3.0	96.2	36.0	2.83	Standard	16.3	111.8	PO 161

Notes:

1. On-Site Location: OU-4, Silos 1 - 3
2. Sample Type: Bulk Bulk Sample
3. Compaction Method: Standard Standard Proctor Compactive Effort (ASTM D 698)
4. Data Source: PO 161 Silo Superstructure Geotechnical Design Investigation, Geotechnical Laboratory Data Report, April 12, 1996 by SAIC Golden, CO, PARSONS Project Order 161.

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Table 3-5 - Summary of Consolidation Tests, Undisturbed Specimens

On-Site Location	Boring No.	Sample No.	Sample Type	Top Depth (feet)	Bottom Depth (feet)	Color (from field log)	General Stratum	USCS Group Name	USCS Group Symbol	Test Type	Initial Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Percent Saturation (%)	Specific Gravity	Coefficient of Consolidation (Cv) Square inch/minute, @ 100 Loading 0.4 (tsf)	0.8 (tsf)	1.6 (tsf)	3.2 (tsf)	6.4 (tsf)	Average Overburden Pressure (psf)	Maximum Past Pressure (psf)	Initial Void Ratio	Compression Index (Cc)	Recompression Index (Cr)	Overconsolidation Ratio (OCR)	Data Source
Site 1	12060	411304	ST	7.0	8.3	Yellowish Brown	Fill	Sandy Silty Clay	CL-ML	CON_s	13.5	138.8	122.2	89	2.79	---	3.1E-02	4.3E-02	1.9E-02	2.0E-02	1234	1995	0.43	0.070	0.016	1.6	PO 161
Site 1	12061	411335	ST	8.5	9.0	Yellowish Brown	Loess	Lean Clay	CL	CON_s	19.9	132.6	110.7	97	2.79	---	5.8E-02	5.3E-02	5.3E-02	7.0E-02	958	2187	0.57	0.073	0.025	2.3	PO 161
Site 1	12061	411336	ST	10.5	13.0	Yellowish Brown	Stratified Glacial Deposits	Sandy Silt	ML	CON_s	12.8	141.5	125.5	95	2.78	---	5.3E-02	6.6E-02	8.1E-02	6.6E-02	1706	2344	0.37	0.047	0.008	1.4	PO 161
Site 2	12062	411318	ST	15.0	17.0	Olive Brown	Gray Till	Sandy Silt	ML	CON_s	14.9	139.8	121.7	93	2.84	---	1.6E-01	6.2E-02	1.4E-01	5.1E-02	2195	2239	0.46	0.035	0.004	1.0	PO 161
Site 2	12063	411322	ST	4.0	9.0	Olive Brown	Stratified Glacial Deposits	Lean Clay	CL	CON_s	20.3	128.3	106.7	92	2.74	---	6.6E-02	5.7E-02	4.6E-02	4.6E-02	768	3981	0.60	0.136	0.023	5.1	PO 161
Site 3	12064	411370	ST	17.5	20.0	Dark Grayish Brown	Stratified Glacial Deposits	Lean Clay with Sand	CL	CON_s	14.2	140.7	123.2	95	2.80	1.6E-02	2.1E-02	1.3E-02	2.4E-02	---	2475	2398	0.42	0.061	0.016	1.0	PO 161
Site 3	12066	411383	ST	6.0	8.0	Light Olive Brown	Stratified Glacial Deposits	Lean Clay	CL	CON_s	19.8	133.2	111.2	98	2.78	3.6E-02	6.4E-02	6.2E-02	8.9E-02	---	835	1047	0.56	0.067	0.020	1.3	PO 161
Site 3	12067	411345	ST	11.5	14.0	Dark Gray	Brown Till	Lean Clay	CL	CON_s	23.2	130.3	106.8	100	2.78	1.8E-02	1.1E-02	1.3E-02	2.1E-02	---	1643	2884	0.64	0.102	0.029	1.8	PO 161

Notes:

1. On-Site Location: OU-4, K-65 Sites 1 - 3
2. Sample Type: ST Shelby Tube Sample (ASTM D 1587)
3. Test Type: CON_s Consolidation with time readings, ASTM D 2435, undisturbed specimen at saturated conditions
4. Data Source: PO 161 Site Superstructure Geotechnical Design Investigation, Geotechnical Laboratory Data Report, April 12, 1996 by SAIC Golden, CO, PARSONS Project Order 161.

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Table 3-6 - Summary of Mohr Circle Constructions from Consolidated, Undrained Triaxial Compression Tests, Undisturbed Specimens

On-Site Location	Boring No.	Sample No.	Sample Type	Top Depth (feet)	Bottom Depth (feet)	Color (from field log)	General Stratum	USCS Group Name	USCS Group Symbol	Test Type	Effective Cohesion (psf)	Effective Friction Angle (degrees)	Total Cohesion (psf)	Total Friction Angle (degrees)	Data Source
Silo 1	12060	411304	ST	7.0	9.5	Yellowish Brown	Fill	Sandy Silty Clay	CL-ML	CU	300	29	400	23	PO 161
Silo 1	12060	411306	ST	11.0	13.5	Dark Gray	Gray Till	Sandy Silty Clay	CL-ML	CU	0	34	0	27	PO 161
Silo 1	12061	411333	ST	6.5	9.0	Yellowish Brown	Loess	Lean Clay	CL	CU	130	34	80	32	PO 161
Silo 1	12061	411335	ST	10.5	13.0	Yellowish Brown	Stratified Glacial Deposits	Sandy Silt	ML	CU	170	36	200	32	PO 161
Silo 2	12063	411322	ST	4.0	6.0	Olive Brown	Stratified Glacial Deposits	Lean Clay	CL	CU	360	27	500	16	PO 161
Silo 2	12063	411324	ST	8.0	10.5	Dark Yellowish Brown	Stratified Glacial Deposits	Silty Clay with Sand	CL-ML	CU	170	35	0	32	PO 161
Silo 2	12063	411327	ST	12.0	14.5	Gray	Stratified Glacial Deposits	Lean Clay	CL	CU	0	32	210	22	PO 161
Silo 3	12064	411372	ST	21.5	24.0	Dark Grayish Brown	Stratified Glacial Deposits	Lean Clay with Sand	CL	CU	60	31	220	23	PO 161
Silo 3	12065	411383	ST	6.0	8.0	Light Olive Brown	Stratified Glacial Deposits	Lean Clay	CL	CU	190	32	290	23	PO 161
Silo 3	12066	411357	ST	11.5	14.0	Olive Brown	Stratified Glacial Deposits	Lean Clay with Sand	CL	CU	330	27	570	16	PO 161
Silo 3	12067	411345	ST	11.5	14.0	Dark Gray	Brown Till	Lean Clay	CL	CU	230	26	400	17	PO 161

Notes:

1. On-Site Location: OU-4, Silos 1 - 3
2. Sample Type: ST Shelby Tube Sample (ASTM D 1587)
3. Test Type: CU Triaxial Shear, Consolidated, Undrained with Pore Pressure Measurements (ASTM D 4767)
4. Data Source: PO 161 Silo Superstructure Geotechnical Design Investigation, Geotechnical Laboratory Data Report, April 12, 1996 by SAIC Golden, CO, PARSONS Project Order 161.

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SECTION 4

EVALUATION

This section summarizes the evaluation of subsurface conditions, bearing capacity, and settlement of the proposed silo superstructure at Silos 1 and 2 based on the proposed design and geotechnical data from the field investigation and geotechnical laboratory testing.

4.1 Proposed Foundations and Loads

Figure 4-1 schematically shows plan and elevation views of the proposed superstructures at Silos 1 and 2. Reinforced concrete mat foundations (32 feet by 22 feet) are proposed for superstructure foundations at the four locations shown in Figure 4-1. The design of each foundation is a flat mat with four pedestals which support the columns of the superstructure. A 3-foot shear key below the concrete mat has also been included in the design. The base of the concrete mat is planned at elevation 576.5 feet mean sea level. Below the base of the concrete mat a granular base of compacted gravel will extend to natural soils. Based on design calculations by PARSONS' Structural Engineering Group, the maximum downward vertical design load for each foundation due to superstructure loads is 541 kips, and the maximum horizontal load is 337 kips ("kick-out" loads).

4.2 Subsurface Conditions

Subsurface materials in the vicinity of the OU-4 silos generally can be placed into five major categories:

1) Fill
2) Loess
3) Stratified glacial deposits
4) Gray till
5) Great Miami Aquifer (GMA)

Although all of these materials are relatively common throughout the FEMP site, it is typical to find some combination of these materials at any particular location, and not necessarily a complete section of each at all specific drilled locations. For purposes of this evaluation, the following general descriptions broadly address each of the five general material types. After the general descriptions, a general discussion focuses on the various types and combinations of materials encountered during the investigation of the silos for the purpose of evaluating foundation conditions for the proposed superstructure being designed to span them.

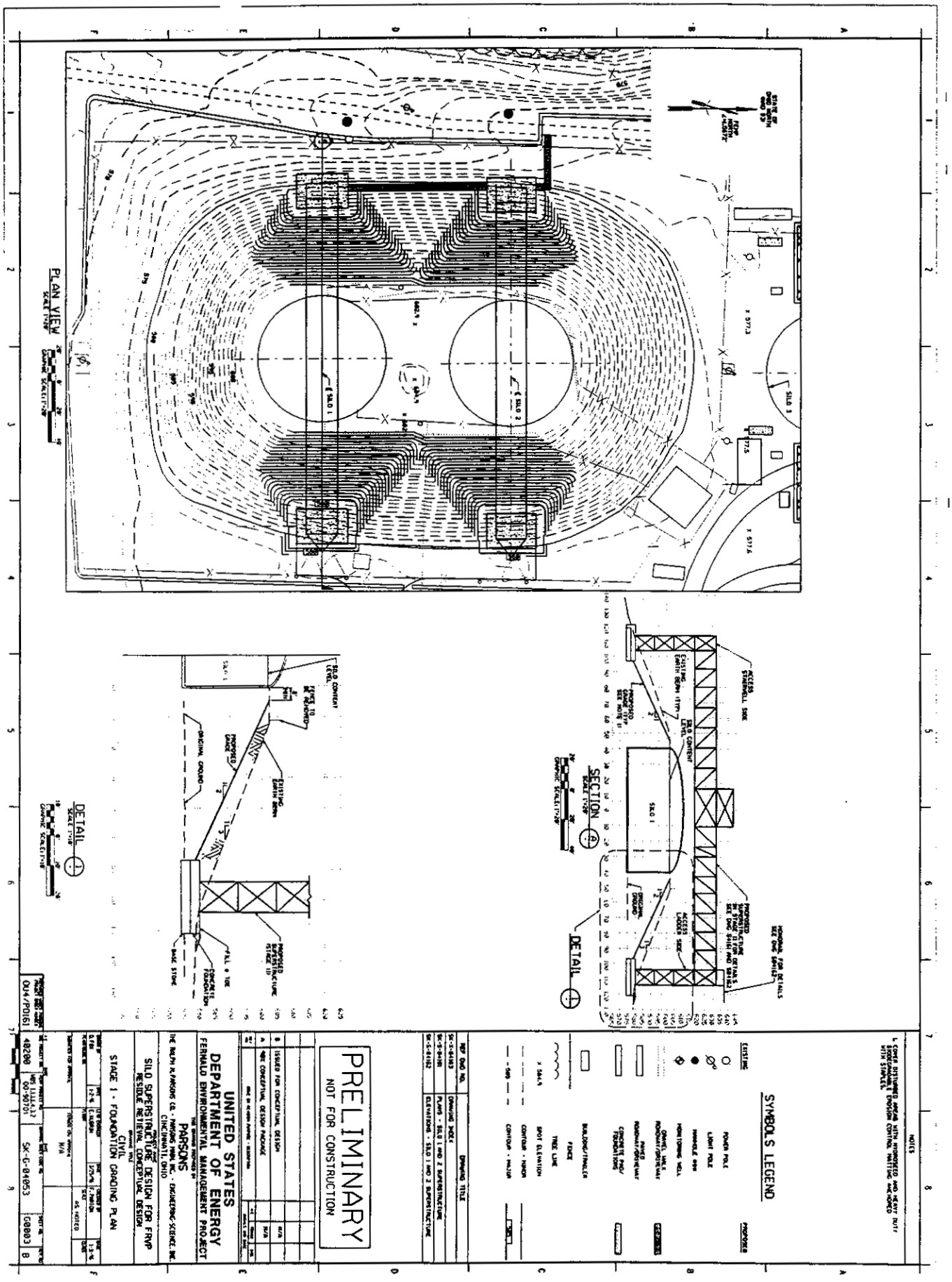
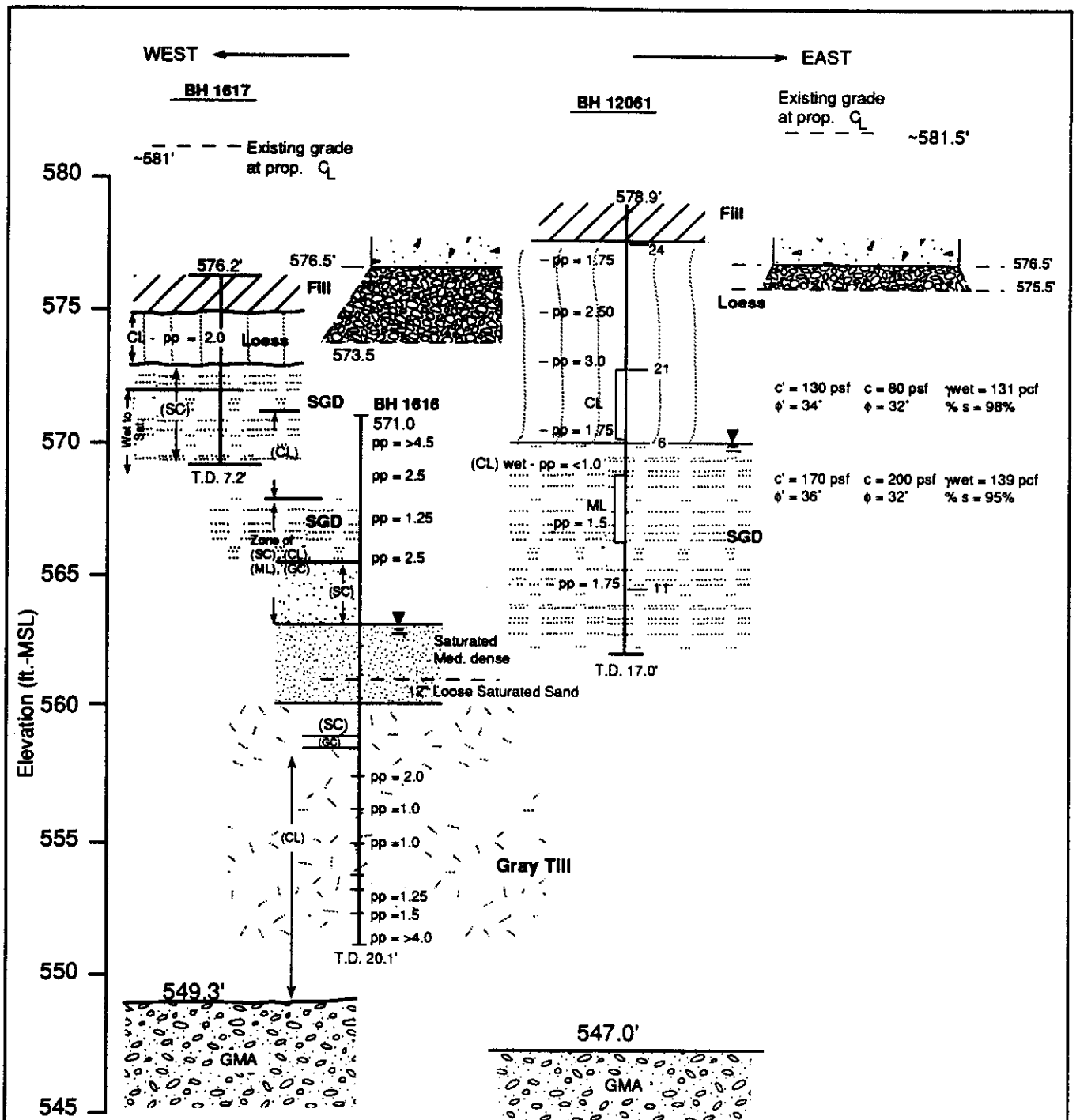


Figure 4-1 - Silos 1 and 2 Superstructure Plan and Elevation Schematic Drawing



Notes: Borings 1616 and 1617 are RI slant borings offset from foundation location.
Boring 12061 offset approximately 10' from foundation centerline.
GMA depths from RI Borings 2032 and 2033
pp = pocket penetrometer reading (tsf)
SGD = stratified glacial deposits
6 = Standard Penetration Test (SPT) N Value
= Shelby tube sample
= estimated perched water elevation
CL = USCS symbol from laboratory tests,
parens ( ) indicate visual classification

Symbols:
- Fill
- Loess
- Sand
- Gray Till
- SGD
- GMA

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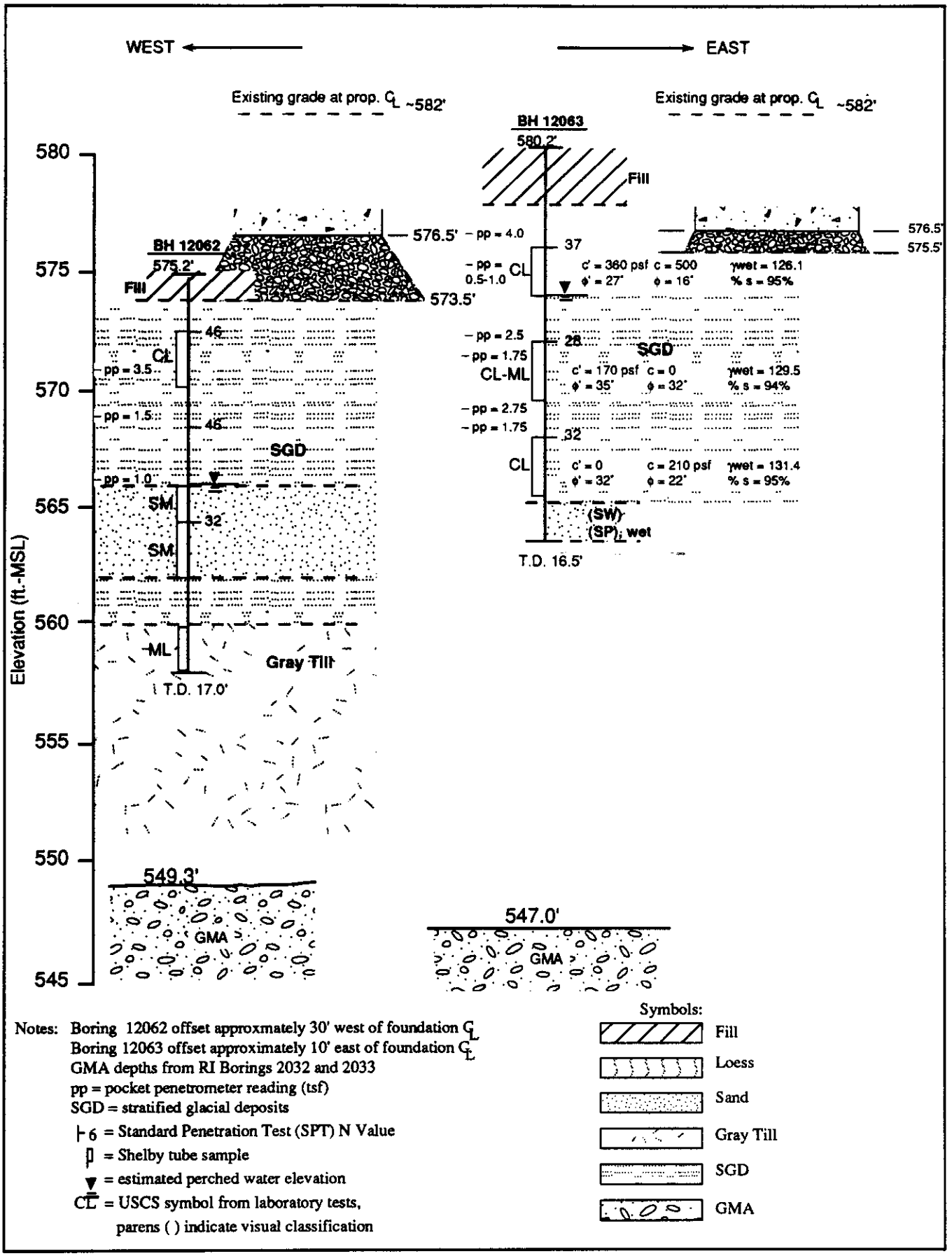
Figure 4-2 - Generalized Subsurface Conditions at Silo 1 Foundation Locations



Notes: Boring 12062 offset approxmately 30' west of foundation ℄
Boring 12063 offset approximately 10' east of foundation ℄
GMA depths from RI Borings 2032 and 2033
pp = pocket penetrometer reading (tsf)
SGD = stratified glacial deposits
⊢6 = Standard Penetration Test (SPT) N Value
▯ = Shelby tube sample
▼ = estimated perched water elevation
CL = USCS symbol from laboratory tests, parens ( ) indicate visual classification

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Figure 4-3 - Generalized Subsurface Conditions at Silo 2 Foundation Locations

4.2.1 Generalized Material Type Descriptions and Discussion

The following are general descriptions of the types of soil materials that were encountered at OU-4 during the field investigation.

1) Fill

Understandably, fill materials consist principally of mixtures of the other material types (with the exception of the GMA) found across the FEMP site. These mixtures are typically clayey and moist, and have a wide range of consistencies and thicknesses.

2) Loess

Loess deposits consist primarily of lean clay (CL). These materials are typically stiff to very stiff, and moist. They are massive in the sense that they are not stratified, and are commonly yellowish brown.

3) Stratified Glacial Deposits

Stratified glacial deposits consist of mottled mixtures of brown till and gray till deposits, as well as localized areas and zones of well-sorted materials of various depositional origin and composition. These deposits are typically higher in silt and sand content than other glacial deposits at the site, and seem to be less gravelly. Stratified glacial deposits exhibit a wide range of consistencies, densities, and moisture contents: from soft to stiff, loose to very dense, and moist to wet. Typically, however, the materials are stiff, dense, and moist. They also display localized clear stratification, as well as zones of mottled coloration, mainly mixtures of brown and gray.

4) Gray Till

The gray till consists predominantly of low-plasticity sandy clay mixtures with scattered gravel throughout. Sand, silty sand, or clayey sand lenses with scattered gravel are present locally. Typically, the till is very stiff to locally hard, and moist.

5) Great Miami Aquifer

The GMA consists of sand/gravel mixtures that are typically dense to hard. The upper portion c stratum lies in the vadose zone and is typically dry.

Discussion

Subsurface materials investigated and sampled generally consist of varying mixtures of fine-grained and coarse-grained soils typical of glacial till and glacio-fluvial deposits. Fine-grained soils within the till are predominantly lean clay, with sand contents ranging between values that result in the materials being classified as sandy lean clay or lean clay with sand; sand contents generally increase with depth. Consistency (firmness or stiffness) of the lean clay generally increases with depth ranging from stiff to very stiff, and hard; plasticity tends to decrease with depth. It should be noted that layers of coarse-grained materials were encountered in borings and locally displayed perched water conditions. The coarse-grained materials range from poorly graded to well-graded sand with scattered gravel, and are typically dense.

Locally, there are areas of stratified glacial deposits composed of fine-grained materials that have been deposited in thinly laminated to massive, alternating layers ranging in thickness from fractions of an inch to a few feet. These materials are predominantly silts and clays with sand/silt mixtures as interbeds. Where these alternating materials were observed, saturation was common and the soils displayed relatively high in-place consistencies and densities as measured by the pocket penetrometer, laboratory testing, and standard penetration test. Typically, underlying these stratified materials are deposits of till. In the area of the silos however, the brown till is commonly absent based on visual boring logs. In some areas, stratified glacial deposits lie directly on the gray till which is underlain in turn by the coarse-grained deposits of the GMA. Boring 12064 at the southwest corner of Silo 3 is the only boring installed for the purpose of this investigation that penetrated into the GMA.

4.2.2 OU-4 Generalized Conditions

Interpretation of subsurface conditions in the vicinity of the silos has been developed based on evaluation of visual logs and laboratory results from boring numbers 1616, 1617, and 12061 for Silo 1, 12062 and 12063 for Silo 2, and 12064 through 12067 for Silo 3. Figure 2-1 shows the locations of these borings, and Figure 2-2 shows the locations where water level readings were taken. Figure 4-2 generalizes the subsurface conditions at the proposed Silo 1 superstructure foundations locations. Figure 4-3 shows the generalized conditions at the proposed locations of the Silo 2 superstructure foundations.

Silos 1 and 2

Angle boring 1617 lies about 100 feet northwest of the proposed west footing for Silo 1. Materials encountered included 1 foot of fill underlain by 2 feet of loess. That in turn was underlain by crudely stratified glacial deposits to the total depth of 7.2 feet. Perched water levels in the immediate vicinity of Boring 1617 are below the depth drilled.

Angle Boring 1616 is located about 100 feet south of the proposed west footing for Silo 1. Materials encountered consisted of 8 feet of stratified glacial deposits underlain by 3 feet of sand. The sand was loose to medium dense, and saturated. The perched water level in boring 1616 was measured at the top of the saturated sand at elevation 563 feet. Below the sand to the total depth of 20.1 feet was gray till.

Boring 12061 is located directly in the area of the proposed east footing for Silo 1. Here there is about 2 feet of fill underlain by 7 feet of loess. The loess was stiff to very stiff, and moist. Below the loess were stratified glacial deposits consisting from top to bottom of lean clay with sand, silty sand, and gravelly, sandy clay. These materials were firm to stiff, loose to medium dense, and wet. The perched water level was measured at the top of the lean clay with sand, at an elevation of 570 feet. Boring 12061 was drilled to a depth of 17 feet.

Elevation of the GMA ranged from about 549 to 547 feet in the vicinity of Silos 1 and 2. These elevations were determined by evaluation of nearby well logs. The water elevation in the GMA at OU-4 is approximately 522 feet.

The proposed footing elevation for the superstructures being designed to span Silos 1 and 2 is 576.5 feet. Because of the elevation differential across the planed spans, gravel may be required to make grade, especially along the west side. Along the east side, the proposed footing elevation will be within the loess. The loess appears to thin toward the north and west, with only 2 feet of it observed in Boring 1617 and none observed in 1616, whereas in Boring 12061 the loess was 7 feet thick.

Standard Penetration Test N values in the loess ranged from 21 to 34 (see Figure 4-2). At the base of and below the loess, the Standard Penetration Values were 6 and 11, respectively. Pocket penetrometer unconfined compressive strength values in the loess deposit ranged from 1.75 tons per square foot to 3.75 ton per square foot, whereas below the loess, pocket penetrometer values dropped to between less than 1, to 1.75 tons per square foot.

Boring 12062 in the area of the west footing of Silo 2 encountered a foot of fill underlain by 14 feet of stratified glacial deposits which are underlain in turn by gray till. The fill materials consist of gravel road base. The stratified glacial deposits are composed of layers of sandy clay, lean clay with sand, gravelly clay, and silty sand. The clayey materials extend to about elevation 566 feet and are very stiff to hard, and moist. Below the clayey deposits is a 7-foot-thick layer of silty sand that is typically medium dense, and wet. Underlying the silty sand is a gray till deposit of sandy silt that is stiff, and wet. Boring 12062 extended 1 foot into the gray till to a total depth of 17 feet.

Along the east side of Silo 2, the proposed footing elevation of 576.5 feet will result in being founded in stratified glacial deposits. The west side of Silo 2, similar to Silo 1, will probably require gravel to raise the grade. At Boring 12603 on the east side of Silo 2, the stratified glacial deposits consisted of lean clay that is stiff to very stiff, and moist. The clay extends from about elevation 578 feet to the depth

drilled (16.5 feet) with a firm, moist to wet silt interbed between elevations 569 and 572 feet. The bottom 2 feet of the boring encountered a gravely sand, that is very dense and wet.

Standard Penetration Test N values in the clayey deposits ranged from 28 to 37. Pocket penetrometer values in the clayey materials ranged from 0.5 to 4.0 tons per square foot (see Figure 4-3).

Silo 3

Boring 12064 was drilled adjacent to and southwest of Silo 3, and Boring 12065 was drilled adjacent to and southeast of Silo 3 (See Figure 2-1). Borings 12066 and 12067 were drilled just northwest and northeast respectively of Silo 3.

Materials encountered in 12064 consisted of crudely stratified deposits with layers of gravelly clay, lean clay, silty sand, sandy clay, and sand. The predominant material is lean clay, which is stiff to very stiff and moist, and is present between elevations 568 and 575 feet. Below an elevation of approximately 569 feet, the lean clay becomes wet. A layer of silty sand is present between elevation 564 and 568 feet that is medium dense and wet. Below about elevation 564 feet are alternating deposits 1 to 2 feet thick of sandy clay, and sand, down to about elevation 557 feet. The sandy clay is stiff to very stiff, and moist to wet. The sand is medium dense and wet. Between elevation 557 and 549 feet is an 8-foot-thick layer of stiff, moist to wet sandy clay.

The clayey materials exhibit Standard Penetration N Values ranging between 16 and 53. Pocket penetrometer values on the same materials range between 1.0 tons per square foot and greater than 4.5 tons per square foot.

Boring 12064 was advanced about 3 feet into the GMA which was a very dense, moist sand at that location. The total depth of boring 12064 was 34.5 feet.

Boring 12065 was composed predominantly of lean clay and lean clay with sand that was firm to stiff, and moist. Two interbeds, one a silty sand, the other a fat clay, were each about 2 feet thick and were present between elevations 564 and 568 feet. The silty sand was dense and moist and the clay was firm to stiff, and moist.

Standard Penetration N Values ranged between 13 and 24. One standard penetration value at 1 foot in depth yielded a value of 49, but that was probably due to the ground being frozen at the time of testing. Pocket penetrometer values for the clayey materials ranged between 1.0 and 4.5 tons per square foot.

Materials encountered in Boring 12066 consisted primarily of lean clay that was firm to stiff and moist. These clayey deposits were present between elevations 576 and 562 feet. The lean clay exhibited a common characteristic of stratified glacial deposits, with localized, thin 1/16-inch interbeds or laminae

of fine sand. These locally stratified glacial deposits were underlain by a gravelly clay member of the gray till. The gravelly clay was firm to stiff, and moist.

Standard Penetration Test N values in the lean clay ranged between 10 and 23, and pocket penetrometer values ranged between 0.5 (at about elevation 560 to 562 feet) to 4.5 tons per square foot between elevations 569 and 571 feet. The total depth of Boring 12066 was 20 feet.

Similar to the other three borings around Silo 3, Boring 12067 encountered several feet of stratified glacial deposits underlain by gray till. The stratified glacial deposits consisted predominantly of lean clay from elevation 576 feet down to elevation 568 feet. The lean clay was typically stiff to very stiff and moist, with localized 1- to 2-inch stringers of silt. Below the lean clay was a fat clay about 5 feet in thickness and exhibiting consistencies from soft to stiff. The fat clay was moist. About 6 inches of sandy gravel was at the base of the fat clay, and rested atop a sandy clay with gravel that is a member of the gray till.

Standard Penetration Test N Values in the stratified glacial deposits ranged between 16 and 32, and pocket penetrometer values ranged between less than 0.5 at elevation 563 feet to 4.0 tons per square foot at elevation 572 feet. Total depth of the boring was 19.5 feet.

Water levels were measured in the borings around Silo 3 immediately after drilling and yielded the following results shown in Table 4-1.

Table 4-1 - Water Levels at Silo 3 Immediately After Drilling

Boring Number	Ground Elevation	Depth to Water (ft)
12064	577.1	1.0
12065	577.6	3.0
12066	577.4	9.0
12067	577.8	3.0

4.3 Bearing Capacity

Calculations using the Vesic general bearing capacity model (ASCE 1993) were performed to provide an estimate of the general bearing capacity of the underlying soils in the vicinity of Silos 1 and 2. From the calculations, allowable bearing capacity of the soils underlying the four proposed mat foundations at Silos 1 and 2 is 2,900 pounds per square foot (psf). This estimated bearing capacity corresponds to a Factor of Safety (FOS) of about 3.1. The recommend FOS in *Bearing Capacity of Soils* (ASCE 1993)

1993 for mat foundations is " > 3." This bearing capacity estimate assumed a 1-foot gravel base beneath the mat foundations, and considered the effects of the slope towards Paddys Run to the west of OU-4.

A bearing capacity estimate for the foundations on the east side of Silos 1 and 2 only resulted in an allowable bearing capacity of about 3,700 psf, assuming that the foundation bears on natural soil without the 1-foot gravel base. This bearing capacity corresponds to an FOS of about 3.1. The increased bearing capacity is primarily a result of the level topography at the east side of the silos, that is, the allowable bearing capacity is not reduced due to slope.

4.4 Settlement

Based on eight consolidation tests performed in the geotechnical laboratory, calculations were performed to estimate the total and differential consolidation settlement of the individual superstructure foundations for Silos 1 and 2. Table 4-2 summarizes the estimated settlement for the proposed structures. These estimates assume that a compacted base bears on the natural soil beneath the foundations, and does not bear on fill. In general, the stratified glacial deposits unit provides the greatest contribution to the total settlement. Assuming double drainage conditions, it is estimated that 95 percent of the total settlement will occur within about 3 months to a year following construction.

Table 4-2 - Estimate of Total and Differential Settlement for Silos 1 and 2 Superstructure Foundations

Silo	Side	Total Settlement (in)	Differential Settlement (in)
1	West East	0.7 0.5	0.2
2	West East	0.8 0.8	0

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

This section summarizes conclusions and recommendations with respect to the proposed Silos 1 and 2 foundations.

1) Based on the proposed bottom of concrete foundation elevations at 576.5 feet, the foundations will bear within natural soils at the east side of Silos 1 and 2, and will bear within fill at the west side of the silos. Thus, an approximately 2- to 3-foot, well-graded gravel base may be necessary at the west side to reach the estimated elevation of natural soils suitable as bearing soils. (It should be noted that the fill/natural soil elevation at the proposed foundation locations at the west side of Silos 1 and 2 is less certain than at the east side since the elevations were estimated by projecting borings offset from the foundation locations.) A well-graded gravel base should be considered at the east foundations as a means of replacing soft natural soils, if encountered during construction. Additionally, the gravel base (about 6 to 12 inches thick) should also be placed under the foundations to provide frictional resistance to lateral design loads if design calculations require the material in contact with concrete foundation base to have an undrained friction angle (phi) of greater than 16 degrees and a cohesion of at least 500 psf.

2) The depth of excavation into natural soil beneath the foundations should be kept to the minimum depth required for the design to minimize encountering locally perched zones of groundwater within the stratified glacial deposits. Soils with suitable bearing capacity are anticipated at elevations immediately below the fill.

3) Total and differential settlements of the structure do not appear to be excessive, considering normally tolerable settlements for superstructure spans. Typical allowable total settlements for structures is 1 inch, and a typical allowable "differential/span length" ratio is 1/500 where the "differential" is the differential movement within span length. The designer should evaluate the acceptability of the estimated settlements with respect to requirements/tolerances associated with the proposed design.

4) This (Phase 1) geotechnical design investigation was initially designed to be conducted in two phases. This report contains Phase I data. Phase 2 planned for four additional test borings located approximately midway up the proposed berms. Access to the these locations was not available for the Phase 1 Investigation. The general purpose of this second phase was to (1) y the depth of the fill and strength of natural soils beneath the footings, and (2) provide gth or evaluation of berm slope stability at design slope angles.

Phase 2 of this investigation has been placed on hold, however, based on the revised superstructure design and data collected during the Phase 1 Investigation, the following activities for the Phase 2 Investigation are recommended:

(1) Investigate depth of fill at proposed foundation locations at the west side of Silos 1 and 2 and classify the underlying natural soils. This could be accomplished with shallow borings/probes at the proposed locations. Samples of the underlying natural soils within the bearing stratum should be collected for classification testing. Water levels at the boring locations should be measured.

(2) Obtain undisturbed samples of existing berm soils for classification and strength tests. The strength and unit weight measurements from these tests provide data to evaluate the stability of the proposed 2H:1V berm slopes. This could be accomplished by collecting thin-wall tube samples of berm soils at two shallow boring locations within the Silos 1 and 2 berm.

The general purpose of this Phase 2 Investigation is the same as initially planned; however, based on the present proposed foundation locations, the depth of the borings within the silos' berm will be more shallow.

SECTION 6

REFERENCES

(ASCE 1993) American Society of Civil Engineers, 1993. *Bearing Capacity of Soils*, Technical Engineering and Design Guides as Adapted from the U.S. Army Corps of Engineers, No. 7. New York: ASCE.

(ASTM 1995) American Society for Testing and Materials, 1995. *Annual Book of Standards, Volume 4.08, Soil and Rock*. Philadelphia: ASTM.

(FERMCO 1996) Fernald Environmental Restoration Management Corporation, January 1996. *Project-Specific Plan for Silo Superstructure Design Investigation, Phase 1*, RI/FS WBS Number 40.03.10, Revision 0. Fernald, Ohio: FERMCO.

(SAIC 1996) Science Applications International Corporation, April 12, 1996. *Silo Superstructure Geotechnical Design Investigation, Geotechnical Laboratory Data Report*. Golden, Colorado: SAIC.

APPENDIX A

COORDINATES

PO 161 Test Boring Locations at OU4

Boring ID	Point Number	Northing (NAD 83)	Easting (NAD 83)	Elevation (ft MSL)	Depth (ft)
12060	BH-1	480431	1346871	572.1	17.0
12061	BH-4	480430	1347132	578.9	17.0
12062	BH-5A	480553	1346867	575.2	17.0
12063	BH-8	480553	1347132	580.3	16.5
12064	BH-9	480719	1346987	577.1	34.5
12065	BH-10	480715	1347061	577.6	20.0
12066	BH-11	480796	1346987	577.4	20.0
12067	BH-12	480796	1347060	577.8	19.5

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APPENDIX B

BORING LOGS

PO-161 FIELD BORING LOGS

FEMP
LITHOLOGIC LOG

CONTROL NO:

Page 1 of 1

PROJECT NAME: Silo Superstructure Geotechnical Design Investigation, Phase I	PROJECT NUMBER: 40.03.10
BORING NUMBER: 12060	COORDINATES:
RELATED FAL NOs.:	
SURFACE ELEVATION:	GROUNDWATER LEVEL: / DATE: / TIME:
DATE STARTED: 1-3-96	
GEOLOGIST: R. Nicks	GROUNDWATER LEVEL: / DATE: / TIME:
DATE COMPLETED: 1-3-96	
WATER USED DURING DRILLING: None	DRILLING CONTRACTOR: Alliance
DRILLING EQUIPMENT: Mobile B61 HSA 6" OD	DRILLER/HELPER: ED, Mark

DEPTH (FEET)	SAMPLE TIME, DATE, AND NUMBER	BLOWS (per 6 inch)	RECOVERY (inches)	DESCRIPTION (Colors identified per Munsell Color Chart)	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	L			Sandy Clay 5Y 4/4 Olive, very stiff, moist w/scattered gravel to 1/2", and stringers of 5Y 3/2 dark olive gray, low plasticity	CL	>4.5	
	1332 1/3/96 411301	5 4 5	14"				
	1347 1/3/96 411302	S H (N/A) L B Y	25"	Silty Sand with Clay 10YR 5/4 yellowish brown dense ~~very stiff~~, moist, some gravel to 1/4" Q.	SM	3.5	← Silty Sand w/gravel in tip 600 lbs down pressure
5	1355 1/3/96 411303	2 1 1	1"				← wet between 5 1/2-7
	1420 1/3/96 411304	S H E L B Y	30"	? ? ?			Q ~~weight of rods~~ - ~~no~~ down pressure for full 30" push did not register on gauge - that means <100 lbs pressure applied
				Lean Clay 2.5Y 4/2 dark grayish brown, stiff with stringers of m-c sand to 1".	CL	>4.5	
10	1428 1/3/96 411305	9 13 18	13"	5Y 4/2 olive gray very stiff w/scat. angular to subrounded gravel to 1/4"	CL	4.0	← 1/2" thick gravelly sand stringer @ 10° to 16°
	1445 1/3/96 411306	S H E L B Y	22"	5Y 4/1 dark gray v.stiff w/gravel to 3"	CL	>4.5	
	1450 1/3/96 411307	8 9 12	14"	5Y 3/2 dark olive gray, stiff to v.stiff moist w/scattered gravel to 1/4"	CL	2.0 2.25	
15	1505 1/3/96 411308	3 5 7 7	24"	5Y 3/2 dark olive gray, firm, wet	CL-CH	1.25 Q. 2.0 Q. 3.75	
				TOTAL DEPTH 17°			

FILL? (Pass granular utility trench backfill) 411310

Time 1515

INSTRUMENT	BACKGROUND	DATE	TIME
PID			
ALPHA			
BETA/GAMMA			

NOTES:

*SAMPLES COLLECTED PER ASTM STANDARD PENETRATION TEST.

*ILLUS\MISC\GEOTECH\LITHO LOG.EPS

FEMP
LITHOLOGIC LOG

CONTROL NO:

Page 1 of 1

PROJECT NAME:	PROJECT NUMBER:
SILO SUPERSTRUCTURE GEOTECHNICAL DESIGN INVESTIGATION PHASE I	40.03.10

BORING NUMBER:	COORDINATES:	RELATED FAL NOs.:
12061		

SURFACE ELEVATION:	GROUNDWATER LEVEL:	DATE:	TIME:	DATE STARTED:
				1-5-96

GEOLOGIST:	GROUNDWATER LEVEL:	DATE:	TIME:	DATE COMPLETED:
R. Nicks				

WATER USED DURING DRILLING:	DRILLING CONTRACTOR:	DRILLING EQUIPMENT:	DRILLER/HELPER:
NONE	ALLIANCE	Mobile B61 HSA 6" O.D.	ED. MARK

DEPTH (FEET)	SAMPLE TIME, DATE, AND NUMBER	BLOWS (per 6 inch)	RECOVERY (inches)	DESCRIPTION (Colors identified per Munsell Color Chart)	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				Silty SAND 10YR 3/6 dark yellowish brown, med. dense to dense	SM		
	1048 1/5/96 411330	10 11 13	12"	Lean CLAY w/sand 10YR 3/3 dk. brown stiff, moist	CL		topsoil Frozen
				Lean CLAY 10YR 5/4 yellowish brown, v.stiff, moist	CL	1.75	spoon outside wet
	1115 1/5/96 411331	SHELBY	14"	10YR 4/6 dark yellowish brown	CL	2.50	300 lbs down pressure
5	1124 1/5/96 411332	4 9 12	16"	10YR 5/6 yellowish brown, v.stiff, moist	CL	3.00 3.75	
	1133 1/5/96 411333	SHELBY	30"	10YR 5/4 yellowish brown, stiff		1.75 2.50	400 lbs down pressure
				Lean Clay with sand			
10	1140 1/5/96 411334	0 2 4	6"	10YR 5/4 yellowish brown, firm, wet, with sand	CL	<1	
	NOON 1/5/96 411335	SHELBY	30"	Silty SAND 10YR 5/4 yellowish brown, Med. dense, wet, with some clay	SM	1.5	600 lbs down pressure Tip Bent
	1205 1/5/96 411336	3 4 7 9	18"	Gravelly, sandy Clay 2.5Y 4/2 dark grayish brown, firm-stiff, moist to wet w gravel to 1"	CL	1.75	
15	1215 1/5/96 411337	SPOON 3"	12"	4" Silty Sand 10YR 5/4 yellowish brown soft and wet			
				T.D. 17.0			

INSTRUMENT	BACKGROUND	DATE	TIME	NOTES:
PID				
ALPHA				
BETA/GAMMA				

*SAMPLES COLLECTED PER ASTM STANDARD PENETRATION TEST.

FEMP
LITHOLOGIC LOG

CONTROL NO:

Page 1 of 1

PROJECT NAME:	Silo Superstructure Geotechnical Design Investigation, Phase I
PROJECT NUMBER:	40.03.10
BORING NUMBER:	12062
COORDINATES:	
RELATED FAL NOs.:	
SURFACE ELEVATION:	
GROUNDWATER LEVEL:	
DATE:	
TIME:	
DATE STARTED:	1/4/96
GEOLOGIST:	R. Nicks
GROUNDWATER LEVEL:	
DATE:	
TIME:	
DATE COMPLETED:	1/4/96
WATER USED DURING DRILLING:	None
DRILLING CONTRACTOR:	Alliance Environmental
DRILLING EQUIPMENT:	Mobile B-61 6" O.D. HSA
DRILLER/HELPER:	ED, Mark

DEPTH (FEET)	SAMPLE TIME, DATE, AND NUMBER	BLOWS (per 6 inch)	RECOVERY (inches)	DESCRIPTION (Colors identified per Munsell Color Chart)	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				SANDY GRAVEL			Gravel Road Base top 6" to 14"
	0915 411311 1/4/96	Sh 30 27 19	4"	~~Clayey~~ SANDY CLAY AND GRAVEL 2.5Y 4/4 OLIVE BRN. V.STIFF TO HARD	CL	NA	Frozen Ground to ≈ 2ft.
	411312	S4		LEAN CLAY w/SAND AND SCATTERED GRAVEL 10YR 4/4 dark yellowish brown, v.stiff with moist	CL	3.5	600 lbs. down pressure on gauge.
	0927 1/4/96	6 8 7	28"				
5	0937 1/4/96 411313	8 17 29	10"	GRAVELLY CLAY 10YR 4/4 dark yellowish brn. GRAVEL TO 1", V.stiff moist.	CL	1.5	
	0955 1/4/96 411314	S4 6 8 7	10"		CL		-900 lbs. down pressure -CRUSHED SHELBY -DISTURBED
10	1003 1/4/96 411315	12 15 17	13"	SILTY SAND with scattered gravel 10YR 4/4 dark yellowish brown, Medium dense, wet gravel to 1".	SM	1.0	OUTSIDE OF SPOON WET
	1019 1/4/96 411316	S4 6 8 7	6"	10 YR 3/4 yellowish brown	SM	NA	1300 lbs. down pressure SHELBY STUCK IN AUGERS CRUSHED AND DISTURBED
15	1045 1/4/96 411317	3" S P N	12"	2.5Y 4/4 olive brown, Med. dense, wet	SM	NA	
	1100 1/4/96 411318	S4 6 8 7	10"	SANDY SILT 10 YR 5/1 Gray in tip, stiff; wet	~~SM~~ ML		BENT TIP
				TOTAL DEPTH 17'			

INSTRUMENT	BACKGROUND	DATE	TIME
PID			
ALPHA			
BETA/GAMMA			

NOTES:

*SAMPLES COLLECTED PER ASTM STANDARD PENETRATION TEST.

*ILLUSTMISC\GEOTECH\LITHO LOG.EPS

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FEMP
LITHOLOGIC LOG

CONTROL NO:

Page 1 of 1

PROJECT NAME: SILO SUPERSTRUCTURE GEOTECHNICAL DESIGN INVESTIGATION, PHASE I	PROJECT NUMBER: 40.03.10
BORING NUMBER: 12063	COORDINATES:
RELATED FAL NOs.:	
SURFACE ELEVATION:	GROUNDWATER LEVEL: DATE: TIME:
DATE STARTED: 1/4/96	
GEOLOGIST: R. Nicks	GROUNDWATER LEVEL: DATE: TIME:
DATE COMPLETED: 1/4/96	
WATER USED DURING DRILLING: NONE	DRILLING CONTRACTOR: ALLIANCE
DRILLING EQUIPMENT: MOBILE B61 HSA 6" O.D.	DRILLER/HELPER: ED. MARK

DEPTH (FEET)	SAMPLE TIME, DATE, AND NUMBER	BLOWS (per 6 inch)	RECOVERY (inches)	DESCRIPTION (Colors identified per Munsell Color Chart)	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	1425 1/4/96 411320	Shelby	22"	Silty Sand 10YR 3/6 dark yellowish brown. M. dense to dense, moist	SM		200 lbs. down pressure Topand bottom of shelby bent.
	1435 1/4/96 411321	12 22 15	12"	Lean Clay w/sand 10YR 3/3 dk. brn. v. stiff	CL	2.5	Topsoil
				Lean Clay 10YR 4/6 dark yellowish brown, v. stiff stiff, moist w/scat. M-F sand	CL	4.0	600 lbs. down pressure
5	1492 1/4/96 411322	Shelby	24"	2.5Y 4/4 olive brown, stiff, moist		0.5-1.0	
	1453 1/4/96 411323	6 12 16	18"	2.5Y 4/4 olive brown		2.5	
10	1500 1/4/96 411324	Shelby	38"	Silt 10YR 4/6 dk. yellowish brown firmy moist	ML	1.75	600 lbs down pressure
	1515 1/4/96 411326	8 15 17	18"	10YR 4/8 yellowish brown wet Fat 2/23/96 per RN Confirmation		2.25	
				Lean Clay 10YR 5/1 gray, stiff, moist highly plastic	CH	1.25	600 lbs
	1527 1/4/96 411327	Shelby	30"				900 lbs.
15	1543 1/4/96 411328	3" Spoon	12"	Gravelly Sand 10YR 4/6 dk. yellowish brown, v. dense w/gravel to 1". wet	SW SP	NA	
				TD 16'			

LK SAMPLE 411325 1512

INSTRUMENT	BACKGROUND	DATE	TIME	NOTES:
PID				
ALPHA				
BETA/GAMMA				

*SAMPLES COLLECTED PER ASTM STANDARD PENETRATION TEST.

*ILLUS\MISC\GEOTECH\LITHO LOG.EPS

4/96

FEMP
LITHOLOGIC LOG

CONTROL NO:

PROJECT NAME: SIT INFRASTRUCTURE GEOTECHNICAL DESIGN INVESTIGATION PHASE I				PROJECT NUMBER: 46 C5 11
BORING NUMBER: 12-64	COORDINATES:	RELATED FAL NOs.:		
SURFACE ELEVATION:	GROUNDWATER LEVEL: 18ft. below ground level	DATE: 1-16-96	TIME: NOON	DATE STARTED: 1-11-96
GEOLOGIST: R. Nicks	GROUNDWATER LEVEL:	DATE:	TIME:	DATE COMPLETED: 1-15-96
WATER USED DURING DRILLING:	DRILLING CONTRACTOR: ALLIANCE	DRILLING EQUIPMENT: MOBIE B-61 (HSA) 8¼"		DRILLER/HELPER: ED MARK

DEPTH (FEET)	SAMPLE TIME, DATE, AND NUMBER	BLOWS (per 6 inch)	RECOVERY (inches)	DESCRIPTION (Colors identified per Munsell Color Chart)	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				Gravelly Clay 2.5y 5/4 light olive brown v stiff, moist	CL		8¼" ID Auger
	1455 1-11-96 411362	9 13 13	13"	Lean Clay 2.5y 5/4 light olive brown stiff to v stiff, moist	CL	2.4	Visibly Frozen
5	1510 1-11-96 411363	SHELBY	22"	2.5y 4/4 olive brown v stiff, moist	CL	4.25 4.25	300# for first 24" then 900# for last 6"
	1530 1-11-96 411364	5 13 22	15	2.5y 5/4 light olive brown v stiff, moist, locally highly plastic	CL CH	2.45	sampler wet
	1541 1-11-96 411365	SHELBY	30				300# for first 24" then upto ≈ 700# for last 6"
10	1557 1-11-96 411366	5 4 7	8"	Silty Sand 2.5y 5/4 light olive brown Dense, moist w/scat. gravel to 1/4" 2.5y 4/4 olive brown, med. dense, wet	SM		Barrel or split spoon wet
	1615 1-11-96 411367	7 8 13 11	24"				Sampler wet
1-11-96				Sandy Clay with gravel 2.5y 4/4 olive brown v. st. stiff moist	CL	2.6	
1-12-96	1334 1-12-96 411368	SHELBY	27"	SAND, 2.5y 4/1 DARK GRAY, Med Dense, wet	SP		250# gauge down pressure
	1400 1-12-96 411369	12 12 15	16"	SANDY CLAY 2.5y 4/2 Dark Grayish Brown, stiff to v. stiff, wet	CL		200# gauge down pressure
1-12-96 20	1412 1-12-96 411370	SHELBY	30"	LEAN CLAY 2.5y 4/2 Dark Grayish Brown, v. stiff, moist to wet	CL	3.0	

INSTRUMENT	BACKGROUND	DATE	TIME
PID			
ALPHA			
BETA/GAMMA			

NOTES: 2 coring ≈ 3' [illegible] w/ stake

*SAMPLES COLLECTED PER ASTM STANDARD PENETRATION TEST.

*ILLUS\MISC\GEOTECH\LITHO LOG.EPS

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FEMP
LITHOLOGIC LOG

PROJECT NAME:	PROJECT NUMBER:	BORING NUMBER:
SILO SUPERSTRUCTURE GEOTECH. DESIGN INVEST. PHASE I	40.03.10	12064

DEPTH (FEET)	SAMPLE TIME, DATE, AND NUMBER	BLOWS (per 6 inch)	RECOVERY (inches)	DESCRIPTION (Colors identified per Munsell Color Chart)	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1-15-96 20	1304 1-15-96 411371	4 6 10	18	SANDY CLAY w/GRAVEL 2.5Y 4/2 DARK GRAYISH BROWN STIFF, MOIST; GRAVEL TO 1/4" TO WET	CL	1.0-1.5	
	1317 1-15-96 411372	SHELBY	30"			1.25	200# DOWNPRESSURE ON GAUGE Tip bent slightly
25	1335 1-15-96 411373	50 for 4"	4	V. STIFF TO HARD - CEMENTED LOCALLY		>4.5	DRILL OUT SAMPLE Bn. INTERVAL TO ~~26~~ 25.5
	1350 1-15-96 411374	23 2" SPOON 50 for 5"	10"	Cemented 2.5Y 5/1 Gray		>4.5	
	1400 1-15-96 411375	16 27 26	18	CLAYEY SILT w/SAND 2.5Y 5/4 LIGHT OLIVE BROWN	ML	3.0	
30	1410 1-15-96 411376	SHELBY	20	SILT 10YR 4/6 DARK YELLOWISH BROWN V. STIFF, MOIST	ML	>4.5	PUSH 27, recover 20
	1415 1-15-96 411377	21 31 36	14"	SAND 10YR 5/6 YELLOWISH BROWN V. DENSE, MOIST, CROSS BEDDED, THINLY LAMINATED, IRON STAINED	SP		
	~~1415~~ 1-15-96 411378	~~21~~ ~~31~~ ~~36~~	14"				
	1420	25 39 46					
35				TOTAL DEPTH = 34.5			

NOTES:

FEMP
LITHOLOGIC LOG

CONTROL NO:

Page 1 of 1

PROJECT NAME: SILO SUPERSTRUCTURE GEOTECHNICAL DESIGN INVESTIGATION PHASE I	PROJECT NUMBER: 40.03.10
BORING NUMBER: 12065	COORDINATES:
RELATED FAL NOs.:	
SURFACE ELEVATION:	GROUNDWATER LEVEL: 8 ft. Below Ground Level; DATE: 1-16-96; TIME: 1230; DATE STARTED: 1-16-96
GEOLOGIST: R. NICKS	GROUNDWATER LEVEL: 3FT. BGL; DATE: 1-16-96; TIME: 1330; DATE COMPLETED: 1-16-96
WATER USED DURING DRILLING:	DRILLING CONTRACTOR: ALLIANCE; DRILLING EQUIPMENT: MOBIL B61 ASA 8 3/4 LD; DRILLER/HELPER: EP, MARK

DEPTH (FEET)	SAMPLE TIME, DATE, AND NUMBER	BLOWS (per 6 inch)	RECOVERY (inches)	DESCRIPTION (Colors identified per Munsell Color Chart)	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				GRAVELLY CLAY with SAND, scat. gravel to 1"	CL	>4.5	(FROZEN)
	0957 1-16-96 411380	17 33 16	6"	2.5 y 4/4 olive brown, v. stiff, moist			
	1006 1-16-96 411381	SHELBY	2"	LEAN CLAY with SAND, 2.5y 5/4 light olive brown, stiff to v. stiff	CL	2.5	300# gauge downpressure DUG out of tube and put in jar. #411381
5	1013 1-16-96 411382	8 12 12	18"	2.5y 5/4 lt. oliv. brn. stiff to v. stiff, moist with silt interbeds to 2"	CL	1.5-2.5	
	1020 1-16-96 411383	SHELBY	24"	2.5y 5/4 lt. olive brn., v. stiff, moist	CL	4.0-4.5	300# gauge down pressure
	1034 1-16-96 411384	14 28 46	18"	2.5 y 4/1 dark gray		[illegible]	
10	1-16-96	50 for 1"	0"	SILTY SAND 2.5y 4/4 olive brown, dense, moist	SM		NO SAMPLE TRY 3" SPOON - NO SAMPLE
	1052 1-16-96 411386	5 9 14	16"	FAT CLAY 2.5y 5/1 GRAY, Firm to stiff	CH	1.5	
	1101 1-16-96 411387	SHELBY	10"	LEAN CLAY 2.5y 4/2 Dark Gray Brown Firm-Stiff, moist	CL	1.0-1.5	300# gauge downpressure
15	1113 1-16-96 411388	3 5 8	18"	2.5y 4/1 with SAND, gray	CL	1.0	
	1122 1-16-96 411389	SHELBY	24"	w/SCAT Gravel to 1/2"	CL	1.5	400#-600# Down pressure
	1130 1-16-96 411390	2 6 9	9"	T.D. 20°	CL	1.0	
20							

10-47 Bulk 411385

INSTRUMENT	BACKGROUND	DATE	TIME
PID			
ALPHA			
BETA/GAMMA			

NOTES:

*SAMPLES COLLECTED PER ASTM STANDARD PENETRATION TEST.

*ILLUS\MISC\GEOTECH\LITHO LOG EPS

4/95

CONTROL NO:	FEMP LITHOLOGIC LOG	Page 1 of 1

PROJECT NAME:	PROJECT NUMBER:
SILO SUPERSTRUCTURE GEOTECHNICAL DESIGN INVESTIGATION	40.03.10

BORING NUMBER:	COORDINATES:	RELATED FAL NOs.:
12066		

SURFACE ELEVATION:	GROUNDWATER LEVEL:	DATE:	TIME:	DATE STARTED:
	9' BGL	1-11-96	1330	1-10-96

GEOLOGIST:	GROUNDWATER LEVEL:	DATE:	TIME:	DATE COMPLETED:
R. Nicks				1-11-96

WATER USED DURING DRILLING:	DRILLING CONTRACTOR:	DRILLING EQUIPMENT:	DRILLER/HELPER:
None	ALLIANCE	MOBILE B61 HSA 3¼" ID	ED, MARK

DEPTH (FEET)	SAMPLE TIME, DATE, AND NUMBER	BLOWS (per 6 inch)	RECOVERY (inches)	DESCRIPTION (Colors identified per Munsell Color Chart)	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	1445 1-10-96 411350	6 3" 3 S 17 P 18 O N	14"	Gravelly Clay 10YR 3/2 very dark grayish brown v.stiff moist	CL		TOP FOOT FROZEN
				Lean Clay 10YR 4/4 dark yellowish brown	CL	2.75	
	1455 1-10-96 411351	3 7 10	18"	10YR 4/4 dark yellowish brown, firm-stiff, moist	CL	1.5	
5	1502 1-10-96 411352	SHELBY	27"	2.5Y 5/4 light olive brown, v.stiff, moist,	CL	3.75 4.5	750# down pressure on gauge clearly thinly laminated
	1513 1-10-96 411353	5 10 13	17"	2.5Y 4/3 olive brown, v.stiff, moist with some sand	CL	3.25 4.50	
	1525 1-10-96 411354	SHELBY	30"	2.5Y 4/2 dark grayish brown w/sand stringers to 1/16"	CL	3.25	400# down pressure
10	1533 1-10-96 411356	3 5 6	18"	2.5Y 4/6 olive brown, firm to stiff, moist with fine sand laminae to 1/16"	CL	1.0	
	0920 1-11-96 411357	SHELBY	24"		CL	1.75	250# down pressure
15	0937 1-11-96 411358	2 3" 14 S 16 P 20 O N	24"	Gravelly Clay - 2.5Y 4/2 dark grayish brown. Firm to stiff moist w/ gravel to 1". Highly plastic locally	CL CH	0.5 1.25	
	0955 1-11-96 411359	4 3" 9 S 14 P 20 O N	24"		CL	0.5 1.0	
20	1007 1-11-96 411360	5 3" 12 S 19 P 26 O N	24"	TOTAL DEPTH 20'	CL	1.5	

time 1-10-96 1-11-96 # 411355 wlk 1527

INSTRUMENT	BACKGROUND	DATE	TIME	NOTES:
PID				
ALPHA				
BETA/GAMMA				

*SAMPLES COLLECTED PER ASTM STANDARD PENETRATION TEST.

LOGS FROM PRIOR INVESTIGATIONS

313327-A-128 004 KNOX 10/14/92

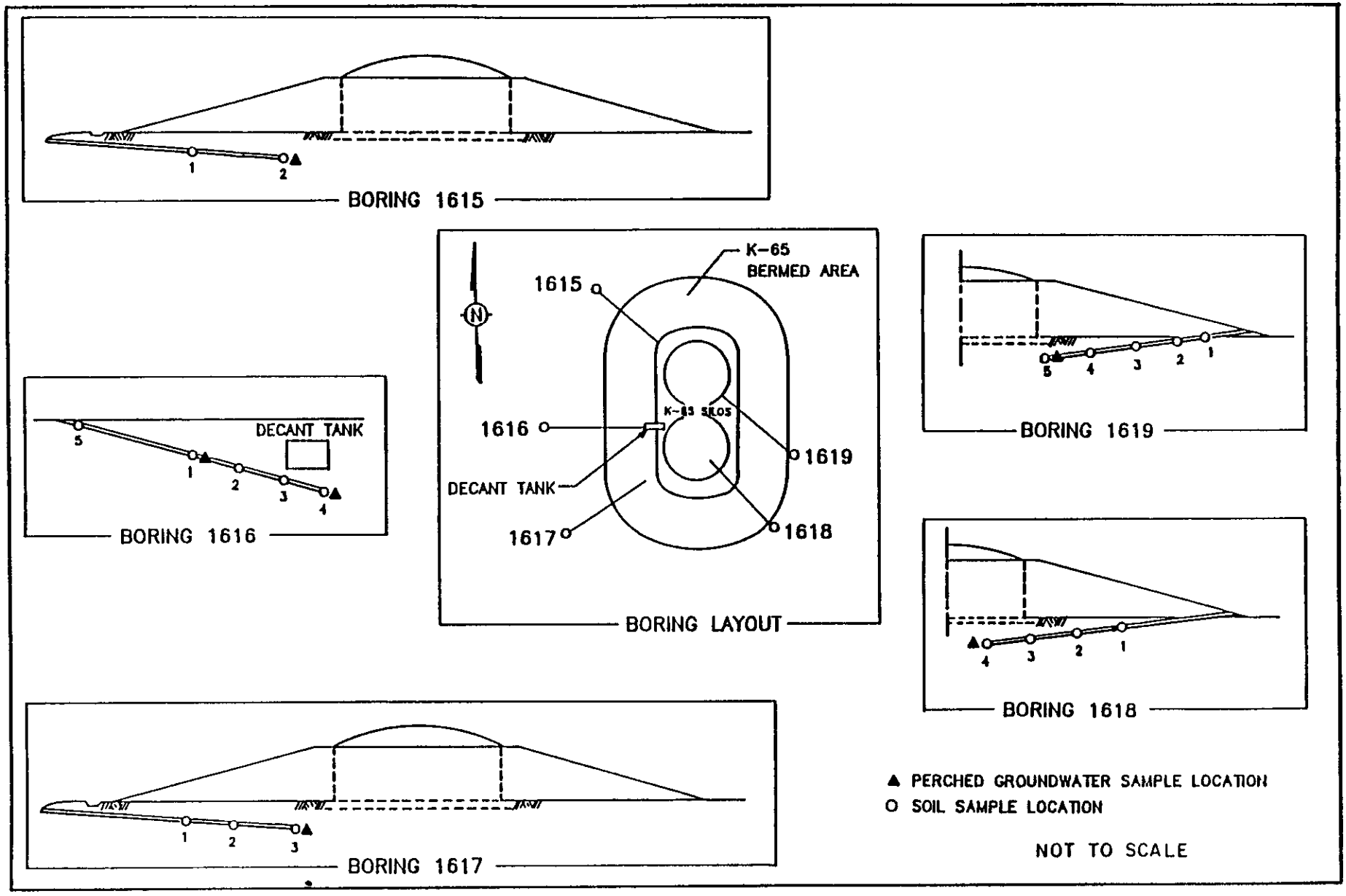
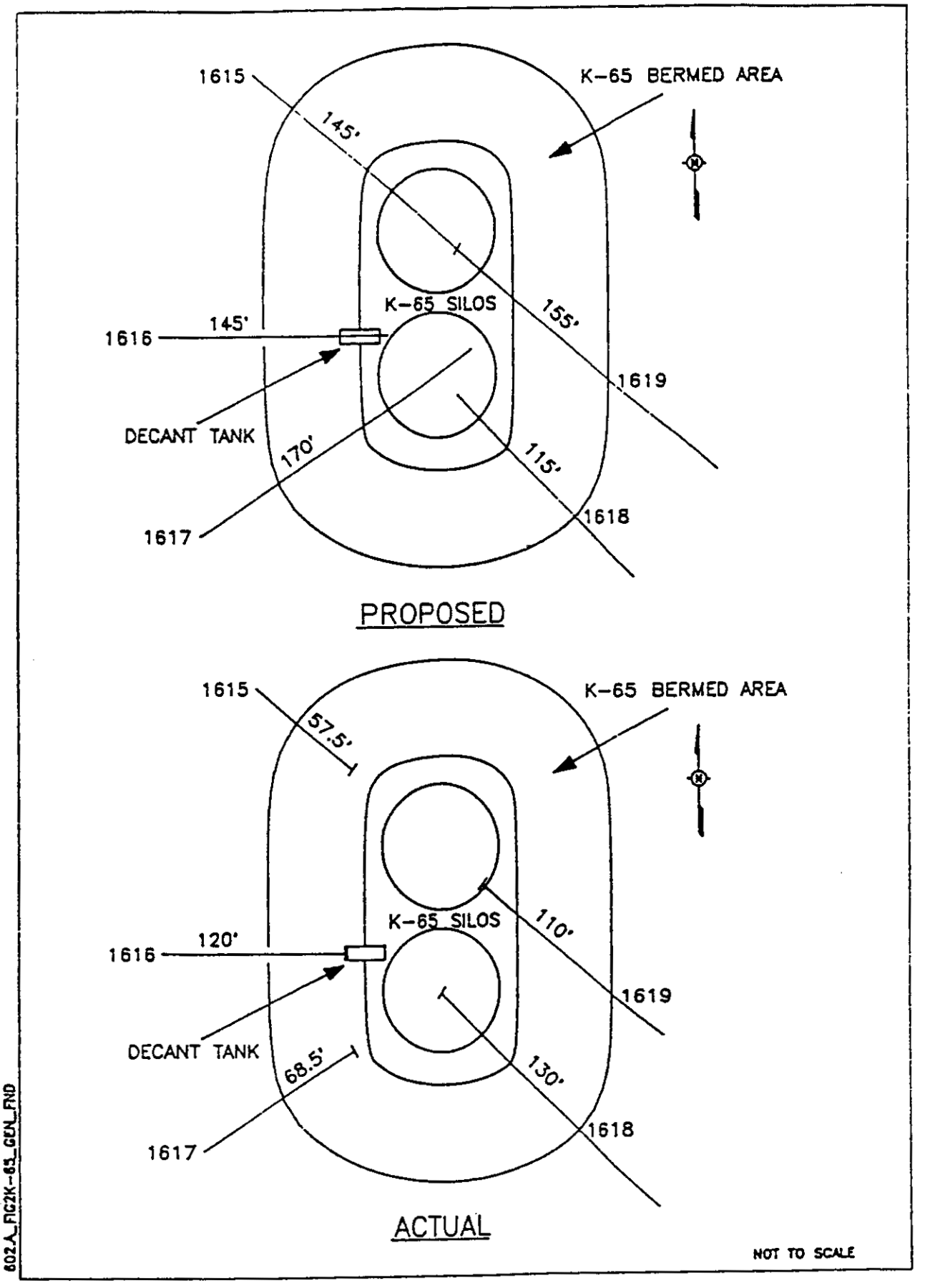


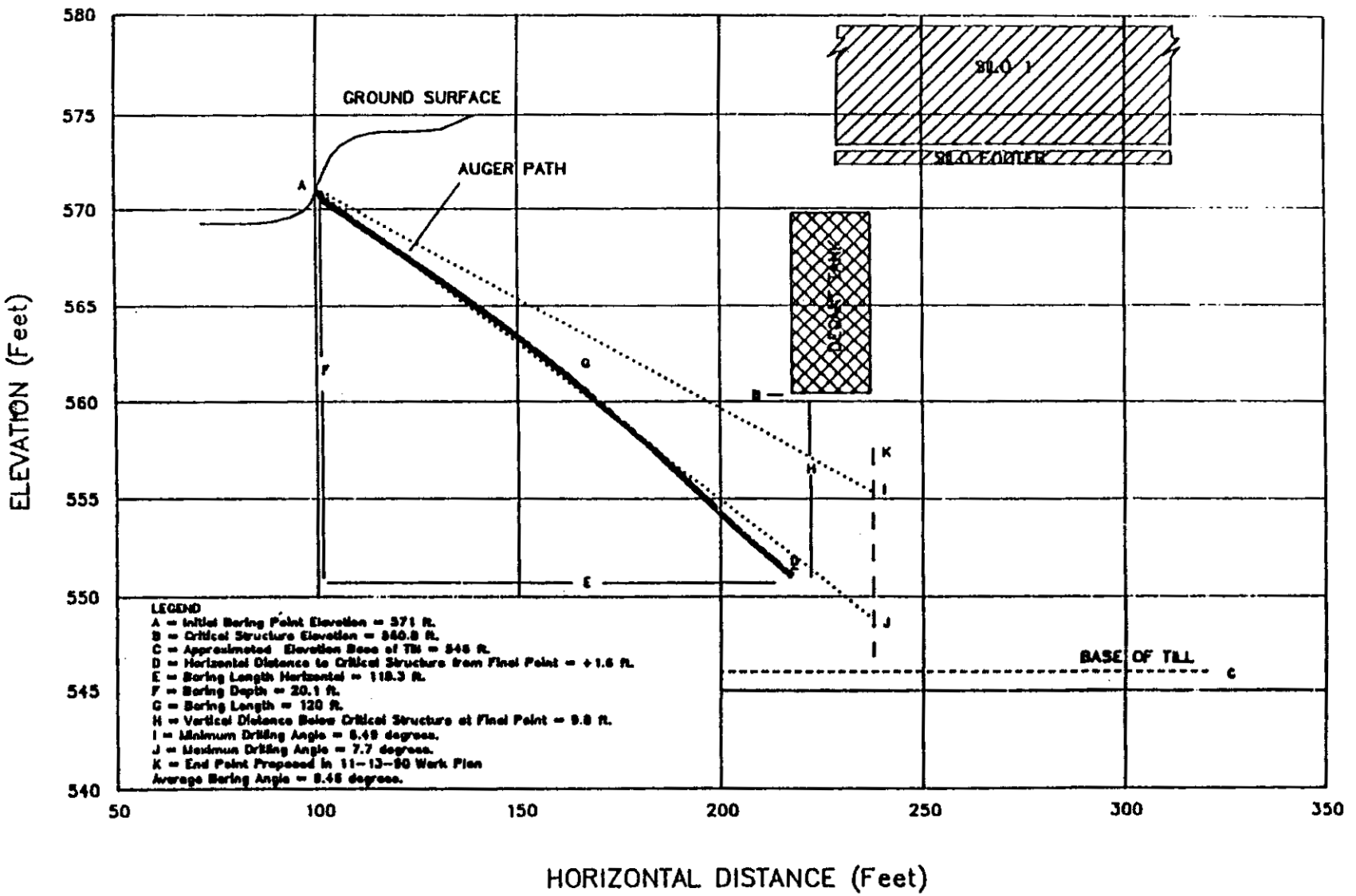
FIGURE 2-5. BORING LAYOUT AND SAMPLING CONFIGURATION



PLAN VIEWS OF PROPOSED AND ACTUAL BORING LENGTHS

SLANT BORING 1616 (No.2) AT K-65 SILOS

Graph #: K65B2C. JULY 02, 1991



MORA_K65B2CC.DRW_ASFNO_08-08-91_REV000

PROJECT NUMBER: 602 3.7	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1616	COORDINATES: NORTH 480,469.31 EAST 1,378,315.91	DATE: 06/08/91
GROUND ELEVATION: 571.0	GWL: Depth N/A Date/Time N/A	DATE STARTED: 06/08/91
ENGINEER/GEOLOGIST: GM, KM	Depth N/A Date/Time N/A	DATE COMPLETED: 07/02/91
DRILLING METHODS: HORIZONTAL DRILL MACHINE WITH 8 1/4 INCH		PAGE 1 OF 3

DEPTH	SAMPLE	DATE TIME	BLOWS ON	SAMPLE	RECOVERY	INCHES		USCS SYMBOL	TSF	REMARKS
5	64011	06/08/91 1600			4.		HARD OLIVE BROWN (2.5Y, 4/4) SANDY CLAY WITH SOME ROOT FRAGMENTS, DRY. HARD OLIVE BROWN (2.5Y, 4/4) SANDY CLAY WITH TRACE COARSE GRAVEL, DRY.	CL CL	>4.5 >4.5	Hnu= 0 ppm α = 400 cpm βΓ = 0 cpm
8	64012	06/08/91 1700			0		NO RECOVERY.	-		
13	64013	06/11/91 1730			4.		DARK YELLOWISH BROWN (10YR, 4/4) VERY STIFF SANDY CLAY WITH GRAVEL, TRACE ORGANIC MATTER, DAMP, LOW PLASTICITY.	CL	2.5	Hnu= .2 ppm α = 200 cpm βΓ = 0 cpm
18	64014	06/12/91 1723			0		NO RECOVERY.	-		
23	64015	06/14/91 0925			4.		DARK YELLOWISH BROWN (10YR, 4/4) STIFF SANDY CLAY WITH GRAVEL, DAMP, MEDIUM PLASTICITY. LIGHT OLIVE BROWN (2.5Y, 5/4) MEDIUM DENSE CLAYEY SAND WITH A LITTLE GRAVEL, MOIST. VERY STIFF CLAYEY SILT WITH PALE YELLOW (2.5Y, 7/3) MOTTLING.	CL SC ML	1.25 1.25 1.25	Hnu= .2 ppm α = 280 βΓ = 0
28	64016	06/14/91 1730			5.		PALE YELLOW (5Y, 7/3) TO OLIVE (5Y, 5/4) MOTTLED VERY STIFF CLAYEY SILT WITH TRACE GRAVEL, DAMP, NON PLASTIC, MOIST.	ML	2.0	Hnu= .2 ppm α = 280 cpm βΓ = 0 cpm
33	64017	06/15/91 1030			5.		PALE YELLOW (2.5Y, 7/3) TO LIGHT YELLOWISH BROWN (2.5Y, 6/4) MOTTLED VERY STIFF CLAYEY SILT, DAMP, NON PLASTIC. DARK YELLOWISH BROWN (10YR, 4/4) SOFT SANDY CLAY, MOIST, LOW PLASTICITY.	ML CL	2.5 2.5	Hnu= .1 ppm α = 260 cpm βΓ = 0 cpm
38	64018	06/15/91 1220			5.		DARK YELLOWISH BROWN (10YR, 4/4) MEDIUM DENSE CLAYEY SAND, MOIST.	SC	NA	Hnu= .1 ppm α = 260 cpm βΓ = 0 cpm
43	64019	06/15/91 1355			4.		DARK YELLOWISH BROWN (10YR, 4/4) MEDIUM DENSE CLAYEY SAND WITH A LITTLE LIGHT GRAY (5Y, 7/1) MOTTLING, MOIST.	SC	NA	Hnu= .1 ppm α = 260 cpm βΓ = 0 cpm
48	64020 64021	06/19/91 1710			5.		DARK YELLOWISH BROWN (10YR, 4/4) MEDIUM DENSE SAND WITH A LITTLE TO TRACE CLAY, SATURATED.	SC	NA	Hnu= .1 ppm α = 250 cpm βΓ = 0 cpm
53	64023	06/21/91 1640			1.		YELLOWISH BROWN (10YR, 5/4) LOOSE SAND WITH A LITTLE GRAVEL AND TRACE FOSSILS, SATURATED.	SC	NA	Hnu= .1 ppm α = 250 cpm βΓ = 0 cpm

NOTES:
BORINGS SAMPLES CONTINUOUS USING A 5.0 SAMPLER. BORING ANGLE CHECKED EVERY 2 FT. USING A SLOPE INDICATOR.
SAMPLES COMPARED TO MUNSELL COLOR CHART.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.7	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1616	COORDINATES: NORTH 480,469.31 EAST 1,378,315.91	DATE: 06/08/91
GROUND ELEVATION: 571.0	GWL: Depth N/A Date/Time N/A	DATE STARTED: 06/08/91
ENGINEER/GEOLOGIST: GM, KM	Depth N/A Date/Time N/A	DATE COMPLETED: 07/02/91
DRILLING METHODS: HORIZONTAL DRILL MACHINE WITH 8 1/4 INCH		PAGE 2 OF 3

DEPTH	SAMPLE	DATE TIME	BLOWS ON SAMPLE	RECOVERY	INCHES	USCS	SYMBOL	TSF	REMARKS
58	64024 06/22/91 0915			3.	LIGHT OLIVE BROWN (2.5Y, SM) MEDIUM DENSE SAND WITH A LITTLE GRAVEL, SATURATED.	SC		NA	Hnu= .1 ppm α = 250 cpm βΓ = 0 cpm
63	64025 06/22/91 1130			4	BROWN (10YR, 5/3) MEDIUM DENSE SAND WITH A LITTLE FINE GRAVEL AND CLAY, SATURATED. OLIVE GRAY (5Y, 5/2) STIFF CLAY, WET, LOW PLASTICITY.	SC CL		NA NA	Hnu= .1 ppm α = 250 cpm βΓ = 0 cpm
68	64026 06/24/91 1000			5.	LIGHT OLIVE BROWN (2.5Y, 5/4) LOOSE SAND, SATURATED. INTERBEDDED LAYERS OF GRAY (5Y, 5/1) STIFF CLAY WITH TRACE GRAVEL, MOIST, LOW PLASTICITY, AND LIGHT OLIVE BROWN (2.5Y, 5/	SC SC		NA NA	Hnu= .1 ppm α = 250 cpm βΓ = 0 cpm
73	64027 06/24/91 1415			5.	GRAY (5Y, 5/1) DENSE GRAVEL, SAND AND CLAY MIXTURE, WET.	GC		NA	Hnu= .1 ppm α = 250 cpm βΓ = 0 cpm
78	64028 06/25/91 1425			5.	GRAY (5Y, 5/1) DENSE GRAVEL, SAND AND CLAY MIXTURE, WET. GRAY (5Y, 5/1) STIFF CLAY WITH TRACE GRAVEL AND SAND MOIST, LOW PLASTICITY. GRAY (5Y, 5/1) STIFF SANDY CLAY WITH A LITTLE GRAVEL, DAMP, NO PLASTICITY.	GC CL CL		NA NA NA	Hnu= 0 ppm α = 280 cpm βΓ = 0 cpm
83	64029 06/25/91 1650			5.	GRAY (5Y, 5/1) STIFF SANDY CLAY WITH A LITTLE GRAVEL, MOIST, LOW PLASTICITY. GRAY (5Y, 5/1) MEDIUM STIFF CLAY WITH SAND AND GRAVEL, MOIST, LOW PLASTICITY.	CL CL		2.0 2.0	Hnu= 0 ppm α = 280 cpm βΓ = 0 cpm
84	64030 64031 06/26/91 0835				GRAY (5Y, 5/1) MEDIUM STIFF CLAY WITH TRACE SAND & GRAVEL DAMP, MED PLASTICITY.				Hnu= 0 ppm α = 280 cpm βΓ = 0 cpm
89.2	64032 64033 06/26/91 1600			5.	GRAY (5Y. 5/1) MEDIUM STIFF CLAY WITH A LITTLE SAND AND GRAVEL, MOIST, HIGH PLASTICITY.	CL		1.0	Hnu= .1 ppm α = 300 cpm βΓ = 0 cpm
90	64034* 06/26/91 1600			5.	GRAY (5Y. 5/1) MEDIUM STIFF CLAY WITH A LITTLE SAND AND GRAVEL, MOIST, HIGH PLASTICITY.	CL		1.0	Hnu= .1 ppm α = 300 cpm βΓ = 0 cpm
93	64036 06/26/91 1600			5.	GRAY (5Y. 5/1) MEDIUM STIFF CLAY WITH A LITTLE SAND AND GRAVEL, MOIST, HIGH PLASTICITY.	CL		1.0	Hnu= .1 ppm α = 300 cpm βΓ = 0 cpm
98	64037 06/27/91 0920			5.	GRAY (5Y, 5/1) MEDIUM STIFF CLAY WITH A LITTLE SAND AND GRAVEL, MOIST, HIGH PLASTICITY.	CL		1.0	Hnu= .1 ppm α = 300 cpm βΓ = 0 cpm

NOTES:
BORINGS SAMPLED CONTINUOUS USING A 5.0 SAMPLER. BORING ANGLE CHECKED EVERY 2 FT. USING A SLOPE INDICATOR.
WATER ENTERED THE SAMPLE FROM A LAYER ABOVE.
THE BOTTOM HALF TENNITE TUBE SPLIT DOWN THE MIDDLE. THE AUGERS WERE USED TO DRILL THIS FIVE FOOT INTERVAL THROUGH THE LIMESTONE SHEET WITHOUT THE SPLIT BARREL SAMPLER.
SAMPLES COMPARED TO MUNSELL COLOR CHART.
* GEOTECHNICAL SAMPLES

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.7	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1616	COORDINATES: NORTH 480,469.31 EAST 1,378,315.91	DATE: 06/08/91
GROUND ELEVATION: 571.0	GWL: Depth N/A Date/Time N/A	DATE STARTED: 06/08/91
ENGINEER/GEOLOGIST: GM, KM	Depth N/A Date/Time N/A	DATE COMPLETED: 07/02/91
DRILLING METHODS: HORIZONTAL DRILL MACHINE WITH 8 1/4 INCH		PAGE 3 OF 3

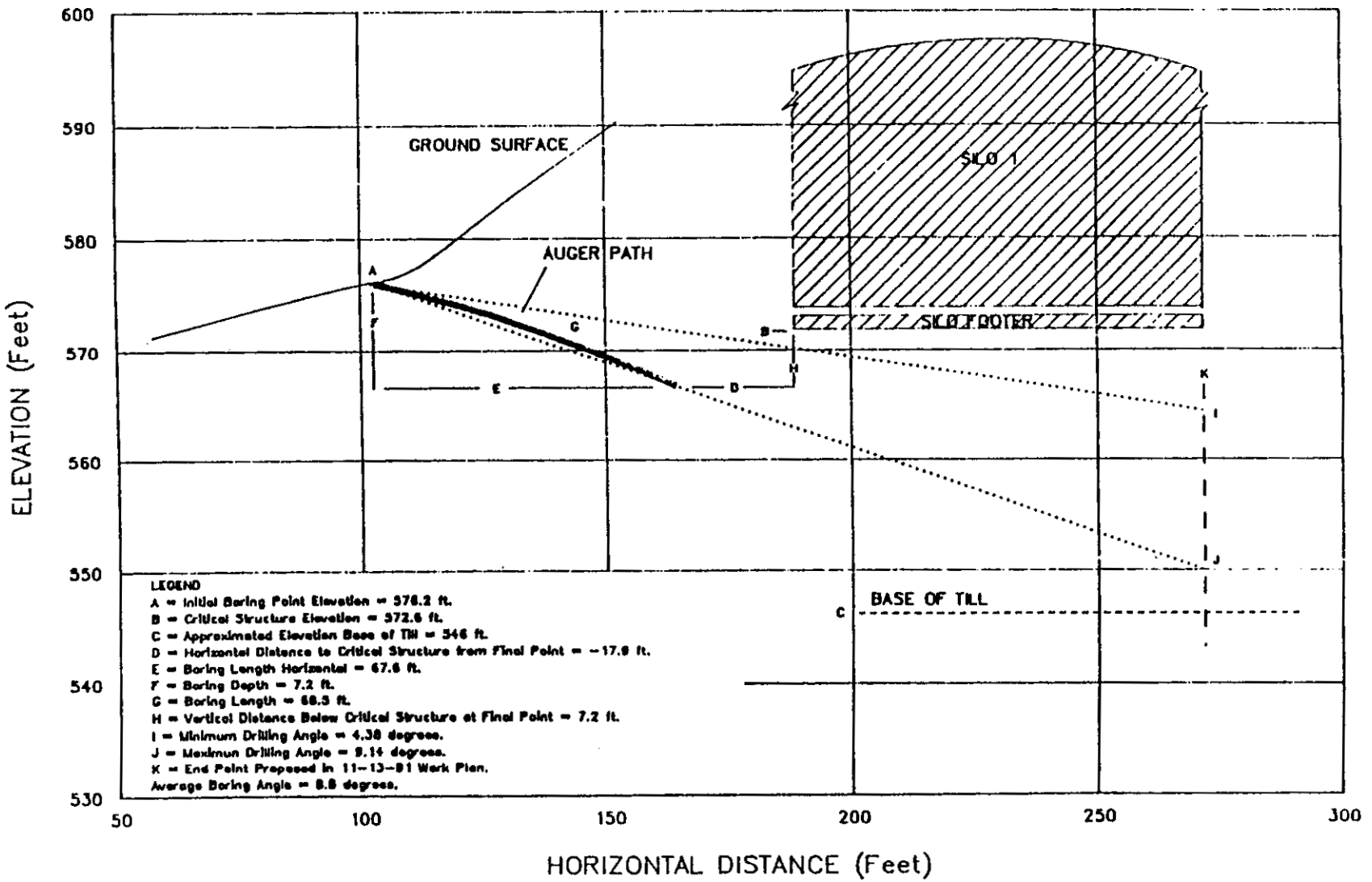
DEPTH	SAMPLE	DATE TIME	BLOWS ON SAMPLE	RECOVERY	INCHES		USCS SYMBOL	TSF	REMARKS
103	64038 06/27/91 1700			5.		GRAY (5Y, 5/1) STIFF CLAY WITH A LITTLE SAND AND TRACE GRAVEL, MOIST, HIGH PLASTICITY.	CL	1.25	Hnu= .1 ppm α = 300 cpm βΓ = 0 cpm
104.-	64039 64040 06/28/91 1000			5.		GRAY (5Y, 5/1) STIFF CLAY WITH A LITTLE SAND AND TRACE GRAVEL, MOIST, HIGH PLASTICITY.	CL	1.25	Hnu= .6 ppm α = 1000 cpm βΓ = 0 cpm
105.	64046 64045 06/28/91 1000			5.		GRAY (5Y, 5/1) STIFF CLAY WITH A LITTLE SAND AND TRACE GRAVEL, MOIST, HIGH PLASTICITY.	CL	1.25	Hnu= .6 ppm α = 1000 cpm βΓ = 0 cpm
106.	64041 64042 06/28/91 1000			5.		GRAY (5Y, 5/1) STIFF CLAY WITH A LITTLE SAND AND TRACE GRAVEL, MOIST, HIGH PLASTICITY.	CL	1.25	Hnu= .6 ppm α = 1000 cpm βΓ = 0 cpm
107	64043* 06/28/91 1000			5.		GRAY (5Y, 5/1) STIFF CLAY WITH A LITTLE SAND AND TRACE GRAVEL, MOIST, HIGH PLASTICITY.	CL	1.25	Hnu= .6 r α = 1000 βΓ = 0 cpm
113	64049 06/29/91 1100			5.		GRAY (5Y, 5/1) STIFF CLAY WITH SAND AND GRAVEL, MOIST, HIGH PLASTICITY. GRAY (5Y, 5/1) LIMESTONE).	CL	1.5	Hnu= .3 ppm α = 1000 cpm βΓ = 0 cpm
119.	64050 07/01/91 2000			1.		OLIVE GRAY (5Y, 5/2) HARD CLAY WITH SAND AND GRAVEL, DRY, NON PLASTIC.	CL	>4.0	Hnu= .3 ppm α = 800 cpm βΓ = 0 cpm
120.	64051 07/02/91 0155			.5		OLIVE GRAY (5Y, 5/2) HARD CLAY WITH SAND AND GRAVEL, DRY, NON PLASTIC.	CL	>4.0	Hnu= .3 ppm α = 800 cpm βΓ = 0 cpm

BOTTOM OF BORING 120.1

NOTES:
BORINGS SAMPLED CONTINUOUS USING A 5.0 SAMPLER. BORING ANGLE CHECKED EVERY 2 FT. USING A SLOPE INDICATOR.
WATER ENTERED THE SAMPLE FROM A LAYER ABOVE.
THE BOTTOM HALF TENNITE TUBE SPLIT DOWN THE MIDDLE. THE AUGERS WERE USED TO DRILL THIS FIVE FOOT INTERVAL THROUGH THE LIMESTONE SHEET WITHOUT THE SPLIT BARREL SAMPLER.
SAMPLES COMPARED TO MUNSELL COLOR CHART.
* GEOTECHNICAL SAMPLES

SLANT BORING 1617 (No.3) AT K-65 SILOS

Graph #: K65B3L. MAY 06, 1991



MORA_K65B3LL.DRW_ASFND_08-08-91_REV000

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.7	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1617	COORDINATES: NORTH 480,309.37 EAST 1,378,393.37	DATE: 05/04/91
GROUND ELEVATION: 576.2	GWL: Depth N/A Date/Time N/A	DATE STARTED: 04/30/91
ENGINEER/GEOLOGIST: GM, KM	Depth N/A Date/Time N/A	DATE COMPLETED: 05/04/91
DRILLING METHODS: HORIZONTAL DRILL MACHINE WITH 8 1/4 INCH		PAGE 1 OF 2

DEPTH	SAMPLE / DATE / TIME	BLOWS ON	SAMPLE	RECOVERY	INCHES		USCS SYMBOL	TSF	REMARKS
1.5	66976 05/02/91 0920			1.		BROWN (10YR, 4/3) SOFT CLAY WITH SOME ROOT FRAGMENTS, LEAVES, ROOT STEMS, AND WILD ONIONS, DAMP, MEDIUM PLASTICITY.	CL	.5	Hnu= 2.0 ppm α = 700 cpm βΓ = 0 cpm
6.5	66977 05/02/91 1025			3.		LIGHT OLIVE BROWN (2.5Y, 5/4) VERY STIFF CLAY WITH A LITTLE SAND, TRACE ROOT FRAGMENTS, AND FINE GRAVEL, DAMP, LOW PLASTICITY.	CL	3.0	Hnu= 2.0 ppm α = 700 cpm βΓ = 0 cpm
11.5	66978 05/02/91 1105			3.		LIGHT OLIVE BROWN (2.5Y, 5/4) VERY STIFF CLAY WITH SOME SAND & TRACE FINE GRAVEL, TRACE STRONG BROWN (7.5YR, 5/8) WEATHERED STAINING, DAMP, LOW PLASTICITY, OLIVE BROWN (2.5Y, 4/3) STIFF	CL	2.5	Hnu= 2.0 ppm α = 700 cpm βΓ = 0 cpm
16.5	66979 05/02/91 1439			3.		DARK YELLOWISH BROWN (10YR, 4/4) STIFF CLAY, MOIST, MEDIUM PLASTICITY.	CL	2.0	Hnu= 1.0 ppm α = 800 cpm βΓ = 0 cpm
18	66981 66982 66983 66984 05/02/91 1535			3.		YELLOWISH BROWN (10YR, 5/4) STIFF CLAY, DAMP, MEDIUM PLASTICITY.	CL	2.0	Hnu= 1.0 ppm α = 800 cpm
21.5	66980 05/02/91 1535			3.		YELLOWISH BROWN (10YR, 5/4) STIFF CLAY, DAMP, MEDIUM PLASTICITY.	CL	2.0	Hnu= 1.0 ppm α = 800 cpm βΓ = 0 cpm
22	66985* 05/02/91 1715			3.		YELLOWISH BROWN (10YR, 5/4) STIFF CLAY, DAMP, MEDIUM PLASTICITY.	CL	2.0	Hnu= 1.0 ppm α = 800 cpm βΓ = 0 cpm
26.5	66986 05/02/91 1715			3.		YELLOWISH BROWN (10YR, 5/4) STIFF CLAY, DAMP, MEDIUM PLASTICITY.	CL	2.0	Hnu= 1.0 ppm α = 800 cpm βΓ = 0 cpm
31.5	66987 05/02/91 1752			4.		DARK YELLOWISH BROWN (10YR, 4/4) VERY STIFF CLAY, DAMP, LOW PLASTICITY. LIGHT YELLOWISH BROWN (2.5Y, 6/4) MEDIUM CLAYEY FINE SAND WITH LIGHT GRAY (10YR, 7/2) MOTTLING, DAMP, NON PLAS	CL	2.0	Hnu= 1.0 ppm α = 800 cpm βΓ = 0 cpm
36.5	66988 05/03/91 1600			4.		LIGHT OLIVE BROWN (2.5Y, 5/4) LOOSE CLAYEY SAND WITH LIGHT GRAY (2.5Y, 7/2) MOTTLING, MOIST. LIGHT OLIVE BROWN (2.5Y, 5/4) SOFT SANDY, SILTY, CLAY, MOIST, HIGH PLASTICITY.	SC	NA	Hnu= 1.2 ppm α = 700 cpm βΓ = 0 cpm

NOTES:
BORINGS SAMPLED CONTINUOUS USING A 5.0 SAMPLER. BORING ANGLE CHECKED EVERY 2 FT. USING A SLOPE INDICATOR.
SAMPLES COMPARED TO MUNSELL COLOR CHART.
* GEOTECHNICAL SAMPLES

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.7	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1617	COORDINATES: NORTH 480,309.37 EAST 1,378,393.37	DATE: 05/04/91
GROUND ELEVATION: 576.2	GWL: Depth N/A Date/Time N/A	DATE STARTED: 04/30/91
ENGINEER/GEOLOGIST: GM, KM	Depth N/A Date/Time N/A	DATE COMPLETED: 05/04/91
DRILLING METHODS: HORIZONTAL DRILL MACHINE WITH 8 1/4 INCH		PAGE 2 OF 2

DEPTH	SAMPLE	DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
40.2	66990 66991 66992 66993 05/03/91 1702			3.	LIGHT YELLOWISH BROWN (2.5Y, 6/4) LOOSE CLAYEY SAND AND CLAY WITH LIGHT GRAY (2.5Y, 7/1) MOTTLING, YELLOWISH BROWN (10YR, 5/8) TO LIGHT OLIVE (2.5Y, 5/6) MEDIUM STIFF SANDY CLAY WITH W	SC	NA	Hnu= 1.2 ppm α = 700 cpm βΓ = 0 cpm
41.5	66989 05/03/91 1702			3.	LIGHT YELLOWISH BROWN (2.5Y, 6/4) LOOSE CLAYEY SAND AND CLAY WITH LIGHT GRAY (2.5Y, 7/1) MOTTLING, YELLOWISH BROWN (10YR, 5/8) TO LIGHT OLIVE (2.5Y, 5/6) MEDIUM STIFF SANDY CLAY WITH W	SC	NA	Hnu= 1.2 ppm α = 700 cpm βΓ = 0 cpm
42.5	66994 05/04/91 0900			4.	LIGHT OLIVE BROWN (2.5Y, 5/4) LOOSE CLAYEY SAND WITH TRACE WEATHERED BLACK ORGANICS, WET.	SC	NA	Hnu= 2.0 ppm α = 600 cpm βΓ = 0 cpm
46.5	66995 05/04/91 0900			4.	LIGHT OLIVE BROWN (2.5Y, 5/4) LOOSE CLAYEY SAND WITH TRACE WEATHERED BLACK ORGANICS, WET.	SC	NA	Hnu= 2.0 ppm α = 600 cpm βΓ = 0 cpm
51.5	66996 05/04/91 0952			4.	LIGHT OLIVE BROWN (2.5Y, 5/4) LOOSE CLAYEY SAND, SATURATED.	SC	NA	Hnu= 2.0 α = 600 βΓ = 0 cpm
56.5	66997 05/04/91 1030			5.	LIGHT YELLOWISH BROWN (2.5Y, 6/4) VERY LOOSE CLAYEY SAND, SATURATED.	SC	NA	Hnu= 2.0 ppm α = 600 cpm βΓ = 0 cpm
59.7	66998 05/04/91 1423			3.	LIGHT OLIVE BROWN (2.5Y, 5/6) LOOSE CLAYEY SAND WITH SOME GRAVEL AND LIMESTONE COBBLES, MOIST TO DAMP.	SC	NA	
61.0	66999 05/04/91 1423			3.	LIGHT OLIVE BROWN (2.5Y, 5/6) LOOSE CLAYEY SAND WITH SOME GRAVEL AND LIMESTONE COBBLES, MOIST TO DAMP.	SC	NA	
68.5	64005 05/04/91 1620			4.	LIGHT OLIVE BROWN (2.5Y, 5/4) CLAY, LOOSE SAND, AND GRAVEL MIXTURE, TRACE LIMESTONE COBBLES, SATURATED, LIGHT BROWNISH GRAY (2.5Y, 6/2) MEDIUM DENSE CLAYEY SAND WITH SOME GRAVEL.	GC	NA	Hnu= 1.3 ppm α = 800 cpm βΓ = 0 cpm

BOTTOM OF BORING 68.5

NOTES:
SAMPLES COMPARED TO MUNSELL COLOR CHART.
* GEOTECHNICAL SAMPLES
THE HOLE WAS STRAPPED AT 63.5 FT. CORRECTED STARTING DEPTH FROM 56.5 TO 58.5 FT.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 2032	COORDINATES: NORTH 480,503.68 EAST 1,378,298.59	DATE: 02/06/90
GROUND ELEVATION: 568.8	GWL: Depth N/A Date/Time N/A	DATE STARTED: 02/06/90
ENGINEER/GEOLOGIST: MIKE SWANSON	Depth N/A Date/Time N/A	DATE COMPLETED: 02/13/90
DRILLING METHODS: CABLE-TOOL		PAGE 1 OF 3

DEPTH	SAMPLE	DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
1.5	032451	02/06/90 1310	3 5 6	7	TOPSOIL, VERY DARK BROWN (10 YR 2/2) SILT, PEBBLES, SLIGHT PLASTICITY, SLIGHTLY MOIST. HARD, GRAY - DARK GRAY (10 YR 5/1;7.5 Y 4/0) SILTY CLAY, TRACE OF SAND, LOW PLASTICITY, DRY TO SLIGHTLY MOIST.	ML CL	2.0 3.0	Hnu= .1 ppm α = 0 cpm βΓ = 400-500cpm
3.0	032452	02/06/90 1316	2 2 3	2	HARD, GRAY-DARK GRAY (10 YR 5/1;7.5 Y 4/0) SILTY CLAY, TRACE OF SAND, LOW PLASTICITY, DRY TO SLIGHTLY MOIST.	CL	3.0	Hnu= .1 ppm α = 0 cpm βΓ = 400-500cpm
4.5	032453	02/06/90 1321	3 6 5	7	HARD, YELLOWISH BROWN (10 YR 5/6) SILTY CLAY, TRACE OF SAND, LOW PLASTICITY, SLIGHTLY MOIST.	CL	2.5	Hnu= .1 ppm α = 0 cpm βΓ = 300-400cpm
6.0	032454	02/06/90 1324	5 8 11	11	MEDIUM DENSE, GRAVELLY WELL GRADED SAND, BROWNISH YELLOW (10 YR 6/6), SOME CLAY, TRACE OF SILT, SUBANGULAR GRAVELS AND SAND	SW	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 300-600cpm
7.5	032455	02/06/90 1329	10 11 8	10	MEDIUM DENSE, GRAVELLY WELL GRADED SAND, BROWNISH YELLOW (10 YR 6/6), SOME CLAY, TRACE OF SILT, SUBANGULAR GRAVELS AND SAND H R	SW CL	N/A 3.5	Hnu= 0 ppm α = 0 cpm βΓ = 400-600cpm
9.0	032456	02/06/90 1335	8 8 8	13	VERY SOFT, LIGHT OLIVE BROWN (2.5 Y 5/6) SANDY SILT, SOME CLAY, WET.	ML	<.25	Hnu= 0 ppm α = 0 cpm βΓ = 400-600cpm
10.5	032457	02/06/90 1454	3 5 6	8	FIRM; LIGHT OLIVE BROWN (2.5 Y 5/6) SANDY, CLAYEY SILT, SLIGHT PLASTICITY, SLIGHTLY MOIST TO MOIST.	ML	1.0	Hnu= 0 ppm α = 0 cpm βΓ = 400-500cpm
12.0	032458	02/06/90 1501	6 6 11	9	FIRM, LIGHT OLIVE BROWN (2.5 Y 5/6) SANDY, CLAYEY SILT, SLIGHT PLASTICITY, SLIGHTLY MOIST TO MOIST. HARD, GRAY (5 Y 5/1) SILTY CLAY, TRACE OF SAND, LOW PLASTICITY, SLIGHTLY MOIST.	ML CL	1.0 2.5	Hnu= .1 ppm α = 0 cpm βΓ = 300-500cpm

NOTES:
ALL SAMPLES IN ACCORDANCE WITH ASTM STANDARD PENETRATION TEST. MUNSELL COLOR CHART USED FOR SOIL SAMPLE COLOR DESCRIPTION.

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1032	COORDINATES: NORTH 480,515.31 EAST 1,378,296.81	DATE: 10/30/87
GROUND ELEVATION: 569.3	GWL: Depth N/A Date/Time N/A	DATE STARTED: 10/30/87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth N/A Date/Time N/A	DATE COMPLETED: 10/31/87
DRILLING METHODS: CABLE-TOOL		PAGE 1 OF 2

DEPTH	SAMPLE	DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
1.5	007494	10/30/87 0740	4 3 3	14	MEDIUM STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) SILT, SOME CLAY, TRACE SAND AND GRAVEL. OLIVE GRAY (5Y, 5/2) CLAY, SOME SILT, TRACE SAND AND GRAVEL - DRY.	ML CL	3.0 1.5	Hnu= 0 ppm α = 0 cpm βΓ = 80 cpm
3.0	007495	10/30/87 0800	3 4 4	12	MEDIUM STIFF OLIVE (5Y, 5/3) CLAY, SOME SILT, TRACE GRAVEL AND SAND - DRY. LIGHT YELLOWISH BROWN (2.5Y, 6/4) SILT, SOME SAND AND CLAY - DRY.	CL ML	1.5 1.5	Hnu= 0 ppm α = 0 cpm βΓ = 70 cpm
4.5	007496	10/30/87 815	3 4 4	10	MEDIUM STIFF YELLOWISH BROWN (10YR, 5/4) CLAY AND SILT, TRACE SAND AND GRAVEL - DRY. DARK BROWN (10YR, 3/3) SILT, SOME CLAY, TRACE SAND AND GRAVEL DRY.	CL ML	3.5 N/A	Hnu= 0 ppm α = 0 cpm βΓ = 70 cpm
6.0	007497	10/30/87 825	8 8 11	14	VERY STIFF YELLOWISH BROWN (10YR, 5/4) CLAY, SOME SILT, TRACE SAND AND GRAVEL - DRY. VERY STIFF BROWNISH YELLOW (10YR, 6/6) SILT, TRACE SAND AND CLAY AND GRAVEL - DRY.	CL ML	3.5 1.5	Hnu= 0 ppm α = 0 cpm βΓ = 70 cpm
7.5	007498	10/30/87 830	9 7 11	14	VERY STIFF BROWNISH YELLOW (10YR, 6/8) SILT, SOME GRAVEL AND SAND, TRACE CLAY - DRY.	ML	1.5	Hnu= 0 ppm α = 0 cpm βΓ = 80 cpm
9.0	007499	10/30/87 1010	13 14 17	12	MEDIUM DENSE BROWNISH YELLOW (10YR, 6/8) GRAVEL, SOME SAND AND SILT - DRY.	GM	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 60 cpm
10.5	007500	10/30/87 1030	8 7 10	10	BROWNISH YELLOW GRAVEL (10YR, 6/8), SOME SAND AND SILT. VERY STIFF YELLOWISH BROWN (10YR, 5/4) CLAY, TRACE SILT AND SAND - MOIST.	CL	4.5	Hnu= 0 ppm α = 0 cpm βΓ = 70 cpm
12.0	007501	10/30/87 1040	3 5 7	14	MEDIUM DENSE LIGHT YELLOWISH BROWN (2.5YR, 6/4) GRAVEL, SOME CLAY, TRACE SAND AND SILT - MOIST. STIFF YELLOWISH BROWN (10YR, 5/4) CLAY, SOME SILT, TRACE SAND - MOIST.	GC CL	N/A 2.5	Hnu= 0 ppm α = 0 cpm βΓ = 80 cpm
13.5	007502	10/30/87 1100	1 2 2	8	SOFT BROWN (10YR, 5/3) CLAY, SOME SAND, TRACE GRAVEL AND SILT - WET.	CH	.25	Hnu= 0 ppm α = 0 cpm βΓ = 70

NOTES:
SAMPLES TAKEN USING ASTM STANDARD PENETRATION TEST. COLORS CLASSIFIED USING MUNSELL COLOR CHARTS.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1032	COORDINATES: NORTH 480,515.31 EAST 1,378,296.81	DATE: 10/30/87
GROUND ELEVATION: 569.3	GWL: Depth N/A Date/Time N/A	DATE STARTED: 10/30/87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth N/A Date/Time N/A	DATE COMPLETED: 10/31/87
DRILLING METHODS: CABLE-TOOL		PAGE 2 OF 2

DEPTH	SAMPLE	DATE TIME	BLOWS ON SAMPLE	RECOVERY		USCS SYMBOL	TSF	REMARKS
15.0	007503	10/30/87 1110	5 11 14	5	VERY STIFF BROWN CLAY (10YR, 5/3) SOME GRAVEL, TRACE SAND AND SILT - DRY.	CH	.25	Hnu= 0 ppm α = 0 cpm βΓ = 70 cpm
15.5	007506	10/30/87 1300			HARD OLIVE GRAY (5Y, 5/2) CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST.	CL	4.25	Hnu= 0 ppm α = 0 cpm βΓ = 60-80 cpm
16.5	007504	10/30/87 1330	5 11 18	13	VERY STIFF OLIVE GRAY (5Y, 5/2) CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST.	CL	4.25	Hnu= 0 ppm α = 0 cpm βΓ = 60-80 cpm
18.0	007505	10/30/87 1400	9 12 42	12	HARD OLIVE GRAY (5Y, 5/2) CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST.	CL	4.25	Hnu= 0 ppm α = 0 cpm βΓ = 60-80 cpm
19.5	007507	10/30/87 1[illegible]	11 13 15	11	HARD OLIVE GRAY (5Y, 5/2) CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST. VERY STIFF YELLOWISH RED (5YR, 5/8) CLAY, SOME SAND, GRAVEL, AND SILT - DRY.	CL CL	4.25 4.00	Hnu= 0 ppm α = 0 cpm βΓ = 60 cpm
21.0	007508	10/30/87 1600	11 11 15	14	BROWNISH YELLOW (10YR, 6/8) SILT, SOME SAND - DRY. MEDIUM DENSE YELLOWISH BROWN (10YR, 5/6) FINE SAND, TRACE SILT AND CLAY - DRY. BROWNISH YELLOW (10YR, 6/8) SILT, SOME SAND - DRY.	ML SP ML	.20 N/A .2	Hnu= 0 ppm α = 0 cpm βΓ = 80 cpm
22.5	007509	10/30/87 1625	8 11 17	12	BROWNISH YELLOW (10YR, 6/8) SILT, SOME SAND - DRY. MEDIUM DENSE YELLOWISH BROWN (10YR, 5/6) FINE SAND - DRY.	ML SP	.20 N/A	Hnu= 0 ppm α = 5 cpm βΓ = 80 cpm
24.0	007510	10/30/87 1635	12 14 18	14	ME JM DENSE YELLOWISH BROWN (10YR, 5/6) FINE SAND - DRY.	SP	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 60 cpm

BOTTOM OF BORING 24.0

NOTES:
SAMPLES TAKEN USING ASTM STANDARD PENETRATION TEST. COLORS CLASSIFIED USING MUNSELL COLOR CHARTS.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 2032	COORDINATES: NORTH 480,503.68 EAST 1,378,298.59	DATE: 02/06/90
GROUND ELEVATION: 568.8	GWL: Depth N/A Date/Time N/A	DATE STARTED: 02/06/90
ENGINEER/GEOLOGIST: MIKE SWANSON	Depth N/A Date/Time N/A	DATE COMPLETED: 02/13/90
DRILLING METHODS: CABLE-TOOL		PAGE 2 OF 3

DEPTH	SAMPLE / DATE / TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
13.5	032459 02/06/90 1513	2 5 10	5	HARD, GRAY (5 Y, 5/1) SILTY CLAY, TRACE OF SAND, LOW PLASTICITY, SLIGHTLY MOIST.	CL	2.5	Hnu= .1 ppm α = 0 cpm βΓ = 400-600cpm
15.0	032460 02/06/90 1519	12 5 15	8	HARD, GRAY (5 Y 5/1) SILTY CLAY, SOME PEBBLES AND GRAVEL, TRACE OF SAND, PEBBLES AND GRAVEL, ABOUT 3.5 IN., LOW PLASTICI	CL	3.0	Hnu= 0 ppm α = 0 cpm βΓ = 400-500cpm
16.5	032461 02/06/90 1553	25 16 16	7	HARD, OLIVE GRAY (2.5 Y 4/2), SILTY CLAY, COBBLE, SOME SAND AND PEBBLES, LOW PLASTICITY, TOP 3 IN MOIST, BOTTOM 4 IN, SLIG	CL	2.0	Hnu= 0 ppm α = 0 cpm βΓ = 300-400cpm
18.0	032462 02/06/90 1601	25 36 40	16	VERY HARD, DARK GRAY (2.5 Y 4/1) SILTY CLAY, TRACE OF SAND, PEBBLES, ONE COBBLE, LOW PLASTICITY, DRY TO SLIGHTLY MOIST.	CL	>4	Hnu= 0 pt α = 0 cpm βΓ = 200-400cpm
19.5	032463 02/07/90 1053	28 21 30	9	HARD, GRAY (5 Y 5/1) SILTY CLAY, TRACE OF SAND, COBBLES (QUARTZ), LOW PLASTICITY, SLIGHTLY MOIST.	CL	2.75	Hnu= .1 ppm α = 0 cpm βΓ = 600-800cpm
22.5	032464 02/07/90 1412	12 13 19	13	DENSE, BROWNISH YELLOW TO YELLOWISH BROWN (10 YR 6/8 TO 5/8), FINE, POORLY GRADED SAND, DRY.	SP	N/A	Hnu= .1 ppm α = 0 cpm βΓ = 300-400cpm
25.0							
26.5	032465 02/07/90 1439	8 7 11	12	MEDIUM DENSE, BROWNISH YELLOW TO YELLOWISH BROWN (10 YR 6/6 TO 5/8) POORLY GRADED SAND, DRY.	SP	N/A	Hnu= .1 ppm α = 0 cpm βΓ = 400 cpm
31.5	032466 02/07/90 1602	3 15 25	10	DENSE, LIGHT YELLOWISH BROWN (10 YR 6/4), WITH 3 IN. LAYER OF BLACK AND WHITE SAND, SAND MEDIUM TO WELL GRADED, TRACE OF PEB	SW	N/A	Hnu= .1 ppm α = 0 cpm βΓ = 350-450cpm

NOTES:
ALL SAMPLES IN ACCORDANCE WITH ASTM STANDARD PENETRATION TEST. MUNSELL COLOR CHART USED FOR SOIL SAMPLE COLOR DESCRIPTION.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 2032	COORDINATES: NORTH 480,503.68 EAST 1,378,298.59	DATE: 02/06/90
GROUND ELEVATION: 568.8	GWL: Depth N/A Date/Time N/A	DATE STARTED: 02/06/90
ENGINEER/GEOLOGIST: MIKE SWANSON	Depth N/A Date/Time N/A	DATE COMPLETED: 02/13/90
DRILLING METHODS: CABLE-TOOL		PAGE 3 OF 3

DEPTH	SAMPLE	DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
36.5	032467	02/13/90 0916	13 27 50	9	VERY DENSE, YELLOWISH BROWN (10 YR 5/6) WELL GRADED SAND, SOME PEBBLES (.2 IN) TRACE OF SILT, CLAY; ROUNDED TO SUBANGULAR, DR	SW	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 350-450cpm
41.5	032468	02/13/90 0946	11 18 23	3	DENSE, OLIVE YELLOW (2.5 Y 6/6) POORLY GRADED FINE GRAINED SAND, DRY TO SLIGHTLY MOIST.	SP	N/A	Hnu= .1 ppm α = 0 cpm βΓ = 300-400cpm
46.5	032469	02/13/90 1114	10 15 23	8	DENSE, DARK YELLOWISH BROWN (10 YR 4/6) WELL GRADED SAND, SOME PEBBLES, SUBROUNDED; TRACE OF GRAVEL (APPROXIMATELY .25 - .5 I	SW	N/A	Hnu= 0.0 ppm α = 0 cpm βΓ = 300-400cpm
51.5	032470	02/13/90 1354	7 9 13	5	MEDIUM DENSE, DARK BROWN (10 YR 3/3) WELL GRADED SANDY GRAVEL (.25 - .4 IN) SUBANGULAR TO SUBROUNDED, WET.	GW	N/A	Hnu= 0.0 ppm α = 0 cpm βΓ = 200-400cpm
56.5	032471	02/13/90 1423	5 5 8	6	MEDIUM DENSE, DARK BROWN (10 YR 3/3) GRAVELLY SAND, WELL GRADED, SUBANGULAR TO ROUNDED, WET.	SW	N/A	Hnu= 0.1 ppm α = 0 cpm βΓ = 250-300cpm
61.5	032472	02/13/90 1537	2 3 6	7	LOOSE, LIGHT YELLOWISH BROWN (10 YR 6/4) WELL GRADED GRAVELLY SAND, (APPROXIMATELY .25 - .5 IN) ANGULAR TO ROUNDED, WET.	SW	N/A	Hnu= 0.1 ppm α = 0 cpm βΓ = 400-500cpm
66.5	032473	02/13/90 1621	5 8 12	6	MEDIUM DENSE, DARK BROWN (10 YR 3/3) (WITH BLACK AND WHITE PARTICLES) GRAVELLY SAND, SOME COBBLES (.5 IN - .75 IN) TRACE	SW	N/A	Hnu= 0.0 ppm α = 0 cpm βΓ = 300-450cpm

BOTTOM OF BORING 65.0

NOTES:
ALL SAMPLES IN ACCORDANCE WITH ASTM STANDARD PENETRATION TEST. MUNSELL COLOR CHART USED FOR SOIL SAMPLE COLOR DESCRIPTION.

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 3032	COORDINATES: NORTH 480,492.78 EAST 1,378,296.62	DATE: 09/21/90
GROUND ELEVATION: 569.1	GWL: Depth N/A Date/Time N/A	DATE STARTED: 09/21/90
ENGINEER/GEOLOGIST: M. GARMAN	Depth N/A Date/Time N/A	DATE COMPLETED: 09/24/90
DRILLING METHODS: CABLE-TOOL		PAGE 1 OF 2

DEPTH	SAMPLE	DATE TIME	BLOWS ON	SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
71.5	033078	09/21/90 1518	10 21 17		17	DENSE (10 YR 4/3) BROWN GRAVELY WELL GRADED SAND, SOME SILT, WET.	SW	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 900 cpm
76.5	033079	09/21/90 1533	17 15 15		14	MEDIUM DENSE (10 YR 3/3) VERY DARK BROWN WELL GRADED SAND, SOME GRAVEL (FINE), TRACE SILT, WET.	SW	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 1000 cpm
81.5	033080	09/21/90 1600	50		5	VERY DENSE (10 YR 4/3) BROWN FINE TO MEDIUM GRAINED SILTY SAND, WET.	SM	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 1000 cpm
86.5	033081	09/23/90 0924	18 22 31		18	VERY DENSE (10 YR 4/2) DARK GRAYISH BROWN WELL GRADED SAND, SOME SILT, WET. (85.0 - 85.9). VERY DENSE (10 YR 4/2) DARK GRAYISH BROWN SILTY FINE TO MEDIUM GRAINED SAND, WET. (85.9 - 86.5).	SW SM	N/A N/A	Hnu= 0 pc α = 0 cpm βΓ = 1000 cpm
91.5	033082	09/23/90 1007	9 10 14		11	MEDIUM DENSE (10 YR 4/2) DARK GRAYISH BROWN SILTY, SANDY FINE GRAVEL, WET.	GM	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 800 cpm
96.5	033083	09/23/90 1419	10 17 15		18	DENSE (10 YR 3/2) VERY DARK GRAYISH BROWN SILTY WELL GRADED SAND, SOME FINE GRAVEL, WET.	SM	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 900 cpm
101.5	033084	09/23/90 1442	7 8 18		14	MEDIUM DENSE (10 YR 4/3) DARK BROWN WELL GRADED SAND, SOME SILT, TRACE FINE GRAVEL, WET.	SW	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 800 cpm
106.5	033085	09/23/90 1626	11 13 11		18	MEDIUM DENSE (10 YR 4/3) DARK BROWN WELL GRADED SAND, TRACE SILT, WET.	SW	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 900 cpm
111.5	033086	09/24/90 0929	12 10 6		18	MEDIUM DENSE (10 YR 5/2) GRAYISH BROWN WELL GRADED SAND, TRACE FINE GRAVEL, TRACE SILT, WET.	SW	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 800 r

NOTES: SAMPLES COMPARED TO MUNSELL COLOR CHART

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 3032	COORDINATES: NORTH 480,492.78 EAST 1,378,296.62	DATE: 09/21/90
GROUND ELEVATION: 569.1	GWL: Depth N/A Date/Time N/A	DATE STARTED: 09/21/90
ENGINEER/GEOLOGIST: M. GARMAN	Depth N/A Date/Time N/A	DATE COMPLETED: 09/24/90
DRILLING METHODS: CABLE-TOOL		PAGE 2 OF 2

DEPTH	SAMPLE	DATE TIME	BLOWS ON	SAMPLE	RECOVERY	INCHES		USCS	SYMBOL	TSF	REMARKS
116.5	033087	09/24/90 1040	14 50		18		VERY DENSE (10 YR 5/2) GRAYISH BROWN WELL GRADED SAND, SOME FINE GRAVEL, TRACE SILT, WET.	SW		N/A	Hnu= 0 ppm α = 0 cpm βΓ = 800 cpm
121.5	033088	09/24/90 1345	11 24 25		15		HARD (5 Y 4/1) DARK GRAY SILTY CLAY, TRACE FINE SAND, SLIGHTLY MOIST TO MOIST, MEDIUM TO HIGH PLASTICITY.	CL		2.25	Hnu= 0 ppm α = 0 cpm βΓ = 800 cpm
123.1	033089	09/24/90 1545			19		HARD (5 Y 4/1) DARK GRAY SILTY CLAY, TRACE FINE SAND, HIGH PLASTICITY, SLIGHTLY MOIST. * SHELBY TUBE SAMPLE 121.5 - 123.1.	CL		2.5	Hnu= 0 ppm α = 0 cpm βΓ = 800 cpm

BOTTOM OF BORING 123.1

NOTES: SAMPLES COMPARED TO MUNSELL COLOR CHART

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1033	COORDINATES: NORTH 480,412.89 EAST 1,378,675.14	DATE: 04/08/88
GROUND ELEVATION: 577.0	GWL: Depth N/A Date/Time N/A	DATE STARTED: 04/08/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 04/10/88
DRILLING METHODS: CABLE-TOOL		PAGE 1 OF 2

DEPTH	SAMPLE	DATE TIME	BLOWS ON	SAMPLE	RECOVERY		USCS SYMBOL	TSF	REMARKS
1.5	008853	04/08/88 1450	3 4 6		18	STIFF DARK YELLOWISH BROWN CLAY (10YR, 4/6), DRY.	CL	1.5	Hnu= 0 ppm α = 0 cpm βΓ = 600 cpm
3.0	008854	04/08/88 1455	9 7 11		12	STIFF YELLOWISH BROWN CLAY (10YR, 5/8) DRY.	CL	1.5	Hnu= 0 ppm α = 0 cpm βΓ = 600 cpm
4.5	008855	04/08/88 1530	10 11 14		18	VERY STIFF YELLOWISH BROWN CLAY (10YR, 5/8), TRACE SILT.	ML	2.5	Hnu= 0 ppm α = 0 cpm βΓ = 600 cpm
6.0	008856	04/08/88 1540	10 10 10		18	VERY STIFF YELLOWISH BROWN CLAY (10YR, 5/8), VERY SILTY MOIST.	ML	2.5	Hnu= 0 α = 0 cpm βΓ = 600 cpm
7.5	008857	04/09/88 1015			18	SHELBY TUBE.			
9.0	008858	04/09/88 1030	1 1 1		12	SOFT OLIVE GRAY CLAY (5Y, 5/2) DRY, HIGH PLASTICITY.	CL	<1	Hnu= 0 ppm α = 0 cpm βΓ = 600 cpm
10.5	008859	04/09/88 1035	1 2 2		18	SOFT OLIVE GRAY SILTY CLAY (5Y, 5/2) DRY, PLASTIC.	CL	<1	Hnu= 0 ppm α = 0 cpm βΓ = 600 cpm
12.0	008860	04/09/88 1040	4 5 3		18	SOFT GRAY SILTY CLAY (5Y, 5/1) TRACE SAND, MOIST, WET. MEDIUM DENSE GRAY SILTY SAND (5Y, 5/1) WET.	CL SM	<1 <1	Hnu= 0 ppm α = 0 cpm βΓ = 600 cpm

NOTES:
COLOR VIA MUNSELL COLOR CHART.

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1033	COORDINATES: NORTH 480,412.89 EAST 1,378,675.14	DATE: 04/08/88
GROUND ELEVATION: 577.0	GWL: Depth N/A Date/Time N/A	DATE STARTED: 04/08/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 04/10/88
DRILLING METHODS: CABLE-TOOL		PAGE 2 OF 2

DEPTH	SAMPLE	DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
13.5	008861	04/09/88 1355	4 7 7	12	MEDIUM DENSE GRAY SILTY SAND (5Y, 5/1), WET.	SM	<1	Hnu= 0 ppm α = 0 cpm βΓ = 450 cpm
15.0	008862	04/09/88 1400	12 10 11	14	MEDIUM DENSE GRAY SILTY SAND (5Y, 5/1) WET, TRACE GRAVEL.	SM	<1	Hnu= 0 ppm α = 0 cpm βΓ = 400 cpm
16.5	008863	04/09/88 1440	5 5 6	10	MEDIUM DENSE GRAY SILTY SAND (5Y, 5/1) WET, TRACE GRAVEL. MEDIUM STIFF DARK GRAY SANDY CLAY (5Y, 5/1) WET, TRACE GRAVEL.	SM CL	<1 <1	Hnu= 0 ppm α = 0 cpm βΓ = 400 cpm
18.0	008864	04/09/88 1530	6 9 11	8	STIFF DARK GRAY CLAY (5Y, 5/1) TRACE GRAVEL, MOIST.	CL	1.5	Hnu= 0 ppm α = 0 cpm βΓ = 400 cpm
19.5	008865	04/09/88 1535	7 9 6	12	MEDIUM DENSE SANDY SILT WITH TRACE OF GRAVEL (5Y, 5/1), MOIST.	SM	<1	Hnu= 0 ppm α = 0 cpm βΓ = 380 cpm
21.0	008866	04/09/88 1630	6 6 8	12	STIFF DARK GRAY CLAY (5Y, 5/1), TRACE OF GRAVEL - DRY.	CL	2.0	Hnu= 0 ppm α = 0 cpm βΓ = 380 cpm

BOTTOM OF BORING 21

NOTES:
COLOR VIA MUNSELL COLOR CHART.

VISUAL CLASS CATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 2033	COORDINATES: NORTH 480,411.10 EAST 1,378,687.33	DATE: 05/31/90
GROUND ELEVATION: 577.0	GWL: Depth N/A Date/Time N/A	DATE STARTED: 05/31/90
ENGINEER/GEOLOGIST: C. GRUBE	Depth N/A Date/Time N/A	DATE COMPLETED: 06/12/90
DRILLING METHODS: CABLE-TOOL		PAGE 1 OF 2

DEPTH	SAMPLE	DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
22.5	032759	05/31/90 1535	7 14 15	5	HARD (5 Y 4/1) DARK GRAY SANDY CLAY, TRACE OF FINE TO ARSE GRAVEL, LOW PLASTICITY, MOIST.	CL	2.0	Hnu= 0.2 ppm α = 0 cpm βΓ = 220-240cpm
24.0	032760	05/31/90 1600	5 7 9	6	FIRM (5 Y 4/1) DARK GRAY SILTY CLAY, TRACE OF SAND AND FINE TO MEDIUM GRAVEL, MEDIUM PLASTICITY, MOIST.	CL	1.75	Hnu= 0.2 ppm α = 0 cpm βΓ = 190-200cpm
25.5	032761	06/05/90 1035	10 50 32	6	FIRM (5 Y 4/1) DARK GRAY SILTY CLAY, SOME SAND, TRACE OF FINE TO COARSE GRAVEL, LOW PLASTICITY, VERY MOIST.	CL	.75	Hnu= 1.0 ppm α = 0 cpm βΓ = 190-200cpm
27.0	032762	06/05/90 1100	32 27 30	9	VERY HARD (5 Y 4/1) DARK GRAY SILTY CLAY, TRACE OF SAND, TRACE OF FINE TO MEDIUM GRAVEL, MEDIUM PLASTICITY, MOIST.	CL	4.5	Hnu= 1.0 p α = 0 cpm βΓ = 200-220cpm
28.5	032763	06/05/90 1108	6 15 22	6	VERY HARD (5 Y 4/1) DARK GRAY SILTY CLAY, TRACE OF SAND, TRACE OF FINE TO COARSE GRAVEL, LOW PLASTICITY, MOIST.	CL	>4.5	Hnu= 1.0 ppm α = 0 cpm βΓ = 220-240cpm
30.0	032764	06/05/90 1400	4 12 18	7	FIRM (5 Y 4/1) DARK GRAY SAND CLAY, TRACE OF FINE TO COARSE GRAVEL, LOW PLASTICITY, MOIST.	CL	1.0	Hnu= 1.2 ppm α = 0 cpm βΓ = 230-240cpm
36.5	032765	06/05/90 1435	10 14 18	12	DENSE (10 YR 5/4) YELLOWISH BROWN WELL TO POORLY GRADED SAND, TRACE OF SILT AND FINE TO MEDIUM GRAVEL, MOIST.	SW	N/A	Hnu= 1.0 ppm α = 0 cpm βΓ = 200-220cpm
40.5	032766	06/05/90 1455	15 45 45	18	VERY DENSE (2.5 Y 5/4) LIGHT OLIVE BROWN TO (2.5 Y 6/4) LIGHT YELLOWISH BROWN POORLY GRADED TO SILTY SAND, TRACE OF FINE GRA	SP	N/A	Hnu= 1.0 ppm α = 0 cpm βΓ = 180-200cpm
46.5	032767	06/05/90 1600	35 50	10	VERY DENSE (2.5 Y 6/4) LIGHT YELLOWISH BROWN SILTY TO GRAVELLY WELL GRADED SAND, DRY TO SLIGHTLY MOIST.	SM	N/A	Hnu= 0.6 ppm α = 0 cpm βΓ = 220-230c

NOTES:
SAMPLES COLLECTED PER ASTM STANDARD PENETRATION TEST - MUNSELL COLOR CHART USED FOR SAMPLE COLOR IDENTIFICATION.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 2033	COORDINATES: NORTH 480,411.10 EAST 1,378,687.33	DATE: 05/31/90
GROUND ELEVATION: 577.0	GWL: Depth N/A Date/Time N/A	DATE STARTED: 05/31/90
ENGINEER/GEOLOGIST: C. GRUBE	Depth N/A Date/Time N/A	DATE COMPLETED: 06/12/90
DRILLING METHODS: CABLE-TOOL		PAGE 2 OF 2

DEPTH	SAMPLE	DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
51.5	032768	06/07/90 0955	18 25 45	12	VERY DENSE (10 YR 5/4) YELLOWISH BROWN, WELL TO POORLY GRADED SAND, TRACE OF FINE TO MEDIUM GRAVEL, VERY MOIST.	SW	N/A	Hnu= 0.2 ppm α = 0 cpm βΓ = 200-220cpm
56.5	032769	06/07/90 1100	3 8 20	8	MEDIUM DENSE (10 YR 4/4) DARK YELLOWISH BROWN POORLY GRADED SAND, TRACE OF SILT AND FINE GRAVEL, WET.	SP	N/A	Hnu= 0.2 ppm α = 0 cpm βΓ = 180-200cpm
61.5	032770	06/12/90 1015	6 9 15	11	MEDIUM DENSE (10 YR 5/4) YELLOWISH BROWN SILTY TO POORLY GRADED SAND, TRACE OF FINE GRAVEL, WET.	SM	N/A	Hnu= 0.4 ppm α = 0 cpm βΓ = 200-220cpm
66.5	032771	06/12/90 1120	20 50	14	VERY DENSE (2.5 Y 5/4) LIGHT OLIVE BROWN POORLY TO WELL GRADED SAND, TRACE OF FINE TO MEDIUM GRAVEL WET.	SP	N/A	Hnu= 0.2 ppm α = 0 cpm βΓ = 160-170cpm
71.5	032772 033078	06/12/90 1518	10 21 17	17	DENSE (10 YR 4/3) BROWN GRAVELLY WELL GRADED SAND, SOME SILT, WET.	SW	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 900 cpm

BOTTOM OF BORING 70

NOTES:
SAMPLES COLLECTED PER ASTM STANDARD PENETRATION TEST - MUNSELL COLOR CHART USED FOR SAMPLE COLOR IDENTIFICATION.

APPENDIX C

WATER LEVEL ELEVATIONS

JANUARY 1996 OU-4 WATER ELEVATIONS

Boring Number	Ground Elevation	Water Elevation
1034	569.2	568.73
2034	569.7	521.79
3034	569.9	521.74
1029	577.3	564.50
1032	569.3	562.99
2032	568.8	522.18
3032	569.1	522.19
1891	571.4	567.94
1892	573.5	566.57
1033	577.0	576.00
1893	575.5	570.00
12061	578.9	570
12062	575.2	566
12063	580.2	574
12064	577.1	576.1
12065	577.6	574.1
12066	577.4	568.4
12067	577.8	574.8

Notes: 1. Water elevations in borings 12061, 12062, and 12063 were inferred from boring logs; other water elevations were directly measured.

2. Water level measurements at borings 12064, 12065, 12066, and 12067 were taken immediately upon completion of drilling.

APPENDIX D

COMPACTION CURVES

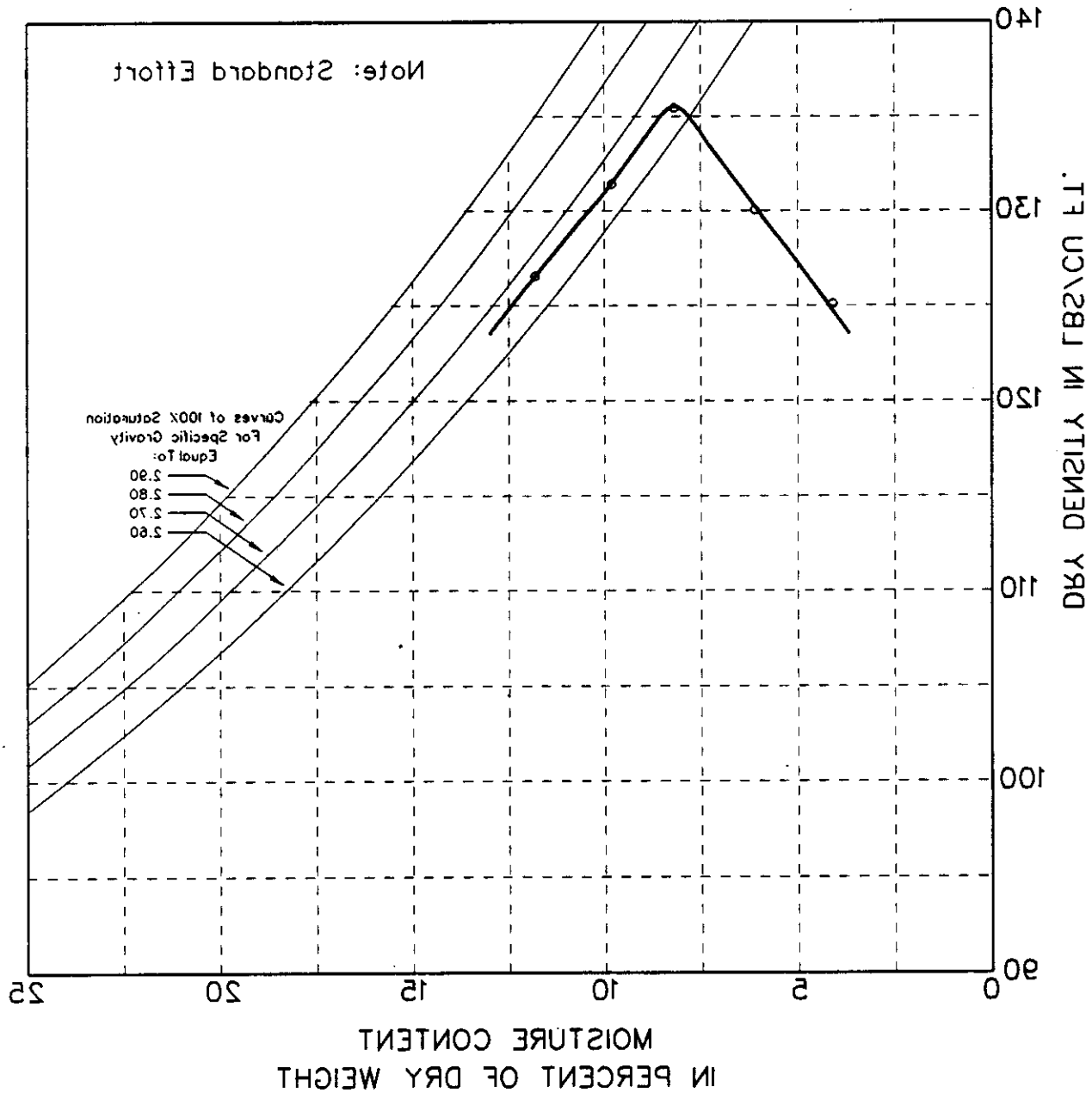
Boring: 12060 Sample Number: 411310 Depth: 0.0-10.0 ft

Description: Yellowish Brown Clayey Sand with Gravel (Fill) [SC]

Optimum Moisture Content: 8.2% Maximum Dry Density: 135.5 lbs/ft^3

Specific Gravity: 2.79 Compaction Method: ASTM D 698 Method A

Lab: Advanced Terra Testing, Inc. Date Tested: 3/11/96



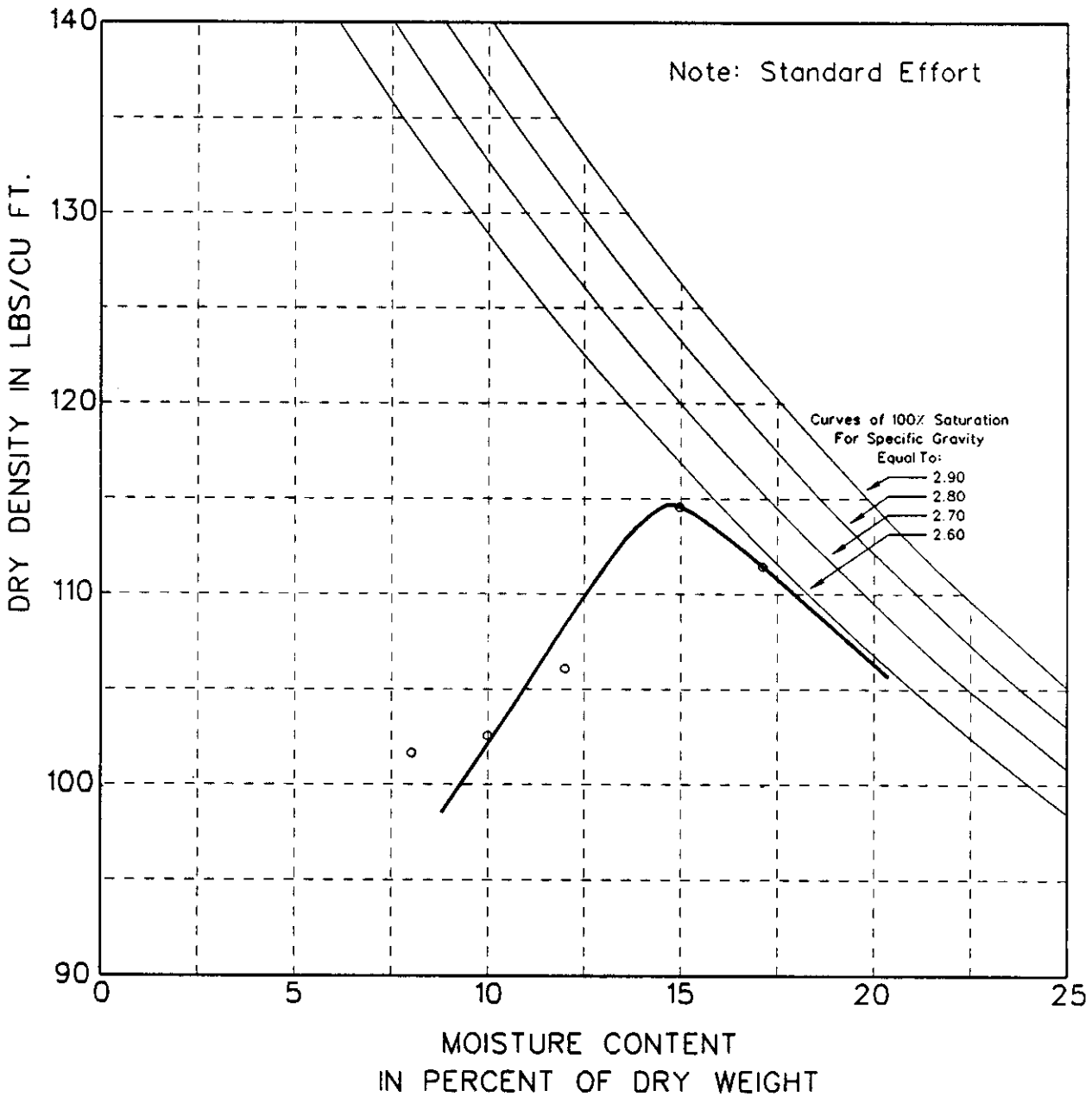
Boring: 12063 Sample Number: 411325 Depth: 0.0-10.0 ft

Description: Dark Yellowish Brown Sandy Lean Clay [CL]

Optimum Moisture Content: 14.7% Maximum Dry Density: 114.7 lbs/ft^3

Specific Gravity: 2.72 Compaction Method: ASTM D 698 Method A

Lab: Advanced Terra Testing, Inc. Date Tested: 3/14/96



FILE:/USR/REF4/OU4/PO161/PO161/DGN/BMP/411325C.DGN (SKK04319)

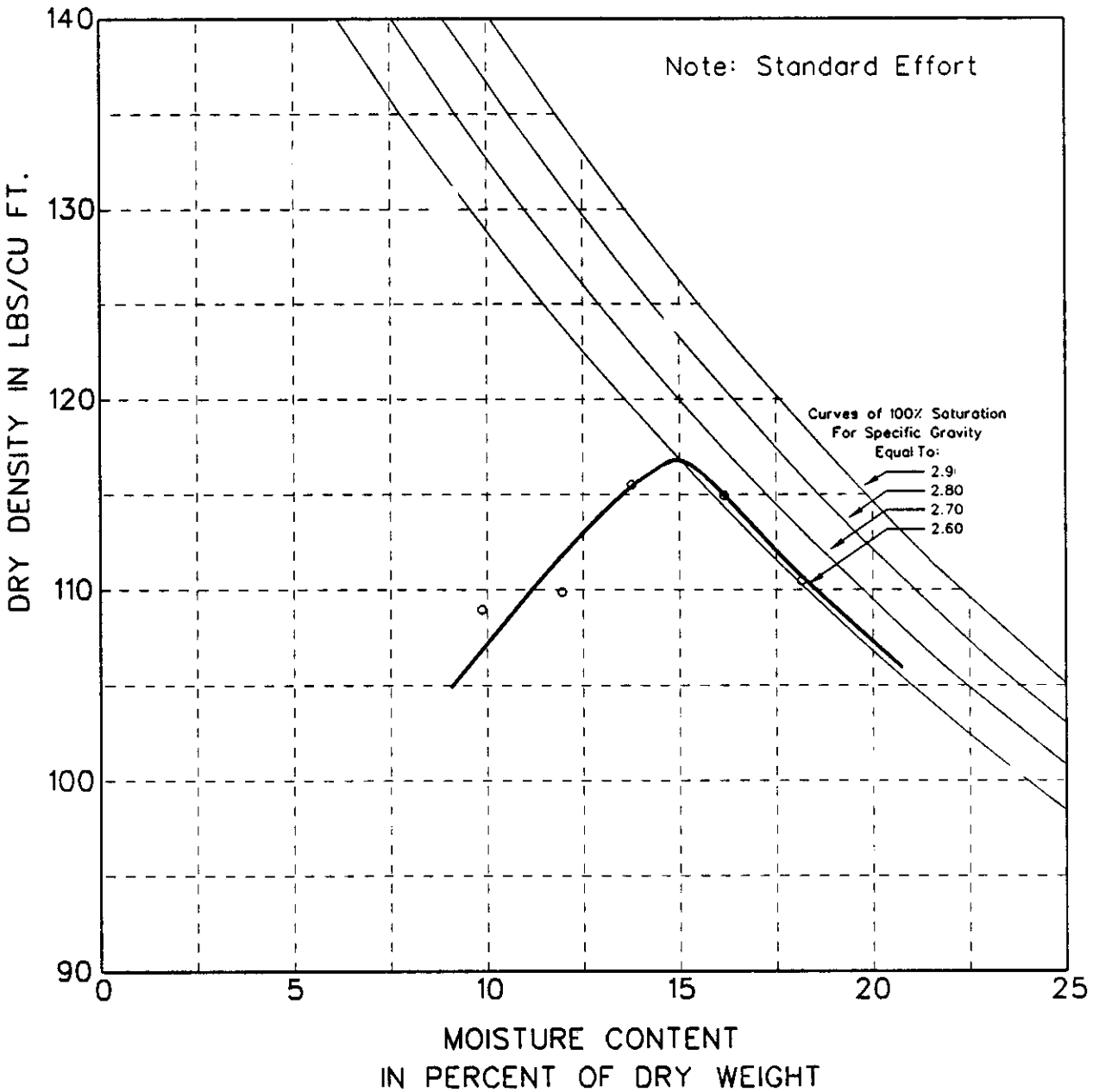
Boring: 12065 Sample Number: 411385 Depth: 0.0-10.0 ft

Description: Light Olive Brown Lean Clay [CL]

Optimum Moisture Content: 14.9% Maximum Dry Density: 116.8 lbs/ft^3

Specific Gravity: 2.78 Compaction Method: ASTM D 698 Method A

Lab: Advanced Terra Testing, Inc. Date Tested: 3/11/96



FILE: /USR/REF4/004/PO161/PO161/DGN/BMP/411385C.DGN (SKX04336)

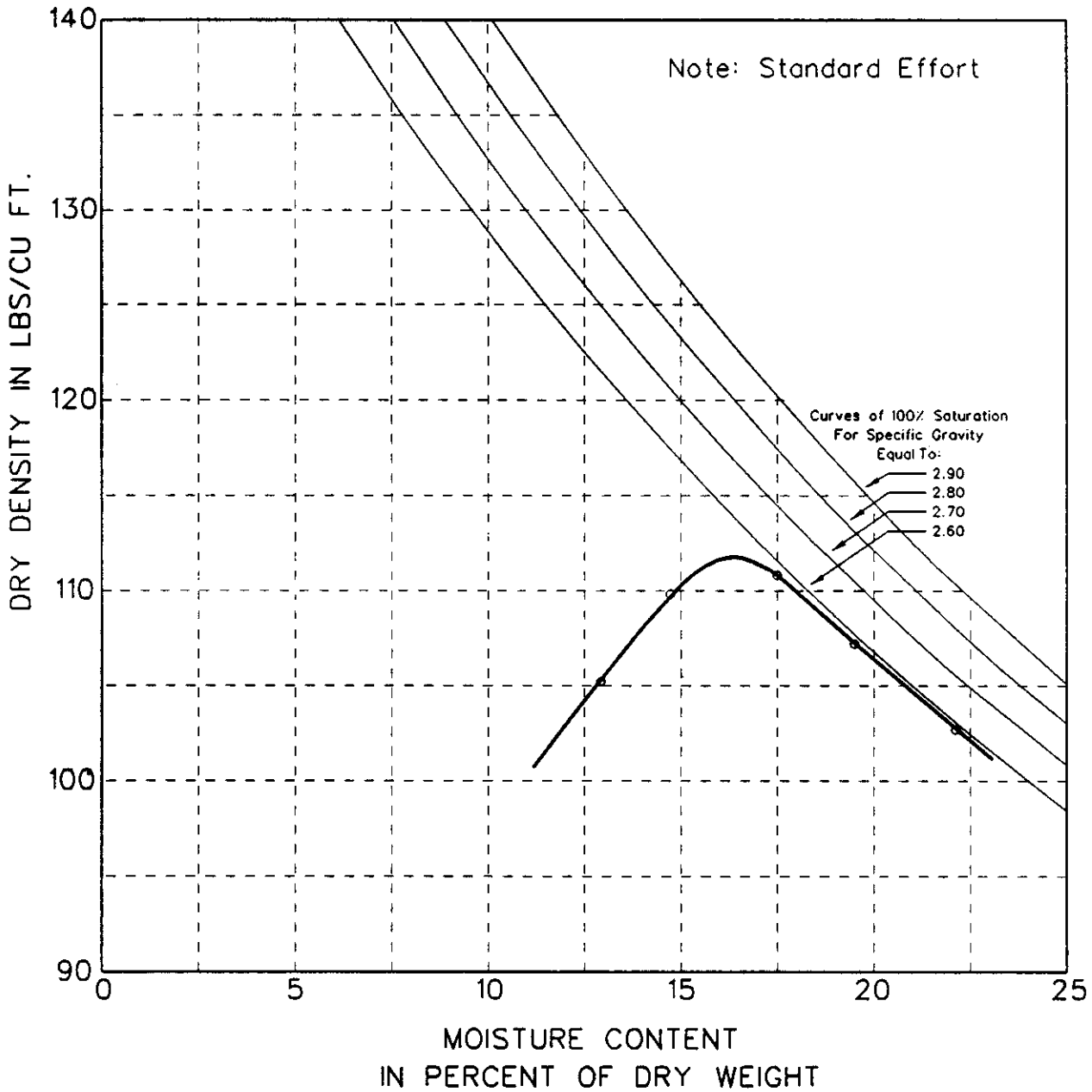
Boring: 12066 Sample Number: 411355 Depth: 0.0-10.0 ft

Description: Yellowish Brown Lean Clay [CL]

Optimum Moisture Content: 16.3% Maximum Dry Density: 111.8 lbs/ft^3

Specific Gravity: 2.83 Compaction Method: ASTM D 698 Method A

Lab: Advanced Terra Testing, Inc. Date Tested: 3/15/96



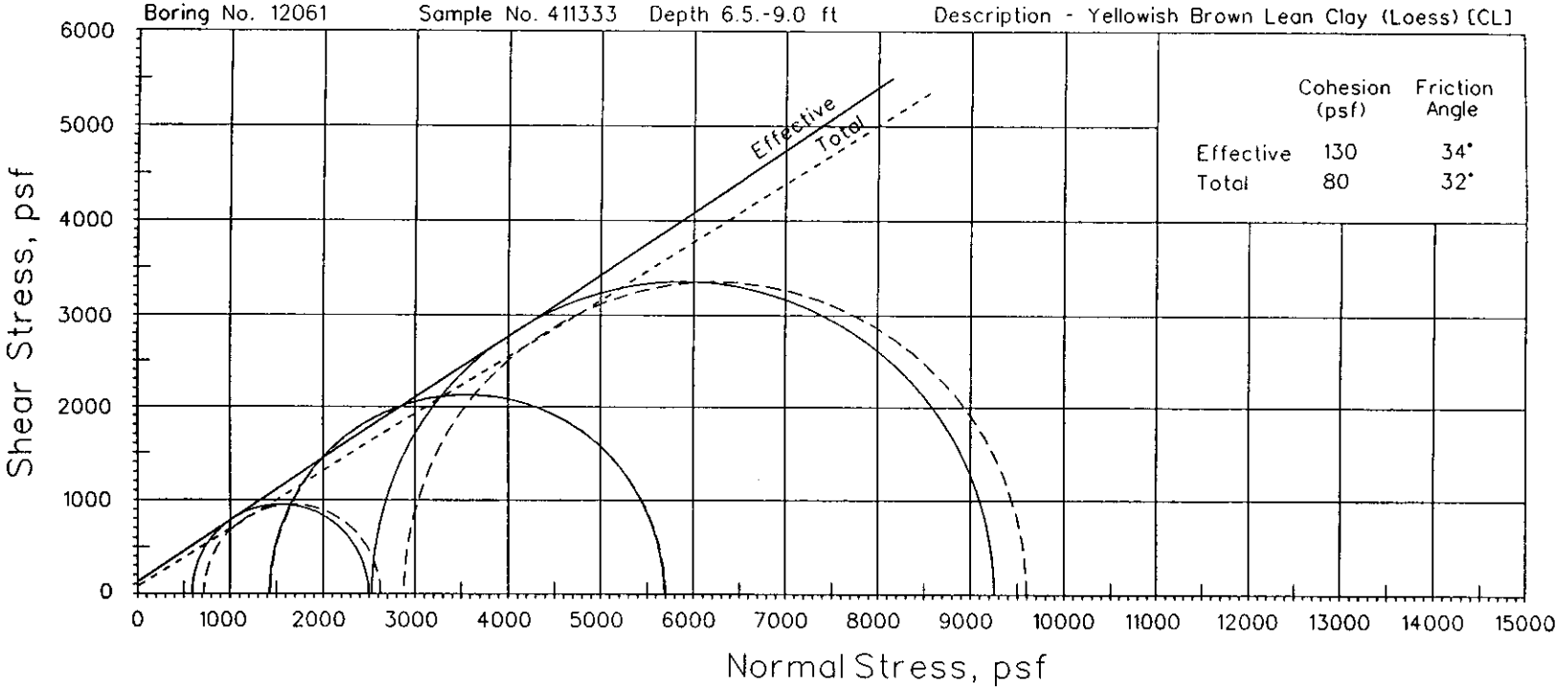
FILE:/USR/REF4/DUN/P0161/P0161/DGN/BMP/411355C.DGN (SKX04317)

APPENDIX E

MOHR CIRCLES

Triaxial Compression Test Report

Boring No. 12061 Sample No. 411333 Depth 6.5.-9.0 ft Description - Yellowish Brown Lean Clay (Loess) [CL]



Type of Test: TX/CUpp Sample Type: In Situ Failure Criteria: Maximum Principal Stress Ratio

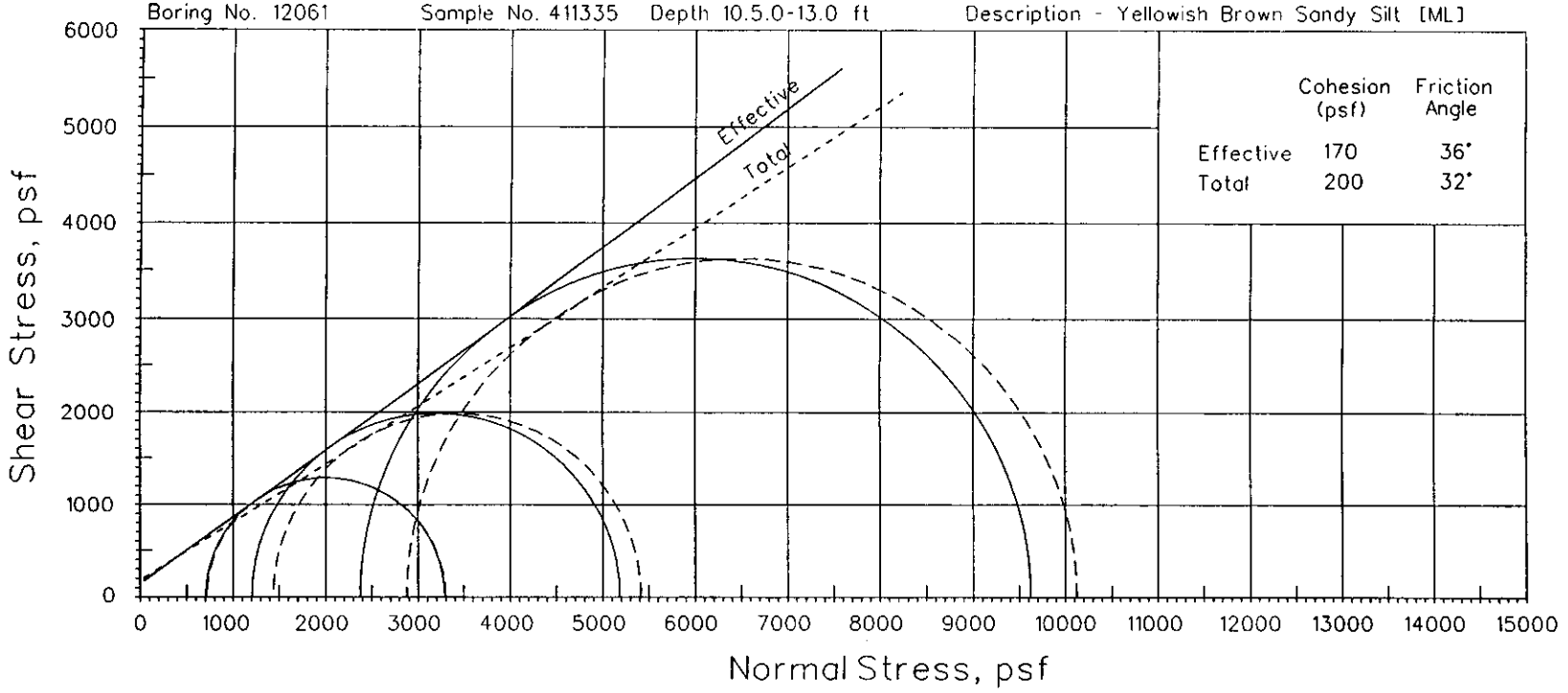
Boring No.	Depth (feet)	Spec. No.	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Delta Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
12061	6.5-9.0	411333A	23.4	22.2	131.2	106.3	7.51	6719	346	2534	9253	3.65
		411333B	23.2	22.9	130.9	106.2	6.02	4263	14	1426	5689	3.99
		411333C	21.6	22.0	130.8	107.5	3.43	1908	130	590	2499	4.23

1. Saturated Test.

CAD FILE: /USR/REF4/OU4/P0161/P0161/DGN/411333_MO.DGN (SKX04309)

Triaxial Compression Test Report

Boring No. 12061 Sample No. 411335 Depth 10.5.0-13.0 ft Description - Yellowish Brown Sandy Silt [ML]



Type of Test: TX/CUpp Sample Type: In Situ Failure Criteria: Maximum Principal Stress Ratio

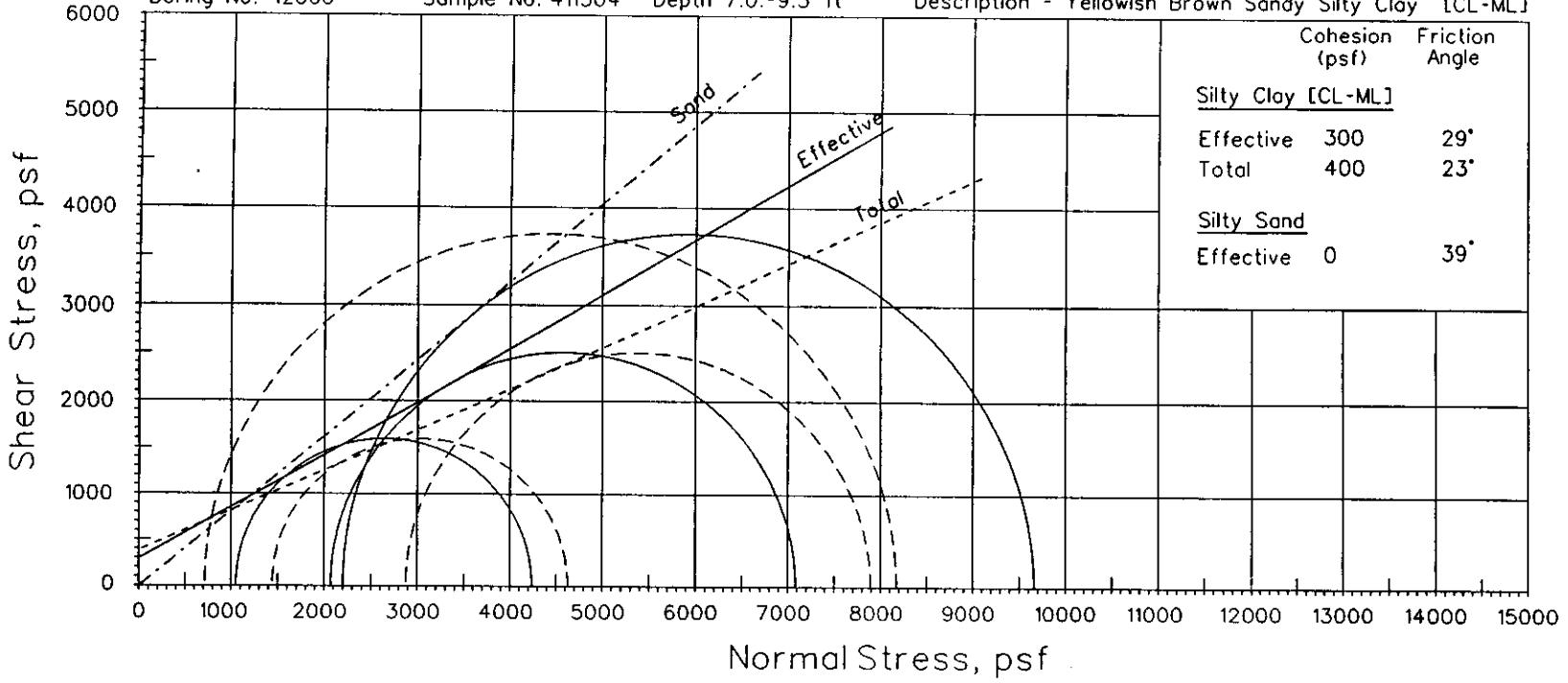
Boring No.	Depth (feet)	Spec. No.	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Delta Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
12061	10.5-13.0	411335A	15.6	16.1	133.6	115.6	6.03	7248	504	2376	9624	4.05
		411335B	13.5	13.0	143.5	126.5	3.01	3977	230	1210	5186	4.29
		411335C	15.9	15.9	137.9	119.0	1.81	2584	14	706	3290	4.66

1. Saturated Test.

CAD FILE: /USR/REF4/OU4/PO161/PO161/DGN/411335_MO.DGN (SKX04310)

Triaxial Compression Test Report

Boring No. 12060 Sample No. 411304 Depth 7.0.-9.5 ft Description - Yellowish Brown Sandy Silty Clay [CL-ML]



Type of Test: TX/CUpp Sample Type: In Situ Failure Criteria: Maximum Principal Stress Ratio

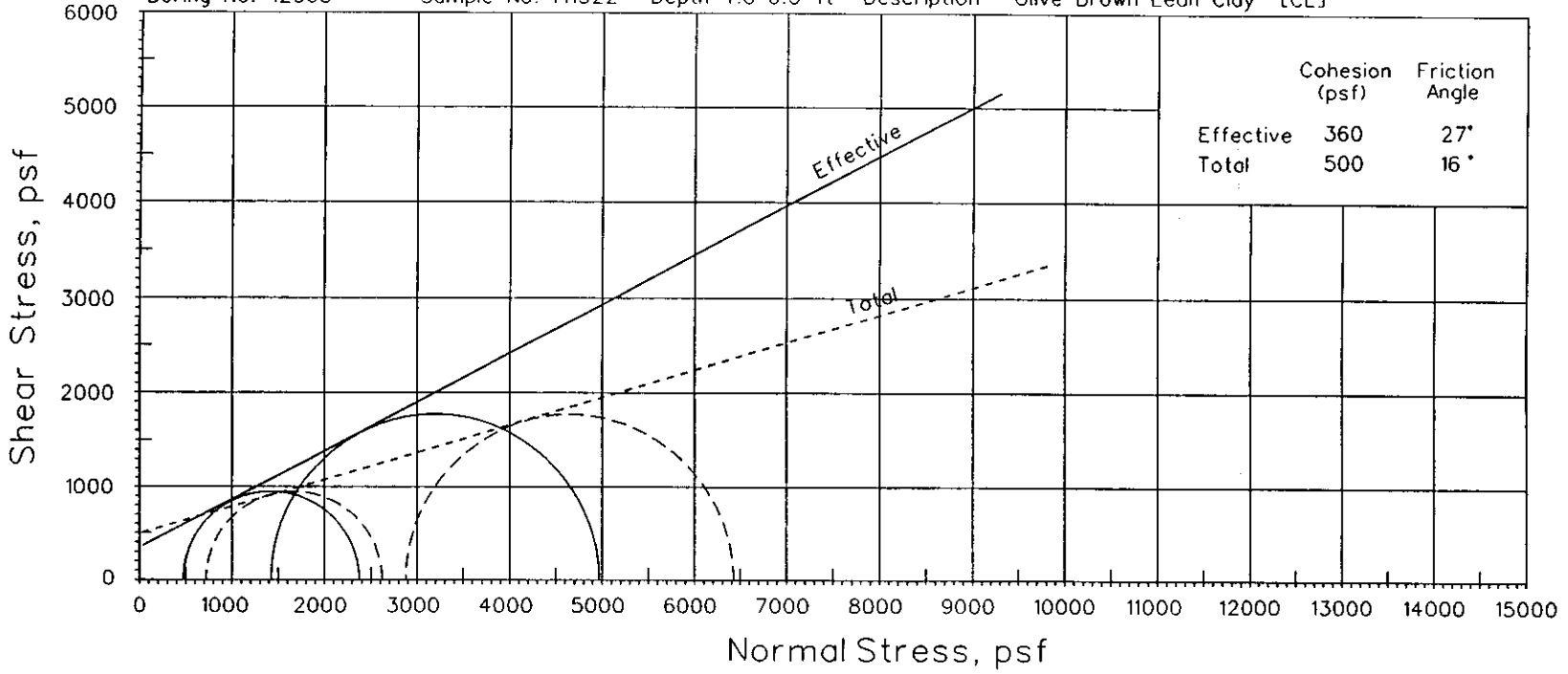
Boring No.	Depth (feet)	Spec. No.	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Delta Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
12060	7.0-9.5	411304A	14.1	12.7	144.8	126.9	6.84	5017	806	2074	7091	3.42
		411304B	17.5	17.3	136.5	116.2	2.52	3188	389	1051	4240	4.03
		411304C	19.1	19.1	133.5	112.1	4.33	7459	-1483	2203	9662	4.39

1. Saturated Test.

CAD FILE: /USR/REF4/OU4/PO161/PO161/DGN/411304_MO.DGN (SKX04306)

Triaxial Compression Test Report

Boring No. 12063 Sample No. 411322 Depth 4.0-6.0 ft Description - Olive Brown Lean Clay [CL]



Type of Test: TX/CUpp Sample Type: In Situ Failure Criteria: Maximum Principal Stress Ratio

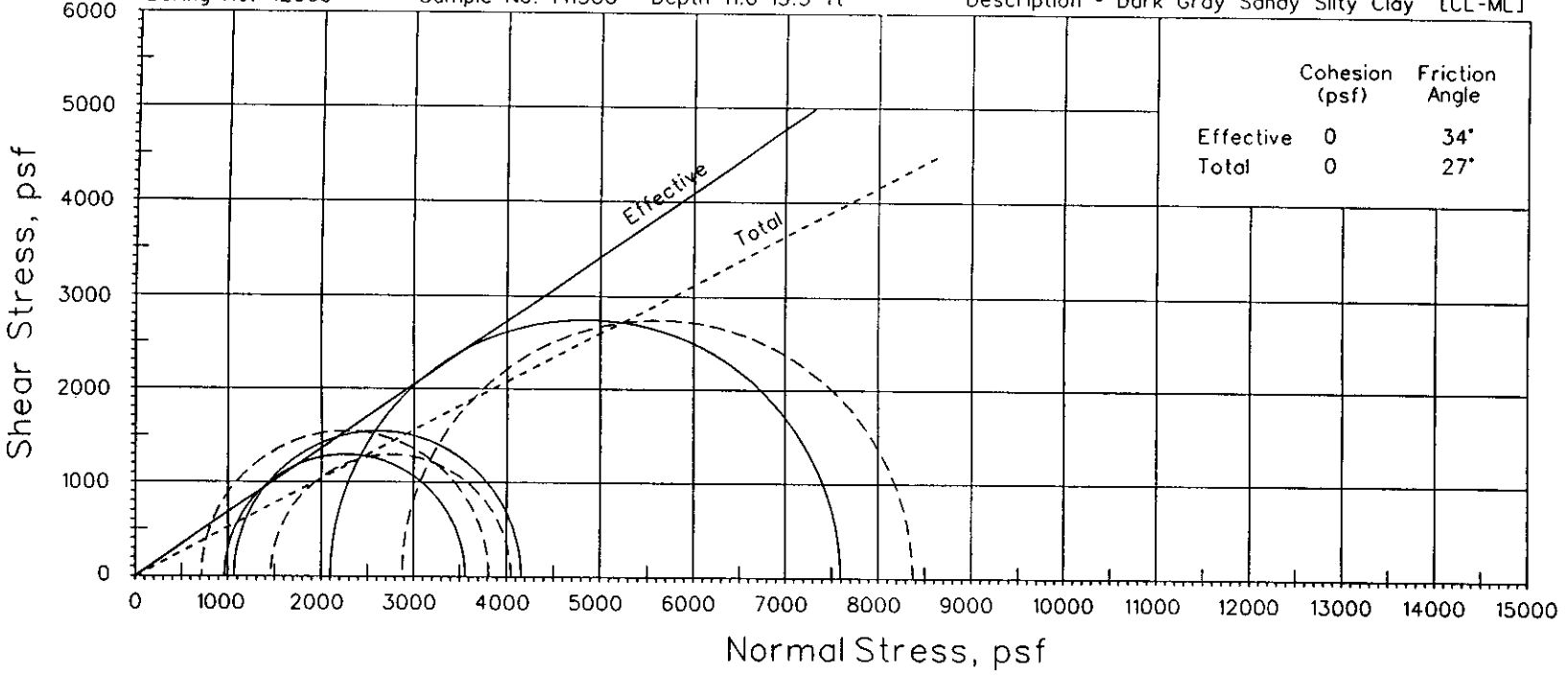
Boring No.	Depth (feet)	Spec. No.	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Delta Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
12063	4.0-6.0	411322B	23.8	24.0	125.9	101.8	6.78	3546	1454	1426	4971	3.49
		411322C	25.2	26.8	125.5	100.3	1.70	1901	245	475	2376	5.00

1. Saturated Test.

CAD FILE: /USR/REF4/OU4/P0161/P0161/DGN/411322_MO.DGN (SKX04308)

Triaxial Compression Test Report

Boring No. 12060 Sample No. 411306 Depth 11.0-13.5 ft Description - Dark Gray Sandy Silty Clay [CL-ML]



Type of Test: TX/CUpp Sample Type: In Situ Failure Criteria: Maximum Principal Stress Ratio

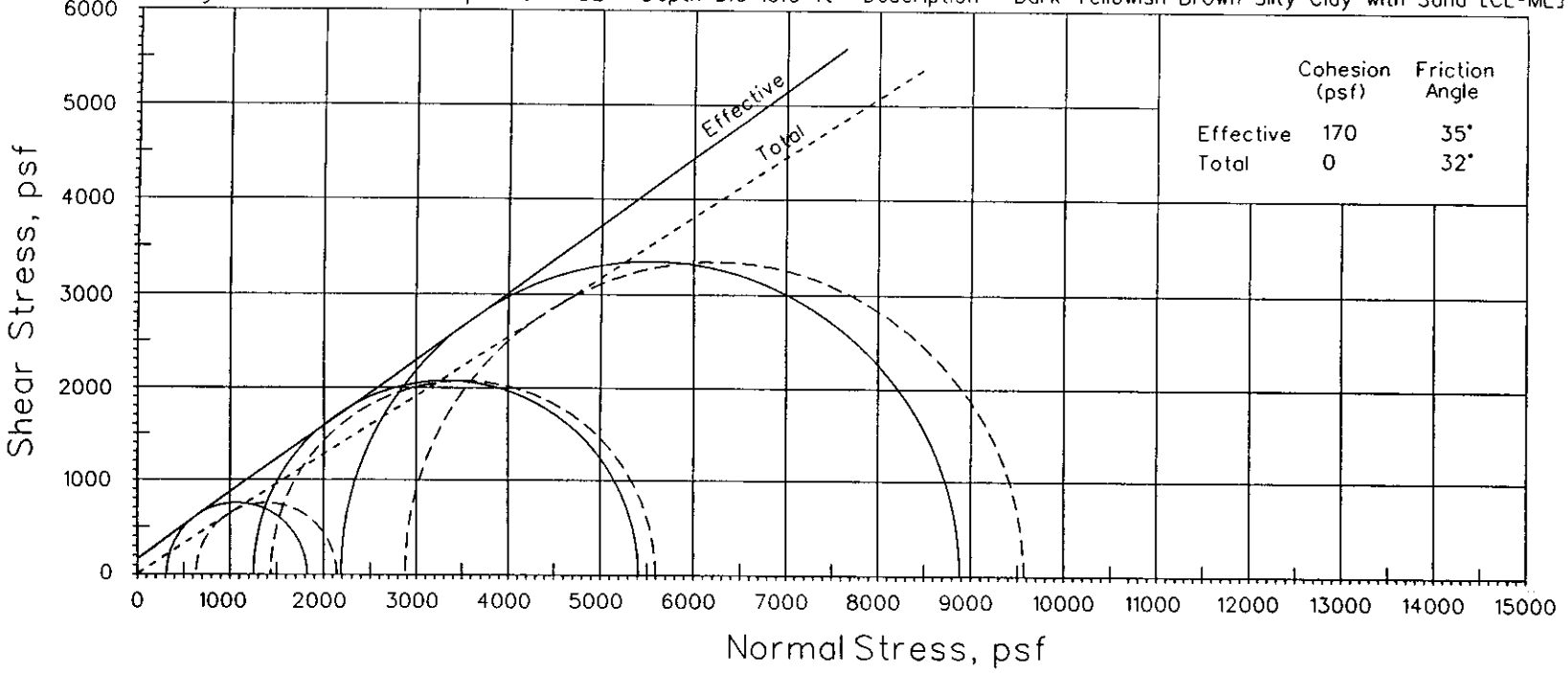
Boring No.	Depth (feet)	Spec. No.	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Delto Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
12060	11.0-13.5	411306A	12.2	11.9	145.4	129.5	4.22	5493	778	2102	7596	3.61
		411306B	13.0	13.0	142.8	126.4	3.42	2613	490	950	3563	3.75
		411306C	11.1	11.5	144.9	130.4	6.04	3094	-346	1066	4160	3.90

1. Saturated Test.

CAD FILE: /USR/REF4/OU4/P0161/P0161/DGN/411306_MO.DGN (SKX04307)

Triaxial Compression Test Report

Boring No. 12063 Sample No. 411324 Depth 8.0-10.5 ft Description - Dark Yellowish Brown Silty Clay with Sand [CL-ML]



Type of Test: TX/CUpp Sample Type: In Situ Failure Criteria: Maximum Principal Stress Ratio

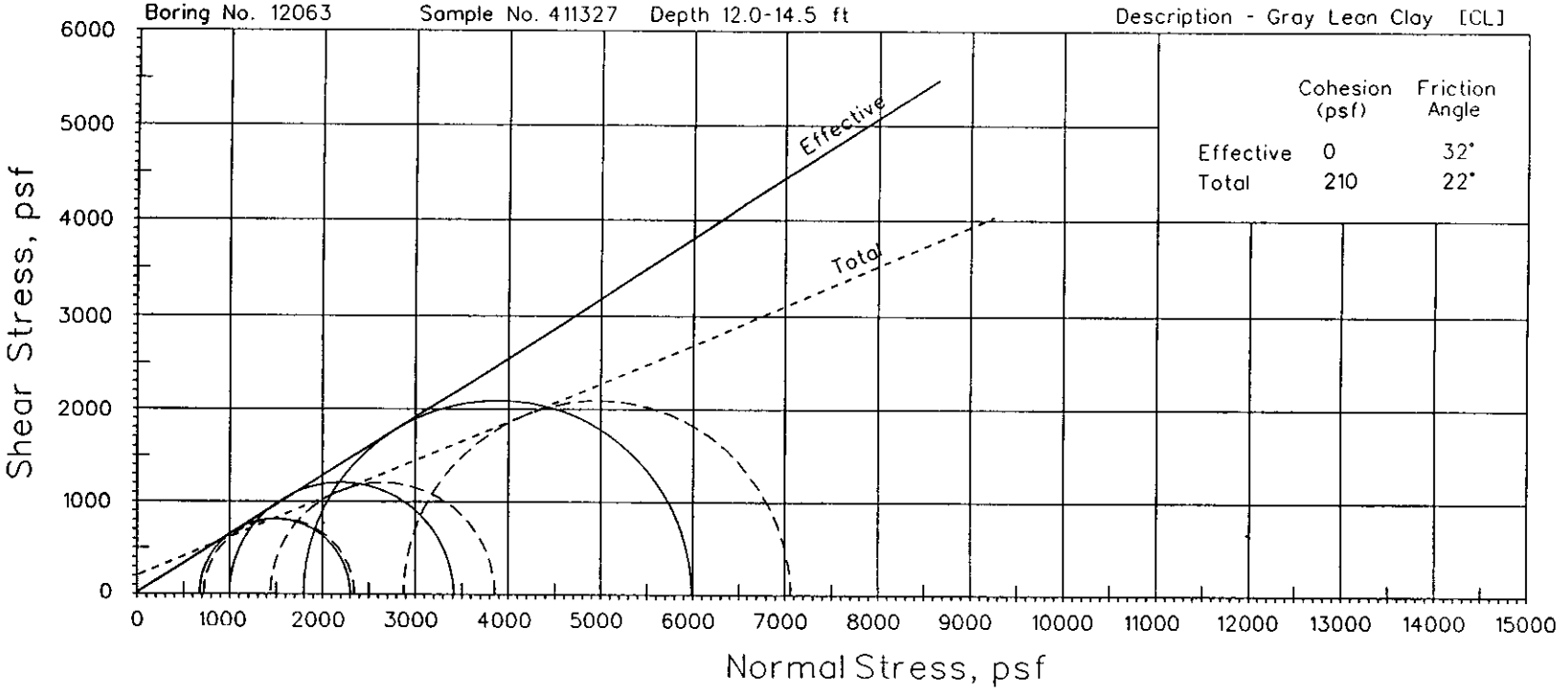
Boring No.	Depth (feet)	Spec. No.	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Delta Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
12063	8.0-10.5	411324A	21.5	19.9	128.1	105.5	5.86	6697	691	2189	8885	4.06
		411324B	21.6	21.3	130.5	107.3	4.24	4160	187	1253	5412	4.32
		411324C	21.0	21.9	129.8	107.3	2.52	1509	403	317	1826	5.76

1. Saturated Test.

CAD FILE: /USR/REF4/OU4/PO161/PO161/DGN/411324_MO.DGN (SKX04340)

Triaxial Compression Test Report

Boring No. 12063 Sample No. 411327 Depth 12.0-14.5 ft Description - Gray Lean Clay [CL]



Type of Test: TX/CUpp Sample Type: In Situ Failure Criteria: Maximum Principal Stress Ratio

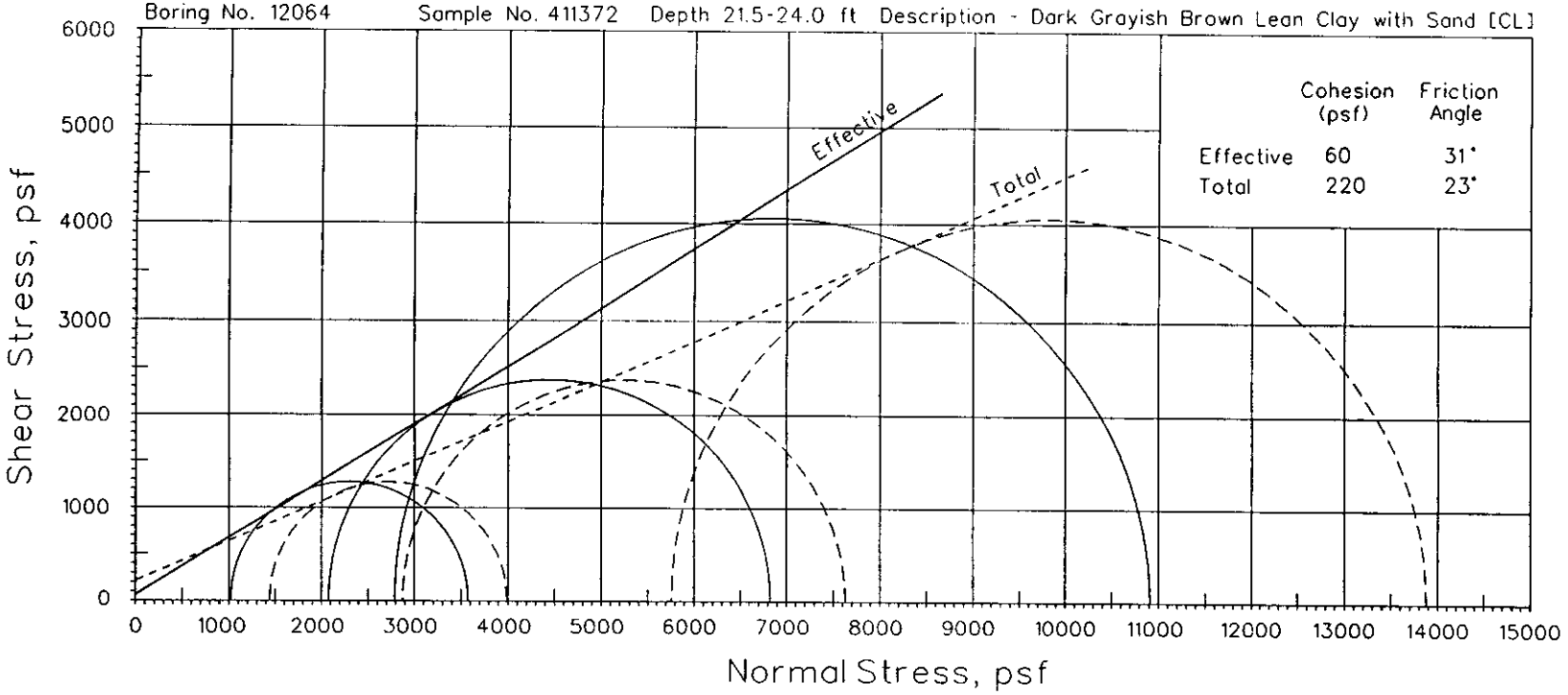
Boring No.	Depth (feet)	Spec. No.	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Delta Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
12063	12.0-14.5	411327A	20.2	20.4	130.1	108.2	3.40	4189	1080	1800	5989	3.33
		411327B	20.9	20.4	131.7	109.0	3.42	2417	444	996	3413	3.43
		411327C	21.2	20.5	132.4	109.3	6.90	1628	43	677	2305	3.41

1. Saturated Test.

CAD FILE: /USR/REF4/0U4/P0161/P0161/DGN/411327_MO.DGN (SKX04341)

Triaxial Compression Test Report

Boring No. 12064 Sample No. 411372 Depth 21.5-24.0 ft Description - Dark Grayish Brown Lean Clay with Sand [CL]



Type of Test: TX/CUpp Sample Type: In Situ Failure Criteria: Maximum Principal Stress Ratio

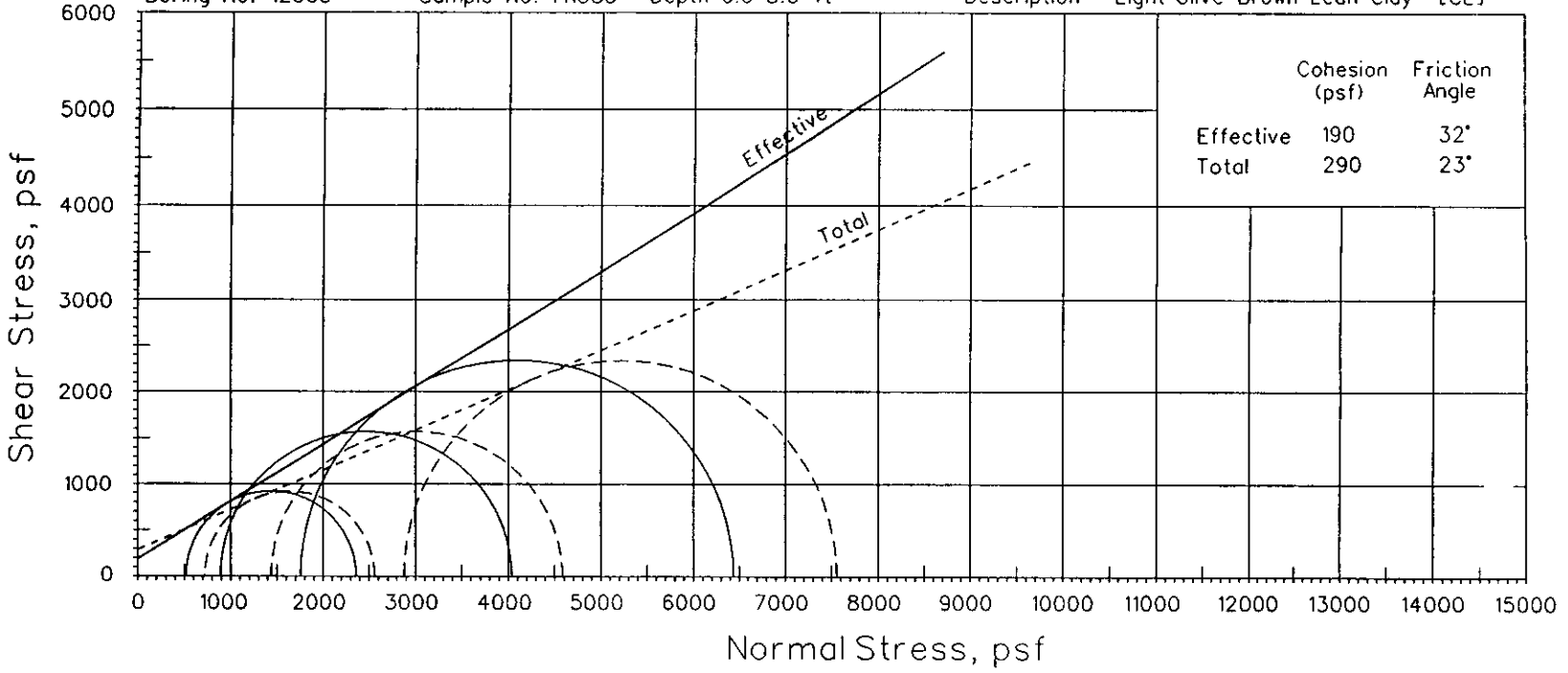
Boring No.	Depth (feet)	Spec. No.	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Delta Pore Pressure (psf)	Effective Confining Pressure (sigma$_3$) (psf)	Major Principal Stress (sigma$_1$) (psf)	Principal Stress Ratio
			Initial	Final								
12064	21.5-24.0	411372A	14.8	12.6	142.1	123.8	8.53	8120	2966	2794	10913	3.91
		411372B	15.3	13.4	141.7	122.9	15.14	4753	801	2079	6832	3.29
		411372C	15.1	14.0	141.1	122.6	5.84	2557	418	1022	3579	3.50

1. Saturated Test.

CAD FILE: /USR/REF4/OU4/PO161/PO161/DGN/411372_MO.DGN (SKX04337)

Triaxial Compression Test Report

Boring No. 12065 Sample No. 411383 Depth 6.0-8.0 ft Description - Light Olive Brown Lean Clay [CL]



Type of Test: TX/CUpp Sample Type: In Situ Failure Criteria: Maximum Principal Stress Ratio

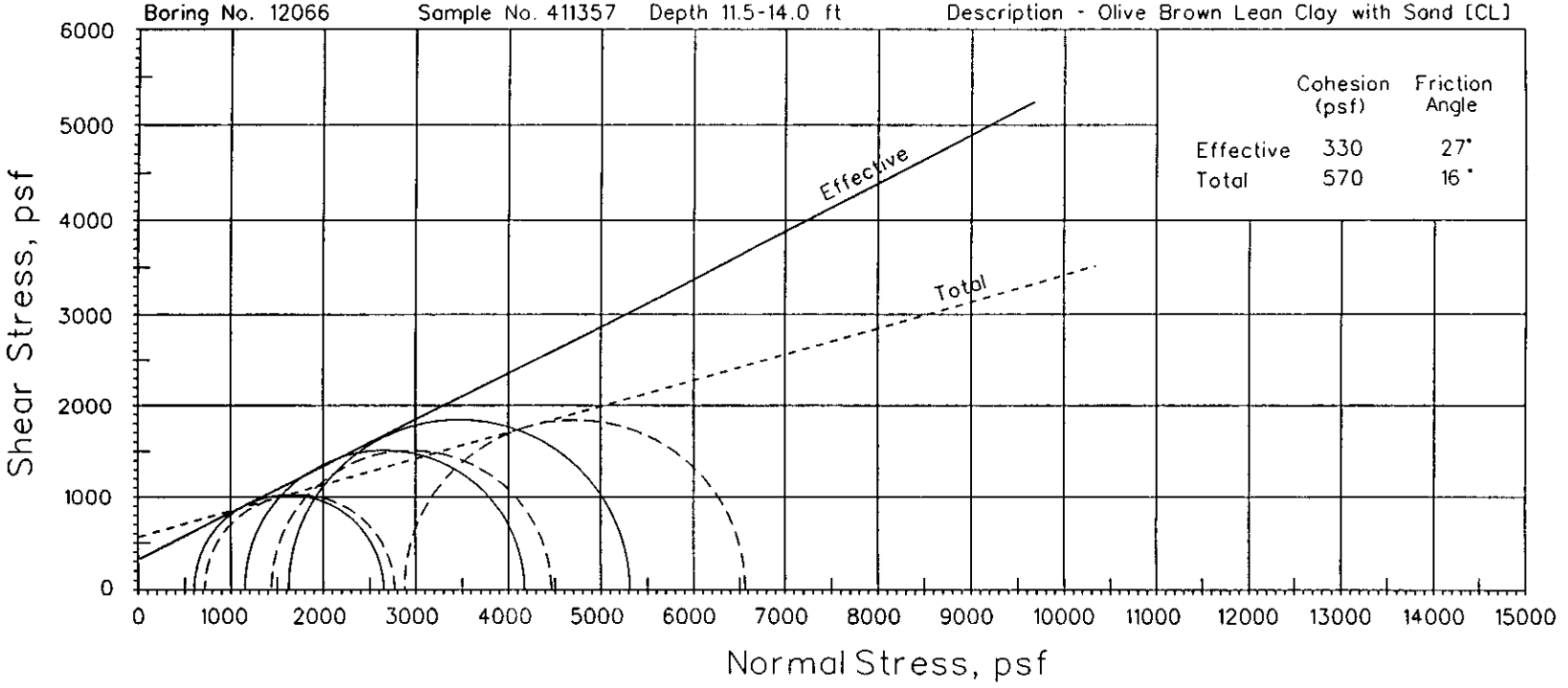
Boring No.	Depth (feet)	Spec. No.	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Delta Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
12065	6.0-8.0	411383A	21.7	21.0	131.6	108.2	5.10	4680	1123	1757	6437	3.66
		411383B	22.2	22.0	131.1	107.2	4.20	3147	547	893	4040	4.53
		411383C	21.1	20.2	133.6	110.4	3.40	1843	202	518	2361	4.55

1. Saturated Test.

CAD FILE: /USR/REF4/OU4/PO161/PO161/DGN/411383_MO.DGN (SKX04338)

Triaxial Compression Test Report

Boring No. 12066 Sample No. 411357 Depth 11.5-14.0 ft Description - Olive Brown Lean Clay with Sand [CL]



Type of Test: TX/CUpp Sample Type: In Situ Failure Criteria: Maximum Principal Stress Ratio

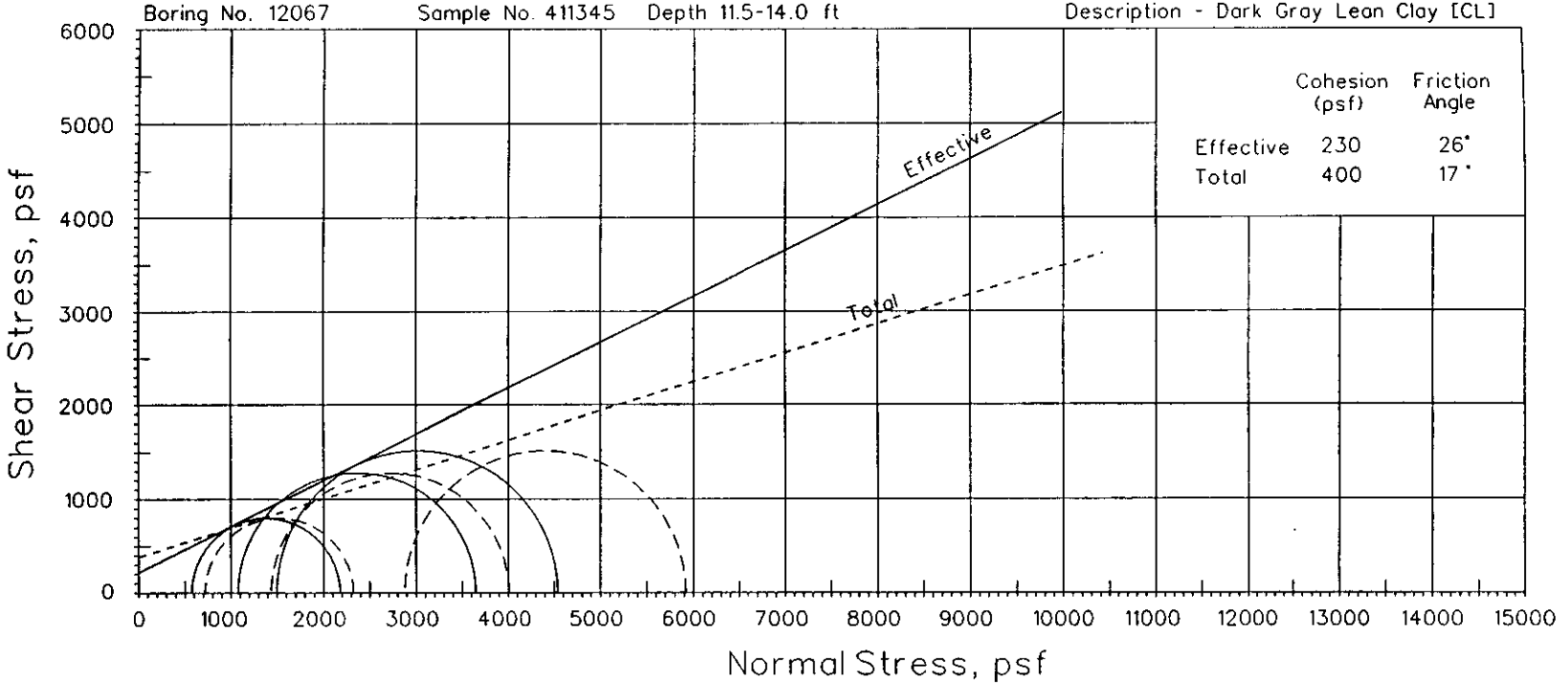
Boring No.	Depth (feet)	Spec. No.	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Delta Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
12066	11.5-14.0	411357A	14.7	14.2	140.9	122.8	6.75	3688	1253	1627	5315	3.27
		411357B	15.0	14.8	141.1	122.7	6.74	3024	288	1152	4176	3.62
		411357C	15.4	15.5	140.5	121.7	5.01	2050	115	605	2655	4.39

1. Saturated Test.

CAD FILE: /USR/REF4/OU4/PO161/PO161/DGN/411357_MO.DGN (SKX04339)

Triaxial Compression Test Report

Boring No. 12067 Sample No. 411345 Depth 11.5-14.0 ft Description - Dark Gray Lean Clay [CL]



Type of Test: TX/CUpp Sample Type: In Situ Failure Criteria: Maximum Principal Stress Ratio

Boring No.	Depth (feet)	Spec. No.	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Delta Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
12067	11.5-14.0	411345A	25.0	22.4	129.2	103.3	4.49	3042	1382	1498	4540	3.03
		411345B	25.6	24.5	128.3	102.2	6.00	2568	360	1080	3648	3.38
		411345C	26.5	26.4	127.2	100.6	5.18	1605	144	576	2181	3.79

1. Saturated Test.

CAD FILE: /USR/REF4/OU4/P0161/P0161/DGN/411345_MO.DGN (SKX04342)