ATTACHMENT F

2003 GEOTECHNICAL REPORT

CENWK-EC-GD May 14, 2003

MEMORANDUM FOR PM-M (ATTN: Richard Whitsell)

SUBJECT: Geotechnical Report, FY03 Family Housing Project, Whiteman Air Force Base, Missouri

1. Transmitted with this memo is the Geotechnical Report for the referenced project.

2. Geotechnical report was written in 1995 and utilized in Desing/Build New Family Housing in 1998-2000. The geotechnical report has been revised based on lessons learned.

3. Whiteman Air Force Base (WAFB) soils are generally high plasticity clays that have a "high" potential for volume change with changing moisture content (i.e. shrink/swell).

4. WAFB geology lends itself to the development of a perched water table, which can impact excavations for footings and utilities. Geotechnical report addresses the development of the perched water table.

5. Spread and continuous footings should be placed a minimum of 46 inches below the adjacent grade to minimize frost heave and movement due to shrink/swell.

6. Select material should be placed within 2 feet of the bottom of slabs on grade. Utilities require an additional 10 inches of select material.

7. Pavement subgrades should be compacted to a density of not less than 90 percent maximum density for non-expansive, cohesive soil and not less than 95 percent maximum density for non-cohesive materials per ASTM D-1557. Prior to compaction the material should be moisture conditioned to 0 to 3 percent wet of optimum. Expansive, cohesive soils should be compacted to not less than 88 percent and not more than 93 percent maximum density at a moisture content of +3 to +8 percent of optimum per ASTM D-1557.

8. Pavement subbase for rigid and flexible pavements should be compacted to a minimum 95 and 98 percent maximum density, respectively, and at a moisture content of -2 to +2 percent of the optimum moisture content per ASTM D-1557.

9. The upper 200-mm of the pavement subgrade should be treated with 5 percent lime by weight. The lime-modified subgrade should then be compacted to 95 percent maximum density for flexible pavements and 90 percent maximum density for rigid pavement based on ASTM 1557.

10. Pavements should be designed with a modulus of subgrade reaction of 100 pounds per cubic inch or a CBR of 5. Pavement sections and material requirements are addressed in the geotechnical report.

11. For questions regarding this report or foundation design guidelines, please feel free to contact Jake Owen at (816) 983-3238.

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Documentation for WAFB 03 Family Housing Project 5/13/03

- A subsurface investigation was performed in 1994 on the project site for family housing. The project was scaled back and the project site was not fully developed. Therefore the soils report finalized in 1995 encompassed the current project site to be developed for family housing.
- Small changes in the scope of the project required additional borings.
- A supplemental soils report was written containing additional data to cover the change in scope from the previous project.
- Slight modifications were made to the original soils report finalized in 1995.
- The government developed the specifications for the earthwork, materials and pavements.
- The government provided specifications were taken from a previous housing project at Whiteman Air Force Base.
- The concrete specifications were design checked by Scott Loehr EC-GD. SAL 5-13-2003
- The specifications pertaining to pavement and the original pavement design were design checked by Jim McBane. Jim McBane EC-GD reviewed modifications to the original soils report and the supplemental soils report. JM 13 May 2003
- The specifications for soils and the soils reports were reviewed, written and modified by Jake Owen EC-GD.

Whiteman AFB
Missouri

US Army Corps
of Engineers
Kansas City District
Leaders in Customer Care

Design/Build New Family Housing

Soils Report
June 1995
Revised April 2003

Prepared by Kansas City District Corps of Engineers
Geotechnical Design and Dam Safety Section
EC-GD

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SOILS REPORT 1995
REVISED 2003
DESIGN/BUILD NEW FAMILY HOUSING
WHITEMAN AIR FORCE BASE, MISSOURI

1. PROJECT DESCRIPTION: This report presents the results of a subsurface investigation and offers recommendations for the design of a proposed family housing project located just outside the southwest boundaries of Whiteman Air Force Base (WAFB), Knob Noster, Missouri.

We understand the project will be designed and constructed with 92 units base bid in FY 2003 with the option of base bidding an additional 100 units in FY 2004. We anticipate a combination of one and two story, single or duplex family housing units. Basements are considered a betterment under the design criteria for these structures and this report assumes that all units will have basements. Maximum wall loads for the structures will be light, on the order of 3 to 4 kips per linear foot or less and isolated column loads on the order of 30 kips.

The project will include grading, support utilities, roads, driveways, sidewalks, curb and gutter, landscaping, and recreational facilities such as fields and playgrounds. The support utilities include a water distribution system, electrical, gas, sanitary sewer and storm sewer.

2. REGIONAL GEOLOGY: WAFB is located in the northeastern part of the Osage Plains Section of the Central Lowland Physiographic Province. The Osage Plains is characterized by gently rolling plains of low relief, that have formed within sedimentary rocks of Pennsylvania age, and are located along the western border of the state. Geologic mapping indicates southern limits of glaciation a relatively short distance north of the project area. During the Kansas glacial advance, areas to the north of the project were mantled by thick quantities of unconsolidated materials that filled previously existing valleys resulting in a greatly modified topography. Ice blockage and thus the damming of major tributaries formed lakes which flanked the glacier and extended south of the present-day Missouri River to with in 18 miles north of the project area. Subsequent erosion and deposition by local streams caused several periods of entrenchment to bedrock and aggradation of alluvial and

colluvial materials grading upwards into loess. As a result, three distinct alluvial terraces along with thick deposits of Pennsylvania channel-filled type sandstone (approximately 100 feet in thickness) outcrop northwest of WAFB from the Missouri southward for over 50 miles. The WAFB area itself is a large area of very low relief and rimmed on the north, south, and west by low hills rising to a maximum of 900 mean sea level (m.s.l.). Relatively thick units of overburden "periglacial" deposits exists across the base and were derived from the accretion of material occurring under poor drainage conditions consequent to glaciation. Today, these periglacial deposits in the WAFB area overlie relatively flat-lying Pennsylvania age bedrock units of shale, sandstone, underclays, and thin coals.

3. SITE GEOLOGY: Whiteman AFB is located atop a gently sloping plateau within the gently rolling Osage Plains. The site for the proposed family housing projects encompasses approximately 77 acres of land and is located just outside the southwest boundaries of WAFB, with Lakeview Subdivision located to the north, a newer family housing subdivision to the east, State Highway 132 to the west, and State Road AB to the south. Vegetation at the site consists primarily of pastureland with a few draws containing woody vegetation(i.e. drainage swales). Topographically, the site is hilly with ridgelines located to the south, east and west. Elevations on the site decrease in a northerly direction at grades approaching 8 percent towards a draw located at the center of the site. A total of 110 feet of relief exists across the site, with a high of 915 feet, m.s.l. to the southeast, to a low of 800 m.s.l. to the north. Surface runoff travels freely across primarily open pastureland and is directed to the north via draws. The draws empty into a medium sized pond located approximately at the center of the site. During periods of heavy rain, overflow from the pond moves in a northerly direction off the site. Soils typical of the project site consist of primarily of Pleistocene age periglacial deposits having a maximum thickness of 40 feet. The soil deposits overlie units of shale, sandstone, underclays, and thin coals of the Cherokee Group from the upper Pennsylvanian Period. These deposits consist predominately of clays having a Unified Soils Classification of CL or CH. These clays have demonstrated a medium to high potential for volume change with changing moisture content (i.e. shrink/swell). . Perched groundwater levels are typically encountered 2 to 5

feet beneath the existing ground surface based on antecedent moisture conditions. A perched groundwater table may develop after precipitation events and the existence of a perched groundwater table will vary based on precipitation events and antecedent moisture conditions. The regional groundwater surface is typically encountered 15-20 feet below the existing ground surface. However, groundwater elevations are variable in this area and should be considered to fluctuate with seasonal and yearly antecedent moisture conditions. Soils encountered at WAFB are typically moderate to severe for corrosion potential.

4. SEISMIC CONDITIONS: In reference to data published in Department of the Army TM 5-809-10, Seismic Design, for Buildings, dated Oct. 92, WAFB, Missouri, lies within a seismic probability area described as Zone 1. This indicates that should a seismic event occur in the vicinity, it would probably have an intensity such that minor damage to structures can be expected. The area has a seismic zone factor "Z" of 0.075 for military building design.

5. SUBSURFACE INVESTIGATION: A subsurface investigation was performed by a drill crew from the Kansas City District Corps of Engineers in November of 1994. The subsurface investigation consisted of drilling a total of twenty-one 7-inch diameter hollow stem auger borings, numbered AD-94-15 through ADU-94-35, using a CME-750 drilling rig. Standard Penetration Tests (SPT's) were performed, which consists of driving a 2-inch diameter (OD) split-spoon sampler a distance of 18 inches with a standard 140-pound hammer falling 30 inches. The field procedure for SPT was conducted in general accordance with ASTM 1586 at predetermined depths to a target depth of 21.5 feet or SPT refusal. SPT refusal is defined as 50 blows of the standard 140 pound hammer in one 6-inch depth increment. The field geologist recorded the hammer blows for each sampling interval. The SPT N-value (which is the number of blows required to drive the SPT sampler 12 inches after it has seated 6 inches) is recorded on the boring logs. The bottom of hole depth, depth to bedrock, depth of refusal, and type of refusal are tabulated in Table 1. Table 2 summarizes the results of SPT testing for each depth increment. Samples of subsurface materials were obtained using the 1-3/8 inch diameter standard penetration split spoon sampler to obtain disturbed samples through hollow stem augers. Jar samples were obtained of representative materials encountered from SPT

tests and Shelby tube samples. Undisturbed samples were obtained using a 5-inch diameter, fixed piston, Shelby tube sampler at a target depth of between 10 to 12 feet. Torvanes were performed at the top, bottom, and midpoint of each 2-foot Shelby sample collected. Samples recovered with the 5-inch Shelby tube samplers were extruded in the field, logged by the field geologist, double-wrapped with aluminum foil and sealed with wax in cardboard tubes. Select samples were then tested in the Missouri River Division laboratory. The depth of groundwater was measured during drilling and at the completion of each boring. All borings were backfilled with spoils prior to leaving the site.

6. SUBSURFACE CONDITIONS: Brief descriptions of the various soils encountered follow. However, the attached strip logs should be reviewed for actual subsurface conditions at each boring location. Appendix A contains a site map, plan view of boring locations and field strip logs.

a. Overburden. Examination of the samples obtained during the subsurface investigation indicate approximately 1 foot of topsoil, overlaying typical periglacial deposits of overburden material (probably associated with Kansas glaciation) comprised primarily of damp, silty low plasticity and high plasticity clays, brownish-gray in color, mottled dark-gray, with some limonite staining and iron concentrations. The consistency of clays vary from medium (500-1000 psf undrained shear strength) to hard (>4000 psf undrained shear strength), with SPT N-values ranging from 11 to 66 blows per foot, with an average SPT N-value of 24 blows per foot. A soil described as being mottled or marked with blotches and spots is an indicator that the water table has been in contact with that soil at sometime and then receded. Therefore mottled soil can be an indicator of a variable water table.

b. Bedrock. Bedrock was encountered at depths ranging from 2.9 to 10.9 feet below the existing surface. Bedrock consisted primarily of a dense, weathered shale, greenish-gray to brown-gray in color, with occasional limonite stains. The hardness of weathered shale is characterized in rock terminology as soft based on SPT N-values. In soil terminology however, this material could be characterized as very stiff to hard, with SPT N-values ranging from 17 to greater than 50 blows per foot. On an average, the

weathered shale zone extends approximately four feet below the soil/shale interface as indicated by generally higher SPT blow counts and decreased water contents prior to encountering competent bedrock or SPT refusal. A thin coal/lignite seam approximately 1 foot in thickness was encountered in boring AD-94-25 at a depth of 8 feet. Boring AD-94-31 encountered a moderately hard, dense, brownish-gray, limestone at a depth of 7.5 feet. Borings ADU-94-17, ADU-94-18 and AD-94-34 encountered a soft, light-gray, friable, argillaceous sandstone at depths of 10.9 feet, 10.3 feet and 3.9 feet, respectively.

c. Groundwater. Phreatic groundwater was not encountered during drilling. However, as previously discussed, ground water elevations are variable in this area as a result of the development of a perched water table and should be considered to fluctuate in accordance with seasonal and yearly antecedent moisture conditions. Also, the majority of overburden material at this site will exhibit low permeability rates and additional water could accumulate in borings or excavations left open for longer periods of time.

Therefore, the groundwater elevation will need to be determined concurrent with construction.

Refer to Table 1 for chart summarizing Bottom of Hole Depth, Depth of Refusal, and Type of Refusal. Refer to Table 2 for chart summarizing SPT N-Values.

7. LABORATORY TESTING: Select samples of soil obtained during the field exploration were tested to determine engineering and physical properties. Classification parameters investigated include: natural moisture contents, Atterberg limits and grain size analysis. The shear strength of the soils was evaluated by performing unconfined compression tests and unconsolidated, undrained (UU) Q triaxial compression tests. Finally, swell consolidation tests were performed to ascertain the swell potential of the soil.

Overburden material was classified according to the Unified Soils Classification System (USCS) as either low plasticity clay (CL) or high plasticity clay (CH), with the majority being CH.

Table 1. Bottom of Hole Depth, Depth to Bedrock, Depth of Refusal, and Type of Refusal.

BORING	BOTTOM OF HOLE (ft)	DEPTH TO BEDROCK (ft)	REFUSAL DEPTH (ft)	TYPE OF REFUSAL
AD-94-15	*	9.5 (Weathered SH)	11.4	SPT
AD-94-16	*	9.5	10.6	SPT
ADU-94-17	*	10.9 (Sandstone)	11.3 / 12.2	SHELBY / SPT
ADU-94-18	*	10.3 (Sandstone)	10.7 / 11.1	SHELBY / SPT
AD-94-19	*	2.9	5.9	SPT
AD-94-20	*	3.7	5.8	SPT
AD-94-21	*	5.4 (Weathered SH)	8.8	SPT
AD-94-22	*	8.8 (Weathered SH)	16.4	SPT
AD-94-23	*	8.6 (Weathered SH)	15.4	SPT
AD-94-24	*	7.0	8.4	SPT
AD-94-25	*	5.8 (Weathered SH)	8.8	SPT
ADU-94-26	*	9.2 (Weathered SH)	16.5	SPT
ADU-94-27	21.5	N/A	N/A	N/A
AD-94-28	*	6.1	8.2	SPT
AD-94-29	*	4.5	8.3	SPT
AD-94-30	*	5.1	9.0	SPT
AD-94-31	*	7.5 (Limestone)	7.7	SPT
ADU-94-32	*	9.5 (Weathered SH)	10.8 / 20.4	SHELBY / SPT
ADU-94-33	*	9.5 (Weathered SH)	16.4	SPT
AD-94-34	*	3.9 (Sandstone)	5.9	SPT
AD-94-35	*	8.0	16.2	SHELBY / SPT

* See SPT Refusal Depth

The Atterberg limits were performed on 15 samples of overburden material. The overburden material had liquid limits (LL) which ranged between 22 and 83, with a mean of 57, plastic limits (PL) ranged between 25 and 14, with a mean of 19 and plasticity indices (PI) which ranged between 7 and 58, with a mean of 38. The moisture content of 48 samples tested of overburden material ranged between 9 and 35 percent, with a mean of 22 percent. The results are presented in Table 3. Forty-eight samples of the overburden soils were tested for natural moisture content, the results ranged from 9 to 35 percent, with a mean of 22 percent. Thirty-five samples of bedrock material were tested for natural moisture content, the results ranged between 7 and 41 percent, with a mean of 16 percent. It is important to note that the in-situ moisture content at the time of the subsurface investigation is very near the plastic limit,

indicating a potential for volume change with changing moisture content. It should be also be noted that the shales underlying the overburden material are the parent material of the overburden. Therefore, the shales will most likely exhibit similar shrink/swell characteristics with changing moisture content.

Generally, the classification for potential swell for this type of material is "high" according to Army Technical Manual TM 5-818-7, Table 4-1. Other classifications based on plasticity indices classify this soil as having a very high potential for swell.

Table 2. SPT N-Values (Family Housing Units)

DEPTH INCREMENT (feet)	SPT N-VALUE (blows/ft)																				
	94-15	94-16	94-17	94-18	94-19	94-20	94-21	94-22	94-23	94-24	94-25	94-26	94-27	94-28	94-29	94-30	94-31	94-32	94-33	94-34	94-35
0.0-2.5 2.5-4.0	- 19	- 40	- 20	- 28	- 45	- 30	- 36	- 36	- 21	- 12	- 14	- 38	- 18	- 23	- 19	- 12	- 66	- 19	- 17	- 23	- 15
4.0-5.0 5.0-6.5	- 50	- 27	- 30	- 14	- +50	- +50	- 27	- 17	- 23	- 26	- 17	- 18	- 20	- 34	- 56	- 51	- 24	- 12	- 11	- +50	- 29
6.5-7.5 7.5-9.0	- 27	- 26	- 12	- 29			- +50	- 29	- 24	- +50	- +50	- 18	- 30	- +50	- +50	- +50	- +50	- 20	- 20		- 36
9.0-10.0 10.0-11.5 11.5-12.0	- +50	- +50	- - +50	- +50				- 61 -	- 55 -			- - -	- - -					- - -	- - -		- - -
12.0-15.0 15.0-16.5								- +50	- +50			- +50	- 18					- 40	- +50		- +50
18.5-20.0 20.0-21.5													- 11					- +50			

Results of unconfined compressive strength testing are summarized in Table 4 and include the unconfined strength (q_u), dry density, natural moisture content, and the depths corresponding to the test locations.

Unconsolidated, undrained (UU) Q triaxial compression tests were performed on a sample obtained from a depth of 10.0-11.9 feet in boring ADU-94-27 at initial confining pressures of 1.0, 2.0, and 4.0 tons per square foot (tsf). The results are presented in Appendix B of this report.

Two consolidation tests were performed on samples of overburden material obtained from a depth of 10.0-11.9 feet in borings ADU-94-26 and ADU-94-27. Consolidation testing indicated an overconsolidated soil with a preconsolidation pressure ranging between 0.07 tsf and 0.16 tsf.

Table 3. Liquid Limit and Plastic Index Test Results

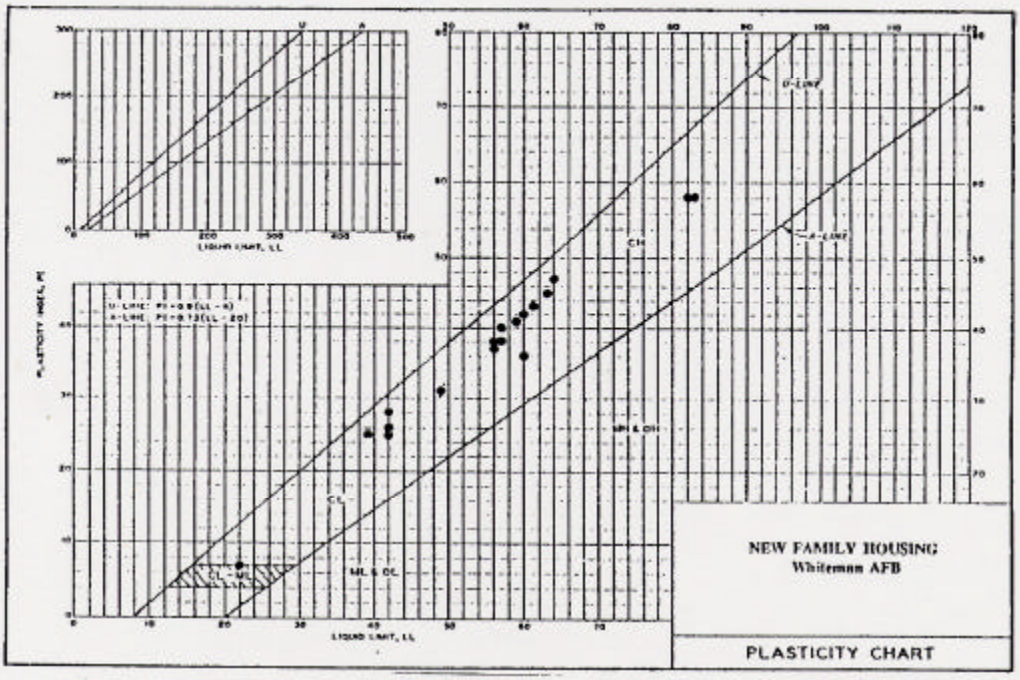


Table 4. Unconfined Compressive Strength and Dry Density Test Results.

Boring Number	Depth (feet)	wo %	q_u (t.s.f.)	Dry Density (p.c.f.)
ADU-94-17	10.0-11.2	16.47	2.06	114.54
ADU-94-26	10.0-11.9	23.36	2.05	103.43

A swell test was performed on an undisturbed sample obtained from boring ADU-94-26 at a depth of 10.0-11.9 feet. The results show a percent swell of 0.3% at a swell pressure of 500 psf. Based on these results, a layer of material 10 feet in thickness would be expected to swell approximately 0.3 inches when subjected to a vertical restraining pressure of 500 psf. It is important to remember this prediction applies only to the material at the insitu moisture and density. If the material is allowed to dry excessively during construction and is then given access to water, the

material has a much greater potential for swell even when subjected to a greater vertical stress. Historically, expansive soils have resulted in heaving slabs-on-grade in a number of structures at WAFB where imported fill material beneath the slab contained weathered shale materials. Although in discussion with the installation, this apparently has not been a significant problem with the existing housing units at WAFB. The approximate floor slab elevations for the new housing units would correspond to the approximate elevation of weathered shale bedrock, therefore special precautions should be imposed during design and construction to prevent the potential for swelling or shrinking.

Results of the laboratory testing performed on selected samples obtained from the project site are included in the appendix of this report.

8. SITE PREPARATION RECOMMENDATIONS: Site preparation will include the removal of any debris, stumps, roots, and/or other deleterious materials from the site and disposing of these materials outside the limits of Government-controlled property. All existing topsoil should be removed to a depth of 12 inches and stored at a designated area.

Depending on the final design, some structures could be placed on engineered fill. Engineered fill is any material with specific compaction requirements. Prior to placement of engineered fill, the native ground surface should be scarified to a depth of 6 inches and compacted to the proper moisture and density according to the material type. Sloped surfaces greater than one vertical to four horizontal should be benched or stepped prior to the placement of any new fill. Engineered fill consisting of high plastic clays should not exceed a depth of one footing width. If an engineered fill is required greater than one footing width the high plastic clay material should be mixed with lime to reduce the plasticity index below 18. Cohesive material should only be used for construction of engineered fills to within 2 feet beneath the bottom of slabs-on-grade and the backfilling of exterior elevations. Undisturbed soil and compacted cohesive fill within 2 feet of the bottom of slabs-on-grade should be removed and replaced with a non-expansive, satisfactory select material.

Borrow material for the construction of engineered fill should be obtained from approved on-base stockpiles or from an approved borrow source off the limits of government property which has been investigated and classified according to Unified Soil Classification System by the Contractor. Satisfactory and unsatisfactory materials will be classified according to the Unified Soils Classification System (USCS) criteria. Satisfactory materials will include the classifications GW, GP, GC, GM, SW, SC, SM, ML, CL, or CH, and unsatisfactory materials will include the classifications of MH, SP, OL, OH, or Pt. Cohesive material with a liquid limit of 50 or greater and a plasticity index of 18 or greater should be classified as expansive and requires special procedures stated herein. Stones greater than 3 inches in diameter will not be allowed in fill material. Soil like materials obtained from the excavations, e.g. intensively weathered sedimentary rock such as sandstone, shale, or underclay, will not be considered satisfactory for use as borrow.

Materials placed in the engineered fill should be placed in loose lifts not to exceed 8 inches in thickness. Select material to be compacted in areas adjacent to buildings, under footings or underneath slabs should be placed in loose lifts no greater than 4 inches in thickness. Compaction shall be accomplished by approved equipment well suited to the material being compacted. Prior to compaction, the moisture content should be adjusted to 3 to 8 percent wet of optimum for expansive material and -1 to +3 percent for non-expansive cohesive materials according to ASTM D 1557. It should be noted that the use of a drying; i.e., type-C fly ash, will be allowed: however use of a drying agent will be considered a means of aeration chosen by the Contractor to allow him to meet construction schedules at no additional cost to the Government. Each lift of expansive cohesive material should be compacted to a range of 88 to 93 percent maximum density and 90 to 95 percent maximum dry density for non-expansive cohesive material according to ASTM D 1557 Methods A, B, C or D. Each lift of select material should be compacted to 95 percent maximum density. In-place densities of engineered fill should be determined using ASTM D-1556, ASTM D-2937, or ASTM D-2922 in conjunction with ASTM D-3017. If ASTM D-2922 is used for field density control, there should be at least one test performed according to ASTM D-1556 per every 10 tests performed according to ASTM D-2922 for verification of

results. Field density tests of the site grading operation should be performed at a frequency not less than one test per lift per 1000 square yards of every 8 inch lift. Field density tests of material placed beneath the building foundation should be performed at a frequency not less than one test per 275 square yards of every 8 inch lift.

Working surfaces should be sloped to prevent the ponding of water during construction. Excessively wet material will either need to be aerated or removed from the fill area prior to the placement of any subsequent lifts. Frozen material will not be not be allowed in the fill. Approved compacted fill should be maintained at the proper moisture and density condition until the slab-on-grade, foundation, or pavement is completed. Within 48 hours of bringing the building area surface to finished grade, a 6-inch working platform should be placed over the surface to assist in maintaining the desired moisture content range of the native materials. Areas disturbed due to construction activity should be recompacted to the specified moisture and density. Fill within the building area should be constructed to the finished grade elevation before the foundations are constructed.

9. DESIGN RECOMMENDATIONS: The proposed units should be constructed on shallow foundations consisting of individual or continuous spread footings. Foundations should be sized using a net allowable bearing pressure of 2,500 p.s.f. In order to minimize differential settlement, all foundations should bear entirely on natural subgrade or a minimum depth of engineered fill equal to one footing width. Total anticipated settlement of this foundation system should be on the order of ½ inch. Foundations should bear a minimum of 46 inches beneath adjacent finished grade to be below the depth of seasonal moisture variation. Foundation trenches for continuous footings should be excavated to the required depth and width with a minimum amount of disturbance to the bearing material and thoroughly "crumbed out". Adequate drainage should be provided to prevent ponding of water both during and subsequent to construction. All runoff should be collected and directed away from structures and excavations.

To reduce the potential for swell in the native shales and high plasticity soils, the material within 2 feet of the bottom of the building slabs-on-grade should consist of select material and the capillary water barrier material.

The minimum limits of the area filled with these materials should be the area inside the foundation walls or, if the building foundation is a slab-on-grade, the area within the foot print of the building. In order to protect the uncovered or placed and compacted expansive soil surface from drying, select material should be placed on this surface at least 8 inches deep immediately after uncovering or placing and compacting material. This layer of select material should be used as a working platform, with excavations for footings and utilities being made through the layer. Any excavations through the working platform should be backfilled with select material the entire depth of the excavation within 48 hours. Six inches of capillary water barrier material should be placed above the top of this select material. All expansive soil surfaces shall be protected from excessive moisture as directed by the Contracting Officer.

Slabs-on-grade should be designed using a coefficient of subgrade reaction of 75 pounds per cubic inch (pci). All slabs-on-grade floor slabs should be isolated from load bearing walls. Non-yielding walls backfilled with native clay materials should be designed using a coefficient of earth pressure at-rest (K_o) of 1.0. The expansive nature of the native clays must be considered in addition to at-rest earth pressure conditions acting on the wall. Non-yielding walls backfilled with granular materials should be designed using a coefficient of earth pressure at-rest (K_o) of 0.55. Yielding exterior walls backfilled with native clays materials should be designed using a coefficient of active earth pressure (K_a) of 0.75. The resistance of concrete against sliding when placed on clay material should be determined by using a coefficient of sliding of 0.35 for the area of concrete in contact with the clay. The passive resistance of the soil should not be used to resist lateral forces. A moist unit weight of 120 pounds per cubic foot (pcf) should be used for the weight of the backfill materials.

Backfill material placed adjacent to footings or behind retaining walls should be placed in loose lift that are a maximum of 8 inches in thickness when compacted with heavy mechanical tampers or a maximum of four inches when power driven hand compaction equipment is used. Heavy equipment for spreading and compacting backfill should not be operated closer to foundation walls or retaining walls than a

distance equal to the height of the backfill above the back of the wall or wall footings.

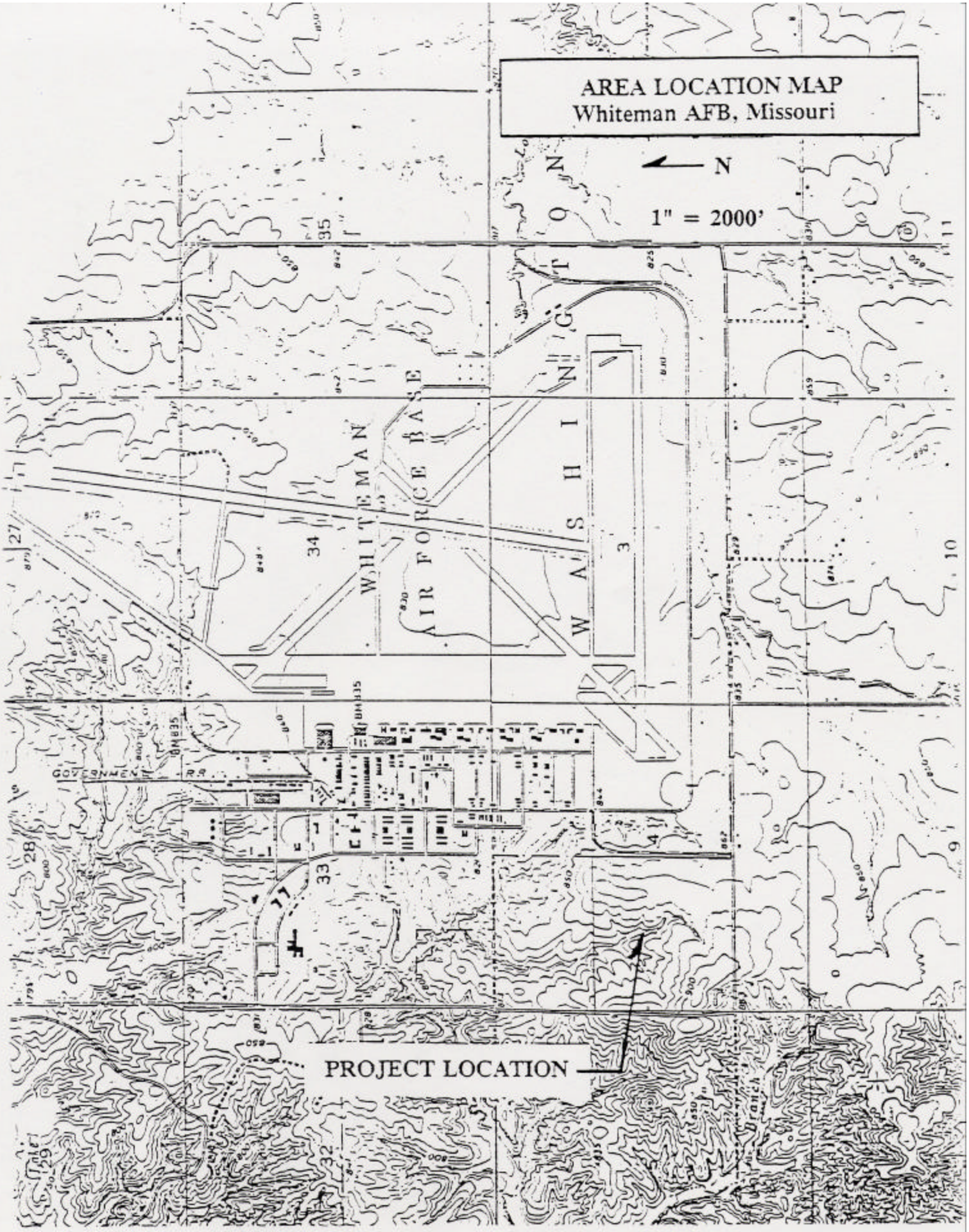
Excavations for utility trenches will need to be braced, shored, sloped, or made with a trench block, per EM 385-1-1 to protect workmen, adjacent structures, and pavements. Excavated material placed near a cut must be at a distance greater than the depth of the excavation. Depending on the season of the year, the location of the excavation, the depth of excavation, and the length of time the trench is left open, groundwater control maybe required. Typical clay materials encountered at WAFB have moderate to severe corrosion potential. All recommendations for buildings should be followed during the installation of utilities. There should also be an additional 10 inches of select material placed on the working platform subsequent to installation of utilities.

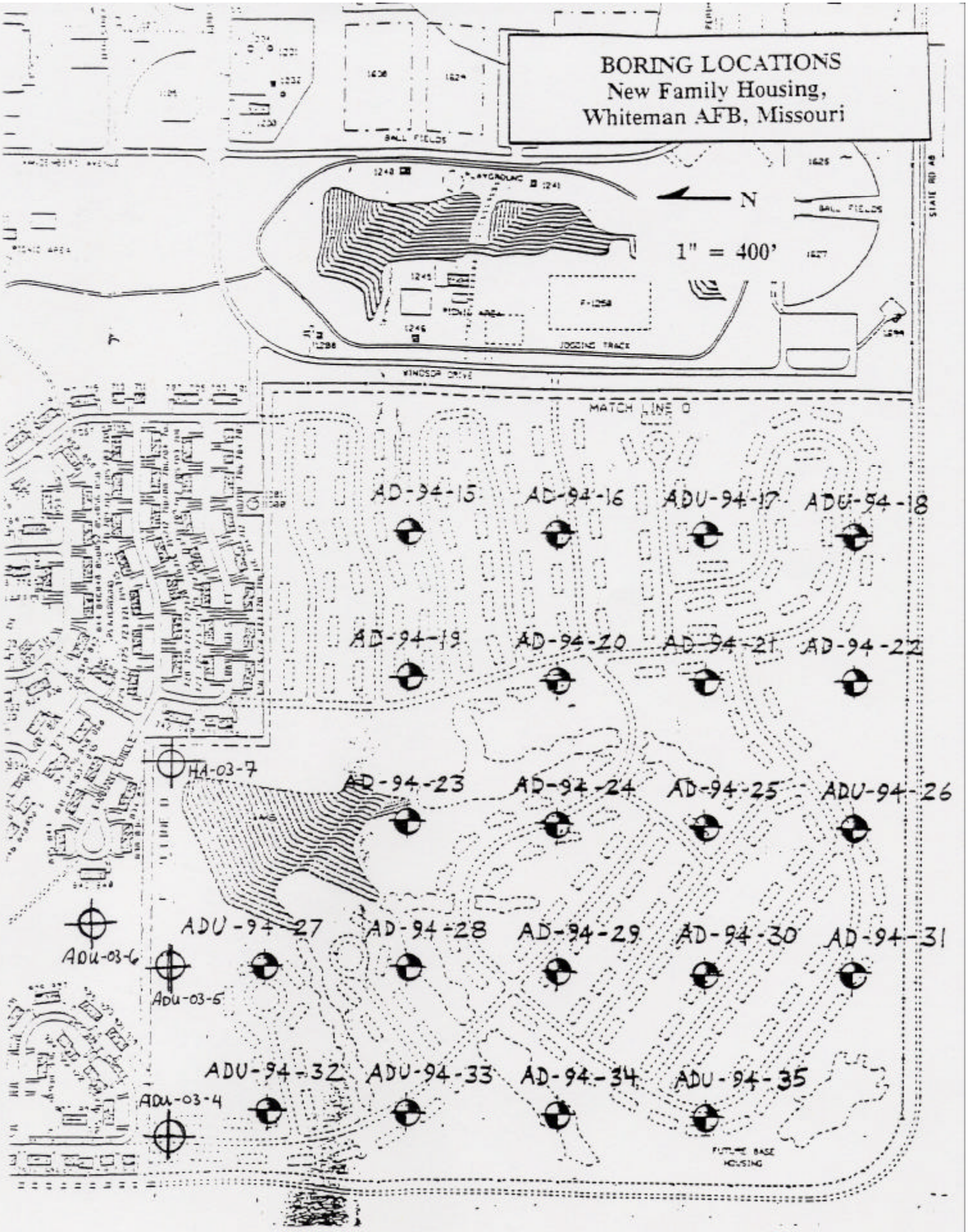
10. PAVEMENT SITE PREPARATION AND CONSTRUCTION: Any remnant of existing construction debris should be completely removed and properly disposed of in designated areas. Topsoil should be stripped to a depth of 12 inches and stockpiled for later use. Due to the potential for high volume changes of the subgrade with varying soil moisture content, the upper 6-inch subgrade below all flexible pavement sections should be lime-modified according to Army Technical Manual TM 5-822-14 to reduce plasticity and provide a working platform for construction traffic. Areas of subgrade which have potential for accumulating high volumes of water below the roadway pavement (normally at pavement low points) should be constructed with transverse under drains to outlet trapped moisture. Sloped surfaces steeper than 1 vertical to 4 horizontal should be stepped or benched prior to the placement of any new fill. New fill should be placed in uncompacted lifts not to exceed 8 inches. Stones having a dimension greater than 3 inches will not be permitted in the engineered fill or pavement subgrade. Native clay materials used for fill to construct parking areas should be compacted to a minimum of 90 percent maximum density as determined by ASTM D-1557 methods B, C or D. The lime-modified subgrade (upper 6 inches) of flexible pavements should be compacted to 95 percent of the maximum density as determined by ASTM D-1557 method B,C, or D. The subgrade (upper 6 inches) of rigid pavements should be compacted to a minimum of 90 percent of the maximum density as determined by ASTM D-1557 methods B,C,or D. Compaction

of native clays materials beneath grassed areas or sidewalks need only be compacted to a maximum density of 85 percent of the maximum density. The moisture content of the subgrade materials should be adjusted either by moistening or aerating as required to a range of 1 to 4 percent wet of optimum moisture. Frozen materials will not be permitted in the fill. Flexible pavement base course should be compacted to a minimum of 98 percent of the maximum density as determined by ASTM D-1557, method B,C,or D. In-place field density tests should be obtained in accordance with ASTM method D-1556, or D-2922 in conjunction with ASTM D-3017. Field density tests should be taken at a frequency not less than one test per each 8-inch lift of every 300 square yards of subgrade. Field density tests should be taken at a frequency not less than one test per each 8-inch lift of every 500 square yards of base course. Material gradation and moisture testing should be performed at a rate of one test per embankments or fills, the working surface should be sloped to prevent the ponding of water. After completion, newly graded areas should be protected from traffic and erosion. The pavement design is shown in Appendix C of this report.

APPENDIX A

SITE MAP
PLAN VIEW OF BORING LOCATIONS
FIELD STRIP LOGS

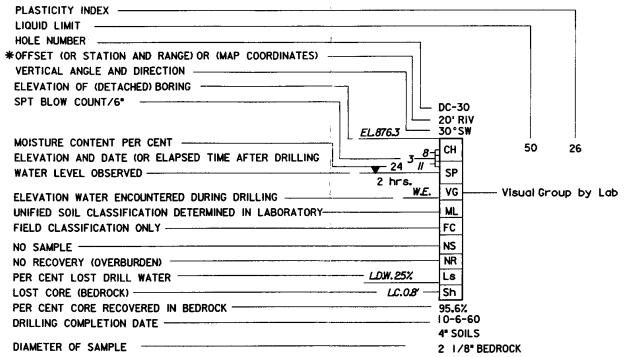

AREA LOCATION MAP
Whiteman AFB, Missouri
N
1" = 2000'
WHITEMAN AIR FORCE BASE
WASHINGTON
GOVERNMENT RR
PROJECT LOCATION


BORING LOCATIONS
New Family Housing,
Whiteman AFB, Missouri
N
1" = 400'
BALL FIELDS
PLAYGROUND
PICNIC AREA
JOGGING TRACK
WINDSOR DRIVE
STATE RD AB
MATCH LINE D
AD-94-15
AD-94-16
ADU-94-17
ADU-94-18
AD-94-19
AD-94-20
AD-94-21
AD-94-22
HA-03-7
AD-94-23
AD-94-24
AD-94-25
ADU-94-26
ADU-94-27
AD-94-28
AD-94-29
AD-94-30
AD-94-31
ADU-03-6
ADU-03-5
ADU-94-32
ADU-94-33
AD-94-34
ADU-94-35
ADU-03-4
FUTURE BASE HOUSING

ABBREVIATIONS

alt	alternating	dmp	damp	lea	leached	rnd (d)	round, (rounded)
ang	angular	dol (c)	dolomite, (dolomitic)	lig	lignite	sat	saturated
an	anhydrite	ext	extremely	ls	limestone	scat	scattered
ar	argillaceous	f (y)	fine, (finely)	lt	light	sd (y)	sand, (sandy)
bdd	bed, bedded, bedding	fe	iron	lo	loose	sev	several
bdr	bedrock	fld	filled	L.C.	lost core	sh (y)	shale, (shaly)
bky	blocky	fm	firm	L.D.W.	lost drill water	sl (y)	silt, (silty)
bl	blue	fos (s)	fossil, (fossiliferous)	med	medium	sls	slitstone
bld	boulder	frac (d)	fractures, (fractured)	mic	micaceous	sl	slightly
blk	black	frag (d)	fragments, (fragmented)	min	mineralized	slcs	siliceous
brec (d)	breccia, (brecciated)	fri	friable	mod (y)	moderate, (moderately)	slks	slickensides
brk	broken	fsl	fissile	mot	mottled	so	soft
brn	brown	gr	grain	mss	massive	sol (d)	solution, (solutionized)
c	coarse	gra	gradation	mst	moist	ss	sandstone
calc	calcareous	grn	green	mtl	material	st (g)	stained, (staining)
carb	carbonaceous	grv (y)	gravel, (gravelly)	mtx	matrix	stf	stiff
cav	cavity	gry	gray	nod	nodules	sty	stylolitic
cbl	cobble	gyp	gypsum	num	numerous	v	very
cht	chert	ha	high angle	occ (y)	occasional, (occasionally)	vert	vertical
circl	circulation	hd	hard	op	open	vgy	vuggy
cl (y)	clay, (clayey)	hld	healed	or	orange	w	water
cld	closed	hor	horizonal	org	organic	w/	with
cmtd	cemented	inbd	interbedded	par	partially	wth	weathered
col	columnar	incl	inclusions	pit	pit, pitted, pitting	wht	white
conc	concretions	inlam	interlaminated	pl	plastic	x-bdd	crossed-bedded
cong	conglomerate	irr	irregular	pla	platy	xln	crystalline
crm	crumbly	jt (s)	joint, (joints)	pln	plane	y	yellow
d	dense	la	low angle	ptg (s)	parting, (partings)	When used as log symbol	
dk	dark	lam (d)	laminae, (laminated)	qtz (e)	quartz, (quartzite)	first letter is capitalized	
				pbls	pebbles		

LEGEND OF LOGS OF BORINGS



*OFFSET FROM PROFILE OR SECTION MAY BE UPSTREAM OR DOWNSTREAM (U OR D,) LANDWARD OR RIVERWARD (LWD OR RIV), OR RIGHT OR LEFT (R OR L) AS DEFINED.

UNIFIED SOIL CLASSIFICATION SYSTEM

- **GW** Well graded gravels, gravel-sand mixtures, little or no fines.
- **GP** Poorly graded gravels or gravel-sand mixtures, little or no fines.
- **GM** Silty gravels, gravel-sand-silt mixtures.
- **GC** Clayey gravels, gravel-sand-clay mixtures.
- **SW** Well-graded sands, gravelly sands, little or no fines.
- **SP** Poorly graded sands or gravelly sands, little or no fines.
- **SM** Silty sands, sand-silt mixtures.
- **SC** Clayey sands, sand-clay mixtures.
- **ML** Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts w/slight plasticity.
- **CL** Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
- **OL** Organic silts and organic silty clays of low plasticity.
- **MH** Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
- **CH** Inorganic clays of high plasticity, fat clays.
- **OH** Organic clays of medium to high plasticity, organic silts.
- **Pt** Peat and other highly organic soils.

Classified from actual laboratory tests where LL and PI are shown.
Dual classication, where used, is in accordance with the Unified Soil Classification System.
For details on the Unified Soil Classification System, See Waterways Experiment Station.
Technical Memorandum No. 3-357 dated March 1953 and revised in 1960.

RQD (Rock Quality Designation)	Description of Rock Quality
0 - 25%	Very Poor
25 - 50%	Poor
50 - 75%	Fair
75 - 90%	Good
90 - 100%	Excellent

TYPE OF EXPLORATION

MAP SYMBOL

- VERTICAL BORING
- 30° INCLINED BORING SHOWING DIRECTION AND VERTICAL ANGLE

CODE DESIGNATION

- D DRIVE SAMPLE HOLE
- C CORE HOLE
- TP TEST PIT (INCLUDES POWER AUGER 24" OR LARGER DIAMETER)
- U UNDISTURBED SAMPLE HOLE
- A AUGER HOLE-HAND OR POWER AUGER LESS THAN 24" DIAMETER.
- NS NOT SAMPLED (FIELD CLASSIFICATION FROM CUTTINGS ONLY
- FS FIELD SECTION OF OUTCROP.
- P PERMANENT PIEZOMETER

DEGREE OF WEATHERING

Unweathered: no evidence of any mechanical or chemical alteration.

Slightly weathered: slight discoloration on surface, slight alteration along discontinuities, less than 10 percent of the rock volume altered, and strength substantially unaffected.

Moderately weathered: discoloring evident, surface pitted and altered with alteration penetrating well below rock surfaces, weathering "halos" evident, 10 to 50 percent of the rock altered, and strength noticeably less than fresh rock.

Highly weathered: entire mass discolored, alteration in nearly all of the rock with some pockets of slightly weathered rock noticeable, some minerals leached away, and only a fraction of original strength (with wet strength usually lower than dry strength) retained.

Decomposed: rock reduced to a soil with relict rock texture (saprolite) and generally molded and crumbled by hand.

TM 5-818-1/AFM 88-3, Chap. 7

BEDROCK UNIT OF THICKNESS

Parting	<0.02'
Band	0.02' to 0.2'
Thin Bed	0.2' to 0.5'
Medium Bed	0.5' to 1.0'
Thick Bed	1.0' to 2.0'
Massive	>2.0'

TERMS FOR CONSISTENCY OF SOIL AND HARDNESS OF BEDROCK

SOIL

Consistency	Estimated Unconfined Compressive Strength (Tons per square foot)
Very soft	<0.25
Soft	0.25-0.5
Medium	0.5-1.0
Stiff	1.0-2.0
Very stiff	2.0-4.0
Hard	>4.0

BEDROCK

SCALE OF HARDNESS

Very soft or plastic	Can be indented easily with thumb.
Soft	Can be scratched with fingernail.
Moderately hard	Can be scratched easily with knife; cannot be scratched with fingernail.
Hard	Difficult to scratch with knife.
Very hard	Cannot be scratched with knife.

NOTE:

FOR LOGS OF EXPLORATIONS, SEE SHEET NO'S G-2

US Army Corps of Engineers
Kansas City District

Symbol	Description	Date	Appr.

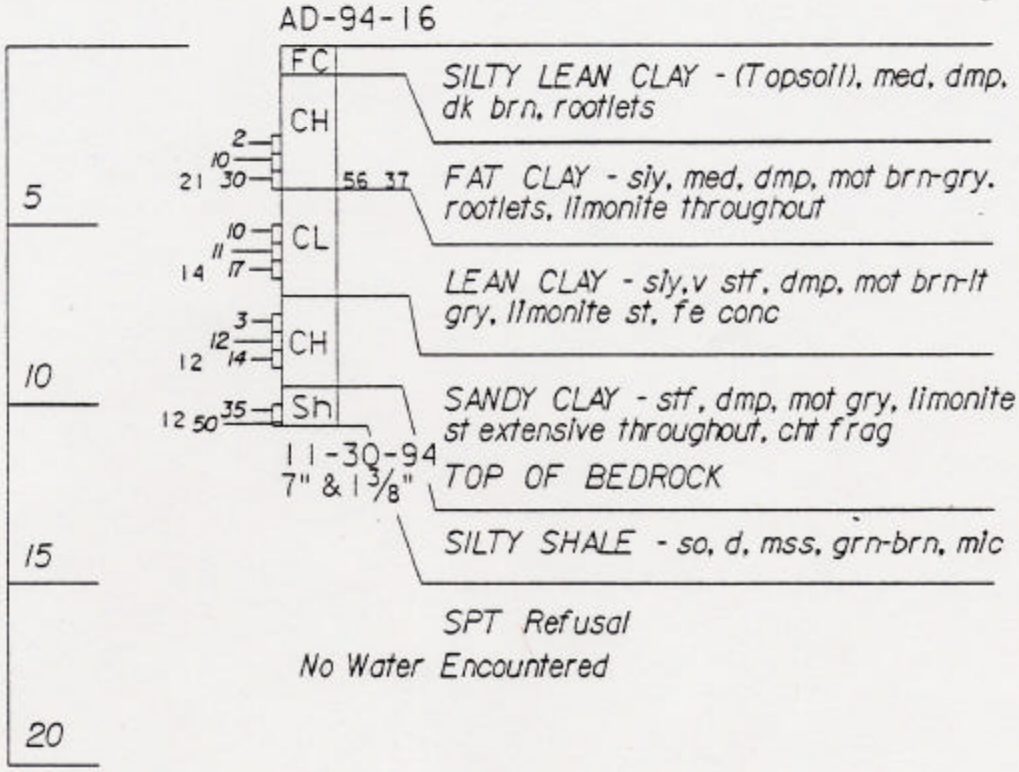
Designed by: J.M.M. | Date: MAY 2003 | Rev.
Dwn by: J.M.M. | Ckd by: A.W.O | Design file no. | Drawing code:
Reviewed by: | Submitted by: | File name: | Plot date: | Plot scale:

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

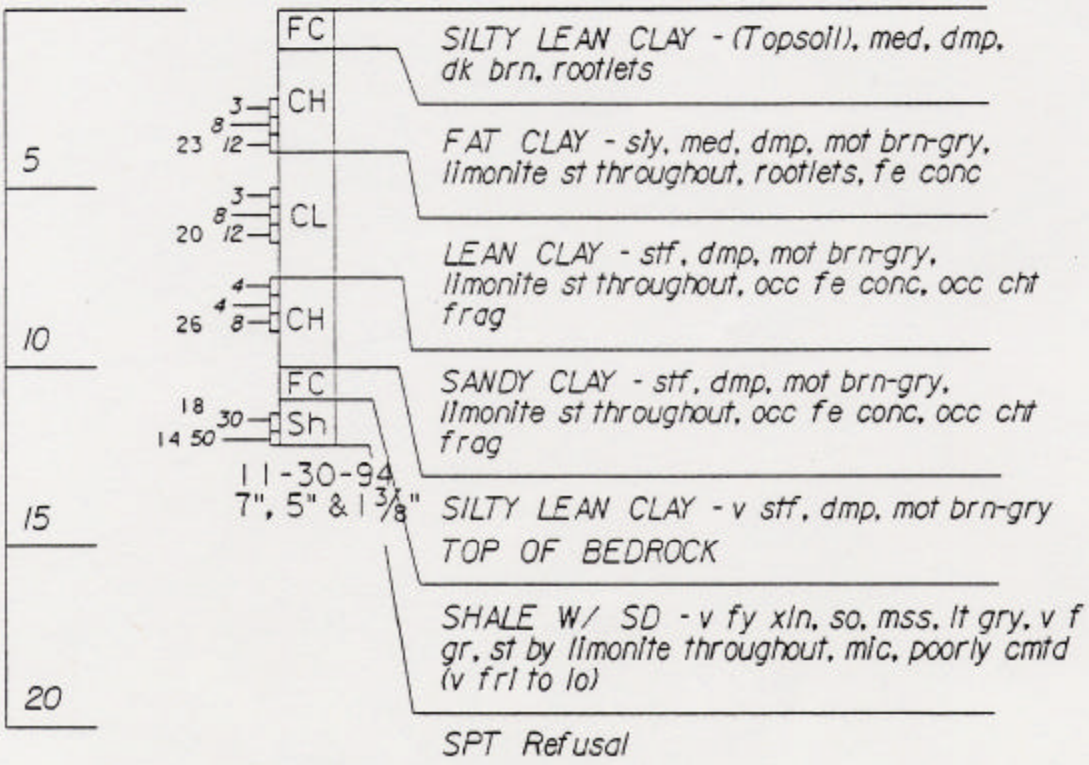
WHITEMAN AIR FORCE BASE MISSOURI
REPLACE FAMILY HOUSING
FY 2003

GEOLOGIC LEGEND AND ABBREVIATIONS

Sheet reference number:
G-1

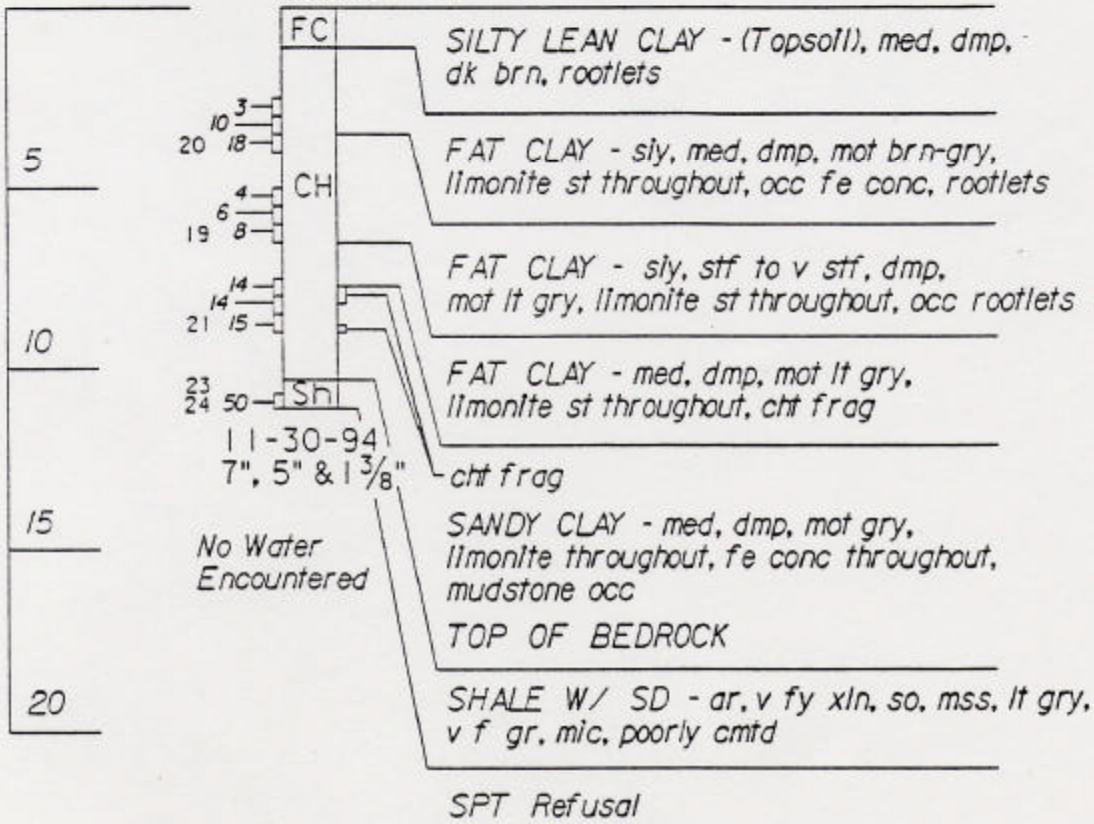

AD-94-16
FC
CH
CL
CH
Sh
2
10
21 30
10
11
14 17
3
12
12 14
12 50 35
56 37
11-30-94
7" & 1 3/8"
5
10
15
20
SILTY LEAN CLAY - (Topsoil), med, dmp, dk brn, rootlets
FAT CLAY - sly, med, dmp, mot brn-gry, rootlets, limonite throughout
LEAN CLAY - sly, v stf, dmp, mot brn-lt gry, limonite st, fe conc
SANDY CLAY - stf, dmp, mot gry, limonite st extensive throughout, cht frag
TOP OF BEDROCK
SILTY SHALE - so, d, mss, grn-brn, mic
SPT Refusal
No Water Encountered

ADU-94-17



No Water Encountered

ADU-94-18


FC
CH
Sh
3
10
20
18
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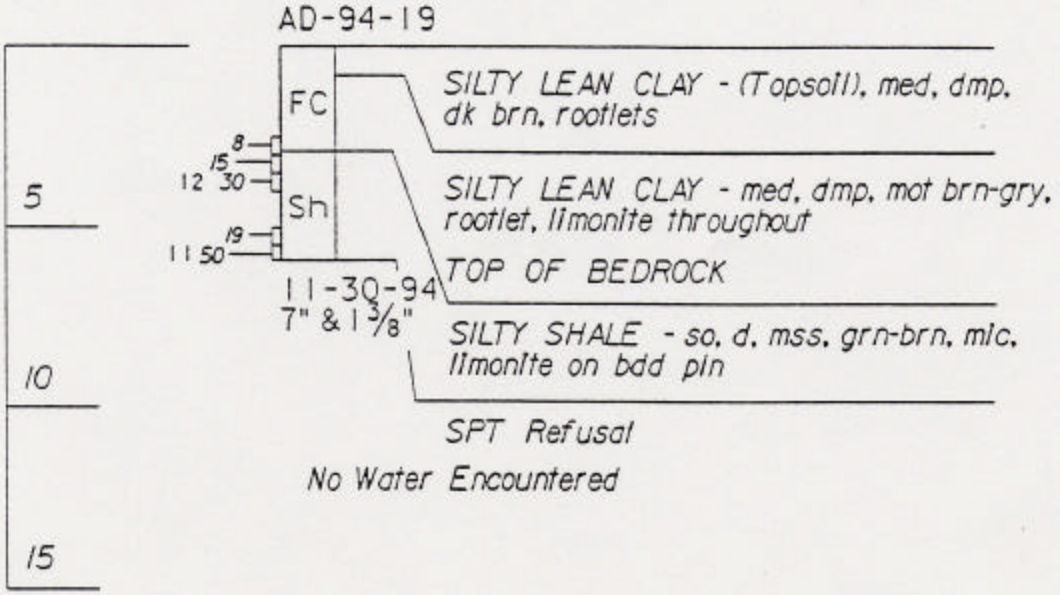
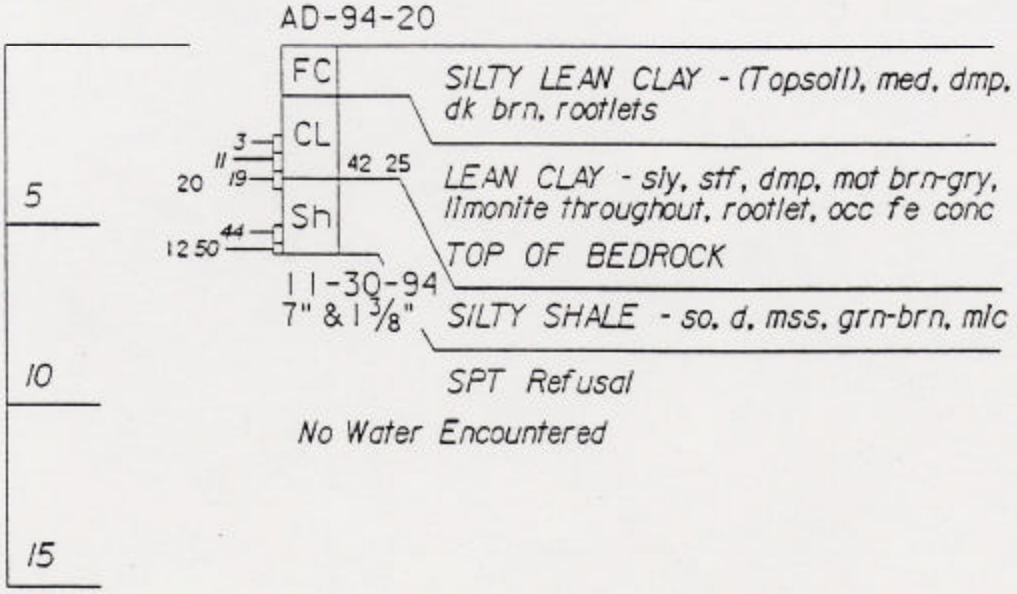
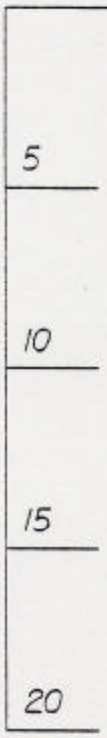
19
8
14
14
21
15
23
24
50
5
10
15
20
SILTY LEAN CLAY - (Topsoil), med, dmp, dk brn, rootlets
FAT CLAY - sly, med, dmp, mot brn-gry, limonite st throughout, occ fe conc, rootlets
FAT CLAY - sly, stf to v stf, dmp, mot lt gry, limonite st throughout, occ rootlets
FAT CLAY - med, dmp, mot lt gry, limonite st throughout, cht frag
11-30-94
7", 5" & 1 3/8"
cht frag
No Water Encountered
SANDY CLAY - med, dmp, mot gry, limonite throughout, fe conc throughout, mudstone occ
TOP OF BEDROCK
SHALE W/ SD - ar, v fy xln, so, mss, lt gry, v f gr, mic, poorly cmtd
SPT Refusal


AD-94-19
FC
Sh
8
15
12 30
19
11 50
5
10
15
SILTY LEAN CLAY - (Topsoil), med, dmp, dk brn, rootlets
SILTY LEAN CLAY - med, dmp, mot brn-gry, rootlet, limonite throughout
TOP OF BEDROCK
11-30-94
7" & 1 3/8"
SILTY SHALE - so, d, mss, grn-brn, mic, limonite on bdd pin
SPT Refusal
No Water Encountered


AD-94-20
FC
CL
Sh
3
11
19
20
44
12 50
42 25
5
10
15
SILTY LEAN CLAY - (Topsoil), med, dmp, dk brn, rootlets
LEAN CLAY - sly, stf, dmp, mot brn-gry, limonite throughout, rootlet, occ fe conc
TOP OF BEDROCK
11-30-94
7" & 1 3/8"
SILTY SHALE - so, d, mss, grn-brn, mlc
SPT Refusal
No Water Encountered

AD-94-21



FC

SILTY LEAN CLAY - (Topsoil), med, dmp, dk brn, rootlets

CH

9, 13, 21, 23

FAT CLAY - sly, stf to v stf, dmp, dk brn, limonite st, rootlets, occ fe conc, occ f grv size cht frag

8, 10, 22, 17

60 36

TOP OF BEDROCK

Sh

19, 28, 16, 50

v sly

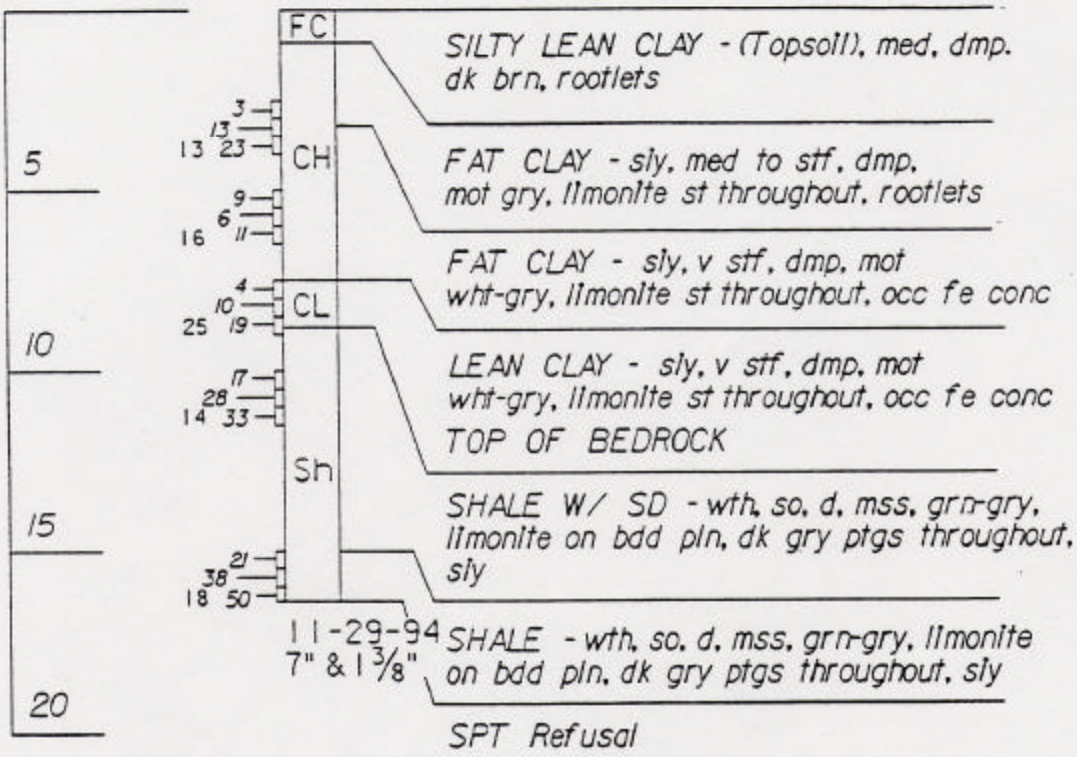
11-29-94
7" & 1 3/8"

SHALE - wth, so, d, mss, grn-gry, limonite on bdd pln, occ mudstone, sly throughout

SPT Refusal

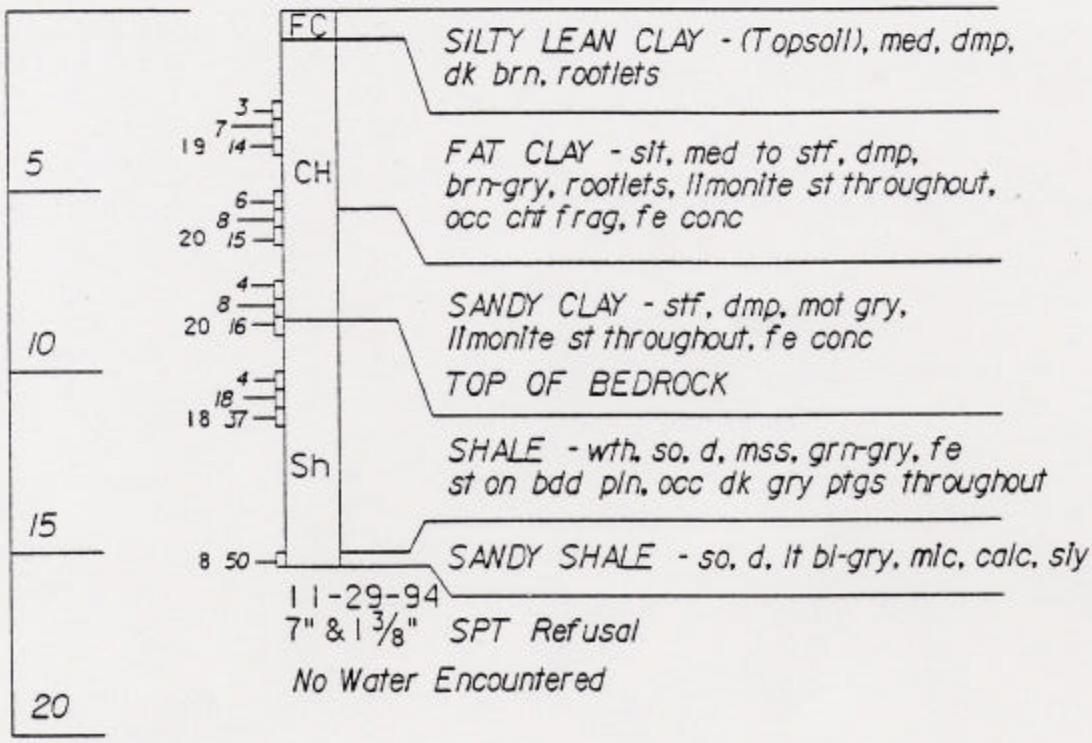
No Water Encountered

AD-94-22



No Water Encountered

AD-94-23


FC
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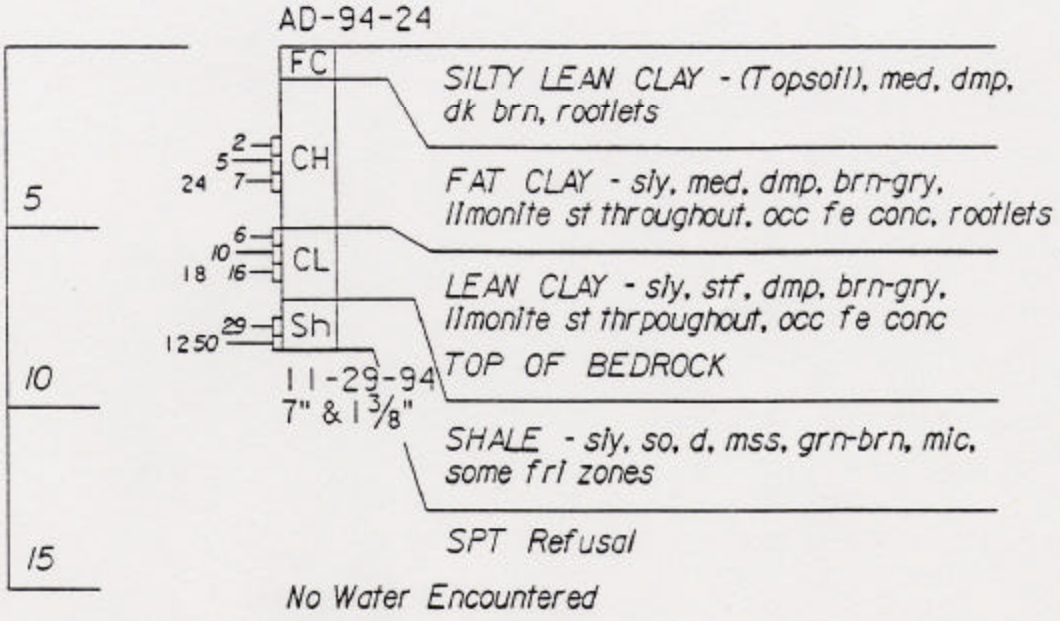
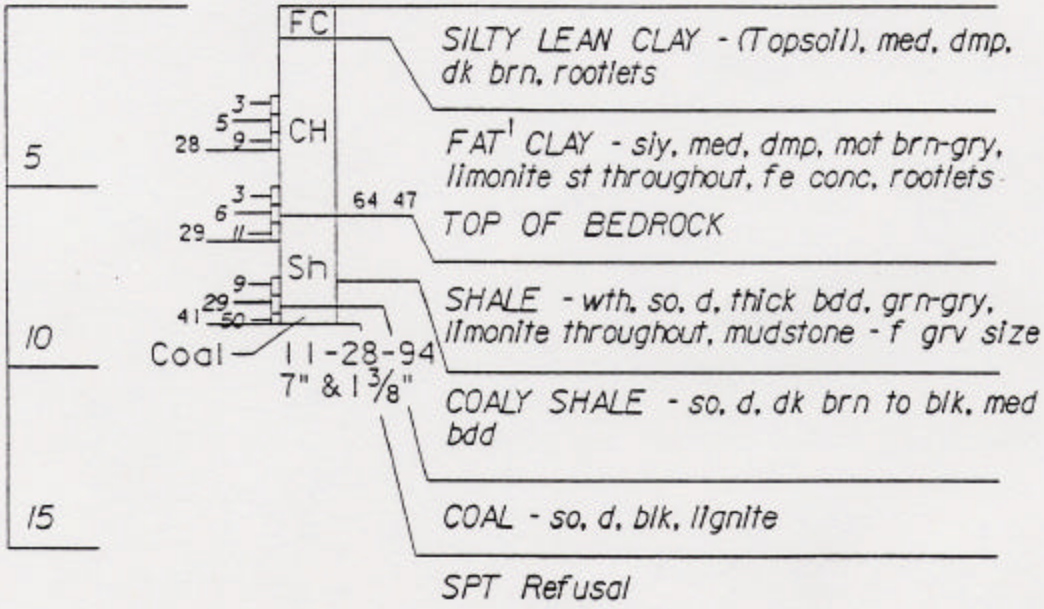
18
37
18
8 50
SILTY LEAN CLAY - (Topsoil), med, dmp, dk brn, rootlets
FAT CLAY - slt, med to stf, dmp, brn-gry, rootlets, limonite st throughout, occ cht frag, fe conc
SANDY CLAY - stf, dmp, mot gry, limonite st throughout, fe conc
TOP OF BEDROCK
SHALE - wth, so, d, mss, grn-gry, fe st on bdd pln, occ dk gry ptgs throughout
SANDY SHALE - so, d, lt bl-gry, mic, calc, sly
11-29-94
7" & 1 3/8" SPT Refusal
No Water Encountered

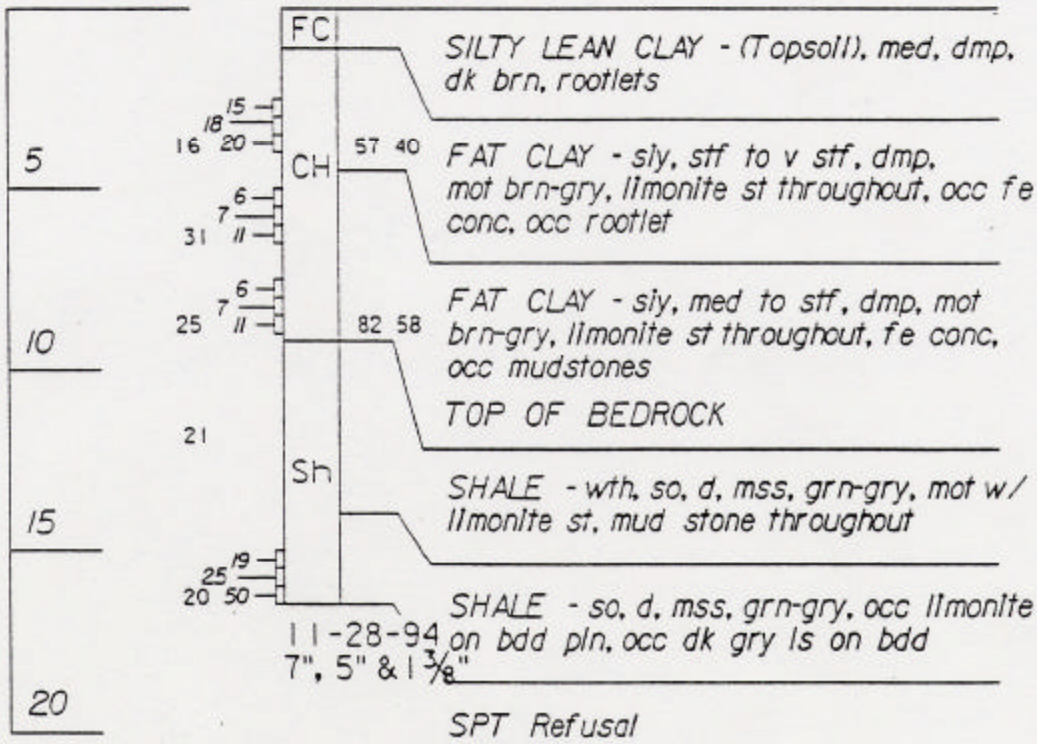

AD-94-24
FC
CH
CL
Sh
2
5
7
24
6
10
16
18
29
1250
5
10
15
SILTY LEAN CLAY - (Topsoil), med, dmp, dk brn, rootlets
FAT CLAY - sly, med, dmp, brn-gry, limonite st throughout, occ fe conc, rootlets
LEAN CLAY - sly, stf, dmp, brn-gry, limonite st thrpoughout, occ fe conc
TOP OF BEDROCK
11-29-94
7" & 1 3/8"
SHALE - sly, so, d, mss, grn-brn, mic, some fri zones
SPT Refusal
No Water Encountered

AD-94-25



No Water Encountered

ADU-94-26



No Water Encountered

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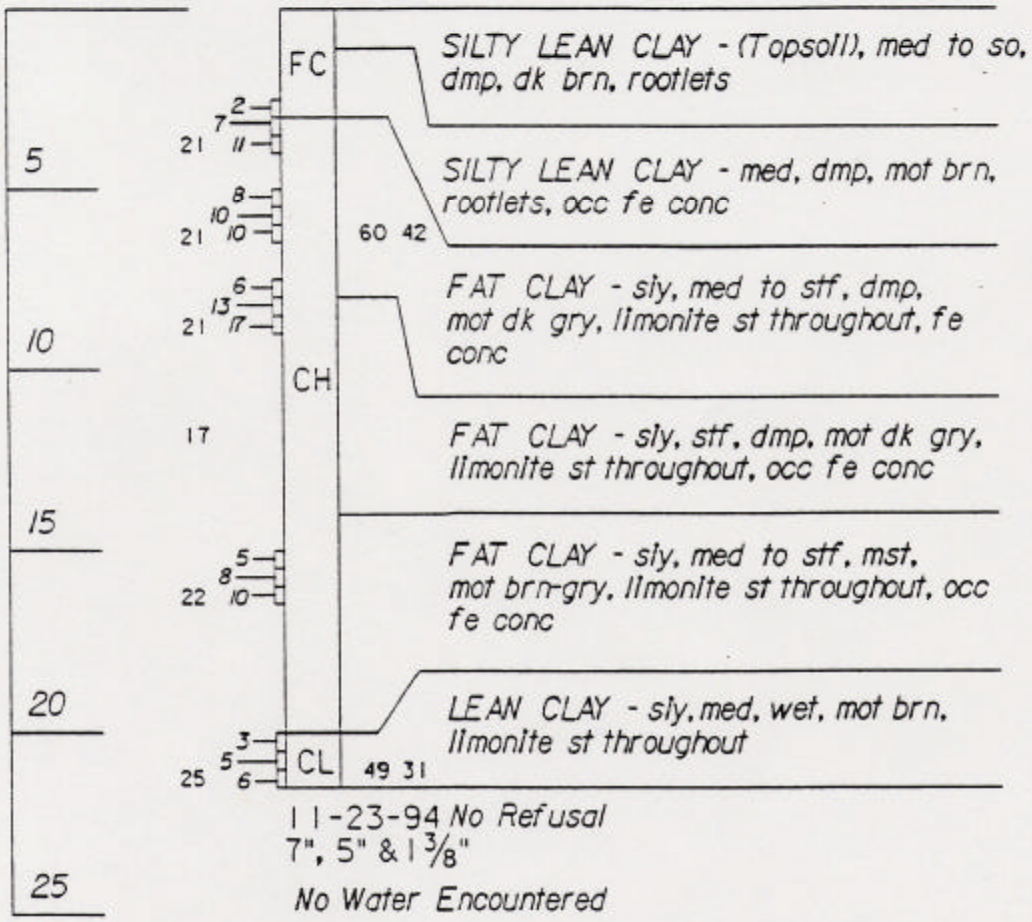
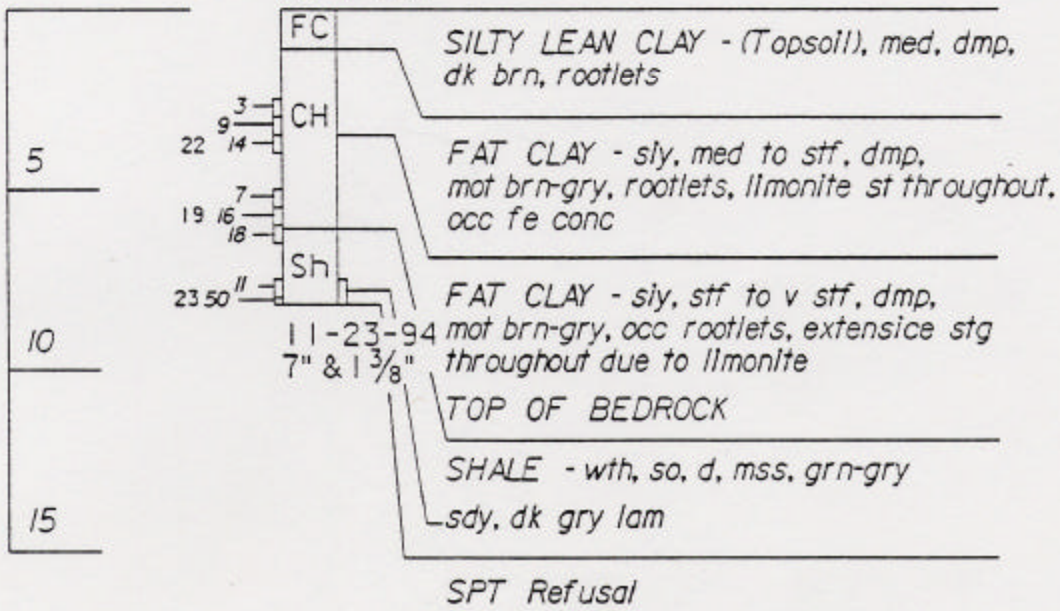


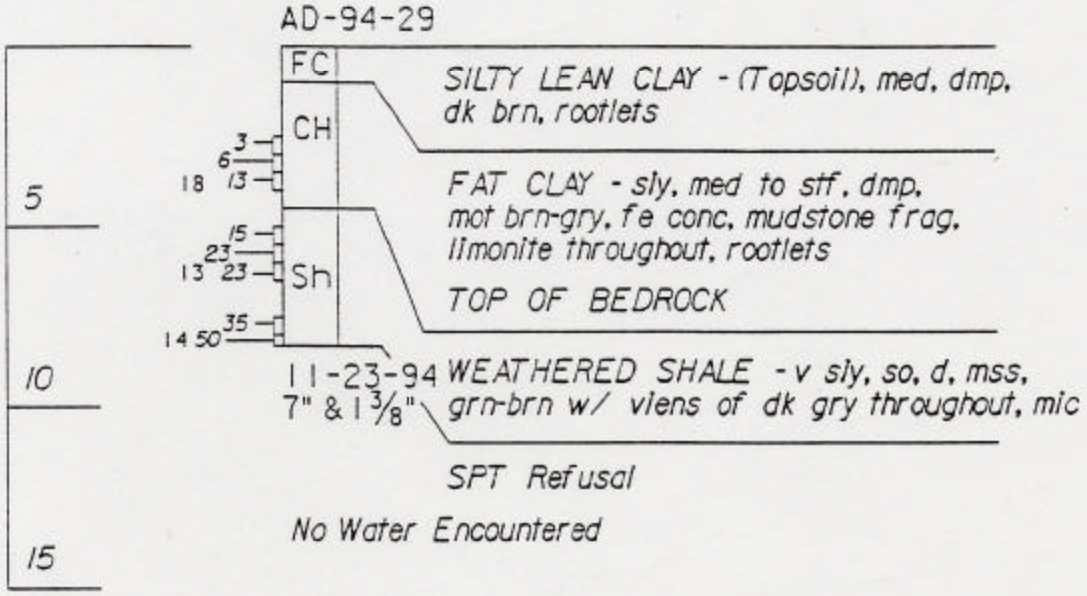
11-23-94 No Refusal
7", 5" & 1 3/8"

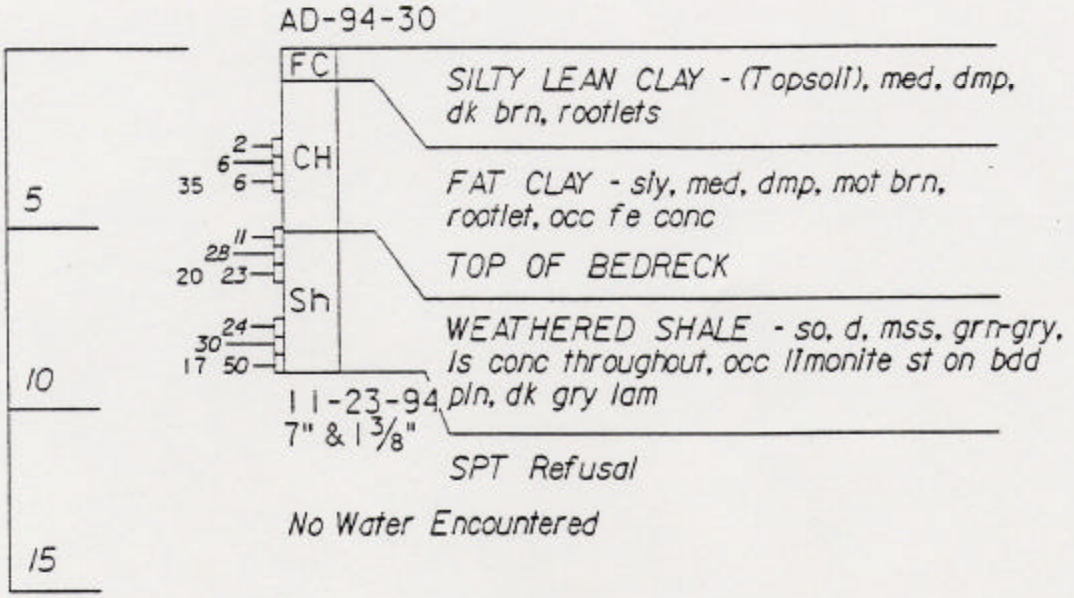
No Water Encountered

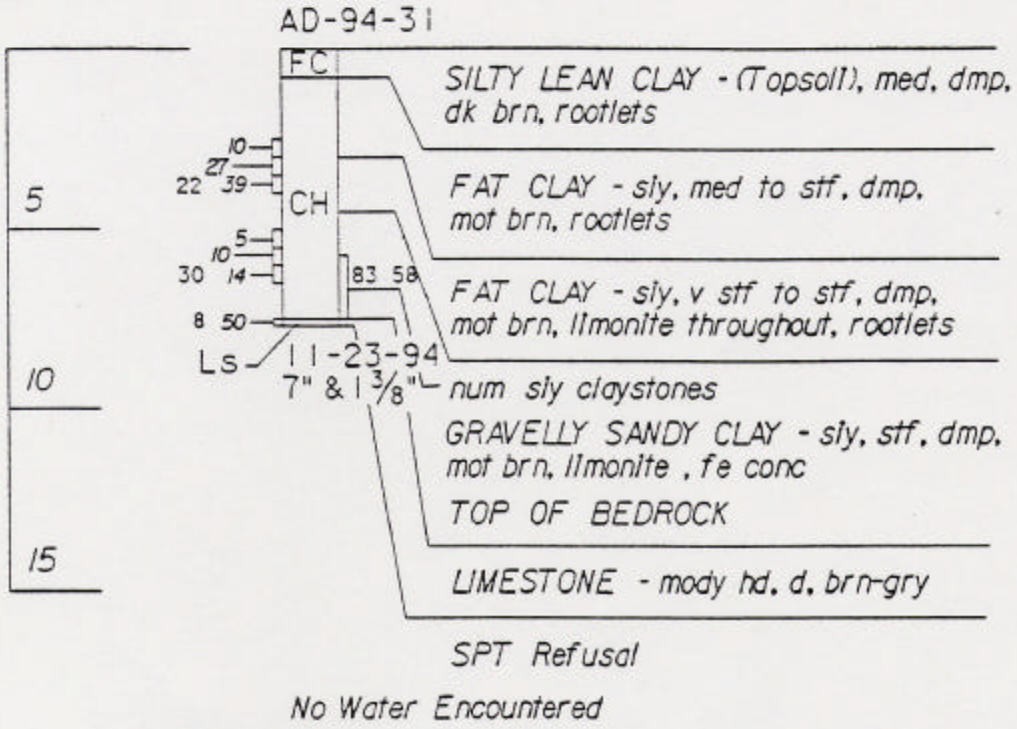
AD-94-28



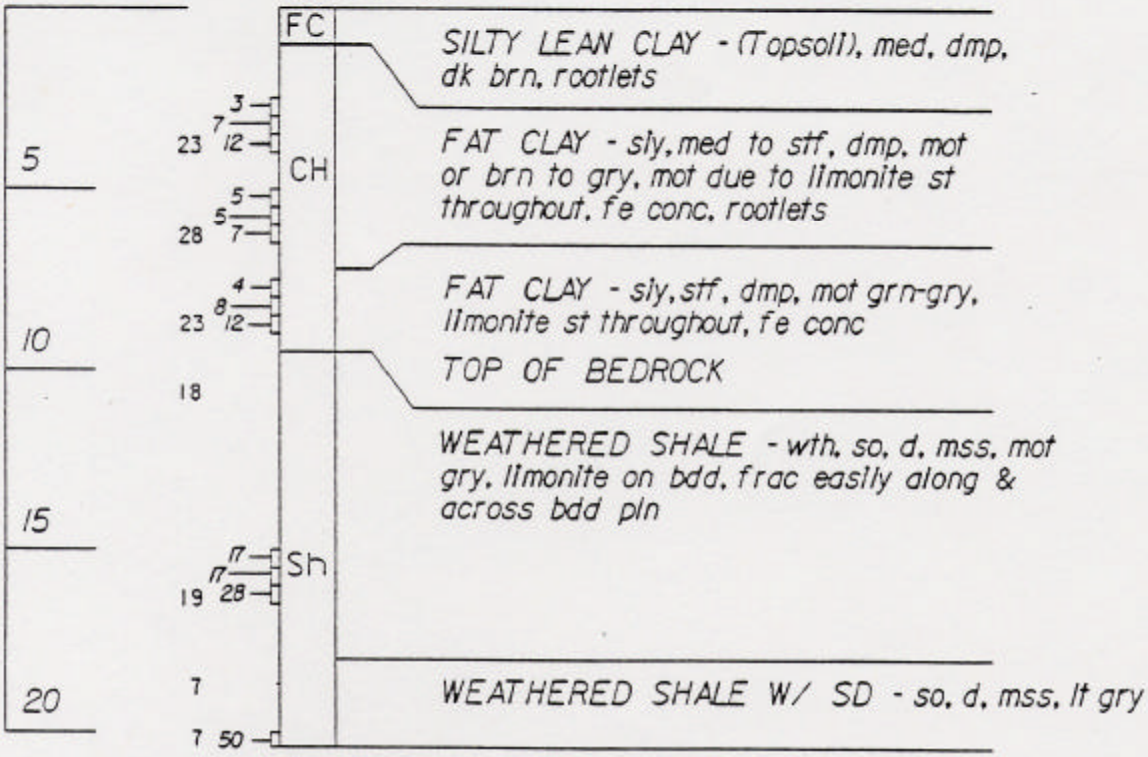
No Water Encountered


AD-94-29
FC
CH
Sh
3
6
18
13
15
23
13
23
35
14
50
5
10
15
SILTY LEAN CLAY - (Topsoil), med, dmp, dk brn, rootlets
FAT CLAY - sly, med to stf, dmp, mot brn-gry, fe conc, mudstone frag, limonite throughout, rootlets
TOP OF BEDROCK
11-23-94
7" & 1 3/8"
WEATHERED SHALE - v sly, so, d, mss, grn-brn w/ viens of dk gry throughout, mic
SPT Refusal
No Water Encountered


AD-94-30
FC
CH
Sh
2
6
35
6
11
28
20
23
24
30
17
50
5
10
15
SILTY LEAN CLAY - (Topsoil), med. dmp, dk brn, rootlets
FAT CLAY - sly, med, dmp, mot brn, rootlet, occ fe conc
TOP OF BEDRECK
WEATHERED SHALE - so, d, mss, grn-gry, ls conc throughout, occ limonite st on bdd pln, dk gry lam
11-23-94
7" & 1 3/8"
SPT Refusal
No Water Encountered


AD-94-31
FC
CH
10
27
22
39
5
10
30
14
83
58
8
50
Ls
11-23-94
7" & 1 3/8"
5
10
15
SILTY LEAN CLAY - (Topsoil), med. dmp. dk brn. rootlets
FAT CLAY - sly. med to stf. dmp. mot brn. rootlets
FAT CLAY - sly. v stf to stf. dmp. mot brn. limonite throughout. rootlets
num sly claystones
GRAVELLY SANDY CLAY - sly. stf. dmp. mot brn. limonite . fe conc
TOP OF BEDROCK
LIMESTONE - mody hd. d. brn-gry
SPT Refusal
No Water Encountered

ADU-94-32

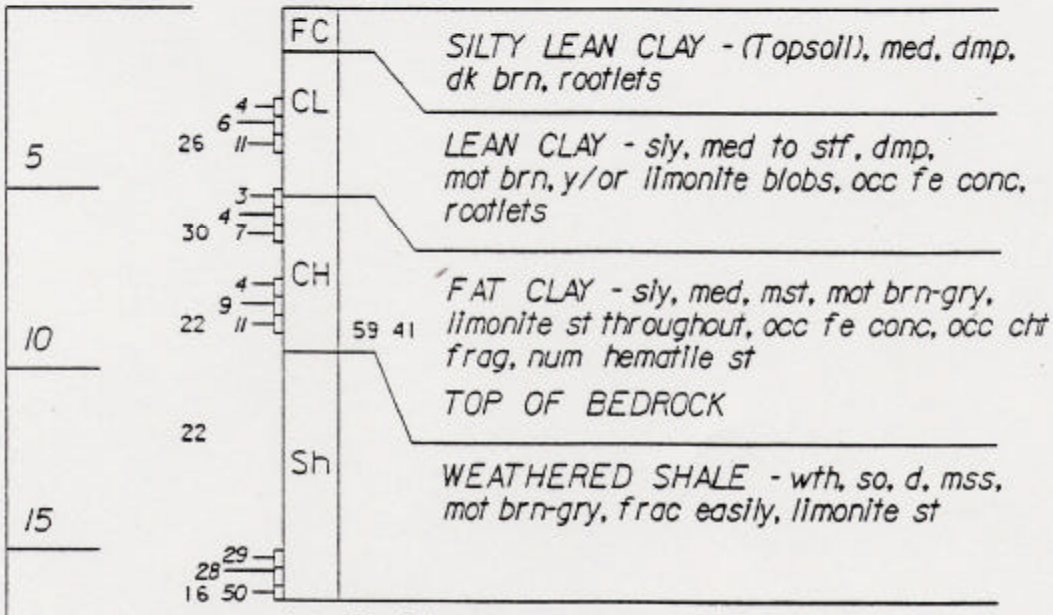


11-22-94
7", 5" & 1 3/8"

SPT Refusal

No Water Encountered

ADU-94-33



5

10

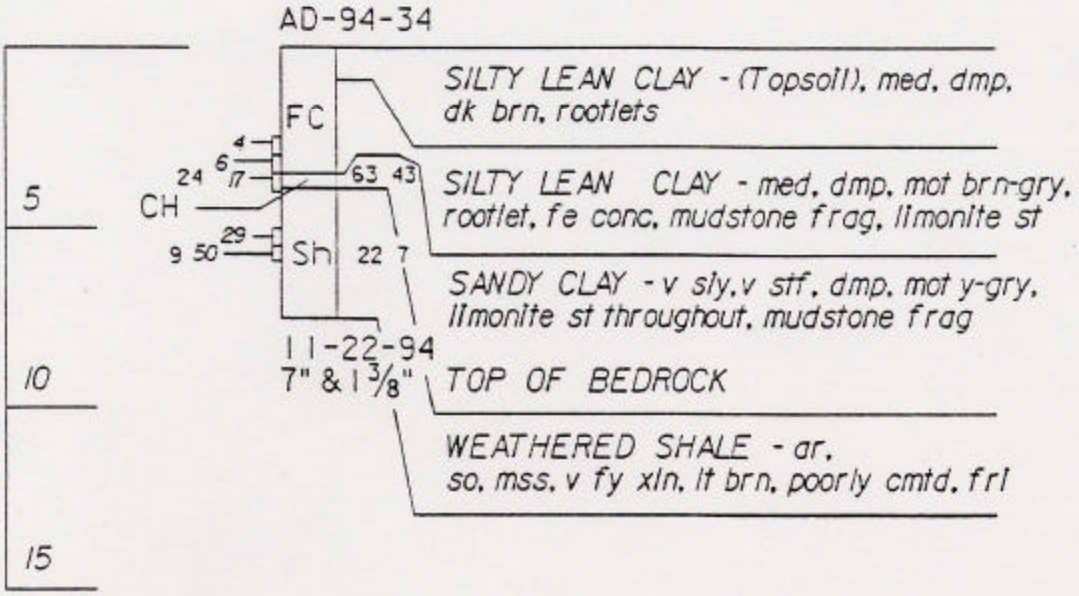
15

20

25

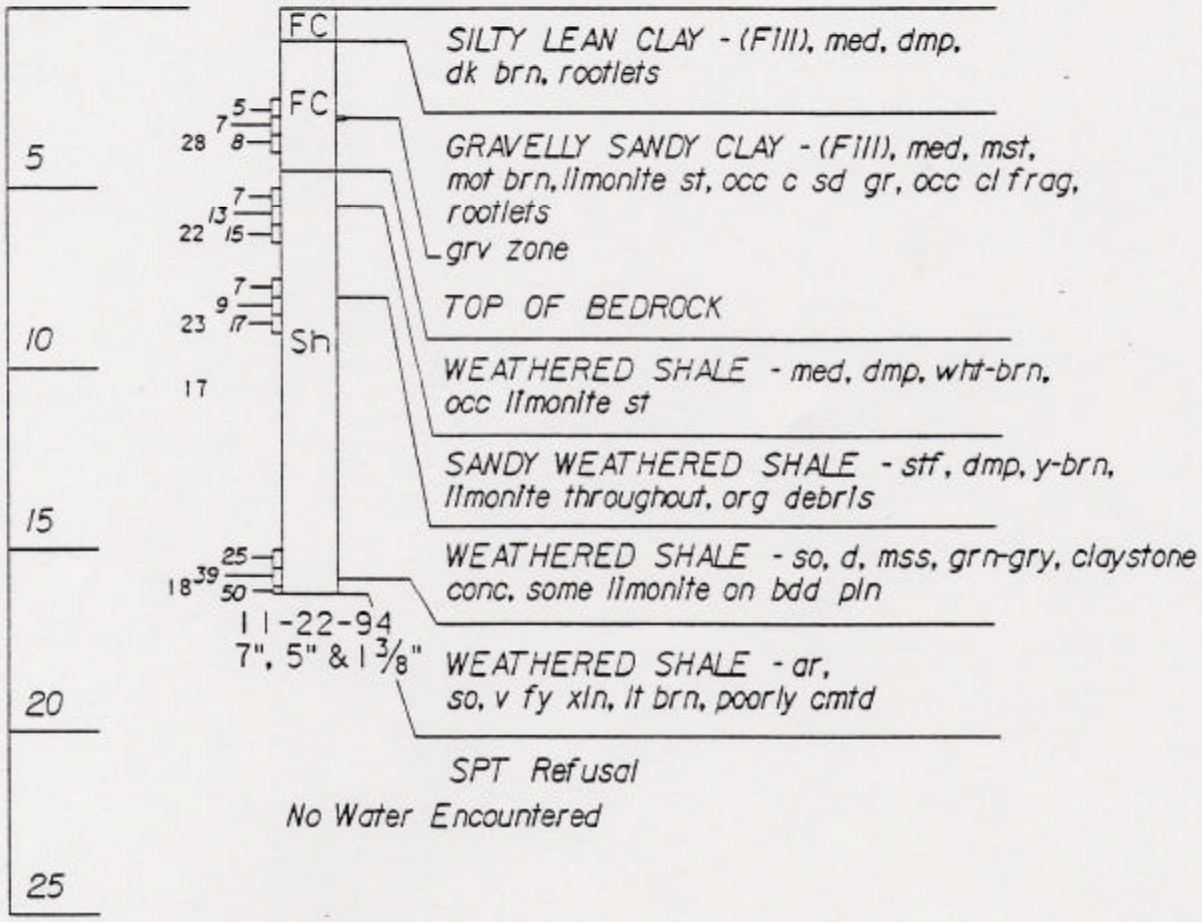
11-22-94 SPT Refusal
7", 5 & 1 3/8"

No Water Encountered



No Water Encountered

ADU-94-35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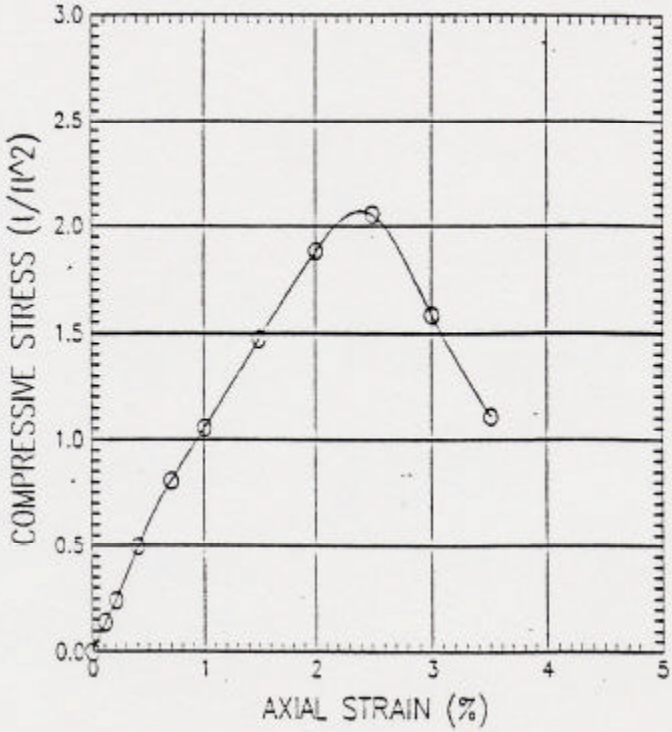
17
18
39
25
50
11-22-94
7", 5" & 1 3/8"
SILTY LEAN CLAY - (FILL), med, dmp, dk brn, rootlets
GRAVELLY SANDY CLAY - (FILL), med, mst, mot brn, limonite st, occ c sd gr, occ cl frag, rootlets
grv zone
TOP OF BEDROCK
WEATHERED SHALE - med, dmp, wht-brn, occ limonite st
SANDY WEATHERED SHALE - stf, dmp, y-brn, limonite throughout, org debris
WEATHERED SHALE - so, d, mss, grn-gry, claystone conc, some limonite on bdd pln
WEATHERED SHALE - ar, so, v fy xln, lt brn, poorly cmtd
SPT Refusal
No Water Encountered

APPENDIX B

STRENGTH TESTING DATA

CONSOLIDATION TEST DATA

FAILURE SKETCHES



☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

SYMBOL			O			
TEST NO.						
TYPE OF SPECIMEN			UNDISTURBED			
INITIAL	WATER CONTENT %	w_o	16.47			
	VOID RATIO	e_o	0.471			
	SATURATION %	S_o	94.43			
	DRY DENSITY (lb/ft^3)	γ_d	114.54			
TIME TO FAILURE (min)		t_f	5			
UNCONFINED COMPRESSIVE STRENGTH (t/ft^2)		q_u	2.06			
UNDRAINED SHEAR STRENGTH (t/ft^2)		s_u	1.03			
RATE OF STRAIN (%/min)			.5			
INITIAL SPECIMEN DIAMETER (in)		D_o	1.38			
INITIAL SPECIMEN HEIGHT (in)		H_o	2.99			

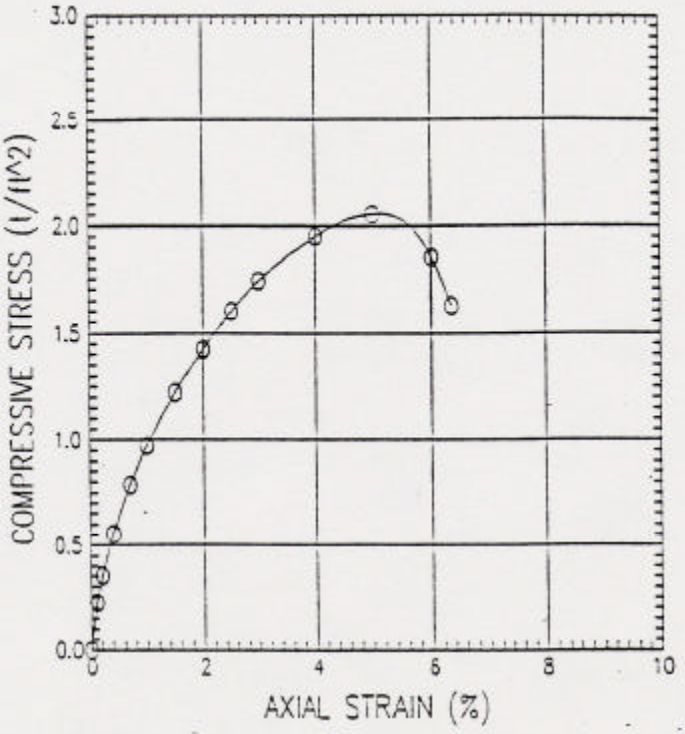
DESCRIPTION OF SPECIMENS: 1) SANDY CLAY, CL

LL : 42.00	PL : 16.00	PI : 26.00	GS : 2.70

REMARKS:	PROJECT WHITEMAN AFB					
1) 1.0 TSF TORVANE						
	BORING NO. ADU 94-17	SAMPLE NO.	W-1			
	TECH. JSS	DEPTH/ELEV	10.0-11.2'			
	LABORATORY	DATE	1/09/95			
	UNCONFINED COMPRESSION TEST REPORT					

Figure 1

FAILURE SKETCHES



☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

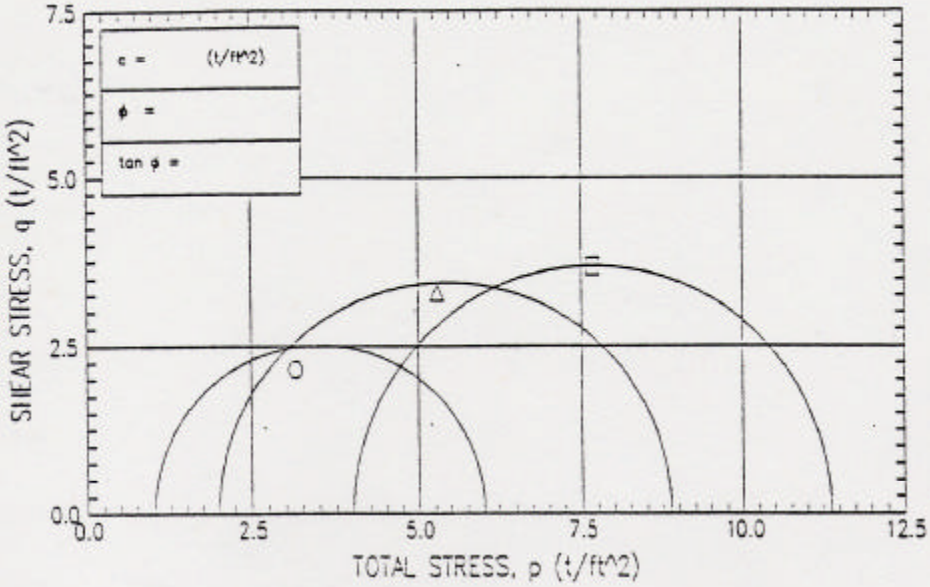
SYMBOL			O			
TEST NO.						
TYPE OF SPECIMEN			UNDISTURBED			
INITIAL	WATER CONTENT %	w_o	23.36			
	VOID RATIO	e_o	0.629			
	SATURATION %	S_o	100.28			
	DRY DENSITY (lb/ft^3)	γ_d	103.43			
TIME TO FAILURE (min)		t_f	10			
UNCONFINED COMPRESSIVE STRENGTH (t/ft^2)		q_u	2.05			
UNDRAINED SHEAR STRENGTH (t/ft^2)		s_u	1.03			
RATE OF STRAIN (%/min)			.5			
INITIAL SPECIMEN DIAMETER (in)		D_o	1.36			
INITIAL SPECIMEN HEIGHT (in)		H_o	3.00			

DESCRIPTION OF SPECIMENS: 1) FAT CLAY WITH GRAVEL, CH

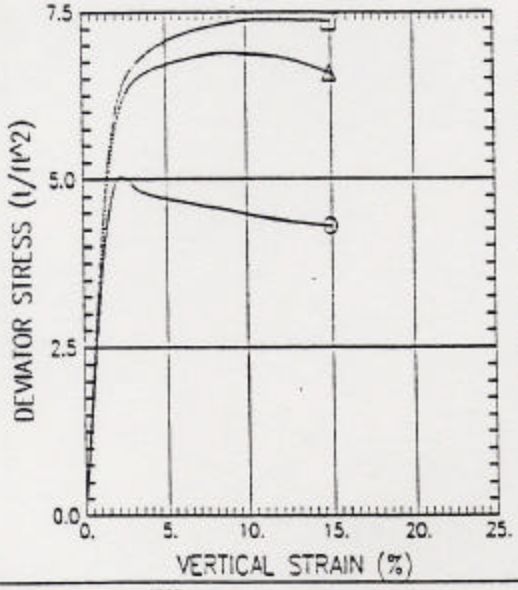
LL : 56.00	PL : 18.00	PI : 38.00	GS : 2.70

REMARKS:	PROJECT WHITEMAN AFB					
1) SPECIMEN CONTAINED LARGE AMOUNTS OF GRAVEL						
	BORING NO. ADU 94-26	SAMPLE NO.	W-1			
	TECH. JSS	DEPTH/ELEV	10.0-11.9'			
	LABORATORY	DATE	1/13/95			
	UNCONFINED COMPRESSION TEST REPORT					

Figure 6



FAILURE SKETCHES



SYMBOL		○	△	□
TEST NO.		Q1	Q2	Q3
INITIAL	WATER CONTENT (%)	19.48	18.32	19.29
	DRY DENSITY (lb/ft^3)	105.54	110.58	104.53
	SATURATION (%)	88.19	94.46	85.14
	VOID RATIO	0.596	0.524	0.612
BEFORE SHEAR	WATER CONTENT (%)	19.48	17.35	18.43
	DRY DENSITY (lb/ft^3)	105.46	111.40	105.20
	SATURATION (%)	88.02	91.43	82.75
	VOID RATIO	0.598	0.512	0.601
	BACK PRESS. (t/ft^2)	0.00	0.00	0.00
MINOR PRIN. STRESS (t/ft^2)		1.00	2.00	4.00
MAX. DEV. STRESS (t/ft^2)		5.02	6.88	7.37
TIME TO FAILURE (min)		5	17	25
RATE OF STRAIN INCR (%/min)		0.50	0.50	0.50
INITIAL DIAMETER (in)		1.40	1.37	1.39
INITIAL HEIGHT (in)		3.00	2.99	3.00

CONTROLLED STRAIN TEST

DESCRIPTION OF SPECIMENS: 1) LEAN CLAY WITH SOME SAND, CL 2)

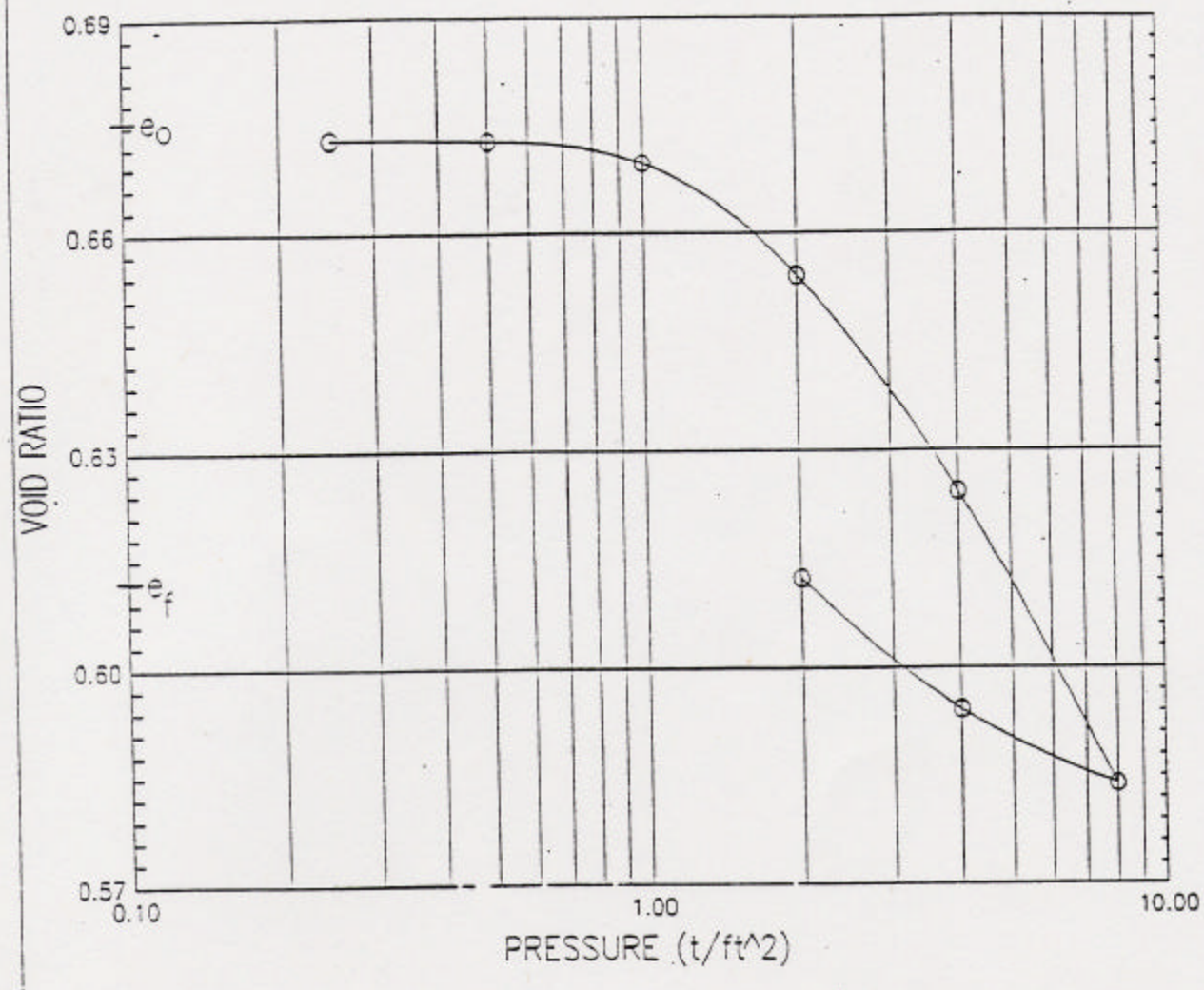
3)

LL 42	PL 14	PI 28	GS 2.70	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST UU (Q)

REMARKS:	PROJECT WHITEMAN AFB				
1) DARK YELLOWISH BROWN	PROJECT NO.3104				
2) NON CALCAREOUS	BORING NO. ADU 94-27	SAMPLE NO.	W-1	W-1	W-1
3) 1.50 TSF TORVANE	TECH. JSS	DEPTH/ELEV	10.0-11.9'	10.0-11.9'	10.0-11.9'
	LABORATORY	DATE	1/20/95	1/23/95	1/23/95

TRIAXIAL COMPRESSION TEST REPORT

Figure 11



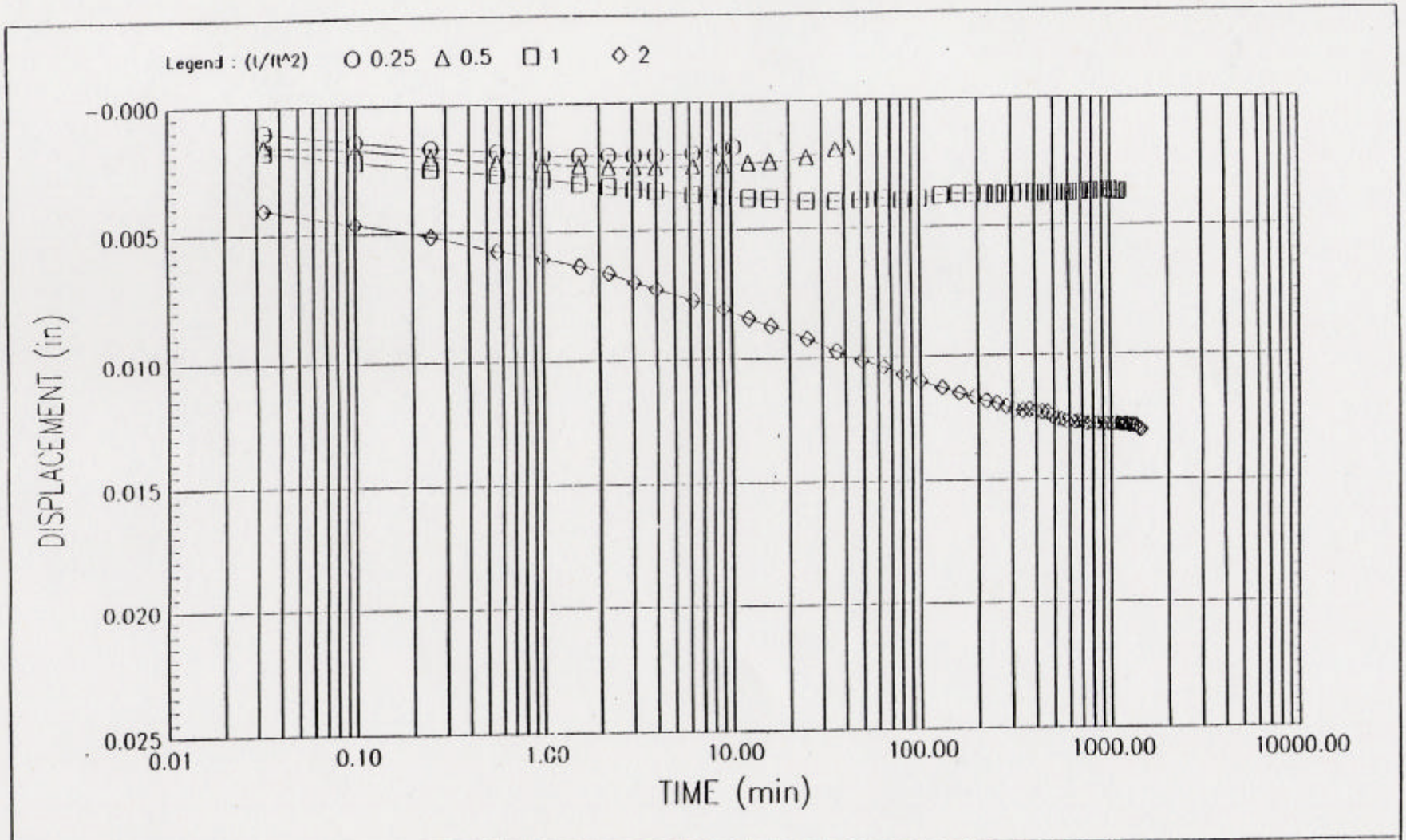
			BEFORE TEST	AFTER TEST
OVERBURDEN PRESSURE (t/ft^2)		WATER CONTENT (%)	23.332	23.339
PRECONSOL. PRESSURE (t/ft^2)		DRY DENSITY (lb/ft^3)	100.569	104.537
COMPRESSION INDEX		SATURATION (%)	93.186	102.901
TYPE SPECIMEN		VOID RATIO	0.676	0.612
DIA. (in) 2.500	HT. (in) 1.000	BACK PRESSURE (t/ft^2)		

CLASSIFICATION Fat clay with gravel, CH

LL 56.0	PL 18.0	PI 38.0	PROJECT WHITEMAN AFB
GS 2.700	D_{10}		Data File: B:WM07.DAT
REMARKS			BORING NO. ADU 94-26 / SAMPLE NO. W-1
			DEPTH 10.0-11.9' / DATE 2/15/95

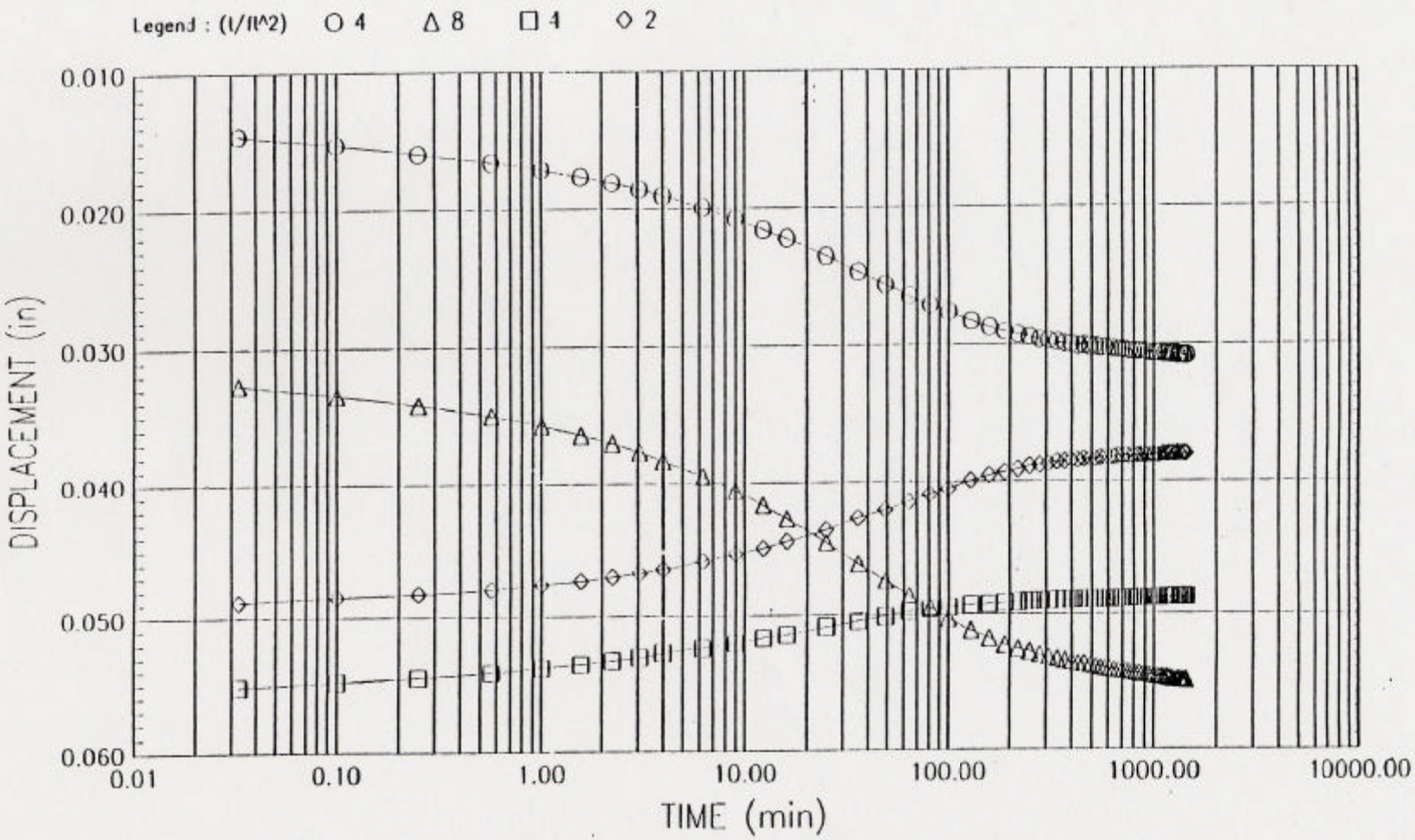
U.S.Army Corps.of Engineers
CONSOLIDATION TEST REPORT

Figure 3



PROJECT	WHITEMAN AFB		U.S.Army Corps.of Engineers
	Data File: B:WM07.DAT		CONSOLIDATION TEST
BORING	ADU 94-26	SAMPLE NO. W-1	TIME CURVES
DEPTH	10.0-11.9'	DATE 2/15/95	

Figure 4



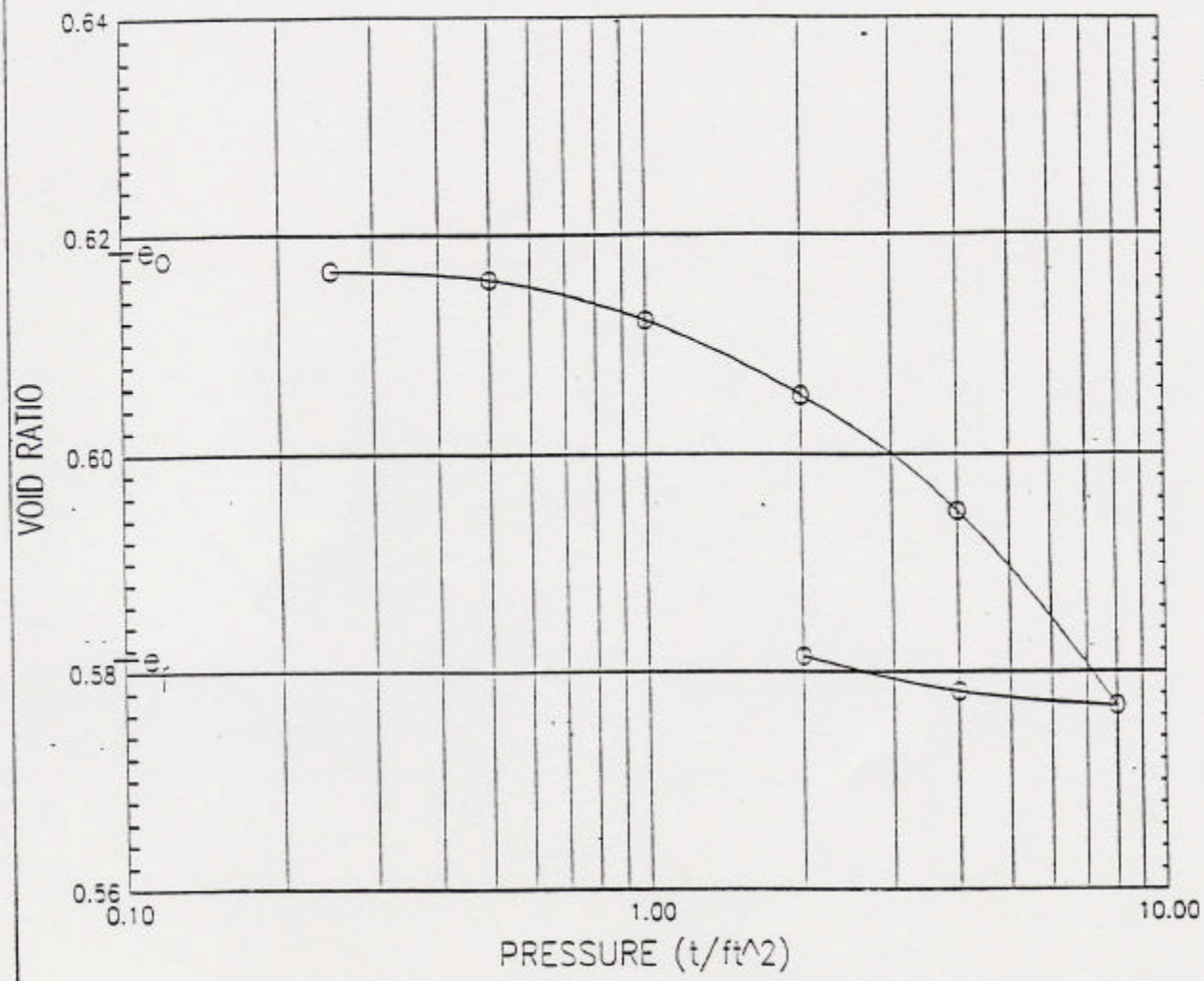
PROJECT	WHITEMAN AFB		U.S.Army Corps.of Engineers CONSOLIDATION TEST TIME CURVES
	Data File: B:WM07.DAT		
BORING	ADU 94-26	SAMPLE NO. W-1	
DEPTH	10.0-11.9'	DATE 2/15/95	

Figure 5

CONSOLIDATION TEST DATA

Project : WHITEMAN AFB
Location :
Project No. : 3104
Test No. :
Boring No. : ADU 94-26
Test Date : 2/15/95
Tested by : JSS
Sample No. : W-1
Sample Type : UNDISTURB
Depth : 10.0-11.9'
Checked by :
Soil Description :
Remarks :

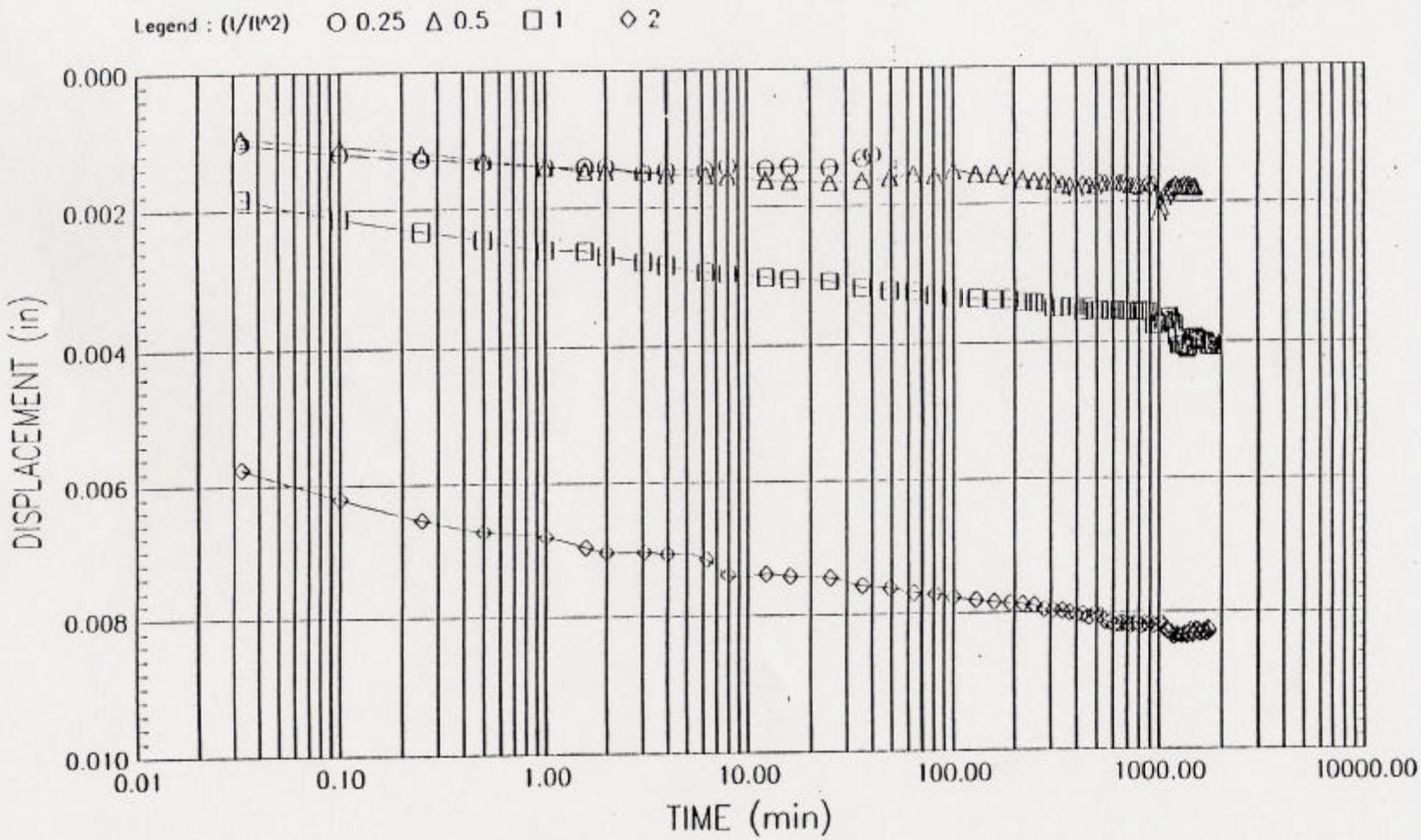
	APPLIED PRESSURE (t/ft^2)	FINAL DISPLACEMENT (in)	VOID RATIO	STRAIN AT END (%)	FITTING TIME (min) SQ.RT.	FITTING TIME (min) LOG	COEFFICIENT OF CONSOLIDATION (in^2/s) SQ.RT.	COEFFICIENT OF CONSOLIDATION (in^2/s) LOG	COEFFICIENT OF CONSOLIDATION (in^2/s) AVE
1)	0.25	0.002	0.673	0.18	0.1	0.0	6.89E-003	0.00E+000	0.00E+000
2)	0.50	0.002	0.673	0.19	0.2	0.0	4.93E-003	0.00E+000	0.00E+000
3)	1.00	0.004	0.670	0.38	0.9	0.0	9.27E-004	0.00E+000	0.00E+000
4)	2.00	0.013	0.654	1.30	17.1	0.0	4.73E-005	0.00E+000	0.00E+000
5)	4.00	0.031	0.624	3.09	18.0	0.0	4.36E-005	0.00E+000	0.00E+000
6)	8.00	0.055	0.584	5.50	18.4	0.0	4.09E-005	0.00E+000	0.00E+000
7)	4.00	0.049	0.594	4.88	8.7	0.0	8.44E-005	0.00E+000	0.00E+000
8)	2.00	0.038	0.612	3.80	23.1	0.0	3.25E-005	0.00E+000	0.00E+000



			BEFORE TEST	AFTER TEST
OVERBURDEN PRESSURE (t/ft^2)		WATER CONTENT (%)	19.448	21.334
PRECONSOL. PRESSURE (t/ft^2)		DRY DENSITY (lb/ft^3)	104.125	106.584
COMPRESSION INDEX		SATURATION (%)	84.860	99.067
TYPE SPECIMEN		VOID RATIO	0.619	0.581
DIA. (in) 2.500	HT. (in) 1.000	BACK PRESSURE (t/ft^2)		
CLASSIFICATION Lean clay with some sand, CL				
LL 42.0	PL 14.0	PI 28.0	PROJECT WHITEMAN AFB	
GS 2.700	D_{10}		Data File: B:WM06.DAT	
REMARKS			BORING NO. ADU 94-27	SAMPLE NO. W-1
			DEPTH 10.0-11.9'	DATE 2/13/95

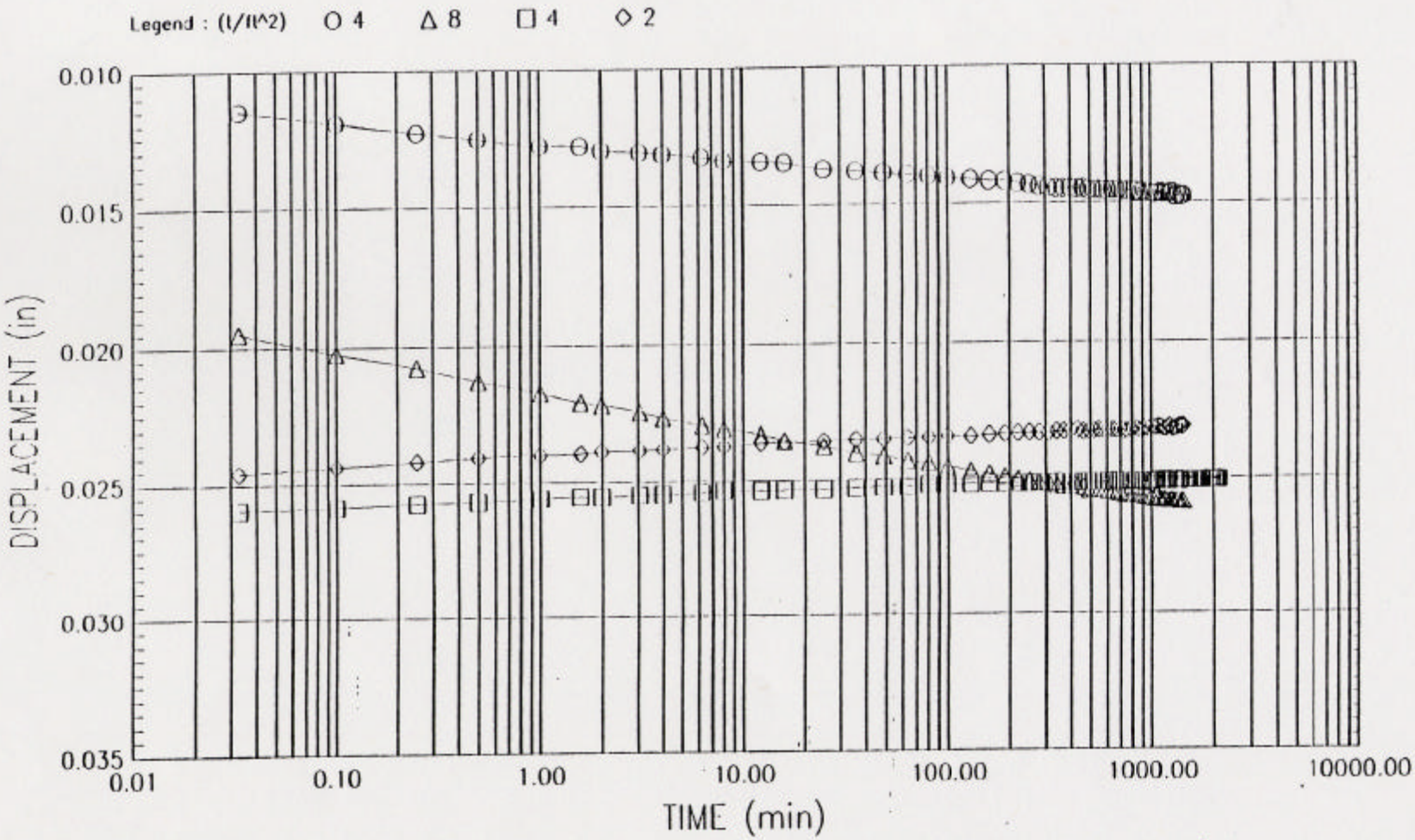
U.S.Army Corps.of Engineers
CONSOLIDATION TEST REPORT

Figure 8



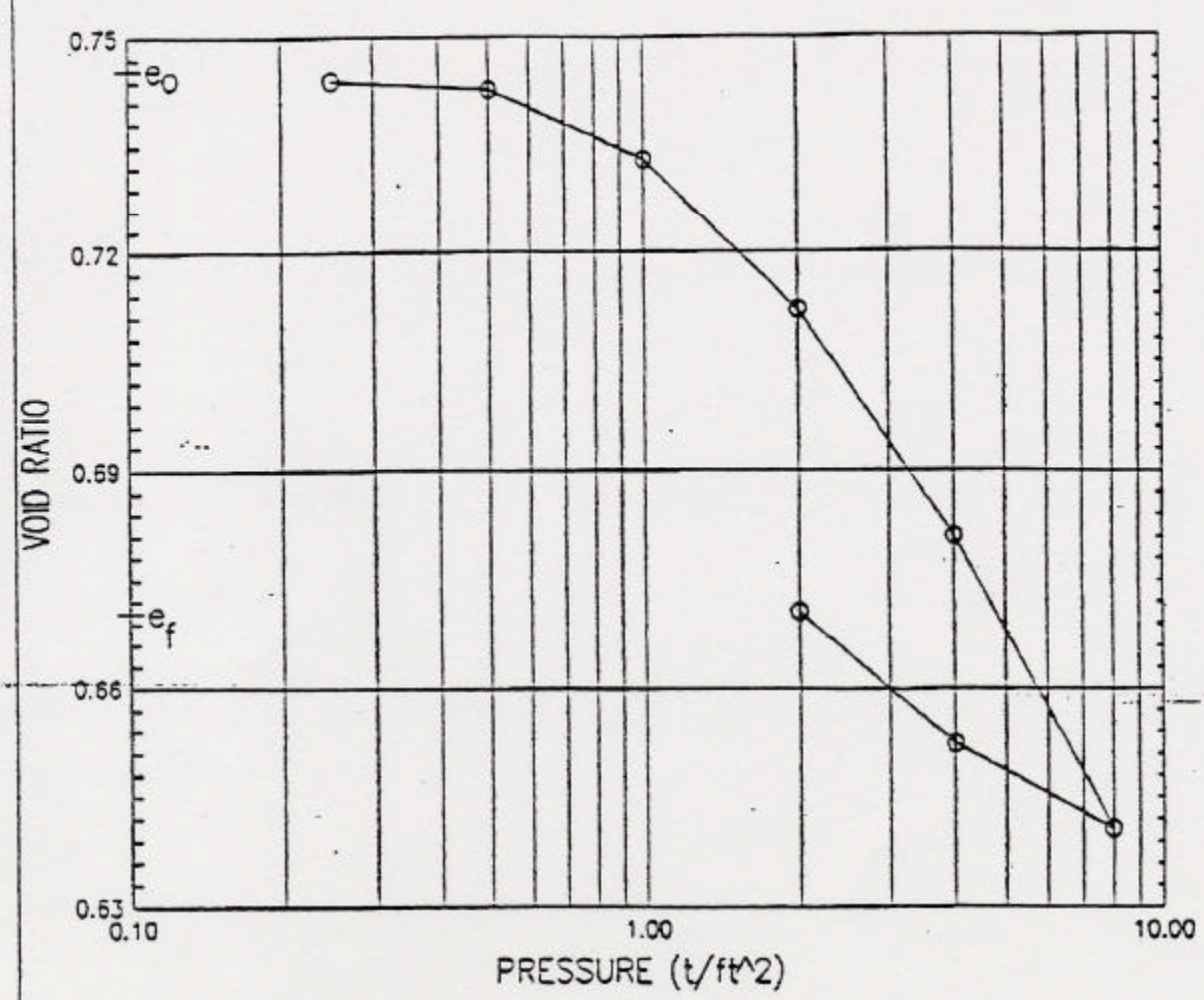
PROJECT	WHITEMAN AFB		U.S.Army Corp's.of Engineers
	Data File: B.WM06.DAT		CONSOLIDATION TEST
BORING	ADU 94-27	SAMPLE NO. W-1	TIME CURVES
DEPTH	10.0-11.9'	DATE 2/13/95	

Figure 9



PROJECT	WHITEMAN AFB		U.S.Army Corps.of Engineers CONSOLIDATION TEST TIME CURVES
	Data File: B:WM06.DAT		
BORING	ADU 94-27	SAMPLE NO. W-1	
DEPTH	10.0-11.9'	DATE 2/13/95	

Figure 10



			BEFORE TEST	AFTER TEST
OVERBURDEN PRESSURE (t/ft^2)		WATER CONTENT (%)	26.8	26.2
PRECONSOL. PRESSURE (t/ft^2)		DRY DENSITY (lb/ft^3)	96.55	100.89
COMPRESSION INDEX		SATURATION (%)	97.17	105.47
TYPE SPECIMEN	UNDISTURB	VOID RATIO	0.75	0.67
DIA. (in) 2.500	HT. (in) 0.750	BACK PRESSURE (t/ft^2)	---	---

CLASSIFICATION FAT CLAY WITH GRAVEL, CH

LL 56.0	PL 18.0	PI 38.0	PROJECT WHITEMAN AFB
GS 2.700	D_{10}		

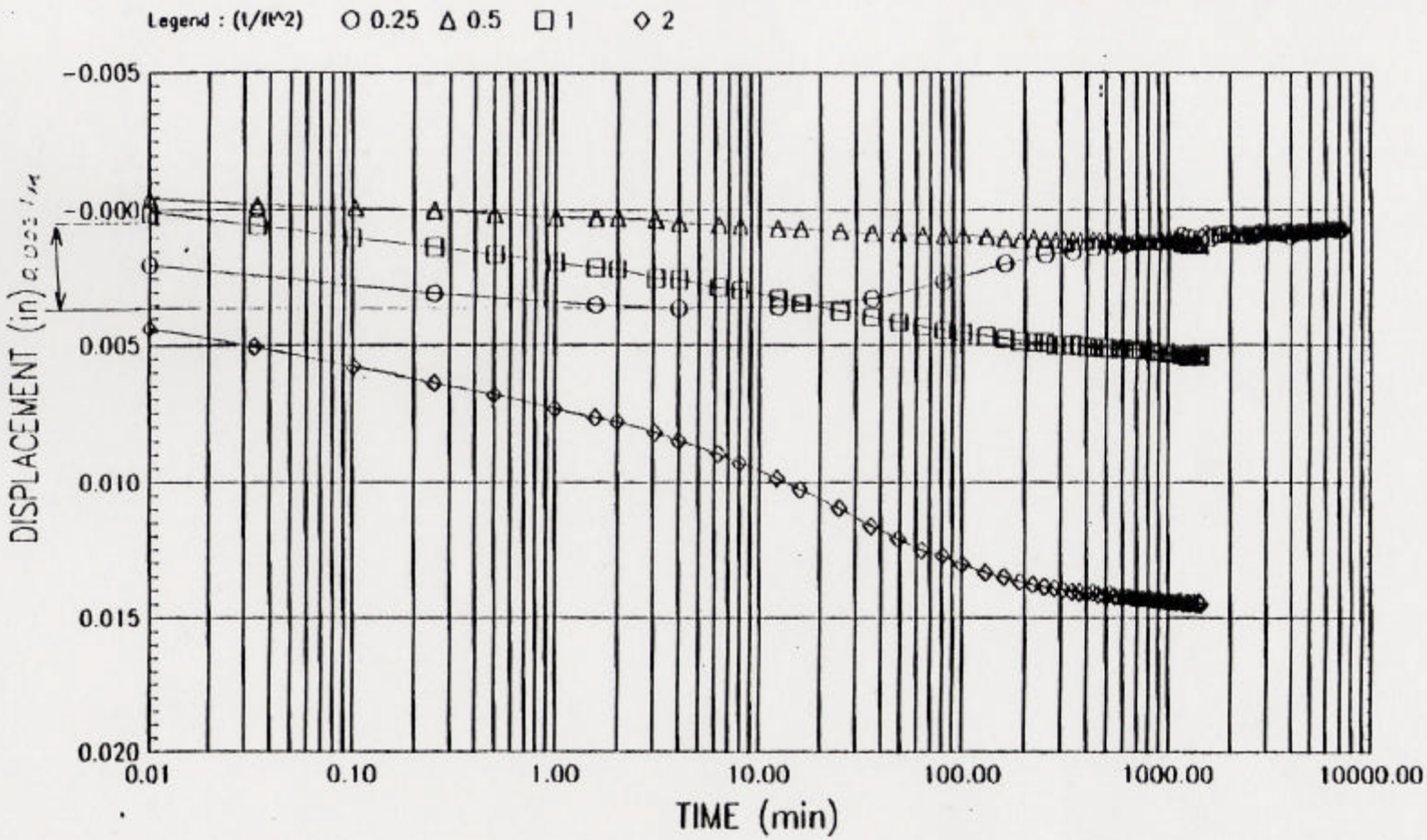
REMARKS FREE SWELL TEST	BORING NO. ADU 94-26	SAMPLE NO. W-1
	DEPTH 10.0-11.9'	DATE 03/10/95

USACOE
CONSOLIDATION TEST REPORT

CONSOLIDATION TEST DATA

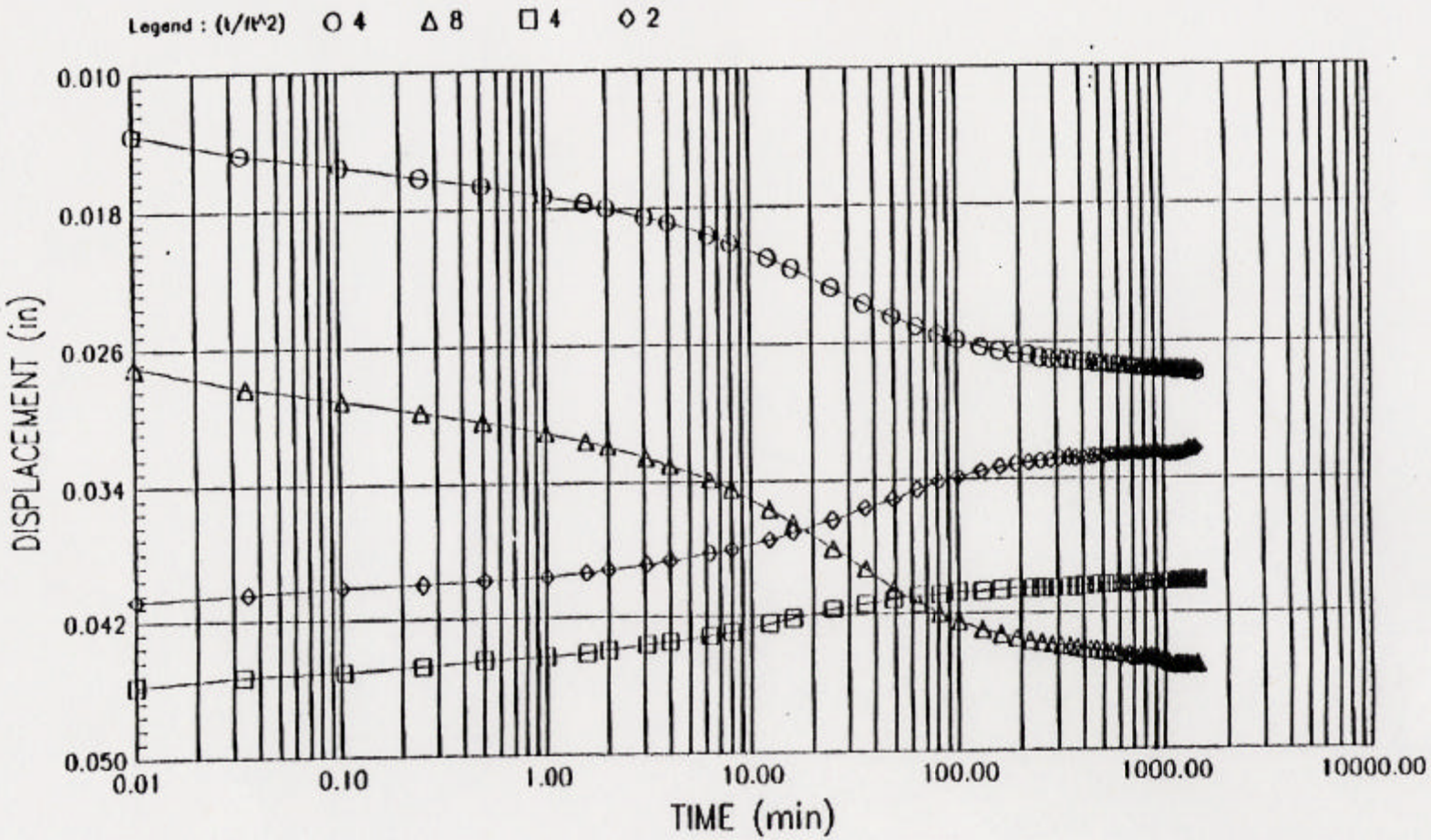
Project : WHITEMAN AFB
Location :
Project No. : 3104
Test No. :
Boring No. : ADU 94-27
Test Date : 2/13/95
Tested by : JSS
Sample No. : W-1
Sample Type : UNDISTURB
Depth : 10.0-11.9'
Checked by :
Soil Description :
Remarks :

	APPLIED PRESSURE (t/ft^2)	FINAL DISPLACEMENT (in)	VOID RATIO	STRAIN AT END (%)	FITTING TIME (min) SQ.RT.	FITTING TIME (min) LOG	COEFFICIENT OF CONSOLIDATION (in^2/s) SQ.RT.	COEFFICIENT OF CONSOLIDATION (in^2/s) LOG	COEFFICIENT OF CONSOLIDATION (in^2/s) AVE
1)	0.25	0.001	0.617	0.13	0.2	0.0	5.26E-003	0.00E+000	0.00E+000
2)	0.50	0.002	0.616	0.18	10.0	0.0	8.19E-005	0.00E+000	0.00E+000
3)	1.00	0.004	0.612	0.41	26.0	0.0	3.14E-005	0.00E+000	0.00E+000
4)	2.00	0.008	0.605	0.83	12.9	0.0	6.28E-005	0.00E+000	0.00E+000
5)	4.00	0.015	0.595	1.48	19.8	0.0	4.05E-005	0.00E+000	0.00E+000
6)	8.00	0.026	0.577	2.59	15.1	0.0	5.23E-005	0.00E+000	0.00E+000
7)	4.00	0.025	0.578	2.51	3.4	0.0	2.26E-004	0.00E+000	0.00E+000
8)	2.00	0.023	0.581	2.31	5.7	0.0	1.37E-004	0.00E+000	0.00E+000



PROJECT	WHITEMAN AFB		USACOE CONSOLIDATION TEST TIME CURVES
Data File:			
BORING	ADU 94-26	SAMPLE NO. W-1	
DEPTH	10.0-11.9'	DATE 03/10/95	

% swell = $\frac{\Delta h}{}$ = 0.0031 in ≐ 0.3%



PROJECT	WHITEMAN AFB		USACOE CONSOLIDATION TEST TIME CURVES
Data File:			
BORING	ADU 94-26	SAMPLE NO. W-1	
DEPTH	10.0-11.9'	DATE 03/10/95	

CONSOLIDATION TEST DATA

Project : WHITEMAN AFB
Boring No.: ADU 94-26
Sample No.: W-1
Test No. :

Location :
Tested by : JSS
Test Date : 03/10/95
Sample Type: UNDISTURB

Project No.: 3104
Checked by :
Depth : 10.0-11.9'

Soil Description : FAT CLAY WITH GRAVEL, CH
Remarks :

	APPLIED PRESSURE (t/ft^2)	FINAL DISPLACEMENT (in)	VOID RATIO	STRAIN AT END (%)	FITTING T50 TIME (min) SQ.RT.	LOG	COEFFICIENT OF CONSOLIDATION (in^2/s) SQ.RT.	LOG	AVE
1)	0.25	0.001	0.744	0.10	431.2	0.0	1.07E-006	0.00E+000	1.07E-006
2)	0.50	0.001	0.743	0.17	12.6	0.0	3.66E-005	0.00E+000	3.66E-005
3)	1.00	0.005	0.733	0.73	6.7	0.0	6.82E-005	0.00E+000	6.82E-005
4)	2.00	0.015	0.712	1.94	7.5	0.0	6.00E-005	0.00E+000	6.00E-005
5)	4.00	0.028	0.681	3.71	10.3	0.0	4.24E-005	0.00E+000	4.24E-005
6)	8.00	0.045	0.641	6.02	11.1	0.0	3.77E-005	0.00E+000	3.77E-005
7)	4.00	0.040	0.652	5.35	5.4	8.7	7.55E-005	4.72E-005	6.14E-005
8)	2.00	0.032	0.671	4.31	15.0	0.0	2.78E-005	0.00E+000	2.78E-005

APPENDIX C

PAVEMENT DESIGN

Reviewed by: JM

Design/Build New Family Housing
Whiteman AFB, Missouri
FLEXIBLE PAVEMENT DESIGN
(Access Roads)

I. Design Parameters.

Composition: Group I Vehicles = 676 / day (98%)
Group II Vehicles = 8 / day (1%)
Group III Vehicles = 4 / day (1%)
Type terrain: Rolling
Designation: Street
DHV: 83

NOTE: Design composition was provided by Whiteman AFB, CES/CEV, Dale Edmundson on 10 February 1995.

II. Strength Design.

1. Class = E (Page 3-1; TM 5-822-2)

2. Category = III (Page 3-6; TM 5-822-2)

3. Design Index = 3 (Table 3-1; TM 5-822-5)

4. CBR = 5

5. Required Thickness = 15 inches (Fig. 8-1; TM 5-822-5)

III. Frost Design.

A. Reduced Subgrade Frost Method.

1. Design Freezing Index: 500 (Fig 3-2 of 5-818-2)

2. Soil Group: F-3

3. Soil Support Index: 3.5

4. Required Thickness = 18 inches

B. Limited Subgrade Frost Penetration Method.

1. Air Freezing Index = 500 (Fig. 3-2 of TM 5-818-2).

2. Water Content of Base Course = 4%

3. Density of Subgrade Base Course = 135 p.c.f.

4. Frost Penetration = a = 38.5 inches (Fig. 3-5, TM 5-818-2).

5. Min. Asphaltic Pavement Thickness = p = 1.5 inches.

Reviewed by: Jm

Design/Build New Family Housing
Whiteman AFB, Missouri
RIGID PAVEMENT DESIGN
(For Driveways)

I. Design Parameters:

Composition: Group I vehicles = 20 / day (100%)
Group II vehicles = 0 / day (0%)
Group III vehicles = 0 / day (0%)

Type Terrain: flat
Designation: Street
DHV: 3

II. Strength Design.

a. Class = F (Page 3-3; TM 5-822-2)

b. Category = I (Page 3-1; TM 5-822-5)

c. Design Index = 1 (Table 3-1; TM 5-822-5)

d. Modulus of Soil Reaction (k) = 75 p.c.i (Table 9-1; TM 5-822-5)

e. 28-day flexural strength = 650 p.s.i.

f. PC Thickness Required = 5.0 inches. (Fig 12-1, 5-822-5).

IV. RECOMMENDED PAVEMENT SECTION:

* 6" PC Concrete Pavement

* 4" Rigid Base Course

* 6" Compacted Subgrade

NOTE: The paving cross sections shall show the base course and subgrade placed and compacted one foot beyond the back side of concrete curb and gutter or the outer edge of pavement if no curb and gutter is used.

Reviewed by: Jm

Design/Build New Family Housing
Whiteman AFB, Missouri
FLEXIBLE PAVEMENT DESIGN
(Access Roads)

6. c = a - p = 38.5 - 1.5 = 37.0 inches

7. r = 3.0 (12% / 4%)

8. Design Base Thickness = b = 24 inches

9. Design Thickness = b+p = 24 + 1.5 = 25.5 inches.

c. Reduced Subgrade Frost Method Controls. Design for 18.0 inches.

IV. Structure of Pavement Section.

Minimum Thickness: Asphalt = 1.5 inches
Base Course = 4.0 inches

Equivalency Factors: Subbase = 2.3 inches
Base = 1.15 inches

6.5" Subbase/2.3 = 2.83" Asphalt

V. Recommended Pavement Section.

* 2" Asphaltic Concrete Surface Course
* Bituminous Tack Coat
* 3" Asphaltic Concrete Intermediate Leveling Course
* Bituminous Prime Coat
* 4" Graded Crushed Aggregate Base Course
* 4" Subbase Material
* 8" Compacted Lime-Stabilized Subgrade

NOTE: The paving cross sections shall show the base, subbase and subgrade placed and compacted one foot beyond the back side of concrete curb and gutter or the outer edge of pavement if no curb and gutter is used.

Design/Build New Family Housing
Supplemental Soils Report
Whiteman AFB

Designer: _____

Peer Reviewer: James G. M. Bass

Independent Technical Reviewer: N/A - DLM

Whiteman AFB
Missouri

US Army Corps
of Engineers
Kansas City District
Leaders in Customer Care

Design/Build New Family Housing

Supplemental Soils Report
May 2003

Prepared by Kansas City District Corps of Engineers
Geotechnical Design and Dam Safety Section
EC-GD

Supplemental Geotechnical Report
Design/Build 03 Family Housing Project
Whiteman Air Force Base

1. INTRODUCTION: This report is a supplement to the report prepared in 1995 and revised in 2003. This report is to be read and interpreted in conjunction with the report prepared in 1995 and revised in 2003. Additional soils data was needed to confirm subsurface conditions for proposed roads and access points to the proposed project site.

2. SUBSURFACE INVESTIGATION: A subsurface investigation was performed by a drill crew from the Kansas City District Corps of Engineers in March of 2003. The subsurface investigation consisted of drilling a total of three 7-inch diameter hollow stem auger borings, numbered ADU-03-4 through ADU-03-06, using a CME-750 drilling rig and one hand auger boring labeled HA-03-07. Standard Penetration Tests (SPT's) were performed, which consist of driving a 2-inch diameter (OD) split-spoon sampler a distance of 18 inches with the standard 140-pound hammer falling 30 inches. The field procedure for SPT was conducted in general accordance with ASTM 1586 at predetermined depths to a target depth of 21.5 feet or SPT refusal. SPT refusal is defined as 50 blows of the standard 140 pound hammer in one 6-inch depth increment. The field geologist recorded the hammer blows for each sampling interval. The blow counts are recorded on the boring logs. The results of SPT testing for each depth increment are summarized in Table 1. Disturbed samples of subsurface materials were obtained using the 1-3/8 inch diameter standard penetration split spoon sampler to obtain disturbed samples through hollow stem augers. Jar samples were obtained of representative materials encountered from SPT tests and Shelby tube samples. Undisturbed samples were obtained using a 5-inch diameter, fixed piston, Shelby tube sampler at a target depth of between 4 to 6 feet and 6 to 8 feet. Torvanes were performed at the top, bottom, and midpoint of each 2-foot Shelby sample collected. Samples recovered with the 5-inch Shelby tube samplers were extruded in the field, logged by the field geologist, double-wrapped with aluminum foil and sealed with wax in cardboard tubes. Select samples were then sent to an independent laboratory for testing. The depth of groundwater was measured during drilling and at the completion of each boring. All borings were backfilled with spoils prior to leaving the site.

Table 1. SPT N Values

Depth Increment (ft)	SPT N-Value Uncorrected blows/ft)		
	ADU-03-4	ADU-03-5	ADU-03-6
2.0-4.0	8	16	33
5-6.5	70	-	-
8.5-10.0	-	30	36
13.5-15.0	-	11	23
18.5-20.0	-	20	8
23.5-25	-	18	43

3. SUBSURFACE CONDITIONS: Brief descriptions of the various soils encountered follow. However, the attached strip logs should be reviewed for actual subsurface conditions at each boring location. Appendix A contains a site map, plan view of boring locations and final boring logs.

a. Overburden. Examination of the samples obtained during the subsurface investigation indicate approximately 1 foot of topsoil, overlaying typical periglacial deposits of overburden material (probably associated with Kansas glaciation) comprised primarily of damp, silty low plasticity and high plasticity clays, brownish-gray in color, mottled dark-gray, with some limonite staining and iron concentrations. The consistency of clays vary from medium to hard, with SPT N-values ranging from 8 to 70 blows per foot, with an average SPT N-value of 26 blows per foot. A soil described as being mottled or marked with blotches and spots is an indicator that the water table has been in contact with that soil at sometime and then receded. Therefore mottled soil can be an indicator of a variable water table.

b. Bedrock. Bedrock was encountered at depths ranging from 6.9 to 26.5 feet below the existing surface. Bedrock consisted primarily of dense, weathered shale, greenish-gray to brown-gray in color, with occasional limonite stains. The hardness of weathered shale and mudstone is characterized in rock terminology as soft based on geologic evaluations. In soil terminology however, this material could be characterized as very stiff to hard, with SPT N-values ranging from 18 to greater than 50 blows per foot.

SPT refusal was encountered at 6.9 feet below ground surface in ADU-03-4, which is located at the extreme northwest portion of the project. Boring ADU-03-4 encountered a moderately hard, dense, brownish-gray, limestone at a depth of 6.9 feet. Borings ADU-03-05 and ADU-03-06 encountered a soft, siltstone and mudstone at 26.5 and 25 feet, respectively.

c. Groundwater. Phreatic groundwater was encountered during drilling. Borings ADU-03-05 and ADU-03-06 encountered water at 15.5 and 15.2 feet respectively. The water level measurements were taken for these two borings the day after drilling was complete. However, as previously discussed, ground water elevations are variable in this area as a result of the development of a perched water table and should be considered to fluctuate in accordance with seasonal and yearly antecedent moisture conditions. Also, the majority of overburden material at this site will exhibit low permeability rates and additional water could accumulate in borings or excavations left open for longer periods of time. Therefore, the groundwater elevation will need to be determined concurrent with construction.

4. LABORATORY TESTING: Select samples of soil obtained during the field exploration were tested to determine engineering and physical properties. Classification parameters investigated include: natural moisture contents, Atterberg limits and grain size analysis. The undrained shear strength of the soils was evaluated by performing unconfined compression tests. Finally, a swell consolidation test was performed to ascertain the swell potential of the soil. Appendix B contains results from laboratory testing.

Overburden material was classified according to the Unified Soils Classification System (USCS) as either low plasticity clay (CL) or high plasticity clay (CH), with the majority being CL.

The Atterberg limits were performed on 6 samples of overburden material. The overburden material had liquid limits (LL), which ranged between 38 and 66, with a mean of 49, plastic limits (PL) ranged between 22 and 15, with a mean of 18 and plasticity indices (PI), which ranged between 16 and 47, with a mean of 30. The moisture content of 17

samples tested of overburden material ranged between 10.5 and 23.2 percent, with a mean of 19 percent. The results are presented in Table 2. It is important to note that the in-situ moisture content at the time of the subsurface investigation is very near the plastic limit, indicating a potential for volume change with changing moisture content. It should also be noted that the shales underlying the overburden material are the parent material of the overburden. Therefore, the shales will most likely exhibit similar shrink/swell characteristics with changing moisture content.

Table 2. Atterberg Limits and Moisture Contents

Boring	Depth (ft)	Liquid Limit	Plastic Limit	Plastic Index	Moisture Content (%)
ADU-03-4	4.0-4.9	38	22	16	17.5
ADU-03-5	4.0-6.0	50	18	32	18.6
ADU-03-6	2.0-3.0	66	19	47	N/A
ADU-03-6	4.0-6.0	49	15	34	17.8
ADU-03-6	8.0-10.0	49	17	32	17.8
ADU-03-6	24.0-24.6	39	18	21	13.5

A grain size analysis was performed on 3 samples from ADU-03-4 and ADU-03-6. Material ADU-03-4 at a depth of 6.5 ft contained 17% gravel, 36% sand and 47% silt and clay. The majority of the size of the material tested classified as a silt or clay according to ASTM 421/422.

Results of unconfined compressive strength testing are summarized in Table 3 and include the unconfined strength (q_u), dry density, natural moisture content, and the depths corresponding to the test locations.

One consolidation test was performed on a sample of overburden material obtained from a depth of 4-4.3 feet in borings ADU-03-4. Consolidation testing indicated an overconsolidated soil with a preconsolidation pressure of 0.9 tsf.

A swell test was performed on an undisturbed sample obtained from boring ADU-03-4 at a depth of 4 to 4.3 feet. The results show a swell pressure of 500 psf based on ASTM D

4546 Method C. It is important to remember this prediction applies only to the material at the insitu moisture and density.

Table 3. Unconfined Compression Results

Boring	Depth (ft)	Q_u (tsf) (unconfined compressive strength)	Moisture Content (w%)	Dry Density (γ_d) pcf
ADU-03-4	4.0-4.9	1.7	17.5	112.2
ADU-03-5	4.0-6.0	2	18.6	98.4
ADU-03-6	4.0-6.0	3.9	17.8	105.0
ADU-03-6	6.0-8.0	4.9	17.0	101.5

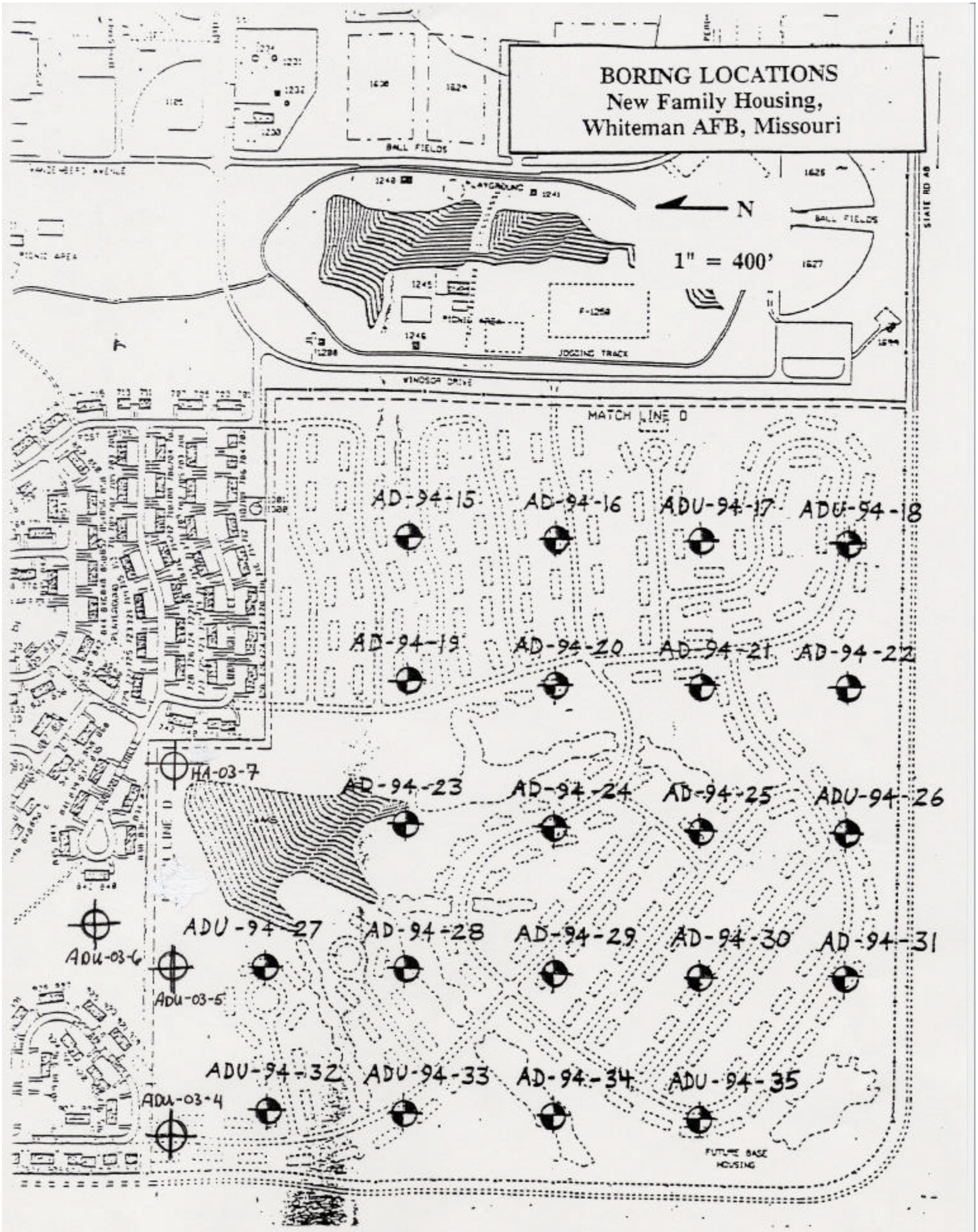
Results of the laboratory testing performed on selected samples obtained from the project site are included in the appendix of this report.

This report is a supplemental report that includes presentation of additional data. This report should be read in conjunction with the main report. No design decision should be made based solely on the results of this supplemental report.

APPENDIX A

Site Map, Plan View of Borings and Final Boring Logs

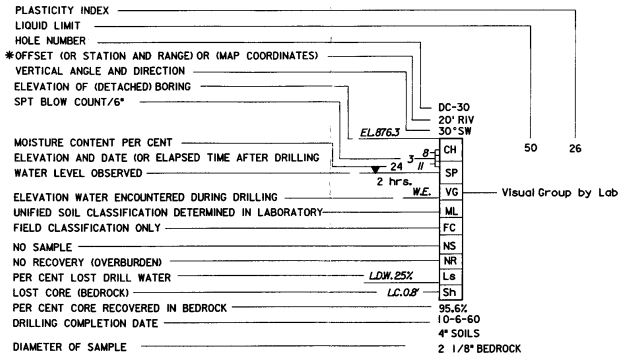
28
27
GOVERNMENT
R R
BM 835
33
34
BM 835
WHITEMAN
AIR FORCE BASE
W A S H I N G
3
4
APPROXIMATE
PROJECT SITE
BOUNDARIES
9
10
Branch


BORING LOCATIONS
New Family Housing,
Whiteman AFB, Missouri
N
1" = 400'
BALL FIELDS
PICNIC AREA
JOGGING TRACK
WINDSOR DRIVE
STATE RD AB
MATCH LINE D
AD-94-15
AD-94-16
ADU-94-17
ADU-94-18
AD-94-19
AD-94-20
AD-94-21
AD-94-22
HA-03-7
AD-94-23
AD-94-24
AD-94-25
ADU-94-26
ADU-03-6
ADU-94-27
AD-94-28
AD-94-29
AD-94-30
AD-94-31
ADU-03-5
ADU-94-32
ADU-94-33
AD-94-34
ADU-94-35
ADU-03-4
FUTURE BASE HOUSING

ABBREVIATIONS

alt	alternating	dmp	damp	lea	leached	rnd (d)	round, (rounded)
ang	angular	dol (c)	dolomite, (dolomitic)	lig	lignite	sat	saturated
an	anhydrite	ext	extremely	ls	limestone	scat	scattered
ar	argillaceous	f (y)	fine, (finely)	lt	light	sd (y)	sand, (sandy)
bdd	bed, bedded, bedding	fe	iron	lo	loose	sev	several
bdr	bedrock	fld	filled	L.C.	lost core	sh (y)	shale, (shaly)
bky	blocky	fm	firm	L.D.W.	lost drill water	sl (y)	silt, (silty)
bl	blue	fos (s)	fossil, (fossiliferous)	med	medium	sls	slitstone
bld	boulder	frac (d)	fractures, (fractured)	mic	micaceous	sl	slightly
blk	black	frag (d)	fragments, (fragmented)	min	mineralized	slcs	siliceous
brec (d)	breccia, (brecciated)	fri	friable	mod (y)	moderate, (moderately)	slks	slickensides
brk	broken	fsl	fissile	mot	mottled	so	soft
brn	brown	gr	grain	mss	massive	sol (d)	solution, (solutionized)
c	coarse	gra	gradation	mst	moist	ss	sandstone
calc	calcareous	grn	green	mtl	material	st (g)	stained, (staining)
carb	carbonaceous	grv (y)	gravel, (gravelly)	mtx	matrix	stf	stiff
cav	cavity	gry	gray	nod	nodules	sty	stylolitic
cbl	cobble	gyp	gypsum	num	numerous	v	very
cht	chert	ha	high angle	occ (y)	occasional, (occasionally)	vert	vertical
circl	circulation	hd	hard	op	open	vgy	vuggy
cl (y)	clay, (clayey)	hld	healed	or	orange	w	water
cld	closed	hor	horizonal	org	organic	w/	with
cmtd	cemented	inbd	interbedded	par	partially	wth	weathered
col	columnar	incl	inclusions	pit	pit, pitted, pitting	wht	white
conc	concretions	inlam	interlaminated	pl	plastic	x-bdd	crossed-bedded
cong	conglomerate	irr	irregular	pla	platy	xln	crystalline
crm	crumbly	jt (s)	joint, (joints)	pln	plane	y	yellow
d	dense	la	low angle	ptg (s)	parting, (partings)	When used as log symbol	
dk	dark	lam (d)	laminae, (laminated)	qtz (e)	quartz, (quartzite)	first letter is capitalized	
				pbls	pebbles		

LEGEND OF LOGS OF BORINGS



*OFFSET FROM PROFILE OR SECTION MAY BE UPSTREAM OR DOWNSTREAM (U OR D,) LANDWARD OR RIVERWARD (LWD OR RIV), OR RIGHT OR LEFT (R OR L) AS DEFINED.

UNIFIED SOIL CLASSIFICATION SYSTEM

- **GW** Well graded gravels, gravel-sand mixtures, little or no fines.
- **GP** Poorly graded gravels or gravel-sand mixtures, little or no fines.
- **GM** Silty gravels, gravel-sand-silt mixtures.
- **GC** Clayey gravels, gravel-sand-clay mixtures.
- **SW** Well-graded sands, gravelly sands, little or no fines.
- **SP** Poorly graded sands or gravelly sands, little or no fines.
- **SM** Silty sands, sand-silt mixtures.
- **SC** Clayey sands, sand-clay mixtures.
- **ML** Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts w/slight plasticity.
- **CL** Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
- **OL** Organic silts and organic silty clays of low plasticity.
- **MH** Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
- **CH** Inorganic clays of high plasticity, fat clays.
- **OH** Organic clays of medium to high plasticity, organic silts.
- **Pt** Peat and other highly organic soils.

Classified from actual laboratory tests where LL and PI are shown.
Dual classication, where used, is in accordance with the Unified Soil Classification System.
For details on the Unified Soil Classification System, See Waterways Experiment Station.
Technical Memorandum No. 3-357 dated March 1953 and revised in 1960.

RQD (Rock Quality Designation)	Description of Rock Quality
0 - 25%	Very Poor
25 - 50%	Poor
50 - 75%	Fair
75 - 90%	Good
90 - 100%	Excellent

TYPE OF EXPLORATION

MAP SYMBOL

- VERTICAL BORING
- 30° INCLINED BORING SHOWING DIRECTION AND VERTICAL ANGLE

CODE DESIGNATION

- D DRIVE SAMPLE HOLE
- C CORE HOLE
- TP TEST PIT (INCLUDES POWER AUGER 24" OR LARGER DIAMETER)
- U UNDISTURBED SAMPLE HOLE
- A AUGER HOLE-HAND OR POWER AUGER LESS THAN 24" DIAMETER.
- NS NOT SAMPLED (FIELD CLASSIFICATION FROM CUTTINGS ONLY
- FS FIELD SECTION OF OUTCROP.
- P PERMANENT PIEZOMETER

DEGREE OF WEATHERING

Unweathered: no evidence of any mechanical or chemical alteration.

Slightly weathered: slight discoloration on surface, slight alteration along discontinuities, less than 10 percent of the rock volume altered, and strength substantially unaffected.

Moderately weathered: discoloring evident, surface pitted and altered with alteration penetrating well below rock surfaces, weathering "halos" evident, 10 to 50 percent of the rock altered, and strength noticeably less than fresh rock.

Highly weathered: entire mass discolored, alteration in nearly all of the rock with some pockets of slightly weathered rock noticeable, some minerals leached away, and only a fraction of original strength (with wet strength usually lower than dry strength) retained.

Decomposed: rock reduced to a soil with relict rock texture (saprolite) and generally molded and crumbled by hand.

TM 5-818-1/AFM 88-3, Chap. 7

BEDROCK UNIT OF THICKNESS

Parting	<0.02'
Band	0.02' to 0.2'
Thin Bed	0.2' to 0.5'
Medium Bed	0.5' to 1.0'
Thick Bed	1.0' to 2.0'
Massive	>2.0'

TERMS FOR CONSISTENCY OF SOIL AND HARDNESS OF BEDROCK

SOIL

Consistency	Estimated Unconfined Compressive Strength (Tons per square foot)
Very soft	<0.25
Soft	0.25-0.5
Medium	0.5-1.0
Stiff	1.0-2.0
Very stiff	2.0-4.0
Hard	>4.0

BEDROCK

SCALE OF HARDNESS

Very soft or plastic	Can be indented easily with thumb.
Soft	Can be scratched with fingernail.
Moderately hard	Can be scratched easily with knife; cannot be scratched with fingernail.
Hard	Difficult to scratch with knife.
Very hard	Cannot be scratched with knife.

NOTE:

FOR LOGS OF EXPLORATIONS, SEE SHEET NO'S G-2

US Army Corps of Engineers
Kansas City District

Symbol	Description	Date	Appr.

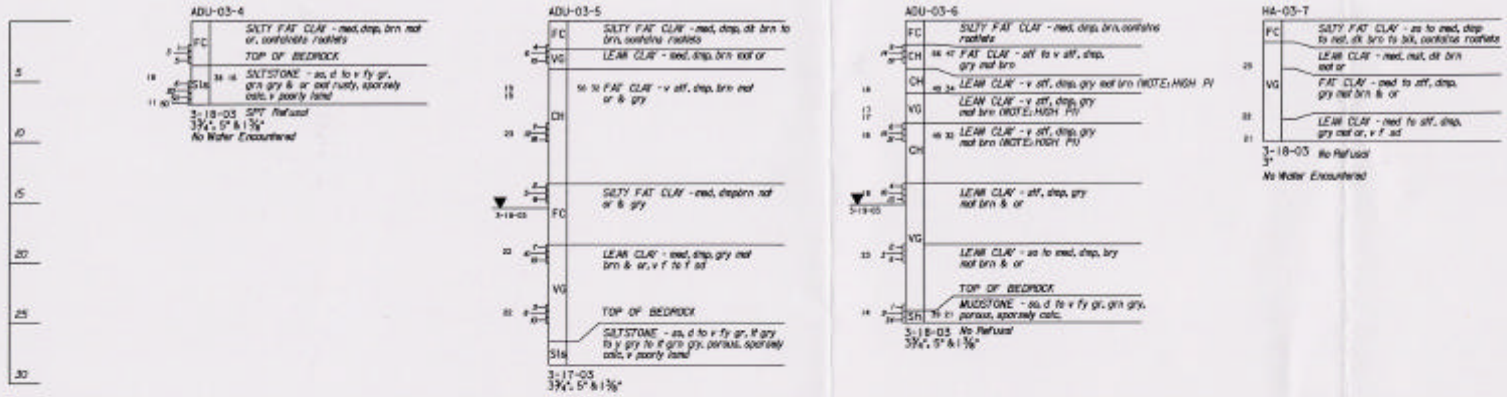
Designed by: J.M.M. | Date: MAY 2003 | Rev.
Dwn by: J.M.M. | Ckd by: A.W.O | Design file no. | Drawing code:
Reviewed by: | Submitted by: | File name: | Plot date: | Plot scale:

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

WHITEMAN AIR FORCE BASE MISSOURI
REPLACE FAMILY HOUSING
FY 2003

GEOLOGIC LEGEND AND ABBREVIATIONS

Sheet reference number:
G-1



NOTE:
For Geologic Legend and Abbreviations, See Sheet No. G-1

US Army Corps of Engineers
Kansas City District

Symbol	Description

Designed by J.B.H.	Date May 2003	Rev.	
Dwn by J.L.H.	Chk by J.W.K.	Design file no.	
Reviewed by		Drawing scale	
Submitted by		File name / Plot date / Plot scale	

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

WHITEMAN AIR FORCE BASE, MISSOURI
REPLACE CONTROL HEADING
FY 2003

LOGS OF EXPLORATIONS

Sheet reference number:
G-2

Appendix B

Laboratory Results

GEOTECHNOLOGY, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
SAINT LOUIS • COLLINSVILLE • KANSAS CITY

May 7, 2003

Mr. Jake Owen
U.S. Army Corps of Engineers
EC-GD, Room 824
601 East 12th Street
Kansas City, MO 64106-2896

Reference: Indefinite Delivery Contract No. DACA41-03-D-0003

Dear Mr. Owen:

Please find attached laboratory testing results for the Whiteman AFB project under the referenced contract. We appreciate the continued opportunity to provide services to the Corps under this contract. Please feel free to call with any questions.

Very truly yours,

Geotechnology, Inc.

William C. Jones, P.E.
Division Manager

WCJ:wcj

Copies submitted: (1)

Attachments: Whiteman AFB Laboratory Testing Results

printed on recycled paper

9136 CODY • OVERLAND PARK, KANSAS 66214 • 913/438-1900 • FAX: 913/438-1923

U.S. Army Corps of Engineers

GEOTECHNOLOGY, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
ST. LOUIS • COLLINSVILLE • KANSAS CITY

6808.01.3213

LABORATORY TESTING RESULTS
Family Housing Project - Whiteman AFB, Missouri

Boring No.	Sample No.	Depth (ft)		Water Content (%)	Atterberg Limits			Unified Classification	Compression Test			Dry Unit Weight (pcf)	Total Sulphates mg/Kg	Soil pH
		From	To		LL	PL	PI		Test Type	Unconfined Compression Strength (tsf)	Failure Strain (%)			
ADU-03-4	Wax-1	4.0	4.9	17.5	38	22	16	CL	Qu	1.7	3.3	112.2		
	J-3	5.0	6.5											
	J-4	6.5	6.9	10.5										
ADU-03-5	Wax-1	4.0	6.0	18.6	50	18	32	CH	Qu	2	1.9	98.4		
	J-1	2.0	2.6					CH					51.8	
	J-2	5.9	6.0	19.4										
	J-4	8.5	10.0	22.8										
	J-6	18.5	19.8	21.8										
	J-7	23.5	25.0	21.7										
ADU-03-6	Wax-1	4.0	6.0	17.8	49	15	34	CL	Qu	3.9	2.2	105		
	Wax-2	6.0	8.0	17.0					Qu	4.9	2.7	101.5		
	J-1	2.0	3.0		66	19	47	CH					53.3	
	J-3	7.9	8.0	16.7										
	J-4	8.5	9.8	17.8	49	17	32	CL						
	J-5	13.5	15.0	17.9										
	J-6	18.5	20.0	22.7										
	J-7	24.0	24.6	13.5	39	18	21	CL						
HA-03-7	J-2	1.8	4.0	23.2				CL						
	J-3	4.0	8.2	22.1										
	J-4	8.2	10.0	21.0										

GEOTECHNOLOGY, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
ST. LOUIS • COLLINSVILLE • KANSAS CITY

SUMMARY OF CLASSIFICATIONS TESTS

Project: Whiteman AFB

Note: By visual examination and classification, samples not tested were compared and grouped with typical test samples described below:

1)	Lean Clay (CL)	Yellowish Brown and Gray, trace fine sand, Fe stains, sandstone nodules (LL-38, PI-16)
2)	Fat Clay (CH)	Dark Olive Brown, medium plastic, trace silt, rock frags (LL-50, PI-32)
3)	Fat Clay (CH)	Dark Yellowish Brown, slickensided, trace silt
4)	Lean Clay (CL)	Olive, silty, laminated, with shaley zones
5)	Lean Clay (CL)	Dark Brown, trace silt, fine sand
6)	Fat Clay (CH)	Light Brownish Gray, trace fine sand, silt, Fe staining (LL-66, PI-47)
7)	Lean Clay (CL)	Gray, with silt, Fe stains and nodules, trace fine sand
8)	Lean Clay (CL)	Gray, w/ shaley zones, silt (LL-39, PI-21)

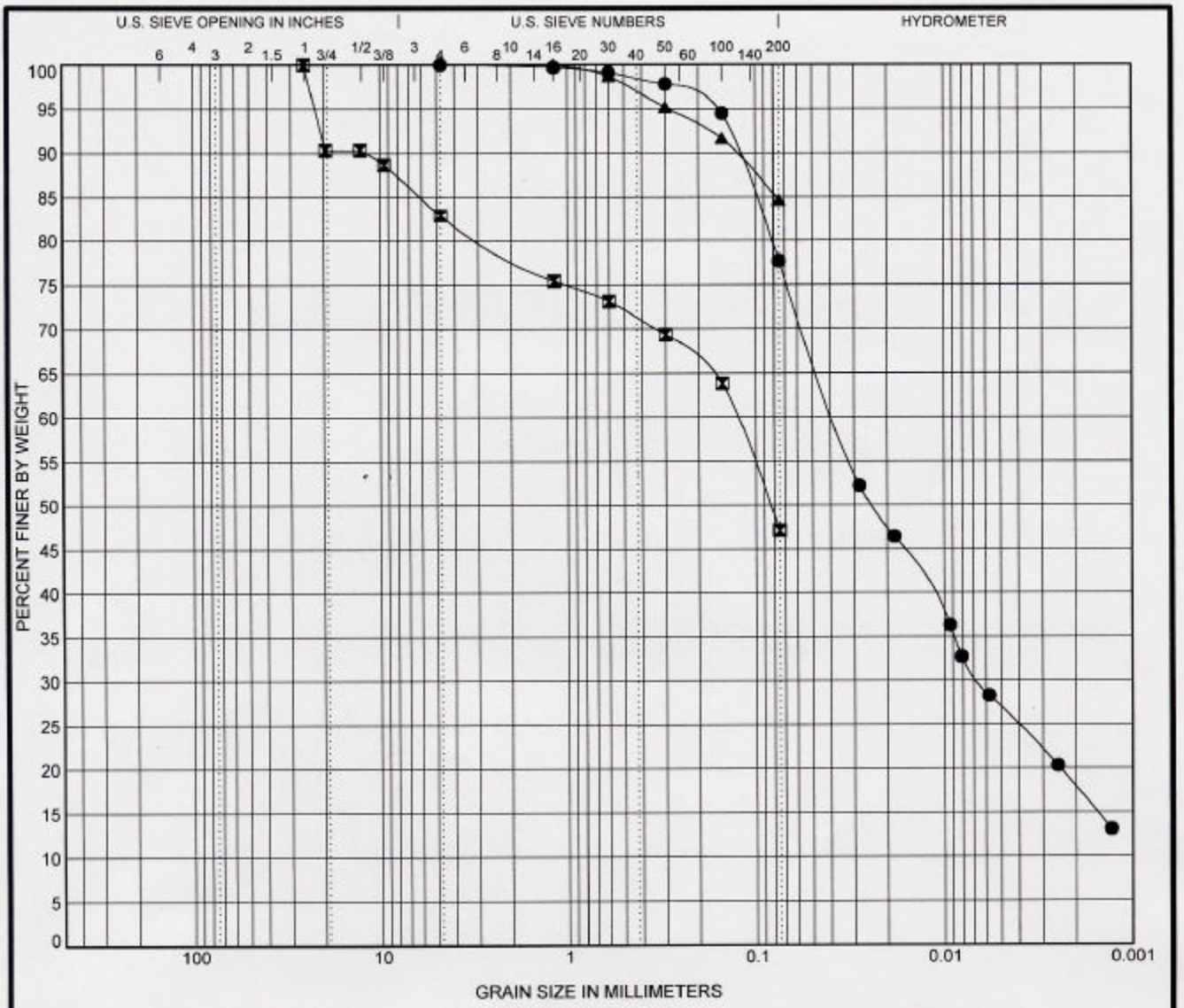
U.S. Army Corps of Engineers

GEOTECHNOLOGY, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES
ST. LOUIS • COLLINSVILLE • KANSAS CITY

6808.01.3213

LABORATORY TESTING RESULTS
Family Housing Project - Whiteman AFB, Missouri

Boring No.	Sample No.	Depth (ft)		Water Content (%)	Atterberg Limits			Soil Group	Compression Test			Dry Unit Weight (pcf)	Total Sulphates mg/Kg	Soil pH
		From	To		LL	PL	PI		Test Type	Unconfined Compression Strength (tsf)	Failure Strain (%)			
ADU-03-4	Wax-1	4.0	4.9	17.5	38	22	16	1	Qu	1.7	3.3	112.2		
	J-3	5.0	6.5					4						
	J-4	6.5	6.9	10.5				4						
ADU-03-5	Wax-1	4.0	6.0	18.6	50	18	32	2	Qu	2	1.9	98.4		
	J-1	2.0	2.6					5					51.8	
	J-2	5.9	6.0	19.4				2						
	J-4	8.5	10.0	22.8				6						
	J-6	18.5	19.8	21.8				7						
	J-7	23.5	25.0	21.7				7						
ADU-03-6	Wax-1	4.0	6.0	17.8	49	15	34	2	Qu	3.9	2.2	105		
	Wax-2	6.0	8.0	17.0				3	Qu	4.9	2.7	101.5		
	J-1	2.0	3.0		66	19	47	6					53.3	
	J-3	7.9	8.0	16.7				3						
	J-4	8.5	9.8	17.8	49	17	32	2						
	J-5	13.5	15.0	17.9				7						
	J-6	18.5	20.0	22.7				7						
	J-7	24.0	24.6	13.5	39	18	21	8						
HA-03-7	J-2	1.8	4.0	23.2				5						
	J-3	4.0	8.2	22.1				2						
	J-4	8.2	10.0	21.0				7						



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	ADU 3-4	5.0	Shale, Olive, silty, with clayey/sandy zones, mica	38	22	16		
⧗	ADU 3-4	6.5	See Log of Boring					
▲	ADU 3-6	24.0	See Log of Boring	39	18	21		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	ADU 3-4	5.0	4.75	0.038	0.007		0.0	22.3	50.8	26.9
⧗	ADU 3-4	6.5	25.4	0.128			17.1	35.8	47.1	
▲	ADU 3-6	24.0	1.18				0.0	15.4	84.6	

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ENGINEERING AND ENVIRONMENTAL SERVICES
ST. LOUIS • COLLINSVILLE • KANSAS CITY

GRAIN SIZE DISTRIBUTION

Whiteman AFB
Family Housing
6808.01.3213

US GRAIN SIZE WHITEMAN.GPJ 2002TEMPLATE.GDT 4/25/03

Boring No.	ADU-3-4
Sample No.	Wax-1
Depth (ft)	4-4.9
Date	4/22/03
Sheet No.	

GEOTECHNOLOGY
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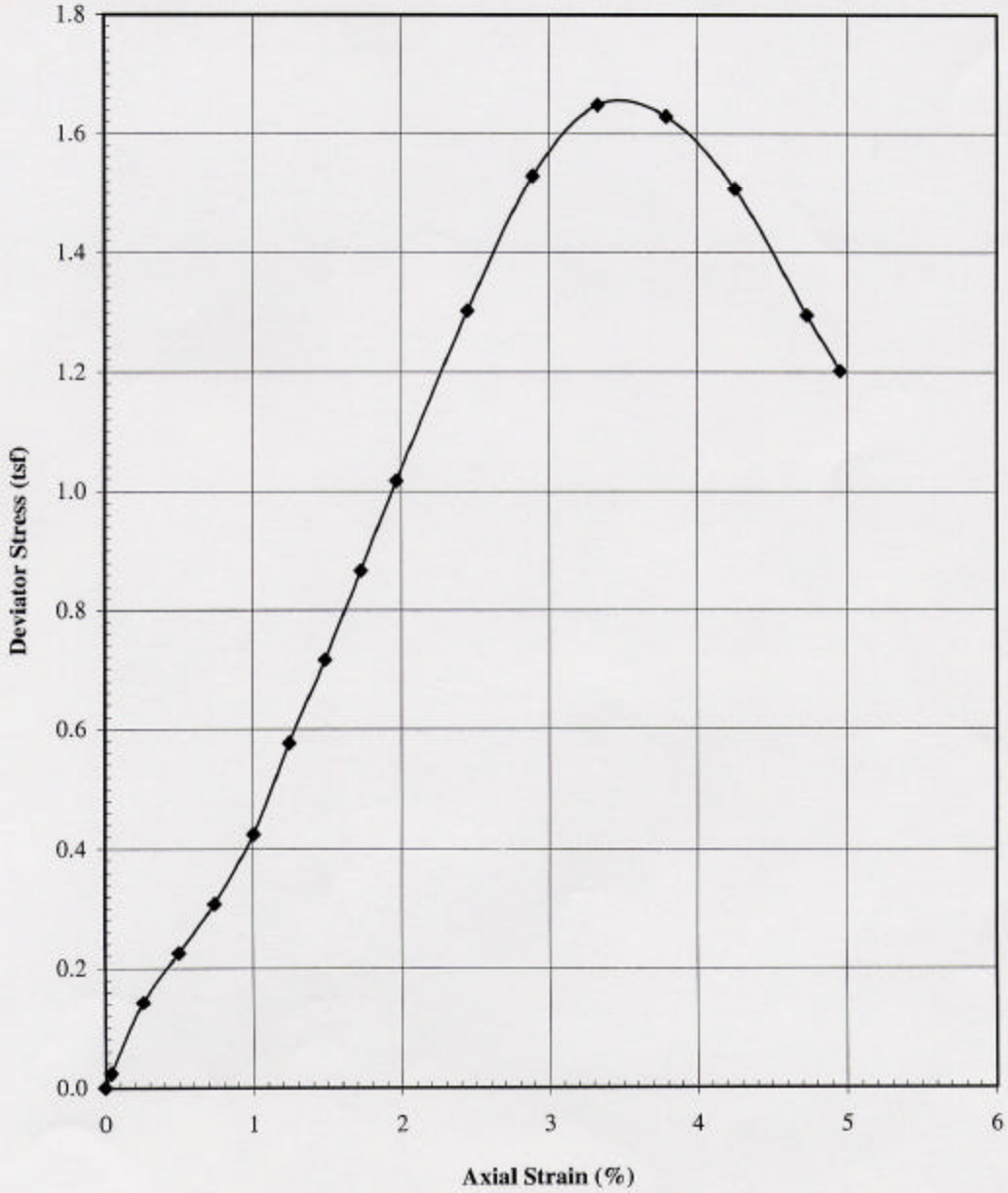
SAINT LOUIS, MISSOURI

UNCONFINED COMPRESSION TEST
Stress-Strain Plot

Job No.	6808.01
Job Name	Whiteman AFB
Tested By	ARK
Calculated By	AW
Checked By	

Max. Shear Strength =	1.65 tsf	Water Content =	17.5 %
Failure Strain =	3.33 %	Dry Unit Weight =	112.2 pcf



Boring No.	ADU-3-5
Sample No.	Wax-1
Depth (ft)	4-6
Date	4/22/03
Sheet No.	

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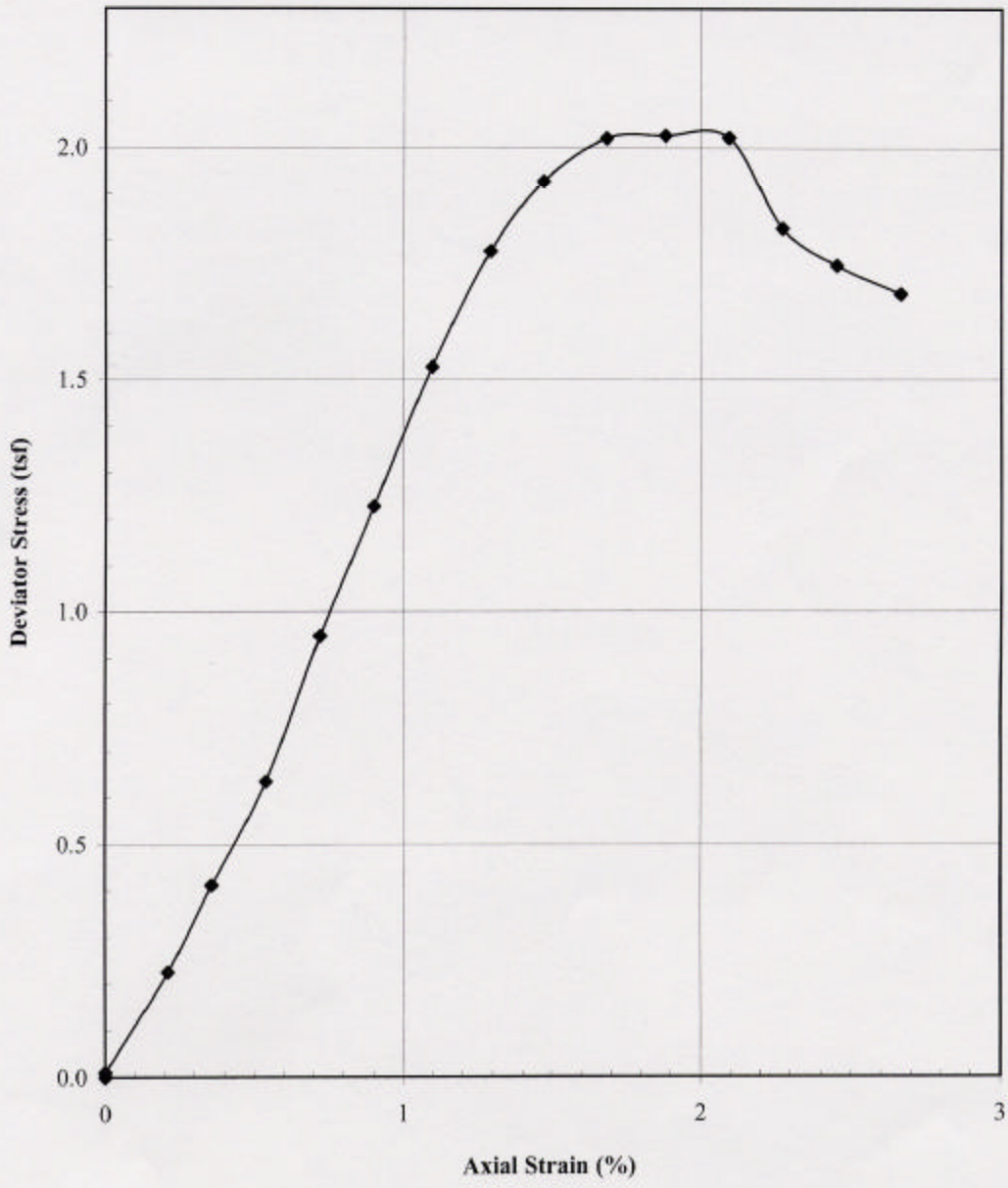
SAINT LOUIS, MISSOURI

UNCONFINED COMPRESSION TEST
Stress-Strain Plot

Job No.	6808.01
Job Name	Whiteman AFB
Tested By	ARK
Calculated By	AW
Checked By	

Max. Shear Strength =	2.03 tsf	Water Content =	18.6 %
Failure Strain =	1.88 %	Dry Unit Weight =	98.4 pcf



Boring No.	ADU-3-6
Sample No.	Wax-1
Depth (ft)	4-6
Date	4/22/03
Sheet No.	

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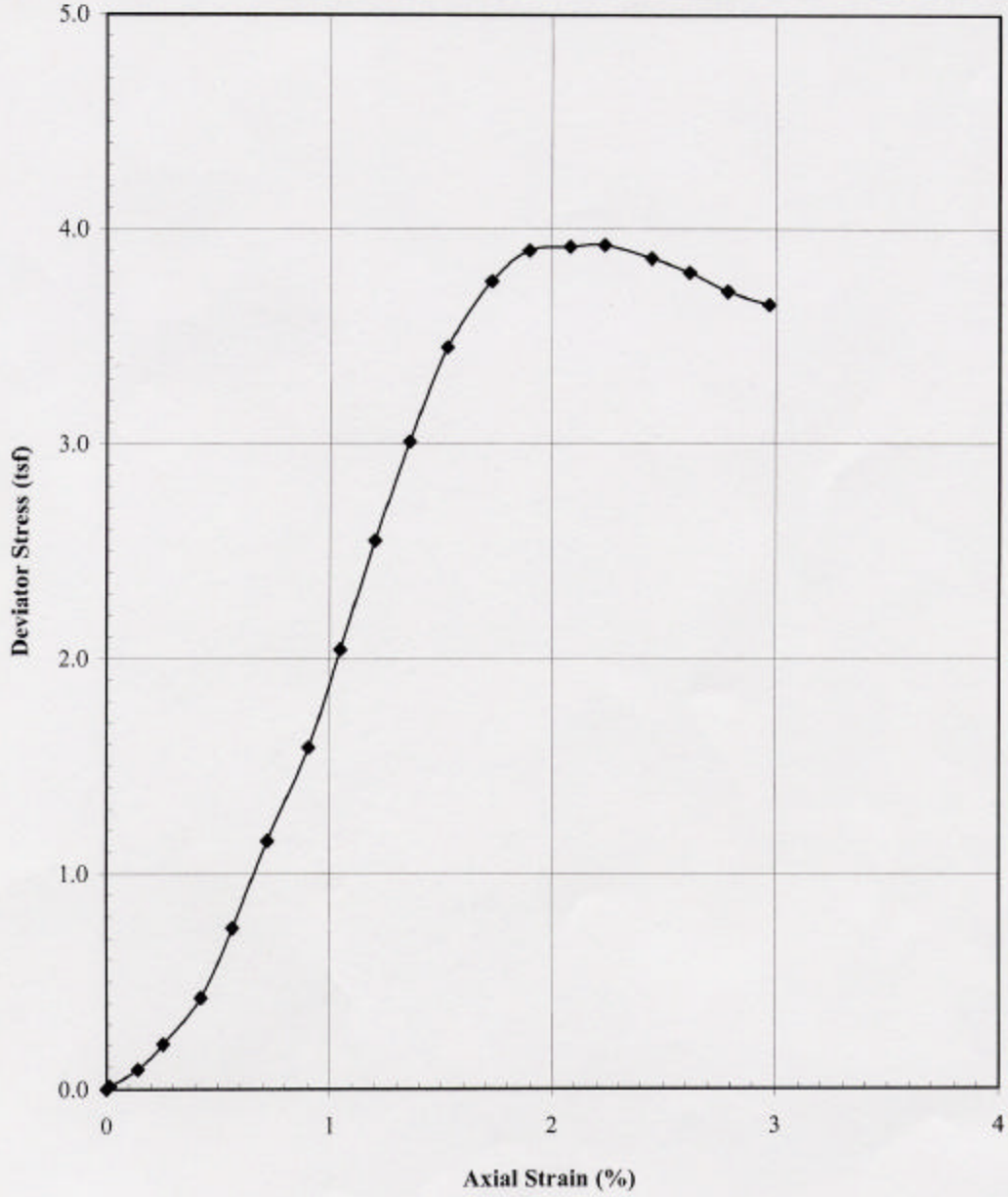
ENGINEERING AND ENVIRONMENTAL SERVICES
SAINT LOUIS, MISSOURI

UNCONFINED COMPRESSION TEST
Stress-Strain Plot

Job No.	6808.01
Job Name	Whiteman AFB
Tested By	ARK
Calculated By	AW
Checked By	

Max. Shear Strength =	3.93 tsf	Water Content =	17.8 %
Failure Strain =	2.24 %	Dry Unit Weight =	105.0 pcf



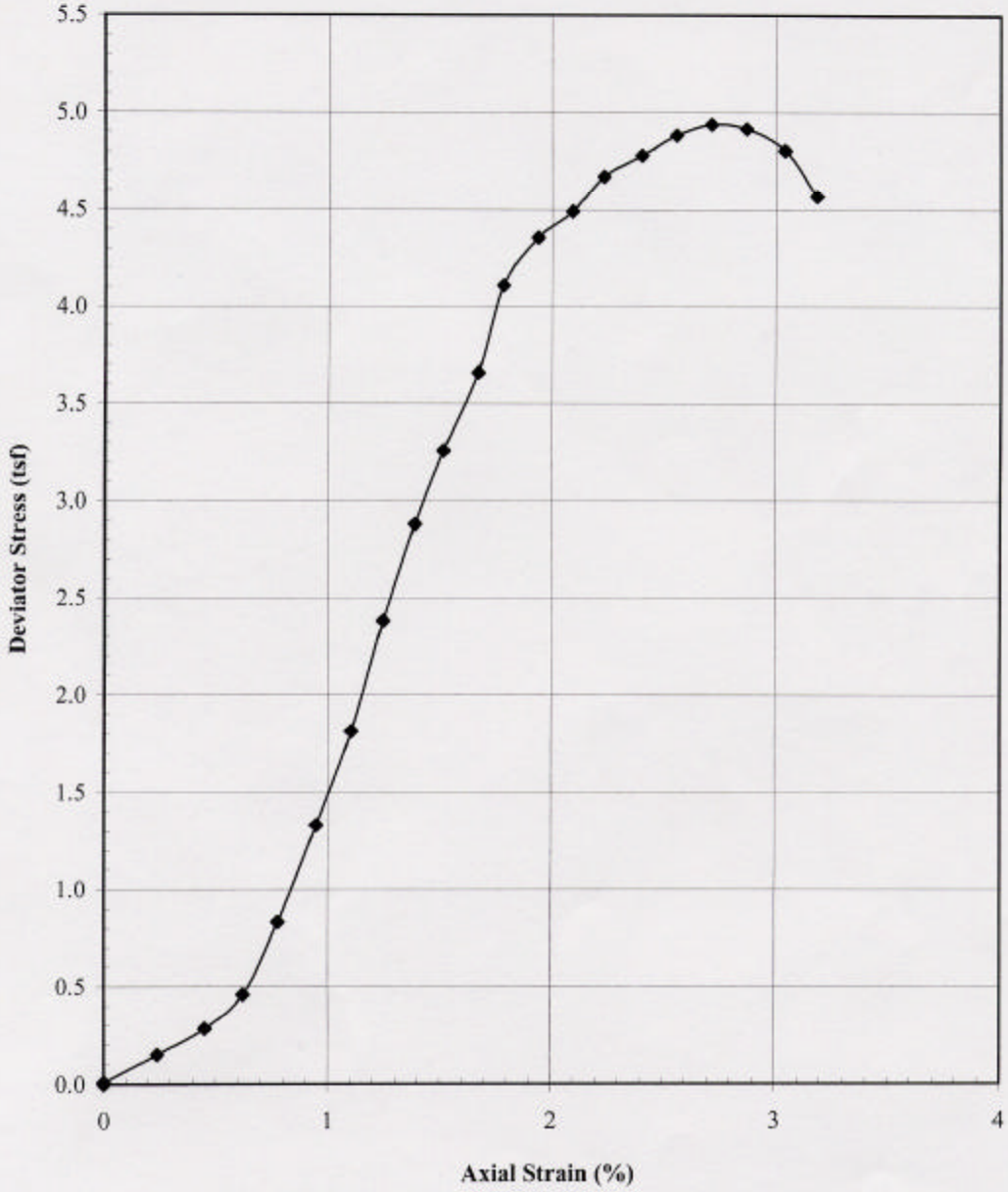
Boring No.	ADU-3-6
Sample No.	Wax-2
Depth (ft)	6-8
Date	4/22/03
Sheet No.	

GEOTECHNOLOGY
ENGINEERING AND ENVIRONMENTAL SERVICES
SAINT LOUIS, MISSOURI

UNCONFINED COMPRESSION TEST
Stress-Strain Plot

Job No.	6808.01
Job Name	Whiteman AFB
Tested By	ARK
Calculated By	AW
Checked By	

Max. Shear Strength =	4.94 tsf	Water Content =	17.0 %
Failure Strain =	2.72 %	Dry Unit Weight =	101.5 pcf

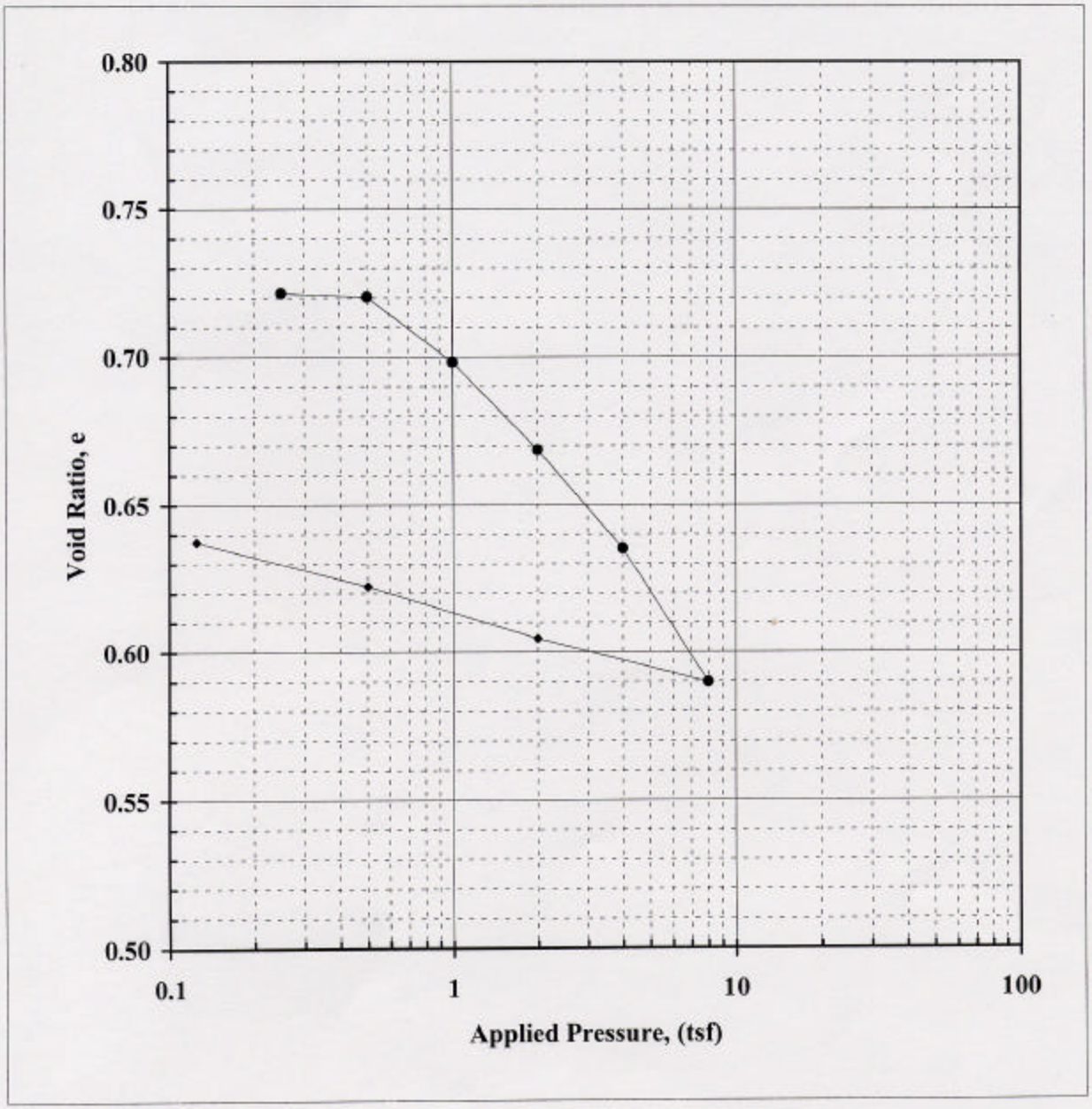


Boring No.	ADU3-4	GEOTECHNOLOGY		Job No.	6808.01
Sample No.	Wax-1	ENGINEERING AND ENVIRONMENTAL SERVICES		Job Name	COE-Whiteman AFB
Depth (ft)	4-4.3	SAINT LOUIS, MISSOURI		Sheet No.	
Tested By	ARK	**One-Dimensional Consolidation Test**		Test Date	4/15/03
Computed By	ARK	**(ASTM D 4546-96-C)**		Checked By	

Plot of Void Ratio versus Log of Pressure

Compression Index, C_c = 0.13 **Void Ratio, e_o =** 0.722

Recompression Index, C_r = 0.03 **Preconsolidation Pressure =** 0.9 **(tsf)**



Boring No.	ADU3-4	GEOTECHNOLOGY		Job No.	6808.01
Sample No.	Wax-1	ENGINEERING AND ENVIRONMENTAL SERVICES		Job Name	COE-Whiteman AFB
Depth (ft)	4-4.3			Sheet No.	
Tested By	ARK	**One-Dimensional Consolidation Test**		Test Date	4/15/03
Computed By	ARK	**(ASTM D 4546-96-C)**		Checked By	

Summary and Computation Sheet

SAMPLE DESCRIPTION

Specific gravity Gs 2.70 (cal. Gs) 2.94

Ring No. #1	BEFORE TEST	AFTER TEST
Height	1.0000 (in.)	0.9509 (in.)
Diameter	2.5000 (in.)	2.5000 (in.)
Area	4.9087 (sq.in.)	4.9087 (sq.in.)
Volume	4.9087 (cu.in.)	4.6677 (cu.in.)
Wt. (ring + wet soil)	370.31 (gm)	376 (gm)
Wt. (ring + dry soil)	342.45 (gm)	342.45 (gm)
Wt. of ring	216.38 (gm)	216.38 (gm)
Wt. of wet soil	153.93 (gm)	159.62 (gm)
Wt. of dry soil	126.07 (gm)	126.07 (gm)
Moisture content	22.1 (%)	26.6 (%)
Wet density	119.5 (pcf)	130.3 (pcf)
Dry density	97.8 (pcf)	102.9 (pcf)
Solids height	0.5807 (in.)	0.5807 (in.)
Ht. of water	0.3465 (in.)	0.4173 (in.)
Saturation	74 (%)	100 (%)

Dial Reading Factor 0.0001 (in.)

Initial Dial Reading 327

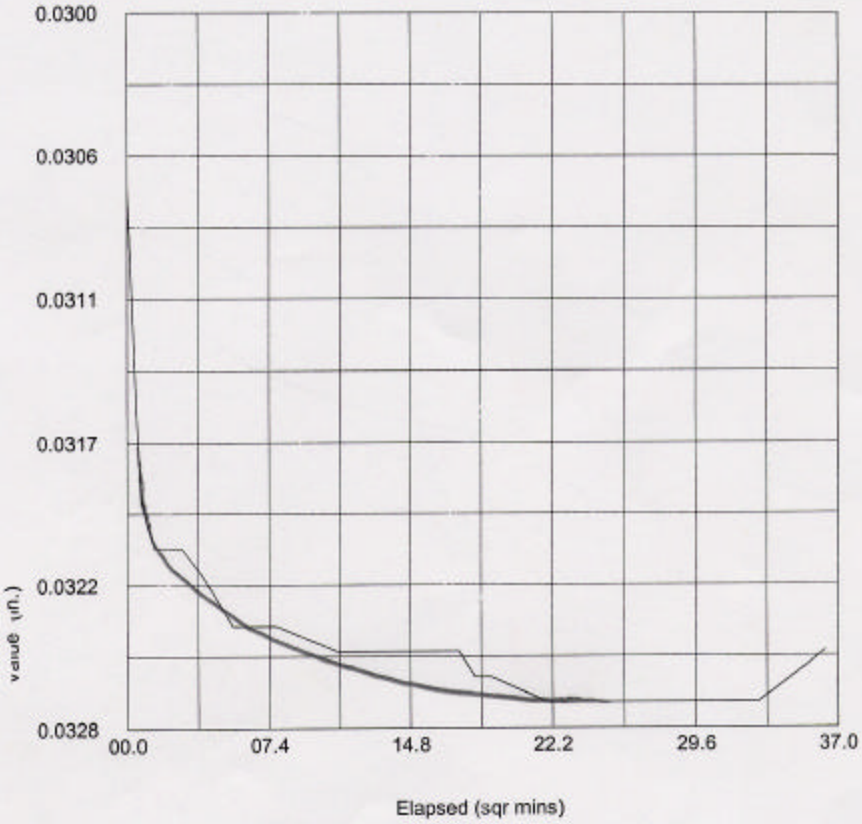
Method for Final Reading (1. Use D_{100} 2. D at end of load, 3. D at specific time): 2

Elaspsed Time (min)	Pressure Increment (tsf)	Dial Reading	Correc-tion	Dial Reading Corrected	Change of Reading	Specimen Height (in.)	Void Ratio	Average Pressure (tsf)	Cv (in.^{2}/min)
	0.01	327	0	327	0	1.0000	0.722		
	0.25	351	21	330	3	0.9997	0.721		
	0.500	374	37	337	7	0.9990	0.720		
	1.000	520	54	466	129	0.9861	0.698		
	2.000	714	76	638	172	0.9689	0.668		
	4.000	933	102	831	193	0.9496	0.635		
	8.000	1213	119	1094	263	0.9233	0.590		
	2.000	1113	104	1009	-85	0.9318	0.605		
	0.500	995	89	906	-103	0.9421	0.622		
	0.125	885	67	818	-88	0.9509	0.637		

Logged Data Printout (3a4 - 1/4 Ton

Configuration Data

Channel:	01 : Consol1	Units	in.
Serial No	021414296	Alarms:	Ignored
Zero (divs)	0	Filter:	1
FSD (divs)	10000	Polarity:	Bipolar
Zero (eng)	0.0000 in.	Cal Factor:	Uses Scaling
FSD (eng)	1.0000 in.	Travel:	Direct



DRAFT

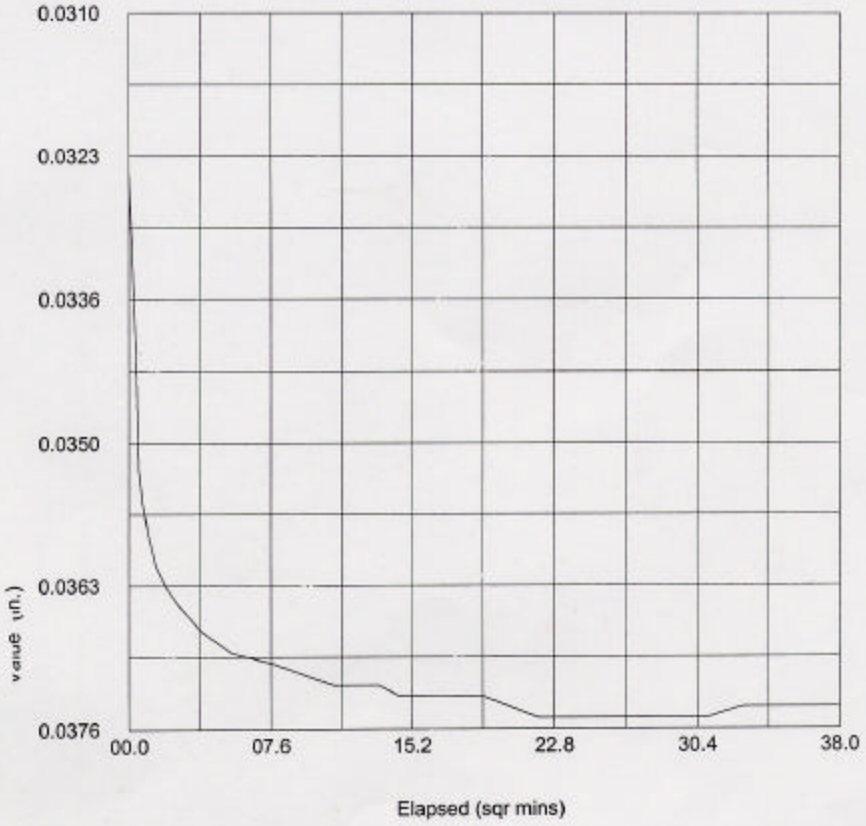
	Operator:	Checked:	Approved:

Logged Data Printout

C 3a4 - 1/2 Ton

Configuration Data

Channel:	01 : Consol1	Units	in.
Serial No	021414296	Alarms:	Ignored
Zero (divs)	0	Filter:	1
FSD (divs)	10000	Polarity:	Bipolar
Zero (eng)	0.0000 in.	Cal Factor:	Uses Scaling
FSD (eng)	1.0000 in.	Travel:	Direct



DRAFT

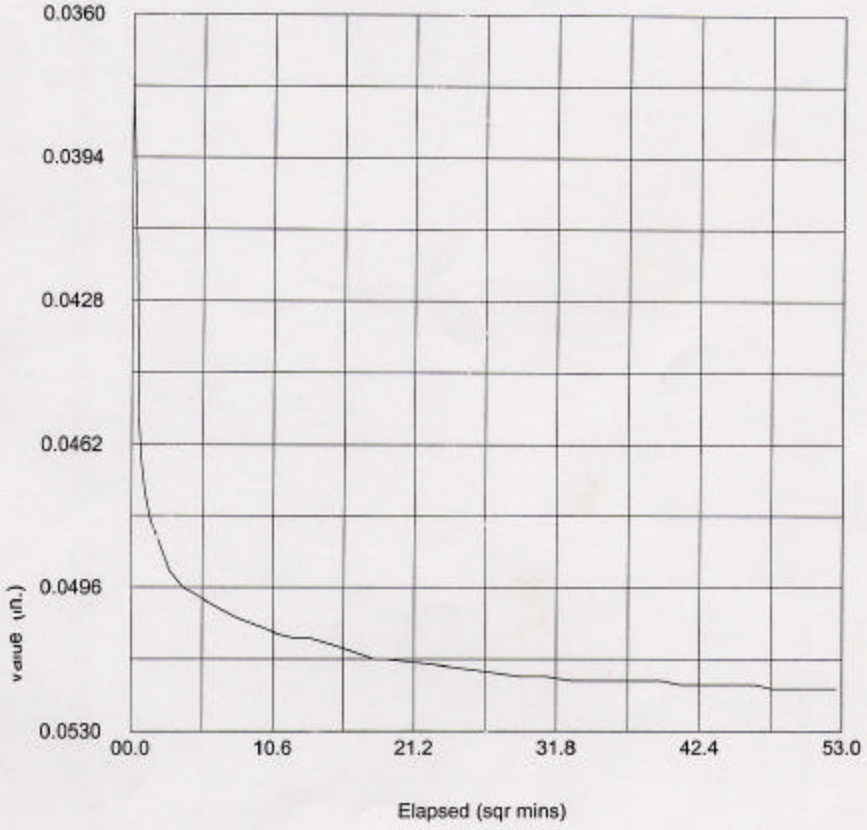
Operator:	Checked:	Approved:

Logged Data Printout

C3A4- 1Ton

Configuration Data

Channel:	01 : Consol1	Units	in.
Serial No	021414296	Alarms:	Ignored
Zero (divs)	0	Filter:	1
FSD (divs)	10000	Polarity:	Bipolar
Zero (eng)	0.0000 in.	Cal Factor:	Uses Scaling
FSD (eng)	1.0000 in.	Travel:	Direct



DRAFT

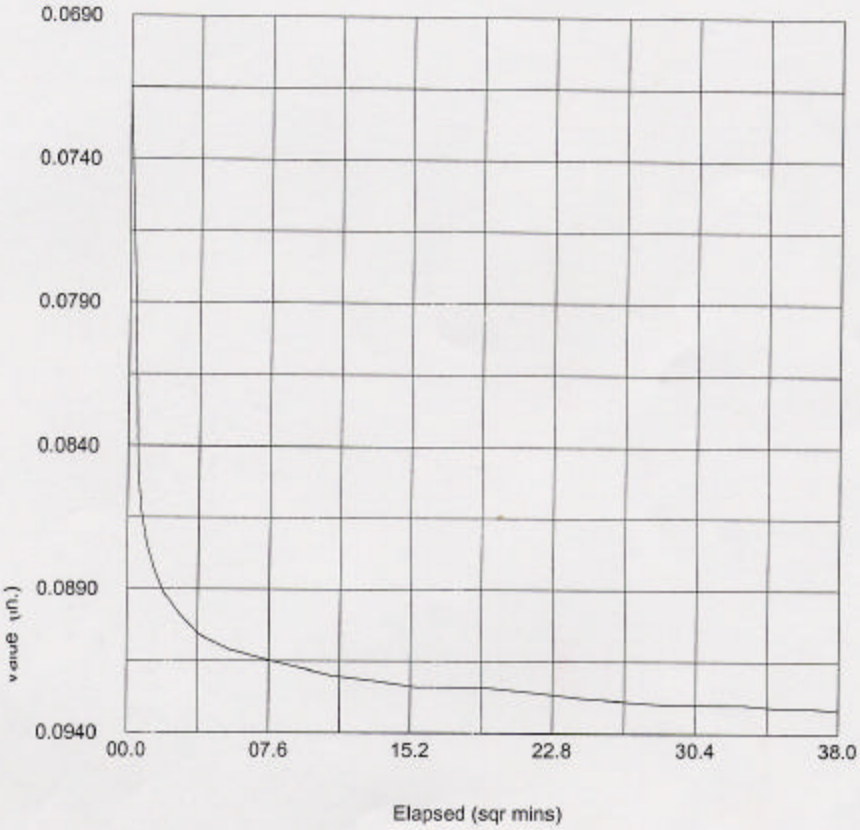
Operator:	Checked:	Approved:

Logged Data Printout

CA34-4Ton

Configuration Data

Channel:	01 : Consol1	Units	in.
Serial No	021414296	Alarms:	Ignored
Zero (divs)	0	Filter:	1
FSD (divs)	10000	Polarity:	Bipolar
Zero (eng)	0.0000 in.	Cal Factor:	Uses Scaling
FSD (eng)	1.0000 in.	Travel:	Direct



DRAFT

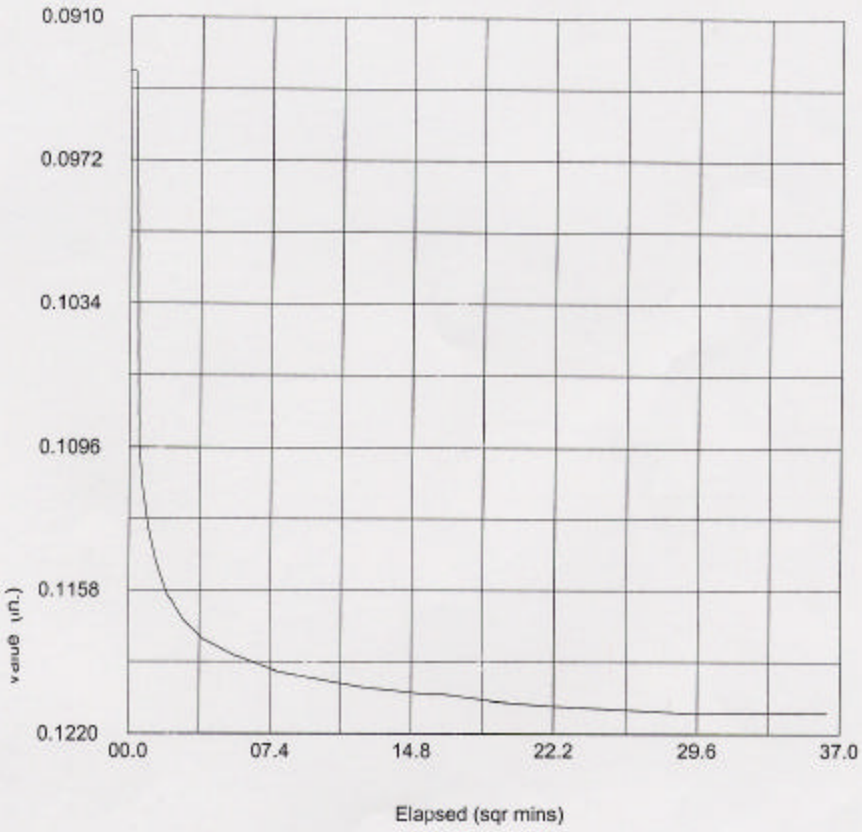
Operator:	Checked:	Approved:

Logged Data Printout

C3A4- 8 Ton

Configuration Data

Channel:	01 : Consol1	Units	in.
Serial No	021414296	Alarms:	Ignored
Zero (divs)	0	Filter:	1
FSD (divs)	10000	Polarity:	Bipolar
Zero (eng)	0.0000 in.	Cal Factor:	Uses Scaling
FSD (eng)	1.0000 in.	Travel:	Direct



DRAFT

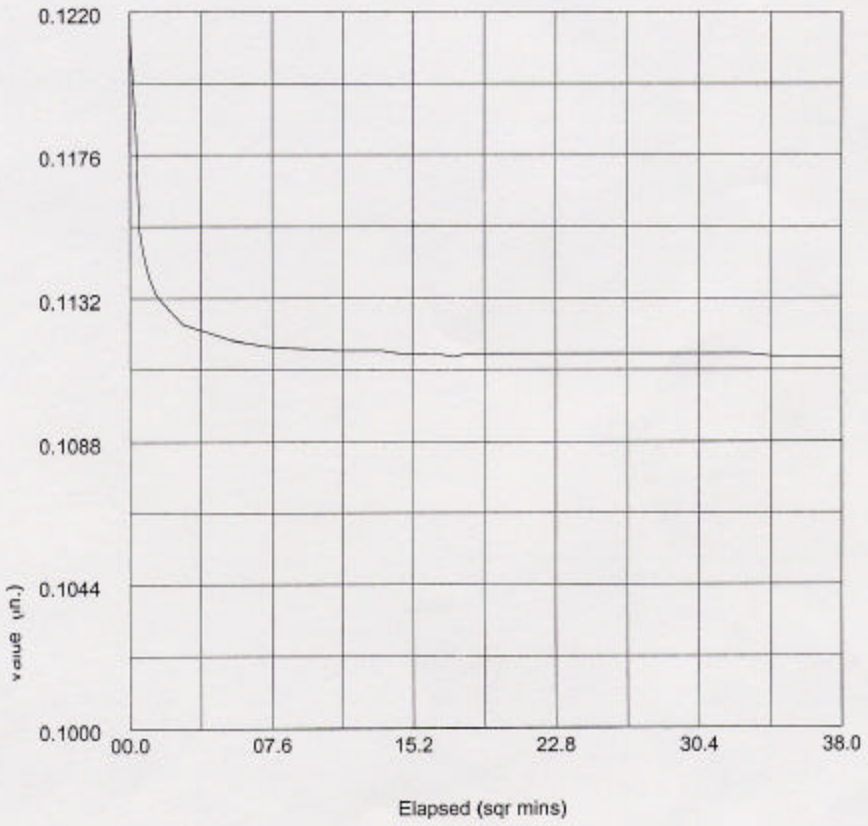
Operator:	Checked:	Approved:

Logged Data Printout

C3a4 2 Ton Unload

Configuration Data

Channel:	01 : Consol1	Units	in.
Serial No	021414296	Alarms:	Ignored
Zero (divs)	0	Filter:	1
FSD (divs)	10000	Polarity:	Bipolar
Zero (eng)	0.0000 in.	Cal Factor:	Uses Scaling
FSD (eng)	1.0000 in.	Travel:	Direct



DRAFT

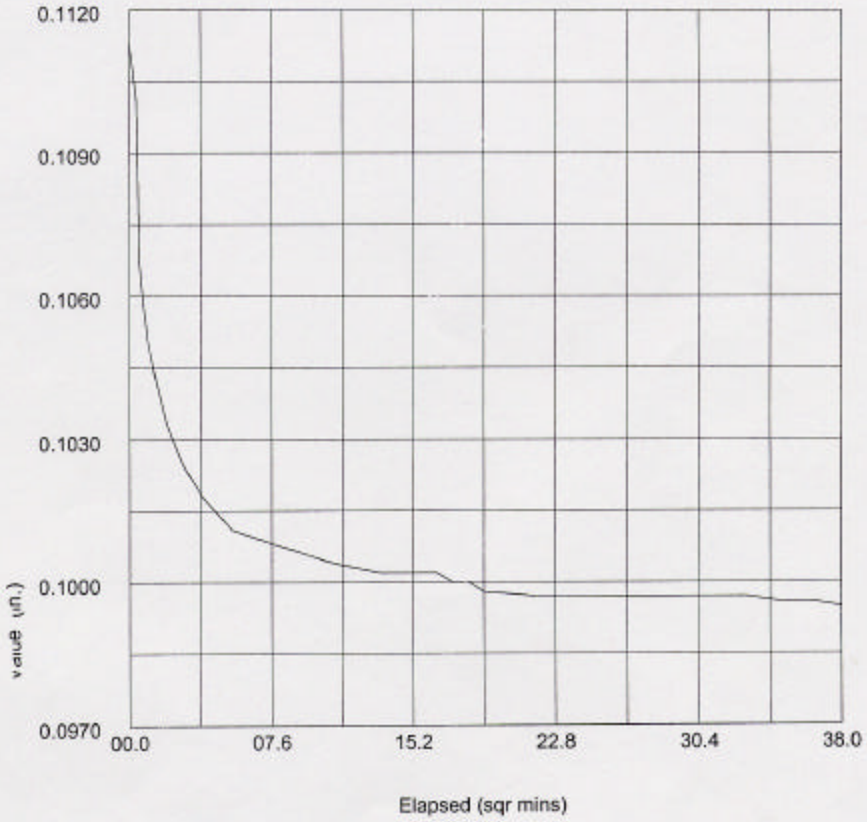
Operator:	Checked:	Approved:

Logged Data Printout

C3a4 1/2 Ton Unload

Configuration Data

Channel:	01 : Consol1	Units	in.
Serial No	021414296	Alarms:	Ignored
Zero (divs)	0	Filter:	1
FSD (divs)	10000	Polarity:	Bipolar
Zero (eng)	0.0000 in.	Cal Factor:	Uses Scaling
FSD (eng)	1.0000 in.	Travel:	Direct



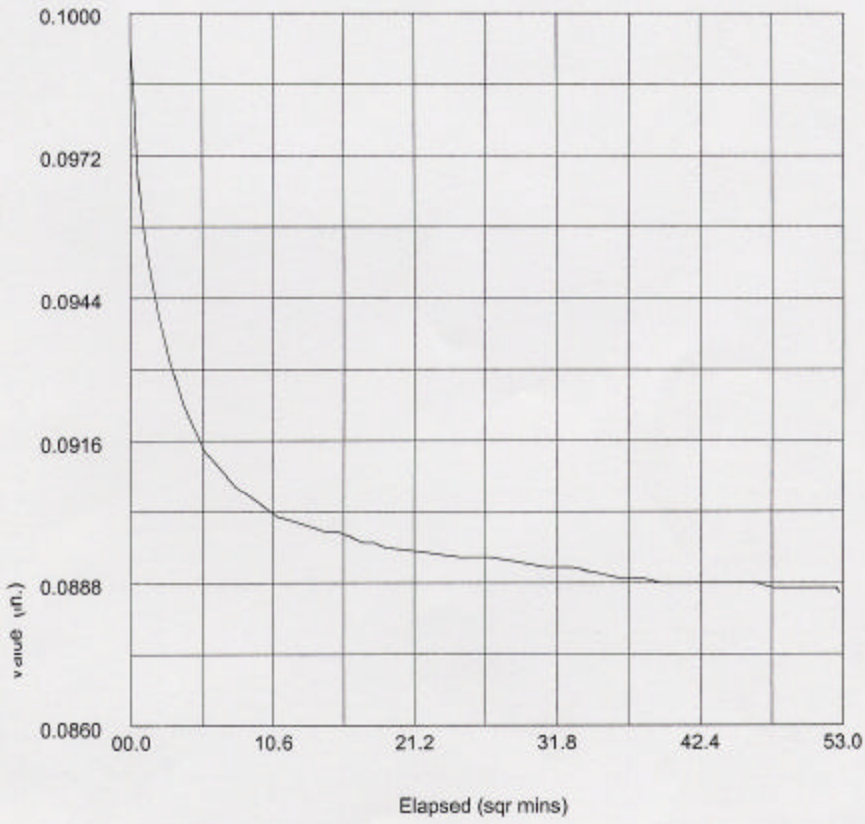
DRAFT

Operator:	Checked:	Approved:

Logged Data Printout (3a4- 1/8 Unload

Configuration Data

Channel:	01 : Consol1	Units	in.
Serial No	021414296	Alarms:	Ignored
Zero (divs)	0	Filter:	1
FSD (divs)	10000	Polarity:	Bipolar
Zero (eng)	0.0000 in.	Cal Factor:	Uses Scaling
FSD (eng)	1.0000 in.	Travel:	Direct



DRAFT

Operator:	Checked:	Approved:

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Lenexa, KS 66219
Phone: 913.599.5665
Fax: 913.599.1759

April 21, 2003

RECEIVED
APR 24 2003

Mr. Andrew Kline
Geotechnology, Inc.
9136 Cody
Overland Park, KS 66214

RE: Lab Project Number: 6069488
Client Project ID: WHITEMAN

Dear Mr. Kline:

Enclosed are the analytical results for sample(s) received by the laboratory on April 16, 2003. Results reported herein conform to the most current NELAC standards, where applicable, unless otherwise narrated in the body of the report.

If you have any questions concerning this report please feel free to contact me.

Sincerely,

Adam Taylor

Adam Taylor
adam.taylor@pacelabs.com
Project Manager

Kansas/NELAP Certification Number E-10116

Enclosures

REPORT OF LABORATORY ANALYSIS

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SAMPLE SUMMARY

Lab Project Number: 6069488
Client Project ID: WHITEMAN

Project Sample Number	Sample Number	Client Sample ID	Matrix	Date Collected	Date Received
6069488-001	605992841	ADU-03-6 J-1	Soil	04/15/03	04/16/03 10:45
6069488-002	605992858	ADU-03-5 J-1	Soil	04/15/03	04/16/03 10:45

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SAMPLE ANALYTE COUNT

Lab Project Number: 6069488
Client Project ID: WHITEMAN

Project Sample Number	Sample No	Client Sample ID	Analysis Code		Analysis Description	Analytes Reported
6069488-001	605992841	ADU-03-6 J-1	3000	SPAC	Anions Ion Chromatography Soil	1
6069488-002	605992858	ADU-03-5 J-1	3000	SPAC	Anions Ion Chromatography Soil	1

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Lab Project Number: 6069488
Client Project ID: WHITEMAN

Solid results are reported on a wet weight basis

Lab Sample No: 605992841 | Project Sample Number: 6069488-001 | Date Collected: 04/15/03 00:00
Client Sample ID: ADU-03-6 J-1 | Matrix: Soil | Date Received: 04/16/03 10:45

Parameters	Results	Units	Report Limit	Analyzed	By	CAS No.	Qual	RegLmt
Wet Chemistry								
Anions Ion Chromatography Soil Method: EPA 300.0								
Sulfate	53.3	mg/kg	1.00	04/18/03 16:42	HTN			

Date: 04/21/03

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Lab Project Number: 6069488
Client Project ID: WHITEMAN

Lab Sample No: 605992858
Client Sample ID: ADU-03-5 J-1

Project Sample Number: 6069488-002
Matrix: Soil

Date Collected: 04/15/03 00:00
Date Received: 04/16/03 10:45

Parameters	Results	Units	Report Limit	Analyzed	By	CAS No.	Qual	RegLmt
Wet Chemistry								
Anions Ion Chromatography Soil Method: EPA 300.0								
Sulfate	51.8	mg/kg	1.00	04/18/03 17:20	HTN			

Date: 04/21/03

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Lab Project Number: 6069488
Client Project ID: WHITEMAN

PARAMETER FOOTNOTES

ND	Not detected at or above adjusted reporting limit
NC	Not Calculable
J	Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit
MDL	Adjusted Method Detection Limit

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QUALITY CONTROL DATA

Lab Project Number: 6069488
Client Project ID: WHITEMAN

QC Batch: 143133
QC Batch Method: EPA 300.0
Analysis Method: EPA 300.0
Analysis Description: Anions Ion Chromatography Soil
Associated Lab Samples: 605992841 605992858

METHOD BLANK: 605998509
Associated Lab Samples: 605992841 605992858

Parameter	Units	Blank Result	Reporting Limit	Footnotes
Sulfate	mg/kg	ND	1.00	

LABORATORY CONTROL SAMPLE: 605998517

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Footnotes
Sulfate	mg/kg	100.00	93.10	93	85-115	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 605998525 605998533

Parameter	Units	605992841 Result	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Footnotes
Sulfate	mg/kg	53.35	50.00	97.51	96.82	88	87	75-125	1	10	

SAMPLE DUPLICATE: 605998541

Parameter	Units	605992858 Result	DUP Result	RPD	Max RPD	Footnotes
Sulfate	mg/kg	51.80	50.20	3	10	

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Phone: 913.599.5665
Fax: 913.599.1759

Lab Project Number: 6069488
Client Project ID: WHITEMAN

QUALITY CONTROL DATA PARAMETER FOOTNOTES

Consistent with EPA guidelines, unrounded concentrations are displayed and have been used to calculate % Rec and RPD values.

LCS(D)	Laboratory Control Sample (Duplicate)
MS(D)	Matrix Spike (Duplicate)
DUP	Sample Duplicate
ND	Not detected at or above adjusted reporting limit
NC	Not Calculable
J	Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit
MDL	Adjusted Method Detection Limit
RPD	Relative Percent Difference

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CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

719756

Required Client Information: **Section A**

Company: Geotechnology
Address: 9136 Cody
Phone: | Fax:

Required Client Information: **Section B**

Report To: Andrew Klein
Copy To:
Invoice To:
P.O.
Project Name: Whiteman
Project Number:

Page: 1 of 1

Client Information (Check quote/contract):
Requested Due Date: | *TAT: 3-5 day

* Turn around times less than 14 days subject to laboratory and contractual obligations and may result in a Rush Turnaround Surcharge.
Turn Around Time (TAT) in calendar days.

To Be Completed by Pace Analytical and Client **Section C**

Quote Reference:
Project Manager:
Project #: 60699488
Profile #:
Requested Analysis: Total Sulfides

Section D **Required** Client Information:

SAMPLE ID
One character per box.
(A–Z, 0–9 / .–)
Sample IDs MUST BE UNIQUE

Valid Matrix Codes

MATRIX	CODE
WATER	WT
SOIL	SL
OIL	OL
WIPE	WP
AIR	AR
TISSUE	TS
OTHER	OT

ITEM #	SAMPLE ID	MATRIX CODE	DATE COLLECTED (mm / dd / yy)	TIME COLLECTED (hh:mm a/p)	# Containers	Preservatives: Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Remarks / Lab ID
1	ADU-03-6 J-1		4-15-03										X	605992641
2	ADU-03-5 J-1		4-15-03										X	BSB
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														

SHIPMENT METHOD	AIRBILL NO.	SHIPPING DATE	NO. OF COOLERS

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME
	Bill Madden	4/16/03	10:45	[illegible]	4/16/03	10:45

SAMPLE CONDITION

Temp in °C	22.0
Received on Ice	Y/N C
Sealed Cooler	Y/N C
Samples Intact	Y/N C

SAMPLE NOTES

Additional Comments:

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER:

SIGNATURE of SAMPLER: | DATE Signed: (MM / DD / YY)

3

SEE REVERSE SIDE FOR INSTRUCTIONS

Form COC01 Rev 0402