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FORECASTING TRAFFICABILITY OF SOILS

Report 8

VARIABILITY OF PHYSICAL PROPERTIES OF LOESS SOILS WARREN COUNTY, MISSISSIPPI

by

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FOREWORD

The study reported herein is part of a research program being conducted under Task 1-V-O-21701-A-046-02, "Surface Mobility," of Department of the Army Project 1-V-O-21701-A-046, "Trafficability and Mobility Research," under the sponsorship and guidance of the Directorate of Research and Development, U. S. Army Materiel Command. The study was conducted by personnel of the U. S. Army Engineer Waterways Experiment Station (WES), Mobility and Environmental (M&E) Division, under the general supervision of Mr. W. J. Turnbull, Technical Assistant for Soils and Environmental Engineering; Mr. W. G. Shockley, Chief, M&E Division; Mr. S. J. Knight, Assistant Chief, M&E Division; Mr. A. A. Rula, Chief, Vehicle Studies Branch; and Mr. E. S. Rush, Chief, Soil-Vehicle Studies Section.

The initial fieldwork and analyses were conducted during 1958-1960 by the Forest Service, U. S. Department of Agriculture, with Mr. L. E. Andrew as project leader under the supervision of Mr. H. D. Burke and Dr. F. W. Stearns of the Southern Forest Experiment Station. The final analyses were made and the report was prepared by Mr. C. A. Carlson and the late Mr. A. R. McDaniel.

Directors of the WES during the conduct of this study and the preparation and publication of this report were COL Edmund H. Lang, CE, COL Alex G. Sutton, Jr., CE, and COL John R. Oswalt, Jr., CE. Technical Director was Mr. J. B. Tiffany.

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CONVERSION FACTORS, BRITISH TO METRIC UNITS OF MEASUREMENT

British units of measurement used in this report can be converted to metric units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
inches	2.54	centimeters
feet	0.3048	meters
miles	1.609344	kilometers
acres	4046.9	square meters
pints	0.473166	liters
pounds	0.45359237	kilograms
square inches	6.4516	square centimeters

SUMMARY

This study was undertaken to determine if the average of soil strength values obtained in a small area can be reliably applied to larger areas. The values of those soil properties commonly used in predicting soil strength and classifying soils were compared for areas differing in size. Six test sites in each of four soil series of loessial origin were established in Warren County, Mississippi, using series boundaries on soil survey maps for locating the sites. The series were the Memphis and Loring in the uplands and the Collins and Falaya in the bottomlands. Each site consisted of five sampling rows and each row had four sampling positions. Plots of pedologically distinct soil series were identified from field examination within sites and were used as an additional subdivision of test areas. Tests were conducted on four occasions to collect data on soil strength and moisture content, and once to collect data on other physical properties of the soil.

The four soil series could not be distinguished by soil strength because the cone index varied widely for any one series and the range of cone index for each series was approximately the same. The soils of the 6- to 12-in. layer of the uplands differed from those of the bottomlands in clay content and plasticity, but there was no corresponding difference in strength. The poorly drained Henry series and alluvial-fill soils of the uplands, as identified in the field, had the lowest cone indexes. Certain plots exhibited consistently different cone indexes for each sampling visit than did other plots in the same series, and certain rows in the same plot showed consistently different cone indexes. However, these differences could not be explained satisfactorily in terms of soil series, or soil properties commonly used in the Unified Soil Classification System and the U. S. Department of Agriculture textural classification. Limited data suggest that in future trafficability studies a terrain geometry classification system would be useful for identifying areas considered uniform in soil type but variable in soil strength by indicating areas having differences in reception or retention of water and differential erosion or deposition. Also, the effect of soil factors such as organic matter content, structure, and natural cementing agents should be determined. In a row of relatively uniform soil, five samplings for moisture content and static physical properties, and 10 measurements for soil strength should be made to provide acceptable mean values for trafficability use.

Basic data for each test site are included as Appendix A.

FORECASTING TRAFFICABILITY OF SOILS
VARIABILITY OF PHYSICAL PROPERTIES OF LOESS SOILS
WARREN COUNTY, MISSISSIPPI

PART I: INTRODUCTION

Background

1. In 1945, the U. S. Army Engineer Waterways Experiment Station (WES) began a series of investigations to determine and evaluate soil properties that affect movement of military vehicles.¹ Instruments were designed and built to measure soil strength, and soil strength measurements were correlated with the performance of a wide range of vehicles in prepared test lanes. Later, many soils in different terrains were studied to determine soil strength-vehicle performance relations. Other studies were conducted under diverse soil, weather, and site conditions to develop methods for predicting soil moisture content and its influence on trafficability. From these studies, trafficability classifications and tentative methods for predicting soil moisture have been derived.^{2,3}

2. The soil moisture and strength prediction methods were developed from test data obtained from relatively small areas, about the size of a conventional military vehicle. The measurements obtained in these tests are averages of soil property values that occur within the overall ground contact area of the vehicle. Although studies have been conducted to determine specific soil and site conditions for small test areas, no test has been made of the validity of applying these measurements over large areas. The next step, then, is to determine if the measurements obtained from tests in small areas can be applied to large areas or extrapolated to other areas of similar soil. Knowledge is needed, also, of soil and site factors that define and bound an area considered uniform for soil trafficability purposes.

Purpose

3. The purposes of this study were to:
 - a. Determine if the average of soil strength values obtained in a small area can be reliably used for a larger area of similar soil.
 - b. Determine whether the application of small area test results to larger areas is consistent with passage of time, as the soil moisture content changes.
 - c. Determine whether the variations in values of static soil properties (i.e. those that do not vary with time) and site factors used in soil moisture prediction methods are consistent with variations in strengths for small and large areas.
 - d. Consider the influence on soil strength of soil and site factors other than those that have been intensely studied.
 - e. Determine variation and sampling intensities of soil properties, pertinent to trafficability prediction.

Scope

4. The study was confined to relatively uniform soils developed from loess in Warren County, Mississippi. Four pedological soil series, two in upland positions differing in drainage and two in bottomland positions differing in drainage, were examined. Data were collected at 24 sites, six on each soil series. The static properties and site factors for each site were measured once during the winter-spring period. The dynamic properties that vary with time (i.e. soil strength and moisture content), were measured on four occasions during the year following the measurement of the static properties.

Definitions

5. Specialized terms used in this report are defined below.

Soil series. A group of soils having genetic horizons similar in diagnostic characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Except for texture, especially of the A horizon, the morphological features of the soil profile,

as exhibited in the physical characteristics and thickness of the soil horizons, do not vary significantly within a series.

Loess. Deposit of windblown material, predominantly silty in texture but often containing significant amounts of clay and fine sand.

Soil separates. Mineral particles, less than 2 mm in equivalent diameter, ranging between specified size limits. The names and sizes of separates recognized in the United States are sand, 2.0-0.05 mm; silt, 0.05-0.002 mm; and clay, <0.002 mm.

Fines. Soil grains finer than 0.074 mm (passing a No. 200 sieve).

Liquid limit (LL). The moisture content at which a pat of soil, cut by a groove of standard dimensions, will flow together for a distance of 1/2 in.* under the impact of 25 blows with a standard instrument and procedure. It represents the moisture content at which the characteristics of a mixture of soil and water change from plastic to liquid.

Plastic limit (PL). The moisture content at which a soil just begins to crumble when rolled out into 1/8-in.-diameter threads. It represents the moisture content corresponding to an arbitrary limit between the plastic and semisolid states of consistency.

Plasticity index (PI). The numerical difference in moisture content between the liquid and plastic limits.

Specific gravity. The ratio of the weight of soil after drying to a constant weight at 105 C to the weight of an equal volume of water.

Dry density. Weight of soil after drying at 105 C to a constant weight per unit volume of the soil in its natural structure, expressed as pounds per cubic foot or grams per cubic centimeter. It is comparable to bulk density and dry unit weight of intact samples.

Soil moisture content (MC). The soil moisture content expressed as a percentage of the weight of water driven off at 105 C to the weight of the remaining dry soil.

Moisture tension. Considered to be the force or tension by which water is held to the surface of soil particles or within interstices; it

* A table of factors for converting British units of measurement to metric units is given on page vii.

varies inversely with the soil moisture content. The moisture-tension relation for a particular soil is determined by means of a laboratory device at a sequence of tension or pressure settings. At a given moisture content, the tension is equal to the negative or gage pressure to which free water in the instrument has been subjected in order to be in hydraulic equilibrium, through a permeable wall or membrane, with the water in the soil.

Dynamic property. A property whose value changes with time and weather, e.g. moisture content or soil strength.

Static property. A property with a fixed value, for this study considered unchangeable with time, e.g. grain size or plasticity.

Soil strength. The resistance of a soil to an applied stress. The strength varies with moisture content and the nature, arrangement, and size distribution of the soil particles, and the test itself. The principal unit of strength used in trafficability studies is cone index.

Trafficability. The ability of a soil to permit the movement of a military vehicle.

Critical layer. The layer of soil regarded as most pertinent to establishing relations between soil strength and vehicle performance. In fine-grained soils and sands with fines, poorly drained, it is usually the 6- to 12-in. layer. However, the critical layer may vary with weight of vehicle and with soil strength profile.

Cone index (CI). An index of the shearing resistance of soil obtained with the cone penetrometer. The value represents the resistance of the soil to penetration of a 30-deg cone of 0.5-sq-in. base or projected area. The number, although considered dimensionless, is actually pounds of force on the handle divided by the area of the cone base in square inches.

Remolding index (RI). A ratio expressing the change in strength of a soil that will occur under vehicular traffic.

Rating cone index (RCI). The product of the measured cone index and the remolding index for the critical layer of soil.

Cone penetrometer. A field instrument consisting of a shaft with a 30-deg right cone mounted on one end, and a proving ring with dial gage and handle mounted on the other.

Trafficability sampler. A piston-type soil sampler for obtaining soft soil samples. The sample may be used in its entirety for making a remolding test or cut to known volumes, by the use of spacer bars or pins, for determining dry density.

Remolding equipment. A cylinder of the same diameter as the trafficability sampler cylinder mounted vertically on a base, and a 2-1/2-lb drop hammer that travels 12 in. on an 18-in. section of a cone penetrometer shaft fitted with a circular foot.

Median. The value of the middle item in an array.

Mean. The average value of all items in a sample. It is calculated by dividing the algebraic sum of the observations by their number.

Normal distribution. A type of distribution that serves to describe the frequency of occurrence of many natural facts and phenomena. It has an exact mathematical expression and is the basis of most statistical measures and inferences.

Standard deviation from the mean. The standard deviation from the mean is an index of dispersion of individuals in a sample about the mean of the sample. It is calculated as the square root of the mean of the squared deviations taken from the mean of the distribution. For a sample having a normal distribution, 68 percent of the individuals will have values within plus or minus one standard deviation from the mean.

Probability. As used in statistics, the probability of a given event is the expected frequency of occurrence of this event among events of like sort.

Significance. Significance is a measure of reliability. A given difference is called significant or reliable when the experimenter is satisfied that it cannot be explained away as having arisen from sampling fluctuations or sampling accidents.

Level of significance. A measure of reliability qualified by a statement of probability. A given difference is called significant at the 5 percent level if the probability is 95 times out of 100 that it cannot be explained as having arisen from a sampling accident; a difference is significant at the 1 percent level if the probability is 99 times out of 100 that it cannot be explained away as having arisen from a sampling accident.

Variance. An index of dispersion or variability of sample values or means. It is also called the mean square and is numerically equal to the square of the standard deviation.

F-test. A test comparing variances of two sets of values in a study in order to determine the probability of one set being like the other. The F-value is the ratio of the two variances, which in this study is that of the larger area, the plot variance, divided by that of the smaller area, the row variance. If the ratio is small, the variance of plot values is common with that of the rows within the plots, and the existence of plot differences is remote. If the ratio is large, exceeding a predetermined value based on a normal distribution, the probability exists that the plot values are not common with rows within plots and therefore that plot differences occur.

PART II: TEST PROGRAM

Test Area

6. The study was conducted in the eastern and southern parts of Warren County, Mississippi, in soils derived from loess overlying Tertiary sediments. The county is bounded on the east by the Big Black River, with a valley 1 to 2 miles wide, and on the west by the Mississippi River. The loess deposit thins from a depth of 60 ft near the Mississippi River Valley to a few feet on the hilltops 30 miles to the east. The deep loess has been severely eroded, forming narrow valleys with 30- to 100-ft differences in relief and with steep slopes that are frequently steeper than 50 percent. The valley bottoms are narrow and flat; the hilltops are often narrow ridges, although some wide, flat uplands occur. The loess hills bordering the Big Black River frequently have less slope and relief than the deeper loess hills further west. The terrain pattern of the test area is shown in fig. 1.

7. Soils developed from loess are relatively uniform, consisting primarily of silt, with some fine sand and clay. Differences occur between upland and bottomland soils. The upland loessial soils have weathered in place resulting in an increase in the clay content and a silty clay texture in a layer 10 to 20 in. below the surface, in contrast to a silt loam texture above and below the layer. Due to erosion of the surface at some locations, the clayey layer is at or near the surface. The bottomland soils are derived from recent alluvium washed in from the loess hills, and generally have a silt loam texture throughout the profile. Some bottomland soils along the Big Black River have higher contents of sand resulting from admixtures of sandy Tertiary materials. Loessial terrace soils also occur along the Big Black River, but these soils were not studied.

8. Sequences of soil series with drainages ranging from good to poor are distinguished for the upland and bottomland loessial soils of Warren County. In soils of the uplands, a fragipan occurs in and below the clayey layer. The prevalent soil series and approximate depths to the fragipan, where present, are as follows: Memphis, no fragipan; Loring, 36 in.; Grenada, 24 in.; and Henry, 15 in. In soils of the bottomlands, shallow

groundwater tables have developed a mottled structureless soil layer zone with dark gray and brown colors. The prevalent soil series and approximate depths to the mottled zone are as follows: Collins, 20 in.; Falaya, 10 in.; and Waverly, 3 in.

Test Sites

Selection

9. Sites were selected from soil survey maps of areas mapped as one soil series. It was desired to test soil series of uplands and bottomlands that differed widely in drainage, but examination of the maps showed that very poor and very well-drained soils were not common in the county; therefore, only soils of fair to intermediate drainage in the Memphis and Loring series of the uplands and the Collins and Falaya series of the bottomlands were selected for testing. For each of the four series, six test sites were randomly picked from more than 200 selected locations on the soil maps. The locations of the sites are shown in fig. 1. All sites were non-forested so as to minimize the influence of vegetation in the analyses.

Layout

10. Sites ranged from 100 to 540 ft in length, as determined by the distance between soil map boundaries, and were 30 ft in width. The length of the site was oriented upslope in the uplands, and between the drainage channel and the foot of the uplands in the bottomlands. The site layout is shown in fig. 2. The smallest test area, the row, was established across the width of the site, parallel to the contour of the terrain. Five

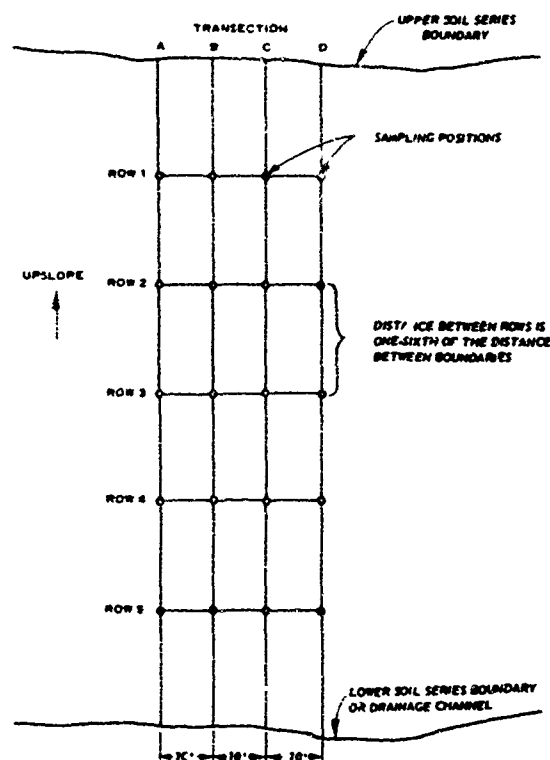


Fig. 2. Site layout

equidistant rows were established at each site, with spacing between rows governed by the site length. Four sampling positions (A, B, C, and D) were located 10 ft apart along each row.

Description

11. The locations and descriptions of the test sites including notes on topography, drainage, vegetation, and land use are given in table 1. Photographs of the sites, inset soil survey maps of areas of 1/2-mile radius around the sites, and the orientation of the sites are shown in plate 1.* More than 50 percent of the areas are mapped as soil series complexes of two or more dominant soil series. For example, 90 percent of the area surrounding site M VIII, a Memphis soil, was mapped as soil complexes. Macrogeometry and microgeometry of the test sites were described by the Geology Branch of the WES, using semiquantitative techniques devised by them.^{5,6}

Selection of Test Plots

12. During sampling at the sites it became obvious that there were inclusions of soil other than that of the mapped soil series. The inclusions were not unexpected since small areas of unlike soils are difficult, if not impossible, to delineate and show at the scale of the soil survey maps. To determine the prevalence and nature of these inclusions, the soils were identified in the field by row, and the series identifications were changed where necessary.** Each two or more rows at a site of the same soil series identified in the field were grouped together for analysis and designated as a plot. Rows of a plot were not necessarily adjacent. Thus, a site identified in the field as a single soil series consisted of one plot; another site identified in the field as two soil series consisted

* The soil maps were taken from unpublished field sheets of the standard soil survey conducted by the Soil Conservation Service of the U. S. Department of Agriculture. Subboundaries separating classes of erosion and slopes are not shown. The results of the soil survey and the maps were published subsequently in 1964.⁴

** Identifications were made by Mr. Y. H. Havens, State Soil Correlator, Soil Conservation Service, Jackson, Mississippi.

of two plots. A cross-reference of soil series by sites and plots is shown in table 2. Field identifications were not made at five sites because the sites or access avenues to the sites were inundated at the time the identifications were made; of the remaining sites the series identifications were changed for 36 of the 95 rows, resulting in a grouping of soils into 23 plots, each with two to five rows. Single rows of a field-identified soil series were not designated as plots and were not included in plot and row analysis. In the uplands the major changes of the field identification were the delineation of areas of alluvial fill and the Henry series from areas mapped as Memphis. In the bottomlands, field identification of Collins and Falaya frequently differed from map identifications. The Hymon series was identified from soils mapped as Collins. Two different soil series were identified at each of four sites.

Data Collection

13. Samples were collected once at a site to obtain data on the static properties of the soil; four visits were made to obtain data on the dynamic properties of the soil for a range of weather conditions. Data were obtained from each of the 20 sampling positions at a site. Tests on successive visits followed a preset pattern that included moving the sampling position one pace from a previous location to preclude testing soil that had been disturbed in a previous test.

Static properties

14. One-pint bulk samples were taken from the surface to 6-in. and 6- to 12-in. layers and analyzed following standard test procedures,⁷ for liquid and plastic limits, specific gravity, and grain sizes. Soil cores were taken with the modified San Dimas soil sampler in 3-in. vertical increments from the surface to a depth of 12 in. and used to determine dry density and soil moisture content at saturation, 0.015-, 0.03-, and 0.06-atm tensions.^{8,9}

Dynamic properties

15. For those properties that vary with time, sampling and

measurements for a given visit to all sites were obtained as quickly as possible to prevent inconsistencies in test results that could result from interim drying or wetting of the soil. Samples for moisture content were taken from the surface to 6-in. and 6- to 12-in. layers, and a remolding index test was conducted on a sample from the 6- to 12-in. layer. Cone penetrometer measurements were taken at 3-in. vertical increments from the surface to 18 in. It was necessary to measure strength when the soil was fairly moist to be within the range of the test instruments. The first winter season was dry, and although two visits were made, the soil was too firm to obtain a sufficient number of strength measurements for analysis. Following a heavy rain in April, another visit was made (visit A). To assure getting data from firm soils, a 0.2-sq-in. cone penetrometer was used. Because of the dry condition experienced on previous visits, no attempt was made to measure moisture contents or take remolding index samples from the 6- to 12-in. layer. In late February of the second winter, a full round of testing was accomplished (visit B). A few days later a 5-in. rain occurred, and an abbreviated set of tests was conducted for check purposes (visit C). Three cone penetrometer measurements were taken at the A position of all rows, and moisture and remolding index samples at the A position of rows 1, 3, and 5. A final visit (visit D) was made in May to collect data for drier conditions. Sampling was the same as on the third visit, except that moisture samples were taken at position A of all rows.

16. Sampling and measurements followed standard test procedures.¹ Moisture contents were determined by oven-drying the soil to a constant weight. For the surface to 6-in. average cone index, the surface, 3-, and 6-in. readings were averaged; for the 6- to 12-in. average cone index, the 6-, 9-, and 12-in. readings were averaged.

PART III: ANALYSIS

17. A small area, considered uniform from a trafficability standpoint, varies because of point-to-point differences in soil materials and moisture content; however, for practical purposes, the area is considered to be of one kind or under one condition of the soil. In a larger area, variation is generally greater because of a gradual change in soil material or condition across the area, or inclusion of different kinds of materials or conditions. For trafficability purposes, it is desired to delineate between areas of relatively uniform soil material or condition. In this study, data of soil properties meaningful to trafficability were grouped by soil series and layer, and by topography, site, plot, and row, and analyzed to determine the variability for areas differing in size. Basic data obtained in this study are given in detail in Appendix A.

Variation by Soil Series

18. One means of distinguishing soil kinds is by soil series, in which soils are grouped pedologically, according to similarities in properties, layer, and parent material. This description is widely used in agriculture and is the basis for delineating soils on most soil maps, so the logical start in the study of variability was to test the usefulness of series as a means of differentiating trafficability conditions. Data from soil series identified from maps (at sites) and from soil series identified in the field (at plots) were analyzed to determine the differences of soil properties for each grouping.

Soil series identified from maps

19. The soil series identified from maps included Memphis and Loring in the uplands, and Collins and Falaya in the bottomlands. An analysis of variation of soil properties between series was compared with variation between sites within series.¹⁰

20. Soil properties, including grain sizes, plasticity, specific gravity, density, and moisture content at 0.06-atm soil moisture tension, were analyzed by 6-in. layers. Results, given in table 3 under "Series

Identified from Soil Maps," include mean values for each soil series, derived from average site values, and the standard deviation of the site values. The probable significance of differences between series values for each property was determined from the statistical F-value; i.e. the ratio of the variance between series to that between sites within series.¹¹ For example, the average values of sand content for Memphis, Loring, Collins, and Falaya soils are 12, 10, 15, and 12 percent, respectively, whereas the standard deviation of a site value within any series is ± 1.7 percent (table 3). The F-ratio of variances is not significant (NS), having a value of 1.44, whereas a minimum F of 2.74 is needed to show a significant difference among series; i.e., the spread of values in sand content between series is small compared to the variability between sites within series.

21. The values for sand, silt, fines, and plastic limit did not differ meaningfully among soil series (see table 3). However, differences in values of clay content for the 0- to 6-in. and 6- to 12-in. layers, and liquid limit and plasticity index for the 6- to 12-in. layer, are indicated between uplands and bottomlands soils rather than by series; the uplands have higher values than those of the bottomlands. Differences also exist in dry density and soil moisture content (0.06-atm tension) values, primarily between the Falaya bottomland and Loring upland soils. However, the Collins bottomland and Memphis upland soils do not differ in these properties. Cone index and moisture content data are not shown here because they had not been collected at this stage of the analysis.

Soil series identified
from field observation

22. Analysis by static properties. A second analysis was made using data for series identified in the field. Results, shown in table 3, under "Series Identified from Field Observations," are essentially the same for the Memphis-Loring upland soil series and Collins-Falaya bottomland soil series as in the analysis of the soil series identified from maps. Statistical analyses for silt, fines, and plastic limit were not made because the analysis of mapped soil series had shown that these properties were extremely uniform; the similarity of series mean values may be noted in table 3. Also, as in the analysis of series identified from maps,

differences occur in clay contents, liquid limits, and plasticity indexes, particularly in the 6- to 12-in. layer. Clay contents in the 6- to 12-in. layer of the Memphis and Loring upland soils averaged 23 percent; those of the Collins and Falaya bottomland soils averaged 12 percent. The liquid limits of the upland soils averaged 43 percent; those of the bottomland soils averaged 32 percent. The plasticity indexes of the upland soils averaged 19 percent; those of the bottomland soils averaged 7 percent. Thus, distinct differences were again indicated between Memphis-Loring upland and Collins-Falaya bottomland series groupings for soil properties that are generally used in soil classification. The soil property values of alluvial fill and the Henry series in the uplands were different from those of the Memphis and Loring series from which the soils were separated, and were similar to the values for bottomland Collins and Falaya series. The Hymon soil, not of pure loess origin, had a higher sand content than the others.

23. Analysis by dynamic properties. Surprisingly, cone index showed no statistically significant differences between series for either soil layer on any sampling visit. Hence, even though the soil series were correctly identified, the series designation was not useful for differentiating these loess soils by cone index. Some trends were evident, however. The strengths of the upland Memphis and Loring series were higher than those of the bottomland Collins and Falaya series at the less moist conditions (on visits A and D), but were almost the same at the more moist conditions (on visits B and C). Also, soils of the alluvial fill and Henry series, that had been separated from the upland Memphis and Loring series, had consistently low strength, usually lower than the bottomland soil series on all visits.

24. Moisture contents differed significantly between series, primarily in the surface to 6-in. layer. Bottomland Collins and Falaya soils had higher moisture contents than the upland Memphis and Loring soils, but at the more moist conditions of visits B and C, differences were small. Moisture contents of the alluvial fill and Henry series of the uplands were as high or higher than those of the bottomland soils on all visits.

25. On the basis of data from the four visits, it can be concluded

that cone indexes of soil series of intermediate drainage are not different. However, lower cone indexes are indicated for soil series with poor drainage than for soil series of intermediate drainage. The analysis shows that even though differences in physical properties (including moisture content) of the soil may occur between series, there may be no meaningful differences in cone index. This statement does not preclude the possibility that strength differences in loess may be differentiated on some basis other than pedological soil series, or that soil series classification may be useful for differentiating strengths of soils from diverse parent materials.

Variation by Plots and Rows Within Uplands and Bottomlands

Division into groups

26. An analysis of variance by plots and rows was conducted on Memphis, Loring, Collins, and Falaya series identified in the field. The other field-identified series were not included because the data for these soils were insufficient for proper analysis. The nine plots of Memphis and Loring and the ten plots of Collins and Falaya were grouped into uplands and bottomlands, respectively. This grouping simplified calculations and was deemed proper because previous analysis showed a similarity of properties between series within each of these groups (see paragraphs 21 and 22). Results of the analysis are given in table 4.

Variation by plots

27. Analysis by static properties. The data show differences in mean clay contents, liquid limits, and plasticity indexes between uplands and bottomlands of the 6- to 12-in. soil layer similar to those found in the analysis by series. However, significant differences in those properties also occur between plots within each group, with the exception of liquid limit in bottomlands. For the surface to 6-in. layer, as in the analysis by series, no differences occur between groups for liquid limit and plasticity index; however, differences again occur between plots within each group. Differences in sand content, dry density, and moisture content at 0.06-atm soil moisture tension were recorded between plots within each group, but only small differences were found for specific gravity. Silts,

finer, and plastic limit were not tested because the small range in plot values precluded any significant difference between plots. In some instances, differences between plots were greater than those between upland and bottomland groups.

28. Analysis by dynamic properties. Highly significant differences in cone index and moisture content were found between plots in both groups for each of the visits.* The differences in cone index between plots contrast sharply with the findings in the analysis by series (see paragraph 23). Also important is the similarity in the means and ranges of cone indexes and moisture contents between plots of uplands and plots of bottomlands for each of the visits. The range in cone index of bottomland plots overlapped that of the upland plots except for the less moist soil conditions of visits A and D, when some of the upland plots had higher strengths. The overlap of values in ranges of moisture contents between uplands and bottomlands was not as inclusive as that for cone indexes, but was still considerable when compared to the discrete ranges for clay, liquid limit, and plasticity index in the 6- to 12-in. layer.

Variation by rows

29. Data from rows within plots were analyzed with the variance attributable to plots excluded (table 4). For most properties, appreciable differences occurred between rows of the uplands and between rows of the bottomlands. The ranges of cone index values of the two groups were similar on all visits, and the mean strengths were about the same on visits B and C, but were somewhat higher in the uplands on visits A and D. The pattern of differences between rows was the same as between plots except that values for the rows exhibited more overlap than those for the plots in the 6- to 12-in. layer for clay content and liquid limit. Row data had a wider range than plot data and the distinction between uplands and bottomlands was not as good. The data indicate that trafficability cannot be discretely quantified by soil series designation or upland-bottomland groupings because of the large cone index variability of plots and rows within the larger units.

* Moisture contents for visits C and D were not included in this analysis because sampling was not complete on all rows.

Variations of Plots and Rows

Comparison of plot cone indexes

30. The array of cone index values for all plots regardless of series and upland-bottomland groupings was next examined. Cone index values for the four visits were averaged, and the array arranged in order of increasing values. Visit values were graphed in the same sequence (plate 2). Some irregularities in visit values are apparent, but in general, the progression for each visit follows that of the average, showing the consistency of plot differences irrespective of time of sampling. The general intermingling in the array of plots irrespective of series and upland-bottomland groupings reveals why no differentiation by series or groups was found. Three Loring plots in the upland (L1, L2, and L4) had high strengths, but the next plots (F2 and C2&F7) of slightly lower strengths were bottomlands. Of the seven weakest plots, five, including one Loring, were uplands. However, of these, two plots of alluvial fill and one plot of the poorly drained Henry series were inclusions that had been separated from the mapped Memphis series. A true Memphis soil also occurred in this group.

31. Two of the four sites, each of which was divided into two plots after field identification of the soil, showed such similar cone indexes throughout the site for the four-visit average that the plots within each were recombined for this part of the analysis, namely plots C3 with F6, and C2 with F7. Plots of the other two sites had distinct cone index differences; the second weakest plot, AF2, was separated from the seventh strongest plot, M4, and the third weakest plot, HNL, was separated from the strongest plot, M3.

Relations between cone index and other soil properties by plots

32. Analyses were made to determine the relation between plot cone indexes and other soil properties of the plot, including dry density, moisture content, plasticity index, and clay content, in the 6- to 12-in. layer. The relations are shown in plate 3. Moisture contents and cone indexes were averaged for all visits to a plot, and each average was

used to characterize the plots. Dry density showed the best probable correlation, exhibiting high strength at high density, but the range in values was small (0.11 g per cc). Moisture content showed poorer correlation (significant at 5 percent level), but with a large range of values (from 23 to 31 percent) and was inversely related to cone index. Correlations were poor with plasticity index (significant at 20 percent level), and clay content (not significant at 20 percent level) and with other soil properties including liquid limit and silt content (not shown).

33. Although it is well established that grain sizes and plasticity constants are related to soil strength, the poor correlations of these properties indicate that they cannot be used to explain strength differences between plots in this study; their effects were secondary to those of such properties as moisture content and dry density. The irregularities in the trends of the arrays of plot values occurred whether correlation was good or poor, although they were more pronounced in the poor correlations. Why upland plots M1 and L3 have the normally low strength of bottomland soils but other soil properties characteristic of the upland soils, and why bottomland plots C2 and F7 and F2 have the normally high strengths of the uplands are not explained completely by moisture content or dry density data. The implication is that other factors not defined in this study contribute significantly to the variation.

Comparison of row cone indexes

34. The analysis of variance of soil properties showed highly significant differences between rows. However, the analysis did not indicate which rows were different or the persistence of difference with time, so variation by rows was examined in more detail. For the first comparison, rows of a plot were ranked from 1 (weakest) to 5 according to increasing average strength for all visits. Then rows of a given rank from all the plots were averaged for each visit (plate 4). A consistent difference in cone index is found between the high- and low-strength rows for all visits; differences are indeterminate for intermediate rows.

35. The cone index of the lowest strength row was not always statistically different from that of the highest strength row in a plot or from the plot average of the remaining rows, so a pooled variance based on all

visits (derived from pooled standard deviation in table 4) was used to select extreme rows (i.e. those with statistically different high and/or low average cone indexes) in each plot. Only three rows, AF1 row 3, C3 and F6 row 3, and HYL row 2, had higher values than the plot average of the remaining rows, whereas 13 rows had lower values. Two rows with low strengths were found in each of three plots, F2 rows 2 and 3, L2 rows 2 and 5, and L1 rows 2 and 3. Soft areas occurred in a plot far oftener than did firm areas and were found throughout the array, although the strongest plots had the double soft rows. Soft rows were found at any row position. The average difference between the low-strength row and the plot average of the remaining rows was 93 CI; the median difference was 63 CI. Either difference is appreciable in terms of trafficability.

36. The cone index values of 10 plots with low-strength rows were plotted by visits in plate 5. The data show a consistent difference in cone index between the average for the plot, excluding the extreme rows (described in paragraph 35) and the low-strength row. Individual measurements of the low-strength row generally cluster about the row mean, showing that all points in the row were uniformly low in strength and the low value of the mean was not caused by a few erratic values. Some individual measurements in the low-strength rows were higher than plot averages on visit A, but not on visits B, C, and D.

Relations between cone indexes and other soil properties, by rows

37. Analyses were made to determine whether the cone indexes of low-strength rows would correlate with other soil properties of the row. The procedure followed that relating plot cone index to other soil properties, discussed in paragraph 32, except that the cone index of the low-strength row was compared with the average cone index of the plot excluding the extreme rows. The B, C, and D visit values of cone index and moisture content were averaged and used as area indexes of strength and moisture, respectively. The relations of cone indexes of low-strength rows and of cone indexes of plot averages with other soil properties including dry density, moisture content, clay content, and plasticity index were similar to those found in the previous analysis of plots (see plate 6). A good

positive correlation occurred between cone index and dry density; a good inverse correlation occurred between cone index and moisture content; and no relation existed between cone index and clay content or plasticity index.

38. When average plot values (extreme rows excluded) were compared with the low-strength row values, the row value of dry density was always lower than that of its plot and the row value of moisture content was higher than that of its plot with one exception (plot F1). No pattern appeared between plots and rows for clay content and plasticity index. The differences among row strengths, like the differences among plot strengths, cannot be ascribed to differences in the grain size or plasticity of the soil, but must result from differences in density, moisture content, and other factors, such as those governing reception and retention of water, state of packing, structure, etc. The low-strength row is a small areal unit distinct from the average of the rows in the plot.

Relation of cone index and moisture content

39. In the analysis for correlations between cone index and moisture content of plots and rows previously discussed, values for the visits were averaged to provide one value for each area irrespective of time. In this analysis, soil strength-moisture relation is based on data averaged for the plot for each individual visit. The graphs of cone index versus moisture content for the 0- to 6-in. and 6- to 12-in. layers show inverse relations (plate 7). The spread of values at a given moisture content (about 200 CI for the surface to 6-in. layer and about 150 CI for the 6- to 12-in. layer) is too great for meaningful grouping of these loess soils together as one trafficability unit. Grouping by soil series for the 6- to 12-in. layer (plate 8) shows more closely defined relations, especially for the Memphis and Loring series. However, the spread of plot values even for a given visit (ranging about 100 CI) indicates that additional criteria are needed to accurately differentiate areas of dissimilar cone indexes within areas of the same series on the same day. The number of visits to a plot were too few to truly determine soil moisture-strength relations.

Remolding index variation

40. Only 200 remolding tests were made, compared to nearly 1000 cone index tests, because the soil was generally too firm to permit insertion of the remolding sampler. The data were not only sparse, but they were biased also because only the weak spots were tested. One hundred sixty-one of the tests were made on visit B, and 71 of these were on Falaya plots; only 25 tests were made on visit C and only 14 tests were made on visit D. A rigorous analysis could not be made because of the data limitation and bias; nevertheless, some measure of variability was obtained.

41. Data at all four sampling positions in a row, used for analysis of variance between rows, were collected from only 31 rows on visit B; 15 of the rows were Falaya. A difference in remolding index between rows was found. The standard deviation was ± 0.12 RI for a sample within a row, a measure of variability in a uniform area of these loess soils. When remolding index data were analyzed as individuals, irrespective of rows, the standard deviation was ± 0.16 RI and the mean was 0.47 RI.

42. Data from the other 76 tests, from rows with less than four remolding index tests, were grouped by visit, series, and then by all tests together, and analyzed. The results and those of an analysis of data from all 200 tests are as follows:

	<u>No. of Samples</u>	<u>Mean Remold- ing Index</u>	<u>Standard Deviation $\pm$</u>
Visit			
B	37	0.53	0.16
C	25	0.55	0.21
D	14	0.69	0.34
Series			
Alluvial fill and Henry	23	0.48	0.29
Memphis and Loring	20	0.63	0.17
Collins, Falaya, and Hymon	33	0.59	0.18
All samples, <4 sampling positions/row	76	0.57	0.23
All samples	200	0.51	0.20

The mean remolding index is highest for the drier soils of visit D, and the variability of the soil for this visit is proportionally higher. Although the alluvial fill-Henry group had the lowest mean remolding index, it had the largest range of values; seven samples were less than 0.25 RI and five samples were more than 0.60 RI, including one with 1.68 RI, the highest in the study. The upland (Memphis and Loring) group had about the same mean remolding index and standard deviation as the bottomland (Collins and Falaya). The variation of all samples was almost twice that within rows.

43. The plot averages of remolding index were graphed versus those of moisture content for all visits (plate 9) and show an approximate inverse relation. Similar graphs of remolding index versus dry density, clay content, liquid limit, and plasticity index were made, but no trends were indicated. Plot and row differences could not be determined from these data.

Influence of Rainfall, Terrain, and Other Factors

44. Results showed that cone index values of small areas, such as rows or plots, could not be applied with reasonable accuracy to large areas, designated by soil series or upland-bottomland groups, due to the large and overlapping ranges in values for the small areas. Furthermore, the soil classification parameters could not be used to differentiate the high-strength from low-strength areas; clay content and plasticity index did not correlate with strength differences among plots or rows, even though these properties differed as much as 15 percent among plots or rows. The influence of these properties on strength apparently was masked by more dominant influences of other factors. Significant moisture content differences were found for certain plots and rows irrespective of soil series. Since moisture content correlated with strength, moisture differences within a plot are undoubtedly one cause of the strength variations in plots and rows. Questions arise as to why the moisture differences existed, how the moist spots can be ascertained and accounted for in trafficability estimations across an area, and whether factors other than moisture contribute materially to the strength differences.

Moisture conditions at sampling

45. Wetting or drying during sampling can produce differences in soil moisture and strength that would mask the inherent variability between areas. To minimize these effects between sites for a particular visit, sampling was accomplished in one day with no rainfall, and in winter or spring when the rate of drying is small. The moisture condition can be considered the same throughout the testing area (although moisture contents were not) as sampling progressed during a visit day.

Antecedent rainfall

46. The effect of antecedent rainfall on plot strength differences is believed to be small, since sampling was done in late winter and spring when rains are general and soils are near the field-maximum moisture content. There is no positive assurance that antecedent rainfall was uniform, since rain gages were not maintained at the test sites; however, at weather stations 10 to 30 miles away bracketing the test area, rainfall measurements were relatively uniform for 19 days preceding each visit. The amounts, tabulated below, indicate that the entire area, including the test sites, received fairly uniform precipitation.

Rain Gage Station	Location of Station from Sites	Rainfall, in.			
		Visit A	Visit B	Visit C	Visit D
Germania	North	5.22	2.20	6.72	2.78
Vicksburg	West	5.27	2.84	5.46	3.93
Oakley	East	3.41	2.47	6.61	3.74
Utica	Southeast	4.69	1.87	5.97	2.95
Port Gibson	South	4.21	1.97	4.38	3.97

47. Plot data substantiate the uniformity of precipitation. Sites were generally located in two clusters, 18 miles apart (fig. 1) with a few sites outlying from them. Strength and moisture differences between plots less than a mile apart within a cluster were as great as between clusters, and large differences occurred between plots at the same test site, 50 to 100 ft apart. Thus, strength differences did not exhibit an areal difference that can be attributed to rainfall pattern.

Water table

48. Part of the moisture differences may arise from differences in

depth to shallow water tables, which were not considered. However, the differences between plots were as great in the uplands as in the bottomlands; the upland soils, except for the Henry plot, were moderately to well drained, supposedly with no influencing water table within the surface 4 ft of soil.

Density and structure

49. The moisture differences did not explain all the strength differences between rows and plots; the low-strength rows had lower strengths than the balance of the plots at comparable moisture contents. Soil density was associated with strength, shown by the positive correlations for plots and rows. Density differences are due in part to structure of the soil (i.e. the arrangement, size, and durability of the clumps or aggregates of the soil) but structure may influence strength directly. Structural differences in the surface layers could have originated by several means. The structure of recently transported material is quite different from that of soil developed in place. The transported material occurs in the bottomlands, but can occur in fill areas of the uplands. These fills may have the same texture, plasticity, and even moisture content as the mature soil, yet strength may differ due to structural differences per se. Soil layers or horizons, such as the surface A horizon and subsoil B horizon, differing in structure, density, and other properties may occur at the same depth due to differential erosion or to development of different thicknesses in a horizon between rows or plots. Structural differences may also result from differing cultural practices. A pasture developed from a woodland can differ from a pasture developed from an old field. Soil structure was not determined in this study because quantitative procedures for determination were not available.

Organic matter

50. Organic matter content, which is not generally considered in WES studies relating properties of soil to strength, can influence soil strength directly or indirectly through its effect on moisture content, plasticity, and structure. The organic content can change with cultural practices and over short distances. Threshold values and quantitative relations of the effect of organic matter on soil strength are unknown.

Terrain

51. The terrain configuration can influence the reception and retention of water with runoff from high spots to low spots. Thus, moisture content differences could occur even though the rainfall pattern was essentially the same over the area. An analysis of the terrain configuration may indicate areas of differential erosion and deposition that relate to differences in soil structure and organic content.

52. Topographic position. A qualitative topographic position classification used in trafficability studies recognizes uplands, terrace, and bottomlands with subdivisions of flat, depression, upper slope, and lower slope. The divisions are not well defined, and classification, in many cases, depends on the judgment of the field observer. In the study reported herein, some sites were 540 ft long and included more than one topographic position. Classification at all sites was done by row, and rows of different topographic positions were examined for differences. The flat areas of the uplands tended to have the lowest strengths; no other trend could be discerned. Most Collins and Falaya rows were bottomland flats, so no differential grouping could be made. This study indicates that a more rigorous definition of classes is needed to enhance the utility of this classification for trafficability purposes.

53. Terrain geometry. The Geology Branch of WES classified microgeometry of each site for trafficability use, using 50 ft of the length and the full width of the site.⁶ Macrogeometry was also classified within a half-mile radius of each site. The relations between cone index and microgeometry and macrogeometry factors are considered here.

54. Microgeometry factors included overall slope, number of slope reversals, modal relief differences, and surface length increase. Cone index of the row nearest the geometry profile was used as a strength measurement. Some trends were shown, as for modal relief differences (plate 10), but scatter generally was wide.

55. Macrogeometry classification was based on terrain conditions within a half-mile radius of the sites (plate 1), so both row and plot strengths were considered. The factors classified included plan profile, characteristic slope, and characteristic relief. An additional factor,

occurrence of slopes steeper than 50 percent, was not used since most sites were in the same slope occurrence class. The macrogeometry factors showed trends with cone index as good or better than the trends for microgeometry factors (plate 10). The broad, flat areas with low relief had lower strengths than the more dissected areas in both uplands and bottomlands, but the point scatter was wide for each of the factors. The relation between row and plot cone index values was better than that between cone index of plot and any of the microgeometry or macrogeometry factors. Results indicate that these factors can aid in estimating trafficability conditions, but they must be improved, perhaps by using the mesoscale, before they can be of any value in accurately predicting trafficability. The terrain surrounding the area of concern also must be defined with reference to its influence on trafficability, though not necessarily by a fixed dimension, and not necessarily equally in all directions.

56. Terrain and plot values. Field notes, topographical maps, and aerial photographs were examined to obtain data on terrain features on and surrounding the plots. The data were compared with cone index of the plots to determine the influence of the features on trafficability. Features studied were distance to hillcrest above row 1; relief difference above row 1; convex or concave curvature of plot surface compared to surroundings; degree of erosion; area of watershed above site; valley floor width; and creek bed depth. Data were listed in order of increasing cone index (table 5). Examination of the data shows that in the uplands curvature of the area and strength are related, with strength lower in concave areas than in convex ones. In the bottomlands, sites in the lower parts of large watersheds had lower strength than sites in the upper reaches, with little drainage area above them. Other features such as degree of erosion, valley width, and creek depth exhibited some trends. Thus, some terrain features can be used to distinguish kinds of trafficability conditions. When they are recognized and taken into account, better deployment of vehicles and prediction of their movements will be possible.

57. Terrain and low-strength row values. Possible influence of features of terrain on extreme low-strength rows was considered next. Differences in strengths between rows could not be resolved from examination

of maps and photographs, so field notes were used to provide information. Data were sparse, so only general observations are offered to explain the low-strength rows. Row M1-5 occurred at the lower end of a concave slope. The soil of row AF1-2 consisted of deep local alluvium which was upslope from shallower local alluvium, resulting in conditions conducive to the development of a perched water table that may have influenced the strength of the soil. Row C3&F6-4 was possibly a filled old drainageway. Row F1-1 was near the toe of a slope and had overlying alluvial fill, but the alluvial fill was not deep enough to classify the row as such. Row L1-3 was a concave row in an otherwise convex plot. Row L5-5 may have been upslope from an old erosion-control terrace. Information was insufficient to suggest a cause for the low-strength rows of the other four plots. Although terrain features noted herein generally are too small to map, they should be observed and considered in any trafficability analysis because they can immobilize a vehicle. The development and use of a suitable terrain geometry classification may have the most immediate promise for differentiating trafficability conditions within areas considered uniform in soil type but variable in soil strength.

Sampling Requirements

58. The number of samples required to test areas of soil considered uniform should be sufficient to provide values within limits of a desired accuracy. For trafficability purposes, areal units for testing and application should be relatively uniform in strength. Data on soil properties used in estimating soil strength should be obtained from samples from the same areas. This study showed that neither series, upland and bottomland groupings of series, nor plots defined an area uniform in cone index. Because of the large variation in strength within these areal divisions, their use would result in large error in the delineation of trafficability conditions. Sampling requirements for these areas also would be large. The row was used for estimating sampling requirements. The 30-ft-long row, corresponding in length to test sites of previous moisture-strength studies, is a minimal size for sampling, approximating the length of most military vehicles.

Sampling by rows versus clusters

59. Row uniformity was checked using cone index measurements of the four visits. On visits A and B samples were taken at 10-ft intervals along the 30-ft row; on visits C and D three samples were taken in a cluster (within 1 ft of each other) at position A. The need to sample all plots within one day and the limited number of personnel available for testing prevented taking both cluster and row samples on the same visit, although this would have been desirable. Data from the upland soils (Memphis and Loring) and bottomland soils (Collins and Falaya) were used. Data were divided further into wet soil condition for visits B and C and moist soil condition for visits A and D.

60. To check consistency of variation between visits divorced from row or cluster effect, single samples from position A of all rows were analyzed (table 6). A difference in variation, expressed by standard deviations and coefficients of variation, occurred between wet and moist sampling conditions; however, with either condition variation was consistent between visits or between upland and bottomland positions. Next, the first three samples in a row were compared with the three in a cluster. The standard deviations of individuals in the triplicate sampling were very close to those of single samples, showing that the pattern of variation was the same. The between rows or cluster effect was next removed, so that variation within rows could be compared to that within clusters. The standard deviations and the standard error of means show that there was some increase in variability in going from the smaller area of clusters to the larger area of rows. The standard error of the bottomland soils increased from 12 to 18 CI on the wet soil condition visits, and from 27 to 39 CI on the moist soil condition visits. It should be noted that a twofold to threefold greater variability occurred between moist and wet conditions than between cluster and row sampling. Thus, the variability of the row can be used as a reasonable measure of the basic variability of these soils, although the basic variation of cone index is larger than desired (For triplicate sampling the standard error was about 16 units when wet and 38 units when moist).

Estimating number of samples

61. With knowledge of basic variation (i.e. the standard deviation or error mean square), a value for allowable error or desired accuracy, and the probability level for attaining that accuracy, the number of samples required to give an acceptable average value of a property can be calculated.*¹¹ The error terms were derived from pooled deviations (table 4) since the upland and bottomland groups did not differ in trafficability characteristics. The plot and row means of the soil properties varied as much in the uplands as in the bottomlands, and their ranges overlapped, so separate sampling plans were not prescribed.

62. The estimate for number of samples can vary considerably, depending upon the desired accuracy (i.e. allowable error) of the factor and the probability level for attaining that accuracy. A larger number of samples would be prescribed for a highly accurate average (i.e. within a narrow range) and for a high chance of success for the average to fall within the narrow range than for an average with a lower accuracy (i.e. within a broader range) and lesser probability. Also, for a given accuracy and probability, a highly variable material (i.e. one with a high standard deviation) would require more samples than a more uniform material. The estimate for number of samples must consider both the desired result and the nature of the material; a close tolerance for highly varied material would lead to a prohibitive sampling requirement.

63. Cone index and moisture content measurements in natural soils vary more than those for grain size, plasticity, and other static properties. A lesser probability level of 20 percent was used for these dynamic properties compared to 5 percent for the static properties. This indicates that there is a 20 percent chance that the measured mean for cone index or moisture content will differ from the true mean by more than the desired accuracy, but only a 5 percent chance that the static properties will. The use of a lower order of probability for natural conditions that are inherently variable is accepted in various fields, e.g. weather and rainfall forecasting.

$$* \text{ Number of samples } (n) = \frac{[\text{probability } ("t")]^2 \times [\text{standard deviation } (s)]^2}{[\text{allowable error of factor } (L)]^2}$$

64. The desired accuracy for an average value of a factor for a row was selected considering what is meaningful and attainable. Cone index accuracy, the primary consideration for trafficability, was set at ± 10 units. The magnitude of variation within the row (table 4) was too great to justify selection of a smaller value. In fact, variation of cone index on the moist soil condition visits was relatively high so that the accuracy range had to be increased to ± 20 units to keep the required number of samples reasonable. Cone index was above 200 on the moist soil condition visits, so the lower accuracy would not be critical. A 1 percent accuracy was selected for moisture content because previous studies have shown that for many soils a change of 1 percent results in a change of 20 CI. Three percent was considered a reasonable degree of accuracy for most static properties and 0.04 g per cc for dry density, since this is equivalent to a pore capacity change sufficient to retain 1 percent moisture for the average soil.

Sampling requirements for rows

65. The estimates of the number of samples for cone index varied by visit and soil layer (table 7). About 10 samples were needed for the wet soil conditions of visits B and C, but more were required for the moist conditions of visit A, even though the range of allowed accuracy was greater. The number of samples for remolding index was three for an accuracy of ± 0.10 , and 10 for an accuracy of ± 0.05 . The latter accuracy is not unrealistic; a difference of 0.10 RI is 10 RCI at 100 CI. The data collected for this study provided little opportunity to evaluate the number of moisture content samples since rows did not have replicated samplings on visits C and D. However, for visit B, the required number of samples for both layers (5) was less than half that required for cone index (11 for the 0- to 6-in. layer and 18 for the 6- to 12-in. layer). About five were required for most static soil properties. In current studies, three samples are taken—at the top, middle, and bottom sections of the plot—and composited as one sample for analysis. Estimates of sample number for dry density and moisture tension, determined on core samples of natural soils, ranged from two to six. At present, three samples are taken for each layer. This study shows that the number of samples required to properly

characterize loess soils are greater than are currently being taken in trafficability prediction studies. A need to increase the sampling intensity by 30 to 60 percent to attain a minimum desired accuracy is indicated.

Applicability of These Results to Other Soils

66. The soils investigated in this study were derived from loess, which is one of the more uniform soil parent materials. Mean values by grain size, plasticity, and density (table 3, field observations), were practically identical between series and between layers except for the 6- to 12-in. layer of the Memphis and Loring upland soils. The higher clay contents, liquid limits, and plasticity indexes of these soils reflected the genesis and illuviation of clay from the upper A to the B horizon. In contrast, strength measurements varied, which can be partly attributed to local differences in moisture content. These local differences are not unique to loess, but will occur in any soil, regardless of parent material. In comparisons of diverse soils, such as silt with clay, expected correlations of strength with grain size and plasticity may be poorer than anticipated, as evidenced in this study, because of the influence of other unknown factors. In other strength studies covering a variety of soils from locations throughout the United States, relations with the known physical properties were relatively poor. Obviously, other factors need to be defined to account for strength differences.

PART IV: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

67. The following conclusions can be made from this study:
- a. Neither map- nor field-identified soil series of moderate- to well-drained loess soil in Warren County, Mississippi, can be used to delineate with sufficient accuracy areas of uniform trafficability. Also, no distinction in trafficability can be made for these series grouped into uplands and bottomlands even though differences do occur in clay content and plasticity constants in the 6- to 12-in. layer (table 3 and pars. 21-25).
 - b. Inclusions of soils, different from those mapped and with lower strengths, were found within the mapped boundaries. These soils, recent alluvial fills and a poorly drained Henry series, covered areas of sufficient size to pose problems in trafficability and should be accounted for, even though some of these areas are too small to depict on maps (table 3 and pars. 12, 23-25).
 - c. The variation of soil strength and moisture content within small areas (plots and rows) was large and masked real differences that may exist between soil series or upland and bottomland series groupings. Because of the large variation, values derived from small areas cannot be applied to large areas with any degree of confidence (table 4 and pars. 28 and 29).
 - d. The cone index differences among plots and rows were significant and consistent for the four visits (plates 2 and 4, and pars. 30 and 34). These differences can be ascribed to differences in local conditions of terrain and soil, rather than to differences in rainfall patterns or other meteorological events (pars. 45-47).
 - e. Small areas of low strength were found as inclusions within larger areas of higher strength (plate 5 and par. 36). These low-strength areas are difficult to identify and explain because the soils are not pedologically distinct and do not substantially differ in grain size or plasticity from soils of the larger enclosed area (plates 3 and 6, and pars. 32, 33, 37, 38, and 44). A suitable terrain geometry classification may have the most immediate promise for identifying these small areas. Differences in the geometry of terrain are observable and suggest probable differences in the reception and retention of water which this study shows, by inference, to be factors that can account for soil strength differences. The terrain geometry also may indicate other

differences associated with surface water movement such as differential soil erosion and deposition that would result in possible differences in dry density, structure, and organic content of the soil (pars. 51-55).

- f. Estimates of the number of samples required to provide reliable mean values for trafficability purposes, based on measurements within rows of relatively uniform soil, indicate that five samples should be taken for determination of the static physical properties, five samples for determination of moisture content, ten measurements for cone index, and ten measurements for remolding index. Ten remolding index tests will provide an accuracy of ± 0.05 unit, whereas three samples will give an accuracy less than desired, i.e. ± 0.10 unit (table 7 and par. 65).

Recommendations

68. The following recommendations are offered for guidance in future studies:

- a. A terrain geometry classification system suitable for trafficability purposes should be developed.
- b. Studies should be conducted to identify and evaluate the effects on trafficability of soil factors that have not been considered in WES trafficability studies, such as organic content, soil structure, and natural cementing agents.
- c. The number of samples should be increased to five for static properties and to ten for strength measurements.

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Table 1

Location and Description of Test Sites

Location and Description of Test Sites													
Site Designation	Location		Orientation Rows 1 to 5	Distance Between Rows ft	Topography		Aspect	Position	Slope %	Drainage		Vegetation	Land Use
	Latitude	Longitude			Surface	Internal							
Memphis Series													
M I	32°20'58"	90°43'18"	N 0° E	48.0	S	Upland ridge and slope	4	Medium	Medium	Grass and weeds	Idle field		
M III	32°20'33"	90°42'38"	N 340° E	75.0	Level	Upland flat	<1	Medium	Medium	Grass and weeds	Pasture		
M IV	32°22'30"	90°40'15"	N 180° E	55.0	N	Upland slope	2-9	Medium	Medium	Row crops	Cultivated		
M V	32°20'54"	90°42'14"	N 100° E	52.0	W	Upland ridge and slope	2	Medium	Medium	Grass	Pasture		
M VI	32°20'54"	90°42'22"	N 350° E	70.0	S	Upland flat and slope	0-2	Medium	Medium	Grass	Pasture		
M VIII	32°27'24"	90°42'28"	N 315° E	35.0	SE	Upland ridge	3	Medium	Medium	Weeds and grass	Idle		
Loring Series													
L I	32°08'36"	90°54'36"	N 50° E	60.0	SW	Upland ridge	2	Medium	Medium	Grass	Pasture		
L III	32°08'31"	90°53'53"	N 315° E	75.0	SE	Upland upper slope	6	Good	Medium	Grass	Pasture		
L IV	32°08'36"	90°53'51"	N 240° E	75.0	NE	Upland slope	6	Good	Medium	Grass	Pasture		
L V	32°09'00"	90°54'27"	N 0° E	90.0	S	Upland upper slope	6	Good	Medium	Grass	Pasture		
L VI	32°27'40"	90°40'50"	N 100° E	60.0	S	Upland upper slope	3	Good	Medium	Grass	Pasture		
L VIII	32°10'10"	90°53'27"	N 225° E	55.0	NE	Upland upper slope	12	Good	Medium	Grass	Pasture		
Collins Series													
C I	32°27'34"	90°41'15"	N 285° E	22.5	Level	Bottomland flat	<1	Poor	Poor	Grass and weeds	Pasture		
C II	32°21'00"	90°40'02"	N 100° E	70.0	Level	Bottomland levee	1	Medium	Poor	Grass	Pasture		
C III	32°21'06"	90°42'52"	N 245° E	55.0	Level	Bottomland flat	1	Poor	Poor	Grass and weeds	Pasture		
C IV	32°10'42"	90°50'30"	N 110° E	50.0	Level	Bottomland flat	1	Poor	Poor	Grass	Pasture		
C V	32°09'05"	90°54'09"	N 265° E	37.0	Level	Bottomland flat	1	Poor	Poor	Weeds	Pasture		
C VI	32°12'33"	90°49'42"	N 355° E	17.0	S	Bottomland flat	2	Medium	Poor	Grass	Idle		
Palaya Series													
P I	32°17'27"	90°42'20"	N 290° E	30.0	Level	Bottomland flat	<1	Poor	Poor	Grass, brambles, and saplings	Idle		
P II	32°09'35"	90°54'22"	N 315° E	35.0	SE	Bottomland flat	2	Medium	Medium	Grass	Pasture		
P III	32°09'45"	90°47'15"	N 65° E	30.0	Level	Bottomland flat	<1	Poor	Poor	Grain	Cultivated		
P V	32°18'00"	90°42'08"	N 350° E	30.0	Level	Bottomland flat	<1	Poor	Poor	Grass, brambles, and saplings	Idle		
P VII	32°23'12"	90°41'04"	N 0° E	20.0	S	Bottomland flat	2	Poor	Poor	Grass and weeds	Idle		
P VIII	32°09'30"	90°54'33"	N 190° E	33.5	N	Bottomland flat	2	Medium	Medium	Grass and weeds	Cultivated		

Table 2
Cross-Reference of Soil Series by Sites and Plots

Site No. for Soil Series Identified on Maps	Plot No. for Soil Series Identified in Field					
	Alluvial Fill	Uplands		Bottomlands		Hymon
		Memphis	Loring	Henry	Collins	Falaya
Memphis Series						
M I		--	--	--	--	--
M III		M2	--	--	--	--
M IV	--	M1	--	--	--	--
M V	--	M4 (1, 5)	--	--	--	--
M VI	--	M3 (4, 5)	--	HNI (1, 2)	--	--
M VIII				Not identified		
Loring Series						
L I	--	--	L2	--	--	--
L III	--	--	L5	--	--	--
L IV	--	--	L4	--	--	--
L V	--	--	L3	--	--	--
L VI	--	--	L1	--	--	--
L VIII				Not identified		
Collins Series						
C I	--	--	--	--	C2 (2, 3, 4)	F7 (1, 5)
C II	--	--	--	--	--	--
C III	--	--	--	--	C1	--
C IV	--	--	--	--	--	F3 (1, 2, 3, 4)
C V	--	--	--	--	--	F5
C VI	--	--	--	--	--	F2
Falaya Series						
F I				Not identified		
F II	--	--	--	--	C3 (1, 3)	F6 (2, 4, 5)
F III				Not identified		
F V				Not identified		
F VII	--	--	--	--	--	F1
F VIII	--	--	--	--	--	F4 (1, 2, 3, 4)

Note: Figures in parentheses refer to row numbers in plot. Plots with no row numbers listed contain five rows of same soil series.

Table 3
Soil Property Values for Soil Series

Soil Property and Unit of Measure	Series Identified from Soil Maps										"F" Significance Series/Sites	Standard Deviation of Site Value	Series Identified from Field Observations										Standard Deviation of Plot Value	"F" Significance Series/Plots			
	Series Means from Site Values					Series Means from Plot Values							Series Means from Plot Values					Series Means from Plot Values									
	Uplands					Bottomlands							Uplands					Bottomlands									
	Memphis	Loring	Collins	Falaya	Memphis	Loring	Collins	Falaya	Memphis	Loring			Collins	Falaya	Memphis	Loring	Collins	Falaya	Memphis	Loring	Collins	Falaya					
0- to 6-in. Soil Layer																											
Sand, %	12	10	15	12	NS	12	11	14	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	2.0	NS	
Silt, %	73	71	74	75	NS	72	71	75	75	72	71	75	75	72	71	75	75	72	71	75	75	72	71	75	2.0	NS	
Clay, %	16	19	11	13	NS	16	18	11	13	16	18	11	13	16	18	11	13	16	18	11	13	16	18	11	2.9	NS	
Fines, %	99	99	96	98	NS	99	99	96	98	99	99	96	98	99	99	96	98	99	99	96	98	99	99	96	3.0	NS	
LT, %	35	36	34	39	NS	34	39	34	36	35	36	34	36	35	36	34	36	35	36	34	36	35	36	34	3.0	NS	
PT, %	25	25	26	27	NS	24	24	27	27	24	24	27	27	24	24	27	27	24	24	27	27	24	24	27	3.0	NS	
Specific gravity	1.44	1.46	1.42	1.34	NS	1.44	1.46	1.42	1.34	1.44	1.46	1.42	1.34	1.44	1.46	1.42	1.34	1.44	1.46	1.42	1.34	1.44	1.46	1.42	3.0	NS	
Density, g/cc	28.1	27.5	29.5	32.8	NS	28.1	27.5	29.5	32.8	28.1	27.5	29.5	32.8	28.1	27.5	29.5	32.8	28.1	27.5	29.5	32.8	28.1	27.5	29.5	32.8	3.0	NS
MC (0.06-atm ten.), %	28.1	27.5	29.5	32.8	NS	28.1	27.5	29.5	32.8	28.1	27.5	29.5	32.8	28.1	27.5	29.5	32.8	28.1	27.5	29.5	32.8	28.1	27.5	29.5	32.8	3.0	NS
MC, %	28.1	27.5	29.5	32.8	NS	28.1	27.5	29.5	32.8	28.1	27.5	29.5	32.8	28.1	27.5	29.5	32.8	28.1	27.5	29.5	32.8	28.1	27.5	29.5	32.8	3.0	NS
At visit A																										3.0	NS
At visit B																										3.0	NS
At visit C																										3.0	NS
At visit D																										3.0	NS
6- to 12-in. Soil Layer																											
Sand, %	10	9	15	12	NS	9	9	14	11	9	9	14	11	9	9	14	11	9	9	14	11	9	9	14	1.8	NS	
Silt, %	70	67	73	74	NS	68	67	75	76	68	67	75	76	68	67	75	76	68	67	75	76	68	67	75	1.8	NS	
Clay, %	20	24	12	14	NS	23	24	11	13	20	24	11	13	20	24	11	13	20	24	11	13	20	24	11	3.2	NS	
Fines, %	99	100	96	98	NS	100	100	98	99	99	100	98	99	99	100	98	99	99	100	98	99	99	100	98	3.2	NS	
LT, %	40	42	32	35	NS	44	42	32	33	44	42	32	33	44	42	32	33	44	42	32	33	44	42	32	3.8	NS	
PT, %	24	24	24	26	NS	24	24	26	25	24	24	26	25	24	24	26	25	24	24	26	25	24	24	26	3.8	NS	
Specific gravity	1.47	1.50	1.45	1.42	NS	1.47	1.50	1.45	1.42	1.47	1.50	1.45	1.42	1.47	1.50	1.45	1.42	1.47	1.50	1.45	1.42	1.47	1.50	1.45	3.5	NS	
Density, g/cc	27.5	26.7	28.5	29.8	NS	27.5	26.7	28.5	29.8	27.5	26.7	28.5	29.8	27.5	26.7	28.5	29.8	27.5	26.7	28.5	29.8	27.5	26.7	28.5	29.8	3.5	NS
MC (0.06-atm ten.), %	27.5	26.7	28.5	29.8	NS	27.5	26.7	28.5	29.8	27.5	26.7	28.5	29.8	27.5	26.7	28.5	29.8	27.5	26.7	28.5	29.8	27.5	26.7	28.5	29.8	3.5	NS
MC, %	27.5	26.7	28.5	29.8	NS	27.5	26.7	28.5	29.8	27.5	26.7	28.5	29.8	27.5	26.7	28.5	29.8	27.5	26.7	28.5	29.8	27.5	26.7	28.5	29.8	3.5	NS
At visit A																										3.5	NS
At visit B																										3.5	NS
At visit C																										3.5	NS
At visit D																										3.5	NS
Not sampled																											
At visit A																										3.5	NS
At visit B																										3.5	NS
At visit C																										3.5	NS
At visit D																										3.5	NS
At visit A																											
At visit B																										3.5	NS
At visit C																										3.5	NS
At visit D																										3.5	NS

Note: NS, not significant at the 5% level.
* Significant at the 5% level.
** Significant at the 1% level.

Table 4
Plot and Row Mean Soil Property Values by Uplands and Bottomlands

Soil Property and Unit of Measure	Uplands				Bottomlands				Analysis by Rows				Standard Deviation of Individual Measurements					
	Plot Values		Sig. (t- test)	Rows/ Plots	Plot Values		Sig. (t- test)	Rows/ Plots	Row Values		Sig. (t- test)	Rows/ Samples	Uplands		Bottomlands			
	Range				Range				Range				Range					
	Mean	Range			Mean	Range			Mean	Range			Mean	Range				
0- to 6-in. Soil Layer																		
Sand, %	11	9-13	**	**	12	8-16	**	**	11	8-14	**	**	12	8-24	**	1.76	1.72	1.72
Silt, %	71	68-77	**	**	76	72-80	**	**	72	63-79	**	**	76	67-82	**	4.75	1.49	3.52
Clay, %	18	11-22	**	**	12	9-15	**	**	17	9-30	**	**	12	8-21	**	3.51	2.55	3.07
Pl, %	99	98-100	**	**	98	98-100	**	**	99	98-100	**	**	98	98-100	**	3.55	2.34	3.03
PL, %	35	27-38	**	**	36	31-43	**	**	35	28-42	**	**	36	32-45	**	0.034	0.031	0.033
Specific Gravity	25	24-26	**	**	27	26-28	**	**	25	23-28	**	**	27	25-30	**	1.24	1.31	1.28
Density, g/cc	10	9-11	**	**	9	7-15	**	**	10	9-17	**	**	9	5-18	**	2.6	2.0	2.32
MC (0.06-atm ten.), %	2.66	2.62-2.68	**	**	2.67	2.64-2.67	**	**	2.66	2.64-2.68	**	**	2.66	2.63-2.67	**	1.6	1.7	1.65
MC, %	1.46	1.43-1.50	**	**	1.40	1.34-1.45	**	**	1.45	1.41-1.51	**	**	1.40	1.30-1.50	**	54.0	41.4	48.1
At visit A	27.3	25.6-28.1	*	*	30.1	28.5-32.0	*	*	27.4	25.1-29.9	**	**	30.0	27.0-32.4	**	25.3	26.0	25.7
At visit B	28.0	24.0-29.9	*	*	32.0	29.8-34.1	*	*	28.4	20.9-32.2	**	**	31.7	27.0-39.8	**	19.0	15.2	17.2
At visit C	29.0	25.8-31.9	**	**	30.6	27.7-33.6	**	**	29.2	24.1-33.3	**	**	30.9	27.2-36.6	**	40.9	27.9	35.0
At visit D	28.0	25.6-30.2	**	**	30.1	27.7-34.9	**	**	28.3	25.7-34.0	**	**	30.1	26.8-37.2	**			
CI	22.3	21.0-23.4	*	*	20.2	22.7-31.2	*	*	22.4	20.7-28.6	**	**	27.4	21.2-34.7	**			
At visit A	193	86-293	**	**	187	69-235	**	**	186	154-220	**	**	149	57-290	**			
At visit B	146	99-185	**	**	150	38-241	**	**	145	74-218	**	**	147	32-260	**			
At visit C	149	108-191	**	**	150	34-260	**	**	147	72-221	**	**	142	14-282	**			
At visit D	305	179-379	*	*	226	75-338	**	**	110	137-233	**	**	213	56-479	**			
6- to 12-in. Soil Layer																		
Sand, %	9	8-11	NS	NS	12	8-16	**	*	9	5-12	*	*	12	7-22	**	1.92	1.27	1.63
Silt, %	68	63-73	*	*	71	73-78	**	**	68	59-78	**	*	75	68-81	*	3.74	1.34	2.81
Clay, %	23	17-28	**	**	13	9-15	**	**	23	12-36	**	**	13	9-18	*	4.48	1.53	3.35
Pl, %	100	99-100	**	**	99	96-100	**	**	100	98-100	**	**	99	95-100	**	4.39	1.77	3.35
PL, %	43	39-46	**	**	33	31-36	NS	NS	42	29-53	**	**	33	29-43	**	0.038	0.024	0.026
Specific Gravity	24	23-26	*	*	25	24-26	**	**	24	22-27	**	**	25	23-27	**	1.08	0.88	0.99
Density, g/cc	19	11-24	*	*	8	6-12	**	**	18	6-28	**	**	6	4-17	**	1.6	1.6	1.6
MC (0.06-atm ten.), %	2.69	2.67-2.71	*	*	2.67	2.67-2.68	**	**	2.69	2.66-2.72	**	**	2.67	2.65-2.68	**	32.1	32.2	33.1
MC, %	1.49	1.47-1.53	*	*	1.44	1.41-1.47	**	**	1.49	1.41-1.55	**	**	1.44	1.35-1.50	**	25.1	21.0	24.1
At visit A	27.0	25.6-28.9	**	**	28.8	27.5-30.4	*	*	27.0	24.8-29.9	**	**	28.7	27.3-30.7	**	53.9	47.1	50.1
At visit B	27.6	25.8-31.1	**	**	29.0	27.5-31.2	*	*	27.7	24.7-33.8	**	**	30.0	23.9-34.4	**			
At visit C	26.7	24.6-29.4	**	**	28.9	26.7-33.2	*	*	26.8	23.8-30.7	**	**	29.0	24.9-35.4	**			
At visit D	20.8	17.0-25.7	**	**	25.9	18.9-30.0	**	**	21.0	10.4-26.6	**	**	28.2	16.5-33.3	**			
CI	280	156-473	**	**	231	144-336	**	**	235	171-717	**	**	230	118-294	**			
At visit A	195	130-268	**	**	210	17-201	**	**	194	104-298	**	**	234	77-400	**			
At visit B	194	130-268	**	**	197	15-286	**	**	191	115-334	**	**	191	45-400	**			
At visit C	196	130-268	**	**	197	15-286	**	**	191	115-334	**	**	191	45-400	**			
At visit D	424	223-561	*	*	302	171-439	**	**	418	174-750	**	**	287	130-229	**			

* Significant at the 5% level.
** Significant at the 1% level.

Table 5
Cone Index, Moisture Content, and Terrain Information for Plots

Plot	Avg CI 4 Visits 6-12 in.	Avg MC, % 3 Visits 6-12 in.	Row Spac- ing ft	Plot Slope %	Distance Upslope from Row 1		Surface Curvature	Erosion
					Distance to Crest ft	Relief Diff ft		
					Uplands			
AF2	164	30.1	52	2, 1*	100	5	Concave	Fill
HN1	170	29.5	70	0	On flat	0	Slight concave	None
M1	176	26.9	55	6, 3*	200	10	Concave	{Rows 1&2 severe {Rows 4&5 none
L3	191	27.5	90	6, 2*	100	5	Concave	Severe
AF1	201	27.0	48	4, 2*	50	5	Concave	Fill
HY1	218	28.0	70	0, 2*	On crest	0	Flat to convex	None
M2	221	26.2	75	0	On flat	0	Straight	None
L5	262	24.4	75	4, 6*	75	5	Convex	{Row 1 some {Rows 2-5 none
M4	283	25.1	52	2	On crest	0	Convex	Some
L2	332	23.8	60	2	60	0	Convex	Some to severe
L1	352	24.7	60	3	100	5	Convex	Severe
L4	354	23.5	75	6	300	10	Straight	Some
M3	364	23.1	70	2	150	5	Convex	Severe

Plot	Avg CI 4 Visits 6-12 in.	Avg MC, % 3 Visits 6-12 in.	Row Spac- ing ft	Plot Slope %	Distance Upslope from Row 1		Watershed Area acres	Valley Floor Width ft	Creek Bed Depth ft
					Distance to Crest ft	Relief Diff ft			
					Bottomlands				
F3	121	31.2	50	1	1400	60	503	500	8
F4	180	30.3	33	2	400	40	732	425	10
C1	205	27.0	55	1, 2*	500	40	22,600	450	10
C3&F6	209	26.2	33	1, 2*	400	40	708	425	10
F1	252	27.4	20	2	150	30	45	180	2
F5	259	27.3	37	1	300	40	416	330	6
C2&F7	296	28.3	23	<1	500	60	108	170	4
F2	319	27.0	17	2	300	50	318	375	9

* Slope changed within the plot; upper slope--left value, lower slope--right value.

Table 6
Sampling by Rows Versus Clusters

Condi- tion	Topo- graphic Position	Visit	Sam- pling Group	Single Sampling			Triple Sampling		
				Std Dev	Mean	Coeff of Varia- tion	Indi- vidual Std Dev	Within Group Std Dev	Std Error
Wet	Upland	B	Row	62	201	0.31	56	35	20
		C	Cluster	56	198	0.28	57	25	14
	Bottomland	B	Row	78	205	0.38	76	31	18
		C	Cluster	69	194	0.35	67	21	12
Moist	Upland	A	Row	173	299	0.58	181	90	52
		D	Cluster	179	423	0.42	183	54	31
	Bottomland	A	Row	115	246	0.47	99	68	39
		D	Cluster	108	294	0.37	113	47	27

Table 7
Sampling Requirements for Soil Properties by Rows

<u>Soil Property</u>	<u>Prob- ability Level, %</u>	<u>Accuracy Desired + -</u>	<u>Est No. of Samples</u>	
			<u>0- to 6-in. Layer</u>	<u>6- to 12-in. Layer</u>
Cone index				
Visit A	20	20 units	10	26
Visit B	20	10 units	11	18
Visit C	20	10 units	5	9
Visit D	20	20 units	5	11
Remolding index	20	0.10 unit	--	3
	20	0.05 unit	--	10
Moisture content				
Visit A	20	1%	9	--
Visit B	20	1%	5	5
Sand	5	3%	2	2
Clay	5	3%	6	4
Liquid limit	5	3%	4	5
Plasticity index	5	3%	4	5
Specific gravity	5	0.05 unit	1	1
Dry density	5	0.04 g/cc	3	2
Moisture content (0.06-atm tension)	5	1%	6	4

Key for Identification of Symbols Used in Plate 1

V	Vicksburg silt loam
C	Collins silt and silt loam
VC	Vicksburg and Collins silt loam
F	Falaya silt and silt loam
W	Waverly silt
WF	Waverly and Falaya silt
S	Swamp
T	Lintonia silt
R	Richland silt
O	Olivier silt
K	Calhoun silt
HY	Hymon silt loam
M	Memphis silt
L	Loring silt
LM	Loring and Memphis silt
MN	Memphis and Natchez silt
HN	Henry silt



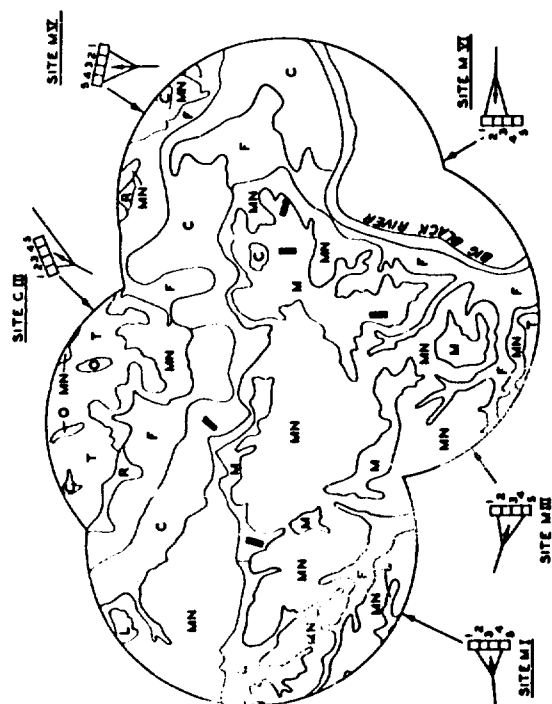
SITE CIII. PLOT CI COLLINS SERIES
AT ALL ROWS



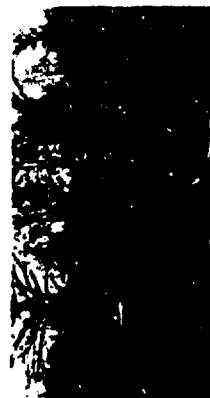
SITE MZ. PLOT M4 MEMPHIS SERIES
AT ROWS 1 AND 5
PLOT AF2 ALLUVIAL FILL
AT ROWS 2, 3, AND 4



SITE MVI. PLOT HN HENRY SERIES
AT ROWS 1 AND 2
PLOT M3 MEMPHIS SERIES
AT ROWS 4 AND 5



SITE MIII. PLOT M2 MEMPHIS SERIES
AT ALL ROWS



SITE MI. PLOT AF1 ALLUVIAL FILL
AT ALL ROWS

VIEW, ORIENTATION, AND SOILS OF TEST SITES

SHEET 1 OF 5



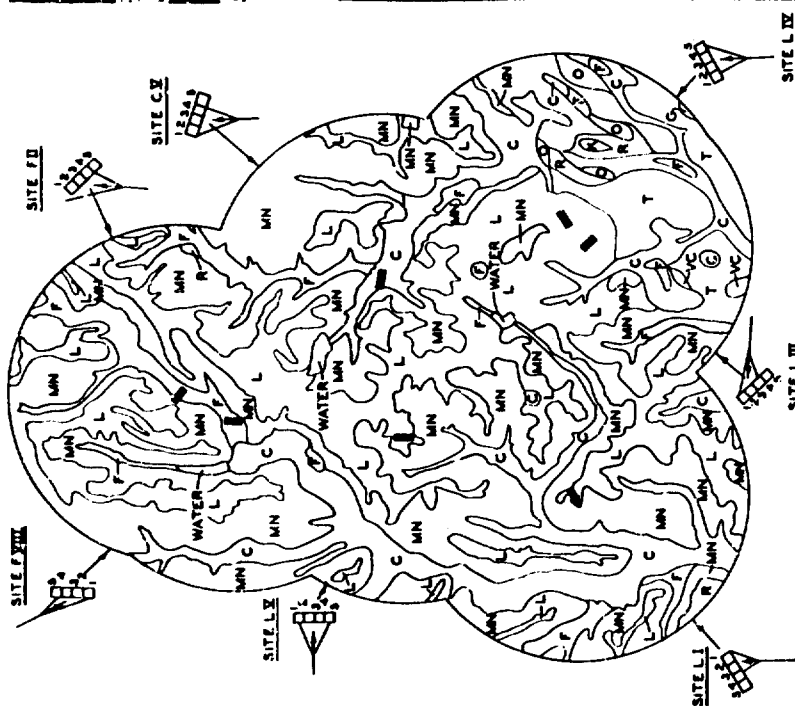
SITE FVIII. PLOT F4 FALAYA SERIES
AT ROWS 1,2,3,AND 4



SITE LX. PLOT L3 LORING SERIES
AT ALL ROWS



SITE LI. PLOT L2 LORING SERIES
AT ALL ROWS



SITE LIII PLOT L5 LORING SERIES
AT ALL ROWS



SITE FII. PLOT C3 COLLINS SERIES
AT ROWS 1 AND 3
PLOT F6 FALAYA SERIES
AT ROWS 2,4,AND 5



SITE CX. PLOT F5 FALAYA SERIES
AT ROWS 1,2,3,AND 4



SITE LIX. PLOT L4 LORING SERIES
AT ALL ROWS

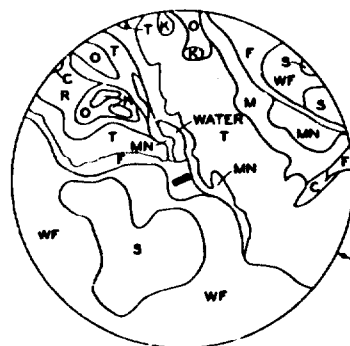
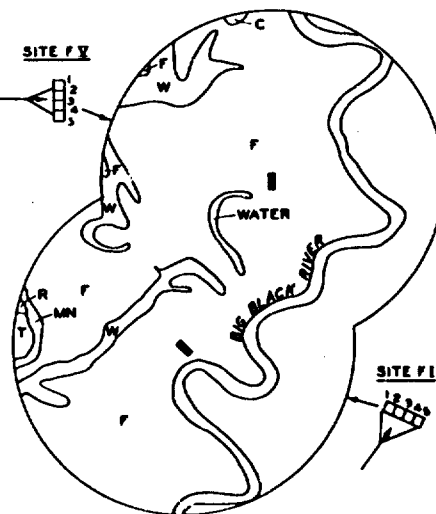
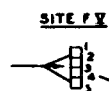
VIEW, ORIENTATION, AND SOILS OF TEST SITES



SITE F VII. PLOT F I FALAYA SERIES
AT ALL ROWS



SITE F V. FALAYA MAP UNIT



SITE F III. FALAYA MAP UNIT



SITE F I. FALAYA MAP UNIT

VIEW, ORIENTATION, AND SOILS OF TEST SITES

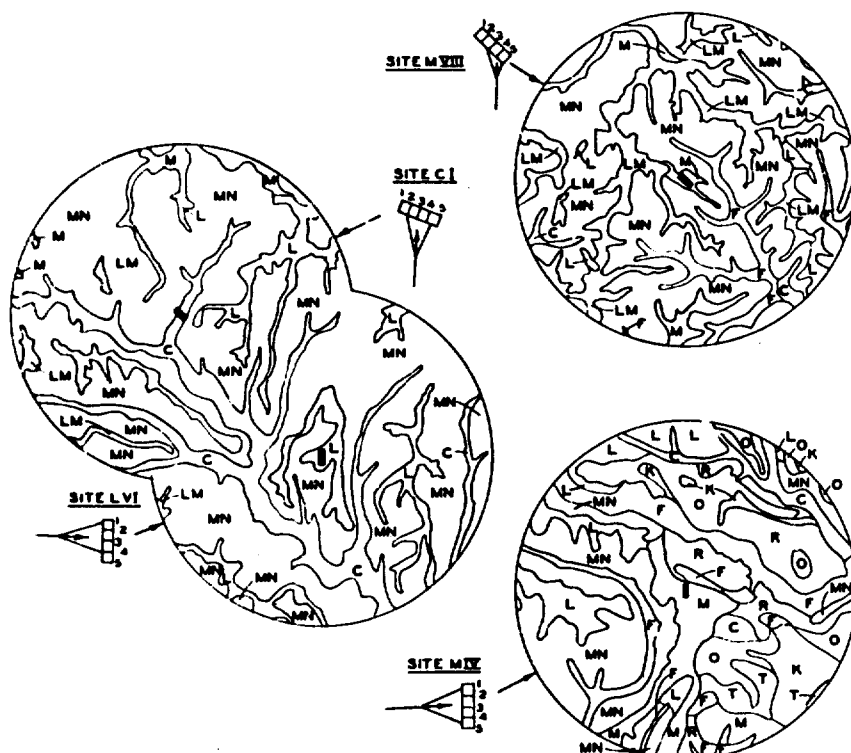
SHEET 3 OF 5



**SITE CI. PLOT F7 FALAYA SERIES
AT ROWS 1 AND 5
PLOT C2 COLLINS SERIES
AT ROWS 2, 3, AND 4**



SITE M VIII. MEMPHIS MAP UNIT



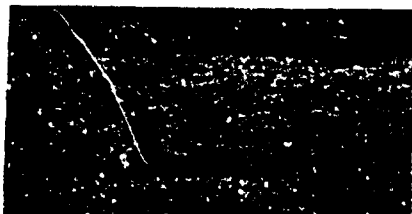
**SITE LVI. PLOT LI LORING SERIES
AT ALL ROWS**



**SITE M IX. PLOT MI MEMPHIS SERIES
AT ALL ROWS**

VIEW, ORIENTATION, AND SOILS OF TEST SITES

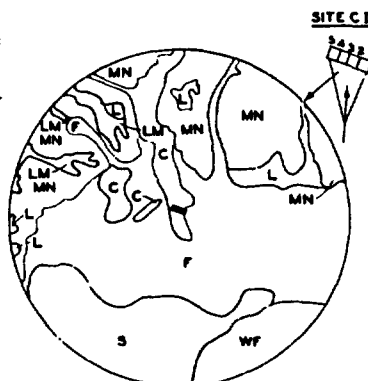
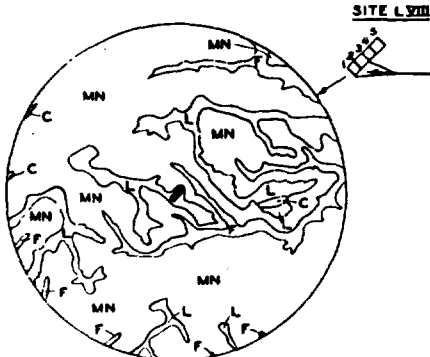
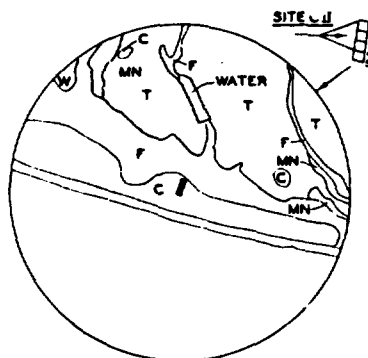
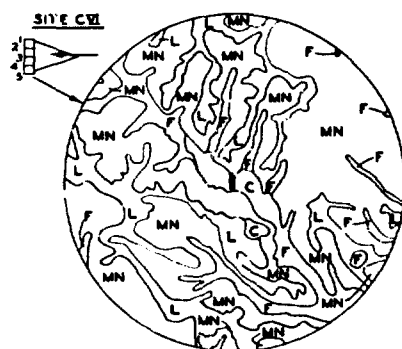
SHEET 4 OF 5



SITE C.VI. PLOT F2 FALAYA SERIES
AT ALL ROWS



SITE C.II. PLOT HYI HYMON SERIES
AT ALL ROWS



SITE L.VIII. LORING MAP UNIT



SITE C.IV. PLOT F3 FALAYA SERIES
AT ALL ROWS

VIEW, ORIENTATION, AND SOILS OF TEST SITES

SHEET 5 OF 5

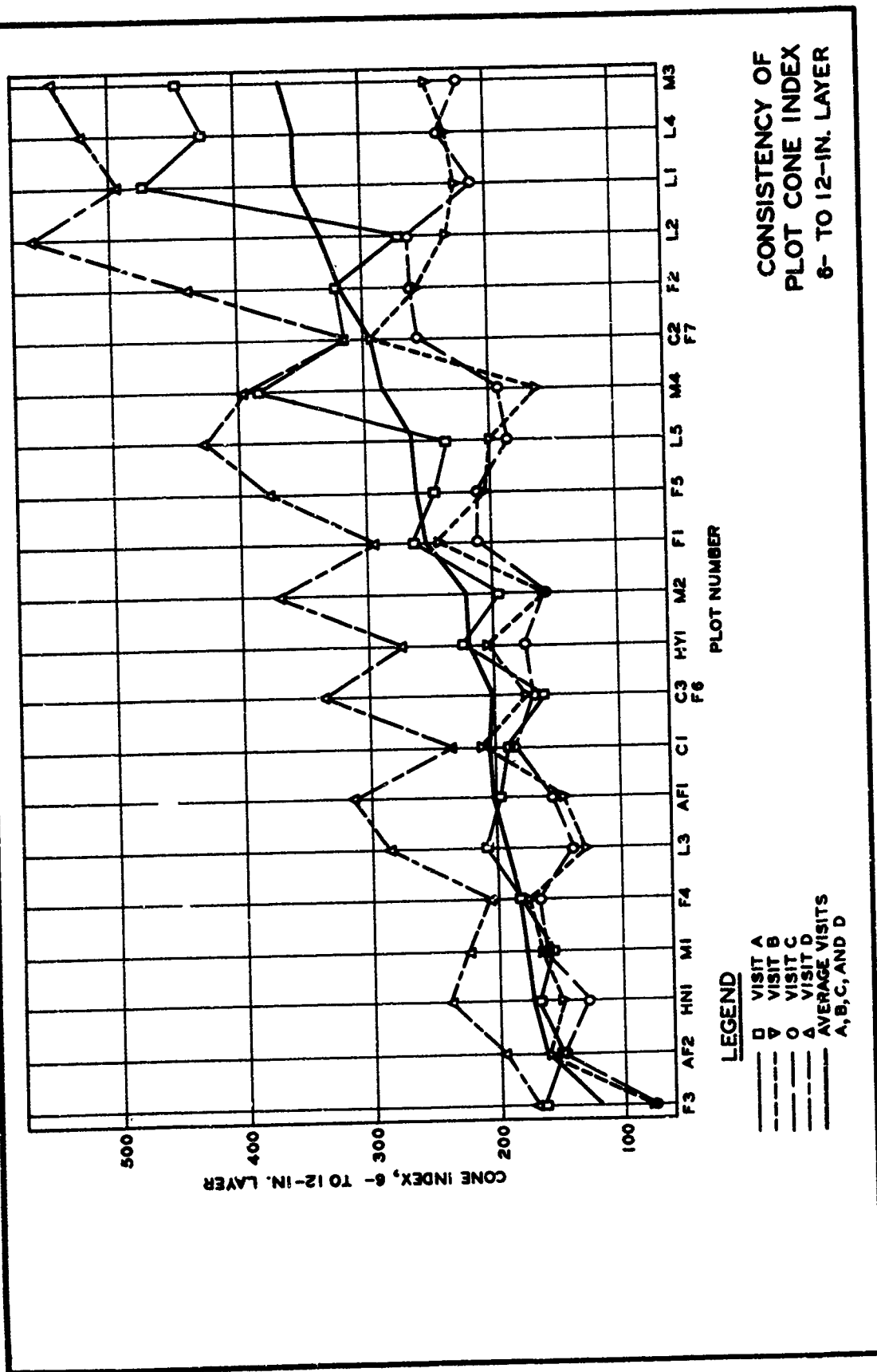
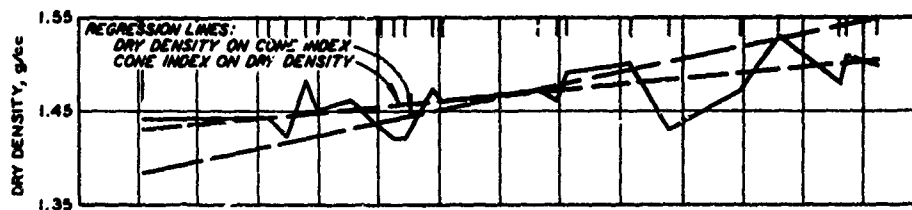
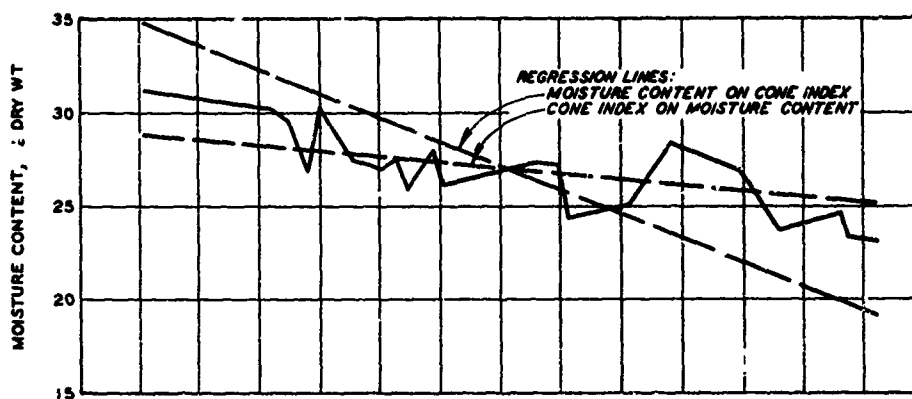


PLATE 2



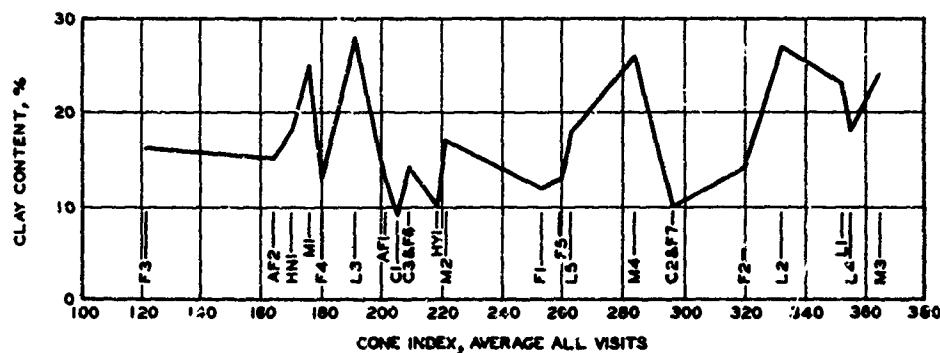
$r=0.68$, HIGHLY SIGNIFICANT, < 1% LEVEL



$r=0.49$, SIGNIFICANT, 5% LEVEL



$r=0.33$, SIGNIFICANT, 20% LEVEL

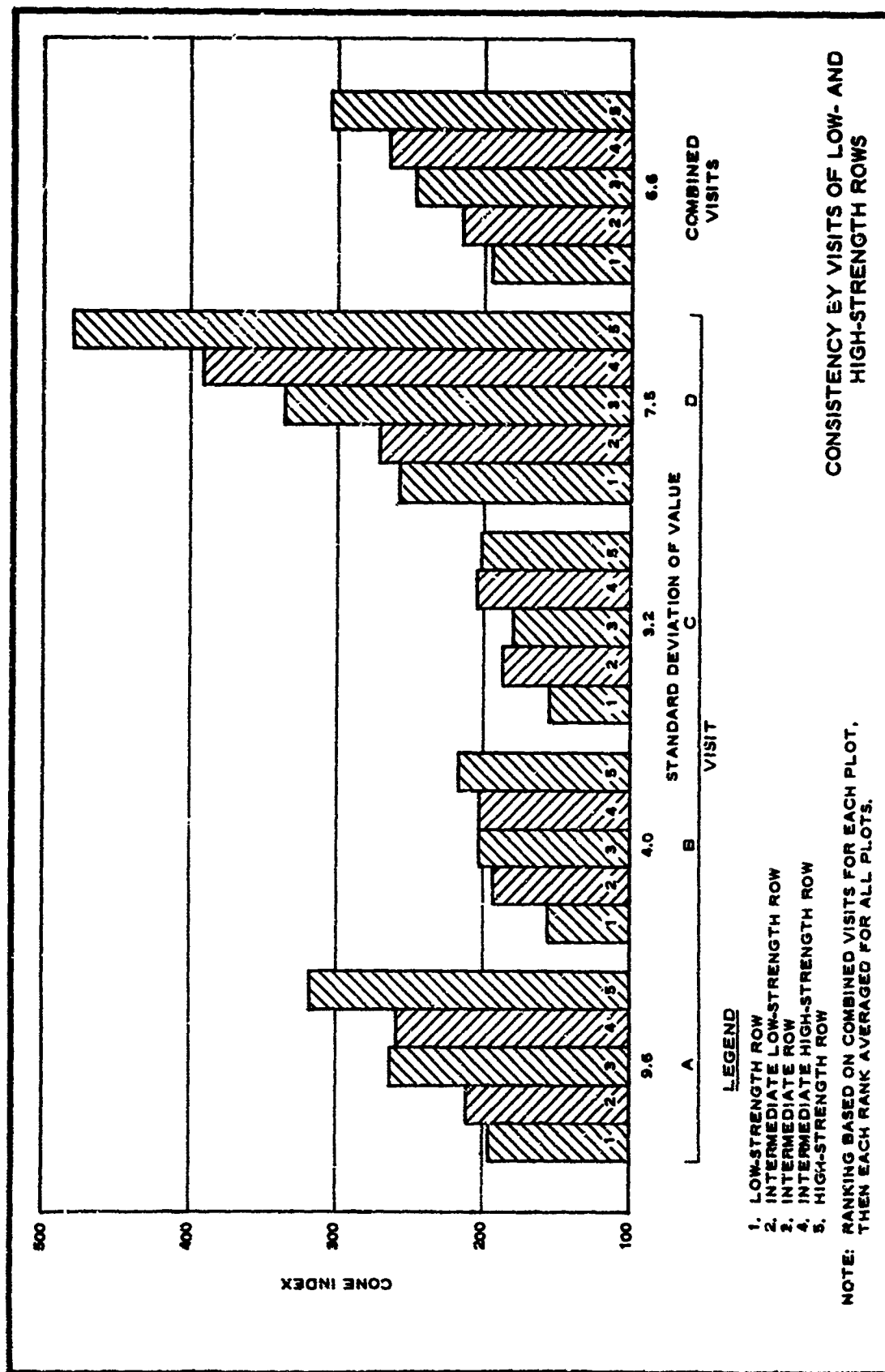


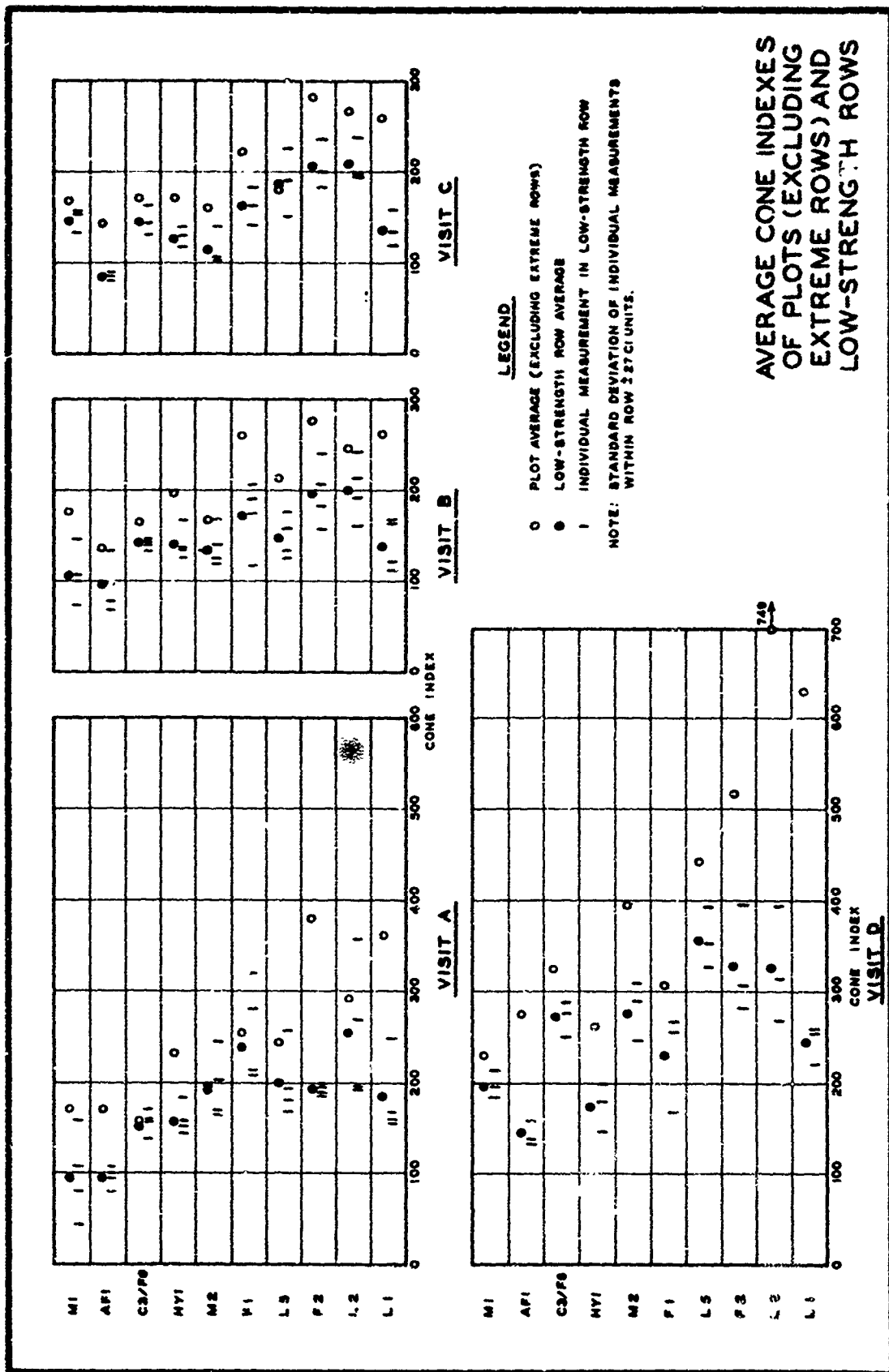
$r=0.27$, NOT SIGNIFICANT, > 20% LEVEL

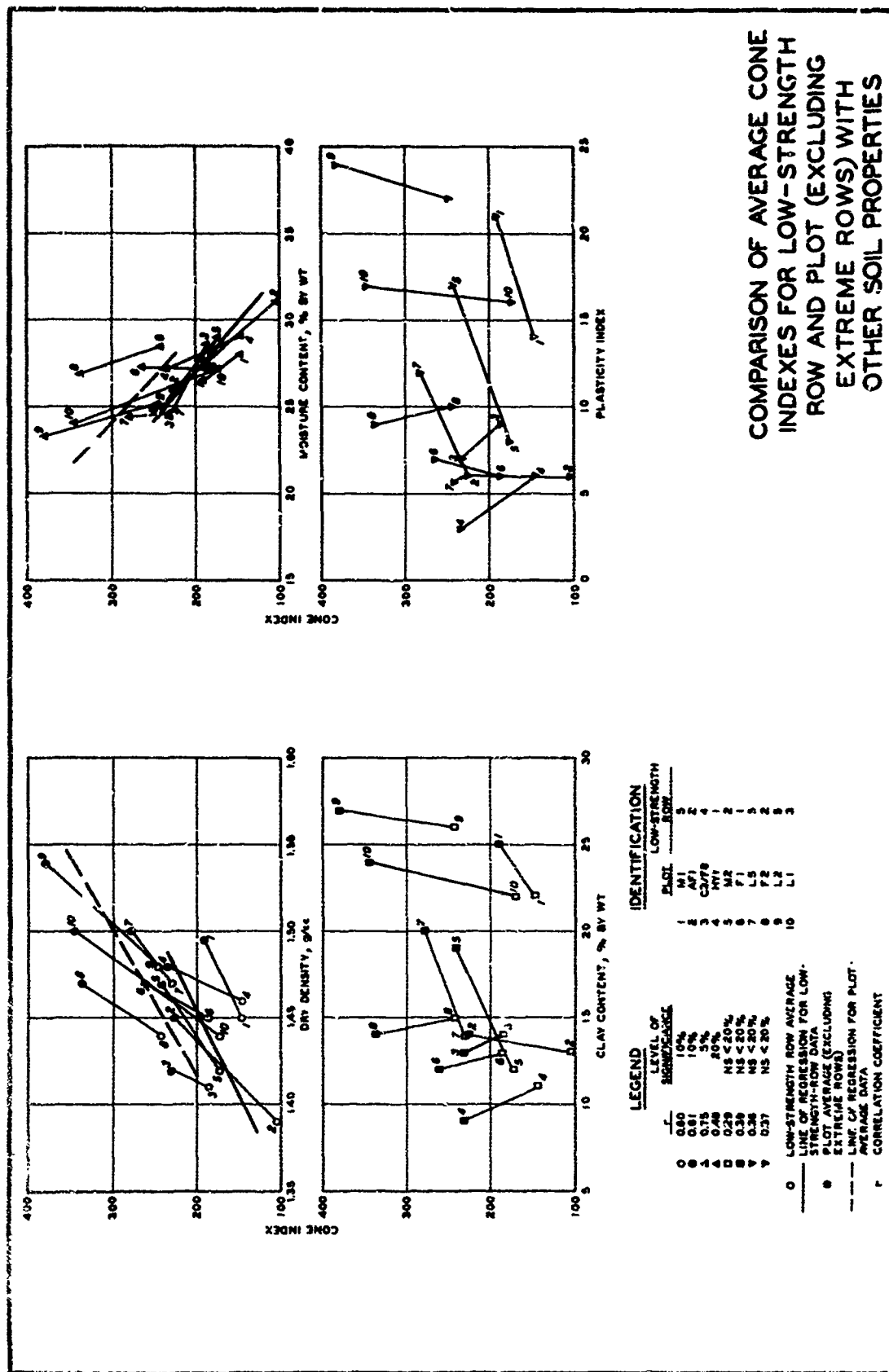
NOTE: r DESIGNATES SAMPLE CORRELATION COEFFICIENT.

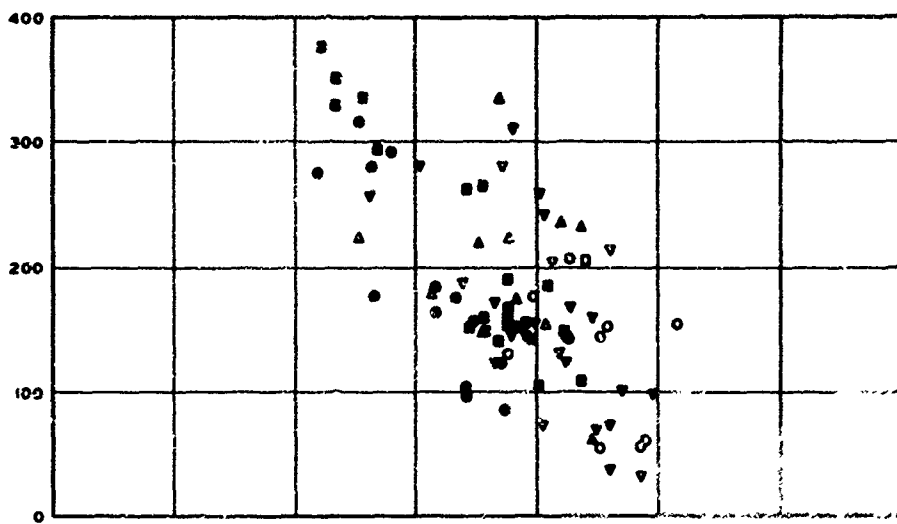
COMPARISON OF PHYSICAL
 PROPERTIES AND CONE INDEX
 6- TO 12-IN. LAYER

PLATE 4

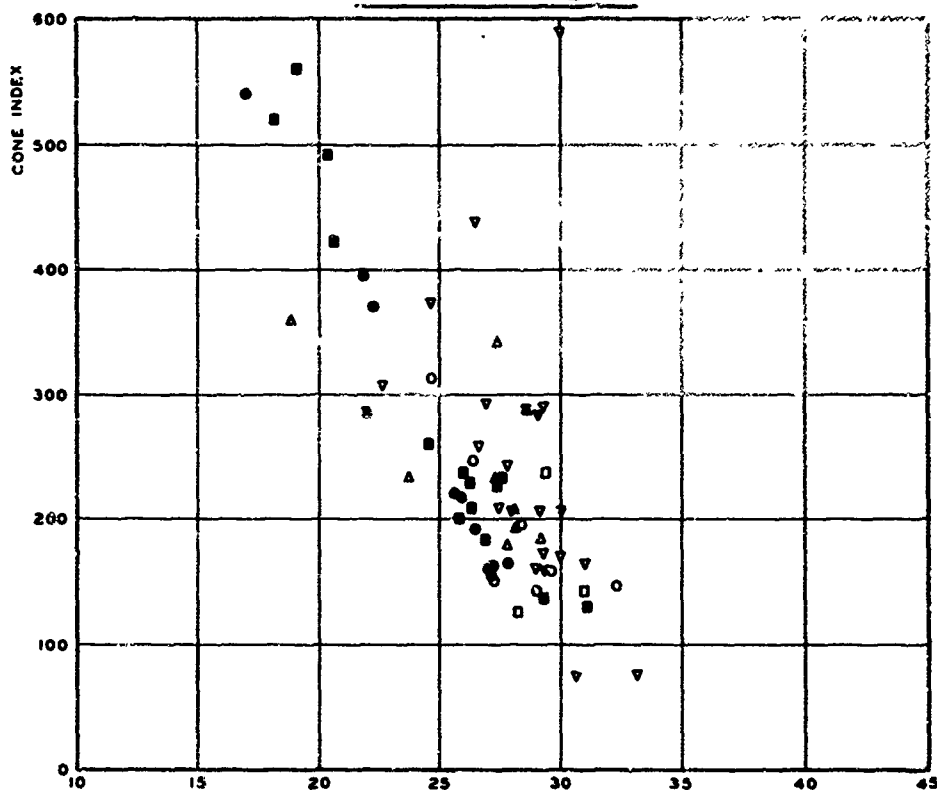








0- TO 6-IN. SOIL LAYER

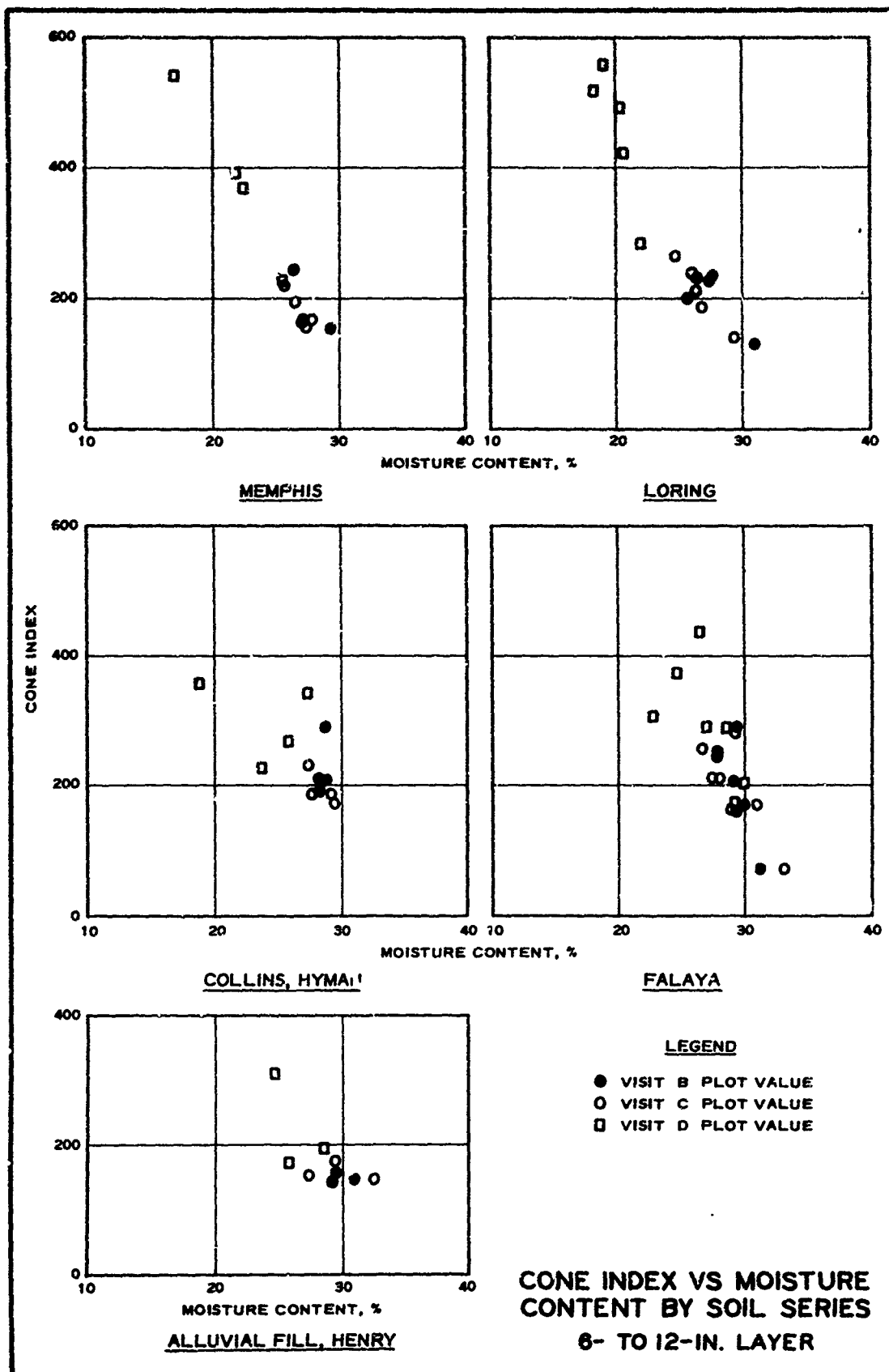


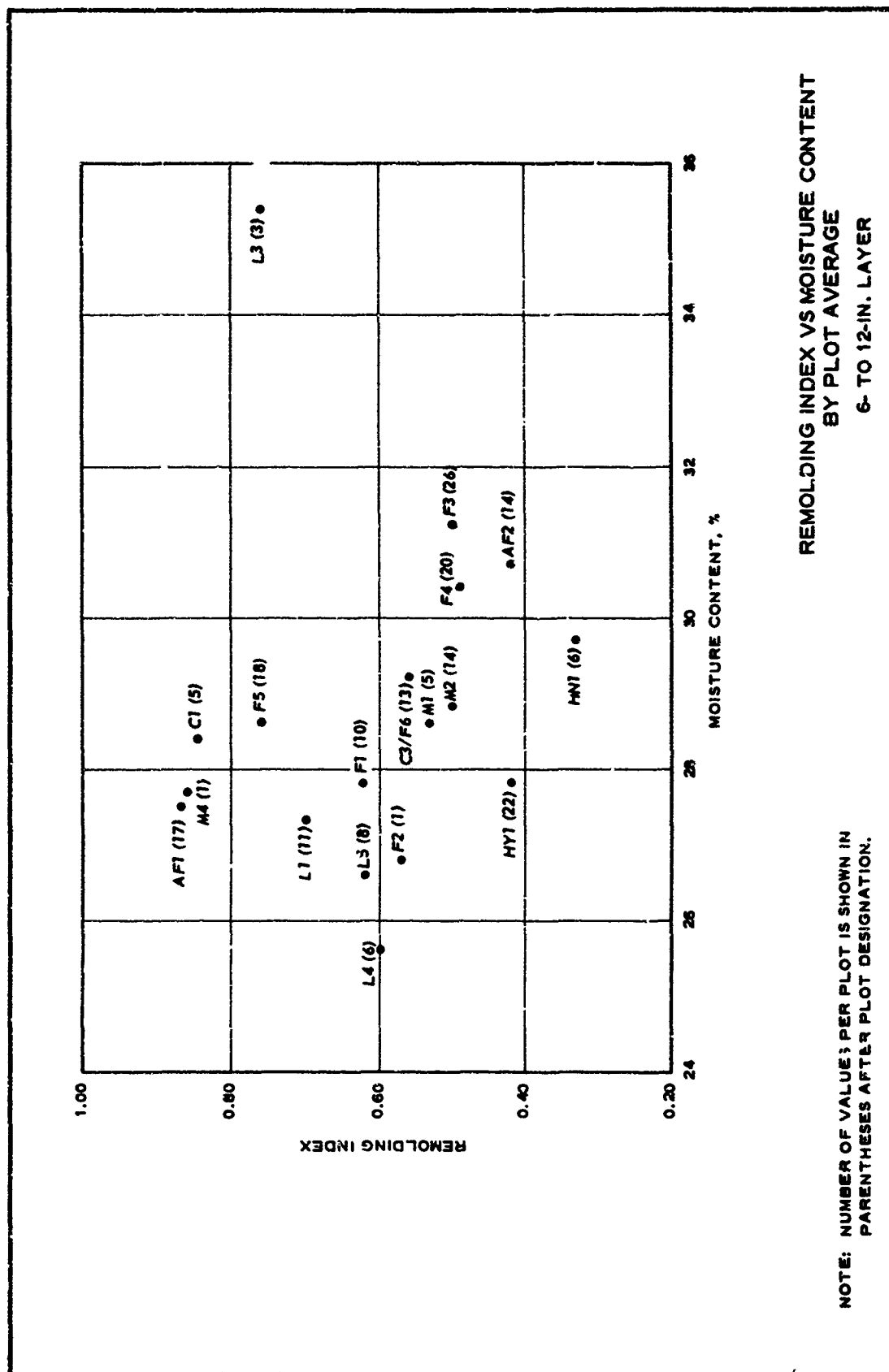
6- TO 12-IN. SOIL LAYER

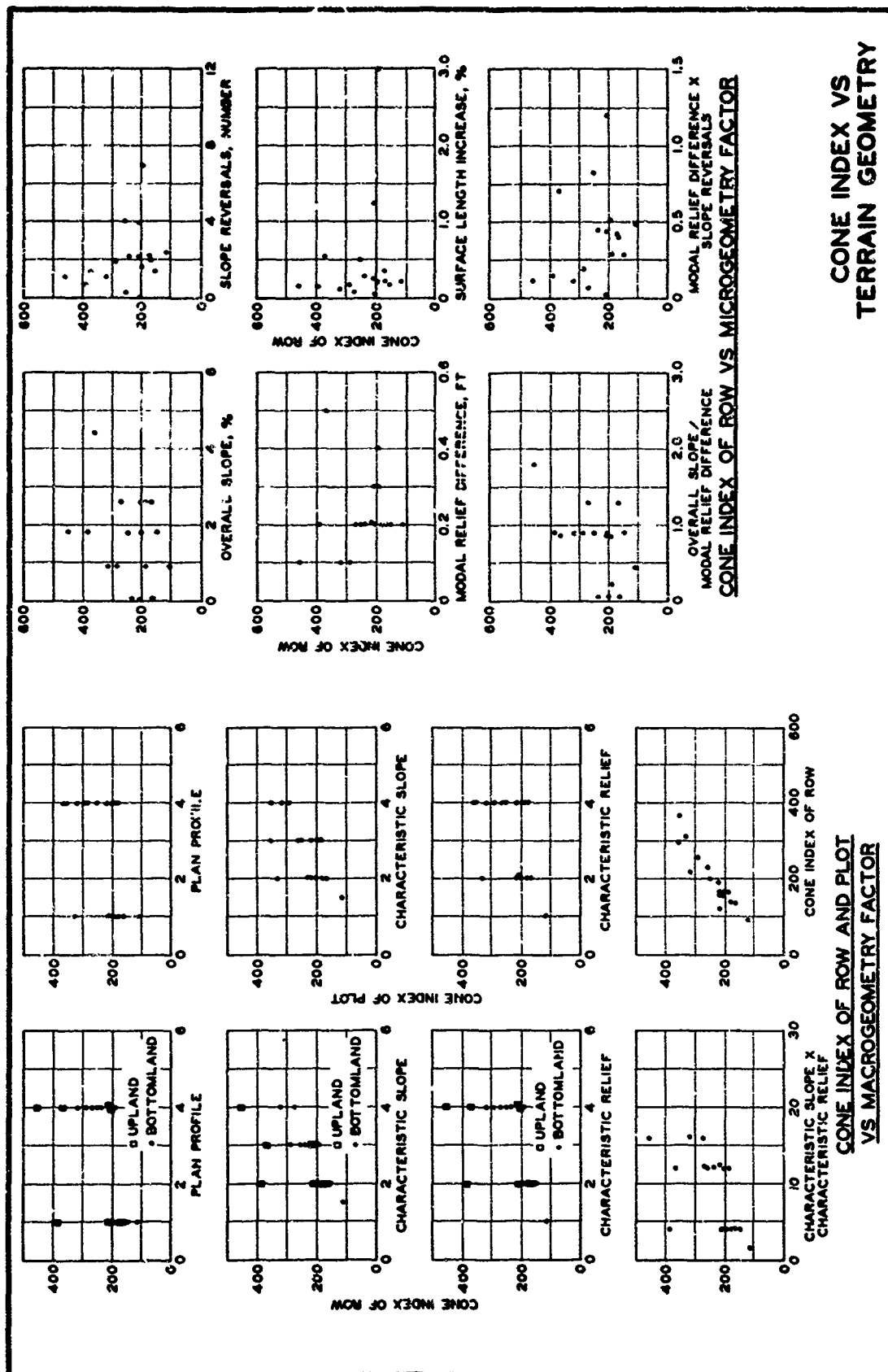
LEGEND

- ALLUVIAL FILL
- MEMPHIS
- LORING
- HENRY
- ▲ COLLINS
- ▼ FALAYA

**CONE INDEX VS
MOISTURE CONTENT
ALL VISITS AND PLOTS**







CONE INDEX VS
TERRAIN GEOMETRY

CONE INDEX OF ROW AND PLOT
VS MACROGEOMETRY FACTOR

APPENDIX A: BASIC DATA

This appendix contains basic data for each of the test sites. Table A1 contains soil strength measurements including cone index and moisture content obtained on four visits to each site. Table A2 contains data on soil properties including United States Department of Agriculture and Unified Soil Classification System soil classes, grain-size analysis, dry density, specific gravity, and moisture contents at 0-, 0.015-, 0.03-, and 0.06-atm tensions.

Table A1
Strength and Moisture Content of Soils at Test Sites*

Identification				Visit A			Visit B			Visit C			Visit D				
Site	Plot	Row	Position	CI	MC		CI	RI	MC	CI	RI	MC	CI	RI	MC		
				0-6	6-12	0-6	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6		
Alluvial Fill																	
M I	AP1	1	A	42	82	33.9	49	97	0.67	29.1	28.3						
			A1									27	110				
			A2									53	173	28.1	26.4		
			A3									47	140	162	282		
			B	12	158	29.2	32	217		29.4	27.8			192	202		
			C	18	32	33.4	26	63	0.44	30.8	30.6						
			D	52	158	23.5	62	120		28.8	27.4						
		2	A	42	80	36.3	13	79	1.18	33.6	32.6						
			A1									34	87				
			A2									37	83	65	138		
			A3									48	86	65	153		
			B	55	100	34.7	60	133	0.28	34.1	31.6			100	132		
			C	68	108	35.9	64	95	0.32	33.2	31.3						
			D	48	95	38.4	35	67	0.24	36.7	30.2						
		3	A	95	350	41.2	34	205	0.49	35.4	26.6						
			A1									123	295	34.2	27.5		
			A2									86	227	158	550		
			A3									82	217	205	600		
			B	50	358	39.9	26	216		36.2	28.1			188	592		
			C	65	238	35.0	122	290		33.7	22.1						
			D	232	525	39.1	93	190	0.40	31.5	29.8						
		4	A	75	155	35.4	55	120	0.48	35.5	30.2						
			A1									36	97				
			A2									30	105	108	282		
			A3									50	107	95	258		
			B	52	212	30.6	67	112	0.33	37.7	28.6			100	258		
			C	50	192	40.7	102	238		35.6	29.5						
			D	32	220	33.4	86	196	0.45	36.9	27.6						
		5	A	82	218	32.0	86	182	0.19	38.3	31.2						
			A1									67	195	0.51	35.2		
			A2									64	167	27.9	27.9		
			A3									77	193	120	258		
			B	45	208	32.5	59	136	0.47	38.0	29.1			115	288		
			C	62	255	31.5	57	107	0.67	36.8	27.9			140	330		
			D	38	180	34.0	36	73	0.64	34.5	31.6						
M V	AP2	2	A	148	155	31.3	212	203	0.49	31.8	27.1						
			A1									170	160				
			A2									173	145	168	145		
			A3									160	150	188	158		
			B	192	208	31.1	193	192	0.50	32.5	28.1			195	225		
			C	162	182	31.4	149	143	0.52	31.0	27.6						
			D	132	120	31.5	125	134	0.66	33.4	28.0						
		3	A	105	162	37.3	120	157	0.20	34.1	32.2						
			A1									133	172	0.23	35.7		
			A2									125	158	32.3	32.3		
			A3									122	153	270	218		
			B	188	212	34.3	129	153	0.25	37.1	31.7			218	200		
			C	170	150	36.1	130	192	0.28	32.3	32.9			188	162		
			D	162	182	31.8	172	163	0.28	34.4	32.1						
		4	A	100	45	30.9	147	142	0.34	30.9	28.2						
			A1									198	125				
			A2									168	128	232	236		
			A3									167	142	242	218		
			B	130	145	30.8	158	151	0.38	30.3	29.6			182	200		
			C	158	142	34.0	177	142	0.38	32.2	28.4						
			D	120	102	31.3	143	137	0.40	34.4	29.1						
		Memphis Soil Series															
		M IV	M1	1	A	105	180	27.6	122	217		27.2	27.5				
					A1									115	175	26.0	27.3
					A2									87	175	152	212
					A3									153	190	150	230
					B	130	158	27.2	70	159		27.3	27.4			100	200
					C	130	220	28.3	112	196		26.9	25.8				
					D	132	242	27.7	105	202		27.3	27.3				
				2	A	42	118	29.0	93	170		27.4	26.8				
					A1									97	142		
					A2									103	172	195	238
					A3									125	183	125	188
					B	88	145	29.6	87	133		28.2	27.1			138	192
					C	62	158	29.1	78	182		26.5	26.2				
D	145				205	26.0	109	195		26.8	26.9						

Note: "0-6" and "6-12" indicate 0- to 6-in. and 6- to 12-in. soil layers, respectively. CI indicates cone index. MC indicates moisture content, percent dry weight. RI indicates remolding index.

* Data are listed by plots according to field-identified soil series.

(1 of 9 sheets)

Table A1 (Continued)

Identification				Visit A			Visit B			Visit C			Visit D		
Site	Plot	Row	Position	CI	RI	MC	CI	RI	MC	CI	RI	MC	CI	RI	MC
				0-6	6-12	0-6	0-6	6-12	6-12	0-6	6-12	6-12	0-6	6-12	0-6
Memphis Soil Series (Continued)															
M IV	M1	3	A	62	132	27.3	92	160	28.5	26.9					
			A1								100	148	27.4	27.3	100
			A2								148	210			208
			A3								95	202			175
			B	92	205	25.2	97	187	27.5	26.2					230
			C	72	175	29.8	73	220	26.7	26.7					
			D	92	230	30.1	96	168	25.7	25.2					
		4	A	62	150	30.7	94	184	26.4	26.8					
			A1								100	145			205
			A2								103	165			188
			A3								78	105			175
			B	48	75	28.8	72	100	27.4	27.0					255
			C	110	225	30.6	122	202	26.6	27.8					268
			D	55	108	28.3	118	159	25.3	26.7					232
		5	A	62	80	28.1	140	144	0.53	28.0	28.8				
			A1								117	157	0.52	28.2	26.7
			A2								85	152			250
			A3								123	132			190
			B	25	42	28.3	89	71	0.68	28.6	28.5				212
			C	70	108	31.8	92	102	0.45	28.3	29.1				182
			D	142	158	30.1	101	100	0.46	27.9	28.1				230
M III	M2	1	A	222	220	31.2	167	173	0.44	31.7	31.2				
			A1								163	175	0.31	32.0	28.3
			A2								117	145			312
			A3								147	140			320
			B	210	173	29.5	165	158	0.69	31.8	28.6				345
			C	280	213	29.0	160	170	0.62	31.9	27.9				380
			D	200	240	31.4	145	148	0.47	31.8	27.4				292
		2	A	157	163	32.1	147	138	0.37	31.4	39.1				
			A1								155	140			118
			A2								157	100			245
			A3								127	103			308
			B	140	247	32.9	145	160	0.57	33.3	30.4				332
			C	153	167	30.2	120	118	0.45	34.3	32.4				288
			D	188	202	33.7	132	122	0.57	33.1	30.1				
		3	A	167	167	29.3	200	198		29.9	28.3				
			A1								217	193	0.55	27.3	26.9
			A2								147	125			300
			A3								222	188			282
			B	247	240	30.4	113	143		31.5	27.4				392
			C	157	193	27.4	180	142		31.0	28.1				312
			D	193	200	29.1	137	185		32.1	26.5				292
		4	A	193	217	29.8	142	142		28.4	27.7				
			A1								158	190			312
			A2								155	170			420
			A3								160	175			525
			B	137	143	28.7	183	212		31.6	27.7				375
			C	143	167	28.7	143	152		31.2	28.8				525
			D	150	183	30.0	120	167		31.3	28.5				
		5	A	182	222	28.0	127	183	0.54	30.4	29.0				
			A1								120	173	28.1	26.5	295
			A2								138	190			350
			A3								128	160			356
			B	153	212	29.0	133	198	0.60	30.3	26.9				382
			C	125	183	30.2	150	142	0.72	31.0	28.1				405
			D	163	163	28.5	128	138	0.66	31.7	28.0				388
M IV	M2	4	A	138	145	26.2	235	257		24.6	26.3				
			A1								132	152			218
			A2								168	177			230
			A3								160	205			225
			B	125	200	27.6	184	187		26.5	27.5				355
			C	182	238	27.4	146	270		25.9	25.9				
			D	220	270	27.2	206	226		27.2	28.1				
		5	A	520	720	22.0	173	272		24.9	24.8				
			A1								172	260	25.6	25.8	275
			A2								185	258			688
			A3								177	272			345
			B	388	650	20.4	128	246		24.9	26.2				732
			C	250	632	20.3	195	247		26.4	26.5				750
			D	520	732	20.8	195	284		26.4	25.8				
M V	M4	1	A	210	400	27.3	138	162		27.8	26.8				
			A1								163	123	26.5	25.1	392
			A2								180	203			605
			A3								170	210			212
			B	158	375	24.6	143	203		27.0	26.0				345
			C	150	305	26.4	125	146		28.4	26.8				512
			D	170	412	28.8	127	158		27.2	26.4				

(Continued)

(2 of 9 sheets)

Table A1 (Continued)

Identification				Visit A			Visit B			Visit C			Visit D		
Site	Plot	Row	Position	CI	MC		CI	RI	MC	CI	RI	MC	CI	RI	MC
				0-6	6-12	0-6	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6
Memphis Soil Series (Continued)															
M V	M4	5	A	128	455	25.9	105	147	0.86	30.0	27.7				
			A1							130	170	28.2	27.9	300	368
			A2							143	168			212	300
			A3							158	177			225	325
			B	322	650	23.6	145	178		27.7	28.0				
			C	162	242	27.0	120	162		31.3	27.7				
			D	108	225	29.6	99	135		28.9	27.5				
Loring Soil Series															
L VI	L1	1	A	358	650	20.4	155	298		27.2	26.0				
			A1							162	250	29.5	25.7	512	750
			A2							182	270			482	750
			A3							158	282			445	750
			B	350	750	26.7	137	243		26.9	26.5				
			C	232	468	31.1	103	203		32.0	28.1				
			D	258	368	29.0	163	203		31.0	28.0				
		2	A	142	250	28.7	168	235	0.26	27.4	29.0				
			A1							150	163			268	375
			A2							128	130			230	355
			A3							85	115			255	278
			B	182	300	26.6	133	168	0.23	28.7	24.3				
			C	125	208	30.6	173	232	0.50	31.7	29.6				
			D	142	258	32.1	173	223	0.34	33.3	29.4				
		3	A	100	250	32.6	157	162	0.51	32.3	29.4				
			A1							137	133	1.02	29.6	27.2	218
			A2							162	118			175	255
			A3							172	157			168	220
			B	83	158	32.4	92	120	0.57	31.5	29.1				
			C	83	168	30.5	103	163	0.64	35.8	29.2				
			D	100	158	32.5	98	110		30.6	27.6				
		4	A	375	600	27.9	158	232		25.5	28.0				
			A1							140	218			280	368
			A2							138	220			282	338
			A3							170	232			345	468
			B	532	718	23.7	222	250		24.1	24.9				
			C	425	692	25.3	215	257		25.4	26.6				
			D	268	600	29.1	165	275		27.8	26.4				
		5	A	225	618	27.2	170	293		28.1	26.2				
			A1							185	282	27.4	26.1	592	750
			A2							168	300			475	750
			A3							183	298			532	750
			B	442	750	19.7	198	297		25.7	27.5				
			C	458	750	22.3	250	300*		25.6	26.4				
			D	442	750	25.8	180	300*	0.37	26.9	25.8				
L I	L2	1	A	180	218	30.2	200	300		32.4	27.4				
			A1							207	300	29.3	23.8	525	750
			A2							220	300			412	750
			A3							217	300			420	718
			B	242	255	28.5	207	193		29.1	25.1				
			C	180	220	26.5	237	300		30.8	25.5				
			D	175	308	27.6	195	185		28.6	27.3				
		2	A	230	418	33.0	240	300		30.4	24.7				
			A1							207	300			232	275
			A2							225	300			252	225
			A3							230	300			200	268
			B	142	108	30.3	130	132		34.2	28.0				
			C	100	142	30.1	200	250		31.7	26.1				
			D	112	200	33.6	150	217		32.6	27.3				
		3	A	130	192	30.8	170	293		30.1	27.2				
			A1							153	260	29.3	24.3	480	750
			A2							188	287			455	750
			A3							207	300			438	750
			B	130	332	26.8	188	230		29.6	28.0				
			C	112	250	28.2	143	218		29.7	30.4				
			D	112	330	28.1	193	240		30.3	28.8				
		4	A	318	625	23.6	175	240		30.4	28.5				
			A1							167	237			432	732
			A2							173	200			458	750
			A3							182	225			432	732
			B	162	445	26.8	113	170		33.2	29.9				
			C	162	188	28.1	227	300		27.4	28.0				
			D	170	170	29.5	233	300		28.7	28.6				

(Continued)

(3 of 9 sheets)

Table A1 (Continued)

Identification			Visit A			Visit B			Visit C			Visit D		
Site	Plot	Row	Position	CI	MC	CI	MC	CI	MC	CI	MC	CI	MC	MC
				0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6
Loring Soil Series (Continued)														
L I	12	5	A	220	358	27.5	180	240	30.3	21.5				
			A1								183	193	27.7	25.8
			A2								142	237	350	312
			A3								163	197	358	392
			B	205	270	27.6	175	213	32.2	29.1				
L V	13	1	C	112	195	34.5	158	190	30.2	28.6				
			D	200	192	26.3	175	160	28.6	31.8				
			A	155	258	29.9	120	143	35.5	32.9				
			A1								125	133	29.4	29.7
			A2								100	120	342	342
			A3								130	188	280	342
			B	168	242	28.0	103	125	30.9	31.9				
			C	180	238	29.2	105	187	31.7	30.8				
			D	118	168	28.6	93	145	31.2	29.7				
			A	118	150	28.8	62	72	0.80	13.5	33.3			
			A1								70	127	300	280
			A2								75	130	305	250
			A3								70	143	220	255
			B	132	180	32.0	117	148	32.6	29.1				
			C	150	150	28.2	105	117	0.74	25.1	40.0			
			D	150	130	31.4	132	95	0.75	34.0	32.7			
			A	145	155	31.3	95	127	33.1	31.9				
			A1								103	108	0.54	31.1
			A2								103	127	342	300
			A3								100	115	338	320
			B	200	200	28.3	105	142	36.4	31.4				
			C	220	282	28.9	145	188	31.8	30.6				
			D	220	262	29.1	115	135	30.2	30.0				
			A	175	245	29.7	72	95	31.2	31.2				
			A1								102	133	350	342
			A2								120	145	332	308
			A3								123	123	325	275
			B	132	180	29.0	112	123	32.2	32.4				
			C	188	230	29.3	135	113	30.5	26.5				
			D	218	350	22.0	162	167	25.1	29.6				
			A	108	150	34.2	78	93	33.8	31.8				
			A1								130	147	30.1	27.9
			A2								140	172	225	208
			A3								127	170	250	225
			B	125	205	24.8	136	157	34.4	27.8				
			C	125	200	30.8	93	127	33.6	28.9				
			D	132	188	29.4	137	123	31.4	30.3				
L IV	14	1	A	182	455	28.4	117	260	29.0	25.6				
			A1								135	263	25.9	24.7
			A2								157	247	230	468
			A3								170	277	255	598
			B	162	318	29.6	162	245	28.3	24.9				
			C	158	438	32.2	133	213	28.5	26.5				
			D	338	750	24.5	120	267	27.2	24.2				
			A	308	550	31.1	120	167	30.3	27.8				
			A1								147	220	392	732
			A2								108	177	385	750
			A3								100	163	392	750
			B	345	750	23.1	128	152	30.4	29.9				
			C	458	750	25.6	112	177	30.6	27.4				
			D	350	442	22.1	115	240	30.7	26.9				
			A	145	382	23.8	138	280	29.9	27.0				
			A1								93	210	28.9	28.0
			A2								137	237	350	482
			A3								82	170	345	545
			B	288	588	24.6	167	243	28.3	27.7				
			C	132	300	32.9	95	210	27.7	25.9				
			D	332	525	27.4	122	225	29.1	26.1				
			A	208	308	28.0	217	257	0.72	24.6	23.5			
			A1								193	287	412	445
			A2								198	292	400	418
			A3								180	257	318	405
			B	145	220	28.8	187	220	24.4	27.0				
			C	155	150	29.6	210	293	24.2	25.7				
			D	175	205	33.0	227	287	23.2	24.6				
			A	362	345	23.9	223	235	0.56	29.2	25.4			
			A1								212	300	0.58	27.2
			A2								177	170	25.2	308
			A3								205	300	358	400
			B	332	255	27.2	210	253	0.60	26.9	26.0			
			C	320	458	25.5	213	210	0.43	26.7	27.4			
			D	382	342	23.3	203	213	0.49	27.8	27.8			

(Continued)

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Table A1 (Continued)

Identification				Visit A			Visit B			Visit C			Visit D			
Site	Plot	Row	Position	CI	MC		CI	RI	MC	CI	RI	MC	CI	RI	MC	
				0-6	6-12	0-6	0-6	6-12	6-12	0-6	6-12	6-12	0-6	6-12	0-6	6-12
Loring Soil Series (Continued)																
L III	L5	1	A	125	405	24.9	113	178	27.5	23.5						
			A1							88	167	27.2	27.8	430	550	
			A2							117	143			442	682	
			A3							77	145			362	558	
			B	138	155	39.7	143	207	28.9	25.7						
			C	132	432	23.0	113	163	28.0	25.2						
			D	92	175	27.2	147	223	29.7	25.1						
		2	A	133	155	28.8	173	227	25.7	21.8						
			A1							150	170			308	392	
			A2							170	197			292	268	
			A3							182	230			305	312	
			B	118	118	33.2	150	243	27.6	24.9						
			C	208	432	28.4	147	177	27.3	25.6						
			D	168	242	28.6	143	223	27.1	25.0						
		3	A	145	155	27.4	147	187	0.57	28.7	26.0					
			A1							157	273	0.79	27.0	26.3	312	
			A2							163	187			322	332	
			A3							210	183			325	358	
			B	250	262	29.6	152	247	28.1	24.8						
			C	132	318	31.2	167	250	27.4	24.3						
			D	212	270	27.3	143	217	26.9	23.7						
		4	A	130	230	31.5	153	220	28.4	26.3						
			A1							157	173			350	608	
			A2							180	187			325	400	
			A3							142	150			345	392	
			B	108	132	32.3	173	193	0.45	29.3	26.5					
			C	125	208	31.8	160	237	30.4	26.5						
			D	132	220	31.3	167	217	29.2	26.2						
		5	A	95	168	30.0	140	177	0.52	29.8	27.1					
			A1							160	227	0.54	29.7	26.6	305	
			A2							153	150			320	350	
			A3							142	190			258	325	
			B	168	258	23.9	100	132	0.73	29.2	27.4					
			C	138	192	30.7	97	157	0.61	30.5	27.4					
			D	142	180	30.0	113	125	0.55	31.0	26.5					
Henry Soil Series																
M VI	BD1	1	A	120	208	29.4	127	145	30.0	34.5						
			A1							135	147	0.32	31.2	28.2	168	
			A2							193	145			195	305	
			A3							128	125			138	150	
			B	130	195	32.2	122	101	30.0	35.2						
			C	138	150	30.1	145	190	31.0	32.8						
			D	145	108	30.7	162	139	31.2	24.4						
		2	A	208	155	32.3	183	171	0.23	31.3	27.4					
			A1							165	138			230	245	
			A2							128	110			250	275	
			A3							153	100			270	220	
			B	180	112	32.9	164	172	0.31	31.6	26.5					
			C	188	245	36.4	128	108	0.38	33.1	28.9					
			D	218	158	32.8	155	148	0.22	32.7	28.0					
Collins Soil Series																
C III	C1	1	A	208	218	30.2	213	223	0.73	30.3	29.7					
			A1							162	212	0.67	30.7	30.0	192	
			A2							178	202			270	345	
			A3							208	157			295	320	
			B	182	142	29.1	156	182	0.81	30.5	30.1					
			C	155	255	30.8	209	278	31.0	30.1						
			D	125	130	30.4	200	203	0.68	31.6	29.1					
		2	A	142	220	31.2	178	163	30.5	28.2						
			A1							156	200			132	145	
			A2							167	177			168	232	
			A3							168	185			188	238	
			B	125	208	31.0	198	235	29.4	28.5						
			C	142	138	30.7	237	227	28.2	28.8						
			D	158	182	31.7	183	229	29.9	29.2						
		3	A	150	225	30.3	161	177	29.3	28.2						
			A1							155	140	29.8	28.5	150	238	
			A2							192	247			188	230	
			A3							175	208			155	230	
			B	150	238	29.1	187	219	28.7	28.0						
			C	182	238	31.0	154	193	28.5	27.5						
			D	95	130	31.8	145	162	28.5	28.8						

(Continued)

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Table A1 (Continued)

Identification				Visit A			Visit B			Visit C			Visit D									
Site	Plot	Row	Position	CI		MC	CI		RI	MC		CI		RI	MC		CI		RI	MC		
				0-6	6-12		0-6	6-12		0-6	6-12	0-6	6-12		0-6	6-12	0-6	6-12		0-6	6-12	
Collins Soil Series (Continued)																						
C III	C1	4	A	152	138	30.0	74	241		29.3	26.6											
			A1									103	215			132	145		26.6	24.6		
			A2										118	200			168	232				
			A3										115	180			188	238				
		B	142	138	28.2	204	208		27.8	27.1												
		C	162	192	27.2	186	181		27.6	27.1												
		D	125	208	28.4	187	215		27.8	27.0												
		5	A	122	192	28.5	179	211		27.3	27.4											
	A1										150	163		30.4	28.9	150	248		24.1	23.5		
	A2										142	163				188	230					
	A3										142	137				155	230					
	B	82	188	29.1	171	253		29.3	26.3													
	C	142	210	25.9	155	175		27.9	27.6													
	D	118	195	30.0	155	206		30.0	26.6													
	C I	C2	2	A	282	382	42.0	262	300		31.5	28.8										
				A1									270	222			338	308		28.8	28.4	
A2													255	222			325	220				
A3													222	203			292	275				
B			300	358	31.1	240	300		31.9	28.0												
C			175	225	33.0	267	300		29.9	28.3												
D			225	238	30.2	232	300		31.1	28.2												
3			A	242	250	31.7	262	300		31.4	28.5											
			A1									245	290		28.8	27.4	288	305		28.5	27.1	
			A2									237	283				282	300				
			A3									222	250				382	392				
B			175	218	32.5	152	194		32.1	30.7												
C		182	282	31.4	200	300		31.2	28.3													
D		275	268	30.5	260	300		29.1	28.5													
4		A	262	305	30.8	245	300		30.6	28.8												
		A1									203	212				370	392		28.3	26.7		
		A2									167	220				430	470					
		A3									202	210				338	420					
B		205	318	28.6	257	300		32.6	28.8													
C		282	408	29.8	203	300		29.9	28.9													
D		218	318	29.6	270	300		30.8	28.0													
F II		C3	1	A	82	142	31.6	133	157		28.6	27.2										
				A1									100	140	0.60	28.3	27.2	145	425		24.2	21.2
				A2									117	180				170	275			
	A3											85	205				168	308				
	B		63	80	30.6	187	160		27.5	28.0												
	C		88	132	33.6	120	133	0.35	27.8	27.8												
	3	D	55	120	33.5	153	223		28.8	28.8												
		A	55	180	32.8	160	217		27.5	27.8												
	3	A1									142	202		27.1	28.4	303	392		21.2	16.6		
		A2									143	207				295	355					
		A3									138	155				258	392					
		B	62	175	32.5	147	180		26.6	27.2												
C		42	145	32.0	180	205		28.0	30.9													
D		68	182	31.8	220	263		26.5	27.5													
Falaya Soil Series																						
F VII	F1	1	A	192	208	27.0	140	115	0.67	27.8	27.9											
			A1									177	183	0.46	27.6	28.6	142	268		24.5	24.5	
			A2									153	140				182	255				
			A3									178	162				175	168				
		B	195	280	26.8	142	190	0.32	27.6	27.7												
		C	145	212	27.7	127	173	0.64	27.9	29.0												
		D	300	320	28.3	160	207		30.1	28.8												
		2	A	212	392	28.5	118	250		29.9	26.9											
			A1									143	188				188	238		26.7	29.4	
			A2									172	185				150	245				
			A3									147	192				232	262				
		B	120	280	29.7	123	257		29.3	26.4												
	C	158	258	32.4	192	300	0.51	28.7	26.2													
	D	52	238	29.2	180	230		31.2	26.9													
	3	A	225	350	30.5	147	300		29.6	26.6												
		A1									157	247	0.84	30.2	26.8	195	355	0.72	26.8	27.7		
		A2									150	225				205	295					
		A3									142	215				250	350					
	B	125	270	27.2	177	233		28.1	27.7													
	C	212	312	29.1	152	300		31.2	27.6													
	D	120	280	31.8	133	220	0.57	31.5	27.9													

Table A1 (Continued)

Identification				Visit A			Visit B			Visit C			Visit D		
Site	Plot	Row	Position	CI	MC	0-6	CI	MC	0-6	CI	MC	0-6	CI	MC	0-6
Ferry's Soil Series (Continued)															
F VII	F1	4	A	119	204	30.7	138	300	30.1	28.8					
			A1								143	220			
			A2								170	182		175	292
			A3								120	183		248	420
			B	80	192	30.5	163	300	0.48	30.4	27.8			212	355
			C	182	270	30.7	150	247		31.2	26.6				
			D	132	175	31.1	140	168	0.34	29.3	29.4				
		5	A	92	170	34.4	187	293		28.9	28.1				
			A1								152	280			
			A2								138	270		162	308
			A3								143	273		155	286
			B	115	218	31.0	168	243		30.4	28.8			180	300
			C	108	280	31.6	168	300		31.6	29.7				
			D	160	200	30.2	122	192		31.5	28.1				
	F2	1	A	366	750	30.4	194	287		30.0	29.7				
			A1								203	300			
			A2								143	300		270	280
			A3								207	300		312	330
			B	282	300	28.5	193	300		30.0	29.7				
			C	200	232	31.6	187	247		32.8	30.7				
			D	312	375	28.7	143	223		31.0	29.5				
		2	A	162	188	34.6	143	183		32.0	31.0				
			A1								130	200		268	395
			A2								150	183		270	305
			A3								180	237		295	260
C IV	F1	3	A	170	282	30.7	177	247		30.4	28.2				
			A1								143	243			
			A2								170	233		232	258
			A3								147	260		262	405
			B	143	275	31.1	157	257		32.2	28.6				
			C	132	275	34.0	173	267		32.2	28.6				
			D	242	242	30.6	193	247		32.2	27.7				
		4	A	158	392	31.3	163	257		30.7	27.5				
			A1								120	247		232	612
			A2								140	280		258	625
			A3								123	243		258	650
			B	142	342	31.2	177	287		33.8	26.0				
			C	175	220	32.1	133	247		34.2	27.6				
			D	170	275	32.0	167	277		30.6	26.5				
		5	A	162	330	26.9	197	300	0.57	29.2	26.8				
			A1								260	300		292	570
			A2								240	300		405	542
			A3								190	273		355	560
			B	362	518	26.8	223	300		29.2	29.1				
			C	258	530	27.3	140	247		29.9	21.1				
			D	175	518	27.2	173	287		31.4	18.5				
	F2	1	A	130	125	32.4	42	37	0.56	37.1	32.4				
			A1								47	80		50	138
			A2								30	67		80	158
			A3								58	62		75	95
			B	158	158	31.5	18	45	0.49	33.5	32.1				
			C	125	130	31.8	27	93	0.51	33.9	31.2				
			D	120	162	31.5	55	103	0.40	35.2	28.8				
		2	A	168	212	32.4	45	115	0.48	34.5	30.8				
			A1								33	77		50	158
			A2								30	82		75	170
			A3								32	97		62	168
			B	132	170	32.6	50	70	0.39	32.1	32.1				
			C	188	150	31.1	35	48	0.57	35.3	29.9				
			D	132	118	34.8	17	66	0.37	36.1	30.4				
		3	A	180	205	32.7	53	53	0.40	33.4	31.0				
			A1								17	40		82	195
			A2								13	40		70	100
			A3								13	55		82	138
			B	160	195	30.1	30	60	0.37	32.8	37.5				
			C	150	168	29.6	73	147	0.46	31.4	29.3				
			D	145	130	31.1	30	55	0.37	35.5	30.0				
		4	A	130	188	29.7	37	50	0.59	35.1	30.7				
			A1								47	92		80	195
			A2								42	92		132	268
			A3								43	125		112	280
			B	142	132	31.1	35	73	0.43	31.8	29.1				
			C	132	148	31.9	48	82	0.55	31.5	30.7				
			D	155	170	29.6	37	87	0.50	32.5	26.9				

(Continued)

(7 of 2 sheets)

Table A1 (Continued)

Identification				Visit A			Visit B				Visit C				Visit D								
Site	Plot	Row	Position	CI	MC		CI	RI	MC		CI	RI	MC		CI	RI	MC						
				0-6	6-12	0-6	0-6	6-12		0-6	6-12	0-6	6-12		0-6	6-12	0-6	6-12					
Palaya Soil Series (Continued)																							
C IV	F3	5	A	168	162	28.8	38	75	0.24	31.8	31.6												
			A1										53	92	0.66	35.7	34.6						
			A2										38	52				55	168				
			A3										40	78				45	188				
			E	132	158	28.5	28	80	0.56	30.1	30.1							82	212				
			C	142	192	29.2	52	90	0.47	31.1	30.5												
			D	108	182	29.0	42	75	0.57	30.9	30.6												
			F VIII	F4	1	A	132	182	36.2	106	157	0.41	36.0	33.6									
						A1										90	103	0.41	37.2	35.4			
						A2										90	112				145	205	
A3													87	103				138	195				
B	88	108				42.0	88	108	0.32	35.3	32.7							130	192				
			C	70	125	34.5	83	122	0.47	38.5	32.9												
			D	82	232	37.2	123	140	0.87	35.5	38.3												
						2	A	70	145	35.2	90	167	0.29	34.4	29.8								
							A1										90	150				105	168
							A2										90	170				125	138
A3														97	157				108	218			
B	50	158					40.6	125	233	0.42	34.1	33.0											
			C	54	188	37.5	90	230	0.48	35.4	30.2												
			D	95	238	39.4	110	187	0.52	35.9	29.5												
						3	A	68	150	39.6	90	177	0.49	33.1	28.1								
							A1										107	218	0.52	32.6	26.6		
							A2										120	203				130	212
A3														100	147				150	250			
B	65	138					37.2	112	220	0.51	31.3	24.4											
			C	70	220	42.0	67	195	0.64	37.4	29.7												
			D	30	155	40.4	120	187	0.47	31.5	23.6												
						4	A	118	292	35.4	138	203	0.65	31.3	27.3								
							A1										110	212				118	270
							A2										103	200				118	175
A3														117	203				120	230			
B	20	130					27.1	80	103	0.41	28.0	26.3											
			C	112	232	21.2	107	192	0.34	28.1	28.4												
			D	70	192	31.7	118	155	0.46	31.1	32.4												
			C V	F5	1	A	68	195	35.0	145	197	0.69	30.4	29.4									
						A1										120	277	0.92	31.4	28.4			
						A2										147	213				342	362	
A3													120	190				232	308				
B	232	358				30.5	133	148	0.56	30.0	31.7							330	412				
			C	220	208	31.7	143	16	0.60	34.1	29.2												
			D	242	200	30.8	92	170	0.88	30.3	29.5												
						2	A	150	142	35.3	117	208	0.57	33.2	29.6								
							A1										140	157				283	312
							A2										140	200				200	358
A3														135	127				258	332			
B	95	150					31.7	142	227	0.51	30.1	26.5											
			C	70	262	33.6	98	243	0.57	32.8	28.4												
			D	120	275	29.6	133	147	0.59	29.8	29.3												
						3	A	218	305	32.6	135	207	0.70	31.6	31.1								
							A1										205	278	0.80	27.7	27.7		
							A2										252	270				232	332
A3														157	273				350	392			
B	180	338					34.0	175	287	0.71	33.9	28.9							305	342			
			C	205	282	29.0	147	278	0.78	30.4	28.0												
			D	80	188	33.3	82	197	0.71	29.5	28.8												
						4	A	215	255	30.6	152	197	0.42	30.1	30.5								
							A1										140	180				250	395
							A2										120	163				245	500
A3														177	177				258	450			
B	182	230					32.4	127	210	0.73	29.9	28.7											
			C	158	292	32.4	145	260	0.68	29.9	27.5												
			D	132	268	34.2	143	210	0.67	30.1	29.3												
			F II	F6	2	A	120	230	29.0	157	167		29.1	28.1									
						A1										120	187				218	318	
						A2										138	173				168	238	
A3													113	207				255	255				
B	82	192				32.5	187	150	0.57	28.7	28.6												
			C	62	100	30.2	193	153	0.36	29.1	29.7												
			D	82	225	29.6	153	227		30.7	28.1												
						4	A	52	138	33.8	163	143	0.49	28.5	31.3								
							A1										133	143				232	288
							A2										127	163				258	275
A3														120	130				225	250			
B	58	158					33.6	128	142	0.45	27.7	25.9											
			C	52	158	32.8	147	133	0.42	27.8	29.8												
			D	70	170	33.4	173	150	0.46	28.5	29.6												

(Continued)

(8 of 9 sheets)

Table A1 (Concluded)

Identification				Visit A			Visit B			Visit C			Visit D						
Site	Plot	Row	Position	CI	6-12	MC	CI	6-12	MC	CI	6-12	MC	CI	6-12	MC				
Palaya Soil Series (Continued)																			
F II	F6	5	A	128	208	35.4	155	185	0.54	29.9	28.5								
			A1							138	145	0.71	28.4	29.0	318	342	21.4	18.6	
			A2							118	150				375	425			
			A3							133	153				250	368			
			B	62	138	33.2	120	157	0.45	31.1	29.9								
C I	F7	1	C	35	168	33.2	113	148	0.42	28.9	29.1								
			D	30	162	34.0	100	170	0.42	29.2	29.7								
			A	182	375	39.0	255	300		29.2	28.4								
			A1							270	262		31.3	28.1	300	382	29.6	26.8	
			A2							252	265				292	305			
			A3							252	292				288	292			
			B	268	325	35.9	203	227		32.4	29.0								
			C	232	368	29.8	272	300		29.4	29.6								
			D	182	325	38.8	245	300		31.4									
					5	A	232	332	29.5	265	300		30.5	32.0					
A1										250	300		28.9	30.4	300	275	28.4	30.4	
A2										270	300				355	238			
A3										267	300				325	245			
B	242	308				30.9	233	300		39.4	29.7								
			C	225	425	30.4	242	300		23.7	28.6								
			D	158	292	29.6	212	300		26.5	28.6								
			Hymon Soil Series																
			C II	HY1	1	A	175	158	31.8	133	137	0.28	34.6	30.1					
						A1							150	130	0.33	32.9	31.7	162	375
A2										122	140				155	145			
A3										123	117				192	200			
					B	150	150	30.6	143	167		32.2	26.8						
					C	175	142		123	132	0.46	33.0	27.4						
					D	182	182	32.5	120	125	0.32	33.9	32.9						
					2	A	242	275	34.9	178	300		37.2	30.3					
A1										195	173				170	358	35.2	29.7	
A2										197	232				162	350			
A3										217	245				168	503			
					B	300	280	36.3	155	215		37.7	30.0						
					C	158	158	40.6	180	300	0.30	39.2	32.8						
					D	292	308	35.6	188	300	0.42	36.8	32.1						
					3	A	232	308	34.4	185	300	0.77	33.3	26.9					
A1										168	167	0.53	31.8	29.5	230	368	27.6	24.9	
A2										172	202				280	332			
A3										183	233				345	342			
					B	218	192	32.3	213	158	0.64	34.3	28.8						
					C	218	150	31.6	155	100	0.21	34.6	31.1						
					D	242	232	37.3	123	163	0.14	33.0	30.6						
					4	A	208	342	35.2	152	295	0.15	30.1	26.9					
A1										157	183				245	245	26.1	24.0	
A2										175	192				188	188			
A3										152	152				318	270			
					B	232	250	30.0	182	127	0.33	29.3	27.3						
					C	168	153	28.8	188	148	0.13	28.0	26.3						
					D	168	250	31.2	195	297	0.08	29.9	25.9						
					5	A	168	182	25.8	150	178	0.17	29.6	27.9					
A1										135	118	0.16	28.9	27.0	195	255	0.52	26.1	24.1
A2										138	153				192	205			
A3										165	157				182	192			
					B	175	168	26.9	183	123	0.23	26.8	28.2						
					C	318	382	26.0	220	190	0.35	26.8	26.1						
					D	192	192	26.5	187	300	0.55	28.8	27.4						

Table 2

Classification and Properties of Soils at Test Sites*

Site	Plot	Row	Post-tension	Classification				Grain-Size Analysis, %				Atterberg Limits				Dry Density	Specific Gravity	Soil Moisture, % at															
				0-6		6-12		Sand	Silt	Clay	Lineal	0-6		6-12				Liquid	Plastic	Saturation	0.002-mm	0.075-mm	2.0-mm										
				0-5	5-12	0-5	5-12					0-5	5-12	0-5	5-12									0-5	5-12	0-5	5-12	0-5	5-12	0-5	5-12	0-5	5-12
M I	AF1	1	A	SIL	SIL	CL	CL	14	12	67	65	19	23	99.0	98.0	38	35	26	23	12	12	1.36	1.36	2.69	2.71	32.6	32.1	31.3	30.8	30.8	30.3	29.9	29.2
		2	B	SIL	SIL	CL	CL	15	9	69	74	16	17	98.8	99.4	31	29	24	23	7	6	1.38	1.44	2.68	2.70	33.0	30.4	31.3	29.7	30.7	29.2	29.8	28.6
		3	C	SIL	SIL	CL	CL	13	13	73	73	16	14	99.6	99.6	33	30	25	25	8	5	1.28	1.40	2.68	2.70	33.2	28.9	31.6	27.8	29.7	29.2	29.8	26.5
		4	D	SIL	SIL	CL	CL	10	10	64	72	26	18	99.6	99.8	35	33	23	22	11	11	1.50	1.42	2.69	2.71	28.4	34.0	27.8	32.4	27.2	31.2	26.7	30.0
	2	1	A	SIL	SIL	CL	CL	12	12	77	75	11	13	99.4	99.6	34	31	30	26	5	5	1.24	1.40	2.68	2.70	42.0	31.4	30.4	30.7	30.4	30.1	32.0	29.4
		2	B	SIL	SIL	CL	CL	10	12	77	77	13	12	98.4	99.6	36	31	27	26	9	5	1.36	1.35	2.69	2.70	32.6	34.3	32.2	31.8	31.0	31.2	30.0	29.9
		3	C	SIL	SIL	CL	CL	9	14	74	73	17	13	99.4	99.4	48	32	31	26	17	6	1.35	1.40	2.69	2.70	33.4	31.6	32.7	30.8	32.2	30.2	31.6	29.5
		4	D	SIL	SIL	CL	CL	15	14	73	77	12	9	98.6	99.6	36	26	28	26	8	0	1.40	1.51	2.68	2.70	32.4	26.8	31.3	26.0	30.0	29.6	30.0	29.0
	3	1	A	SIL	SIL	CL	CL	12	16	75	76	13	8	98.5	99.4	39	27	25	26	13	7	1.30	1.43	2.69	2.69	35.6	29.6	34.7	29.1	34.2	28.6	33.6	28.0
		2	B	SIL	SIL	CL	CL	12	15	76	75	12	10	98.2	98.4	34	27	26	25	7	2	1.32	1.46	2.69	2.70	36.6	28.8	33.2	28.2	34.0	27.8	33.2	27.2
		3	C	SIL	SIL	CL	CL	11	10	76	79	13	11	98.8	99.8	36	32	27	24	9	8	1.34	1.46	2.68	2.71	35.3	29.6	24.6	29.2	34.0	28.8	33.5	28.0
		4	D	SIL	SIL	CL	CL	10	9	73	74	17	17	99.0	99.8	37	30	27	24	10	6	1.30	1.48	2.69	2.71	38.4	26.4	37.2	26.0	36.6	29.8	35.7	25.2
4	1	A	SIL	SIL	CL	CL	11	9	79	73	10	18	99.0	99.6	33	32	27	23	6	9	1.43	1.48	2.69	2.71	30.6	29.0	28.6	28.6	29.4	28.1	28.9	27.9	
	2	B	SIL	SIL	CL	CL	14	14	77	78	11	14	99.2	99.2	40	27	30	24	3	3	1.41	1.44	2.68	2.70	31.2	30.7	30.2	29.1	29.8	27.8	29.2	27.3	
	3	C	SIL	SIL	CL	CL	12	12	77	78	9	14	97.8	99.6	37	29	28	25	9	4	1.29	1.49	2.68	2.71	38.0	29.2	36.9	28.5	36.2	27.9	35.4	27.3	
	4	D	SIL	SIL	CL	CL	12	12	75	78	13	10	98.0	99.6	41	30	30	28	11	2	1.31	1.42	2.68	2.70	37.0	32.2	35.1	30.2	34.5	29.2	33.6	28.6	
M V	AF2	1	A	SIL	SIL	CL	CL	12	12	75	78	13	10	98.0	99.6	41	30	30	28	11	2	1.31	1.42	2.68	2.70	37.0	32.2	35.1	30.2	34.5	29.2	33.6	28.6
		2	B	SIL	SIL	CL	CL	15	15	74	75	14	13	98.2	99.4	41	29	25	23	6	5	1.37	1.48	2.68**	2.71**	33.8	27.0	32.4	26.0	31.6	25.5	36.9	25.0
		3	C	SIL	SIL	CL	CL	12	13	74	74	14	13	98.2	98.8	38	31	29	25	11	5	1.27	1.47	2.69	2.71	36.3	27.1	36.2	26.6	34.4	26.4	34.4	26.0
		4	D	SIL	SIL	CL	CL	13	10	74	74	13	15	98.6	99.6	36	29	26	24	10	5	1.34	1.42	2.68	2.71	34.6	29.4	33.6	28.7	33.0	28.4	32.0	27.4
	2	1	A	SIL	SIL	CL	CL	13	14	73	72	12	14	99.0	99.0	33	32	28	23	5	9	1.40	1.42	2.66	2.69	32.2	31.6	30.9	30.6	30.6	29.9	30.0	29.2
		2	B	SIL	SIL	CL	CL	14	12	76	72	10	16	98.8	99.2	37	31	28	22	9	9	1.41	1.50	2.66	2.69	30.1	25.2	27.0	28.2	27.0	26.6	28.2	26.0
		3	C	SIL	SIL	CL	CL	16	11	75	74	9	18	97.2	99.6	32	33	23	21	7	12	1.40	1.46	2.66	2.69	31.0	29.2	29.3	28.2	29.3	27.4	28.6	26.9
		4	D	SIL	SIL	CL	CL	15	11	75	78	10	21	97.5	99.4	31	40	23	21	8	19	1.44	1.49	2.66	2.70	29.2	27.4	28.4	26.7	27.9	26.4	27.4	26.2
	3	1	A	SIL	SIL	CL	CL	12	9	78	77	10	14	98.6	98.8	43	29	33	24	10	5	1.37	1.36	2.66	2.69	33.8	37.2	32.4	34.4	28.0	33.6	31.5	32.6
		2	B	SIL	SIL	CL	CL	12	10	78	76	10	14	99.0	99.6	36	33	28	25	7	8	1.34	1.47	2.66	2.69	32.8	33.8	32.7	32.3	31.0	31.8	31.8	32.6
		3	C	SIL	SIL	CL	CL	13	10	79	77	8	13	98.8	99.4	26	31	24	23	2	8	1.44	1.44	2.66	2.69	30.7	31.8	29.7	29.8	28.6	28.6	28.2	28.6
		4	D	SIL	SIL	CL	CL	13	10	79	77	8	13	98.8	99.4	26	31	24	23	2	8	1.44	1.44	2.66	2.69	30.6	31.8	29.2	29.8	28.6	28.6	28.2	28.6
4	1	A	SIL	SIL	CL	CL	12	10	79	75	9	15	99.0	99.4	36	35	28	24	8	11	1.42	1.42	2.66	2.70	32.7	30.8	30.0	30.0	30.4	29.2	32.8	28.7	
	2	B	SIL	SIL	CL	CL	12	10	78	74	10	16	99.0	99.4	35	29	28	22	7	7	1.42	1.44	2.66	2.70	32.6	31.2	30.9	29.4	30.4	28.8	29.8	28.2	
	3	C	SIL	SIL	CL	CL	12	10	79	73	9	17	98.8	99.4	34	29	25	21	9	8	1.40	1.46	2.66	2.70	32.8	30.6	31.4	28.8	31.0	28.0	30.4	27.6	
	4	D	SIL	SIL	CL	CL	13	10	77	76	10	14	98.0	99.4	36	30	27	20	9	10	1.40	1.44	2.66	2.70	32.8	31.9	31.6	30.1	31.2	29.4	30.5	28.9	
M IV	AF1	1	A	SIL	SIL	CL	CH	12	8	70	62	18	30	99.6	99.8	41	54	25	27	16	27	1.44	1.48	2.66**	2.71	30.1	30.0	28.6	28.6	28.4	28.4	27.9	28.2
		2	B	SIL	SIL	CL	CH	7	7	64	62	29	31	99.8	99.8	49	54	24	29	25	25	1.46	1.50	2.69	2.71	29.3	28.5	28.3	27.8	28.0	27.8	27.6	27.8
		3	C	SIL	SIL	CL	CH	11	6	69	63	20	29	99.4	99.8	36	48	23	27	13	21	1.50	1.48	2.69	2.71	28.4	29.0	27.4	28.2	27.1	28.2	27.6	27.6
		4	D	SIL	SIL	CL	CH	12	8	65	66	23	28	99.4	100.0	40	54	25	25	15	29	1.42	1.50	2.69	2.71	31.0	28.6	29.6	27.7	29.1	27.7	28.1	27.6

(Continued)

Note: "0-6" and "6-12" indicate 0- to 6-in. and 6- to 12-in. soil layers, respectively.
 * Data are listed by plots according to field-identified soil series.
 ** Estimated.

(1 of 10 sheets)

Posi- tion	Classification		Grain-size Analysis, %		Atterberg Limits		Dry		Soil Moisture, % at	
	USDA	UCS	Sand	Silt	LL	PL	Density	Specific Gravity	0.015-mm	0.075-mm
1	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
2	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
3	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
4	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
5	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
6	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
7	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
8	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
9	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
10	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
11	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
12	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
13	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
14	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
15	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
16	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
17	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
18	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
19	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
20	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
21	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
22	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
23	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
24	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
25	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
26	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
27	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
28	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
29	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
30	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
31	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
32	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
33	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
34	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
35	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
36	CL	UCS-3	0-5	6-13	0-6	6-12	0-6	6-12	0-6	6-12
37	CL	UCS-3								

[illegible]

44 Totalized.

(2 of 10 sheets)

Table A2 (Continued)

Site	Plot	Row	Col	Post- ion	Classification		Gravimetric Analysis, g										Dry										Soil Moisture, % at													
					0-5	5-10	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50				
Marble Hill Series (Continued)																																								
M VI	M 5	A	SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	9	9	68	71	23	20	20	20	20	20	19	1.42	1.54	2.67	2.70	27.1	28.0	26.1	26.8	26.2	27.0	26.0	26.8	
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	11	9	67	70	22	21	21	21	21	21	23	1.46	1.52	2.69	2.71	29.6	28.0	28.4	27.0	28.4	27.2	27.6	26.7
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	10	10	67	68	23	22	22	22	22	22	19	1.52	1.52	2.69	2.71	26.9	27.0	28.0	26.0	28.0	27.0	27.0	26.8
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	10	10	67	68	23	22	22	22	22	22	19	1.50	1.50	2.69	2.70	27.0	28.0	28.4	27.0	28.4	27.2	27.6	26.8
M V	M 4	A	SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	11	9	71	69	18	22	22	22	22	22	18	1.44	1.48	2.66	2.71	30.0	27.8	29.1	27.1	29.1	27.1	28.8	27.1	
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	10	8	69	69	21	21	21	21	21	21	21	1.48	1.54	2.66	2.71	27.1	28.0	28.4	27.0	28.4	27.2	27.6	26.8
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	13	9	74	67	13	24	24	24	24	24	21	1.48	1.54	2.66	2.71	27.1	28.0	28.4	27.0	28.4	27.2	27.6	26.8
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	14	9	71	68	15	23	23	23	23	23	21	1.48	1.54	2.66	2.71	27.1	28.0	28.4	27.0	28.4	27.2	27.6	26.8
M VI	M 3	A	SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	14	8	70	64	16	28	28	28	28	28	25	1.52	1.50	2.66	2.71	26.2	27.5	28.2	26.8	28.2	27.0	28.8	26.6	
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	16	8	69	63	17	28	28	28	28	28	25	1.48	1.48	2.66	2.71	26.2	27.5	28.2	26.8	28.2	27.0	28.8	26.6
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	16	8	69	63	17	28	28	28	28	28	25	1.52	1.50	2.66	2.71	26.2	27.5	28.2	26.8	28.2	27.0	28.8	26.6
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	11	8	63	64	26	26	26	26	26	26	21	1.51	1.46	2.68	2.71	27.1	29.6	26.2	28.8	26.0	28.8	25.7	28.6
L VI	L 1	A	SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	9	8	64	64	26	26	26	26	26	26	21	1.42	1.52	2.68	2.71	29.6	23.4	28.2	27.2	28.0	27.2	27.4	26.8	
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	10	8	63	64	26	26	26	26	26	26	21	1.46	1.56	2.68	2.71	29.6	23.4	28.2	27.2	28.0	27.2	27.4	26.8
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	10	8	66	64	13	28	28	28	28	28	21	1.41	1.46	2.66	2.71	29.4	29.1	28.7	28.3	28.4	27.7	28.0	28.2
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	10	8	66	64	13	28	28	28	28	28	21	1.41	1.46	2.66	2.71	29.4	29.1	28.7	28.3	28.4	27.7	28.0	28.2
M VI	M 2	A	SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	12	10	74	68	14	22	22	22	22	22	14	1.44	1.44	2.66	2.69	29.5	30.6	28.4	29.0	27.9	28.5	27.7	28.0	
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	11	11	73	77	10	13	13	13	13	13	14	1.46	1.44	2.66	2.66	28.4	29.6	27.2	28.3	26.7	27.4	26.4	26.8
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	11	9	72	77	10	13	13	13	13	13	14	1.39	1.36	2.66	2.66	28.4	29.6	27.2	28.3	26.7	27.4	26.4	26.8
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	9	9	72	77	10	13	13	13	13	13	14	1.39	1.36	2.66	2.66	28.4	29.6	27.2	28.3	26.7	27.4	26.4	26.8
M VI	M 3	A	SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	11	10	74	68	15	19	19	19	19	19	9	1.42	1.44	2.67	2.69	32.2	30.2	31.0	29.0	30.4	28.5	29.6	27.7	
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	12	9	76	68	12	23	23	23	23	23	17	1.40	1.44	2.65	2.70	31.6	30.2	30.8	29.2	30.2	28.8	29.2	28.1
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	12	9	76	70	12	23	23	23	23	23	17	1.42	1.44	2.65	2.70	31.6	30.2	30.8	29.2	30.2	28.8	29.2	28.1
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	11	11	72	67	17	21	21	21	21	21	20	1.42	1.44	2.65	2.71	31.3	31.1	30.2	30.1	29.5	29.6	29.1	35.0
M VI	M 4	A	SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	12	8	64	64	26	26	26	26	26	26	21	1.48	1.53	2.69	2.71	28.0	27.8	27.4	26.8	27.0	26.8	26.7	26.4	
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	12	8	64	64	26	26	26	26	26	26	21	1.48	1.53	2.69	2.71	28.0	27.8	27.4	26.8	27.0	26.8	26.7	26.4
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	12	8	64	64	26	26	26	26	26	26	21	1.48	1.53	2.69	2.71	28.0	27.8	27.4	26.8	27.0	26.8	26.7	26.4
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	12	8	64	64	26	26	26	26	26	26	21	1.48	1.53	2.69	2.71	28.0	27.8	27.4	26.8	27.0	26.8	26.7	26.4
M VI	M 5	A	SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	10	9	70	72	20	19	19	19	19	19	15	1.48	1.52	2.68	2.68	28.8	28.0	27.7	27.2	27.3	27.0	27.3	26.8	
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	10	9	70	72	20	19	19	19	19	19	15	1.48	1.52	2.68	2.68	28.8	28.0	27.7	27.2	27.3	27.0	27.3	26.8
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	10	9	70	72	20	19	19	19	19	19	15	1.48	1.52	2.68	2.68	28.8	28.0	27.7	27.2	27.3	27.0	27.3	26.8
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	10	9	70	72	20	19	19	19	19	19	15	1.48	1.52	2.68	2.68	28.8	28.0	27.7	27.2	27.3	27.0	27.3	26.8
L 1	L 2	A	SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	12	8	72	61	16	31	31	31	31	31	30	1.51	1.53	2.65	2.71	31.0	28.8	29.4	27.0	29.1	26.6	28.8	26.6	
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	12	8	69	62	20	30	30	30	30	30	30	1.44	1.56	2.68	2.70	32.2	27.0	31.3	26.0	30.3	25.9	30.1	25.8
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	12	8	69	62	20	30	30	30	30	30	30	1.44	1.56	2.68	2.70	32.2	27.0	31.3	26.0	30.3	25.9	30.1	25.8
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	12	8	69	62	20	30	30	30	30	30	30	1.44	1.56	2.68	2.70	32.2	27.0	31.3	26.0	30.3	25.9	30.1	25.8
M VI	M 6	A	SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	12	10	80	70	8	20	20	20	20	20	17	1.34	1.52	2.64	2.69	35.7	28.1	33.6	26.9	33.0	26.5	32.6	26.1	
			SIL	SIL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	14	8	77	62	9	30	30	30	30	30	23	1.45	1.54	2.64	2.71								

Table A2 (Continued)

[illegible]

(continued)

04 - Reflected:

(4 of 10 sheets)

Table 12 (Continued)

Site	Plot	Row	Position	Grain-Size Analysis, %										Atterberg Limits										Dry Density		Specific Gravity		Saturation		0.015-ata Tension		0.06-ata Tension	
				USDA					UNES					PI					G-12					G-12		G-12		G-12		G-12		G-12	
				Sand	Silt	Clay	Plasticity	Shrinkage	Sand	Silt	Clay	Plasticity	Shrinkage	PI	LL	PL	Sh	G-12	G-12	G-12	G-12	G-12	G-12	G-12	G-12	G-12	G-12	G-12	G-12	G-12	G-12	G-12	G-12
L III	15	3	A	SIL	SIL	ML	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
				11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
				75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	
				11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
		4	B	A	SIL	SIL	ML	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
					11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
					75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
					11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
		5	C	B	SIL	SIL	ML	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
					11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
					75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
					11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
L VI	16	3	A	SIL	SIL	ML	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	
				11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
				75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	
				11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
		4	B	A	SIL	SIL	ML	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
					11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
					75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
					11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
		5	C	B	SIL	SIL	ML	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
					11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
					75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
					11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39

(Continued)

.. Estimated.

(5 of 10 sheets)

Table A2 (Cont'd)

Post- tion	Plot	Site	Core	Class-ification				Grain-Size Analysis, %				Atterberg Limits				Dry Density g/cc	Specific Gravity G-6	Soil Moisture, %											
				USDA		USCS		Sand		Silt		Clay		Liquid				Plastic		Liquid		Plastic							
				0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12			0-6	6-12	0-6	6-12	0-6	6-12						
C 11	1	C1	A	SIL	SIL	ML	ML	11	8	80	81	9	11	99.6	99.8	34	28	12	7	1.44	1.38	2.6	2.67	29.6	31.2	23.5	30.5	28.9	29.4
			B	SIL	SIL	ML	ML	11	7	79	81	10	11	99.6	99.8	34	28	12	4	1.44	1.38	2.6	2.67	30.0	31.2	26.5	30.0	28.2	29.2
			C	SIL	SIL	ML	ML	11	9	81	80	10	11	99.6	99.8	34	28	12	6	1.44	1.44	2.6	2.67	29.0	30.8	29.0	30.0	28.1	28.6
			D	SIL	SIL	ML	ML	11	9	81	81	10	11	99.8	99.8	34	25	27	7	1.43	1.43	2.6	2.67	30.1	31.2	23.2	30.2	28.2	29.0
	2	C2	A	SIL	SIL	ML	ML	12	12	80	78	9	10	99.0	99.6	38	32	20	6	1.42	1.42	2.66	2.67	31.6	32.7	25.2	29.8	31.1	30.2
			B	SIL	SIL	ML	ML	11	13	80	77	10	10	99.2	99.6	37	34	20	6	1.43	1.43	2.66	2.67	32.2	33.5	26.9	30.2	30.2	29.2
			C	SIL	SIL	ML	ML	13	12	77	78	10	10	99.2	99.6	37	34	20	9	1.43	1.43	2.67	2.68	31.0	32.2	26.9	30.0	28.7	29.0
			D	SIL	SIL	ML	ML	13	13	78	77	10	10	99.2	99.6	35	30	24	5	1.33	1.40	2.65	2.67	31.3	31.3	30.1	30.1	28.1	29.4
	3	C3	A	SIL	SIL	ML	ML	15	15	76	75	9	10	98.0	97.2	34	28	20	7	1.33	1.40	2.64	2.67	31.2	31.2	31.1	30.2	29.0	29.0
			B	SIL	SIL	ML	ML	15	15	76	75	10	10	97.8	97.0	34	28	21	7	1.40	1.48	2.66	2.67	31.2	31.2	31.1	30.2	29.0	29.0
			C	SIL	SIL	ML	ML	15	17	76	75	9	8	98.8	97.2	34	29	22	8	1.34	1.43	2.65	2.67	31.2	31.2	31.1	30.2	29.0	29.0
			D	SIL	SIL	ML	ML	15	15	77	75	8	10	97.4	96.4	32	20	26	5	1.33	1.42	2.65	2.66	31.0	31.0	30.0	29.4	28.1	28.6
4	C4	A	SIL	SIL	ML	ML	20	24	72	68	8	8	94.4	89.6	34	29	27	6	1.37	1.40	2.66	2.67	31.1	31.1	26.9	29.3	31.3	29.0	
		B	SIL	SIL	ML	ML	25	25	68	66	6	10	84.8	84.8	31	24	25	4	1.46	1.46	2.65	2.66	31.1	31.1	26.9	29.0	30.0	29.0	
		C	SIL	SIL	ML	ML	25	20	67	70	8	10	83.8	84.0	31	29	26	3	1.43	1.43	2.65	2.66	31.0	30.9	26.7	29.0	29.0	29.0	
		D	SIL	SIL	ML	ML	25	20	67	71	8	9	98.0	93.6	29	30	26	3	1.34	1.44	2.65	2.66	31.3	30.4	26.2	29.3	31.0	30.9	
5	C5	A	SIL	SIL	ML	ML	15	19	77	71	8	10	94.0	93.6	29	27	28	2	1.40	1.42	2.66	2.67	31.2	31.2	26.8	29.4	29.6	28.1	
		B	SIL	SIL	ML	ML	10	20	70	69	10	11	94.4	94.2	13	29	29	6	1.30	1.43	2.66	2.67	31.0	31.0	26.9	29.8	29.8	29.4	
		C	SIL	SIL	ML	ML	20	20	73	70	9	10	94.4	94.2	14	29	29	5	1.41	1.43	2.65	2.67	31.3	31.3	26.8	29.4	29.4	29.4	
		D	SIL	SIL	ML	ML	23	20	69	70	8	10	94.6	92.4	35	30	27	8	1.34	1.44	2.65	2.66	31.5	31.7	26.7	29.4	29.4	29.4	
2	C2	A	SIL	SIL	ML	ML	14	16	76	74	10	10	99.0	99.4	34	31	27	7	1.47	1.42	2.67	2.67	30.0	31.2	28.1	31.0	28.1	28.1	
		B	SIL	SIL	ML	ML	15	15	75	74	10	11	99.6	99.2	32	32	26	6	1.44	1.42	2.67	2.67	31.4	31.8	31.6	31.4	31.1	30.2	
		C	SIL	SIL	ML	ML	15	15	75	75	10	10	99.6	99.2	33	31	26	7	1.43	1.46	2.67	2.67	30.3	30.4	30.2	30.2	29.8	29.5	
		D	SIL	SIL	ML	ML	15	15	75	75	10	10	99.6	99.2	33	31	26	7	1.45	1.43	2.67	2.67	30.3	30.8	29.0	29.8	30.2	29.3	
3	C3	A	SIL	SIL	ML	ML	15	15	76	75	9	10	99.6	99.6	33	33	28	5	1.46	1.46	2.67	2.67	31.3	32.0	30.2	29.7	29.8	29.0	
		B	SIL	SIL	ML	ML	17	16	74	75	9	9	99.6	99.4	31	31	26	5	1.48	1.44	2.67	2.67	31.8	31.4	29.1	28.8	29.6	28.8	
		C	SIL	SIL	ML	ML	16	16	75	75	9	9	99.6	99.4	31	31	24	9	1.46	1.46	2.67	2.67	31.8	31.4	29.1	29.6	29.2	28.7	
		D	SIL	SIL	ML	ML	16	15	75	75	9	10	99.4	99.6	33	31	27	6	1.45	1.44	2.67	2.67	31.5	32.0	29.8	30.4	29.4	29.6	
4	C4	A	SIL	SIL	ML	ML	15	15	75	76	10	9	99.6	99.8	35	33	28	7	1.44	1.44	2.67	2.67	32.2	32.3	30.4	30.6	28.7	29.5	
		B	SIL	SIL	ML	ML	15	15	77	76	9	9	99.6	99.8	33	31	27	6	1.48	1.44	2.67	2.67	30.5	32.2	29.0	28.7	29.3	29.4	
		C	SIL	SIL	ML	ML	15	15	75	75	10	10	99.6	99.6	34	32	27	6	1.46	1.44	2.67	2.67	31.0	31.4	29.2	29.7	29.6	28.7	
		D	SIL	SIL	ML	ML	16	15	75	76	9	9	99.6	99.6	32	31	26	7	1.46	1.45	2.67	2.67	31.0	30.8	29.0	29.2	28.8	28.4	
1	C1	A	SIL	SIL	ML	ML	12	14	75	72	13	14	99.2	98.4	35	31	26	9	1.33	1.40	2.66	2.67**	31.7	30.6	31.0	29.8	28.2	29.1	
		B	SIL	SIL	ML	ML	12	14	75	75	13	13	99.6	99.6	36	33	27	9	1.32	1.44	2.67	2.66	31.3	30.1	29.8	29.0	28.0	28.1	
		C	SIL	SIL	ML	ML	12	12	76	76	12	12	99.4	99.8	36	32	27	9	1.35	1.42	2.67	2.67	31.3	31.2	28.6	30.3	28.8	29.9	
		D	SIL	SIL	ML	ML	11	11	75	75	14	14	99.8	99.8	36	33	27	9	1.27	1.44	2.66	2.67	30.1	29.6	29.0	29.7	28.1	28.6	
3	C3	A	SIL	SIL	ML	ML	12	12	77	75	11	13	99.4	99.4	31	31	24	8	1.34	1.44	2.67	2.66	31.6	30.6	30.0	29.4	28.2	29.2	
		B	SIL	SIL	ML	ML	12	12	76	74	12	14	99.4	99.4	35	32	27	8	1.39	1.45	2.66	2.66	31.6	30.9	29.6	28.6	28.0	28.2	
		C	SIL	SIL	ML	ML	12	12	74	76	14	12	99.4	99.4	36	31	26	10	1.31	1.44	2.67	2.66	31.4	31.7	29.9	29.2	29.4	28.1	
		D	SIL	SIL	ML	ML	12	12	76	76	12	12	99.2	99.4	33	31	26	7	1.43	1.43	2.67	2.66	29.7	31.2	29.1	30.1	28.6	29.5	

(Continued)

Estimated,

(6 of 20 sheets)

Table A2 (Continued)

Site	Date	Pit-	Grain-size Analysis, %		Moisture, %	Atterberg Limits, %		Dry Density, g/cc	Specific Gravity, 2.65	Liquid Limit, %	Plastic Limit, %	Shrinkage, %	0.075-mm, %	0.002-mm, %									
			Clay, %	Silt, %		W _L	W _P																
F VI	71	A	81L	81L	99.0	99.6	33	28	27	7	1.46	1.46	2.63	2.62	28.4	30.6	27.8	29.3	26.0	28.2	26.7	27.9	
		B	81L	81L	99.0	99.6	33	28	26	24	7	1.46	1.46	2.63	2.62	29.6	30.5	28.6	29.4	27.5	28.3	27.2	27.8
		C	81L	81L	99.0	99.6	31	31	27	27	4	1.46	1.46	2.63	2.66	30.2	30.2	29.2	28.9	28.0	27.8	27.5	27.5
		D	81L	81L	99.0	99.6	31	31	27	27	2	1.46	1.46	2.63	2.66	28.1	29.9	27.0	28.9	28.0	27.8	27.5	27.5
	72	A	81L	81L	99.2	99.8	33	31	25	26	8	1.39	1.40	2.63	2.62	30.9	31.4	28.4	30.8	29.4	29.2	29.2	28.6
		B	81L	81L	99.2	99.8	33	31	25	26	7	1.39	1.40	2.63	2.62	28.7	29.4	28.4	30.8	29.4	29.2	29.2	28.6
		C	81L	81L	99.2	99.8	33	31	25	26	10	1.39	1.40	2.63	2.62	28.7	29.4	28.4	30.8	29.4	29.2	29.2	28.6
		D	81L	81L	99.2	99.8	31	31	27	26	5	1.45	1.48	2.63	2.65	29.2	29.2	28.3	28.4	26.7	27.3	27.1	26.8
	73	A	81L	81L	99.0	99.8	35	29	26	24	5	1.40	1.50	2.64	2.65	30.9	29.0	28.3	28.4	26.7	27.3	27.1	27.2
		B	81L	81L	99.0	99.8	35	29	26	24	5	1.39	1.48	2.64	2.66	30.2	29.3	28.3	28.4	26.7	27.3	27.1	27.2
		C	81L	81L	99.0	99.8	34	28	26	26	5	1.39	1.48	2.64	2.66	31.2	29.3	28.3	28.4	26.7	27.3	27.1	27.2
		D	81L	81L	99.0	99.8	34	31	27	25	7	1.36	1.46	2.64	2.66	28.7	29.8	27.7	29.2	28.3	28.3	28.1	28.2
74	A	81L	81L	99.4	99.6	34	31	26	26	8	1.37	1.50	2.63	2.65	33.2	27.8	28.4	27.3	27.3	27.3	30.9	29.9	
	B	81L	81L	99.4	99.6	34	31	26	26	7	1.37	1.46	2.63	2.66	32.6	29.5	27.5	28.3	27.3	27.3	30.9	29.9	
	C	81L	81L	99.4	99.6	33	32	25	25	6	1.40	1.48	2.64	2.66	31.1	28.0	28.3	28.4	26.9	27.8	28.9	27.1	
	D	81L	81L	99.4	99.6	33	32	25	25	7	1.43	1.48	2.64	2.66	30.4	28.5	29.6	28.0	26.9	27.5	28.9	27.0	
75	A	81L	81L	99.4	99.4	34	33	25	24	9	1.40	1.46	2.63	2.65	30.4	29.5	29.7	28.0	29.1	28.4	28.4	28.3	
	B	81L	81L	99.4	99.4	34	33	26	25	8	1.37	1.39	2.64	2.66	30.1	31.4	27.2	30.7	26.3	30.1	35.0	29.1	
	C	81L	81L	99.4	99.4	34	33	26	26	10	1.37	1.50	2.64	2.66	30.3	31.4	27.2	30.7	26.9	28.3	28.3	28.0	
	D	81L	81L	99.4	99.4	33	33	28	25	8	1.42	1.47	2.64	2.66	30.5	28.0	29.5	27.8	28.7	27.2	28.3	28.1	
G VI	76	A	81L	81L	99.2	99.8	37	36	25	23	12	1.42	1.40	2.66	2.69	31.4	30.9	30.1	31.8	29.8	31.2	29.7	30.9
		B	81L	81L	99.2	99.8	36	34	25	24	11	1.40	1.44	2.66	2.67	32.7	31.0	31.2	29.6	31.0	29.1	30.9	28.7
		C	81L	81L	99.2	99.8	36	34	25	24	11	1.40	1.44	2.66	2.67	32.1	32.1	31.1	30.5	30.7	29.5	30.7	28.9
		D	81L	81L	99.2	100.0	36	33	27	24	9	1.42	1.48	2.66	2.68	31.4	30.3	30.4	29.0	29.9	28.3	29.8	28.1
	77	A	81L	81L	98.6	99.8	36	34	27	24	9	1.45	1.47	2.66	2.69	30.0	29.9	29.1	28.9	28.8	28.4	28.8	28.3
		B	81L	81L	99.0	99.6	37	34	27	23	10	1.39	1.46	2.66	2.68	33.0	31.7	31.2	29.9	30.4	29.0	30.8	28.8
		C	81L	81L	99.2	100.0	34	34	28	23	6	1.41	1.46	2.66	2.69	29.5	29.2	28.3	28.1	28.2	27.7	28.5	27.5
		D	81L	81L	98.2	99.8	39	33	30	24	9	1.42	1.48	2.66	2.68	30.7	29.5	29.6	28.1	29.4	27.6	28.5	27.4
	78	A	81L	81L	98.0	99.4	37	33	26	23	11	1.44	1.44	2.66	2.69	30.7	31.8	29.7	29.6	29.5	28.5	29.2	28.0
		B	81L	81L	97.8	99.6	34	34	25	25	9	1.42	1.48	2.66	2.67	31.7	30.6	30.5	29.0	30.0	28.3	30.0	28.5
		C	81L	81L	97.6	99.6	34	34	27	24	8	1.42	1.42	2.66	2.68	33.9	33.2	30.4	31.3	29.7	30.0	29.7	29.9
		D	81L	81L	99.2	99.4	37	35	26	26	11	1.37	1.44	2.66	2.68	33.4	30.6	32.0	29.3	31.6	28.3	31.5	28.2
79	A	81L	81L	97.8	99.6	37	33	26	25	11	1.48	1.47	2.66	2.69	29.0	30.9	29.4	28.9	27.4	28.1	27.6	27.8	
	B	81L	81L	90.8	99.4	35	25	24	10	8	1.46	1.50	2.66	2.69	29.6	29.6	27.9	27.9	27.4	27.4	27.6	27.1	
	C	81L	81L	99.6	99.6	34	34	28	24	10	8	1.46	1.50	2.66	2.69	30.0	31.1	27.7	29.1	27.4	28.2	27.2	
	D	81L	81L	86.8	99.4	34	34	26	25	8	1.47	1.49	2.66	2.69	30.0	31.1	27.7	29.1	27.4	28.2	27.2	27.9	

(Continued)

Estimated.

(7 of 20 sheets)

Table A2 (Continued)

Site	Plot	Row	Position	Grain-Size Analysis, %										Soil Moisture, % at															
				USDA					USCS					Dry					0.03-water					Saturation					
				0-6	6-12	12-18	18-24	24-30	0-6	6-12	12-18	18-24	24-30	0-6	6-12	12-18	18-24	24-30	0-6	6-12	12-18	18-24	24-30	0-6	6-12	12-18	18-24	24-30	
C IV F3	1	A	SIL	8	8	80	72	12	20	99.6	99.0	36	43	27	25	9	18	1.45	1.44	2.65	2.67	30.8	30.6	29.8	30.3	30.1	28.8	29.7	
			SIL	7	7	80	77	13	16	99.6	99.4	40	43	29	25	11	18	1.42	1.43	2.65	2.67	31.7	31.4	31.0	30.6	30.2	29.2	30.2	
			SIL	8	7	79	74	13	19	99.0	99.0	37	44	28	26	9	14	1.44	1.42	2.65	2.68	30.8	30.2	29.7	31.2	31.2	29.2	30.7	
			SIL	8	6	80	77	12	17	99.2	99.0	36	40	28	26	9	14	1.38	1.40	2.65	2.68	33.3	32.9	32.4	32.1	31.3	31.7	30.7	
	2	A	SIL	8	9	81	77	11	14	99.4	99.8	36	33	26	23	10	10	1.40	1.42	2.65	2.67	32.7	32.5	32.1	31.4	31.6	30.7	31.2	32.1
			SIL	8	7	81	76	11	12	99.4	99.6	34	34	27	22	9	8	1.38	1.40	2.65	2.67	32.7	32.5	32.0	31.3	31.5	30.8	31.0	29.2
			SIL	8	7	81	76	11	12	99.4	99.6	34	34	27	22	9	8	1.38	1.40	2.65	2.67	32.7	32.5	32.0	31.3	31.5	30.8	31.0	29.2
			SIL	8	6	81	76	11	12	99.4	99.4	37	36	28	24	9	12	1.42	1.46	2.65	2.68	30.1	30.1	31.7	31.3	31.3	29.2	30.9	28.7
	3	A	SIL	9	7	80	79	11	14	99.8	99.8	33	33	28	25	5	8	1.42	1.46	2.65	2.67	32.1	32.1	30.8	30.3	30.5	28.9	30.0	28.5
			SIL	5	10	77	76	12	13	99.8	99.8	35	32	26	24	8	8	1.39	1.45	2.66	2.67	32.6	32.6	31.8	31.7	31.7	29.0	31.1	29.0
			SIL	9	9	81	78	11	13	99.6	99.8	32	33	27	26	8	7	1.44	1.46	2.65	2.67	31.4	30.9	30.1	30.7	29.0	29.3	28.7	28.5
			SIL	10	9	79	79	11	12	99.8	99.8	36	31	28	26	8	5	1.42	1.44	2.65	2.67	31.4	30.7	30.7	30.2	29.5	29.8	29.5	29.5
4	A	SIL	9	9	79	77	12	14	99.8	99.8	35	32	26	22	9	7	1.41	1.48	2.65	2.67	33.1	32.8	31.7	31.2	31.2	28.2	30.6	27.7	
		SIL	9	10	78	76	13	14	99.6	99.8	32	33	27	26	8	7	1.42	1.44	2.65	2.67	31.6	31.6	30.7	30.2	29.7	29.7	29.1	28.1	
		SIL	10	6	79	76	11	15	99.4	99.6	35	38	27	25	8	11	1.44	1.46	2.65	2.67	31.3	29.5	30.3	31.7	30.8	29.9	28.7	29.3	
		SIL	8	7	79	75	13	18	99.8	99.4	32	34	24	23	10	9	1.42	1.48	2.66	2.68	31.5	30.5	31.7	30.0	31.1	29.5	30.6	27.2	
5	A	SIL	10	10	77	73	13	17	99.4	99.4	32	33	25	23	7	10	1.46	1.49	2.66	2.67	29.2	28.6	28.2	27.6	27.8	27.5	27.4	27.2	
		SIL	9	10	78	76	13	16	99.0	99.4	34	35	24	23	10	12	1.40	1.49	2.66	2.67	29.3	28.8	28.3	27.3	27.5	27.1	27.1	27.2	
		SIL	9	11	77	72	14	17	99.0	99.0	33	34	26	23	7	11	1.46	1.49	2.66	2.67	29.3	28.3	28.5	28.5	29.2	29.3	27.7	27.2	
		SIL	8	8	78	75	14	15	98.6	99.8	41	37	28	25	13	12	1.38	1.48	2.65	2.66	32.1	32.2	31.5	31.4	31.4	31.1	30.8	30.3	
1	B	SIL	12	9	77	75	14	10	98.6	99.8	41	37	28	25	13	11	1.34	1.39	2.65	2.66	34.0	34.0	33.2	33.2	33.2	31.9	32.0	30.8	
		SIL	12	13	80	76	10	12	98.2	98.2	42	33	30	26	12	7	1.34	1.37	2.65	2.66	34.0	33.5	33.7	33.4	33.5	31.9	31.0	29.1	
		SIL	11	12	80	76	9	12	98.8	99.4	37	34	31	28	6	6	1.38	1.43	2.65	2.66	34.6	34.6	34.0	33.7	33.7	32.1	32.8	29.1	
		SIL	12	12	76	76	13	13	96.0	98.8	44	34	30	24	13	11	1.38	1.46	2.65	2.66	32.2	32.2	32.0	31.9	32.0	31.0	31.0	27.6	
2	B	SIL	12	13	76	76	13	13	96.0	98.8	44	34	30	24	13	11	1.38	1.46	2.65	2.66	32.2	32.2	32.0	31.9	32.0	31.0	31.0	27.6	
		SIL	12	11	75	76	13	13	96.0	98.8	44	34	30	24	13	11	1.38	1.46	2.65	2.66	32.2	32.2	32.0	31.9	32.0	31.0	31.0	27.6	
		SIL	10	10	78	76	13	16	99.0	99.0	33	34	26	23	10	9	1.46	1.49	2.66	2.67	29.3	28.3	28.5	28.5	29.2	29.3	27.7	27.2	
		SIL	12	13	78	74	10	12	98.2	98.2	42	33	30	26	12	7	1.34	1.37	2.65	2.66	34.0	33.5	33.7	33.4	33.5	31.9	31.0	29.1	
3	B	SIL	11	12	80	76	9	12	98.8	99.4	37	34	31	28	6	6	1.38	1.43	2.65	2.66	34.6	34.6	34.0	33.7	33.7	32.1	32.8	29.1	
		SIL	12	10	76	76	13	13	96.0	98.8	44	34	30	24	13	11	1.38	1.46	2.65	2.66	32.2	32.2	32.0	31.9	32.0	31.0	31.0	27.6	
		SIL	16	17	69	69	26	14	92.6	98.8	42	31	26	23	10	6	1.36	1.48	2.67	2.68	34.2	34.2	33.7	33.4	33.4	31.9	31.9	27.6	
		SIL	12	15	68	72	20	13	94.6	94.2	44	32	30	24	11	8	1.40	1.49	2.66	2.67	32.2	32.2	31.7	31.7	31.7	30.4	31.2	27.7	
4	A	SIL	13	17	68	66	19	17	94.0	91.8	51	30	24	24	14	6	1.36	1.52	2.67	2.68	32.0	27.0	33.4	32.4	32.4	31.0	31.0	26.1	
		SIL	13	16	66	70	19	15	93.4	90.8	49	31	30	24	13	6	1.32	1.42	2.67	2.68	32.1	27.0	33.4	32.4	32.4	31.0	31.0	26.1	
		SIL	25	21	63	67	12	14	77.4	88.8	35	29	25	24	10	5	1.44	1.48	2.67	2.68	30.0	28.5	29.6	28.8	28.8	28.8	28.8	25.9	
		SIL	19	17	63	69	11	14	90.6	98.8	34	32	24	22	10	10	1.37	1.50	2.67	2.68	33.0	27.1	32.6	27.2	27.2	27.2	27.2	26.2	
1	B	SIL	9	9	78	80	13	11	99.4	99.8	37	35	24	25	13	7	1.39	1.44	2.66	2.67	33.7	32.3	33.0	31.8	31.8	30.3	31.6	30.5	
		SIL	8	8	80	78	12	13	99.2	99.8	38	36	25	24	12	10	1.40	1.46	2.66	2.67	33.6	31.6	33.0	31.6	31.6	31.6	31.6	30.5	
		SIL	8	7	79	80	13	13	99.8	100.0	35	35	25	24	12	9	1.44	1.46	2.66	2.67	31.4	31.8	30.8	31.6	31.6	29.7	29.7	29.4	
		SIL	9	8	79	79	13	14	99.6	99.8	39	34	27	26	12	8	1.42	1.49	2.66	2.67	32.5	30.2	31.6	29.5	30.1	28.5	30.3	28.1	

Table A2 (Continued)

Site	Plot	No.	Post- t-0	Classification				Grain-Size Analysis, %				Atterberg Limits				Dry Density g/cc	Specific Gravity	Soil Moisture, % at																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
				USCS				Sand				Liquid Limit						Plastic Limit																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
				0-6	6-12	12-18	18-24	0-6	6-12	12-18	18-24	0-6	6-12	12-18	18-24			0-6	6-12	12-18	18-24																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
CV	P5	2	A	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	81L	

Soil Series

** Estimated.

Table A2 (Continued)

Table A2 (Continued)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
Post- ion	Row	Site	Plot	Grain Size Analysis, %										Atterberg Limits				Dry Density				Specific Gravity				Saturation				Soil Moisture, % at				Tension				Temperature																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
				USDA					ASTM					Liquid	Plastic	Shrinkage	Dry	Density	Specific Gravity	Saturation	Soil Moisture		Soil Moisture		Saturation		Tension		Tension		Temperature		Temperature																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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13. ABSTRACT This study was to determine if the average of soil strength values obtained in a small area can be reliably applied to larger areas. Values of properties used in predicting soil strength and classifying soils were compared for areas differing in size. Six test sites in each of four loessial soil series were established, using series boundaries on soil survey maps to locate the sites. The series were Memphis and Loring in the uplands and Collins and Palaya in the bottomlands. Each site had five sampling rows; each row had four sampling positions. Plots of pedologically distinct soil series were identified from field examination within sites and were used as an additional subdivision of test areas. Soil strength and moisture content data were collected on four visits, other physical property data on one visit. The four series could not be distinguished by soil strength because the cone indexes (CI's) varied widely for any one series and the range of CI for each series was about the same. Soils of the 6- to 12-in. layer of the uplands differed from those of the bottomlands in clay content and plasticity, but not in strength. The poorly drained Henry series and alluvial-fill soils of the uplands, as identified in the field, had the lowest CI's. Certain plots exhibited consistently different CI's for each visit than did other plots in the same series, and certain rows in the same plot showed consistently different CI's. These differences could not be explained satisfactorily in terms of soil series, or soil properties commonly used in the Unified Soil Classification System and the U. S. Department of Agriculture textural classification. Limited data suggest that in future studies a terrain geometry classification system would be useful for identifying areas considered uniform in soil type but variable in strength by indicating areas of differential erosion or deposition. Also, the effect of soil factors such as organic matter content, structure, and natural cementing agents should be determined. In a row of relatively uniform soil, five samplings for moisture content and static physical properties and ten for soil strength should be made to provide acceptable mean values for trafficability use. Appendix A includes basic data for each site.		

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Trafficability						
Variation						

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