EVALUATION OF PRE-TAXONOMY SOIL SURVEYS

by

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INTRODUCTION

There are 17 pre-taxonomy (i.e., correlated according to the 1938 system of soil classification) soil surveys in Virginia that provide useful soils information, but were completed before our current soil classification system was adopted. A functional system for evaluating these pre-taxonomy soil surveys could save a substantial amount of time and money.

Southwestern Virginia's coal resources will be relied upon heavily to meet fossil fuel demands. Since reclamation efforts must comply with laws written to take into account soils information, it is paramount that this information be made available as soon as possible. At the current rate of mapping progress, southwestern Virginia will not likely be remapped until the 1990's, thus delaying availability of useful soils information.

Nationwide, there are as many pre-taxonomy soil surveys as there are current soil surveys. Therefore, a system to update pre-taxonomy soil surveys would not only benefit Virginia, but also be advantageous for other states.

Early soil surveys were made using most of the fundamental concepts used to map soils today. Landscape position, parent material, and other features were closely observed and formed the basis for placement of soil boundaries. The definition of an individual soil has changed, however, as a result of new concepts in _Soil Taxonomy_ (Soil Survey Staff, 1975a). A name given to a soil in the past does not represent the same concept of that soil today, but rather may encompass several soils.

The purpose of this research was to develop a cost-efficient methodology to evaluate pre-taxonomy soil surveys. Bland County, Virginia, was chosen as a representative county to implement this research. The principal objectives of this research were (1) to determine if a random selection of delineated areas represented "soil landscape units", as defined by Schelling (1970), that could serve as a basis for the evaluation of accurate soil boundary placement, (2) to determine the accuracy of soil boundary placement based on those "soil landscape units", and (3) to evaluate the composition of those delineations.

LITERATURE REVIEW

Since 1899, the U. S. Department of Agriculture in cooperation with state agricultural experiment stations and other federal and state agencies has been making and publishing soil surveys (Soil Conservation Service Staff, 1980). Simonson (1952) stated that the chief purpose of the soil mapping program was to determine the nature, distribution and extent of different soils. Because of the need and demand for soils information, the Virginia Commission of the Industry of Agriculture (1969) stated it was essential that soil survey work receive high priority. Even though a significant percentage of the nation has been surveyed, there are numerous soil surveys that do not conform to current standards yet have very useful soils information. An accurate and rapid system for evaluating these surveys with a minimum of human resources involved is urgently needed. Evaluation with respect to a soil survey poses the following questions: 1) are the soil boundaries drawn to delineate "soil landscape units", and 2) what are the soils contained within those delineations?

Of the 100 cities and counties in the state of Virginia, there are presently 72 soil surveys that are published, awaiting publication with mapping completed or that are in progress of soil mapping (USDA, SCS, 1982). Seventeen of these surveys do not meet current standards and are considered pre-taxonomy, and 12 of these surveys contain soil maps not printed on a photomosaic base. Out of approximately 3,000 published soil surveys in the United States, approximately 50% of those surveys do not meet current standards (Soil Conservation Service Staff, 1980). Although in excess of 50% of the United States has been surveyed, a significant portion needs to be updated. Current soil surveys contain many new kinds of interpretations for a given soil not included in older soil surveys. Older soil surveys were primarily agriculturally oriented with respect to interpretations of soil properties. As knowledge of soils increased, knowledge of potential uses increased, and therefore the different kinds of interpretations about each soil mapped in an area increased. When the eight Tennessee Valley Authority counties in southwest Virginia were mapped between 1935 and 1940, no ratings or thoughts were given for non-agricultural uses (Lietzke and Porter, 1978). Not only are our current soil survey maps printed on a photomosaic base, but more detail is provided by use of a larger mapping scale than in the past. Although the kinds of interpretations included in a current soil survey vary with the specific needs of the area, the following interpretations are usually included: (a) estimated yields of common agricultural crops under specified levels of management, (b) land capability interpretations, (c) soil-woodland uses, (d) rangeland uses, (e) engineering uses, and (f) interpretations for community planning, suitability of soil for drainage and irrigation, and suitability of the soil for wildlife and recreation (Soil Conservation Service Staff, 1980).

Another substantial difference between pre-taxonomy and recent soil surveys is the contrast in classification systems. The 1938 system of soil classification was first published in the Yearbook of Agriculture (USDA,1938) and expounded the concept of zonal, intrazonal, and azonal soils. After a 1951 revision of this classification, some seven approximations followed until the publication in 1975 of Soil Taxonomy (Soil Survey Staff, 1975a). Soil Taxonomy (Soil Survey Staff, 1975a) represents a major change in the concept of a pedological class. In previous systems, the limits of the taxon were not defined so that inclusions in mapping units were subject to personal judgments. Soil Taxonomy (Soil Survey Staff, 1975a) defines class limits in quantitative terms, thereby focusing attention on the boundaries of taxa. As a result, the landscape in the field has been subdivided along well defined lines which may not coincide with mappable boundaries (Cline, 1977).

With soils becoming more narrowly defined, the purity of a mapping unit was adversely affected. Various workers studying the purity of mapping units found greater than 15% inclusions (McCormack and Wilding, 1969; Powell and Springer, 1965; Wilding et al., 1965). Chapter 5 of the revised Soil Survey Manual (Soil Survey Staff, 1979) defines a map unit as a collection of areas defined in terms of their soils or miscellaneous areas, or both, while each individual area on the map is a delineation. Even though it is highly unlikely that a mapping unit will be completely free of inclusions, the objective is to define map units that will contain as few inclusions as possible of soils that behave differently from the named soil. Soil Taxonomy (Soil Survey Staff, 1975a) defines permissable inclusions in a map unit in respect to similar and dissimilar soils. Chapter 5 of the revised Soil Survey Manual (Soil Survey Staff, 1979) defines similar soils as soils that are alike in most properties, and the differences do not significantly affect major interpretations. Dissimilar soils differ appreciably in one or more properties, and the differences are great enough to affect major interpretations. Dissimilar soils are of two kinds, namely limiting and nonlimiting. Inclusions that have less severe restrictions on use than the dominant soil of a map unit and do not adversely affect predictions about the map unit as a whole are considered nonlimiting. If the inclusion has significantly lower potential for use than the dominant soil in the map unit or the inclusion adversely affects the management of the unit, the soil inclusion is considered limiting. Four different kinds of map units are used, namely a consociation which is dominated by a single kind of soil, a complex which consists of two or more dissimilar soils occurring in a regular repeating pattern but cannot be mapped separately at the scale used to map the area, an association which has a pattern of occurrence and is defined very much like a complex but its components can be separated at the scale used to map the area, and an undifferentiated map unit which consists of two or more soils that are not consistently geographically associated but are mapped together because of some common feature. As a general rule, Chapter 5 of the revised Soil Survey Manual (Soil Survey Staff, 1979) states that at least one-half of the pedons in each delineation of a consociation are the phase providing the name for the map unit. Up to 50% of the area of a map unit may consist of similar soils. Dissimilar soils may not exceed 15% of the map unit.

Because soils are not homogeneous bodies (Hammond, 1958; Hutcheson, 1964), we must always accept a certain amount of variability within any given soil map unit. Most variability in a field is present within areas as small as 1-100 m^2, and we cannot delineate these areas anyway at the usual mapping scales (Beckett, 1971). It stands to reason then that a certain amount of soil variability must be accepted as permitted by the Soil Survey Manual (Soil Survey Staff, 1951) in defining a map unit. Soil variability in the vertical dimension is the basis for identification of soil profiles. If vertical variation did not exist, a morphological soil description would be less meaningful. Variation in this study refers to lateral variation or spatial variation in soil properties that if extensive enough may lead to significant taxonomic differences within map unit delineations.

There are numerous statistical procedures used to assess soil variability. One statistical procedure that has been used to evaluate the variability of a mapping unit is analysis of variance. Analysis of variance is a statistical procedure whereby the total variance is partitioned into individual variance components in a hierarchical system. This method, developed by R. A. Fisher, is particularly applicable to experimental design (Sokal and Rohlf, 1969). If the population is divided into several classes and these classes are divided into smaller classes, then the result is a nested or hierarchical classification with two different levels

(Webster, 1977). There are five basic assumptions that must be followed in order to make definitive statements from ANOVA (Sokal and Rohlf, 1969). The assumptions are: 1) random sampling, 2) independence, 3) homogeneity of variances, 4) normality, and 5) additivity. Sokal and Rohlf (1969) also point out that departures from some of the assumptions can be corrected by using a variety of measures, such as transfers of the data.

USE OF ANOVA AS A SAMPLING PLAN TO ANALYZE THE COMPOSITION OF A SOIL MAPPING UNIT

Youden and Mehlich (1937) studied the Culvers gravelly silt loam (an uncultivated soil in New York) using a three-level nested ANOVA design to locate the variability of pH within the upper six inches of the soil. One primary conclusion was that the variance increased greatly as the distance between the sampling points increased. The results showed that samples collected from widely separated areas varied considerably more than samples collected close together. Some of the same techniques have been applied to observing the spatial variation of soil properties within soil survey mapping units. McCormack and Wilding (1969), in a study in northwestern Ohio, looked at the variation of soil properties within mapping units of soils with contrasting substrata. The ANOVA involved 10 mapping units, two delineations within each mapping unit, and 10 observations within each delineation, totaling 220 observations. The results indicated that the variability within the delineations was equal to or greater than the variation between the delineations with respect to all properties observed. As a result of the variation of soil properties within delineations, their recommendation was that exploratory work should be conducted in complex areas before the initial mapping legend was established.

Not all studies have resulted in the conclusion that variability exists predominantly within the delineation. Variability between delineations was observed by Wilding et al. (1965). The sampling plan employed was a two-level nested ANOVA design where a total of 240 samples were taken. Although the majority of soil properties were significantly less variable within mapping delineations than between delineations, all delineations contained at least 30% or more inclusions of other soils, and the mapping units would have been more appropriately named a complex or undifferentiated unit. Wilding et al. (1965) commented that most mapping units probably contain greater than 15% inclusions and recommended that the percentage figure be eliminated and instead the dominant taxonomic member be expressed. Even though this variation existed, there was a good grouping of pedons meaning that delineations were well defined.

A hierarchical system or ANOVA was used to separate parent materials in England (Nortcliff, 1978). The author indicated that knowledge of soil variability at the reconnaissance stage of soil survey was extremely important and could improve the detailed survey.

Some of the most recent work employing ANOVA has been in a study of soil variability in family differentia in a second-order soil survey mapping unit (Edmonds et al., 1982). The mapping unit was sampled by using a random effects, two-level, nested ANOVA design. Replicate samples were collected within 7 m. Primarily, the variability existed within delineations, and only a small percentage of variability was contributed by short range variation.

OTHER PROCEDURES USED TO DETERMINE THE COMPOSITION OF A SOIL MAPPING UNIT

Transect

Another technique that can be used to determine the composition of a mapping unit is the transect method. Three mapping units in Walton County, Georgia, were evaluated with respect to their composition and their precision of mapping using the point-intercept method (Powell and Springer, 1965). With the point-intercept method, the surveyor selects the directions of the transects at random, after which he walks the transects stopping at regular intervals while counting his steps. At each stop, a soil description is taken, and the number of steps assigned to each kind of soil is proportional to the area of each kind of soil. Although highly reliable groupings of similar soils existed in Walton County, all but one mapping unit contained greater than 15% inclusions of other soils. Out of 518 observations, the mapping units contained from approximately 17 to greater than 40% inclusions of other soils. Chayes (1956) has proven the transect method as a mathematically valid technique.

A random transect method has also been used and highly advocated for primarily wooded areas or where soil boundaries cannot be observed due to limited accessibility (Steers and Hajek, 1979). In this procedure, the soil populations are defined in terms of transects, but it is not designed to locate soil boundaries. Each delineation is represented by one potential transect which is located during the mapping process.

Although most people accept the transect method as a reconnaissance or exploratory technique, the validity of this approach for estimating the composition of a mapping unit on a routine basis has been questioned. Based on a statistical calculation employing a 95% confidence interval, if the average soil map delineation was considered to be 32 acres, then 100 transects at 0.05 miles per transect would be required in order to adequately evaluate the delineations. For 30 delineations of a given unit, 150 miles of transects would be required, thus severely limiting the practicality of this method (White, 1966).

Statistical Functions

Soil mapping units have been studied to determine the spatial variability within small areas of the mapping unit. Since present standards (Soil Survey Staff, 1979) allow inclusions of soils similar to the named soil to be as great as 50%, few definitive statements can be made about the exact location of the variability on the landscape. However, if samples were collected at regular spatial intervals instead of following an ANOVA design, then place-to-place variation could be described by a statistical function called spatial autocorrelation (Campbell, 1979). The disadvantage of this procedure is that the samples must be collected at equal intervals along straight line transects. Campbell (1977, 1978) worked with a linear discriminant function which was used to actually locate the boundary between two mapping units. Henderson and Ragg (1980) applied this same technique to four mapping units in Scotland.

Other techniques have been used to study mapping units such as multivariate methods. Norris (1972) commented that all survey work was actually based on multivariate concepts because soils are defined using many variables. Another technique which employs multiple regression analysis provides a very convenient procedure for looking at a large number of observations and then making a statement that expresses the extent to which differences in the dependent variable are associated with differences in the other variables (Wadleigh, 1954). Soil variability within a mapping unit can be expressed by a polynomial expression known as trend analysis (Walker, 1968), which can be used to predict values of a given soil property within a sample grid. Arkley (1976) stated that instead of subjectively grouping soils based on a few properties, one should use an objective statistical procedure such as cluster analysis which will determine the natural groups of soil that make up the population. The soil classification system produced by cluster analysis, however, remains to be developed, and one major disadvantage is the time required to set up the data file. When developed, this system will have some of the problems inherent in the current systems in use.

Use of Rating Systems in Soil Science Research

Soil scientists often find it difficult to describe soil properties quantitatively. The use of a rating system facilitates this task. Bilzi and Ciolkosz (1977) developed a rating system to quantify various morphological properties of a soil so that the data could be easily interpreted and compared. The system was used to determine the relative distinctness of two horizons and to compare the relative profile development of each horizon. In a later study, Meixner and Singer (1981) used a field morphology rating system to evaluate soil formation and discontinuities in California. A rating system was also used to study mapping unit homogeneity by assigning a weighted contrast value to each unit thus permitting a comparison of homogeneity (Amos and Whiteside, 1975).

Other rating systems have been used for many years in which the binomial distribution is used to express the data. The binomial distribution is well documented in statistical texts as a means of predicting a probability distribution of events that can occur (Sokal and Rohlf, 1969). One example is how petrographers use the point-count method to estimate the percent or volume of components in thin sections. The data is then expressed by a binomial distribution (Daniels et al., 1968). Transects were used in one study where the state of the ground cover at various points was recorded. A value of 1 indicated living cover, a value of 0 indicated no living cover, thus utilizing the fundamental principle for a binomial distribution (Williams, 1956).

The author was unable to find any published work regarding a methodology to evaluate the placement of soil boundaries in a soil survey. Research in this area appears to be deficient.

Although the literature has indicated numerous possibilities and alternatives to studying the composition of a soil mapping unit, the techniques chosen in soil survey investigations will be contingent upon time and money with a minimum of human and material resources. Some of the techniques would lend themselves to this while others would not. This study has focused upon those techniques that could ultimately conserve time and money.

MATERIALS AND METHODS

REGIONAL SETTING

Bland County is in the southwestern part of Virginia bordering Giles and Pulaski Counties to the east, Wythe and Smyth Counties to the south, and Tazewell County to the west (Figure 1). The land area totals approximately 356 square miles or 227,840 acres. Approximately 50 percent of the county is forested and the remaining is predominantly in pasture and cropland. Physiographically, the county lies within the Ridge and Valley province and is a part of the great Appalachian Valley that extends through southwestern Virginia (Porter, et al. 1954). Bland is a typical county in the Appalachian Valley with surface relief that is primarily undulating, rolling, and hilly, but also with many steep areas particularly in the mountainous sections. Approximately 6 percent of the county is nearly level, 10 percent rolling, 21 percent hilly, and 63 percent steep or very steep (Porter, et al. 1954). Elevation ranges from approximately 1,900 feet to approximately 4,400 feet above sea level. Based on HISARS program[1] the climate of Bland County is

[1] Wiser, E. H. User's guide for Hydrologic Information Storage and Retrieval System (HISARS), North Carolina State University, Raleigh, NC (Revised edition by T. W. Johnson, et al., 1975, Virginia Water Resources Research Center, Blacksburg, VA), unpublished mimeo.

temperate and continental with a mean annual air temperature of 50.3°F (Figure 2) and mean annual precipitation of 43.6 inches (Figure 3). Rainfall is fairly well distributed throughout the year.

Most of the rocks underlying the land surface in Bland County were deposited as sediments during the Paleozoic Era. Most are sandstone and acid shale but some are high-grade limestone, dolomitic limestone, and interbedded limestone and shale. These rocks are distributed in narrow parallel bands in a northeast-southwest orientation across the county. Folding, faulting, and differential weathering caused by variable content of soluble materials, mainly carbonate, have resulted in three physiographic subdivisions: (1) Cambrian and Ordovician limestone valleys, (2) Devonian sandstone and shale valleys, and (3) Silurian sandstone mountain ridges. As the surface geology of Bland County consists chiefly of very old formations that were folded and faulted many years ago, the present relief is a product of geologic weathering and erosion. Jefferson fine sandy loam primarily developed from sandstone colluvium of the Chemung formation and other rock waste accumulated in beds near the foot of mountains. Leadvale silt loam primarily developed from shale colluvium of the Brallier shale formation and also other rock waste accumulated in beds near the foot of mountains.

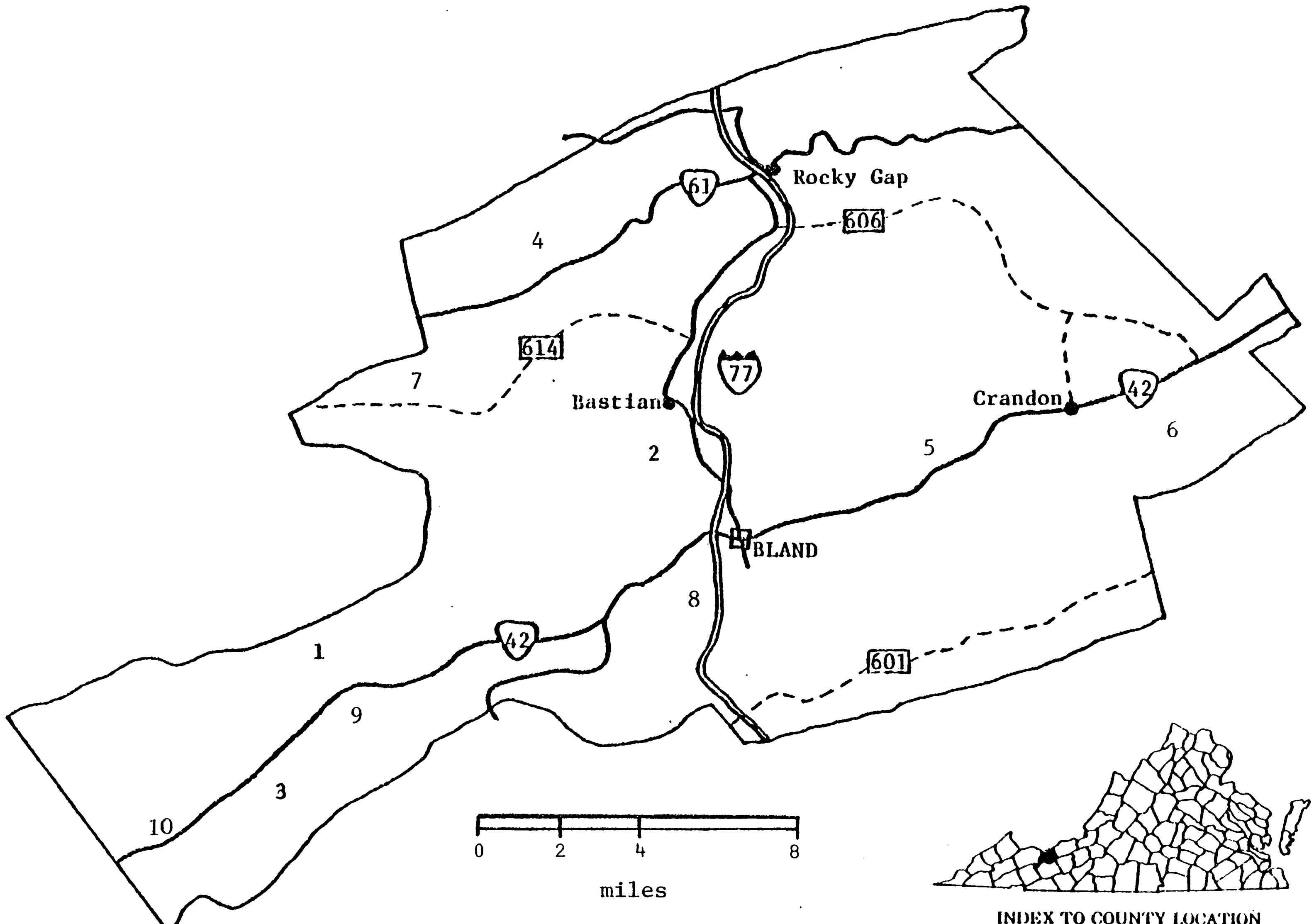

FIGURE 1. Relative Location of Transects in Bland County and Location of the County in Virginia.

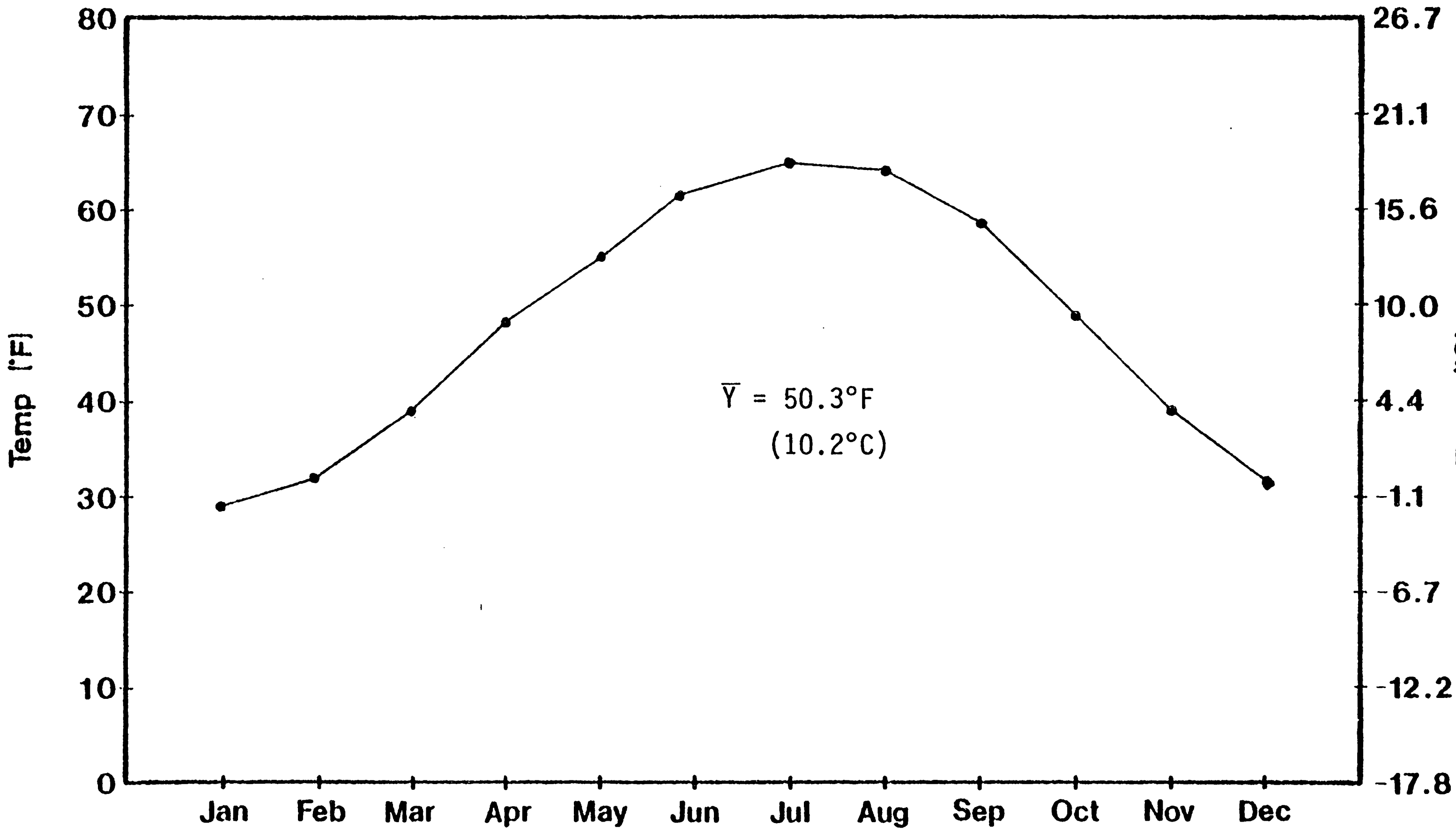

FIGURE 2. Mean Monthly Air Temperature for Burkes Garden, Virginia (Official Weather Station for Bland County, Virginia).

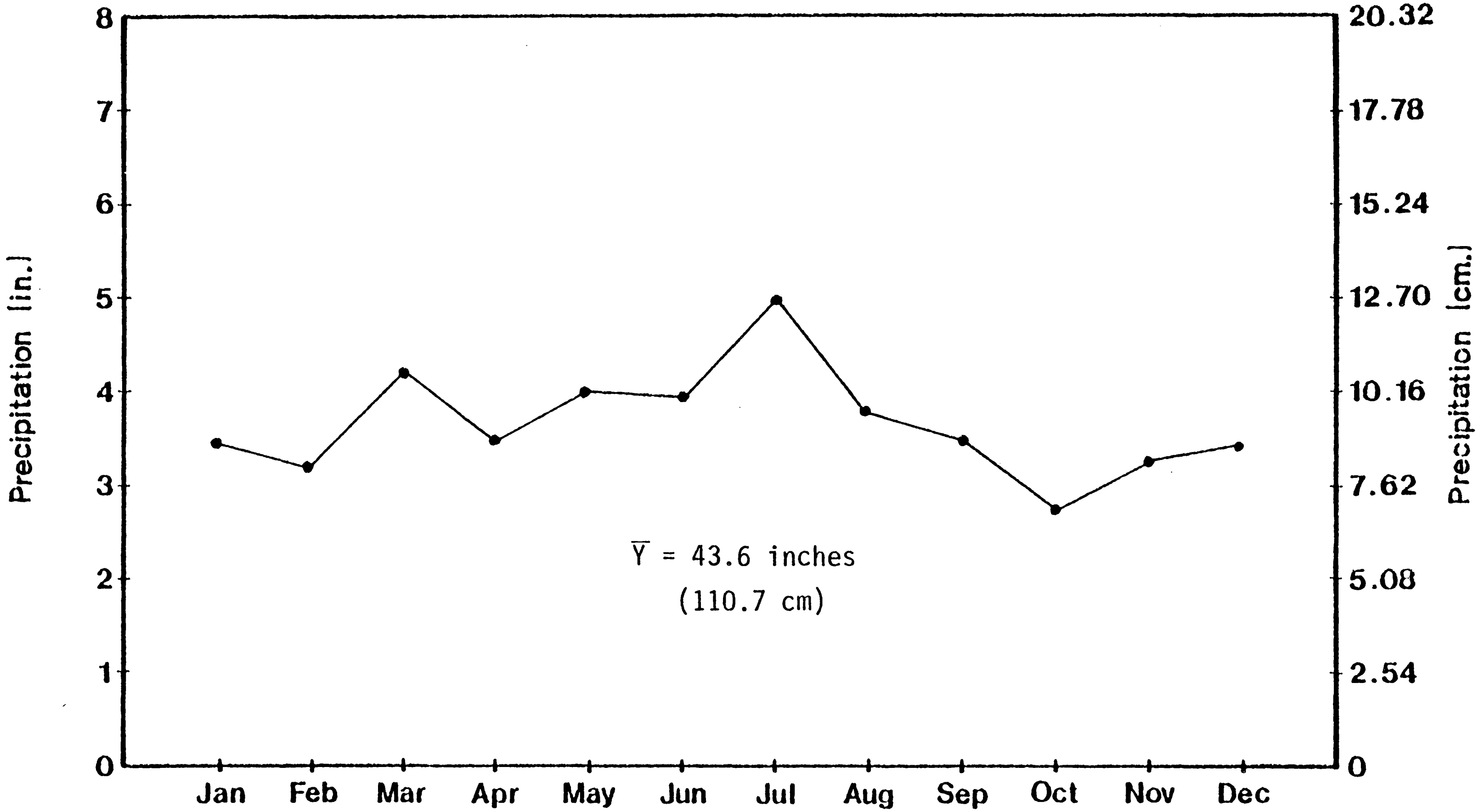

FIGURE 3. Mean Monthly Precipitation for Burkes Garden, Virginia (Official Weather Station for Bland County, Virginia).

Montevallo developed from residual material of acid Brallier shale and Devonian black shale formations. Muskingum developed from residual material of acid Clinch and Chemung sandstone formations.

Soils in Bland County have a udic moisture regime, and an estimated mean annual soil temperature of 52.1^{0}F which places them in a mesic temperature regime, based on Soil Taxonomy (Soil Survey Staff, 1975a). There are many different kinds of soil in the county, occurring on various landscape positions. The most inherently fertile and productive soils are found in the limestone valleys that characteristically have relief favorable to cultivation. The less productive soils are in the sandstone and shale valleys or in the mountain uplands. These infertile soils are usually shallow to bedrock, stony, and/or occupy steep positions in the landscape, and for this reason, much of the county is unsuitable for cultivated crops.

The Bland County soil survey was one of the eight nonphotobase southwestern Virginia surveys that were published in cooperation with the Tennessee Valley Authority (T.V.A.) in the 1950's. The survey was also similar to other older surveys in Virginia that lack a photobase. The Bland County soil survey was chosen primarily because it was representative of pre-taxonomy soil surveys. The Bland County soil survey was made and published with no ratings or thoughts given for non-agricultural uses. The main emphasis was on agricultural interpretations for use and management. There were 89 mapping units compared with approximately two-thirds that number for a current survey such as Pulaski or Giles County. Although these dissimilarities exist, it is apparent that the Bland County soil survey is a well written and well documented survey and was, therefore, used as an implement to develop a methodology in which to update other pre-taxonomy soil surveys.

PROCEDURE FOR EXAMINING SOIL LANDSCAPE UNITS TO EVALUATE SOIL BOUNDARY PLACEMENT

The 1954 Bland County soil survey was mapped at a scale of 1:24,000 which is compatible with 7.5 minute topographic maps. The published survey was not on an aerial photographic base, thus ground control was made easier by transfering the soil delineations to the topographic maps. The published Bland County soil maps have a superimposed boldface grid that represents 2.5 minute quadrangles. In this study, each 2.5 minute quadrangle was divided into four 1.25 minute quadrangles that represented approximately 1,046 acres each. Using this system, Bland County was ultimately divided into 260 quadrangles and numbered consecutively. Ten of the 260 quadrangles were randomly chosen to study "soil landscape units", as defined by Schelling (1970), which ultimately formed the basis for evaluating the placement of soil boundaries. If the soil lines delineated "soil landscape units", then we could conclude that the soil boundaries were accurate. The "soil landscape units" were determined by evaluating slope, parent material, and landscape position.

A random transect was located in each of the ten randomly chosen 1.25 minute quadrangles by the following procedure: 1) x and y axes were marked off into 60 and 76 100-foot increments, respectively; 2) the direction of the transect was randomly selected to determine either a north-south or an east-west orientation; 3) the point of origination of each transect was randomly chosen along the northern side of the 1.25 minute quadrangle for a north-south transect and along the western side for an east-west transect at a randomly chosen 100-foot interval.

In the field each transect was walked on a compass bearing, and each encountered delineation was evaluated by first writing a complete profile description based on an auger boring using a standard 60" by 3" diameter bucket auger. In addition, slope was measured several times in each delineation and the predominant slope class was determined using a clinometer. Parent material was identified, and landscape position was observed for each delineation along the transect. Parent material, as recorded by auger descriptions, was compared to the description of parent material for that same soil as described by Porter, et al. (1954). Also the landscape position of each delineation was compared to the landscape position designated by Porter, et al. (1954).

These data can be conveniently summarized by means of the binomial expansion, applicable to samples of any size from any population which contains only two classes, (i.e., a dichotomus data set) (Sokal and Rohlf, 1969). The two classes used in this study were: 1) success, or agreement between the observed slope, parent material, and landscape position described by Porter, et al. (1954) designated by "1", and 2) failure, or lack of agreement designated by "0".

PROCEDURE FOR THE EVALUATION OF A MAPPING UNIT

Five mapping units were selected, based upon their ability to represent: 1) significant parts of the landscape; 2) a range of land uses common to the survey area; and 3) a significant range in slope, parent material, and landscape position. The soils selected were: (a) Jefferson fine sandy loam, 5-15% slope, developed from sandstone colluvium and comprising 1,044 acres; (b) Leadvale silt loam, 8-16% slope, developed from shale colluvium and comprising 2,216 acres; (c) Muskingum very fine sandy loam, 30-60% slope, developed from sandstone residuum and comprising 31,339 acres; (d) Muskingum stony very fine sandy loam, 30-60% slope, developed from sandstone residuum and comprising 28,321 acres; and (e) Montevallo shaly silt loam, 30-60% slope, developed from shale residuum and comprising 36,435 acres.

The mapping units were sampled according to a random effects, two-level, nested ANOVA design. For the Montevallo, Muskingum and Muskingum stony mapping units, there were two delineations with six sites within each delineation and two profiles (within 7 m) within each site randomly selected for sampling. Only two delineations were chosen in these mapping units due to the extensive size of any one mapping unit, some units comprising thousands of acres. Six sites were randomly chosen to provide sufficient points of observation within the two delineations. For the Leadvale and Jefferson mapping units, there were four delineations with two sites within each delineation and two profiles (within 7 m) within each site randomly selected for sampling. Four delineations were randomly chosen in these units because there were numerous delineations. Because of the small size of the majority of these units, only two sites were randomly chosen within each delineation. This sampling design generated descriptions for 72 profiles in the mountains and 32 profiles in colluvial positions, making a total of 104 profiles. Soil samples were collected from the control section of each profile for chemical and textural analyses. All sample sites were selected at random from the soil map prior to field observation. The selected sample site was then located in the field using the Bland County field sheet and a 7.5 minute topographic map. At each of the 104 sample sites, a complete soil description was taken on the basis of an auger boring.

LABORATORY METHODS

Samples were air-dried and passed through a 10-mesh sieve to remove fragments greater than 2 mm. Percent clay was determined by the hydrometer method (Day, 1965), sand by sieving and free Fe by citrate-dithionite extraction (Holmgren, 1967). Exchangeable bases were determined by a modification of a procedure described by Jackson (1958) in which the soil was extracted using $\underline{N}$ NH_4OAc and Ca, Mg, and K determined by atomic absorption spectrophotometry. Exchangeable Al was determined after extraction in $\underline{N}$ KCl then titrating with 0.1 N NaOH. This is a modification of a procedure described by Yuan (1958). Titratable acidity was determined by leaching the soil with barium chloride (0.5 N) triethanolamine (0.2 N), ($BaCl_2$-TEA), the pH adjusted with HCl to pH of 8.2 and titrating the leachate with 0.1 N HCl.

This is a modification of a procedure by Peech et al. (1962). Percent organic matter was determined by a procedure in which the oxidizeable organic matter was oxidized by excess $Cr_2O_7^{-2}$ with the reaction facilitated by the heat generated from the addition of H_2SO_4. Then the excess $Cr_2O_7^{-2}$ was determined by back titration with standard $FeSO_4$ solution (Walkley and Black, 1934). Soil pH was determined with a glass electrode in a 1:1 soil to water suspension that was allowed to equilibrate for 30 minutes after stirring (Peech, 1965). For Alfisols and Ultisols, CEC was determined by the addition of the sum of extractable bases, by N NH_4OAc at pH 7, and the titratable acidity by $BaCl_2$-TEA at pH 8.2 (USDA, SCS, 1972). For Inceptisols, CEC was determined by extracting the soil with N NH_4OAc at pH 7, exchanging off NH_4^+ with 10% acidified NaCl and distilling the leachate with a Kjeldahl distillation unit. Ammonium was subsequently determined by titrating with 0.1 N H_2SO_4 (Chapman, 1965). Base saturation was determined for Alfisols and Ultisols by dividing the sum of NH_4OAc extracted bases by the CEC which was determined by the method described above for Alfisols and Ultisols (USDA, SCS, 1972). Base saturation for the Inceptisols was determined by dividing the sum of NH_4OAc extracted bases by the CEC which was determined by the method described above for Inceptisols (USDA, SCS, 1972).

Samples prepared for mineralogical analysis were first pretreated with H_2O_2 in NaOAc adjusted to pH 5.0 to remove organic matter and followed by citrate-dithionite-bicarbonate to remove Fe oxide coatings. The sand-size fraction was separated by sieving and the clay-size fraction separated by centrifugation and decantation (Day, 1965). The clay-size fraction was flocculated by lowering the pH to 4.0 and/or adding 20 g of NaCl per liter of suspension. The less than 2 µm clay fraction was used to prepare oriented mounts by depositing 250 mg of sample on each of two ceramic tiles (Rich, 1969). Clay on one tile was saturated with K and clay on the other with Mg after which they were washed free of salts and the Mg saturated clay tile glycolated. X-ray diffraction patterns were obtained for the Mg saturated samples at room temperature and 110^0 C and for the K saturated samples at room temperature, 100, 300 and 550^0 C. Using CuKα radiation, the samples were scanned at $2^0 2\theta$ per minute on a Diano XRD-8300 AD x-ray diffractometer equipped with a graphite crystal monochromator and PDP-8 computer.

Using a Dupont 1090 Differential Scanning Calorimeter, thermal analysis was accomplished where the samples were heated in an N_2 atmosphere from 50 to 625^0 C at a rate of 20^0 C/min. Kaolinite and gibbsite were then quantified by integrating the area under the respective endothermic peaks at 520 and 280° C and comparing with standard curves. X-ray fluorescence spectrometry was used to help quantify mica. Other clay-size minerals were quantified by proportioning integrated peak areas of the appropriate diffractograms and using kaolinite as an internal standard, assuming the minerals detected were equal to 100%.

Sand-size minerals were identified using a Zeiss polarizing microscope. Grain mounts from the < 40 mesh fraction were prepared and counted according to the line count method (Galehouse, 1971).

PROCEDURE FOR SELECTING TYPIFYING PEDON

In this study, typifying pedons for each mapping unit were selected and completely characterized. Morphological properties for each profile were evaluated and ultimately used along with physical and chemical properties to classify the soils according to Soil Taxonomy (Soil Survey Staff, 1975a). The percentage of each taxonomic group that occurred in any one mapping unit was considered during selection of the typifying pedon. The 90% confidence intervals on the mean for percent total sand, percent clay, base saturation, and pH of the control section were determined for all taxa. Each of the 104 profiles was evaluated to ascertain whether or not each parameter fell within its confidence interval, and was subsequently rated "1" if it fell within the interval, and "0" if it fell outside the interval. The profile with the highest cumulative rating was considered in making the selection. Finally, two distribution free non-parametric statistical procedures were used. Wilcoxon Rank Sum (Hollander and Wolfe, 1973) was used to test for significance between two or more mapping units with respect to a given property, and Box and Whisker plots were used to graphically illustrate the data (Barr et al., 1979).

STATISTICAL ANALYSES

Analysis of Variance

Two linear statistical models were used in this study. One supported the random effects, two-level, nested analysis of variance (ANOVA) sampling design. The second model supported a mixed effects, three-level, nested ANOVA design. The latter design was used to make comparisons between various combinations of soil. The model statement for the random effects, two-level nested ANOVA is:

$$Y_{ijk} = \mu + D_i + S_{ij} + e_{ijk},$$

where Y_{ijk} represents the total variability of the observations, μ represents an overall mean, D_i represents the effect due to the particular delineation, S_{ij} represents the effect due to the particular site, and e_{ijk} represents the variation among the samples within a particular profile (within 7 m). Included in this error term are also errors in sampling and laboratory procedures. It is assumed that D_i, S_{ij} and e_{ijk} were normally and independently distributed with zero means and respective variances of σ^2_D, σ^2_S, and σ^2_e.

The linear model statement for the mixed effects, three-level, nested ANOVA is:

$$Y_{ijkl} = \mu + \alpha_i + D_{ij} + S_{ijk} + e_{ijkl},$$

where Y_{ijkl} represents the total variability of the observations obtained in this study, α_i represents the effect due to the particular soil, D_{ij} represents the effect due to the particular delineation, S_{ijk} represents the effect due to the particular site, and e_{ijkl} represents the variation among the samples within a given pedon (within 7 m), and as before represents errors in sampling and laboratory procedures.

The mean squares in ANOVA were examined to determine if the model was appropriate. Ascending mean squares may indicate an appropriate model. Conversely, descending mean squares may indicate an inappropriate model, which necessitates pooling of the variance. Webster (1977) indicates that one explanation for descending mean squares is sampling error in situations where the differences between classes are small and descend because of errors in sampling and laboratory measurements.

The expression for setting the confidence interval (CI) or μ is:

$$\bar{Y} \pm t_{0.10} \, (MS_D/n)^{\frac{1}{2}},$$

where $t_{0.10}$ is the upper 10% point of a t variable with (D-1) degrees of freedom, MS_D is the delineation mean squares, and n is the total number of samples (Edmonds, et al., 1982).

The percentage of variation contributed by each level in the ANOVA is determined according to:

(a) $V_{Soil} = \dfrac{MS_{Soil} - MS_D}{nbc}$

(b) $V_D = \dfrac{MS_D - MS_S}{nb}$

(c) $V_S = \dfrac{MS_S - MS_P}{n}$

(d) $MS_P = MS_E$

where MS_D, MS_S, MS_P, and MS_E is the mean square for delineation, site, profile, and error, respectively, and where n, b, and c are the number of profiles, sites, and delineations.

Both the ANOVA and variance component (VARCOMP) tests were performed using the statistical analysis system developed by Barr et al. (1979), except when the data necessitated pooling, in which cases a hand calculator was used.

Binomial Distribution

A binomial distribution was used to summarize the data from the transect study to express probabilities of success such that:

$$P = \binom{n}{x} p^x q^{n-x}$$

$$\text{and } \binom{n}{x} = \frac{n!}{x!\,(n-x)!}$$

where n is the total number of observations, x is the number of successful observations, p is an estimation based on the ratio of the number of successful observations to the total number of observations, and q = 1-p. The mean and standard deviation of a binomial distribution are, respectively, $\mu = np$, and $\sigma = \sqrt{npq}$. The 90% confidence interval on the mean can be obtained by using a continuity correction factor of 0.5, in which the binomial distribution is adjusted from a discrete random variable to a continuous random variable. With K representing the binomial mean and Z representing the Z-score for normally distributed data, the 90% confidence interval may be expressed as:

$$-Z_{.90} \leq \frac{K - np + \frac{1}{2}}{\sqrt{npq}} \leq Z_{.90}$$

or

$$np - \sqrt{npq}\, Z_{.90} - \tfrac{1}{2} \leq \mu \leq np + \sqrt{npq}\, Z_{.90} - \tfrac{1}{2}.$$

Nonparametric Statistics

The Wilcoxon Rank Sum Test was used to aid in the selection of typifying pedons (Hollander and Wolfe, 1973). The central hypothesis is that there is no shift in the median value or that the samples can be thought of as a single sample from one population. The model statement is:

$$X_i = e_i, \quad i = 1, \ldots, m,$$

and

$$Y_j = e_{m+j} + \Delta, \quad j = 1, \ldots, n,$$

where X's and Y's are observable, $e_{m+1}, \ldots, e_{m+n}$ are unobservable random variables and Δ, which is the parameter of interest, is the unknown shift in location due to the treatment. This further assumes that the N e's are mutually independent and each e comes from the same population. The data from these analyses are illustrated by using Box and Whisker Plots (Barr et al., 1979).

RESULTS AND DISCUSSION

EVALUATION OF SOIL BOUNDARY PLACEMENT

Soil classification tends to be a science, but soil mapping is both an art and a science (Moon, 1949) and in no dimension of soil mapping is the art more evident than in placement of soil boundaries by soil surveyors. Competent soil surveyors may differ in placement of boundaries - a difference that is very difficult to study. Quantitative assessment of boundary placement between two soils is a difficult task, yet one that is necessary if valid evaluations of pre-taxonomy soil surveys are to be made.

The randomly chosen transects in Bland County (Figure 1) traversed many different kinds of landscapes with a wide range in slope, aspect, and topographic shape. While some transects were confined primarily to either relatively flat bottom land or to steep mountainous land, other transects traversed a combination of both topographies.

The number of delineations encountered by any one transect ranged from 4 to 18. The probability of observing the correct slope ranged from .600 to 1.000 (Table 1). Although the probability for observing the correct slope class was as low as .600 and .625 for transects number 6 and 4, the probabilities for the remaining 8 transects were sub-

TABLE 1

Range of Transect Probabilities for Successful Observation of Slope.

Transect Number	Number Possible Observations	Number Successes	Probability
1	6	5	0.833
2	4	4	1.000
3	18	15	0.833
4	8	5	0.625
5	11	10	0.909
6	10	6	0.600
7	8	6	0.750
8	5	4	0.800
9	10	8	0.800
10	9	7	0.778

stantially higher. The mean probability for the successful observation of slope (Table 1), which was calculated by summing the individual probabilities and dividing by 10, was .793 or approximately 79%.

The 10 transects traversed 89 delineations, of which 70 were within tolerance with respect to slope. Therefore, the probability of accurate slope determination (p) in the survey was .786, or approximately 79%. Alternatively, the probability for inaccurate slope determination (q) in the survey was .214, or approximately 21%. Using the calculated p and q values, a binomial distribution for 10 random observations of slope was estimated (Table 2). Any number may be chosen to express the distribution range, but for the purpose of being concise and minimizing calculations, the number 10 was chosen to illustrate the binomial distribution with respect to each of the 3 variables. The probability of observing exactly 7 correct and exactly 3 incorrect slopes out of 10 randomly chosen slopes was .217, or approximately 22%. The probability of observing 7 or more correct slopes out of 10 randomly chosen slopes was .854, or approximately 85% (Table 2). The mean number of correct slopes out of 10 random observations of slope was 7.865 indicating that if the experiment were repeated, one would expect to find between 7 and 8 correct slopes out of 10 random observations. A 90% confidence interval on the mean yielded

$$5.70 \leq \mu \leq 9.13.$$

The accurate delineation of "soil landscape units" with regard to slope seemed more profound considering the less sophisticated instruments that were used when the field work was done in Bland County between 1935 and 1940. In this evaluation, more than one slope determination was made for each delineation encountered compared to a more customary procedure of taking an occasional reading which is practiced by most trained soil scientists.

The lowest probability for observing the correct parent material among the 10 transects was .625 with the mean probability equalling .815 (Table 3). There were 71 successful observations of parent material out of the 89 total observations or delineations encountered, yielding a probability of success (p) of .798. The probability of observing 7 or more successful observations of parent material out of 10 random observations was .875, or approximately 88% (Table 4). With a mean of 7.978, a 90% confidence interval on the mean may be expressed as

$$5.850 \leq \mu \leq 9.106.$$

Frequently the original parent material is not visible or recognizable to the soil scientist, hence inferences of parent material are made based on soil characteristics.

TABLE 2

Binomial Distribution for 10 Random Observations of Slope.

Success	Failure	Probability (P)	Cumulative P
10	0	0.091	0.091
9	1	0.246	0.336
8	2	0.300	0.637
7	3	0.217	0.854
6	4	0.103	0.957
5	5	0.034	0.991
4	6	0.008	0.999
3	7	0.001	≃1.000
2	8	<0.001	≃1.000
1	9	<0.001	≃1.000
0	10	<0.001	≃1.000

Therefore, identification of parent material is subjective. When one considers the inherent problems with identifying parent material after it has been altered into soil, 88% accuracy most likely is indicative of a close correlation of the map unit to parent material.

The mean probability of .913 for the successful observations of landscape position, with respect to any one transect, was higher than either slope or parent material (Table 5). Out of the 89 total observations there were 81 landscape position evaluations that were in agreement with the soil survey. This yielded a probability of success (p) of .910. The probability of observing seven or more successes out of 10 random observations of landscape position was .991, or approximately 99% (Table 6). The mean for 10 random observations of landscape position was 9.10. A 90% confidence interval on the mean may be written as

$$7.44 \leq \mu \leq 9.76.$$

The binomial distributions for slope, parent material, and landscape position (Tables 2, 4, and 6) indicated the probability of success for 7 or more random observations out of 10 was at least 85%. Presently, a consociation allows up to 15% inclusions of dissimilar soils as previously discussed in the Literature Review. If 15% of the evaluated

TABLE 3

Range of Transect Probabilities for Successful Observation of Parent Material.

Transect Number	Number Possible Observations	Number Successes	Probability
1	6	5	0.833
2	4	4	1.000
3	18	15	0.833
4	8	5	0.625
5	11	9	0.818
6	10	8	0.800
7	8	7	0.875
8	5	5	1.000
9	10	7	0.700
10	9	6	0.667

TABLE 4

Binomial Distribution for 10 Random Observations of Parent Material.

Success	Failure	Probability (P)	Cumulative P
10	0	0.104	0.104
9	1	0.265	0.369
8	2	0.302	0.671
7	3	0.204	0.875
6	4	0.091	0.966
5	5	0.028	0.993
4	6	0.006	0.999
3	7	0.001	≃1.000
2	8	<0.001	≃1.000
1	9	<0.001	≃1.000
0	10	<0.001	≃1.000

TABLE 5

Range of Transect Probabilities for Successful Observation of Landscape Position.

Transect Number	Number Possible Observations	Number Successes	Probability
1	6	6	1.000
2	4	4	1.000
3	18	17	0.944
4	8	4	0.500
5	11	10	0.909
6	10	10	1.000
7	8	8	1.000
8	5	5	1.000
9	10	10	1.000
10	9	7	0.778

TABLE 6

Binomial Distribution for 10 Random Observations of Landscape Position.

Success	Failure	Probability (P)	Cumulative P
10	0	0.390	0.390
9	1	0.385	0.775
8	2	0.171	0.946
7	3	0.045	0.991
6	4	0.008	0.999
5	5	0.001	≃1.000
4	6	<0.001	≃1.000
3	7	<0.001	≃1.000
2	8	<0.001	≃1.000
1	9	<0.001	≃1.000
0	10	<0.001	≃1.000

variables were allowed to exceed tolerance in a soil survey, then 85% probability would be an excellent correlation. The relatively high correlation of field observations with the original map in regard to slope, parent material, and landscape position supported the conclusion that the delineations represented "soil landscape units", as defined by Schelling (1970). With this conclusion, there is no justification to remap Bland County based on the present data and the level of detail required for an order-two soil survey. Minimum map scales range from as large as 1:12,000 to as small as 1:31,680 for order-two soil surveys. Order-two soil surveys have less than 20 percent inclusions of limiting dissimilar soils, and the mapping units are mainly consociations defined as phases of soil series (Soil Survey Staff, 1975b). Agencies evaluating pre-taxonomy soil surveys in other regions will have to establish their individual minimum standards for acceptance. The three variables used in Bland County, Virginia, may not be applicable when evaluating surveys in a different physiographic region. Other variables may be more appropriate such as depth to water table or coarse fragment content.

EVALUATION OF MAPPING UNIT COMPOSITION

Morphological descriptions were recorded for every profile that was sampled in Bland County. In the field, a soil was classified as either an Ultisol or Alfisol if the profile had an argillic horizon and lacked a thick dark surface, spodic horizon, or other limiting characteristic. Alternatively, a soil was classified as an Inceptisol if it lacked evidence of clay illuviation, but instead had a cambic horizon. Therefore, morphological properties dictated the soil order and subsequently the sampling and analytical techniques. All profiles of Jefferson and Leadvale had argillic horizons, but profiles of Montevallo, Muskingum, and Muskingum stony either had an argillic or a cambic horizon. The taxonomic classification of each mapping unit is listed in Appendix D.

Particle size analyses for the control sections of each profile (Table 7) and chemical analyses of each control section (Table 8) were used in ANOVA to locate the source of variability in a mapping unit. It was recognized that all the assumptions required for ANOVA were not satisfied. Two factors that affect the alpha level or power of the test are abnormally distributed data and unequal variances, both of which may be factors in this study. Therefore, the ANOVA was used primarily as an indication of the source and amount of variation and secondarily as an indication of significant differences in the means of various classes in the experimental design. The objectives of evaluating the map units were two-fold: 1) To observe differences within and among delineations and sites, and 2) to estimate the magnitude and source of the variation within each measured variable.

Table 7. Particle Size Analysis of the Control Section.+

Observation	Soil	Delineation	Site	Profile	VC	C	M	F	VF	Clay	Total Sand	Silt
					%							
1	JB	1	1	1	1.2	2.8	5.6	9.4	6.8	42	25.8	32.2
2	JB	1	1	2	0.6	2.4	5.6	14.8	2.2	40	25.6	34.4
3	JB	1	2	1	0.4	1.3	4.0	30.6	2.9	23	39.2	37.8
4	JB	1	2	2	0.7	1.4	4.4	27.5	9.4	25	43.4	31.6
5	JB	2	1	1	0.7	1.9	5.3	15.8	4.2	49	27.9	23.1
6	JB	2	1	2	0.9	2.5	6.4	20.1	4.2	38	34.1	27.9
7	JB	2	2	1	0.6	1.4	5.8	35.2	10.5	25	53.5	21.5
8	JB	2	2	2	0.8	1.3	5.7	37.5	7.2	19	52.5	28.5
9	JB	3	1	1	4.0	7.5	14.5	22.4	7.1	31	55.5	13.5
10	JB	3	1	2	3.4	4.8	11.0	25.2	7.3	23	51.7	25.3
11	JB	3	2	1	0.7	1.9	3.9	9.2	3.3	44	19.0	37.0
12	JB	3	2	2	1.0	1.6	3.3	10.9	4.2	41	21.0	38.0
13	JB	4	1	1	0.1	0.8	4.5	20.7	6.9	31	33.0	36.0
14	JB	4	1	2	0.1	1.1	5.5	23.8	5.4	30	35.9	34.1
15	JB	4	2	1	0.3	2.0	7.1	34.5	6.8	25	50.7	24.3
16	JB	4	2	2	0.1	1.0	5.7	30.1	4.6	29	41.5	29.5
17	LA	1	1	1	1.2	1.6	1.6	1.6	1.8	51	7.8	41.2
18	LA	1	1	2	1.1	1.5	1.4	1.8	2.5	39	8.3	52.7
19	LA	1	2	1	1.7	1.7	1.3	1.2	1.5	51	7.4	41.6
20	LA	1	2	2	2.2	1.9	1.3	1.3	1.4	43	8.1	48.9
21	LA	2	1	1	6.1	5.6	3.6	3.6	4.0	44	22.9	33.1
22	LA	2	1	2	5.0	5.2	3.7	3.6	3.7	41	21.2	37.8
23	LA	2	2	1	0.8	1.0	1.3	1.6	2.0	58	6.7	35.3
24	LA	2	2	2	1.0	1.4	1.5	1.6	1.8	46	7.3	46.7
25	LA	3	1	1	0.2	0.7	1.0	1.8	5.8	53	9.5	37.5
26	LA	3	1	2	0.2	0.4	0.4	1.1	4.4	47	6.5	46.5
27	LA	3	2	1	8.7	7.1	3.9	3.0	3.2	46	25.9	28.1
28	LA	3	2	2	3.0	3.3	2.1	2.2	3.4	39	14.0	47.0
29	LA	4	1	1	0.9	2.5	3.7	6.2	3.6	42	16.9	41.1
30	LA	4	1	2	0.9	2.7	4.2	6.4	3.6	31	17.8	51.2
31	LA	4	2	1	1.9	3.0	2.7	3.4	1.9	58	12.9	29.1
32	LA	4	2	2	5.0	4.8	4.6	5.7	2.8	38	22.9	39.1
33	ME	1	1	1	10.3	8.7	4.2	2.9	1.8	26	27.9	46.1
34	ME	1	1	2	14.6	10.1	4.5	2.7	1.7	20	33.6	46.4
35	ME	1	2	1	8.4	10.2	6.2	3.2	2.1	25	30.1	44.9
36	ME	1	2	2	13.3	8.9	4.6	2.6	1.4	24	30.8	45.2
37	ME	1	3	1	10.8	9.2	5.3	3.6	2.4	25	31.3	43.7
38	ME	1	3	2	14.9	11.6	7.5	4.6	1.4	21	40.0	39.0
39	ME	1	4	1	5.0	3.6	3.2	2.2	0.9	29	14.9	56.1

+JB = Jefferson; LA = Leadvale; ME = Montevallo; MG = Muskingum stony; MK = Muskingum; VC = very coarse sand; C = coarse sand; M = medium sand; F = fine sand; VF = very fine sand

Table 7. Particle Size Analysis of the Control Section. (cont.)+

Observation	Soil	Delineation	Site	Profile	VC	C	M	F	VF	Clay	Total Sand	Silt
					%							
40	ME	1	4	2	2.3	2.9	3.0	2.1	1.2	33	11.5	55.5
41	ME	1	5	1	9.9	4.4	1.9	1.4	1.6	22	19.2	58.8
42	ME	1	5	2	3.7	3.7	2.6	1.6	1.2	25	12.8	62.2
43	ME	1	6	1	2.9	4.2	3.2	2.3	1.2	37	13.8	49.2
44	ME	1	6	2	3.8	4.5	2.8	2.5	1.3	34	14.9	51.1
45	ME	2	1	1	1.1	0.6	0.9	3.4	7.7	23	13.7	63.3
46	ME	2	1	2	0.9	0.5	0.9	3.4	8.0	26	13.7	60.3
47	ME	2	2	1	3.9	3.5	2.7	2.1	1.0	45	13.2	41.8
48	ME	2	2	2	9.7	7.3	4.7	2.5	0.6	23	24.8	52.2
49	ME	2	3	1	23.0	11.8	7.0	4.2	1.1	22	47.1	30.9
50	ME	2	3	2	20.0	10.8	6.4	2.9	0.8	26	40.9	33.1
51	ME	2	4	1	2.1	2.8	3.3	2.5	1.4	30	12.1	57.9
52	ME	2	4	2	4.1	4.5	3.8	2.6	1.2	33	16.2	50.8
53	ME	2	5	1	8.4	5.7	3.9	3.0	2.9	22	23.9	54.1
54	ME	2	5	2	8.7	6.3	4.0	3.0	2.6	25	24.6	50.4
55	ME	2	6	1	9.6	7.6	4.8	3.8	1.3	32	27.1	40.9
56	ME	2	6	2	3.5	3.8	3.5	2.4	1.0	39	14.2	46.8
57	MG	1	1	1	1.8	4.3	6.5	20.4	5.3	33	38.3	28.7
58	MG	1	1	2	3.5	5.2	5.6	17.6	10.3	28	42.2	29.8
59	MG	1	2	1	5.2	5.3	4.0	11.7	9.2	30	35.4	34.6
60	MG	1	2	2	3.6	4.5	3.8	13.9	10.4	25	36.2	38.8
61	MG	1	3	1	1.3	3.1	5.2	15.9	3.9	30	29.4	40.6
62	MG	1	3	2	2.9	3.6	4.6	9.9	7.5	33	28.5	38.5
63	MG	1	4	1	1.2	4.7	7.1	23.6	6.4	32	43.0	25.0
64	MG	1	4	2	1.2	5.7	8.2	24.3	5.8	27	45.2	27.8
65	MG	1	5	1	5.6	6.3	8.6	20.5	6.5	26	47.5	26.5
66	MG	1	5	2	4.4	5.8	7.9	19.1	7.4	27	44.6	28.4
67	MG	1	6	1	2.2	3.5	2.2	13.0	14.6	23	35.5	41.5
68	MG	1	6	2	4.0	4.2	2.7	8.6	13.1	24	32.6	43.4
69	MG	2	1	1	0.0	0.2	5.4	45.2	1.4	19	52.2	28.8
70	MG	2	1	2	0.0	0.2	4.8	41.3	1.0	23	47.3	29.7
71	MG	2	2	1	0.5	1.1	9.6	38.2	7.4	23	56.8	20.2
72	MG	2	2	2	0.3	1.1	11.2	39.6	7.6	18	59.8	22.2
73	MG	2	3	1	0.4	0.6	1.7	45.1	13.5	20	61.3	18.7
74	MG	2	3	2	0.2	0.5	1.9	43.7	14.3	19	60.6	20.4
75	MG	2	4	1	1.1	2.1	8.6	25.0	4.6	34	41.4	24.6
76	MG	2	4	2	0.9	2.3	10.0	25.2	3.0	28	41.4	30.6
77	MG	2	5	1	6.4	5.7	4.2	2.8	1.0	34	20.1	45.9
78	MG	2	5	2	6.2	5.9	4.6	3.0	1.0	32	20.7	47.3
79	MG	2	6	1	0.4	0.7	2.8	30.9	7.0	26	41.8	32.2

+JB = Jefferson; LA = Leadvale; ME = Montevallo; MG = Muskingum stony; MK = Muskingum; VC = very coarse sand; C = coarse sand; M = medium sand; F = fine sand; VF = very fine sand

Table 7. Particle Size Analysis of the Control Section. (cont.)+

Observation	Soil	Delineation	Site	Profile	VC	C	M	F	VF	Clay	Total Sand	Silt
					%							
80	MG	2	6	2	0.2	0.7	3.7	30.5	2.9	27	38.0	35.0
81	MK	1	1	1	5.9	5.8	3.6	3.0	2.4	28	20.7	51.3
82	MK	1	1	2	2.5	4.0	3.0	2.3	1.2	28	13.0	59.0
83	MK	1	2	1	0.4	0.5	1.2	11.4	1.9	23	15.4	61.6
84	MK	1	2	2	0.2	0.5	0.8	2.0	16.8	24	20.3	55.7
85	MK	1	3	1	0.8	1.0	1.1	5.7	8.1	15	16.7	68.3
86	MK	1	3	2	1.1	1.2	1.2	16.1	6.2	17	25.8	57.2
87	MK	1	4	1	0.8	0.6	2.5	25.3	3.9	29	33.1	37.9
88	MK	1	4	2	0.4	0.6	1.8	24.0	3.4	29	30.2	40.8
89	MK	1	5	1	0.8	1.4	1.2	1.8	3.2	16	8.4	75.6
90	MK	1	5	2	0.5	1.1	1.3	1.9	2.9	18	7.7	74.3
91	MK	1	6	1	1.6	1.4	1.0	2.2	11.4	25	17.6	57.4
92	MK	1	6	2	1.6	1.5	1.0	1.6	10.0	26	15.7	58.3
93	MK	2	1	1	5.1	2.5	1.6	5.2	8.9	18	23.3	58.7
94	MK	2	1	2	2.3	1.3	1.8	9.8	2.3	21	17.5	61.5
95	MK	2	2	1	1.2	1.8	1.4	3.6	10.5	27	18.5	54.5
96	MK	2	2	2	2.4	2.1	2.3	6.4	6.2	28	19.4	52.6
97	MK	2	3	1	2.4	2.7	2.5	2.2	1.3	30	11.1	58.9
98	MK	2	3	2	3.1	3.4	2.9	2.8	1.7	31	13.9	55.1
99	MK	2	4	1	7.6	5.6	4.5	2.7	1.6	27	22.0	51.0
100	MK	2	4	2	8.0	6.6	3.8	2.2	1.1	26	21.7	52.3
101	MK	2	5	1	6.4	3.2	2.7	2.2	2.5	31	17.0	52.0
102	MK	2	5	2	3.4	3.1	2.8	2.2	2.4	31	13.9	55.1
103	MK	2	6	1	3.1	3.2	2.2	2.0	1.3	24	11.8	64.2
104	MK	2	6	2	13.3	5.6	2.6	1.7	2.3	22	25.5	52.5

+JB = Jefferson; LA = Leadvale; ME = Montevallo; MG = Muskingum stony; MK = Muskingum; VC = very coarse sand; C = coarse sand; M = medium sand; F = fine sand; VF = very fine sand

Table 8. Chemical Analysis of the Control Section.+

Observation	Soil	Delineation	Site	Profile	pH	Ca	Mg	K	H	Al	SB	CEC	BS
						meq/100 g							%
1	JB	1	1	1	4.00	0.81	0.45	0.19	10.6	5.05	1.45	12.05	12.03
2	JB	1	1	2	4.45	0.50	0.63	0.14	11.4	5.65	1.27	12.67	10.02
3	JB	1	2	1	5.20	0.28	1.04	0.15	11.4	3.95	1.47	12.87	11.42
4	JB	1	2	2	4.76	0.67	0.80	0.13	6.8	1.65	1.60	8.40	19.04
5	JB	2	1	1	4.35	0.70	0.42	0.15	11.0	4.95	1.27	12.27	10.35
6	JB	2	1	2	4.30	0.58	0.30	0.17	10.8	4.45	1.05	11.85	8.86
7	JB	2	2	1	4.40	0.57	0.34	0.10	10.8	5.15	1.01	11.81	8.55
8	JB	2	2	2	4.10	0.97	0.32	0.09	10.8	4.85	1.38	12.18	11.33
9	JB	3	1	1	5.36	2.87	0.40	0.06	4.8	0.10	3.33	8.13	40.95
10	JB	3	1	2	4.75	2.54	0.43	0.14	3.2	0.15	3.11	6.31	49.28
11	JB	3	2	1	4.18	0.20	0.17	0.19	9.0	3.75	0.56	9.56	5.85
12	JB	3	2	2	4.02	0.22	0.15	0.19	7.8	3.05	0.56	8.36	6.69
13	JB	4	1	1	3.93	0.02	1.25	0.16	14.8	8.45	1.43	16.23	8.81
14	JB	4	1	2	4.20	0.06	1.10	0.14	13.0	8.05	1.30	14.30	9.09
15	JB	4	2	1	4.53	0.09	0.25	0.14	10.2	5.65	0.48	10.68	4.49
16	JB	4	2	2	4.50	0.03	0.31	0.14	11.4	6.05	0.48	11.88	4.04
17	LA	1	1	1	4.45	0.10	0.13	0.18	15.8	9.25	0.41	16.21	2.52
18	LA	1	1	2	4.08	0.47	0.27	0.16	18.4	9.15	0.90	19.30	4.66
19	LA	1	2	1	4.25	0.11	0.19	0.08	11.4	6.15	0.38	11.78	3.22
20	LA	1	2	2	4.26	0.08	0.17	0.09	11.8	6.65	0.34	12.14	2.80
21	LA	2	1	1	4.00	0.26	0.15	0.19	15.4	6.95	0.60	16.00	3.75
22	LA	2	1	2	4.31	0.16	0.18	0.19	13.8	6.75	0.53	14.33	3.69
23	LA	2	2	1	4.17	0.03	0.11	0.11	14.6	8.25	0.25	14.85	1.68
24	LA	2	2	2	4.22	0.10	0.27	0.25	15.8	8.25	0.62	16.42	3.77
25	LA	3	1	1	4.40	0.22	0.89	0.22	10.8	5.55	1.33	12.13	10.96
26	LA	3	1	2	4.48	0.07	0.77	0.19	9.8	5.95	1.03	10.83	9.51
27	LA	3	2	1	4.85	1.28	0.67	0.23	10.4	3.75	2.18	12.58	17.32
28	LA	3	2	2	4.60	0.37	0.52	0.18	9.4	4.75	1.07	10.47	10.21
29	LA	4	1	1	4.04	0.20	0.15	0.09	13.8	7.65	0.44	14.24	3.08
30	LA	4	1	2	4.05	0.20	0.17	0.15	14.4	8.05	0.52	14.92	3.48
31	LA	4	2	1	4.20	0.75	0.45	0.19	13.8	7.35	1.39	15.19	9.15
32	LA	4	2	2	4.20	0.40	0.27	0.16	12.0	3.05	0.83	12.83	6.46
33	ME	1	1	1	4.35	0.76	1.08	0.24	11.2	4.05	2.08	10.76	19.33
34	ME	1	1	2	4.65	1.73	1.65	0.24	8.6	1.85	3.62	9.51	38.06
35	ME	1	2	1	4.45	2.55	2.00	0.24	8.8	1.65	4.79	13.59	35.24
36	ME	1	2	2	4.50	1.02	1.29	0.20	10.4	3.45	2.51	12.91	19.44
37	ME	1	3	1	4.55	3.34	1.32	0.22	10.2	1.95	4.88	11.77	41.46
38	ME	1	3	2	4.42	3.98	1.05	0.43	17.4	2.75	5.46	16.85	32.40
39	ME	1	4	1	3.95	0.17	0.09	0.16	17.6	6.55	0.42	13.50	3.11
40	ME	1	4	2	4.16	0.08	0.06	0.12	15.0	6.15	0.26	12.49	2.08

+JB = Jefferson; LA = Leadvale; ME = Montevallo; MG = Muskingum stony; MK = Muskingum; SB = sum of bases; CEC = cation exchange capacity; BS = base saturation

Table 8. Chemical Analysis of the Control Section. (cont.)+

Obser- vation	Soil	Deline- ation	Site	Pro- file	pH	Ca	Mg	K	H	Al	SB	CEC	BS
						--------	--------	--------	meq/100 g	--------	--------	--------	--%--
41	ME	1	5	1	4.22	0.24	0.45	0.37	10.4	4.05	1.06	9.48	11.18
42	ME	1	5	2	4.20	0.10	0.73	0.34	10.6	4.25	1.17	11.77	9.94
43	ME	1	6	1	4.32	0.32	0.27	0.23	10.8	5.75	0.82	12.02	6.82
44	ME	1	6	2	4.50	0.20	0.19	0.20	10.2	5.45	0.59	10.02	5.89
45	ME	2	1	1	4.40	0.16	0.30	0.08	6.8	3.75	0.54	7.34	7.35
46	ME	2	1	2	4.20	0.15	0.26	0.12	18.0	8.65	0.53	18.53	2.86
47	ME	2	2	1	4.11	0.68	0.70	0.18	9.4	6.55	1.56	10.96	14.23
48	ME	2	2	2	4.00	0.60	0.41	0.17	13.2	4.05	1.18	10.68	11.05
49	ME	2	3	1	4.15	0.46	0.55	0.19	15.4	5.85	1.20	14.24	8.43
50	ME	2	3	2	4.20	0.90	0.50	0.23	17.8	6.25	1.63	16.02	10.17
51	ME	2	4	1	4.12	1.03	0.64	0.31	11.2	4.55	1.98	10.46	18.93
52	ME	2	4	2	4.15	0.57	0.42	0.28	12.2	5.55	1.27	11.32	11.22
53	ME	2	5	1	4.35	1.85	0.65	0.34	12.4	3.05	2.84	12.94	21.95
54	ME	2	5	2	4.30	0.76	0.44	0.32	13.0	4.55	1.52	11.59	13.11
55	ME	2	6	1	4.24	0.16	0.29	0.25	13.0	6.85	0.70	11.03	6.35
56	ME	2	6	2	4.10	0.25	0.29	0.17	12.4	6.75	0.71	11.17	6.36
57	MG	1	1	1	4.20	0.02	0.06	0.16	13.2	5.55	0.24	13.44	1.78
58	MG	1	1	2	4.05	0.26	0.12	0.23	13.2	4.35	0.61	11.19	5.45
59	MG	1	2	1	4.55	2.64	0.68	0.31	15.0	4.25	3.63	15.41	23.56
60	MG	1	2	2	4.60	1.42	0.52	0.25	14.4	4.05	2.19	11.91	18.39
61	MG	1	3	1	4.70	0.08	0.16	0.14	14.2	6.35	0.38	14.58	2.60
62	MG	1	3	2	5.94	0.06	0.18	0.13	13.0	6.75	0.37	13.37	2.76
63	MG	1	4	1	4.33	0.06	0.20	0.08	11.8	5.05	0.34	12.14	2.80
64	MG	1	4	2	4.20	0.16	0.07	0.09	10.0	3.85	0.32	10.32	3.10
65	MG	1	5	1	4.00	0.18	0.06	0.18	13.0	4.45	0.42	13.42	3.12
66	MG	1	5	2	4.20	0.15	0.33	0.23	16.2	8.15	0.71	16.91	4.19
67	MG	1	6	1	4.31	1.15	0.84	0.20	8.6	2.25	2.19	10.79	20.29
68	MG	1	6	2	4.77	1.10	0.78	0.15	8.4	3.75	2.03	10.43	19.46
69	MG	2	1	1	4.35	0.12	0.03	0.06	5.2	2.05	0.21	4.18	5.02
70	MG	2	1	2	4.15	0.03	0.14	0.11	7.2	3.45	0.28	7.08	3.95
71	MG	2	2	1	4.15	0.15	0.05	0.08	7.0	2.95	0.28	7.28	3.84
72	MG	2	2	2	4.70	0.16	0.07	0.04	4.4	1.25	0.27	4.67	5.78
73	MG	2	3	1	4.52	0.10	0.08	0.07	5.8	2.75	0.25	5.04	4.96
74	MG	2	3	2	4.37	0.09	0.05	0.05	5.2	2.35	0.19	5.16	3.68
75	MG	2	4	1	4.56	0.04	0.12	0.15	13.0	5.85	0.31	13.31	2.32
76	MG	2	4	2	4.41	0.05	0.42	0.11	10.8	3.45	0.58	11.38	5.09
77	MG	2	5	1	4.38	0.05	0.64	0.18	8.8	4.95	0.87	9.67	8.99
78	MG	2	5	2	4.30	0.18	0.41	0.18	8.0	5.05	0.77	8.77	8.77
79	MG	2	6	1	4.34	0.20	0.11	0.04	8.0	3.35	0.35	8.35	4.19
80	MG	2	6	2	4.38	0.40	0.17	0.06	10.8	5.25	0.63	11.43	5.51

+JB = Jefferson; LA = Leadvale; ME = Montevallo; MG = Muskingum stony; MK = Muskingum; SB = sum of bases; CEC = cation exchange capacity; BS = base saturation

Table 8. Chemical Analysis of the Control Section. (cont.)+

Observation	Soil	Delineation	Site	Profile	pH	Ca	Mg	K	H	Al	SB	CEC	BS
						meq/100 g							--%--
81	MK	1	1	1	4.31	0.27	0.21	0.17	10.6	5.25	0.65	9.21	7.06
82	MK	1	1	2	4.00	0.14	0.08	0.14	14.0	5.35	0.36	11.32	3.18
83	MK	1	2	1	4.12	0.04	0.03	0.12	8.8	4.05	0.19	8.99	2.11
84	MK	1	2	2	4.32	0.06	0.04	0.09	11.0	4.55	0.19	11.19	1.69
85	MK	1	3	1	4.00	0.16	0.08	0.12	5.8	3.05	0.36	6.06	5.94
86	MK	1	3	2	4.22	0.09	0.08	0.11	6.4	2.65	0.28	5.70	4.91
87	MK	1	4	1	4.40	0.02	0.32	0.15	8.8	3.05	0.49	9.29	5.27
88	MK	1	4	2	4.68	0.12	0.40	0.19	6.8	2.45	0.71	7.51	9.45
89	MK	1	5	1	4.20	0.09	0.09	0.18	11.2	4.25	0.36	8.31	4.33
90	MK	1	5	2	4.14	0.09	0.06	0.17	10.6	4.95	0.32	8.26	3.87
91	MK	1	6	1	4.14	0.16	0.24	0.14	7.4	4.95	0.54	7.94	6.80
92	MK	1	6	2	4.80	0.11	0.03	0.16	6.4	4.75	0.30	6.70	4.47
93	MK	2	1	1	3.95	0.01	0.06	0.11	7.6	3.15	0.18	6.68	2.62
94	MK	2	1	2	4.01	0.02	0.04	0.10	7.0	3.05	0.16	7.10	2.25
95	MK	2	2	1	3.80	0.11	0.09	0.20	11.4	5.95	0.40	11.80	3.38
96	MK	2	2	2	4.25	0.10	0.14	0.14	11.4	5.75	0.38	9.65	3.94
97	MK	2	3	1	4.00	0.10	0.06	0.16	15.6	6.75	0.32	13.28	2.41
98	MK	2	3	2	4.15	0.28	0.10	0.20	18.0	7.65	0.58	15.46	3.75
99	MK	2	4	1	4.02	0.14	0.12	0.22	12.4	4.55	0.48	10.51	4.57
100	MK	2	4	2	4.55	0.12	0.64	0.19	8.4	4.75	0.95	8.26	11.50
101	MK	2	5	1	4.35	0.89	0.53	0.43	14.6	4.45	1.85	13.48	13.72
102	MK	2	5	2	4.04	0.26	0.29	0.17	14.0	5.05	0.72	11.76	6.12
103	MK	2	6	1	4.10	0.16	0.16	0.14	14.8	5.35	0.46	12.93	3.56
104	MK	2	6	2	4.10	0.14	0.09	0.18	15.2	6.55	0.41	13.90	2.95

+JB = Jefferson; LA = Leadvale; ME = Montevallo; MG = Muskingum stony;
MK = Muskingum; SB = sum of bases; CEC = cation exchange capacity; BS = base saturation

Base saturation, cation exchange capacity (CEC), and particle size analysis are several of the principal criteria used to classify soils in <u>Soil Taxonomy</u> (Soil Survey Staff, 1975a). For this reason, the emphasis in this research was upon those variables which taxonomically differentiate soils. Therefore, the discussions and conclusions from ANOVA were primarily focused on CEC and percent base saturation, total sand, and clay content of the control section. Other physical and chemical variables used in ANOVA are listed in Appendix F.

The highest percentage of variation, with respect to CEC, was contributed by delineations of Jefferson. However, the sites within the delineations contributed most of the variation with respect to the other three variables (Table 9). Because differences between delineations of Jefferson were so small with respect to base saturation, clay, and total sand content, a definitive statement could not be made about delineations of Jefferson. When the variance of delineations and sites was pooled, however, the indeterminate statement could be made, for example, that at the .05 level delineations and sites were significantly different with respect to base saturation (Table 9). Pooling tends to reduce the alpha level and make it easier to reject the null hypothesis by increasing the degrees of freedom, and at the same time increasing the percent of variance component. Interpretations after pooling are less precise, but nevertheless give an indication of the variability.

Most of the variation in Leadvale with respect to CEC and total sand content was among the sites as opposed to base saturation in which variation was among the delineations. No statement could be made for clay content because too little difference existed in Leadvale to be detected or analyzed by ANOVA (Table 10).

Because the data necessitated pooling, CEC was indeterminant in Montevallo. With respect to percent base saturation and total sand content, variation was greatest among the sites. However, profiles contributed 67% of the variation with respect to clay (Table 11).

In the Muskingum stony mapping unit, CEC variation was greatest among the delineations (60%). Base saturation, total sand, and clay variation was greatest among sites within delineations (Table 12).

The variation in Muskingum with respect to CEC, clay, and total sand was greatest among the sites. However, 68% of the base saturation variation was contributed by profiles (Table 13).

In effect, the data in Tables 9 through 13 illustrated that the variation or heterogeneity of any given mapping

TABLE 9

ANOVA and VARCOMP for Jefferson fsl.*

Variable**	Delineation alpha***	Delineation %****	Site alpha***	Site %****	Error %****
CEC	0.124	49	0.096	24	27
BS	-	-	<0.001	95	5
Clay	-	-	<0.005	81	19
Total sand	-	-	<0.050	64	36

*ANOVA = analysis of variance; VARCOMP = variance component analysis

**CEC = cation exchange capacity; BS = base saturation

***probability of rejecting a true null hypothesis

****percent of total variability contributed by each level in ANOVA design

TABLE 10

ANOVA and VARCOMP for Leadvale sil.*

Variable**	Delineation		Site		Error
	alpha***	%****	alpha***	%****	%****
CEC	0.363	15	0.025	57	28
BS	0.037	70	0.190	10	20
Clay	-	-	-	-	-
Total sand	-	-	<0.025	67	33

*ANOVA = analysis of variance; VARCOMP = variance component analysis
**CEC = cation exchange capacity; BS = base saturation
***probability of rejecting a true null hypothesis
****percent of total variability contributed by each level in ANOVA design

TABLE 11

ANOVA and VARCOMP for Montevallo sh sil.*

Variable**	Delineation		Site		Error
	alpha***	%****	alpha***	%****	%****
CEC	-	-	-	-	-
BS	0.231	8	0.002	66	26
Clay	-	-	<0.250	33	67
Total sand	-	-	<0.001	81	19

*ANOVA = analysis of variance; VARCOMP = variance component analysis
**CEC = cation exchange capacity; BS = base saturation
***probability of rejecting a true null hypothesis
****percent of total variability contributed by each level in ANOVA design

TABLE 12

ANOVA and VARCOMP for Muskingum Stony vfsl.*

Variable**	Delineation		Site		Error
	alpha***	%****	alpha***	%****	%****
CEC	0.006	60	0.010	25	15
BS	0.332	1	<0.001	94	5
Clay	0.298	3	0.002	69	28
Total sand	0.319	2	<0.001	96	2

*ANOVA = analysis of variance; VARCOMP = variance component analysis
**CEC = cation exchange capacity; BS = base saturation
***probability of rejecting a true null hypothesis
****percent of total variability contributed by each level in ANOVA design

TABLE 13

ANOVA and VARCOMP for Muskingum vfsl.*

Variable**	Delineation		Site		Error
	alpha***	%****	alpha***	%****	%****
CEC	0.054	36	<0.001	49	15
BS	-	-	<0.250	32	68
Clay	0.299	3	<0.001	93	4
Total sand	-	-	<0.025	58	42

*ANOVA = analysis of variance; VARCOMP = variance component analysis
**CEC = cation exchange capacity; BS = base saturation
***probability of rejecting a true null hypothesis
****percent of total variability contributed by each level in ANOVA design

unit was primarily among the sites within the delineations. Generally, it could not be stated that delineations were different with respect to any one soil. Both the ANOVA and the variance component data helped substantiate this conclusion. Knowing that the heterogeneity of a mapping unit was among the sites within delineations was not necessarily an unfavorable finding, because soils generally are variable. A certain part of this variability is acceptable, particularly if it is confined within the delineation. Recognition of this fact further supported the accuracy of soil boundary placement in delineating "soil landscape units", because delineations were not significantly different from each other, and because of the high probability of success with respect to landscape position as previously reported. Drafting different soil boundary lines for the mapping units would not significantly improve the quality of the soil map.

TYPIFYING PEDONS

It was paramount to ascertain whether or not there was sufficient difference between Jefferson and Leadvale, Montevallo and Muskingum, Montevallo and Muskingum stony, and Muskingum and Muskingum stony in order to constitute separate mapping units as reported in the Bland County soil survey. The Jefferson-Leadvale ANOVA indicated that at the .05

level the two soils were significantly different with respect to percent total sand and clay (Table 14). The Wilcoxon Rank Sum Test further substantiated the distinctness of Jefferson and Leadvale with respect to percent clay in the control section, which is a series criterion for separation. The median percent clay for Leadvale was 45% as opposed to 30.5% for Jefferson (Figure 4). Typifying pedons for these soils (Tables 15 and 16) were selected based on these median percentages. Twelve of the 16 total profiles described in Jefferson were an aquic subgroup.

Analysis of variance did not indicate any significant difference at the .05 level between Montevallo and Muskingum stony or between Muskingum and Muskingum stony with respect to CEC, percent base saturation, total sand, and clay content (Tables 17 and 18). Total sand content was significantly different at the .05 level between Montevallo and Muskingum (Table 19). However, Wilcoxon Rank Sum Test statistically indicated that with respect to percent total sand, Muskingum and Montevallo had a median total sand content of approximately 18% in the control section, but Muskingum stony was significantly different from either of the other two soils with a median total sand content of 50% (Figure 5). Therefore, Muskingum and Montevallo were sampled as one soil (Table 20), and Muskingum stony was sampled

TABLE 14

ANOVA and VARCOMP for Jefferson fsl and Leadvale sil.*

Variable**	Soil		Delineation		Site		Error
	alpha***	%****	alpha***	%****	alpha***	%****	%****
CEC	0.094	31	0.141	23	0.010	27	19
BS	0.146	16	-	-	<0.001	78	6
Clay	<0.001	54	-	-	<0.050	21	25
TS	<0.001	74	-	-	<0.001	23	3

*ANOVA = analysis of variance; VARCOMP = variance component analysis
**CEC = cation exchange capacity; BS = base saturation; TS = total sand
***probability of rejecting a true null hypothesis
****percent of total variability contributed by each level in ANOVA design

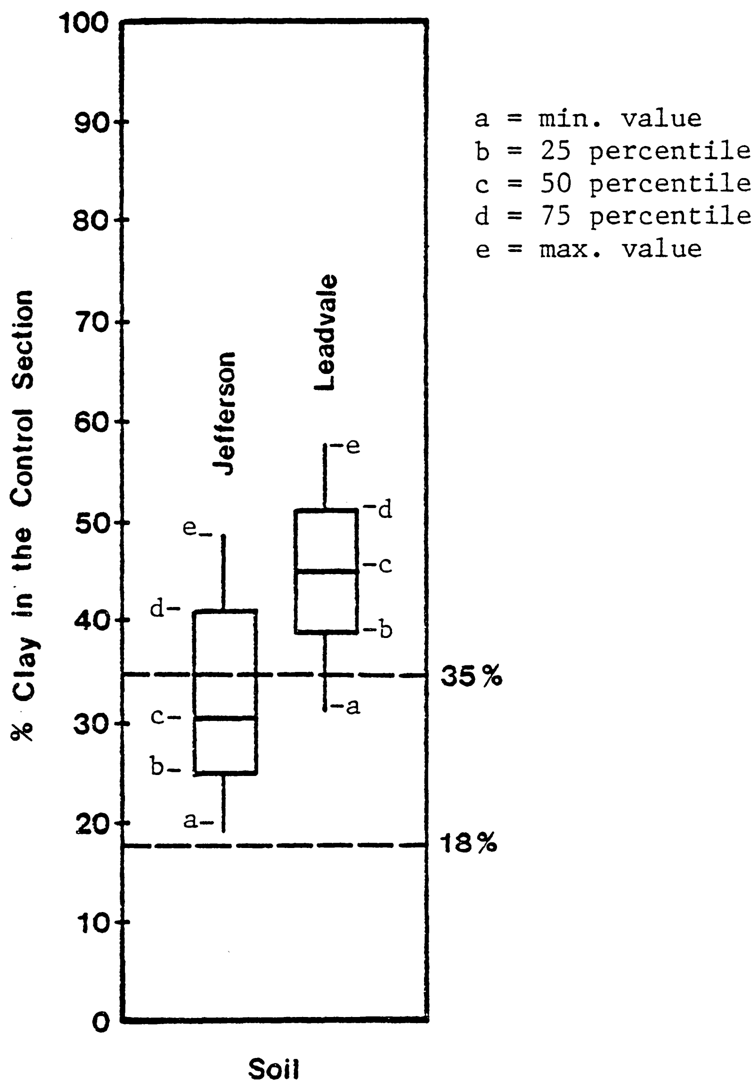

Figure 4. Box and Whisker Plot for Percent Clay in the Control Section of Jefferson fsl and Leadvale sil.

TABLE 15

Jefferson Typifying Pedon.

Ap -- 0 to 7 inches; dark yellowish brown (10YR 4/4) loam; moderate fine granular structure; very friable, slightly sticky, slightly plastic; common fine and medium roots; very strongly acid; gradual smooth boundary.

Bt1 -- 7 to 15 inches; strong brown (7.5YR 5/6) clay loam; strong medium and coarse subangular blocky structure; firm, slightly sticky, plastic; common thin discontinuous clay films on faces of peds; common fine roots; very strongly acid; clear smooth boundary.

Bt2 -- 15 to 26 inches; strong brown (7.5YR 5/6) clay loam; strong medium and coarse subangular blocky structure; firm, slightly sticky, plastic; few fine roots; common thin discontinuous clay films on faces of peds; strongly acid; clear smooth boundary.

Bt3 -- 26 to 33 inches; strong brown (7.5YR 4/6) sandy clay loam; common fine distinct yellowish red (5YR 5/8) and few fine distinct light brownish gray (10YR 6/2) mottles; strong medium and coarse subangular blocky structure; firm, slightly sticky, plastic; few fine roots; common thin discontinuous clay films on faces of peds; strongly acid; clear smooth boundary.

Bt4 -- 33 to 45 inches; yellowish brown (10YR 5/4) sandy clay loam; common medium prominent light brownish gray (10YR 6/2) and common fine distinct yellowish red (5YR 5/8) mottles; strong medium and coarse subangular blocky structure; firm, sticky, plastic; few fine roots; common thin discontinuous clay films on faces of peds; strongly acid; clear smooth boundary.

2C1 -- 45 to 58 inches; gray (10YR 6/1) clay; common medium prominent yellowish brown (10YR 5/8) mottles; massive; very firm, sticky, plastic; few fine roots; common medium clay flows; very strongly acid; clear smooth boundary.

2C2 -- 58 to 72 inches; gray (10YR 6/1) clay; many medium prominent yellowish brown (10YR 5/8) mottles; massive; very firm, sticky, plastic; common medium clay flows; very strongly acid.

TABLE 16

Leadvale Typifying Pedon.

Ap -- 0 to 5 inches; yellowish brown (10YR 5/4) silty clay loam; moderate fine and medium granular structure; very friable, slightly sticky, slightly plastic; common fine medium and coarse roots; very strongly acid; gradual smooth boundary.

Bt1 -- 5 to 15 inches; yellowish brown (10YR 5/6) silty clay loam; moderate fine and medium subangular blocky structure; friable, slightly sticky, plastic; few fine and medium roots; common thin discontinuous clay films on faces of peds; very strongly acid; clear smooth boundary.

Bt2 -- 15 to 32 inches; yellowish brown (10YR 5/8) clay loam; moderate fine and medium subangular blocky structure; friable, sticky, plastic; few fine roots; many medium continuous clay films on faces of peds; about 30 percent of horizon is weathered rock; very strongly acid.

R --32+ inches; black shale.

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as a separate soil (Table 21). Although Muskingum and Montevallo were mapped separately in Bland County, the two soils developed in interstratified sandstone and shale which was responsible for a wide range in particle size distribution, thus offering an explanation for the similarity between the two soils.

Total acreage of the five original mapping units was approximately 100,000 acres or about 44% of the county, and this represented 13 different taxonomic units (Table 22). Occurrence of an argillic horizon, thickness and color of the surface horizon along with numerous other differentiating criteria dictate the taxonomic classification of a soil. Although 13 taxonomic units might seem to be a large number, it is inevitable as a result of our present system of soil classification. The intent of this research is to define the composition of the map units. Decisions regarding acceptance or rejection of each map unit is left to the discretion of the agency making the evaluation.

Taxonomically, the soil names Jefferson, Leadvale, Muskingum, and Montevallo as reported in the Bland County soil survey do not represent the current series concepts accepted today for these soils, but have been used throughout this study for purposes of uniformity and clarity. These old units can be placed in the current taxonomy using morpholo-

TABLE 17

ANOVA and VARCOMP for Montevallo sh sil and Muskingum st vfsl.*

Vari-able**	Level: Soil		Delineation		Site		Error
	alpha***	%****	alpha***	%****	alpha***	%****	%****
CEC	-	-	<0.005	38	0.093	17	45
BS	0.212	19	0.254	5	<0.001	59	17
Clay	-	-	-	-	<0.001	69	31
TS	-	-	<0.005	45	<0.001	50	5

*ANOVA = analysis of variance; VARCOMP = variance component analysis

**CEC= cation exchange capacity; BS= base saturation; TS = total sand

***probability of rejecting a true null hypothesis

****percent of total variability contributed by each level in ANOVA design

TABLE 18

ANOVA and VARCOMP for Muskingum st vfsl and Muskingum vfsl.*

Vari-able**	Soil		Delineation		Site		Error
	alpha***	%****	alpha***	%****	alpha***	%****	%****
CEC	-	-	<0.005	41	<0.001	41	18
BS	0.387	1	-	-	<0.001	83	16
Clay	-	-	<0.500	2	<0.001	82	16
TS	-	-	<0.001	66	<0.001	30	4

*ANOVA = analysis of variance; VARCOMP = variance component analysis
**CEC = cation exchange capacity; BS= base saturation; TS = total sand
***probability of rejecting a true null hypothesis
****percent of total variability contributed by each level in ANOVA design

TABLE 19

ANOVA and VARCOMP for Montevallo sh sil and Muskingum vfsl.*

Variable**	Soil		Delineation		Site		Error
	alpha***	%****	alpha***	%****	alpha***	%****	%****
CEC	0.250	18	0.067	15	0.066	21	46
BS	0.126	36	0.239	5	<0.001	42	17
Clay	-	-	<0.500	3	<0.001	56	41
TS	0.013	6	-	-	<0.001	70	24

*ANOVA = analysis of variance; VARCOMP = variance component analysis

**CEC= cation exchange capacity; BS= base saturation; TS = total sand

***probability of rejecting a true null hypothesis

****percent of total variability contributed by each level in ANOVA design

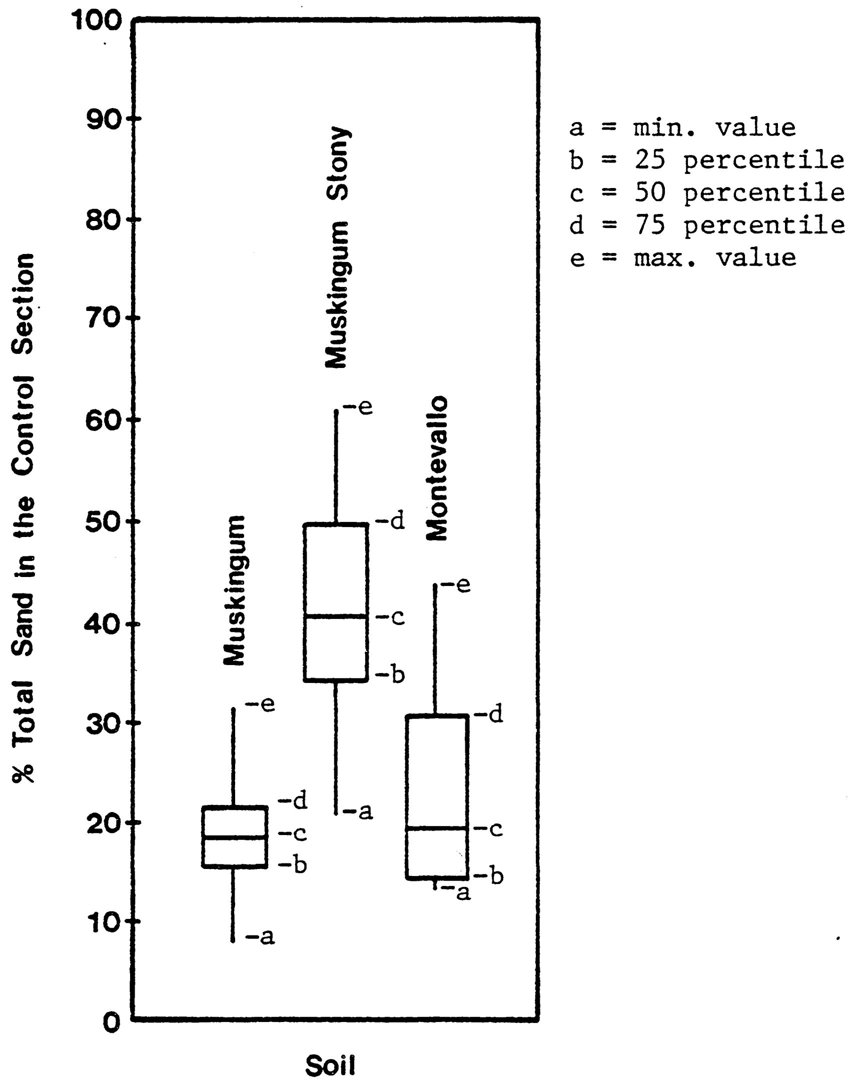

FIGURE 5. Box & Whisker Plot for % Total Sand in the Control Section of Muskingum vfsl, Muskingum st vfsl, & Montevallo sh sil.

TABLE 20

Muskingum/Montevallo Typifying Pedon.

Oi -- 2 to 0 inches; partially decomposed leaves and twigs.

E -- 0 to 4 inches; grayish brown (10YR 5/2) very gravelly silt loam; moderate fine granular structure; very friable, slightly sticky, slightly plastic; many fine and medium roots; about 50 percent of horizon is rock fragments; extremely acid; clear smooth boundary.

Bw1 -- 4 to 20 inches; brownish yellow (10YR 6/6) gravelly silt loam; moderate fine and medium subangular blocky structure; friable, slightly sticky, slightly plastic; common fine and medium roots; few thin discontinuous clay films on faces of peds; about 20 percent of horizon is rock fragments; very strongly acid; clear smooth boundary.

Bw2 -- 20 to 33 inches; yellowish brown (10YR 5/6) gravelly loam; moderate medium subangular blocky structure; friable, slightly sticky, slightly plastic; few fine roots; few thin discontinuous clay films on faces of peds; about 30 percent of horizon is rock fragments; very strongly acid; gradual smooth boundary.

C -- 33 to 72 inches; yellowish brown (10YR 5/6) very gravelly loam; massive; friable, slightly sticky, slightly plastic; few thin clay flows; about 55 percent of horizon is red and gray fine grained sandstone fragments; strongly acid.

TABLE 21

Muskingum Stony Typifying Pedon.

Oi -- 2 to 0 inches; partially decomposed leaves and twigs.

A -- 0 to 4 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate fine granular structure; very friable, slightly sticky, slightly plastic; common fine and medium roots; very strongly acid; clear smooth boundary.

BA -- 4 to 22 inches; strong brown (7.5YR 4/6) sandy clay loam; moderate fine subangular blocky structure; friable, sticky, slightly plastic; common fine and medium roots; few thin discontinuous clay films on faces of peds; very strongly acid; clear smooth boundary.

Bt1 -- 22 to 41 inches; strong brown (7.5YR 5/6) clay loam; moderate fine and medium subangular blocky structure; friable, sticky, slightly plastic; few fine and medium roots; common thin discontinuous clay films on faces of peds; common medium black manganese stains on faces of peds; strongly acid; gradual smooth boundary.

Bt2 -- 41 to 55 inches; strong brown (7.5YR 5/8) clay; moderate medium and coarse subangular blocky structure; firm, sticky, plastic; few fine roots; many medium clay films on faces of peds; strongly acid; gradual smooth boundary.

C -- 55 to 76 inches; yellowish brown (10YR 5/6), brownish yellow (10YR 6/6), and light brownish gray (10YR 6/2) sandy clay loam; massive; firm, sticky, plastic; few fine roots; few thin clay flows; about 30 percent of horizon is stratified highly weathered sandstone and shale; strongly acid.

TABLE 22

Taxonomic Groupings of the Jefferson, Leadvale, Muskingum, Montevallo, and Muskingum stony Mapping Units.

Taxonomic Group	Percent
Jefferson fine sandy loam	
fine-loamy Aquic Paleudults	25
clayey Aquic Hapludults	31
fine-loamy Aquic Hapludults	19
Other soils	25
Leadvale silt loam	
clayey Aquic Hapludults	25
clayey Aquic Paleudults	25
clayey Typic Hapludults	25
Other soils	25
Muskingum very fine sandy loam	
loamy Lithic Dystrochrepts	24
loamy-skeletal Lithic Dystrochrepts	38
loamy-skeletal Typic Dystrochrepts	8
Other soils	30
Montevallo shaly silt loam	
loamy-skeletal Lithic Dystrochrepts	33
loamy-skeletal Typic Dystrochrepts	17
loamy Lithic Dystrochrepts	17
clayey-skeletal Lithic Dystrochrepts	8
Other soils	25
Muskingum stony very fine sandy loam	
fine-loamy Typic Hapludults	33
fine-loamy Typic Dystrochrepts	17
fine-loamy Humic Hapludults	12
loamy Lithic Dystrochrepts	8
fine-loamy Lithic Hapludults	8
Other soils	22

gical, physical, and chemical data. Jefferson is a member of the fine-loamy, siliceous, mesic family of Aquic Paleudults, and Leadvale is a member of the clayey, mixed, mesic family of Typic Hapludults. The classification fine-loamy, siliceous, mesic, Typic Dystrocrept applies to Muskingum and Montevallo which were combined and considered as the same soil. Muskingum stony is a member of the fine-loamy, siliceous, mesic family of Typic Hapludults. In retrospect, Montevallo and Muskingum, according to the soil survey, differed primarily in that Montevallo developed from shale and Muskingum developed from sandstone. The findings from this study, however, indicate that the two soils as they occur in Bland County are similar and that attempts to separate them as different soils would be both impractical and meaningless. As reported in the soil survey, only a phase distinction separated Muskingum from Muskingum stony, the latter soil having stones on the surface. The findings from this study, however, indicate that these soils are significantly different.

The recommendation is that Jefferson and Leadvale mapping units be combined as a consociation. Because of the similarity between Muskingum and Montevallo mapping units, the recommendation is to combine these soils into one mapping unit or consociation. Likewise, Muskingum stony should be mapped as a consociation.

A taxonomic and mapping unit description in addition to selected interpretations (Bartelli, 1978) for Jefferson was written to exemplify the procedure recommended for the remaining three soils. Included is the Jefferson series description for comparison (Appendix J). There is presently no current series that fits the taxonomic classification of Jefferson soil mapped in Bland County. The taxonomic and mapping unit description for Jefferson conforms to SCS policies and procedures for a current soil survey.

SUMMARY AND CONCLUSIONS

The 10 random transects in Bland County traversed 89 delineations of which 70 were within tolerance with respect to slope. The probability of observing 7 or more correct slopes out of 10 randomly chosen slopes was approximately 85%. There were 71 successful observations of parent material out of 89 total delineations encountered. The probability of observing 7 or more succesful observations of parent material out of 10 random observations was approximately 88%. Out of 89 total observations, there were 81 landscape position evaluations that were in agreement with the Bland County soil survey. The probability of observing 7 or more successes out of 10 random observations of landscape position was approximately 99%.

The relatively high correlation of field observations with the Bland County soil survey in regard to slope, parent material, and landscape position supported the conclusion that the delineations represented "soil landscape units", as defined by Schelling (1970).

Variability in all mapping units with respect to CEC, base saturation, total sand, and clay was primarily among sites within delineations. Heterogeneity confined within a delineation further supported the conclusion that the delineations represented "soil landscape units". Remapping would not significantly improve the quality of the soil map, since the original maps delineated valid "soil landscape units".

The soil mapped as Jefferson fine sandy loam in Bland County is a member of the fine-loamy, siliceous, mesic family of Aquic Paleudults. The soil mapped as Leadvale silt loam in Bland County is a member of the clayey, mixed, mesic family of Typic Hapludults. Muskingum very fine sandy loam and Montevallo shaly silt loam as mapped in Bland County are the same soil which is classified as a fine-loamy, siliceous, mesic, Typic Dystrocrept. Muskingum stony very fine sandy loam is different from its non-stony phase and is classified as a fine-loamy, siliceous, mesic, Typic Hapludult.

This study has shown that areas formerly mapped as Jefferson, Leadvale, Montevallo, and Muskingum soils actually are composed of more than one taxonomic unit, but are so intermingled that they cannot be separated by order-two soil survey into smaller map units of individual soils (Table 22). Hence, the suggested disposition of the map units is to rename them as a consociation and list percentages of individual soils. Interpretations for the map units would consider individual soil characteristics and their proportions of the map unit. A detailed disposition of Jefferson is shown in Appendix J. Other map units may require establishment of new series.

The total acreage from the five mapping units that were evaluated in Bland County was approximately 100,000 acres. At a mapping rate of 30,000 acres per year at an average cost of $2.50 per acre, it would require over 3 years' time at a cost of about $250,000 to remap 100,000 acres. Using the developed methodology and considering approximately 12 weeks for field work, 6 weeks for lab analyses, and 2 weeks for data analyses, 100,000 acres were evaluated in less than 6 months. Considering approximately $5,000 for laboratory and computer analyses and 6 months' salary for a soil scientist, 100,000 acres were evaluated for $20,000 using the developed methodology. Similar savings could be expected for order-two soil surveys in other counties that are comparable in topography, size of mapping units, and other features common to Bland County.

The Bland County soil survey map is a superior map, and there is little reason for remapping the county considering current demands and costs. The primary task is to evaluate the mapping units and transfer the soil boundary lines to an aerial photographic base.

If the methodology proposed in this research is followed, a substantial amount of time and money can be saved in updating pre-taxonomy soil surveys.

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Appendix A -- Particle Size Analysis of Typifying Pedons.

Horizon	Depth	Coarse Fragments	SAND Very Coarse	SAND Coarse	SAND Medium	SAND Fine	SAND Very Fine	SAND Total	Silt	Clay	Textural Class
	in.	%	%	%	%	%	%	%	%	%	
Jefferson fine sandy loam											
Ap	0-7	<5	0.28	1.58	6.92	26.85	9.05	44.68	34.32	21.00	l
Bt1	7-15	<5	0.10	1.28	5.65	22.10	7.80	36.93	30.67	32.40	cl
Bt2	15-26	<5	0.08	0.90	5.68	24.50	8.52	39.68	25.72	34.60	cl
Bt3	26-33	<5	0.25	1.88	7.85	27.48	8.52	45.98	23.02	31.00	scl
Bt4	33-45	<5	0.42	2.42	9.42	31.85	8.55	52.66	18.34	29.00	scl
2C1	45-58	<5	0.00	0.08	0.50	3.50	2.25	6.33	36.07	57.60	c
2C2	58-72	10	0.15	1.02	3.55	8.90	4.15	17.77	37.73	44.50	c
Leadvale silt loam											
Ap	0-5	<2	0.62	0.88	1.35	1.90	2.88	7.63	63.97	28.40	sicl
Bt1	5-15	<2	0.48	1.05	1.20	1.55	2.50	6.78	55.62	37.60	sicl
Bt2	15-32	30	1.78	4.20	3.90	5.30	15.00	30.18	29.82	40.00	cl-c
Muskingum very fine sandy loam / Montevallo shaly silt loam											
E	0-4	50	0.92	0.78	0.72	2.58	12.10	17.10	60.30	22.60	sil
Bw1	4-20	<20	0.85	1.50	1.20	2.82	13.25	19.62	56.78	23.60	sil
Bw2	20-33	35	2.48	4.08	2.85	5.15	16.72	31.28	46.72	22.00	l
C	33-72	55	2.70	5.80	4.22	5.80	15.62	34.14	45.86	20.00	l
Muskingum stony very fine sandy loam											
A	0-4	5	0.68	1.38	7.20	25.92	12.05	47.23	26.77	26.00	scl
BA	4-22	5	0.32	0.70	5.12	26.55	13.70	46.39	27.61	26.00	scl-cl-l
Bt1	22-41	<5	0.20	0.88	4.60	22.85	15.78	44.31	21.69	34.00	cl
Bt2	41-55	<5	0.02	0.15	0.88	8.40	16.50	25.95	24.85	49.20	c
C	55-76	20	0.05	0.30	1.50	31.42	26.10	59.37	9.63	31.00	scl

Appendix B -- Chemical Analysis of Typifying Pedons.

Horizon	Depth	pH	Organic Matter	Free Fe	Ca	Mg	K	H	Al	Total+	Sum of Bases*	CEC**	Base Saturation
	in.		---- % -----		------------------- meq/100 g						------------------		--- % ----
Jefferson fine sandy loam													
Ap	0-7	4.98	1.63	0.88	0.39	0.15	0.09	7.60	2.45	8.23	----	----	7.65
Bt1	7-15	4.75	0.43	1.90	0.30	0.16	0.08	8.00	3.65	8.54	----	----	6.32
Bt2	15-26	5.24	0.14	3.05	0.35	0.43	0.15	8.80	3.95	9.73	----	----	9.56
Bt3	26-33	5.23	0.09	2.65	0.10	0.42	0.16	7.40	3.75	8.08	----	----	8.42
Bt4	33-45	5.12	0.09	2.35	0.10	0.43	0.12	5.40	3.35	6.05	----	----	10.74
2C1	45-58	4.77	0.23	2.95	0.14	1.40	0.21	13.60	8.85	15.35	----	----	11.40
2C2	58-72	4.90	0.06	6.00	0.08	1.10	0.13	8.60	5.55	9.91	----	----	13.22
Leadvale silt loam													
Ap	0-5	4.48	2.79	1.90	0.20	0.07	0.14	12.20	4.35	12.61	----	----	3.25
Bt1	5-15	4.61	0.52	4.20	0.14	0.17	0.16	11.00	5.75	11.47	----	----	4.10
Bt2	15-32	4.70	0.21	3.65	0.14	0.40	0.16	12.20	7.35	12.90	----	----	5.43
Muskingum very fine sandy loam / Montevallo shaly silt loam													
E	0-4	4.37	4.64	1.40	0.19	0.07	0.20	12.80	4.35	----	0.46	10.85	4.24
Bw1	4-20	4.68	1.86	1.40	0.10	0.04	0.13	7.80	2.95	----	0.27	6.49	4.16
Bw2	20-33	4.93	0.06	2.63	0.05	0.16	0.18	5.80	4.15	----	0.39	6.98	5.59
C	33-72	5.08	0.09	2.38	0.10	0.23	0.15	6.00	3.75	----	0.48	6.30	7.62
Muskingum stony very fine sandy loam													
A	0-4	4.83	4.46	2.35	0.04	0.11	0.18	14.20	2.45	14.53	----	----	2.27
BA	4-22	5.02	0.70	2.20	0.11	0.29	0.13	7.00	2.55	7.53	----	----	7.04
Bt1	22-41	5.25	0.12	8.40	0.12	0.10	0.10	9.80	3.65	10.12	----	----	3.16
Bt2	41-55	5.36	0.09	9.68	0.04	0.08	0.14	10.80	3.75	11.06	----	----	2.35
C	55-76	5.06	0.03	7.25	0.08	0.06	0.10	6.00	3.05	6.24	----	----	3.85

+Does not include Al
*Includes Ca, Mg, K
**By Kjeldahl disstillation of NH4+ saturated soil

Appendix C -- Petrographic Analysis of the >50 μ (sand) Fraction of Typifying Pedons.

Horizon	Depth	Quartz	Feldspar	Mica	Opaques	H.M.	Rock Frag.
		Minerals Present+ >50 μ (sand) fraction (frequency/100 grains)					
	in.	%					
Jefferson fine sandy loam							
Ap	0-7	99 ± .9	Tr	Tr	Tr	Tr	Tr
Bt1	7-15	99 ± .9	Tr	Tr	Tr	Tr	Tr
Bt2	15-26	97 ± 1.0	Tr	Tr	Tr	Tr	2 ± .9
Bt3	26-33	96 ± 1.0	Tr	Tr	Tr	Tr	3 ± 1.0
Bt4	33-45	97 ± 1.0	Tr	Tr	Tr	Tr	2 ± .9
2C1	45-58	97 ± 1.0	Tr	Tr	1 ± .8	Tr	2 ± .9
2C2	58-72	97 ± 1.0	Tr	Tr	Tr	Tr	Tr
Leadvale silt loam							
Ap	0-5	93 ± 1.5	1	Tr	2 ± .9	-	4 ± 1.4
Bt1	5-15	91 ± 2.0	Tr	1 ± .8	1 ± .8	Tr	6 ± 1.5
Bt2	15-32	88 ± 2.4	Tr	Tr	Tr	-	11 ± 2.4
Muskingum very fine sandy loam / Montevallo shaly silt loam							
E	0-4	97 ± 1.0	Tr	Tr	Tr	Tr	2 ± .9
Bw1	4-20	97 ± 1.0	Tr	Tr	1 ± .8	Tr	1 ± .8
Bw2	20-33	97 ± 1.0	Tr	Tr	Tr	Tr	2 ± .9
C	33-72	94 ± 1.5	Tr	1 ± .8	2 ± .9	Tr	3 ± 1.0
Muskingum stony very fine sandy loam							
A	0-4	98 ± .9	Tr	Tr	2 ± .9	Tr	Tr
BA	4-22	98 ± .9	Tr	Tr	Tr	Tr	2 ± .9
Bt1	22-41	99 ± .9	Tr	Tr	Tr	Tr	Tr
Bt2	41-55	98 ± .9	Tr	Tr	1 ± .8	-	1 ± .8
C	55-76	99 ± .9	Tr	Tr	Tr	Tr	Tr

+ Opaques = opaque minerals (ilmenite, magnetite, etc.); H.M. = translucent heavy minerals (zircon, tourmaline, rutile, epidote, hornblende, etc.); Rock frag. = rock fragments (mineral aggregates).

Appendix D -- Taxonomic Classification of Mapping Units.

Del	Sit	Pro	Classification
Jefferson fine sandy loam			
1	1	1	clayey, siliceous, mesic Aquic Hapludult
1	1	2	clayey, siliceous, mesic Aquic Hapludult
1	2	1	fine-loamy, siliceous, mesic Aquic Hapludult
1	2	2	fine-loamy, siliceous, mesic Typic Hapludult
2	1	1	clayey, siliceous, mesic Aquic Hapludult
2	1	2	clayey, siliceous, mesic Lithic Hapludult
2	2	1	fine-loamy, siliceous, mesic Aquic Hapludult
2	2	2	fine-loamy, siliceous, mesic Aquic Hapludult
3	1	1	loamy-skeletal, siliceous, mesic Ultic Hapludalf
3	1	2	loamy-skeletal, siliceous, mesic Typic Paleudalf
3	2	1	clayey, siliceous, mesic Aquic Hapludult
3	2	2	clayey, siliceous, mesic Aquic Hapludult
4	1	1	fine-loamy, siliceous, mesic Aquic Paleudult
4	1	2	fine-loamy, siliceous, mesic Aquic Paleudult
4	2	1	fine-loamy, siliceous, mesic Aquic Paleudult
4	2	2	fine-loamy, siliceous, mesic Aquic Paleudult

Del	Sit	Pro	Classification
Leadvale silt loam			
1	1	1	clayey, siliceous, mesic Aquic Paleudult
1	1	2	clayey, siliceous, mesic Aquic Paleudult
1	2	1	clayey, siliceous, mesic Aquic Paleudult
1	2	2	clayey, siliceous, mesic Aquic Paleudult
2	1	1	clayey, siliceous, mesic Typic Hapludult
2	1	2	clayey, siliceous, mesic Lithic Hapludult
2	2	1	clayey, siliceous, mesic Typic Hapludult
2	2	2	clayey, siliceous, mesic Typic Hapludult
3	1	1	clayey, siliceous, mesic Aquic Hapludult
3	1	2	clayey, siliceous, mesic Aquic Hapludult
3	2	1	clayey, siliceous, mesic Typic Hapludult
3	2	2	clayey, siliceous, mesic Aquic Hapludult
4	1	1	clayey, siliceous, mesic Aquic Hapludult
4	1	2	fine-silty, siliceous, mesic Typic Hapludult
4	2	1	clayey, siliceous, mesic Ochreptic Hapludult
4	2	2	clayey, siliceous, mesic Typic Hapludult

Del = Delineation; Sit = Site; Pro = Profile

Appendix D -- Taxonomic Classification of Mapping Units. (cont.)

Del	Sit	Pro	Classification
Muskingum very fine sandy loam			
1	1	1	loamy-skeletal, siliceous, mesic Typic Dystrochrept
1	1	2	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
1	2	1	loamy, siliceous, mesic Lithic Dystrochrept
1	2	2	fine-silty, siliceous, mesic Lithic Hapludult
1	3	1	loamy, siliceous, mesic Lithic Dystrochrept
1	3	2	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
1	4	1	fine-loamy, siliceous, mesic Typic Hapludult
1	4	2	fine-loamy, siliceous, mesic Ochreptic Hapludult
1	5	1	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
1	5	2	loamy, siliceous, mesic Lithic Dystrochrept
1	6	1	fine-silty, siliceous, mesic Typic Hapludult
1	6	2	fine-loamy, siliceous, mesic Aquic Paleudult
2	1	1	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
2	1	2	fine-loamy, siliceous, mesic Typic Dystrochrept
2	2	1	fine-loamy, siliceous, mesic Lithic Hapludult
2	2	2	loamy, siliceous, mesic Lithic Dystrochrept
2	3	1	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
2	3	2	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
2	4	1	loamy, siliceous, mesic Lithic Dystrochrept
2	4	2	loamy-skeletal, siliceous, mesic Typic Dystrochrept
2	5	1	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
2	5	2	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
2	6	1	loamy, siliceous, mesic Lithic Dystrochrept
2	6	2	loamy-skeletal, siliceous, mesic Lithic Dystrochrept

Del = Delineation; Sit = Site; Pro = Profile

Appendix D -- Taxonomic Classification of Mapping Units. (cont.)

Del	Sit	Pro	Classification
Muskingum stony very fine sandy loam			
1	1	1	fine-loamy, siliceous, mesic Lithic Hapludult
1	1	2	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
1	2	1	fine-loamy, siliceous, mesic Typic Dystrochrept
1	2	2	loamy, siliceous, mesic Lithic Dystrochrept
1	3	1	fine-loamy, siliceous, mesic Typic Hapludult
1	3	2	fine-loamy, siliceous, mesic Typic Hapludult
1	4	1	fine-loamy, siliceous, mesic Typic Hapludult
1	4	2	fine-loamy, siliceous, mesic Lithic Hapludult
1	5	1	loamy-skeletal, siliceous, mesic Lithic Hapludult
1	5	2	loamy-skeletal, siliceous, mesic Typic Hapludult
1	6	1	fine-loamy, siliceous, mesic Typic Hapludult
1	6	2	fine-loamy, siliceous, mesic Humic Hapludult
2	1	1	loamy, siliceous, mesic Lithic Dystrochrept
2	1	2	fine-loamy, siliceous, mesic Typic Dystrochrept
2	2	1	fine-loamy, siliceous, mesic Typic Hapludult
2	2	2	fine-loamy, siliceous, mesic Typic Hapludult
2	3	1	fine-loamy, siliceous, mesic Typic Dystrochrept
2	3	2	fine-loamy, siliceous, mesic Typic Dystrochrept
2	4	1	fine-loamy, siliceous, mesic Typic Paleudult
2	4	2	fine-loamy, siliceous, mesic Typic Hapludult
2	5	1	fine-loamy, siliceous, mesic Typic Hapludult
2	5	2	fine-loamy, siliceous, mesic Ochreptic Hapludult
2	6	1	fine-loamy, siliceous, mesic Humic Hapludult
2	6	2	fine-loamy, siliceous, mesic Humic Hapludult

Del = Delineation; Sit = Site; Pro = Profile

Appendix D -- Taxonomic Classification of Mapping Units. (cont.)

Del	Sit	Pro	Classification
Montevallo shaly silt loam			
1	1	1	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
1	1	2	loamy-skeletal, siliceous, mesic Typic Dystrochrept
1	2	1	fine-loamy, siliceous, mesic Ultic Hapludalf
1	2	2	fine-loamy, siliceous, mesic Humic Hapludult
1	3	1	loamy-skeletal, siliceous, mesic Typic Dystrochrept
1	3	2	loamy-skeletal, siliceous, mesic Typic Dystrochrept
1	4	1	loamy, siliceous, mesic Lithic Dystrochrept
1	4	2	loamy, siliceous, mesic Lithic Dystrochrept
1	5	1	loamy, siliceous, mesic Lithic Dystrochrept
1	5	2	fine-loamy, siliceous, mesic Lithic Hapludult
1	6	1	clayey-skeletal, siliceous, mesic Lithic Dystrochrept
1	6	2	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
2	1	1	fine-silty, siliceous, mesic Typic Hapludult
2	1	2	fine-silty, siliceous, mesic Aquic Hapludult
2	2	1	clayey, siliceous, mesic Ochreptic Hapludult
2	2	2	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
2	3	1	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
2	3	2	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
2	4	1	loamy, siliceous, mesic Lithic Dystrochrept
2	4	2	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
2	5	1	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
2	5	2	loamy-skeletal, siliceous, mesic Lithic Dystrochrept
2	6	1	loamy-skeletal, siliceous, mesic Typic Dystrochrept
2	6	2	clayey-skeletal, siliceous, mesic Lithic Dystrochrept

Del = Delineation; Sit = Site; Pro = Profile

Appendix E -- Confidence Interval on the Mean for Selected Chemical and Physical Variables.

	90% Confidence Interval on Mean				
Variable*	Jefferson fsl	Leadvale sil	Montevallo sh sil	Muskingum stony vfsl	Muskingum vfsl
pH	4.44 ± 0.26	4.28 ± 0.24	4.27 ± 0.51	4.44 ± 0.16	4.19 ± 0.09
Ca**	0.69 ± 0.58	0.30 ± 0.18	0.92 ± 0.53	0.37 ± 1.50	0.15 ± 0.24
Mg**	0.52 ± 0.23	0.34 ± 0.30	0.60 ± 1.24	0.26 ± 0.45	0.16 ± 0.07
K**	0.14 ± 0.02	0.17 ± 0.04	0.23 ± 0.04	0.14 ± 0.27	0.16 ± 0.13
H**	9.86 ± 3.08	13.21 ± 2.53	12.33 ± 1.19	10.22 ± 14.94	10.76 ± 11.21
Al**	4.43 ± 0.60	6.72 ± 1.50	4.76 ± 4.87	4.23 ± 4.24	4.68 ± 3.60
CEC**	11.22 ± 2.61	14.01 ± 2.04	--	10.43 ± 15.15	9.81 ± 9.08
BS***	13.80 ± 8.75	6.02 ± 4.86	14.87 ± 24.46	7.87 ± 11.94	5.00 ± 1.26
VC***	0.98 ± 1.07	2.49 ± 1.48	8.12 ± 2.93	2.23 ± 5.34	3.12 ± 10.97
C***	2.23 ± 1.40	2.78 ± 1.24	6.13 ± 1.72	3.22 ± 9.23	2.53 ± 5.66
M***	6.14 ± 2.35	2.39 ± 1.23	3.95 ± 0.85	5.62 ± 1.42	2.12 ± 3.00
F***	22.98 ± 6.28	2.88 ± 2.07	2.81 ± 0.36	23.71 ± 45.25	5.84 ± 14.28
VF***	5.81 ± 1.13	2.96 ± 1.15	1.99 ± 0.99	6.88 ± 9.39	4.73 ± 7.71
clay***	32.19 ± 5.88	--	27.79 ± 2.71	26.71 ± 9.21	24.75 ± 10.00
TS***	38.14 ± 8.33	13.51 ± 2.25	23.01 ± 5.24	41.66 ± 21.84	18.34 ± 2.95
silt***	29.67 ± 4.24	41.05 ± 4.07	49.20 ± 4.38	31.63 ± 4.31	56.91 ± 4.24

*CEC=cation exchange capacity; BS=base saturation;
VC=very coarse sand; C=coarse sand; M=medium sand; F=fine sand;
VF=very fine sand; TS=total sand

**meq/100 g

***percent

APPENDIX F

ANOVA AND VARCOMP*

Jefferson fine sandy loam

Variable**	Delineation		Site		Error
	alpha***	%****	alpha***	%****	%****
pH	-	-	<0.025	66	34
Ca#	-	-	<0.001	96	4
Mg#	-	-	<0.001	93	7
K#	-	-	<0.100	10	90
H#	0.135	49	0.038	32	19
Al#	0.139	52	0.001	42	6
VC##	0.322	23	<0.001	73	4
C##	0.469	2	0.004	89	19
M##	-	-	<0.001	88	12
F##	-	-	<0.001	93	7
VF##	-	-	<0.500	5	95
Silt##	-	-	<0.050	64	36

(Level: Delineation, Site, Error)

*ANOVA = analysis of variance; VARCOMP = variance component analysis
**VC= very coarse sand; C=coarse sand; M=medium sand; F= fine sand; VF= very fine sand
***probability of rejecting a true null hypothesis
****percent of total variability contributed by each level in ANOVA design
#meq/100 g
##percent

Appendix F -- ANOVA and VARCOMP.* (cont.)

Leadvale silt loam

Variable**	Delineation		Site		Error
	alpha***	%****	alpha***	%****	%****
pH	0.053	61	0.316	6	33
Ca#	-	-	<0.250	33	67
Mg#	0.022	79	0.700	11	10
K#	0.269	21	0.295	15	64
H#	0.219	37	0.007	49	14
Al#	0.376	12	0.051	51	37
VC##	-	-	<0.050	56	44
C##	-	-	<0.025	72	28
M##	0.310	22	0.019	54	24
F##	0.062	67	0.022	23	10
VF##	0.305	24	0.003	63	13
Silt##	-	-	-	-	-

*ANOVA = analysis of variance; VARCOMP = variance component analysis

**VC= very coarse sand; C=coarse sand; M=medium sand; F= fine sand; VF= very fine sand

***probability of rejecting a true null hypothesis

****percent of total variability contributed by each level in ANOVA design

#meq/100 g

##percent

Appendix F -- ANOVA and VARCOMP.* (cont.)

Montevallo shaly silt loam					
	Level				
Variable**	Delineation		Site		Error
	alpha***	%****	alpha***	%****	%****
pH	0.086	26	0.014	44	30
Ca#	-	-	<0.001	81	19
Mg#	0.172	15	<0.001	68	17
K#	-	-	<0.010	66	34
H#	-	-	<0.500	8	92
Al#	0.086	23	0.097	29	48
VC##	-	-	<0.001	78	22
C##	-	-	<0.001	85	15
M##	-	-	<0.001	80	20
F##	-	-	<0.010	63	37
VF##	-	-	<0.001	97	3
Silt##	-	-	<0.001	86	14

*ANOVA = analysis of variance; VARCOMP = variance component analysis
**VC= very coarse sand; C=coarse sand; M=medium sand; F= fine sand; VF= very fine sand
***probability of rejecting a true null hypothesis
****percent of total variability contributed by each level in ANOVA design
#meq/100 g
##percent

Appendix F -- ANOVA and VARCOMP.* (cont.)

Muskingum stony very fine sandy loam

	Level				
Variable**	Delineation		Site		Error
	alpha***	%****	alpha***	%****	%****
pH	-	-	<0.250	37	63
Ca#	0.181	14	<0.001	70	16
Mg#	0.340	0	<0.001	82	18
K#	0.032	43	<0.001	44	13
H#	0.008	59	<0.001	31	10
Al#	0.102	21	0.077	33	46
VC##	0.172	15	<0.001	74	11
C##	0.011	58	<0.001	39	3
M##	-	-	<0.001	95	5
F##	0.058	37	<0.001	61	2
VF##	0.231	9	0.002	78	13
Silt##	-	-	<0.001	95	5

*ANOVA = analysis of variance; VARCOMP = variance component analysis

**VC= very coarse sand; C=coarse sand; M=medium sand; F= fine sand; VF= very fine sand

***probability of rejecting a true null hypothesis

****percent of total variability contributed by each level in ANOVA design

#meq/100 g

##percent

Appendix F -- ANOVA and VARCOMP.* (cont.)

Muskingum very fine sandy loam					
	Level				
Variable**	Delineation		Site		Error
	alpha***	%****	alpha***	%****	%****
pH	-	-	<0.500	4	96
Ca#	-	-	<0.250	36	64
Mg#	-	-	<0.100	37	63
K#	0.180	10	0.245	18	72
H#	0.068	33	<0.001	55	12
Al#	0.144	19	<0.001	72	9
VC##	0.018	42	0.213	14	44
C##	0.085	29	<0.001	59	12
M##	0.097	27	<0.001	64	9
F##	0.252	7	<0.001	74	19
VF##	0.225	7	0.177	26	67
Silt##	-	-	<0.001	78	22

*ANOVA = analysis of variance; VARCOMP = variance component analysis
**VC= very coarse sand; C=coarse sand; M=medium sand; F= fine sand; VF= very fine sand
***probability of rejecting a true null hypothesis
****percent of total variability contributed by each level in ANOVA design
#meq/100 g
##percent

Appendix F -- ANOVA and VARCOMP.* (cont.)

Jefferson fine sandy loam and Leadvale silt loam

Vari-able**	Soil alpha***	Soil %****	Delineation alpha***	Delineation %****	Site alpha***	Site %****	Error %****
pH	-	-	-	-	<0.005	66	34
Ca#	0.240	6	-	-	<0.001	83	11
Mg#	0.324	2	0.224	26	<0.001	64	8
K#	0.243	5	-	-	<0.050	39	56
H#	0.096	33	0.087	29	0.002	26	12
Al#	0.120	27	0.123	28	<0.001	33	12
VC##	0.044	17	-	-	<0.005	52	31
C##	-	-	-	-	<0.001	75	25
M##	-	-	<0.250	26	<0.001	65	9
F##	-	-	<0.050	62	<0.001	35	3
VF##	0.002	52	-	-	<0.250	11	37
Silt##	0.004	54	-	-	<0.250	11	35

*ANOVA = analysis of variance; VARCOMP = variance component analysis

**VC= very coarse sand; C=coarse sand; M=medium sand; F= fine sand; VF= very fine sand

***probability of rejecting a true null hypothesis

****percent of total variability contributed by each level in ANOVA design

#meq/100 g

##percent

Appendix F -- ANOVA and VARCOMP.* (cont.)

Montevallo shaly silt loam and
Muskingum stony very fine sandy loam

Vari-able**	Soil		Delineation		Site		Error
	alpha***	%****	alpha***	%****	alpha***	%****	%****
pH	0.236	9	-	-	<0.050	35	56
Ca#	0.279	9	0.314	3	<0.001	71	17
Mg#	0.204	24	0.174	9	<0.001	54	13
K#	0.161	35	0.115	11	<0.001	39	15
H#	-	-	<0.010	34	0.036	25	41
Al#	-	-	<0.100	16	0.027	33	51
VC##	-	-	<0.050	29	<0.001	57	14
C##	0.214	24	0.134	12	<0.001	55	9
M##	-	-	<0.500	0	<0.001	92	8
F##	0.100	64	0.023	13	<0.001	22	1
VF##	0.089	48	0.257	4	<0.001	42	6
Silt##	-	-	<0.001	55	<0.001	41	4

*ANOVA = analysis of variance; VARCOMP = variance component analysis

**VC= very coarse sand; C=coarse sand; M=medium sand; F= fine sand; VF= very fine sand

***probability of rejecting a true null hypothesis

****percent of total variability contributed by each level in ANOVA design

#meq/100 g

##percent

Appendix F -- ANOVA and VARCOMP.* (cont.)

Muskingum stony very fine sandy loam and
Muskingum very fine sandy loam

Vari-able**	Soil		Delineation		Site		Error
	alpha***	%****	alpha***	%****	alpha***	%****	%****
pH	0.133	19	-	-	<0.100	22	59
Ca#	-	-	<0.250	11	<0.001	69	20
Mg#	0.335	3	-	-	<0.001	65	32
K#	-	-	<0.050	18	0.007	53	29
H#	-	-	<0.025	36	<0.001	51	13
Al#	-	-	<0.250	14	<0.001	52	34
VC##	-	-	<0.050	26	0.009	35	39
C##	-	-	<0.025	37	<0.001	55	8
M##	-	-	<0.010	43	<0.001	54	3
F##	0.141	50	0.039	16	<0.001	32	2
VF##	0.380	2	0.218	8	0.002	51	39
silt##	-	-	<0.001	73	<0.001	24	3

*ANOVA = analysis of variance; VARCOMP = variance component analysis

**VC= very coarse sand; C=coarse sand; M=medium sand; F= fine sand; VF= very fine sand

***probability of rejecting a true null hypothesis

****percent of total variability contributed by each level in ANOVA design

#meq/100 g

##percent

Appendix F -- ANOVA and VARCOMP.* (cont.)

Montevallo shaly silt loam and
Muskingum very fine sandy loam

Vari-able**	Level						
	Soil		Delineation		Site		Error
	alpha***	%****	alpha***	%****	alpha***	%****	%****
pH	-	-	<0.100	16	0.234	13	71
Ca#	-	-	<0.100	22	<0.001	62	16
Mg#	0.135	39	0.158	8	<0.001	40	13
K#	-	-	<0.100	17	0.004	43	40
H#	-	-	<0.100	16	0.012	38	46
Al#	-	-	<0.250	12	0.002	50	38
VC##	-	-	<0.100	23	<0.001	54	23
C##	0.087	43	0.354	1	<0.001	48	8
M##	-	-	<0.025	32	<0.001	56	12
F##	0.313	7	0.254	7	<0.001	68	18
VF##	0.172	21	0.265	4	0.024	30	45
Silt##	-	-	<0.250	9	<0.001	76	15

*ANOVA = analysis of variance; VARCOMP = variance component analysis

**VC= very coarse sand; C=coarse sand; M=medium sand; F= fine sand; VF= very fine sand

***probability of rejecting a true null hypothesis

****percent of total variability contributed by each level in ANOVA design

#meq/100 g

##percent

APPENDIX G

DESCRIPTIVE STATISTICS OF THE PARTICLE SIZE CONTROL SECTION.

Variable*	Mean	Minimum Value	Maximum Value	Range	Standard Deviation	N
	%					
Jefferson						
VC	0.97	0.10	4.00	3.90	1.12	16
C	2.23	0.80	7.50	6.70	1.70	16
M	6.14	3.30	14.50	11.20	2.83	16
F	22.98	9.20	37.50	28.30	9.24	16
VF	5.81	2.20	10.50	8.30	2.32	16
CLAY	32.19	19.00	49.50	30.00	8.97	16
TS	38.14	19.00	55.50	36.50	12.24	16
SILT	29.67	13.50	38.00	24.50	6.86	16
Leadvale						
VC	2.49	0.20	8.70	8.50	2.45	16
C	2.77	0.40	7.10	6.70	1.95	16
M	2.39	0.40	4.60	4.20	1.35	16
F	2.88	1.10	6.40	5.30	1.81	16
VF	2.96	1.40	5.80	4.40	1.22	16
CLAY	45.44	31.00	58.00	27.00	7.41	16
TS	13.51	6.50	25.90	19.40	6.81	16
SILT	41.06	28.10	52.70	24.60	7.45	16
Montevallo						
VC	8.12	0.90	23.00	22.10	5.90	24
C	6.13	0.50	11.80	11.30	3.39	24
M	3.95	0.90	7.50	6.60	1.71	24
F	2.81	1.40	4.60	3.20	0.76	24
VF	1.99	0.60	8.00	7.40	1.89	24
CLAY	27.79	20.00	45.00	25.00	6.37	24
TS	23.01	11.50	47.10	35.60	10.44	24
SILT	49.20	30.90	63.30	32.40	8.59	24

*VC = very coarse sand; C = coarse sand; M = medium sand; F = fine sand; VF = very fine sand; TS = total sand; N = number of observations

Appendix G -- Descriptive Statistics of the Particle Size Control Section. (cont.)

Variable*	Mean	Minimum Value	Maximum Value	Range	Standard Deviation	N
	%					
Muskingum stony						
VC	2.23	0.00	6.40	6.40	2.12	24
C	3.22	0.20	6.30	6.10	2.15	24
M	5.62	1.70	11.20	9.50	2.72	24
F	23.71	2.80	45.20	42.40	13.14	24
VF	6.88	1.00	14.60	13.60	4.23	24
CLAY	26.71	18.00	34.00	16.00	4.93	24
TS	41.66	20.10	61.30	41.20	11.31	24
SILT	31.63	18.70	47.30	28.60	8.25	24
Muskingum						
VC	3.12	0.20	13.30	13.10	3.17	24
C	2.53	0.50	6.60	6.10	1.84	24
M	2.12	0.80	4.50	3.70	1.00	24
F	5.85	1.60	25.30	23.70	6.82	24
VF	4.73	1.10	16.80	15.70	4.15	24
CLAY	24.75	15.00	31.00	16.00	5.00	24
TS	18.34	7.70	33.10	25.40	6.33	24
SILT	56.91	37.90	75.60	37.70	8.54	24

*VC = very coarse sand; C = coarse sand; M = medium sand; F = fine sand; VF = very fine sand; TS = total sand; N = number of observations

APPENDIX H

DESCRIPTIVE STATISTICS OF THE CHEMICAL CONTROL SECTION.

Variable*	Mean	Minimum Value	Maximum Value	Range	Standard Deviation	N
Jefferson						
pH	4.44	3.93	5.36	1.43	0.41	16
Ca**	0.69	0.02	2.87	2.85	0.84	16
Mg**	0.52	0.15	1.25	1.10	0.34	16
K**	0.14	0.06	0.19	0.13	0.04	16
H**	9.86	3.20	14.80	11.60	2.95	16
Al**	4.43	0.10	8.45	8.35	2.36	16
SB**	1.36	0.48	3.33	2.85	0.82	16
CEC**	11.22	6.31	16.23	9.92	2.53	16
BS***	13.80	4.04	49.29	45.25	12.81	16
Leadvale						
pH	4.28	4.00	4.85	0.85	0.23	16
Ca**	0.30	0.03	1.28	1.25	0.32	16
Mg**	0.33	0.11	0.89	0.78	0.25	16
K**	0.17	0.08	0.25	0.17	0.05	16
H**	13.21	9.40	18.40	9.00	2.53	16
Al**	6.72	3.05	9.25	6.20	1.80	16
SB**	0.80	0.25	2.18	1.93	0.51	16
CEC**	14.01	10.47	19.30	8.83	2.36	16
BS***	6.02	1.68	17.33	15.65	4.27	16
Montevallo						
pH	4.27	3.95	4.65	0.70	0.18	24
Ca**	0.92	0.08	3.98	3.90	1.05	24
Mg**	0.65	0.06	2.00	1.94	0.50	24
K**	0.23	0.08	0.43	0.35	0.08	24
H**	12.33	6.80	18.00	11.20	3.12	24
Al**	4.76	1.65	8.65	7.00	1.80	24
SB**	1.80	0.26	5.46	5.20	1.49	24
CEC**	12.12	7.34	18.53	11.19	2.48	24
BS***	14.87	2.08	41.46	39.38	11.42	24

*SB = sum of bases; CEC = cation exchange capacity;
BS = base saturation; N = number of observations
**meq/100 g
***percent

Appendix H -- Descriptive Statistics of the Chemical Control Section. (cont.)

Variable*	Mean	Minimum Value	Maximum Value	Range	Standard Deviation	N
Muskingum stony						
pH	4.44	4.00	5.94	1.94	0.38	24
Ca**	0.37	0.02	2.64	2.62	0.62	24
Mg**	0.26	0.03	0.84	0.81	0.25	24
K**	0.14	0.04	0.31	0.27	0.07	24
H**	10.22	4.40	16.20	11.80	3.47	24
Al**	4.23	1.25	8.15	6.90	1.63	24
SB**	0.77	0.19	3.63	3.44	0.86	24
CEC**	10.43	4.18	16.91	12.73	3.52	24
BS***	7.07	1.78	23.56	21.77	6.40	24
Muskingum						
pH	4.19	3.80	4.80	1.00	0.24	24
Ca**	0.15	0.01	0.89	0.88	0.17	24
Mg**	0.17	0.03	0.64	0.61	0.16	24
K**	0.17	0.09	0.43	0.34	0.07	24
H**	10.76	5.80	18.00	12.20	3.48	24
Al**	4.68	2.45	7.65	5.20	1.33	24
SB**	0.48	0.16	1.85	1.69	0.35	24
CEC**	9.81	5.70	15.46	9.76	2.72	24
BS***	5.00	1.70	13.72	12.03	2.98	24

*SB = sum of bases; CEC = cation exchange capacity; BS = base saturation; N = number of observations
**meq/100 g
***percent

Appendix I -- Mineralogical Composition of the Typifying Pedons.

Horizon	Depth	KK	MI	VM	MM	IMV	HIEP	IKEP	QZ	FD	GI	Oxidic Ratio
		Minerals Present+ <2 μm (clay) fraction										
	in.	%										
Jefferson fine sandy loam												
Ap	0-7	7	40	33	-	-	5	-	15	-	-	0.04
Bt1	7-15	8	40	32	5	-	5	-	10	-	-	0.06
Bt2	15-26	21	45	19	10	-	Tr	-	5	-	-	0.09
Bt3	26-33	21	45	14	15	-	Tr	-	5	-	-	0.08
Bt4	33-45	21	45	14	15	-	Tr	-	5	-	-	0.08
2C1	45-58	21	50	14	10	-	Tr	-	5	-	-	0.05
2C2	58-72	21	50	14	10	-	-	-	5	-	-	0.13
Muskingum stony very fine sandy loam												
A	0-4	25	5	-	-	-	55	-	15	5	Tr	0.09
BA	4-22	32	10	10	-	-	32	-	15	Tr	1	0.09
Bt1	22-41	21	20	-	-	47	-	-	10	Tr	2	0.27
Bt2	41-55	4	50	-	-	41	-	-	5	Tr	Tr	0.20
C	55-76	5	54	-	-	41	-	-	Tr	Tr	-	0.23
Muskingum very fine sandy loam / Montevallo shaly silt loam												
E	0-4	15	15	-	-	-	65	-	5	Tr	-	0.06
Bw1	4-20	15	20	-	-	-	55	5	5	Tr	Tr	0.06
Bw2	20-33	18	40	-	-	27	-	5	10	-	-	0.12
C	33-72	23	45	-	-	17	-	5	10	-	-	0.12
Leadvale silt loam												
Ap	0-5	5	30	-	-	10	40	-	15	-	-	0.07
Bt1	5-15	10	35	-	-	25	20	-	10	-	-	0.11
Bt2	15-32	8	35	-	-	37	10	-	10	-	-	0.09

+ KK=Kaolinite; MI=mica; VM=vermiculite; MM=montmorillonite; IMV=interstratified montmorillonite-vermiculite; HIEP=hydroxyinterlayered expandable 2:1 phyllosilicate; IKEP=interstratified kaolinite-expandable 2:1 phyllosilicate; QZ=quartz; FD=feldspars and GI=gibbsite

APPENDIX J

TAXONOMIC & MAPPING UNIT DESCRIPTION INCLUDING SELECTED INTERPRETATIONS FOR JEFFERSON VARIANT LOAM.

Jefferson Variant Loam

Soils of the Jefferson Variant are members of the fine-loamy, siliceous, mesic family of Aquic Paleudults. They are deep and moderately well drained. These soils formed in colluvial materials weathered from sandstone and shale. They are on footslopes in the Ridge and Valley physiographic province. Slopes range from 5 to 15 percent.

Jefferson Variant soils are near Leadvale and Hayter soils of the colluvial lands and Muskingum and Montevallo soils of the uplands. Leadvale soils have more clay, Hayter soils have a darker surface, and Muskingum and Montevallo soils have more rock fragments in the solum.

A typical pedon of Jefferson Variant loam, in an area of Jefferson Variant loam, 5 to 15 percent slopes, is located about 1.6 miles east (90^0) of the intersection of Interstate 77 and Highway VA-606, and about 100 feet south of Highway VA-606.

Ap--0 to 7 inches; dark yellowish brown (10YR 4/4) loam; moderate fine granular structure; very friable, slightly sticky, slightly plastic; common fine and medium roots; very strongly acid; gradual smooth boundary.

Bt1--7 to 15 inches; strong brown (7.5YR 5/6) clay loam; strong medium and coarse subangular blocky structure; firm, slightly sticky, plastic; common thin discontinuous clay films on faces of peds; common fine roots; very strongly acid; clear smooth boundary.

Bt2--15 to 26 inches; strong brown (7.5YR 5/6) clay loam; strong medium and coarse subangular blocky structure; firm, slightly sticky, plastic; few fine roots; common thin discontinuous clay films on faces of peds; strongly acid; clear smooth boundary.

Bt3--26 to 33 inches; strong brown (7.5YR 4/6) sandy clay loam; common fine distinct yellowish red (5YR 5/8) and few fine distinct light brownish gray (10YR 6/2) mottles; strong medium and coarse subangular blocky structure; firm, slightly sticky, plastic; few fine roots; common thin discontinuous clay films on faces of peds; strongly acid; clear smooth boundary.

Bt4--33 to 45 inches; yellowish brown (10YR 5/4) sandy clay loam; common medium prominent light brownish gray (10YR 6/2) and common fine distinct yellowish red (5YR 5/8) mottles; strong medium and coarse subangular blocky structure; firm, sticky, plastic; few fine roots; common thin discontinuous clay films on faces of peds; strongly acid; clear smooth boundary.

2C1--45 to 58 inches; gray (10YR 6/1) clay; common medium prominent yellowish brown (10YR 5/8) mottles; massive; very firm, sticky, plastic; few fine roots; common medium clay flows; very strongly acid; clear smooth boundary.

2C2--58 to 72 inches; gray (10YR 6/1) clay; many medium prominent yellowish brown (10YR 5/8) mottles; massive; very firm, sticky, plastic; common medium clay flows; very strongly acid.

Solum thickness ranges from 35 to 60 inches. Depth to the 2C horizon ranges from 35 to 44 inches. Depth to bedrock is greater than 72 inches. Coarse fragments range from 0 to 5 percent in the solum and amounts vary in the 2C horizon. Reaction is very strongly acid or strongly acid, unless limed.

The Ap horizon has value of 4 through 6, and chroma of 3 or 4. It is sandy loam or loam in the fine earth fraction.

The Bt horizon has hue of 10YR through 2.5YR, value of 5 or 6, and chroma of 4 through 8. Low chroma mottles are common. The Bt also has brownish yellow and reddish yellow mottles with sandy clay loam or clay loam textures.

The 2C horizon is variable in color and texture and ranges from sandy loam through clay in the fine earth fraction. Rock fragments range from gravel through boulders in size.

<u>Jefferson Variant loam, 5 to 15 percent slopes</u>. This soil is deep and moderately well drained. It is on strongly sloping footslopes. Delineations range in size from 2 to 30 acres.

A typical profile has a dark yellowish brown loam surface layer 7 inches thick. The subsoil, from 7 to 45 inches, is strong brown clay loam in the upper part and strong brown or yellowish brown sandy clay loam in the lower part. The lower part of the subsoil has light brownish gray and yellowish red mottles. The substratum, from 45 to 72 inches, is gray clay with yellowish brown mottles.

Small areas of Leadvale and other soils with a significant percentage of rock fragments in the solum are included in delineations of this soil. Leadvale soil has higher content of clay.

Permeability is moderately slow. Available water capacity is medium. Natural fertility and organic matter content are moderately low. The rooting zone and depth to bedrock are greater than 60 inches. The surface and subsoil are very strongly acid or strongly acid, unless limed. Surface runoff is moderate. Potential frost action is moderate. Shrink-swell potential is low. A seasonal high water table ranges from 18 to 30 inches.

This soil is used mainly for general field crops. A small part is in permanent pasture and forest.

Cultivated crops, such as corn, are moderately well suited to this soil. Small grains and vegetables are better suited to this soil. Slope is a limitation. The erosion hazard is moderate without adequate plant cover. Practices that help reduce runoff and control erosion are contour tillage, minimum tillage, and conservation cropping systems that include grasses and legumes. Crop yields can be increased by applications of lime and fertilizer. Tilth is good except in some areas where stones are scattered on the surface.

Pasture and hay grasses and legumes are well suited to this soil. Useful pasture management practices are maintaining a mixture of grasses and legumes, rotating pastures, controlling weeds, using proper stocking rates, and applying lime and fertilizer.

Timber production is moderately high on this soil.

Building site development and sanitary facilities, including septic tank absorption fields, are limited by wetness, slope, and clayey subsoils.

Capability subclass is IIIe.

TABLE 1. Engineering Index Properties for Jefferson Variant Loam.

Depth in.	USDA Texture	Classification		Frag-ments >3 in.	Percent Passing Sieve Number				Liquid Limit	Plasticity Index
		Unified	AASHTO		4	10	40	200		
0-7	sandy loam, loam	SM,ML	A-4	0	100	95-100	57-90	28-71	-----	-----
7-45	sandy clay loam, clay loam	SC,ML-CL	A4,A6	0	100	95-100	76-95	33-76	25-43	5-15
45-72	var.	----	-----	----	-----	-----	-----	-----	-----	-----

TABLE 2. Physical and Chemical Properties for Jefferson Variant Loam.

Depth in.	Clay <2 mm %	Permeability in./hr.	Available Water Capacity in./in.	Soil Reaction pH	Shrink-Swell Potential	Erosion Factors K	Erosion Factors T	Organic Matter %
0-7	10-25	0.6-2.0	.13-.22	4.5-5.5	Low	.43	3-2	1.0-2.0
7-45	28-35	0.2-0.6	.15-.19	4.5-5.5	Low	.43	3-2	0.5-1.0
45-72	--	--	--	--	--	--	--	--

TABLE 3. Selected Interpretations for Jefferson Variant Loam.

Recreational Development

Camp Areas	Picnic Areas	Playgrounds	Paths and Trails	Golf Fairways
Moderate: slope, wetness	Moderate: slope, wetness	Severe: slope	Moderate: wetness	Moderate: wetness, slope

Building Site Development

Shallow Excavations	Dwellings without Basements	Dwellings with Basements	Small Commercial Buildings	Local Roads and Streets	Lawns and Landscaping
Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness, slope	Severe: low strength	Moderate: wetness, slope

Construction Materials

Roadfill	Sand	Gravel	Topsoil
Poor: low strength	Improbable source: excess fines	Improbable source: excess fines	Poor: thin layer, wetness

Sanitary Facilities

Septic Tank Absorption Fields	Sewage Lagoon Areas	Trench Sanitary Landfill	Area Sanitary Landfill	Daily Cover for Landfill
Severe: wetness	Severe: slope, wetness	Severe: wetness	Severe: wetness	Fair: too clayey, slope, wetness

Water Management

Limitations For		Features Affecting			
Pond Reservoir Areas	Embankments, Dykes, and Levees	Drainage	Irrigation	Terraces and Diversions	Grassed Waterways
Severe: slope	Severe: piping, wetness	Slope	Wetness, Slope	Slope, Wetness	Slope

Established Series
Rev. JHN:RED
2/79

JEFFERSON SERIES

The Jefferson series consists of deep, well-drained soils on mountain sides and footslopes. Permeability is moderately rapid. Slopes range from 5 to 60 percent.

__Taxonomic Class:__ Fine-loamy, siliceous, mesic Typic Hapludults.

__Typical Pedon:__ Jefferson gravelly loam--on a convex 30 percent slope on the lower part of a steep mountain side in woods.
(Colors are for moist soils.)

A1--0 to 3 inches; very dark grayish brown (10YR 3/2) gravelly loam; moderate fine granular structure; very friable; many roots; 20 percent sandstone fragments; medium acid; abrupt smooth boundary. (2 to 5 inches thick)

A2--3 to 10 inches; brown (10YR 5/3) gravelly loam; weak fine granular structure; very friable; many roots; 15 percent sandstone fragments; medium acid; clear smooth boundary. (4 to 9 inches thick)

B1--10 to 17 inches; yellowish brown (10YR 5/6) gravelly loam; weak fine subangular blocky structure; friable; many roots; 15 percent sandstone fragments; strongly acid; clear smooth boundary. (0 to 10 inches thick)

B21t--17 to 30 inches; strong brown (7.5YR 5/6) gravelly heavy loam; moderate medium subangular blocky structure; friable; common roots; many thin clay films; 15 percent sandstone fragments; very strongly acid; gradual smooth boundary. (10 to 30 inches thick)

B22t--30 to 43 inches; strong brown (7.5YR 5/8) gravelly heavy loam; few fine distinct yellowish brown (10YR 5/4) and yellowish red (5YR 5/6) mottles; weak medium subangular blocky structure; friable; few roots; common thin clay films; 25 percent sandstone fragments; very strongly acid; gradual smooth boundary. (10 to 20 inches thick)

B3--43 to 50 inches; strong brown (7.5YR 5/6) very gravelly sandy loam; common fine distinct yellowish brown (10YR 5/4) and yellowish red (5YR 5/6) mottles; weak medium subangular blocky structure; friable; few roots; 40 percent sandstone fragments; strongly acid; gradual smooth boundary. (0 to 15 inches thick)

C--50 to 65 inches; mottled reddish brown (5YR 5/4) and light yellowish brown (10YR 6/4) very gravelly sandy loam; massive; friable; 60 percent sandstone fragments; very strongly acid.

__Type Location:__ Harlan County, Kentucky; 150 feet north of U. S. Highway 119, near borrow pit, 5 1/2 miles northeast of Harlan, about 1 mile east of Rosspoint.

__Range in Characteristics:__ Thickness of the solum ranges from 40 to 60 inches. Content of rock fragments of sandstone range from 5 to 35 percent to a depth of about 3 feet, and below 3 feet from 20 to 80 percent. Some areas are stony to extremely stony. The soil ranges from strongly to very strongly acid, except the A horizons range from very strongly acid to neutral.

The A1 horizon has hue of 10YR, value of 3 to 5, and chroma of 1 to 3. The A2 horizon has hue of 10YR, value of 4 to 6, and chroma of 3 or 4. The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 to 4. They are loam, fine sandy loam, or sandy loam, and gravelly or cobbly analogues.

The B horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 4 to 8. Some pedons have mottles in shades of brown, yellow, and red, and the lower part shades of gray. It is loam, sandy clay loam, clay loam, or gravelly and cobbly analogues. Some pedons have B1 horizons. Some pedons have B3 horizons similar to the C horizon.

The C horizon is in shades of brown, red, or gray, and are usually mottled. It is gravelly or channery analogues of sandy loam, fine sandy loam, sandy clay loam, or clay loam. Some pedons have a IIC horizon, below a depth of about 50 inches, that are from shaly material with a higher content of clay.

__Competing Series:__ These are the Lily, Lonewood, Marr, Riney, Sassafras, and Sunnyside series. Lily soils have bedrock at less than 40 inches. Lonewood, Marr, and Sassafras soils lack coarse fragments in the solum. Riney and Sunnyside soils have B horizons with hue redder than 7.5YR.

__Geographic Setting:__ Jefferson soils are on steep mountain sides and footslopes, often below sandstone escarpments, with slopes ranging from 5 to 60 percent. These soils formed in colluvium from soils formed in residuum of acid sandstone, shale, and siltstone. Near the type location the average annual precipitation is about 49 inches and the average annual temperature is about 57° F.

__Geographically Associated Soils:__ These are the competing Clymer and Shelocta series and the Dekalb, Gilpin, Muse, Ramsey, and Whitley series. Dekalb and Ramsey soils lack argillic horizons. Muse soils have more clay and less sand and Whitley soils have more silt and less sand than Jefferson soils.

__Drainage and Permeability:__ Well drained with rapid or medium runoff, depending on slope. Permeability is moderately rapid.

__Use and Vegetation:__ Most areas are in forest but less steep areas are used mainly for pasture and crops. The forest vegetation is chiefly yellow poplar, upland oaks, Virginia and shortleaf pine, hickory, and laurel.

__Distribution and Extent:__ Southern Kentucky, Tennessee, and Virginia. The series is extensive.

__Series Established:__ Reconnaissance Survey of Southwestern Pennslyvania; 1909.

__Remarks:__ The Jefferson series formerly included Paleudults. These are excluded by this description of the Jefferson series. Mineralogy data for some sampled sites in Tennessee and three in southern Kentucky show that the 20 to 200 micron fraction is siliceous. Three sites in northern and eastern Kentucky are mixed for which the Rigley series has been established.

KY0018 SOIL INTERPRETATIONS RECORD

MLRA(S): 125, 147, 148 JEFFERSON SERIES
REV. APS,FSA, 5-75
TYPIC HAPLUDULTS, FINE-LOAMY, SILICEOUS, MESIC

THE JEFFERSON SERIES CONSISTS OF DEEP, WELL DRAINED SOILS ON UPLANDS. THEY FORMED IN COLLUVIAL MATERIAL. TYPICALLY THESE SOILS IN WOODED AREAS HAVE A VERY DARK GRAYISH BROWN GRAVELLY LOAM SURFACE LAYER 3 IN. THICK, AND A BROWN GRAVELLY LOAM SUBSURFACE LAYER 7 IN. THICK. THE SUBSOIL FROM 10 TO 17 IN. IS YELLOWISH-BROWN GRAVELLY LOAM. FROM 17 TO 43 IN. IS STRONG BROWN GRAVELLY HEAVY LOAM, AND FROM 43 TO 50 IN. IS STRONG BROWN GRAVELLY FINE SANDY LOAM. THE SUBSTRATUM FROM 50 TO 65 IN. IS MOTTLED REDDISH-BROWN AND LIGHT YELLOWISH-BROWN VERY GRAVELLY SANDY LOAM. SLOPES RANGE FROM 5 TO 50 %.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-10	GR-L, GR-FSL, L	SM, SC, ML, CL	A-2, A-4	0-5	75-90	50-90	50-80	30-65	20-35	2-10
10-43	GR-L, GR-CL, GR-SCL	SM, SC, ML, CL	A-4, A-2, A-6	0-5	75-90	50-90	50-80	30-70	15-35	2-15
43-65	GR-L, GR-CL, GR-SCL	GM, SM, ML, GM-GC	A-2, A-4, A-1	0-5	55-75	25-75	20-70	10-60	20-35	2-10

DEPTH (IN.)	CLAY (PCT <2MM)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND ERO. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-10	10-25	1.20-1.50	2.0-6.0	0.10-0.16	4.5-5.5	-	LOW	.28	4	-	.5-5	MODERATE	HIGH
10-43	18-34	1.30-1.65	2.0-6.0	0.10-0.16	4.5-5.5	-	LOW	.28					
43-65	15-30	1.30-1.65	2.0-6.0	0.08-0.14	4.5-5.5	-	LOW	.17					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-	[illegible]	B	-

SANITARY FACILITIES (B)

SEPTIC TANK ABSORPTION FIELDS	5-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	5-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	5-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (AREA)	5-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
DAILY COVER FOR LANDFILL	5-8%: FAIR-TOO CLAYEY,SMALL STONES 8-15%: FAIR-TOO CLAYEY,SMALL STONES,SLOPE 15+%: POOR-SLOPE

BUILDING SITE DEVELOPMENT (B)

SHALLOW EXCAVATIONS	5-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS	5-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	5-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	5-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	5-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	5-8%: MODERATE-SMALL STONES 8-15%: MODERATE-SMALL STONES,SLOPE 15+%: SEVERE-SLOPE

CONSTRUCTION MATERIAL (E)

ROADFILL	5-15%: GOOD 15-25%: FAIR-SLOPE 25+%: POOR-SLOPE
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	5-15%: POOR-SMALL STONES,AREA RECLAIM 15+%: POOR-SMALL STONES,AREA RECLAIM,SLOPE

WATER MANAGEMENT (3)

POND RESERVOIR AREA	5-20%: SEVERE-SEEPAGE 20+%: SEVERE-SEEPAGE,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	SLOPE
TERRACES AND DIVERSIONS	5-8%: FAVORABLE 8+%: SLOPE
GRASSED WATERWAYS	5-8%: FAVORABLE 8+%: SLOPE

REGIONAL INTERPRETATIONS

RECREATIONAL DEVELOPMENT (B)

CAMP AREAS	5-8%: MODERATE-SMALL STONES 8-15%: MODERATE-SLOPE,SMALL STONES 15+%: SEVERE-SLOPE	PLAYGROUNDS	5-6%: SEVERE-SMALL STONES 6+%: SEVERE-SLOPE,SMALL STONES
PICNIC AREAS	5-8%: MODERATE-SMALL STONES 8-15%: MODERATE-SLOPE,SMALL STONES 15+%: SEVERE-SLOPE	PATHS AND TRAILS	5-15%: SLIGHT 15-25%: MODERATE-SLOPE 25+%: SEVERE-SLOPE

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY		CORN (BU)		OATS (BU)		WHEAT (BU)		TOBACCO (LBS)		ALFALFA HAY (TONS)		GRASS HAY (TONS)		PASTURE (AUM)	
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
5-6%	2E		95		75		35		2600		4.0		3.0		6.0	
6-12%	3E		85		70		35		2400		4.0		3.0		6.0	
12-20%	4E		75		60		30		1900		3.5		2.5		5.5	
20-30%	6E		-		-		-		-		-		-		-	
30-60%	7E		-		-		-		-		-		-		-	

WOODLAND SUITABILITY (C)

CLASS-DETERMINING PHASE	ORD SYM	EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORTLTY.	WINDTH. HAZARD	PLANT COMPET.	COMMON TREES	SITE INDX	TREES TO PLANT
		MANAGEMENT PROBLEMS					POTENTIAL PRODUCTIVITY		
5-15%	3O	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	NORTHERN RED OAK	70 *	EASTERN WHITE PINE
							YELLOW-POPLAR	101*	YELLOW-POPLAR
							SHORTLEAF PINE	69 *	LOBLOLLY PINE
							VIRGINIA PINE	70 *	VIRGINIA PINE
							LOBLOLLY PINE	77 *	SHORTLEAF PINE
15-35% NORTH	2R	SLIGHT	MODERATE	SLIGHT	SLIGHT	MODERATE	NORTHERN RED OAK	76 *	BLACK WALNUT
35+% NORTH	2R	MODERATE	SEVERE	SLIGHT	SLIGHT	MODERATE	YELLOW-POPLAR	100	YELLOW-POPLAR
							VIRGINIA PINE	75	EASTERN WHITE PINE
							LOBLOLLY PINE	85	VIRGINIA PINE
15-35% SOUTH	3R	SLIGHT	MODERATE	SLIGHT	SLIGHT	MODERATE	NORTHERN RED OAK	62 *	EASTERN WHITE PINE
35+% SOUTH	3R	MODERATE	SEVERE	SLIGHT	SLIGHT	MODERATE	SHORTLEAF PINE	65 *	LOBLOLLY PINE
							VIRGINIA PINE	70	SHORTLEAF PINE
							LOBLOLLY PINE	80	VIRGINIA PINE

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY (D)

CLASS-DETERMINING PHASE	GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
	POTENTIAL FOR HABITAT ELEMENTS								POTENTIAL AS HABITAT FOR:			
5-8%	FAIR	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	GOOD	V. POOR	-
8-15%	FAIR	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	-
15-25%	POOR	FAIR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	GOOD	V. POOR	-
25-35%	V. POOR	FAIR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	GOOD	V. POOR	-
35+%	V. POOR	POOR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	POOR	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT): FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

A ESTIMATES OF ENGINEERING PROPERTIES BASED ON TEST DATA OF 7 PEDONS FROM KENTUCKY
B RATINGS BASED ON NSH, PART II, SECTION 403, 3-78.
C RATINGS BY SOILS MEMO. 26, SEPT. 1967 AND REGIONAL CRITERIA. SITE INDEX VALUES MAY RANGE + OR -5 OR MORE.
D WILDLIFE RATINGS BASED ON SOILS MEMORANDUM 74, JAN. 1972
1 EXCESSIVE PERMEABILITY MAY POLLUTE GROUND WATER.
* SITE INDEX IS A SUMMARY OF 5 OR MORE MEASUREMENTS ON THIS SOIL.

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EVALUATION OF PRE-TAXONOMY SOIL SURVEYS

by

William Dean Cowherd

ABSTRACT

A 1954 soil survey of Bland County, Virginia, was evaluated to determine if remapping was required to meet current soil survey standards. Considerable savings of time and money may be realized if a complete remap was not required. Ten random transects were chosen to study soil landscape units which formed the basis for the evaluation of soil boundary placement. The soil landscape units were determined by evaluating slope, parent material, and landscape position for each traversed delineation. Based on a binomial distribution, a numerical rating was used to evaluate each delineation. Out of 89 total delineations, there were 70, 71, and 81 successful observations with respect to slope, parent material, and landscape position, respectively. Out of 10 random observations of slope, parent material, and landscape position, the probability of observing 7 or more correct observations was approximately 85, 88, and 99%, respectively.

Five mapping units occurring on sideslope and/or colluvial positions were sampled according to a random effects, two-level nested analysis of variance (ANOVA) design. Phy-

sical and chemical analyses of the control section for 104 profiles were determined. All soils were described in the field and classified according to Soil Taxonomy of 1975. Variability in all mapping units with respect to cation exchange capacity (CEC), base saturation, total sand, and clay content was primarily among sites within delineations. All mapping units were composed of more than one soil. Similar soils comprised major percentages of each mapping unit.

The methodology proposed by this study suggested that the Bland County soil survey could not be significantly improved upon by remapping. However, a redefinition of mapping units and redrafting onto an aerial photobase would increase its usefulness to the comparable state of many current soil surveys.