SUMMARY AND RECOMMENDATIONS

1. Soil Taxonomy, the new soil classification system adopted by the Soil Conservation Service of the U.S. Department of Agriculture, emphasizes various measured soil properties, including particle size, clay mineralogy, color, and field relationships, to define soil orders, suborders, great groups, subgroups, and families. This is in contrast to earlier systems, which had a genetic emphasis. The advantage of the new system for engineering is that it rests on hard data and thus reduces the role of speculation and changing opinion concerning soil origins.

2. The expressed intent of the family category is to group soils having similar physical and chemical properties that affect their response to management and manipulation. One disadvantage of going to a nongenetic classification is that important information that does relate to soil genesis may be lost or relegated to a secondary role. An example cited in this paper is that of loess and till-derived soils occurring in the same family despite significant differences in physical properties. In that case a family distinction could be made on the basis of dry density or other factors. Such separations seem appropriate to increase the usefulness of the system for engineers.

3. The new Soil Taxonomy uses the concept of the control section to define the range of depths over which soil properties are averaged for classification. The control section emphasizes soil properties at greater depths than did previous classifications, which tended to emphasize properties of topsoil, a concept little used in engineering. The definition and use of control sections are therefore highly advantageous for engineers.

4. In this connection, an important contrasting property not presently recognized in the family category but that appears to deserve recognition because of its major influence on engineering uses is bedrock deeper than 50 cm (20 in). Although it may be argued that such an occurrence does not in itself strongly influence soil properties, the family designation is intended to be pragmatic in purpose and, from an engineering viewpoint, nothing could be more pragmatic than the knowledge that rock occurs at a depth of 0.6 to 0.9 m (2 to 3 ft).

5. The COLE value, a measure of the shrinkage of undisturbed soil clods, should be relevant to engineering uses and in fact may be more relevant than traditional engineering tests such as the shrinkage limit, which uses mixed and remolded soil.

6. Finally, the authors feel that the clay mineralogy of soils classified as fine-silty or fine-loamy (clay content of 18 to 35 percent) is pertinent and should be recognized at the family level.

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Soil Series and Soil Taxonomy

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Soil series are the lowest and most narrowly defined units in Soil Taxonomy. They have from the beginning been the primary vehicle through which information gained from experience with and research on soil performance has been accumulated, organized, and presented to assist with land-use and management decisions. Soil series are defined according to the kind, sequence, and thickness of soil horizons and the physical and chemical properties of each horizon. The occurrence of a soil series is limited to unique kinds of geologic formations, landscape positions, and climates. Most soil series are subdivisions of soil families in which specific ranges in composition, thickness, structure, or other properties are narrower than they are for the soil family. Some soil series include the full range of the soil family. Among the soil properties used to define each horizon of soil series are those that determine the performance of the soil as an engineering material. Important in situ properties such as density and seasonal moisture content have narrow ranges in each horizon of soil series.

Soil series are the lowest categorical level of Soil Taxonomy (13). They have a narrower range in properties and thus in occurrence and in performance than classes at the five higher categories in the system. Each soil series is uniquely placed into one of the classes of higher categories. Because all classes in Soil Taxonomy are mutually exclusive, the limit in all definitive properties used at categories above the series becomes part of series definitions. A soil series is thus confined within the range of one family. Most series are defined to include only a portion of a family although some cover the entire range of the family in most or all properties.

Soil series have been used as the basic unit of soil classification since the beginning of soil surveys in the United States in 1899. Soil series are the focal point of all of the information that soil scientists accumulate about soils. They are named after places where they were first identified, e.g., Miami.

HISTORY OF THE SOIL SERIES

The term soil series goes back to the idea of early pedologists that they would find on each kind of parent material a complete series of soils of various textures ranging from sand to clay. The member of the soil series having a different texture, the surface soil, was called the soil type. The Miami series was thought to encompass all soils on glacial drifts—from the soil type Miami sand on outwash to the soil type Miami clay on some unusually fine-textured glacial till. It is not surprising that with such a broad definition the Miami series appeared on early soil maps from Illinois to the New England states. As our knowledge of soils has increased and soil survey procedures have become more sophisticated, the definition of soil series has become progressively narrower in range of properties.

In 1913, Marbut defined a soil series as "a group of soils having the same range in color, the same character of subsoil, particularly as regards color and structure, broadly the same type of relief and drainage, and a common or similar origin" (12). In 1938 (1), the soil series was defined as a group of soils "having genetic horizons similar as to differentiated characteristics and arrangement in the soil profile, except for the texture of the surface soil, and developed from a particular parent material."

By 1965, when the National Cooperative Soil Survey adopted Soil Taxonomy, the definition of soil series had become so narrow that relatively few series had more than one or two soil types. Hence, soil type was dropped from the classification system although the texture of the surface soil is still used in the names of soil phases.

An important practical consequence of these changes in the series concept is that soil series defined by various soil surveys are not necessarily the same. Soil series of older surveys tend to be much more broadly defined than those of surveys completed in the last 20 years. And, since soil surveys in adjacent counties may have been completed some 10 or 20 years apart, the series concept in those two surveys may be different. It is important, therefore, that a knowledgeable soil scientist be consulted if an old survey must be used for planning purposes. In particular, soil surveys completed before 1956 and published on line maps may not meet modern standards.

ROLE OF THE SOIL SERIES

About 12 000 soil series are now in use in the United States. Soil scientists have described all of these series in considerable detail in terms of both their morphological characteristics and their behavior for many uses, including engineering uses. Each soil series is different from any other soil soil series in one or more of the set of definitive soil properties. A wide range of activities have been carried out on most soil series: Crops have been grown, cattle grazed, houses and roads built, and other activities performed that are influenced by the nature of the soil. The soils performed well for some activities and not for others. Through past decades, by trial and error, soil scientists have collected an enormous volume of such field data on soil performance, organized by soil series.

Research has also contributed a great deal to our understanding of soils and their performance. Early work focused on learning how to manage soils for crop production. More recently, substantial research has been done to learn more about the engineering behavior of soil series. One early example of such research was the cooperative effort initiated by the U.S. Bureau of Public Roads, in cooperation with the Soil Conservation Service, to sample major soil series in the United States and determine important engineering index properties. This effort is being continued in many states by state highway departments. Thousands of soil profiles have been analyzed, and a significant conclusion is that specific horizons of soil series do in fact have a specific pattern of test results.

The first major role of the soil series is to provide a basis for organizing knowledge about soils. A structure is necessary through which knowledge gained from experience and research can be aggregated. Considering the vast amount of data available, such an aggregation is required in order to determine meaningful relations between soil properties and soil performance. Soil series, as well as the higher categories of Soil Taxonomy, provide the required structure.

A second major role of the soil series is to provide a basis for the transfer of information about soils from points where specific measurements are made to other areas. Such transfer has been the basic goal of soil surveys from the beginning, through the process referred to as soil interpretations. This principle has been used by the Michigan Department of State Highways and Transportation for many years. More recently, extensive application of soil interpretations has been made in South Dakota (3) and Ohio (5). Establishing confidence in this procedure requires that data be organized and evaluated by soil series. Such data must include validation in terms of both test data and observations of actual performance. That validation has been accomplished in the states mentioned above.

A third role of the soil series is to provide a structure for research and testing to improve understanding of the parameters that affect soil performance. It has been said that the main goal of classification is to give soil scientists the greatest command of what they already know and to lead them most directly to the acquisition of more knowledge (8). For many research projects, specific kinds of soils must be chosen for study. Choosing specific soil series provides a good basis for obtaining the soil samples needed. For each soil series a type location has been established; that is, a soil that has the grain-size distribution, clay mineralogy, and other physical and chemical properties typical of the series is found at that location. Extensive testing to characterize the soil has already been done at the type location of many soil series. As a result, soils that are known to meet the requirements of the research project can be selected. This was done in a recent study of chemical compaction aids sponsored by the Federal Highway Administration and carried out by the Civil Engineering Department of Iowa State University in which roughly 25 soil series from throughout the United States, representing fine-grained soils of known clay mineralogy and kind of parent material, were selected for testing.

PEDOLOGIC VERSUS ENGINEERING APPROACH TO SOIL CLASSIFICATION

The in situ soil profile, each series in which has specific kinds and arrangements of soil horizons, is what pedologists classify. Emphasizing a set of soil horizons, each with a defined set of properties, is in contrast to the common engineering approach of using a specific sample, chosen to represent conditions at a given site and stratum, as the basic unit of classification. This basic difference is highly important in contrasting the approaches to soil classification by the two disciplines.

The pedologic classification considers soil as a product of its natural environment and incorporates into the classification several aspects of that environment. Climate and vegetation, for example, are important factors

in soil formation. Both mean annual soil temperature (MAST) and degree of seasonal variation in soil temperature are criteria in pedologic classification. Soil moisture regimes and their seasonal variation, in relation to both climate and local relief, as well as marks left by natural vegetation, such as the thickness and organic matter content of the A horizon, are also used as classification criteria.

Both the American Association of State Highway Officials (AASHO) and Unified Soil Classification systems consider a specific sample, but the classifications themselves neglect the environmental conditions in which the sample exists in situ. To the pedologist these conditions are important soil properties that may have a great influence on the performance of the soil. In reports of soil engineering investigations of specific sites, soil moisture states at the time of the investigation are commonly referred to and general information is sometimes available on the seasonal variations in both soil moisture and temperature for the area. Differences between local soils in the pattern of seasonal moisture variation are often overlooked in engineering investigations, with unfortunate results. This information is among the most useful of the pedologist's contributions to the engineer.

CRITERIA USED IN RECOGNIZING AND DEFINING SOIL SERIES

Of the 5100 families in Soil Taxonomy, about 3100 have only 1 series, another 1500 have between 2 and 4 series, and only about 100 have more than 10 series. Criteria for subdividing families vary widely: Some have to do with difference in soil texture in critical horizons, some with differences in soil moisture regimes, some with the thickness or presence or absence of certain horizons, and some with differences in composition or mineralogy that may reflect different parent materials.

Characteristics used in defining soils either are observable in the field or by visual and tactile examination and simple field tests or they are inferred from observable features. The principal observable features are the kind, number, thickness, and arrangements of horizons in the profile and—for each horizon—the color, including patterns of mottles, and the texture, structure, consistency, and reaction (pH). Other observable features used in classification are the presence of coarse fragments such as gravel or cobbles and the presence of carbonates, gypsum, and soluble salts.

The thickness and degree of expression of a diagnostic soil horizon are common criteria used to separate series within a soil family. Such a horizon may range in thickness from several centimeters to a meter or more. It may be thin but strongly expressed or thick but weakly expressed.

The principal inferred properties used in classification are moisture and temperature regimes; the number of days during most years when the soil is dry, moist, or saturated; average and summer soil temperature; percentage base saturation; percentage sodium saturation; the cation exchange capacity of the clay fraction; and the mineralogy of both the clay and larger particles. In addition, soil scientists infer and measure many other soil parameters that are important for the use and management of soil series. Among them are the standard index properties for the engineering classification of soils, available water capacity, permeability, soil reaction, shrink-swell potential, corrosivity of steel and concrete, susceptibility to water and wind erosion, susceptibility to flooding, depth to water tables, susceptibility to subsidence, hydrologic groupings, and other properties.

A carefully planned soil testing program is used to verify the relations required to accurately infer soil properties. Through such testing, the local relations between the five soil-forming factors—parent material, climate, organisms, topography, and time—and the properties of soils are determined. State agricultural experiment stations, state highway departments, and others contribute to the test program. Through these cooperative efforts a vast amount of data about the properties of soils has been assembled.

Soil series are the equivalent of the species of botany or zoology. Just as not all members of a species of plants are identical, so also are there differences among members of a soil series. It is necessary to define ranges in soil properties, ranges that are sufficiently limited or narrow that reasonably specific and narrow ranges in performance for a soil series will result. In defining soil series, pedologists try to meet this requirement, and the attempt appears to have been successful. (Continuing investigation of the effectiveness of this procedure would be a useful cooperative project for engineers and pedologists in the future.)

The pedologist's insistence that slope is a soil property is contested by many engineers and deserves some explanation. In the first place, soils are considered three-dimensional bodies with areal extent. Thus the configuration of the surface is an important property of those bodies. Perhaps more important is the configuration of the boundaries between soil horizons in the soil profile. In most soils the permeability of adjacent horizons is different. Thus, slope not only affects the total amount of water that infiltrates into the soil but also strongly influences the fate of the water after it enters the soil surface. Seep lines resulting from the lateral flow of free water above the sloping boundary of a subsurface horizon that is of slower permeability than overlying horizons are the source of many engineering problems. Location of such seep lines may be predicted if the soil series and its slope are known.

SOIL CLASSIFICATION BELOW THE SERIES LEVEL

For many practical purposes, it is necessary to subdivide soil series into soil phases. For example, some soil series are found on a wide range of slopes, from gently sloping to very steep. Because recognition and mapping of several slope classes of the same series may provide valuable information needed for planning the use and management of the soil, phases of soil slope are established.

In addition to the degree of slope, the degree of past erosion is a common criterion for soil phases. Besides its obvious importance to the growth of plants, it may be of interest to the highway engineer. Eroded A horizons do not have to be excavated and wasted in construction. The nature and amount of the A horizon available for topsoiling are also important, as is the effect of past erosion on vegetating ungraded areas such as rest areas and roadside parks.

Other soil characteristics of importance to the engineer, such as stoniness or depth to rock, are frequently used as phase criteria. Soil phase criteria are simple and can be described by simple modifiers so that, if one understands a soil series, one can readily understand the phase from the additional descriptors. Miami silt loam, 0 to 3 percent slope, is a phase name. The soil phase name is used to put a label on soil mapping units, but phases and soil mapping units are not synonymous. The soil phase is a taxonomic unit—an abstraction—whereas the mapping units are the land areas that are used and managed. This distinction is important because mapping units can commonly have "inclusions" of con-

Table 1. Moisture content data for Canfield and Geeburg soils.

Soil Series and Horizon	Sites	Moisture Content: 33-kPa Tension	Optimum	In Situ: Autumn	Optimum (%)	Spring	Optimum (%)
Canfield							
Bt	15	19.1	16.2	17.7	109	21.2	131
Bx	15	14.1	14.3	13.3	93	16.2	113
B3	15	12.6	12.6	12.9	102	14.5	115
Geeburg							
Bt	12	18.9	21.3	17.1	80	23.3	109
C	12	20.3	21.1	16.3	77	18.6	88

Note: 1 Pa = 1 x 10^{-6} bar.

Table 2. Density measurements for Canfield and Geeburg soils.

Soil Series and Horizon	Site	Oven-Dry Density (g/cm^3)	33-kPa Density (g/cm^3)	Maximum Dry Density (g/cm^3)
Canfield				
Bt	SK-4	1.57	1.54	1.73
	SK-30	1.58	1.53	1.80
	ST-5	1.59	1.52	1.74
	WN-S41	1.57	1.54	1.71
	WN-S42	1.63	1.62	1.78
	Mean	1.59	1.55	1.74
Bx	SK-4	1.81	1.79	1.93
	SK-30	1.89	1.82	1.82
	ST-5	1.80	1.77	1.93
	WN-S41	1.80	1.79	1.81
	WN-S42	1.83	1.79	1.86
	Mean	1.83	1.79	1.87
B3	SK-4	1.82	1.81	1.89
	SK-30	1.79	1.81	2.03
	ST-5	1.79	1.80	2.05
	WN-S41	1.80	1.78	1.89
	WN-S42	1.79	1.80	1.94
	Mean	1.80	1.80	1.96
Geeburg				
Bt	MH-2	1.86	1.70	1.65
	MH-13	1.87	1.73	1.70
	PG-S12	1.82	1.62	1.63
	SK-11	1.78	1.55	1.63
	TR-8	1.78	1.66	1.68
	Mean	1.82	1.65	1.66
C	MH-2	1.86	1.71	1.66
	MH-13	1.92	1.78	1.71
	PG-S12	1.87	1.72	1.66
	SK-11	1.83	1.66	1.65
	TR-8	1.89	1.80	1.76
	Mean	1.87	1.73	1.69

Notes: 1 Pa = 1 x 10^{-5} bar; 1 g/cm^3 = 0.58 oz/in^3.
All values are means of tests on 3 clods 250 to 400 g in weight. Average mean deviation in sets of 3 clods is 0.02 g/cm^3; minimum is 0 g/cm^3; and maximum is 0.13 g/cm^3.

trasting soils but phases cannot.

SOIL SERIES VERSUS SOIL MAPPING UNITS

Soil series names are used to identify mapping units in soil surveys. Mapping units are named after the dominant soil series, or phase of a soil series, in the mapping unit. At least 85 percent of a mapping unit named for a single soil series consists of soils identical to or very similar to the series named. Because of cartographic limitations, most mapping units contain some inclusions of soils other than the one given in the name. These inclusions, if they are quite contrasting, may comprise as much as 15 percent of the area of the mapping unit; they may have a steeper slope, a finer texture, or a different moisture regime. Only in large-scale, experimental surveys can all contrasting taxonomic units be delineated. On scales between 1:15 840 and 1:24 000, the scales of most published modern soil surveys, it is impossible to delineate small areas of contrasting soils. It is therefore important that, for critical uses, soil surveys be supplemented by on-site investigations.

USE OF SOIL SERIES DATA IN ENGINEERING

To illustrate the kind of data about soils that may be obtained through knowledge of soil series and soil horizons, two soil series were chosen: Canfield and Geeburg, soil series found in eastern Ohio and western Pennsylvania respectively. Both soils formed in glacial till of late Wisconsin age. The unweathered till below both soils is weakly calcareous. Both occupy convex portions of the landscape where runoff exceeds runon and where good soil drainage would be expected. Both soils formed under deciduous hardwood forest, and both occur in very similar climates. The striking differences in the two soils result mainly from the fact that the Canfield soils formed in glacial till of loam texture, a sandy silt or ML in engineering classification, whereas the Geeburg soils formed in silty clay to clay (CH) glacial till. Water moves more readily through the Canfield soil and causes the profile to be altered to a greater depth [2 m (6.6 ft)] than it is in the Geeburg soil [1 m (3.3 ft)].

In Soil Taxonomy, Canfield soils are Aquic Fragiudalfs in the fine-loamy, mixed, mesic family; Geeburg soils are Aquic Hapludalfs in the fine, illitic, mesic family. Both Canfield and Geeburg soils have ochric epipedons and argillic horizons. The thickness and organic content of the ochric epipedons are about the same in the two soils. The argillic horizon is 1 to 2 m (3.3 to 6.6 ft) thick in Canfield soils but only 0.3 to 0.8 m (1 to 2.6 ft) thick in Geeburg soils. But the most striking difference in soil horizons is the presence of a fragipan within the argillic horizon of the Canfield soils and its lack in Geeburg soils. The fragipan is a very dense, compact layer with slow permeability and poor soil structure.

Seasonal Moisture Content

The classification of Canfield and Geeburg soils in aquic subgroups reflects the presence of mottles in the upper part of the B horizon that indicate saturated conditions in the B horizon during short periods of time in late fall or early spring. If the soils were saturated for longer periods of time, gray colors would predominate immediately below the surface soil and the soils would be classified in the Aqualf suborder.

Data in Table 1 were obtained in Ohio in a study by McCormack and Wilding (7). The in situ moisture con-

Table 3. Atterberg limits for Canfield and Geeburg soils at five sites.

Soil Series and Horizon	Liquid Limit		Plastic Limit		Plasticity Index	
	Mean	Range	Mean	Range	Mean	Range
Geeburg						
Bt	53.6	48.5 to 58.5	26.3	24 to 30	27.3	22.5 to 33.5
C	48.8	42 to 54	25	23.5 to 27	23.8	17 to 28.5
Canfield						
Bt	25.3	31.5 to 37.5	22	22 to 23.5	13.1	11.5 to 14
Bx	29.4	25.5 to 33.5	18.8	15.5 to 21.5	10.6	9 to 12
B3	24.5	20 to 29.6	17.6	15.5 to 21.5	6.9	4.5 to 10

tent of all Canfield horizons is near the optimum moisture content in the autumn but well above it in the spring. In the Geeburg soils, both the Bt and C horizons have in situ moisture contents well below optimum in the autumn. In the spring the Geeburg Bt horizon is slightly more moist than the optimum moisture content. Where soil material is to be excavated for compacted fills, a knowledge of the seasonal in situ moisture content of soil horizons of specific soil series should be valuable to the engineer.

Many studies have demonstrated the relation between soil moisture classes and the depth to free water in soils (4, 6, 14), and this relation is reported for all soils in published soil surveys. Depth to free water has an important influence on the ease of excavation and is one of the soil properties influencing frost heaving.

Soil Density

The kind and arrangement of soil particles—which are strongly influenced by the range in particle sizes or grading—and the shape and the packing of the particles determine soil density and strongly influence several aspects of the engineering behavior of soils. Most engineering texts discuss the importance of desiccation and weathering on the engineering behavior of soils derived from specific kinds of parent materials. In the definition of soil series, not only is the kind of parent material specified but also the conditions of weathering history, including climate, vegetation, and relief or landscape position, as well as the relative age of the surface during which weathering has been in progress are confined into definite ranges. Considering the unique phenomena that act on a soil element in a specific kind of geologic material at a given depth, the in situ density of given horizons of a soil series should not vary widely.

This premise was tested for each major horizon of the Canfield and Geeburg soils by measuring the density at 0.33-bar (33-kPa) tension and oven dryness of undisturbed clods, following standard procedures (2). The results are given in Table 2. The set of five samples from each horizon, taken from sites as far as 100 km (60 miles) apart, show a very narrow range in density. In fact few of the measurements vary from the mean by more than the 3 to 5 percent coefficient of variation often cited as normal experimental error in density measurements. The compaction characteristics within samples of each horizon also fall within a narrow range.

Soil Texture

Soil texture is a highly important soil property that is recognized and used for classification at levels above the soil series, principally at the family level. In the definition of many soil series, the range in texture of the family is subdivided and the range in thickness of horizons with defined textures is specified. Soil families recognize only the texture of specified parts of the soil profile, e.g., the texture of the upper 50 cm (20 in) of the argillic horizon. Soil series definitions specify the textural range of all parts of the soil profile.

In Canfield soils, only a part of the full range in texture of the fine-loamy family is included. The clay content of the argillic horizon above the fragipan is 18 to 27 percent whereas the fine-loamy family of which Canfield is a member ranges up to 35 percent in clay content. Canfield soils also have 10 to 25 percent gravel and cobbles in the soil profile whereas other series in the same family are free of gravel.

The definition of Geeburg soils also subdivides the textural range of a soil family. Clay content for the fine family ranges from 35 to 60 percent. Geeburg soils have 46 to 60 percent clay in the argillic horizon. Ellsworth soils, otherwise closely similar to Geeburg, have 35 to 45 percent clay.

Atterberg limits are closely related to soil texture where clay mineralogy, organic content, and carbonate content are constant. In Table 3, the means and ranges in liquid limit (LL), plastic limit, and plasticity index (PI) from five sites of each of the two soil series are given. The sites were chosen to represent the full range in texture of each of the two soil series. In multiple regression analysis of the data, clay content was found to explain a very high proportion of the variation in LL and PI. The following equations were derived.

$$LL = 9.51 + 0.81C \qquad r^2 = 0.96 \qquad (1)$$

$$PI = 4.28 + 0.591C \qquad r^2 = 0.95 \qquad (2)$$

Data from 25 samples were used in the analysis.

As indicated by the limited range in grain-size distribution, mineralogy, and plasticity, specific horizons of soil series fall into a narrow range of Unified Soil Classification System and AASHO classes. For the five Geeburg pedons tested, all samples of both the Bt and C horizons were in the A-7-6 AASHO class. For the Bt horizon four samples were CH and one was CL borderline to CH. All samples for the C horizon were near the CL-CH boundary; three placed as CL and two as CH. For the five Canfield profiles, all samples of the Bt horizon placed as A-6 and CL, on the low plasticity side. All samples from the Bx horizon were CL; three were A-6 and two were A-4. All samples from the B3 horizon placed as A-4; three placed as CL, one as CL-ML, and one as SM-SC.

Clay Mineralogy

Because all soils in a soil series have formed in a similar parent material and have been subjected to similar soil weathering, the kind of clay minerals is relatively uniform within the series. In both Canfield and Geeburg soils the dominant clay mineral is illite (7).

Soil Structure

Each horizon of the soil series has a limited range in soil structure; soil weathering and the parent material are similar wherever the soil occurs. Soil struc-

ture is one of the major determinants of soil permeability and also affects the ease of soil excavation. For example, the fragipans of Canfield soils, which have a weak, platy structure, are very dense, very hard when dry, and more difficult to excavate than horizons above and below. The C horizons of Geeburg soils are also compact, but the high clay content of Geeburg soils causes them to be sticky and difficult to grade when they are moist or wet. In both soils, the blocky structure of the upper B horizon results in easy excavation.

Soil pH and Exchangeable Cations

These properties are important in preparing specifications for concrete, and they also influence the proper use of lime or other chemicals for stabilization of soils as subgrade. Again, as a result of the same kind and degree of soil weathering in similar parent material, given horizons of soil series have a narrow range in these properties.

SUMMARY

Soil series are the lowest category in Soil Taxonomy, having a narrower range in both properties and performance than any of the five higher categories. Soil series occupy unique landscape positions and have narrow ranges in important site and environmental conditions that are considered soil properties in pedology but not in soil mechanics.

Confined in their ranges by the limits of the higher categories, soil series represent the product of a specific kind and degree of soil weathering. Of particular importance is a limited and specifically defined range in composition (especially in mineralogy and particle size) that relegates the occurrence of soil series to a specific kind, or very similar kinds, of parent material. Knowledge of the soil series thus identifies, within narrow ranges, not only the parent material but also the grain-size distribution, composition, and chemical properties of each horizon, the thickness and structure of each, and the seasonal soil temperature and wetness at the site.

Soil series provide a structure for organizing knowledge about soils and a basis for predicting the performance of soils in highway construction and for other engineering uses. Identifying soil series is helpful in planning the testing programs required for highway design.

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Application of Soil Taxonomy in Engineering

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Transferral of soil information among the disciplines concerned with soil is important. One of the traditional sources of basic soils information for engineering uses at the reconnaissance level has been the pedological maps and soil surveys prepared by the Soil Conservation Service. The new Soil Taxonomy incorporated by the Soil Conservation Service and other, cooperating agencies into all recent pedological mapping and reports contains key formative elements as building blocks for constructing soil classifications. Engineers may obtain useful information concerning soils on a regional basis by becoming familiar with the new Soil Taxonomy. Individual soil profiles are classified and the formative elements give clues