
Soil Survey

Hamblen County Tennessee

By

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UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils, and Agricultural Engineering
In cooperation with the
Tennessee Agricultural Experiment Station
and the Tennessee Valley Authority

HOW TO USE THE SOIL SURVEY REPORT

SOIL SURVEYS provide a foundation for all land use programs. This report and the accompanying map present information both general and specific about the soils, the crops, and the agriculture of the area surveyed. The individual reader may be interested in the whole report or only in some particular part. Ordinarily he will be able to obtain the information he needs without reading the whole. Prepared for both general and detailed use, the report is designed to meet the needs of a wide variety of readers of three general groups: (1) Those interested in the area as a whole; (2) farmers and others interested in specific parts of it; and (3) students and teachers of soil science and related agricultural subjects. Attempt has been made to meet the needs of all three groups by making the report comprehensive for purposes of reference.

Readers interested in the area as a whole include those concerned with general land use planning—the placement and development of highways, power lines, urban sites, industries, community cooperatives, resettlement projects, and areas for forest and wildlife management and for recreation. The following sections are intended for such users: (1) Description of the County Surveyed, in which location and extent, physiography, geology, relief, and drainage, water supply, organization, population, and cultural development, and transportation and industries are discussed; (2) Agriculture, in which a brief history and the present status of the agriculture are described; (3) Productivity Ratings and Physical Land Classification, in which is presented the productivity of the soils, which are grouped according to their relative physical suitability for agricultural use; (4) Soil Associations; (5) Land Use and Soil Management, in which the present use of the soils is described, their management requirements discussed, and suggestions made for improvement; and (6) Water Control on the Land, in which problems pertaining to drainage and control of runoff are treated.

Readers interested chiefly in specific areas—as some particular locality, farm, or field—include farmers, agricultural technicians interested in planning operations in communities or on individual farms, and real estate agents, land appraisers, prospective purchasers and tenants, and farm loan agencies. These readers should (1) locate on the map the tract with which concerned; (2) identify the soils on the tract by locating in the legend on the margin of the map the symbols and colors that represent them; and (3) locate in the table of contents in the section on Soils and Crops the page where each type is described in detail and information given as to its suitability for use and its relations to crops and agriculture. They will also find useful specific information relating to the soils in the sections on Productivity Ratings and Physical Land Classification, Soil Associations, Land Use and Soil Management, Water Control on the Land, and Forests.

Students and teachers of soil science and allied subjects—including crop production, forestry, animal husbandry, economics, rural sociology, geography, and geology—will find their special interest in the section on Morphology and Genesis of Soils. They will also find useful information in the section on Soils and Crops, in which are presented the general scheme of classification of the soils of the area and a detailed discussion of each type. For those not already familiar with the classification and mapping of soils, these subjects are discussed under Soil Survey Methods and Definitions. Teachers of other subjects will find the sections on Description of the County Surveyed, Agriculture, Productivity Ratings and Physical Land Classification, Soil Associations, and the first part of the section on Soils and Crops of particular value in determining the relations between their special subjects and the soils of the area. Soil scientists and students of soils will find special interest in the section on Morphology and Genesis of Soils.

This publication on the soil survey of Hamblen County, Tenn., is a cooperative contribution from the—

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SOIL SURVEY OF HAMBLLEN COUNTY, TENNESSEE

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¹ A. C. Orvedal, of the Division of Soil Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering, cooperated substantially in preparing this report.

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THE first white settlement in what is now Hamblen County was on the Nolichucky River in 1783. Early settlements were near Russellville, Witt, and Panther Springs and along the Holston River. In general the county is agricultural, although there are a few small factories that employ several hundred people. Morristown, the county seat and the principal trading center of the county and of much of the surrounding territory, is an important market for agricultural products and is one of the largest in the South for poultry. Corn and wheat are the most important crops both for subsistence and as sources of income. Oats, barley, and rye are less important, and hay and forage are increasing in importance. Tobacco is the only important

strictly cash crop. To provide a basis for the best uses of the land a soil survey of the county was begun in 1940 by the United States Department of Agriculture in cooperation with the Tennessee Agricultural Experiment Station and the Tennessee Valley Authority. The results may be summarized as follows.

SUMMARY

Hamblen County is in the northeastern part of the State of Tennessee, in the Great Valley of East Tennessee. The total land area is 112,000 acres, or approximately 175 square miles.

The relief is predominantly rolling to hilly, although it ranges from nearly level to steep. The elevation above sea level ranges from about 900 to 2,000 feet, but in most places it is between 1,100 and 1,500 feet. The county is drained by the Holston and Nolichucky Rivers, both of which eventually find their way to the Tennessee River.

The climate is temperate and continental. Its salient features consist of moderate winters with short erratic cold spells, moderate summers with cool evenings, and a well distributed mean annual precipitation of about 45 inches, including about 10 inches of snow. The average frost-free season is about 206 days.

Ever since the first crop was harvested by white men, about 150 years ago, the industry of the county has been dominantly agricultural. The agriculture has developed from typical pioneer farming to the present widely diversified farming. Corn, wheat, lespedeza, grasses, clovers, alfalfa, and tobacco are the important crops; and oats, barley, rye, sorgo, peaches, apples, pears, cherries, small berries, and vegetables represent less important crops. Dairying and poultry raising are the chief livestock enterprises; the raising of beef cattle, swine, and sheep represents less important branches. The many crops combined with the livestock enterprises make up a highly diversified agriculture. Diversified farming is a natural response toward the adjustment of agriculture to an intricate distribution of soils differing from one another in their physical suitability for their various uses.

The soils of the county differ widely in character and in the conditions associated with productivity and adaptations for use. Largely on the basis of differences in color, texture, consistence, fertility, relief, stoniness, eroded condition, and content of moisture, the soils of the county are classified and mapped in 84 unit separations, consisting of 28 soil types, 46 soil phases, 4 complexes, and 6 miscellaneous land types.

Gray and brown colors predominate in the surface soils, and red and yellow predominate in the subsoils. Of the total county area, silt loams occupy about 23 percent, cherty or shaly silt loams about 20 percent, silty clay loams, including about 15 percent of shaly, cherty, or gravelly silty clay loam, about 34 percent, and fine sandy loams, including loamy fine sands, about 13 percent. About 10 percent of the county is included in the miscellaneous land types. About 7 percent of the land is nearly level, 6 percent is undulating, 34 percent is rolling, 38 percent is hilly, and 15 percent is steep. The soils in about 59 percent of the area of the county are moderately eroded, those in about 33 percent are uneroded or slightly eroded, those in about 7 percent are severely eroded, and those in a little less than

1 percent are badly gullied. The soils are prevailingly well drained, although those in about 1 percent of the area of the county are poorly drained and those in about 3 percent are imperfectly drained.

According to the position occupied in the broad landscape, the soils may be placed in four groups, as follows: (1) Soils of the uplands, (2) soils of the colluvial lands, (3) soils of the terraces, and (4) soils of the bottom lands.

Soils of the uplands developed over limestones are members of six series—the Dewey, Decatur, Fullerton, Clarksville, Bolton, and Talbott. In the sequence Decatur-Dewey-Fullerton-Clarksville the color of the surface soil ranges from brown to light gray, natural fertility and susceptibility to erosion decrease, and the content of chert increases. The outstanding feature of the Talbott soils is the tough plastic character of the subsoil; the surface soil is light grayish brown. Like the Dewey soils, the Bolton soils are brown, but they are coarser textured and more friable and occupy steeper areas.

The second subgroup of soils of the uplands includes soils developed over calcareous shales. Of these the Needmore are the deeper and better suited to the production of crops, and the Dandridge are better suited to pasture.

Soils developed over interbedded shales and limestones, which make up the third subgroup of soils of the uplands, are classified in four series—the Sequoia, Armuchee, Litz, and Upshur. Occupying gently sloping areas, the Sequoia soils are moderately deep, but the Litz, Armuchee, and Upshur soils occupy very strongly sloping areas and are shallow over bedrock.

Interbedded sandstones and shales underlie the members of the Lebew series, which are shallow and inextensive.

Six miscellaneous land types are also mapped in the uplands. Four of these contain limestone outcrops, and two contain numerous gullies. Of these only rolling stony land and hilly stony land (Talbott soil material) are physically suited to pasture; the others are limited chiefly to forest.

Soils of the colluvial lands are developed from accumulations formed at the base of slopes. Although inextensive, these soils are productive and important in the agriculture of the county. The Emory, Abernathy, Ooltewah, and Greendale soils are developed chiefly from materials washed from the uplands underlain chiefly by limestone, and the Leadvale and Whitesburg soils are developed from materials washed from the uplands underlain chiefly by shale.

The soils of the terraces occupy former flood plains of the present streams and creeks. In general, the surface is nearly level to gently sloping, but some areas have been recently dissected so as to be undulating or even rolling. The soils of six series—the Waynesboro, Holston, Monongahela, Tyler, Purdy, and Sequatchie—are developed from materials washed mainly from the uplands underlain by sandstone and shale. Drainage becomes progressively poorer from the Waynesboro soils, which are well drained, to the Purdy, which are poorly drained; the Sequatchie soils on the younger terraces are brown and well drained. The soils of two series—the State and Altavista—are developed chiefly from materials washed mainly from uplands underlain by granite, gneiss, schist, slate, and quartzite. Both of these soils are productive, but the State, being darker and better drained, is the more productive.

The remaining soils occupy the bottom lands. Although occasional floods restrict the adaptation of these soils for crops, they also renew their fertility. These soils differ chiefly in the source of the alluvium and in drainage conditions. Those consisting of alluvium derived chiefly from shales, limestones, and sandstones are members of the Staser and Hamblen series and of the Lindsides-Roane and Melvin-Atkins complexes. Those consisting of alluvium derived chiefly from granites, gneisses, schists, slates, and quartzites are members of the Congaree and Chewacla series. The Staser and Congaree soils are well drained; the Roane soils are well drained but cherty; the others are imperfectly and poorly drained.

The soils in Hamblen County differ widely in physical suitability for use and in requirements for management. Such differences are accounted for by differences in the number of internal and external soil features and conditions, such as texture, structure, consistence, quantity and character of organic matter, chemical character, moisture conditions, depth of soil, eroded condition, stoniness, and degree of slope. As these soil features and conditions affect soil use and management through the three conditions of (1) productivity, (2) workability, and (3) conservability, the soil types and phases and miscellaneous land types are grouped in the section on Productivity Ratings and Physical Land Classification into five classes according to these three conditions. For convenience these classes are referred to as First-class soils, Second-class soils, Third-class soils, Fourth-class soils, and Fifth-class soils.

The First-class soils are productive, easy to work, and easy to conserve; hence they are very well suited to the growing of crops in the present agriculture. These soils include 3.9 percent of the area of the county.

As compared with the First-class soils, the Second-class soils are somewhat less favorable in productivity, workability, and conservability; but they are nevertheless physically moderately well suited to the production of crops in the present agriculture. They include 24.5 percent of the area of the county.

As compared with the Second-class soils, the Third-class soils are less favorable in productivity, workability, and conservability; nevertheless they are considered to be suitable for the principal crops in the present agriculture, provided good management is practiced; and at present they are used chiefly for the production of crops. They include 28.1 percent of the area of the county.

In the Fourth-class soils chiefly workability and conservability are so unfavorable that the soils are not physically suited to the production of the common crops of the areas under feasible current management. Their productivity, however, is generally favorable enough to warrant their use for pasture, for which they are chiefly used, although a significant proportion of their area is used for field crops and some of it is idle. These soils include 30.3 percent of the area of the county.

Being low to very low in productivity and having highly adverse conditions of workability or conservability or both, the Fifth-class soils are considered physically unsuitable either for crops requiring tillage or for permanent pasture, and under present conditions their best adapted use in most places apparently is forestry. They include 13.2 percent of the area of the county.

The use of the soils in Hamblen County in general is fairly well adjusted to the physical limitations of the soils, and the management of the soils is likewise fairly well adjusted to their limitations. Evidences of improper soil use and improper soil management, especially the latter; however, are altogether too frequent; and adjustment of the use and management to the physical limitations of the various soils is one of the basic agricultural problems in the area. The soils differ greatly from one another in their management requirements, but a number of them are more or less similar in their requirements. In the section on Land Use and Soil Management the soils are classified in 11 groups on the basis of their management requirements under adapted uses; and in the section on Water Control on the Land the general aspects of control of runoff and erosion are treated.

In the section on Soil Associations a generalized map is presented showing the general distribution of geographically associated series of soils. Each association is discussed briefly.

In the section on Forests the forests of the county are discussed, beginning with the early white settlements and leading up to the present time. The relation that exists between forests and soils and, to a less extent, the place of forests in relation to the rest of the county are discussed.

The section of the report entitled "Morphology and Genesis of Soils" deals with the soils from the viewpoint of the soil scientist, particularly in connection with soil classification. Hamblen County lies in the northern part of the zone of Red and Yellow Podzolic soils, and the well-developed, well-drained soils apparently belong in the Red and Yellow Podzolic groups. The predominant soils of the county are developed from material that is residual from weathering of sedimentary rock, chiefly (1) limestones, (2) calcareous shales, and (3) interbedded shales and limestones. The soils developed from limestone residuum are by far the most extensive. Nearly all of these are well drained and have well-developed profiles; and most of them are predominately red in the subsoil, indicating that they belong in the group of Red Podzolic soils. The predominant soils developed over calcareous shales and interbedded shales and limestones are azonal-lithosols, which are generally hilly and steep, shallow over shale bedrock, and contain varying amounts of shale fragments.

DESCRIPTION OF THE COUNTY SURVEYED

LOCATION AND EXTENT

Hamblen County is located in the northeastern part of Tennessee (fig. 1). It is separated from the North Carolina-Tennessee boundary by one tier of counties and from the Virginia-Tennessee boundary by two tiers of counties. Morristown, the county seat and the only city in the county, is 40 miles by air line northeast of Knoxville. The county is roughly rectangular, and its greatest length is in a northeast-southwest direction. The Nolichucky River and the Bays Mountains form most of the boundary on the southeast, and the Holston River forms the boundary on the northwest. The total land area of the county is 175 square miles, or 112,000 acres.

PHYSIOGRAPHY, GEOLOGY, RELIEF, AND DRAINAGE

Physiographically, the entire county lies in the Appalachian Valley, which extends from central Alabama to southern New York. The part of this valley included in Tennessee is known as the Great Valley of East Tennessee, and it crosses the eastern part of the State in a north-east-southwest direction. The average width of this valley is about 40 miles. It slopes gently to the southwest, from a general elevation of about 2,000 feet above sea level in the northeastern part of the State near Bristol to about 900 feet in the southeastern part in the vicinity of Chattanooga. Parallel highland belts extend along both sides of the Great Valley. The Great Smoky Mountains, which in some places reach an elevation of slightly more than 6,000 feet, form the highland belt on the southeast; and the Cumberland Plateau, which in a few places in Tennessee reaches an elevation of about 3,000 feet, forms the highland belt on the northwest.

The Great Valley is not a river valley; it is merely a lowland belt, as compared with the parallel highland belts on both sides. Nearly all of this valley is underlain by sedimentary rocks—limestones, shales, and sandstones—of the Paleozoic era, which in nearly all parts have been folded and faulted. As a group, these rocks are less resistant

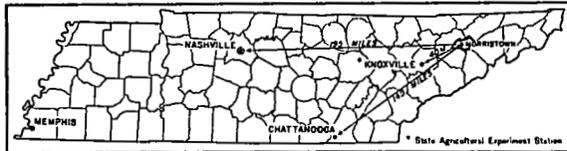


FIGURE 1.—Location of Hamblen County in Tennessee.

to weathering than those of either the Great Smoky Mountains on the southeast or the Cumberland Plateau on the northwest. The rocks in the Great Valley itself, however, differ greatly from one another in resistance to weathering; and, partly because of these differences, but also because of the intense folding and faulting of the rocks, the Great Valley is characterized by numerous parallel ridges and valleys, with the most resistant rocks forming the ridges and the less resistant ones forming the valleys. These smaller ridges and valleys run in a general southwest-northeast direction, parallel to the Great Valley.

In the part of the Great Valley in which Hamblen County is located, the underlying rocks consist mainly of limestones and shales, the limestones predominating. Both the limestones and the shales vary considerably from place to place. The greater proportion of the limestones are dolomitic. In most areas these dolomitic limestones contain considerable chert, in other areas sand, and in some areas both chert and sand. Some of the limestones, especially those adjacent to the shales, contain clay. Some of the shales are high in lime (calcium carbonate). The others are generally acid, containing little or no lime. Interbedded with these acid shales in most areas in Hamblen County, however, are thin, widely spaced layers of limestone.

The relief of the county is prevailingly rolling and hilly, although it ranges from nearly level to steep. In most places the difference in elevation between the stream bottoms and the adjacent hills and ridges ranges between 100 and 300 feet, although in some places this difference

is as much as 500 feet. Sinkholes characterize the landscape in those parts of the county underlain by limestone, and where sinkholes are abundant they give rise to what is called a karst relief.

Throughout most of the county the elevation² ranges between 1,100 and 1,500 feet above sea level. The lowest point, along the Holston River in the western tip of the county, is between 930 and 940 feet in elevation; and the highest point, on Crockett Ridge about 2½ miles northwest of Morristown, is about 1,960 feet. Elevations of the crests of other mountains are as follows: Bays Mountains, about 1,600 feet; Boatman Mountain, 1,500 feet; and River Ridge, 1,300 feet. Morristown is about 1,300 feet and the Nolichucky River at the southern tip of the county is 975 feet above sea level.

The county is well drained. About one-third of it—the southeastern part—drains into the Nolichucky River, and the northwestern two-thirds drains into the Holston River. Small streams, many of which are intermittent, are abundant nearly everywhere. They are especially numerous in the areas underlain by insoluble shale; they are less abundant in the areas underlain by soluble limestone. Nevertheless, drainage of the latter areas is very good, as much of the drainage water finds its way through underground channels. As indicated by the number of sinkholes in which water rapidly disappears, and also by the disappearance and reappearance of streams, such underground channels must be abundant in certain parts of the county underlain by limestone; but they are absent in the areas underlain by shale. Chiefly because of the underground drainage, the areas underlain by limestone generally do not manifest well-defined surface drainage patterns; whereas the areas underlain by shale generally show a fairly well developed drainage pattern. There are no large natural lakes in the county, although some of the sinkholes retain water part or all of the time, thereby forming small lakes or ponds.

The typical ridge-valley topography of the Great Valley as a whole is inconspicuous in Hamblen County for several reasons, namely, the narrowness of the county, the proximity of the two rivers—the Holston and the Nolichucky—and the comparatively gentle dip of the rock formations, which therefore outcrop over broad areas. Nevertheless there are three fairly well defined topographic belts—a broad belt through the middle of the county, flanked by two narrow belts. Certain kinds of rocks and certain groups of soils are associated with each belt.

The first topographic belt is a narrow but conspicuous one along the northwestern boundary of the county, adjacent to the Holston River. Its greatest width is only about 2 miles. The area is thoroughly dissected, and it is characterized by cordons of steep, sharply pointed, symmetrical hills and ridges. Shales, nearly all of which are acid at the surface and which contain only thin and widely spaced layers of limestone, underlie most of the area; but conspicuous areas underlain by limestone are included. The shallow and shaly Litz soils of steep areas greatly predominate, but where the land is underlain by limestone the miscellaneous stony land types predominate. The general eleva-

² Data pertaining to elevations were obtained from recent topographic maps published cooperatively by the U. S. Geological Survey and the Tennessee Valley Authority, as follows: Bean Station (1939), Mohawk (1940), Morristown (1939), Rankin (1939), Russellville (1940), Springvale (1939), and Talbott (1940).

tion of the area ranges between 1,000 and 1,300 feet, although some of the knobs reach a greater elevation.

The second belt, a broad one through the middle of the county, includes between two-thirds and three-fourths of the total area of the county. Predominantly rolling and hilly, the relief ranges from undulating to steep. As compared with the first belt, the hills in the second belt tend to be broad and rounded instead of sharply pointed, and the slopes tend to be longer and more gentle. Sinkholes are common. The area is well drained, chiefly through underground channels. It is underlain by limestones, nearly all of which are dolomitic.

The limestones under most of the broad belt contain considerable chert; those under a small part are relatively free from chert but contain some clay; and those under another small part are considered high-grade, as they are low in both chert and clay. Ordinarily, where these various kinds of limestones occur in close association, the cherty limestones are associated with ridges, the clayey limestones with valleys, and the high-grade limestones with positions intermediate in elevation. Probably owing to the proximity of the Holston River, this relation does not hold for all of the belt; but it is manifest in the vicinity just west of Morristown, where Crockett Ridge, which is underlain by cherty limestone, forms a conspicuous feature of the landscape. The Fullerton soils, which are underlain by the cherty dolomitic limestones, are by far the most extensive. The Dewey and Decatur soils, which are generally underlain by fairly high-grade limestones, predominate in a narrow belt that runs through the approximate middle of the wide belt, and the relief of these soils is gentler than that of the broad belt as a whole. Other soils of significant area in the area as a whole are the Talbott, Clarksville, and Bolton soils, and miscellaneous stony land types. Included in this belt is an area of several square miles south of Morristown, considered as a part of Bays Mountains, which resembles the first belt, the one near the Holston River.

Like the first belt, the third belt, lying along the southeastern border of the county, is underlain by shales and is characterized by sharply pointed, symmetrical hills and narrow ridges. In contrast with the shales of the first belt, however, which are generally acid, the shales of the third belt are generally calcareous. The Dandridge soils greatly predominate in this belt. This area is thoroughly dissected, and the relief is characteristically hilly and knobby.

In addition to these three major belts, there are several minor topographic features in the county. One consists of stream terraces. The widest of these occur along the Nolichucky River, and others occur along the Holston River and the larger creeks. Another feature is the ridge, considered a part of Bays Mountains, that forms a part of the boundary between Hamblen and Green Counties. Still another rather conspicuous feature is Stone Mountain in the extreme northeastern corner of the county. This so-called mountain rises to a height of about 1,700 feet, overlies sandstone and shale, and includes the Lelew soils.

WATER SUPPLY

The county is well supplied with water. Numerous perennial streams provide a supply for a large part of the permanent pasture, and intermittent streams also furnish considerable water during sea-

sons of heavy rainfall. Springs are rather common; some of the large ones in the limestone valleys are really outflowings of subterranean streams. Cisterns afford the main sources of water for farm and family use in some of the areas underlain by cherty limestone, but wells are common in the areas underlain by shale. As sources of water for livestock, farmers depend largely on sinkholes that retain water and on springs (pl. 1). Some of the springs are intermittent or "wet-weather springs," as they are called. Most of them, however, are perennial. During dry periods it is necessary to haul water from a distance for livestock needs on a few of the farms.

ORGANIZATION, POPULATION, AND CULTURAL DEVELOPMENT

Hamblen County was created in 1870 from parts of Grainger, Hawkins, and Jefferson Counties. It was named in honor of Hezekiah Hamblen, of Hawkins County (6).³

Most of the early settlers came from the East, and they were principally of English, Scotch, and Irish descent. The first early settler came during the decade from 1783 to 1793. One of the first settlements, if not the first, was at the bend of the Nolichucky River in 1783. In 1784 Thomas Jarnagin was given permission to build a mill on Long Creek (10). Other early settlements were in the vicinities of Russellville, Witt, and Panther Springs and along the Holston River. Morristown was founded some time later.

The United States census for 1880 reported the county's population as 10,187, all classed as rural. The 1940 census reported a total county population of 18,611, of which 10,561 were classed as rural. There has been very little change in the rural population during the last 50 years. It is approximately 60.7 persons to the square mile, and it is rather uniformly distributed. Negroes comprise about 10 percent of the population, and most of them live in the urban areas. The increase of the population represents largely the growth of the city of Morristown, the present (1940) population of which is 8,050.

Morristown is the county seat, and it is the principal trading center of the county and of much of the surrounding territory. It is an important market for agricultural products, and it is one of the largest poultry markets in the South. Russellville, Whitesburg, Witt, and Alpha are small agricultural trading centers.

All communities are provided with schools and churches, and school bus and rural mail delivery services extend to practically all parts of the county. Telephone services are available in most places, and electric power facilities have been extended greatly during recent years. Of the 1,853 farms in 1940, 773 reported 819 automobiles, 149 reported 154 motortrucks, and 72 reported 73 tractors. Dwellings on 288 farms were lighted by electricity, 27 of these by home plants, and 181 farms had telephones.

TRANSPORTATION AND INDUSTRIES

The transportation facilities of Hamblen County are good. A main line and two branch lines of the Southern Railway and two United States highways (Nos. 11E and 25E) cross the county. Paved or

³ Numbers in parentheses refer to Literature Cited, p. 167.

graveled roads, State or county, penetrate all parts of the county. These roads are well maintained and provide easily traveled routes to markets at all seasons of the year. A few farms in the less productive districts are one-half to three-quarters of a mile from an improved road. According to the Federal census for 1940, 263 farms were situated on hard-surfaced roads, 1,384 on gravel roads, 19 on improved dirt roads, and 119 on unimproved dirt roads.

Hamblen County is in an agricultural region, and its people are largely dependent upon agriculture for their livelihood. There are, however, a few small factories. Two knitting mills, two furniture factories, a wood-turning factory, and a wagon factory in Morristown employ several hundred people. A few portable sawmills, a few small canning factories, and a few gristmills employ a small number of people. Several tobacco warehouses and wholesale houses are located in Morristown.

CLIMATE

The climate of Hamblen County is temperate and continental. Its salient features consist of moderate winters characterized by short erratic cold spells, mild summers with cool pleasant evenings, and a well-distributed mean annual precipitation of about 45 inches, including about 10 inches of snow. Summer temperatures of more than 100° F. are rare. The spread between the mean summer and winter temperatures is not great, being only about 35°.

Although no data of purely local variations in temperature and precipitation are available, it is apparent that such variations exist. So far as is known, such variations are explained by the lay of the land, including direction of slope, and the effect of relief on air drainage, differences in elevation, and the proximity and relation to mountains. Frosts frequently occur in valleys and depressions when vegetation on the ridges shows no injury from frost, and the early fall and late spring frosts are invariably more injurious in the lower situations. Frost injury of fruit trees is less frequent on ridge tops and north-facing slopes, as growth in spring is retarded here, as compared with the growth of orchards on south-facing slopes. Winter-killing of perennials, small grains, and other winter crops, owing to freezing and heaving, is more frequent on slopes characterized by seepage.

The information on climate is from the data collected at the United States Weather Bureau station at Rogersville, Hawkins County, Tenn. Because of the differences between the data of this station and the one at Knoxville, however, it is thought that there is also some difference between the climate of Hamblen County and Rogersville. The principal differences are in the length of the frost-free season and the temperature.

The average frost-free season according to the Rogersville station is 188 days, extending from April 16, the average date of the latest killing frost, to October 21, the average date of the earliest. Frosts have occurred as late as May 10 and as early as September 26, but at such unusual dates they are seldom severe. The average frost-free season at the Knoxville station is 212 days, which is ample time to grow and mature practically all of the important southern field crops except

cotton. The grazing period extends from the latter half of April to the last of November.

Although -18° F. has been recorded at the station at Rogersville, subzero weather is unusual. Winters are not ordinarily severe, the most disagreeable feature being the characteristic sudden changes associated with high humidity. The winters for the most part are sufficiently open to allow outdoor work; and even though winter crops get practically no effective protection from a snow blanket, a variety of winter cover crops, alfalfa, and small grains are grown with little danger of winterkilling on well-drained soils. Such winter vegetables as turnips, cabbage, celery, and kale are grown successfully.

The rainfall is evenly distributed throughout the winter, spring, and summer, and is about 35 percent lower in the fall, when many of the crops are maturing and being harvested. The total annual rainfall is ample for even the most exacting crops of the region, but, partly because of the heavy downpours in which some of it comes, much is lost through surface runoff. Neither extremely low nor excessively heavy amounts of rainfall are common, but crop yields are sometimes materially reduced because of periods of light rainfall, especially on soils that are shallow over bedrock or are otherwise droughty. Destructive hailstorms and tornadoes are to be expected, but not frequently.

Table 1 gives the important climatic data as recorded at the Rogersville station.

TABLE 1.—Normal monthly, seasonal, and annual temperature and precipitation at Rogersville, Hawkins County, Tenn.

[Elevation, 1,006 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year (1925)	Total for the wettest year (1901)	Average snowfall
	$^{\circ}$ F.	$^{\circ}$ F.	$^{\circ}$ F.	Inches	Inches	Inches	Inches
December.....	38 7	71	-18	4 22	1 43	10 70	2 6
January.....	37 8	74	-13	3 86	4 43	3 86	3 4
February.....	30 9	70	-17	3 71	2 81	1 41	2 3
Winter.....	38 8	79	-18	11 79	8 07	15 07	8 3
March.....	47 8	86	7	4 68	1 34	4 66	1 1
April.....	60 5	95	20	3 57	1 92	4 09	. 5
May.....	64 9	95	30	3 74	1 36	4 95	(¹)
Spring.....	50 4	95	7	11 89	4 62	14 60	1 6
June.....	72 3	98	40	4 17	3 24	2 96	0
July.....	75 4	101	48	4 05	3 54	2 72	0
August.....	74 5	102	48	3 90	1 57	10 21	0
Summer.....	74 1	102	40	12 81	8 35	15 89	0
September.....	69 8	103	32	2 83	90	4 60	0
October.....	67 9	91	19	2 63	0 98	1 48	(¹)
November.....	46 7	80	6	2 59	3 46	1 30	. 4
Fall.....	58 1	103	6	8.05	11 34	7 38	4
Year.....	56 9	103	-18	44 54	32 98	63 84	10 3

¹ Trace.



Important sources of water for livestock in areas underlain by limestone: *A*, Springs, such as this one. Many of these springs are actually reappearing streams that have flowed underground for a distance. *B*, Sinkholes, such as this one in an area of rolling stony land and hilly stony land (Talbot soil material), that retain water for long periods.



A, An excellent stand of tobacco on Dewey silt loam; B, tobacco barn, in which burley tobacco is hung late in summer to be air-cured, prepared for market, and kept until about December or January, when it is auctioned at tobacco warehouses.

AGRICULTURE

HISTORY AND DEVELOPMENT

The territory now comprising Hamblen County was once occupied by Indians. Their agriculture, according to Williams (16), was simple, of small extent, and confined for the most part to the raising of corn. This same authority states that the early settlers were indebted to the Chickasaw Indians for superior species of peaches and plums. He also states that these Indians had a fine breed of Spanish horses derived from those left by De Soto.

The first white settlement in what is now Hamblen County was on the bend of the Nolichucky River in the year 1783, and the first settlers were Robert McFarland and Alexander Outlaw. They made a crop in 1782, but it was a year later before they brought their families and settled (10).

The early agriculture of the white men was simple but self-sufficient. As the means of transporting goods from the rest of the country were very poor, the early settlers depended almost entirely on the land for their food, clothing, and shelter. The few supplies brought from the East were transported either by pack animals or by wagons over very poor roads. Later a few flatboats navigated the larger streams, but this was largely a one-way traffic, because it was extremely difficult to pole these boats upstream. Flatboats were used principally for transporting the products of the land, which were sold on markets located on the larger rivers such as the Tennessee, Ohio, and Mississippi. Corn was the principal crop. It was ground at small grist-mills operated by power obtained from creeks or from large springs. Clothing was made in the home, and the cloth called linsey-woolsey was made from home-grown flax and wool. Sugar was obtained from the abundant maple trees.

As the county became more settled, more land was cleared, and corn and wheat became important crops, both for subsistence and as sources of income. There is some evidence that tobacco became a limited cash crop at an early date.

According to the first complete agricultural census of this area of the United States, made in 1880, 45,872 acres were used for the production of crops (including rotation grass but excluding orchards and permanent pastures) at that time. Since then the acreage of crops has changed but little, as the total acreage of cropland in 1939 was about 46,278 acres. During this period from 1879 to 1939 the acreages in wheat and oats declined, that of corn remained about the same, and that of hay crops, tobacco, and barley increased. Legume hay crops, particularly lespedeza and alfalfa, have shown considerable increases in acreage. Lespedeza became an important hay and pasture crop about 1930, and alfalfa had its greatest increase in acreage somewhat later.

The value of agricultural products reached a peak in 1919, largely as a result of the high prices that prevailed at that time. Poultry and dairy products have continued to increase in total value despite the decline in prices, except that poultry products declined between 1929 and 1939.

The relative importance of the several sources of farm income is brought out in table 2.

TABLE 2—Value of farm products sold, traded, or used by farm households in Hamblen County, Tenn., in 1929 and 1939

Product	1929	1939
Crops sold or traded.....	\$396, 282	\$370, 402
Field crops ¹	(?)	350, 346
Vegetables.....	(?)	19, 628
Fruits and nuts.....	(?)	6, 430
Forest products sold.....	25, 330	5, 750
Livestock sold or traded.....	414, 436	203, 532
Livestock products sold or traded.....	310, 040	108, 008
Dairy products.....	(?)	107, 109
Poultry and poultry products.....	(?)	60, 166
Other livestock products.....	(?)	1, 543
Total products sold or traded.....	1, 146, 697	844, 598
Products used by farm households.....	390, 815	380, 167
Total products sold, traded, or used.....	1, 537, 512	1, 230, 765

¹ Includes potatoes and sweetpotatoes² Not reported separately

CROPS AND PRACTICES

Acres of principal crops for stated years are given in table 3.

TABLE 3—Acreage of the principal crops and number of principal fruit trees in Hamblen County, Tenn., in stated years

Crop	1870	1880	1890	1909	1919	1929	1939
	<i>Acres</i>						
Corn.....	16, 143	14, 785	18, 610	17, 141	19, 661	15, 841	15, 171
Wheat.....	11, 085	9, 193	15, 438	8, 240	11, 651	5, 195	6, 645
Oats.....	6, 731	4, 876	1, 235	2, 573	1, 183	431	523
Barley.....	130	19	—	—	133	401	820
Rye.....	78	28	80	73	269	172	310
Potatoes.....	—	174	140	333	223	300	210
Sweet potatoes.....	103	143	158	230	223	217	103
Market vegetables.....	—	—	—	—	1, 133	1, 013	576
Tobacco.....	81	112	26	113	73	926	1, 543
Sorgo for strup.....	—	344	171	221	204	47	51
All hay.....	2, 933	5, 860	6, 161	10, 147	9, 352	10, 012	14, 000
Timothy and clover, alone or mixed.....	—	—	1, 415	5, 732	5, 517	6, 128	4, 011
Lespedeza.....	—	—	—	—	—	113	7, 200
Alfalfa.....	—	—	—	—	135	214	1, 283
Grains cut green.....	—	—	712	1, 483	97	116	256
Legumes cut for hay.....	—	—	—	—	1, 209	1, 220	279
Other hay.....	—	—	4, 034	2, 932	2, 304	2, 221	1, 031
Silage and forage crops ⁴	—	—	230	421	11, 103	858	632
	<i>Trees</i>						
Apples.....	—	35, 562	51, 118	28, 650	22, 483	19, 183	13, 081
Peaches.....	—	52, 467	11, 274	17, 008	22, 711	12, 230	11, 451

¹ Exclusive of sorghums² Clover alone³ Includes some sweetclover⁴ Mainly corn, sorghums (including sorghums for hay in some years), and oats cut and fed unthreshed.⁵ For the year 1890.⁶ For the year 1900.⁷ For the year 1930.⁸ For the year 1940.

Corn is the most important single crop in the present agriculture of the county, and it is raised on practically all of the farms. The acreage has varied during the last 60 years, but there has been no upward or downward trend during that period. In 1939 the average yield of corn for grain was about 26 bushels an acre. Although this crop is raised on practically all of the soils commonly tilled, a larger proportion of the soils of the bottom lands and small alluvial areas and

smooth to rolling areas of Dewey and Decatur soils of the uplands is used for this crop. The yields on these areas are higher than the average for the county, and yields of 40 to 50 bushels an acre are common. Commercial fertilizers are applied on about 50 percent of the uplands used for corn, but only a very limited amount is used on the bottom lands. Most of the corn is fed on the farms where it is raised.

Wheat is not now so important a crop as it was up to 1920. The acreage decreased almost half during the two decades from 1919 to 1939. The average yield for census years rose steadily from about 6 bushels an acre in 1879 to 14 bushels in 1939, reflecting the increasing use of commercial fertilizer. At present all wheatland is fertilized with from 150 to 400 pounds of commercial fertilizer containing phosphate and usually potash. Exceptional yields of more than 40 bushels to the acre have been reported on Dewey and Decatur soils.

All the wheat is sown in fall, and most of it is produced on the more productive soils of the uplands and alluvial terraces. Some is grown on the soils of the bottom lands that are not subject to frequent overflow, but on such soils the plant grows at the expense of the grain, resulting in lower yields of grain and greater losses because of lodging. The county agricultural agent estimates that three-fourths of the wheat is consumed on the farms and one-fourth is sold.

Oats, barley, and rye are less important crops, but recent indications are that their acreage is increasing. Oats were an important crop 60 years ago, but the acreage decreased steadily until 1929, after which it increased slightly to 756 acres in 1939, including 233 acres cut and fed unthreshed. Rye and barley were never of importance, but during the last two or three decades the acreages have shown some increase. In 1939, 310 acres were planted to rye and 820 acres to barley. A larger acreage of rye is used for winter pasture and a winter cover crop, and this crop is harvested only occasionally for grain. Oats and barley are threshed and consumed on the farm.

Hay and forage crops are becoming increasingly important. The acreage of hay crops increased from 2,933 acres in 1879 to 14,060 acres in 1939. Lespedeza is the most important single hay crop, and it has developed in this county chiefly during the last two decades. Both red clover and alfalfa are becoming important hay crops. Red clover is grown either alone or mixed with such grasses as timothy, redbud, and orchard grass; but alfalfa is grown alone for the most part. Most of the red clover and alfalfa are grown on the more productive well-drained soils, whereas lespedeza is grown on a wide variety of soils so far as fertility and drainage are concerned. It is probable that with the increased use of lime and phosphate the acreage of red clover and alfalfa will increase and that of lespedeza will decrease somewhat correspondingly. Some crimson clover is raised, but its chief function is as a winter cover crop rather than a hay crop. It is grown only on the more fertile, well-drained soils. Other important annual legumes grown for hay are soybeans and cowpeas. On some farms these crops are produced regularly as a hay crop; on others they are used as emergency hay crops. The acreage therefore fluctuates considerably from year to year.

In addition to the acreage of clover harvested for hay, 946 acres produced 1,151 bushels of clover seed in 1929, and 646 acres produced 914 bushels in 1939. In the latter year 32,773 pounds of lespedeza seed

was harvested from 347 acres and 367 bushels of grass seed from 87 acres.

Burley tobacco is the only important strictly cash crop, and it has become so only within the last 15 to 20 years. Prior to about 1918 only a small amount of any kind of tobacco was raised, although in the early days tobacco evidently was grown to a small extent as a cash crop. Since that time, however, the production of burley tobacco has increased several fold. A small patch is grown on most farms, and it constitutes the chief source of income on the majority of farms. Much labor and considerable skill are required for the successful growing of this crop, and eastern Tennessee is noted for the quality of its tobacco. Most of the tobacco is raised on well-drained pervious soils, especially Decatur silt loam; Dewey silt loam (pl. 2, A), Emory silt loam, Greendale silt loam, and Fullerton silt loam. The average yield of the 1939 crop was about 1,050 pounds to the acre. The larger yields are obtained on the soils having dark-colored surface layers, but the better quality is generally obtained on the soils having lighter colored surface layers.

Burley tobacco is cut during the late summer and is hung in barns (pl. 2, B) to be air-cured and prepared for market. It generally remains in such barns until December or January, when it is auctioned at tobacco warehouses. The tobacco crop is marketed at Morristown and at a few of the nearby markets, such as Greeneville (in Greene County) and Knoxville.

Fruits and vegetables are produced for consumption in the home and for sale on the local markets. One truck farm is on the bottom lands along the Nolichucky River, and several farmers grow tomatoes for commercial markets. According to the estimate of the county agricultural agent, 1,200 acres of tomatoes were grown in 1940, mostly under contract with canneries. Canneries are located at Morristown, Russellville, and Whitesburg within the county, at White Pine in Jefferson County, and at Newport in Cocke County. On specified days trucks sent by the canneries pick up the tomatoes at the farms.

Potatoes and sweetpotatoes are grown largely for home use. Some of the principal vegetables grown for sale are tomatoes, sweet corn, watermelons, beans, cabbage, and cantaloup. There are three commercial orchards chiefly raising apples and peaches, but their total area is less than 50 acres.

Agronomic practices in the county vary somewhat according to differences in soil types, patterns of soil distribution, lay of the land, and size of farms. Modern machinery is generally used on the larger farms of the smooth to rolling areas. Much of the tillage in the hilly areas and on the small farms is done with one-horse implements and by hand labor. Small grains are generally harvested with grain binders, although small combines are being introduced where comparatively large acreages of grain are grown. Some of the corn is harvested by machinery, but much of it is cut and shocked by hand. Where winter crops are to be sown, the corn is cut before it is ripe enough to be picked, and the ears are gathered late in fall and early in winter (pl. 3, A). Most of the small grains, such as wheat (pl. 3, B), barley, and rye, are planted in fall and harvested during June and July. Grasses and legumes are sown either in fall or in spring. Corn is usually planted during April and May (9).



A, An excellent field of corn on Decatur silt loam, which under good management frequently produces between 50 and 60 bushels an acre. The common practice is to cut and shock the corn before it is fully ripe so that the following winter-grain crop can be planted. Ordinarily the corn ears are gathered late in fall and early in winter. *B*, Winter wheat on Dewey silty clay loam, eroded phase, a brown, friable, well-drained soil productive of most commonly grown crops. The landscape, including the well-built farmstead, is typical of the Dewey soils. The trees on the right almost obscure a large modern farm home.



A, Limestone quarry, typical of areas underlain by limestone; B, sturdy old log houses like this one are scattered throughout the county, especially in the less productive districts, and show that such districts have been settled for a long time.

The use of lime and commercial fertilizers has increased greatly during the last 60 years. According to the Federal census, only \$1,408 was spent for fertilizers in 1879, but by 1939 the expenditures for commercial fertilizers amounted to \$39,737 on 1,258 farms, or about two-thirds of all farms, besides \$6,853 for lime on 239 farms. The largest amount, \$52,268, was spent in 1919, when the largest number of farmers reported the use of commercial fertilizers. The large expenditure may have been the result of the high prices that prevailed at that time. At present (1940), however, more farmers are probably using commercial fertilizers than at any time in the history of the county except for the period of World War I. According to estimates and records of the county agricultural agent, the amounts of commercial fertilizer used for different crops in 1940 were as follows: 1,100,000 pounds for wheat, 100,000 pounds for corn, 450,000 pounds for tobacco, and 4,402,000 pounds for pasture and hay crops. The amount of lime used in 1940 was about 8,000 tons. The fertilizers generally used for corn and wheat are a 0-10-4⁴ mixture, 16- or 20-percent superphosphate, and basic slag. A 3-8-5 mixture is the most common fertilizer used for tobacco. The application of phosphatic fertilizers and lime on pasture and hay crops is becoming a common practice, partly as a result of the Government-sponsored agricultural programs. Most of the commercial fertilizers purchased are ready mixed. Manure is commonly applied to the cropped land, but most of it is used to benefit the tobacco crop.

Limestone quarries (pl. 4, A) are scattered throughout the county in areas underlain by limestone. Most of the soils need lime, which is being supplied in increasing quantities.

LIVESTOCK AND LIVESTOCK PRODUCTS

The number of livestock on farms in stated years is shown in table 4.

TABLE 4.—Number of domestic animals in Hamblen County, Tenn., in stated years

Livestock	1880 ¹	1890 ²	1900 ³	1910 ³	1920 ⁴	1930	1940
Horses.....	1,750	2,015	2,291	2,357	2,206	⁵ 1,460	⁶ 1,467
Mules.....	492	661	960	1,152	1,474	⁵ 1,305	⁶ 1,218
Cattle.....	4,148	5,422	5,543	7,258	7,916	⁵ 7,340	⁶ 8,676
Sheep.....	5,467	6,103	1,035	2,272	806	⁵ 2,296	⁶ 664
Goats.....	172	101	118	⁵ 7140	⁶ 48
Swine.....	9,724	9,541	10,456	7,113	10,049	⁵ 6,166	⁶ 8,223
All poultry.....	25,344	87,673	36,074	60,633	98,921	⁵ 70,666	⁶ 69,707

¹ Of all ages on June 1, excluding spring lambs and spring-hatched chicks.

² Of all ages on June 1, excluding chickens under 3 months.

³ Of all ages on April 15, excluding chickens under 3 months.

⁴ Of all ages on January 1.

⁵ Over 3 months of age on April 1.

⁶ Over 6 months of age on April 1.

⁷ Of all ages on April 1.

⁸ Over 4 months of age on April 1.

The number of cattle in 1940, although not large, is double that reported in 1880. Of the total of 8,676 head over 3 months old on April 1, 1940, 4,687 were cows and heifers over 2 years old, kept mainly for

⁴ Percentages, respectively, of nitrogen, phosphoric acid, and potash.

the production of milk. The value of dairy products sold has increased considerably in the last 20 years. Much of the milk is collected at the farms by trucks and is hauled to milk plants at Morristown, Greeneville (in Greene County), and Rogersville (in Hawkins County). Most of the dairy products marketed locally are sold to a few specialized dairies that have delivery routes in the urban areas. Farms producing milk for these dairies are situated in all parts of the county, especially where the land is suitable for pasture but not for crops (pl. 5, *A*). Jersey is the principal breed of dairy cattle, and Guernsey is second.

Beef cattle are raised throughout the county, but the better and larger herds are in areas of the Dewey-Decatur and Dandridge soil associations (pl. 5, *B*). It is within these areas that bluegrass pasture is most easily maintained. Most of the beef cattle are grade animals, although there are some purebred herds. Hereford, Aberdeen-Angus, and Shorthorn are the chief breeds, and of these the Hereford is the most common. Most beef cattle and veal calves are sold to local buyers and shipped to Jersey City, N. J. Some of the better cattle are shipped to Lancaster, Pa.

The number of hogs has remained comparatively constant during the last 60 years. Poland China and Duroc-Jersey are the popular breeds. A large proportion of the hogs are sold to packing plants in Knoxville. A few are shipped to Roanoke, Va., and Jersey City. The county agricultural agent estimates that about one-fifth of the hogs are consumed on farms.

Sheep declined in numbers from 1890 to 1940, when only 664 sheep over 6 months of age were reported. Hampshire is the most common breed. Most of the sheep are shipped to Jersey City. There are a few goats in the county, but the number has very seldom exceeded 150.

Although the value of poultry and eggs rose from 1909 to 1929, it fell somewhat in the following decade. In 1929, 492,042 dozen eggs were produced, of which 383,219 dozen were sold, and 122,065 chickens were raised, of which 58,775 were sold. In 1939 only 416,626 dozen eggs were produced and 105,346 chickens raised. Poultry diseases and unfavorable market conditions are the reasons given for the decline. White Leghorn, Rhode Island Red, and Plymouth Rock are the common breeds. Only a few turkeys and ducks are raised. Most of the poultry is shipped to eastern markets from Morristown, a leading shipping center for poultry in this region.

Horses were the principal work animals about 60 years ago, but since that time mules have become increasingly common. At present the numbers of horses and mules are about equal. The number of work animals per farm ranges from 1 to 4. During recent years nearly all of the replacements have been raised on the farms, and most of these are mules. The principal breed of horses is the Percheron. During the last decade tractors have replaced many horses and mules in the areas of smoother land.

The total expenditure for feed, the number of farms, and the percentage of farms reporting this expenditure increased from 1899 to 1929, after which there was a slight decrease. In 1939 the number of farms reporting expenditures for feed was 757, or 40.8 percent of all farms, and the amount spent was \$45,454.

LAND USE

The great expansion in agriculture in Hamblen County apparently took place before 1880, the year of the first complete agricultural census, although there have been several changes since that time. In 1880 there were 974 farms, averaging 97.4 acres in size. The total area of farm land was 94,896 acres, of which 54,693 acres, or 57.6 percent, was improved land (cropland or plowable pasture). In 1940 there were 1,853 farms, averaging 56.3 acres in size. Of these farms, 1,548 were less than 100 acres in size, and 839 of them were of less than 30 acres. The total area of farm land was 104,375 acres, of which 81,367 acres, or 78 percent, was classed as improved land. During this same period, according to the census, the rural population changed very little, being 10,187 in 1880 and 10,561 in 1940.

Apparently, relatively little change has taken place in the use of the land in the last 60 years; and in 1940, according to the census figures, 93.7 percent of the total area of the county was in farms. About 44 percent of the farm land was used for the production of crops in 1939; nearly 34 percent was in plowable pasture; nearly 14 percent was in woodland, and the rest was used for miscellaneous purposes. The principal crops grown were corn, wheat, other small grains, and hay. In 1939 corn was grown on about 37 percent of the land harvested; small grains, chiefly wheat, on about 21 percent; and hay on about 34 percent; all these crops accounting for about 92 percent of the land used for crops.

According to the classification of farms in the 1940 census, 149 obtained their major income from livestock sold or traded, 505 from field crops sold or traded, 1,075 from farm products used by farm households, and 53 from dairy products sold or traded.

FARM TENURE AND INVESTMENT

According to the 1940 census, full owners operated 1,129 farms, part owners 169, managers 2, and tenants 553. The proportion of tenancy, which was 29.8 percent in 1940, has not changed much during the last 60 years. Nearly all of the tenants are share tenants, although a few rent for cash. The common landlord-tenant agreement is as follows: The landlord furnishes the tenant with a house, all of the work animals, and the seed, and the tenant furnishes the labor. Fertilizer bills are usually divided according to the sharing of the crop. The tobacco crop is commonly shared equally between the landlord and the tenant, but the corn and small-grain crops are generally shared two-thirds to the landlord and one-third to the tenant.

Farm labor and farm tenure are closely related in Hamblen County. The prevailing practices are as follows: The farmer furnishes the laborer with a house, a small garden patch, pasture for one cow, and fuel when there is a supply of wood on the farm, or otherwise pays half of the coal bill. The laborer receives a wage of about a dollar a day for those days that he works for the farmer. Arrangements are sometimes made whereby the laborer shares in the tobacco or wheat crop. A total of \$60,913 was reported spent for labor in 1939 on 432 farms, or 23 percent of all farms. Generally, the available labor is sufficient and the labor performed is of fair

to good quality. Most of the laborers are white residents, but a few are Negroes.

The average value of land and buildings in 1940 was \$3,457 per farm or \$61.37 per acre, and in 1930 it was \$4,691 per farm or \$68.14 per acre. The buildings on an average farm consist of a house, a barn, a tobacco shed, and in places one or two other small buildings. Some sturdy log houses built in the early days still stand, especially in the less productive districts (pl. 4, *B*). The farm machinery on an average small farm without a tractor generally consists of a plow, a disk, a heavy single-section harrow, a small-grain drill, a row planter, a wagon, a middle breaker, a mower, a hay rake, and a row cultivator. In recent years many small row-crop tractors with tractor machinery have come into use.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field and the recording of their characteristics, particularly in regard to the growth of various crops, grasses, and trees.

The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road and railroad cuts, are studied. Each excavation exposes a series of layers, or horizons, called collectively the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil and its content of lime and salts are determined by simple tests.⁵ The drainage, both internal and external, and other external features, such as the relief or lay of the land, are taken into consideration, and the interrelation of the soil and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, with special emphasis upon the features that influence the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped into classification units, the three principal of which are (1) series, (2) type, and (3) phase. In some places two or more of these principal units may be in such intimate or mixed pattern that they cannot be clearly shown separately on a small-scale map but must be mapped as (4) a complex. Some areas of land—such as rough and stony areas or badly gullied areas—that have no true soil are called (5) miscellaneous land types.

The series is a group of soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile and having similar parent material. Thus, the series comprises soils having essentially the same color, structure, natural drainage conditions, and other important internal characteristics, and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The series are given

⁵ The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality; higher values, alkalinity; and lower values, acidity. Terms referring to reaction and commonly used in this report are defined in the Soil Survey Manual (7). Indicator solutions are used to determine the reaction of the soil. The presence of lime in the soil is detected by the use of a dilute solution of hydrochloric acid.

geographic names taken from localities near which they were first identified. Decatur, Dewey, Fullerton, Talbott, and Dandridge are names of important soil series in this county.

Within a soil series are one or more types, defined according to the texture of the upper part of the soil. Thus, the class name of the texture, such as sand, loamy sand, sandy loam, silt loam, clay loam, silty clay loam, or clay, is added to the series name to give the complete name of the soil type. For example, Fullerton silt loam and Fullerton fine sandy loam are soil types within the Fullerton series. Except for the texture of the surface soil, these types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, differing from the type in some minor feature, generally external, that may be of special practical significance. Differences in relief, stoniness, and degree of accelerated erosion may be shown as phases. For example, within the normal range of relief for a soil type some areas may be adapted to the use of machinery and the growth of cultivated crops and others may not. Even though no important differences may be apparent in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance the more sloping parts of the soil type may be segregated on the map as a sloping or a hilly phase. Similarly, some soils having differences in stoniness may be mapped as phases even though these differences are not reflected in the character of the soil or in the growth of native plants.

Texture refers to the relative amounts of clay, silt, and various grades of sand making up the soil mass. Coarse-textured soils contain much sand and gravel, and fine-textured soils contain much clay. Structure refers to the natural arrangement of the soil material into aggregates, or structural particles or masses. Consistence is a term that has come into rather recent use as regards soil characteristics and refers to such conditions as friability, plasticity, stickiness, hardness, compactness, toughness, and cementation. Permeability and perviousness connote the ease with which water, air, and roots penetrate the soil. Ordinarily the term "surface soil" refers to the coarser textured surface layer that extends generally to a depth of 6 to 12 inches, and "subsoil" refers to the deeper and heavier textured layer, which is generally of a uniform color in well-drained soils. The substratum, which also generally includes the parent material, is beneath the subsoil and is characteristically spotted or mottled with two or more colors. As used here, bedrock refers to the consolidated rock on which the substratum rests. In a practical sense, the degree of acidity may be thought of as the degree of poverty in lime (available calcium). An alkaline soil in this county is rich in available calcium, and a neutral soil contains a sufficient amount for any crop commonly grown in the county.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, complexes, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS

The soils of the county have developed in an environment of a moderately high temperature, heavy rainfall, and forest vegetation. Having developed in such an environment, they are generally leached of most soluble material. Most of them are acid in reaction and medium to low in organic matter. For the most part they have never possessed the inherent fertility characteristic of the soils of the western prairies; on the other hand, they are more fertile than comparable soils farther south and southeast where the temperature is higher and leaching has been more severe and continuous. Nearly all of the soils of the uplands have developed from material that is residual from the weathering of either limestone or shale or both. Red, yellow, and brown are the prevailing colors, and silt loams and silty clay loams are the predominant textures in the surface soil. Drainage of most of the soils is good.

The soils of the county differ greatly from one another in many characteristics, such as color, texture, consistence, depth, reaction, fertility, relief, stoniness, erosion, tilth, permeability, and drainage, all of which bear a close relation to the productivity of the soil, the ease with which it is worked and conserved, or the farm uses to which it is adapted.

They exhibit all shades of color from nearly white through gray, yellow, and brown to dark and deep red. Colors intermediate between brown and light gray predominate in the surface soils, whereas red and yellow predominate in the subsoils.

The texture and consistence range from loose incoherent sands to tough, tenacious clays. The surface soils, however, are predominantly silt loams and silty clay loams, whereas the subsoils and substrata are predominantly silty clays and silty clay loams. The surface soils in about 23 percent of the area of the county are silt loams; those in about 20 percent are cherty or shaly silt loams; those in about 34 percent are silty clay loams, including about 15 percent of shaly, cherty, or gravelly silty clay loams; and those in about 13 percent are lighter than silt loams, chiefly fine sandy loams. The surface soils for the most part are mellow and friable, whereas the subsoils predominantly range from firm but friable to tight, tough, and plastic.

In fertility and reaction the soils vary greatly. Although the greater proportion are strongly to very strongly acid, a significant proportion are approximately neutral. Some of the soils are very low in natural fertility, others are relatively high, and most of them are intermediate between these two extremes. The content of organic matter is generally not high, but the soils differ considerably in this regard also.

The relief is prevailingly rolling to hilly, but it ranges from nearly level to very steep. About 7 percent of the land of the county is nearly level, 6 percent is undulating, 34 percent is rolling, 38 percent is hilly, and about 15 percent is steep.

In depth over bedrock, the soils vary between extremes—from a mere film to a depth of 50 feet or more. The predominant range in depth to bedrock is thought to be between 10 and 50 feet where the bedrock is limestone and between $\frac{1}{2}$ and 2 feet where it is shale.

The degree of accelerated erosion⁶ undergone by the soils varies greatly. According to the accompanying map, the soils in 32.9 percent of the area of the county are uneroded or only slightly eroded, those in 59.1 percent are moderately eroded, and those in 7.1 percent are severely eroded. A little less than 1 percent of the county is mapped as rough gullied land.

The tilth of most soils is favorable; but some, chiefly the silty clay loams, are subject to puddling, surface baking, and clodding when tilled under unfavorable moisture conditions. With relatively few exceptions, such surface soils are due entirely to the loss of the original surface layers by erosion.

Most of the soils, except those that are shallow over bedrock, are penetrable to a great depth by plant roots and water, but they differ considerably in the relative ease with which they can be penetrated. The soils with firm but friable subsoils and substrata are penetrated comparatively easily, but the soils with claypans or with plastic and sticky subsoils and substrata are penetrable only with difficulty and are generally slowly drained internally.

The soils of the county are well drained, except those in about 1 percent of the area are poorly drained and those in about 3 percent are imperfectly drained.

In degree and character of stoniness the soils range between wide extremes. About 10 percent of the land is characterized by numerous outcrops of limestone and is mapped as rolling, hilly, or rough stony land (Talbot soil material). Loose fragments of chert are common in most of the soils developed over limestone. Except for steep and severely eroded phases, the soils that contain enough fragments of chert to interfere materially with cultivation cover about 12 percent of the area of the county. Outcrops of soft shale are common throughout the uplands where the soils are underlain by shale.

Chiefly because of the differences in the characteristics discussed above, the soils differ greatly from one another in their relative suitability for use in the present agriculture of the county. Some are highly productive, easy to work, and easy to conserve, and therefore are physically very well suited to agricultural uses. Others are low in productivity, difficult to work, and difficult to conserve, and are therefore unsuited or very poorly suited to agricultural uses. Most of the soils of the county, however, are between these two extremes. Some, for example, are productive, or, as the farmers say, strong, but they are difficult to work or difficult to conserve. Others are relatively low in productivity and difficult to conserve but are relatively easy to work. Again, some soils rather high in productivity and fairly easy to work are difficult to conserve; still others are intermediate in all these qualities.

On the bases of differences in productivity and the ease with which they may be worked and conserved, the soils have been grouped into five classes.⁷ The First-class soils occupy 3.9 percent of the area of the county, Second-class soils 24.5 percent, Third-class soils 28.1 percent, Fourth-class soils 30.3 percent, and Fifth-class soils 13.2 percent. Under ordinary systems of management common to the area, the First-, Second-, and Third-class soils, which total 56.5 percent of the county,

⁶ For definition, see p. 142.

⁷ For a discussion of this grouping, see pp. 121-125

are considered to be physically suitable for the production of crops requiring tillage; the Fourth-class soils are considered unsuitable or very poorly suited for the production of crops requiring tillage but are suitable for permanent pasture; and the Fifth-class soils are unsuitable or very poorly suited for either crops or permanent pasture but are suitable for forestry.

From observations it is more or less apparent that in Hamblen County the more progressive agricultural communities—as expressed by good farmhouses and other farm buildings, good fences, and ample farm equipment—are generally found where the soils are physically best suited to agriculture. Where First- and Second-class soils predominate, for example, the agriculture appears to be most prosperous. In these areas a high proportion of the farmhouses appear to be well built and well equipped with many modern conveniences, most of the fences are generally well built and well maintained, and the farms are comparatively well equipped with modern farm machinery. Such conditions are apparent in the upland belts where the Dewey and Decatur soils, most of which are included in the First and Second classes, are extensive, and also in the lowland belts where the Staser, Congaree, State, Altavista, and Sequatchie soils, most of which also are included in the First and Second classes, are of significant extent. In other parts of the county, where the Third-, Fourth-, and Fifth-class soils predominate, the agriculture generally appears to be less prosperous, although there are a few prosperous agricultural communities here and there. General observations also indicate that the size of farms is larger where the First- and Second-class soils predominate than where the Third-, Fourth-, and Fifth-class soils predominate. Although the agriculture over the entire county is diversified, it appears to be more diversified in the areas where the Dewey, Decatur, and Fullerton soils are extensive than elsewhere.

The fact that soils differ widely in characteristics, such as color, consistence, drainage, character of the parent material, relief, and erosion, has already been brought out. On the bases of such characteristics, soils of the county have been classified into 35 series and 6 miscellaneous land types. In order to make full use of the soil survey one must comprehend and understand the units on the soil map—units that are designated as soil types or phases of soil types. As explained in the section on Soil Survey Methods and Definitions, a phase is merely a subdivision within the type representing a variation from the normal soil, generally in slope or degree of erosion or both. A soil type, in turn, is a subdivision within the soil series category—the fundamental unit in the natural classification of soils. After one becomes familiar with the soil series, an understanding of the types and phases within each series is simple and easy. The logical procedure, therefore, in obtaining a working knowledge of the soils of the county is to learn first the characteristics of the soils of the different series.

Although there is more than one approach to an effort to identify the soil series, a convenient one, and the one presented, is to associate, first of all, the soils of each series with the position they normally occupy on the broad landscape. Accordingly, in the following discussion the soils are placed into four groups, as follows: (1) Soils of the uplands, (2) soils of the colluvial lands, (3) soils of the terraces,



A, Herd of Jersey cattle on rolling stony land (Talbot soil material). This land, as well as some other land, is too stony for feasible cultivation, though fairly well suited to permanent pasture. This and other favorable circumstances make dairying an important enterprise in this county. **B**, Herd of Hereford cattle in an area of Dandridge soils. Most of the better beef cattle are raised in areas of Dandridge and Dewey-Decatur soil associations.



A, Gentle relief and attractive homestead typical of areas where the Decatur and Dewey soils predominate. *B*, Typical association of the productive Dewey and Decatur soils of prevailing undulating to gently rolling well-drained areas (foreground) and of the less productive Fullerton and Clarksville soils of prevailing hilly areas (background).

and (4) soils of the bottom lands. This grouping is shown in table 5, in which the main characteristics of the various series are tabulated.

In the discussion that follows, these four large groups are further subdivided on the basis of differences in the source of parent material, each series is discussed briefly, and each type and phase is discussed in considerable detail. Each soil type and phase is shown on the soil map accompanying the report, and its area and proportionate extent are given in table 6.

TABLE 6.—*Acres and proportionate extent of the soils mapped in Hamblen County, Tenn.*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Decatur silt loam.....	128	0.1	Dandridge shaly silty clay loam, eroded rolling phase.....	1,020	1.7
Decatur silty clay loam, eroded hilly phase.....	896	.8	Dandridge shaly silty clay loam, eroded steep phase.....	3,584	3.2
Decatur silty clay loam, eroded hilly phase.....	320	.3	Dandridge gravelly silty clay loam, eroded phase.....	1,728	1.5
Dewey silt loam.....	192	.2	Dandridge gravelly silty clay loam, eroded steep phase.....	448	.4
Dewey silty clay loam, eroded phase.....	7,168	6.4	Sequoia silty clay loam, eroded phase.....	1,344	1.2
Dewey silty clay loam, eroded hilly phase.....	3,072	2.8	Armuchee silty clay loam, eroded phase.....	1,152	1.0
Dewey silty clay loam, severely eroded hilly phase.....	1,216	1.1	Armuchee silty clay loam, severely eroded phase.....	384	.3
Dewey silty clay loam, eroded steep phase.....	384	.3	Litz shaly silt loam, eroded phase.....	3,904	3.5
Dewey silty clay loam, severely eroded steep phase.....	256	.2	Litz shaly silty clay loam, severely eroded phase.....	2,496	2.2
Fullerton silt loam.....	512	.5	Litz shaly silt loam, eroded hilly phase.....	1,344	1.2
Fullerton silt loam, eroded phase.....	6,784	6.1	Litz shaly silt loam, eroded rolling phase.....	704	.6
Fullerton silt loam, hilly phase.....	570	.5	Litz-Holston complex.....	448	.4
Fullerton silt loam, eroded hilly phase.....	5,376	4.8	Upshur-Litz silt loams.....	320	.3
Fullerton cherty silt loam.....	832	.7	Lchew very fine sandy loam.....	384	.3
Fullerton cherty silt loam, eroded phase.....	3,904	3.5	Rough gullied land (limestone residuum).....	320	.3
Fullerton cherty silt loam, hilly phase.....	1,344	1.2	Rough gullied land (Litz soil material).....	704	.6
Fullerton cherty silt loam, eroded hilly phase.....	5,312	4.8	Rolling stony land (Talbot soil material).....	2,560	2.3
Fullerton cherty silty clay loam, severely eroded phase.....	2,112	1.9	Hilly stony land (Talbot soil material).....	5,632	5.0
Fullerton cherty silt loam, steep phase.....	704	.6	Rough stony land (Talbot soil material).....	1,728	1.5
Fullerton cherty silt loam, eroded steep phase.....	1,152	1.0	Limestone outcrop.....	512	.5
Fullerton cherty silty clay loam, severely eroded steep phase.....	512	.5	Emory silt loam.....	2,240	2.0
Fullerton fine sandy loam.....	256	.2	Abernathy silt loam.....	192	.2
Fullerton fine sandy loam, eroded phase.....	2,432	2.2	Ooltawah silt loam.....	128	.1
Fullerton fine sandy loam, hilly phase.....	704	.6	Greendale silt loam.....	960	.9
Fullerton fine sandy loam, eroded hilly phase.....	2,024	1.8	Greendale cherty silt loam, sloping phase.....	960	.9
Clarks ville cherty silt loam.....	768	.7	Leadvale silt loam.....	768	.7
Clarks ville cherty silt loam, hilly phase.....	384	.3	Leadvale silt loam, sloping phase.....	1,344	1.2
Clarks ville cherty silt loam, eroded hilly phase.....	704	.6	Whitesboro silt loam.....	640	.6
Clarks ville cherty silt loam, steep phase.....	256	.2	Waynesboro very fine sandy loam.....	1,152	1.0
Bolton loam, eroded phase.....	960	.9	Holston very fine sandy loam.....	704	.6
Bolton loam, eroded rolling phase.....	768	.7	Monongahela very fine sandy loam.....	768	.7
Talbot silty clay loam, eroded phase.....	2,024	1.8	Monongahela very fine sandy loam, eroded sloping phase.....	192	.2
Talbot silty clay loam, severely eroded phase.....	256	.2	Tyler silt loam.....	384	.3
Talbot silty clay loam, eroded hilly phase.....	1,152	1.0	Purdy silt loam.....	512	.5
Talbot silty clay loam, severely eroded hilly phase.....	768	.7	Sequatchie fine sandy loam.....	512	.5
Talbot silty clay loam, eroded steep phase.....	64	.1	State loam.....	384	.3
Needmore silt loam.....	256	.2	Altavista loam.....	384	.3
Needmore silty clay loam, eroded rolling phase.....	256	.2	Staser silt loam.....	512	.5
Dandridge shaly silty clay loam, eroded phase.....	3,712	3.3	Staser fine sandy loam.....	704	.6
			Hamblen silt loam.....	2,624	2.4
			Lindside-Roane silt loams.....	1,280	1.1
			Melvin-Atkins silt loams.....	192	.2
			Congaree very fine sandy loam.....	704	.6
			Congaree loamy fine sand.....	320	.3
			Chewacla loam.....	128	.1
			Total.....	112,000	100.0

SOILS OF THE UPLANDS

The soils of the uplands have developed from materials that are residual from the weathering of sedimentary rocks, chiefly limestone and shale. The properties of the soils are generally closely associated with the character of the underlying rocks from which the parent materials have been weathered, and it is convenient to refer to these rocks as parent rocks, although such references may not be technically correct. In Hamblen County there are four easily recognizable classes or groups of such parent rocks, namely, (1) limestone, (2) calcareous shale, (3) interbedded shale and limestone, and (4) interbedded shale and sandstone.

The soils developed from material that is residual from the weathering of limestone are classified into six series—Decatur, Dewey, Fullerton, Clarksville, Bolton, and Talbott. In many places the Dewey and Decatur soils (pl. 6, *A*) are closely associated, as are the Fullerton and Clarksville soils (pl. 6, *B*). The soils of these series are distinguished in the field chiefly on the basis of differences in color, consistence, and texture, although they also differ in other characteristics. The principal differentiating characteristic of the soils of the Talbott series is the tough, plastic character of the subsoils. The surface soils are light grayish brown, and the subsoils are yellowish red. The surface soils of the Decatur series are definitely brown, those of the Dewey series are grayish brown, those of the Fullerton series are brownish gray, and those of the Clarksville soils are very light gray or almost white. The subsoils of the Decatur soils are very dark red, those of the Dewey soils are brownish red, those of the Fullerton soils are yellowish red, and those of the Clarksville soils are yellow. Natural fertility decreases in the same order from the Decatur soils to the Clarksville soils, and the amount of chert and the resistance to erosion increase in this order. The Bolton soils are similar in color to the Dewey soils, but they are somewhat lighter textured and more friable and generally occupy steeper areas.

The soils developed from material that is residual from the weathering of calcareous (high-lime) shale are classified into two series, Needmore and Dandridge. In general, the Needmore soils are more than 20 inches thick over shale, are less than 15 percent in slope, and show a consistent development of surface soil and subsoil layers. The subsoil is composed of reddish-yellow, tight, tough silty clay. The Dandridge soils, on the other hand, are shallow and occupy strongly sloping areas; they are generally less than 20 inches thick over shale and range from 15 to 60 percent in slope. They show little or no consistent development of surface soil and subsoil layers.

The soils developed from material that is residual from the weathering of interbedded shale and limestone are classified into four series, the Sequoia, Armuchee, Litz, and Upshur. The Sequoia soils are moderately deep and occupy gently sloping areas, whereas the Litz, Armuchee, and Upshur soils are shallow over bedrock and occupy very strongly sloping areas. The Litz soils are differentiated from the Armuchee chiefly by the high proportion of shale and the low proportion of limestone in the parent rocks of the Litz soil; the proportions of shale and limestone underlying the Armuchee soils are about equal. Also, the Litz soils are generally

shallower and, as might be expected, contain more shale than the Armuchee. The Upshur soils are readily distinguished by their purplish color. The Sequoia soils are similar to the Needmore, which are underlain by calcareous shale, in that they occupy gently sloping areas and show a consistent development of surface soil and subsoil layers. The subsoil is composed of reddish-yellow to yellowish-red tight, tough silty clay. In most places the parent rock of the Sequoia soils is similar to that of the Armuchee.

The soils developed from weathered products of interbedded sandstone and shale are classified into one series, the Lehev. Members of this series are easily differentiated from those of all other series in the county, by the purplish color and acid nature of both the parent rocks and the soils.

Six miscellaneous land types are also mapped in the uplands. Four are characterized by outcrops of limestones, and two are characterized by numerous gullies. The names of these separations, which indicate their character, are as follows: (1) Rough gullied land (limestone residuum), (2) rough gullied land (Litz soil material), (3) rolling stony land (Talbot soil material), (4) hilly stony land (Talbot soil material), (5) rough stony land (Talbot soil material), and (6) limestone outcrop.

SOILS DEVELOPED OVER LIMESTONES

Soils developed over limestones, i. e., from material that is residual from the weathering of limestones, are classified into six series, namely, Decatur, Dewey, Fullerton, Clarksville, Bolton, and Talbot. This is the most extensive group in the county; it includes a little more than half of the total area. All these soils are well drained. Leached of most of the soluble material, they are all acid in reaction. They differ in many characteristics, however, especially in color, relief, content of chert fragments, and consistence; and they also differ in their relation to agriculture.

Variations in the underlying limestones are associated with differences between the soil series. The Decatur and Dewey soils, for example, are generally underlain by high-grade limestone; that is, limestone high in carbonates and low in chert, sand, and clay. The Fullerton soils are underlain by limestone that generally contains more chert or sand, or both, than that beneath the Decatur and Dewey soils; and the Clarksville soils are underlain by limestone that is still higher in chert. The Bolton soils are underlain by limestone that appears to be similar to that underlying the lighter textured Fullerton soils. The limestones underlying Decatur, Dewey, Fullerton, Clarksville, and Bolton soils are generally dolomitic; those underlying the Fullerton, Clarksville, and Bolton soils are apparently nearly pure dolomites. The limestone underlying the Talbot soils is relatively free from chert and sand, but it contains considerable clay.

DECATUR SERIES

The Decatur soils are developed from weathered products of high-grade limestone, some of which is dolomitic. These soils occur in the undulating and rolling uplands, where they are easily identified by their brown surface soils and deep-red subsoils—the deepest red of all the soils in the county. In uneroded fields the surface soil is

distinctly brown mellow silt loam, from 10 to 16 inches thick. The subsoil is dark-red or maroon firm but moderately friable silty clay reaching to a depth of 5 to 7 feet. The upper part of this thick subsoil layer is generally somewhat lighter colored and more friable than the lower part. The underlying parent material is firm tough silty clay that is predominantly yellow but is spotted with rust brown, pale yellow, and some gray.

The Decatur soils, considered to be among the most productive in the county, are highly prized by farmers. They are used for the production of the field crops common to the area, but they differ from one another in their relative physical suitability for such use, largely because of differences in degree of slope or erosion or both.

The Decatur soils are not extensive, as they total only 1,344 acres, and only one type and two phases are mapped—Decatur silt loam; Decatur silty clay loam, eroded phase; and Decatur silty clay loam, eroded hilly phase.

Decatur silt loam.—This is a well-drained soil occupying gentle slopes. It has a brown to dark reddish-brown mellow silt loam surface soil from 10 to 16 inches deep, and a dark-red or maroon-red firm dense but moderately friable silty clay subsoil. The subsoil extends to a depth of 5 to 7 feet, and in a few places it rests directly upon the bedrock. Where it does not, the material beneath the subsoil is reddish-yellow heavy tough silty clay spotted with bright yellow, gray, and red.

In the virgin condition the surface soil is relatively high in organic matter for a soil of the uplands in this region. The organic matter is thoroughly incorporated in the 3- to 4-inch surface layer, and with proper management it endures well under cultivation. The tilth is good, and the soil is practically free of stone. In most places the upper part of the thick subsoil layer is somewhat lighter colored and more friable than the lower part. The slope is gentle, ranging from 2 to 5 percent. Drainage, both internal and external, is very good, although surface drainage is rather slow in a few places where the slope is very gentle. The reaction is acid, generally medium to strongly acid.

Decatur silt loam occupies the well-drained uplands and has developed from materials derived chiefly from high-grade limestone; that is, limestone high in carbonates and low in impurities, such as chert, sand, and clay. It is closely associated with the other Decatur soils and the Dewey soils. Only 128 acres is mapped, mostly southwest of Morristown.

Decatur silt loam is characterized by good tilth of the plow layer and favorable physical properties of the subsoil. The favorable physical character of the surface soil and the subsoil increases the capacity to absorb and retain moisture, prevents alternate extremely wet and dry conditions of the surface soil, and reduces loss of plant nutrients by leaching. Such a physical condition makes for good movement of moisture and air throughout the soil and encourages the accumulation, humification, and preservation of organic matter. It accounts in a large measure for the fact that Decatur silt loam ranks among the first of the soils of uplands in productivity and has so wide a range in adaptability.

This soil is used principally for the growing of field crops common to the area, and it has a very wide range in adaptation. Tobacco yields are perhaps higher on it than on any other soil in this county, although some of the other soils may produce tobacco of better quality. Yields of more than 2,000 pounds an acre have been reported, but yields of about 1,500 pounds are more common. Yields of corn generally range from 35 to 45 bushels an acre, but yields of more than 60 bushels have been reported (pl. 3, A). It is an excellent soil for wheat and other small grains. Yields of more than 20 bushels of wheat are frequently obtained. When adequately supplied with lime and phosphate, this soil is well adapted to alfalfa, red clover, and other legumes. Alfalfa often yields from 3 to 5 tons and clover generally about 2 tons. The yield of lespedeza is relatively high, although generally somewhat less than that of red clover. Where the air drainage is satisfactory, fruits and vegetables are grown successfully. About 40 percent of the land is used annually for the growing of corn, about 30 percent for hay, about 20 percent for wheat, and the rest for other crops.

The requirements for the management of Decatur silt loam are simple as compared with the requirements for the management of many other soils in the county. Crops need to be rotated, but the rotation can be rather short, for example 3 years, if the management is otherwise good. The rotation should include a legume or preferably a grass-legume mixture. Fertilizers are ordinarily required in order to maintain the present level of productivity or to increase it. As the soil is acid, lime is needed for most legumes, especially alfalfa. Phosphorus is also known to be a general requirement, especially for legumes and grasses. Although potash is apparently less necessary than lime and phosphate, a greater need for this element may develop in the future. The supply of nitrogen in this soil, as well as in most other soils, is transitory and depends largely on whether legumes have been grown recently. As the natural tilth is good, special practices are not required for its maintenance. Having a gentle slope and a high water-absorbing capacity, this soil is only slightly susceptible to accelerated erosion, and special measures for the control of erosion should not be necessary, but so far as practicable the cultivation should be on the contour. As the soil has such a favorable physical character, excellent response is to be expected from improved management practices, especially adequate fertilization and the proper rotation of crops.

Decatur silty clay loam, eroded phase.—This soil is similar to Decatur silt loam, but it differs (1) in being moderately eroded and hence in having a somewhat thinner and heavier surface soil and (2) in occupying more sloping areas. A large part of the original surface soil has been lost by accelerated erosion, and in most places a small part of the original subsoil has been mixed with the remaining surface soil, thereby making the present surface soil heavier textured and less friable. It ranges from about 5 to 10 inches in thickness and consists of reddish-brown silty clay loam that is friable but somewhat less so than the surface soil of Decatur silt loam. The subsoils of the two soils are similar; they consist of dark-red or maroon-red firm but moderately friable silty clay extending to a depth of 5 to 7 feet. The slope ranges from about 5 to 12 percent.

As mapped, this soil includes numerous small areas of Decatur silt loam and also a few small severely eroded areas that are too small

to delineate separately. Most of these severely eroded areas are small knobs with convex slopes.

Decatur silty clay loam, eroded phase, has a total area of 896 acres. Most of it occurs southwest of Morristown and southeast of Witt, associated with the other Decatur soils and the Dewey soils. At present it is used and managed in much the same way as normal Decatur silt loam.

The eroded phase of Decatur silty clay loam is a good soil for agriculture, but it is slightly inferior to the normal phase, chiefly because it has been injured somewhat by accelerated erosion and because it occupies somewhat more sloping areas. The tilth is less favorable, and good tilth is less easy to maintain than in that soil. As it absorbs water less rapidly and retains less water in an available form than the silt loam, it is considerably more susceptible to further erosion. Because of these differences, the eroded soil requires somewhat more careful management; row crops should be grown less frequently, tillage should be on the contour, and cultivation should be avoided when the soil is very dry or very wet. About the same amounts of fertilizer are needed on the two soils for similar crops, and both are responsive to such treatment; but over a period of years the response from equal fertilization on the eroded soil may be less.

Decatur silty clay loam, eroded hilly phase.—This soil differs from Decatur silty clay loam, eroded phase, chiefly in having a steeper slope, but it is also generally more eroded. In most places the gradient ranges from 12 to 25 percent. The surface soil is from 3 to 10 inches thick. In most places some of the original subsoil has been mixed with the remainder of the original surface soil and the present surface layer is a reddish-brown to brownish-red moderately friable silty clay loam. The subsoil, similar to that of the other Decatur soils, is dark-red firm but moderately friable silty clay.

Included in the areas mapped as this eroded hilly phase is a variation that is similar in slope but is considerably more eroded. Most of the original surface soil has been lost, and tillage is now performed chiefly in the upper part of the original subsoil. This severely eroded variation is somewhat lower in productivity than the soil with which it is included. The tilth is less favorable, and the plants are more susceptible to injury from drought. It is estimated that this variation constitutes between one-fifth and one-fourth of the total area mapped as Decatur silty clay loam, eroded hilly phase. Most of these severely eroded areas occur on the convex slopes or near the foot of relatively long slopes. A rather typical relation is the occurrence of these severely eroded areas on the convex slopes and the moderately or slightly eroded areas on the adjacent concave or cove-facing slopes.

Only 320 acres of this soil is mapped. It occupies the steeper slopes in association with the other Decatur soils and the Dewey soils. The principal areas are southwest of Morristown and southeast of Witt, but a few areas are scattered throughout the county in association with the Fullerton soils. Where this soil occurs in association with the Fullerton soils, it invariably lies on the east-facing slopes.

All the land has been cleared for a number of years. Practically all of it has been and still is used for the production of the crops common to the area, some is used for permanent pasture, and a small part is

lying idle. Normally the yields are lower than on the other Decatur soils.

Chiefly because of the steep slope and the injury sustained from erosion, the soil of this eroded hilly phase is physically less suitable for crop production than the other Decatur soils. Management of this soil is considerably more exacting than that of the other soils, as it requires longer rotations and less frequent growth of row crops; in fact, in many areas it would be preferable to avoid row crops altogether. Where such crops are grown the rotation should be long and should include clovers and grass for 2 years or more. The selection of soybeans and cowpeas should be avoided when practicable, because they leave the surface soil in a loose condition, thereby increasing the susceptibility to erosion. The selection of tobacco also should generally be avoided, because the tith is somewhat unfavorable for this crop. Small grains, grasses, clovers, and alfalfa, however, grow successfully.

Tillage on the contour is desirable, but it may be impracticable in areas where sinkholes are abundant. Cultivation should not be attempted when the soil is very wet or very dry. The soil should not be allowed to remain bare for extended periods. For similar crops the fertilizer requirements presumably would be similar to those of the other Decatur soils, but slightly less response from equivalent fertilization would be expected. Contour strip cropping should prove beneficial where the slopes are suitable. Growing grasses and legumes and turning under green manures, especially leguminous green manures, would be expected to improve this soil greatly.

DEWEY SERIES

The Dewey soils differ from the Decatur soils chiefly in that the surface soils of the former are less brown and the subsoils are a lighter red. High-grade dolomitic limestone underlies the soil. The 8- to 12-inch virgin surface soil is grayish-brown mellow silt loam, and the subsoil is brownish-red or red firm but friable silty clay and extends to a depth of 4 to 5 feet. The underlying material consists of dense or tough silty clay that is dominantly yellow but is splotted with brown, pale yellow, and gray. Ordinarily the subsoil and the substratum contain a few fragments of chert. Depth to bedrock is thought to be generally between 10 and 30 feet, but in some places it is undoubtedly more. As a group the Dewey soils are slightly less productive than the Decatur soils; nevertheless they are productive and generally well suited to agriculture. The several members of the Dewey series differ from one another in relative suitability for use, however, because of differences in degree of erosion, slope, or both. Nearly all of the Dewey soils, like the Decatur soils, have been cleared and used for the production of crops; and under such use they have become eroded in many places, leaving the present surface soil somewhat red.

As Hamblen County is situated near the northern border of the region of the Dewey soils, in some areas these soils resemble the Hagerstown soils, which occur farther north.

The Dewey soils, which occupy a total area of 12,288 acres, are classified and mapped in one soil type and five phases, as follows: Dewey silt loam; Dewey silty clay loam, eroded phase; Dewey silty clay loam, eroded hilly phase; Dewey silty clay loam, severely eroded

hilly phase; Dewey silty clay loam, eroded steep phase; and Dewey silty clay loam, severely eroded steep phase.

Dewey silt loam.—This soil has a grayish-brown to brown mellow surface soil and a red or brownish-red rather firm silty clay to silty clay loam subsoil. The surface soil ranges from 8 to 12 inches in thickness. A moderate quantity of organic matter, well combined with the material in the topmost 3 or 4 inches, imparts a dark cast to the virgin soil. The humus is only slightly less durable than that of Decatur silt loam, but it gradually disappears and allows the surface to become lighter colored under cultivation. In most places the subsoil extends to a depth of 4 to 5 feet, where it grades into reddish-yellow or yellowish-red heavy silty clay to silty clay loam spotted with gray, yellow, and red. Depth to bedrock is thought to range from 15 to 40 feet in most places. In very small patches chert fragments are thinly dispersed over the surface and throughout the soil mass. The tilth is favorable.

The soil is developed on well-drained uplands underlain by dolomitic limestone. Typically, it occurs in the valleys at an elevation little or no higher than that of the Decatur soils but generally higher than that of the Talbott soils and lower than that of the Fullerton soils. The gradient is less than 5 percent.

The total area is only 192 acres. The greater part of this soil occurs in a narrow belt, in which the Dewey soils predominate, extending across the middle of the county. Most of the soil lies in this belt southwest of Morristown, but this soil also occurs southwest of Witt. In these areas it is associated with the Decatur and with other Dewey soils, but a few small areas are mapped in other parts of the county in association with the Fullerton soils.

Dewey silt loam is similar to Decatur silt loam except that it has a lighter colored surface soil, a paler red and less dense subsoil that contains more chert, and lower productivity, probably 10 percent lower. Owing partly to the presence of a moderate sprinkling of chert and a slightly more permeable subsoil, Dewey silt loam is not quite so erodible as the Decatur soil. Although tobacco (pl. 2, A), alfalfa, and a few other crops highly sensitive to soil conditions are not quite so well adapted to Dewey silt loam, it has only a slightly narrower range of adaptation than the Decatur soil. Approximately the same crops are grown in similar proportions on both soils. Nearly all of the land is occupied by crops to which it is very well adapted.

Dewey silt loam and Decatur silt loam are similar in that the productivity of both may be easily built up or restored, and they are also similar in requirements for proper crop rotations and control of erosion.

Dewey silty clay loam, eroded phase.—This soil differs from Dewey silt loam chiefly in having (1) a somewhat steeper slope, ranging from about 5 to 12 percent, and (2) a moderately eroded condition. A large part of the original surface soil has been lost by erosion, and in most places a small part of the original subsoil has been mixed with the remainder of the original surface soil to form the present layer of light reddish-brown friable silty clay loam, which is from about 5 to 9 inches thick. The subsoil, similar to that



A, Good stand of alfalfa on Dewey silty clay loam, eroded phase, obtained by the use of lime and phosphate. *B*, As illustrated here, alfalfa can be grown successfully on Fullerton silt loam, eroded phase, if the land is adequately fertilized, although the soil is not so productive or so well suited to alfalfa as the Dewey and Decatur soils.



A, Improved pasture on hilly phases of the Fullerton soils. Lime and phosphate have been applied, and the weeds have been controlled by mowing. Scattered black locust and black walnut trees apparently benefit bluegrass and white clover pastures, especially on the Fullerton and similar soils. *B*, Unimproved pasture on Fullerton fine sandy loam, eroded hilly phase, consisting chiefly of broomsedge, although there are considerable smilax, cinquefoil, wild strawberries, and blackberry briers. Such poor pasture can be expected on the other sandy and cherty members of the Fullerton series and the cherty Clarksville soils where no lime, phosphate, or potash is used.

of Dewey silt loam, is brownish-red firm but friable silty clay, extending to a depth of about 4 feet. In many places the upper part of the subsoil is somewhat lighter in color and more friable than the lower part and the subsoil contains a moderate to small quantity of chert fragments.

In degree of slope and erosion this soil is similar to the eroded phase of Decatur silty clay loam, from which it differs chiefly in being somewhat lighter colored throughout and slightly less productive.

The eroded phase of Dewey silty clay loam includes two principal variations, both due to differences in degree of erosion. On one, occupying about 45 acres, little or no erosion has taken place, and the surface layer is grayish-brown mellow silt loam from 8 to 12 inches deep. On the other, about 70 acres in extent, nearly all of the original surface soil has been lost, and cultivation is now performed in the upper part of the original subsoil.

Dewey silty clay loam, eroded phase, is a fairly extensive soil, being mapped on a total of 7,168 acres. It is the predominating soil in a narrow belt extending across most of the county along United States Highway No. 11E, the belt in which some of the Decatur soils and many of the other Dewey soils occur. Other areas, generally rather small, are scattered throughout the rest of the county in association with areas of the Fullerton soils. Nearly all such areas are on the east-facing slopes.

Physically this soil is well suited to the production of the commonly grown field crops, and nearly all of it is so used. Practically all of the crops common to the county, including corn, tobacco, wheat (pl. 3, *B*), oats, barley, rye, red clover, clover and timothy, alfalfa, and lespedeza are grown. Under the prevailing management, commonly expected acre yields are as follows: Corn, about 30 bushels; wheat, 18 bushels; clover and grass, 1.5 tons; and alfalfa, 3.5 tons a year. Yields are generally slightly lower than those on normal Dewey silt loam and also slightly lower than those on the eroded phase of Decatur silty clay loam. In the present management the crops are commonly alternated, but a systematic rotation is not practiced everywhere. Commercial fertilizers are nearly always used for tobacco and occasionally for corn and small grains. Lime is ordinarily applied for red clover and grass, and both lime and phosphate are applied for alfalfa (pl. 7, *A*). The requirements for management are similar to those of the eroded phase of Decatur silty clay loam.

Dewey silty clay loam, eroded hilly phase.—This soil differs from Dewey silty clay loam, eroded phase, chiefly in having a steeper slope, but it is also generally somewhat more eroded. The gradient ranges from 12 to 25 percent. In most places some of the original subsoil has been mixed with the remaining part of the original surface soil to form the present surface soil, which consists of light reddish-brown moderately friable silty clay loam, ranging in thickness from about 4 to 8 inches. The subsoil, like that of the other Dewey soils, is brownish-red firm but friable silty clay. As mapped in this county, the chief variations of this soil are in color, content of chert, and degree of erosion. The color ranges from that of the Decatur soils to that of the Fullerton soils. In some places the soil is practically free from chert fragments; in others it contains a considerable quantity; but in most

places it contains a small quantity of these fragments. In some places, little or no accelerated erosion has taken place; in others nearly all of the original surface soil has been lost; but in most places the degree of erosion is intermediate between these two extremes.

This soil is similar in slope and eroded condition to the eroded hilly phase of Decatur silty clay loam, but it differs from that soil in being somewhat lighter in color. It also contains more fragments of chert, is somewhat lower in productivity, and is apparently slightly less susceptible to accelerated erosion than the Decatur soil.

This soil has a total area of 3,072 acres. The larger part of it occurs in the narrow belt, in which the Dewey soils are the predominant soils, running through the approximate middle of the county. In this belt it is associated with the other Dewey soils and the Decatur soils. Many areas are mapped elsewhere, however, in association with areas of the Fullerton soils, generally on the east-facing slopes.

Owing chiefly to the moderately eroded condition and the steep slope, this soil is considerably inferior for the production of crops to any of the three Dewey soils previously discussed. All the land has been cleared and cropped. Most of it is still thus used, but some is in permanent pasture and some is lying idle. Yields of most crops are generally lower than those obtained on the eroded phase of Dewey silty clay loam. They are likewise slightly lower than those obtained on the eroded hilly phase of Decatur silty clay loam, but these two soils are similar as regards requirements for management.

Dewey silty clay loam, severely eroded hilly phase.—As the name implies, this soil differs from the eroded hilly phase of Dewey silty clay loam chiefly in being more eroded. In most places nearly all of the original surface soil has been lost, and tillage is now performed almost entirely in what used to be the topmost part of the original subsoil. The present surface soil consists of reddish-brown to brownish-red silty clay loam that is moderately friable but is subject to puddling and clodding. Like the corresponding layer of the other Dewey soils, the subsoil is brownish-red to red firm but moderately friable silty clay. As on the soil of the eroded hilly phase, the gradient ranges from 12 to 25 percent. A few gullies, some of which cannot be crossed with farm machinery, have formed in many areas.

About 1,216 acres of this soil is mapped. Most of it occurs in a narrow belt through the middle of the county in association with the other Dewey soils and the Decatur soils; but a considerable part, including all of the variation described in the following paragraph, occurs in other parts of the county in association with the Fullerton soils.

Included with this soil is a variation, totaling about 275 acres, that contains more sand and some sandstone fragments and is slightly more friable than the soil with which it is mapped. This variation is similar to the Dewey soil in slope and eroded condition, but in other characteristics it more closely resembles the Bolton soils. Most of this variation occurs in association with the sandy members of the Fullerton and Bolton series, and it nearly everywhere occupies the east-facing slopes.

Chiefly because this soil has been injured more by erosion, it is physically less suitable for agricultural uses than the eroded hilly phase of Dewey silty clay loam. Good till is difficult to maintain.

If cultivated when wet the soil puddles readily; on drying after heavy rains it tends to form a rather hard crust, which hinders the upward penetration of young plants, and it also tends to harden and crack. As the soil absorbs water rather slowly, runoff tends to be relatively great. Plants on this soil are rather easily injured by drought. Cultivation is impaired by both the hilly slope and the heavy texture of the surface soil; and the susceptibility to further erosion is high.

It is evident from the foregoing facts that this soil in its present condition is poorly suited to the production of crops requiring tillage. Nevertheless, a large part of it is thus used, although a large part is also in permanent pasture and some is temporarily idle. Ordinarily this soil is considered relatively better adapted to permanent pasture than to the production of field crops. Lime and phosphate are essential for the establishment and maintenance of good pastures on this soil, and there is some evidence indicating that excellent pastures can be obtained eventually if the soil is properly treated.

Where it is necessary to grow crops requiring tillage, hay crops should be selected in preference to other crops. Good stands of alfalfa have been obtained where lime, phosphate, and manure have been applied to the soil; but because of the unfavorable tilth it is sometimes difficult to obtain satisfactory stands of alfalfa and also of certain other crops. Mixtures of red clover and grass can be grown if lime and phosphate are applied, but a good stand is sometimes difficult to obtain. Sweetclover and lespedeza (including *sericea lespedeza*) would be expected to grow well. Lespedeza will grow with little or no applications of lime and phosphate, but the yields ordinarily will be low. Preferably, grasses should be grown with lespedeza as well as with clover. The growing of grasses and legumes, especially deep-rooted legumes, such as alfalfa and sweetclover, is highly desirable because they have such a favorable effect on the physical condition of the soil. By growing such plants for a period of years, it seems probable that the decreased productivity resulting from the severe erosion would be overcome to a large extent. The growing of corn or other row crops should be avoided, at least until after a period of rehabilitation, and thereafter such crops should be grown sparingly if at all. Small grains may succeed fairly well, but it is unwise to grow them frequently, at least not until the physical condition of the soil has been improved.

Dewey silty clay loam, eroded steep phase.—As compared with the severely eroded hilly phase of Dewey silty clay loam, this soil has a steeper slope but has undergone less erosion—about the same as Dewey silty clay loam, eroded hilly phase. Generally the gradient ranges from 25 to 45 percent, although in some places it is steeper than 45 percent. Like Dewey silty clay loam, eroded hilly phase, this soil has lost a part of its original surface soil and where cultivated the topmost part of the original subsoil has been mixed with the original surface soil to form the present surface soil, consisting of light reddish-brown to grayish-brown friable silty clay loam, about 3 to 7 inches thick. The subsoil is a firm but moderately friable brownish-red or red silty clay, extending to a depth of about 4 feet or slightly less.

In about one-third of the total area mapped, this soil varies from the foregoing description in containing more sand as well as some

sandstone fragments throughout the soil mass, in being somewhat lighter textured, and in being slightly more friable. In color, texture, and consistence this variation closely resembles the Bolton soils. Also included are areas, mostly wooded, that have undergone little erosion, although some erosion appears to have taken place even on many of the wooded areas, some of which have probably been cleared at some time.

Only 384 acres of this soil is mapped. In contrast with the other Dewey soils, which occur chiefly in the narrow belt through the middle of the county, this soil occurs chiefly in widely scattered areas over other parts of the county, where it is associated with the Fullerton soils and to a less extent with the Bolton soils. Where it is associated with the Fullerton and Bolton soils it generally occupies the east-facing slopes.

Most of the land is cleared, although a fairly large part is in woods, characterized by vigorous trees. The cleared area is used largely for pasture, but some is used for crops and some is lying idle.

Ordinarily this soil is considered to be too steep and too susceptible to erosion for the feasible production of field crops over an extended period. It is relatively better suited physically to permanent pasture, and indications are that excellent pastures can be obtained and maintained if lime and phosphate are applied to the soil. The fact that most of the areas of this soil face the east instead of the west further enhances its suitability for pasture, as it is a common observation that both field crops and pasture plants grow better on north- and east-facing slopes than they do on south- and west-facing slopes, especially where the slopes are long and steep.

Dewey silty clay loam, severely eroded steep phase.—This soil differs from the eroded steep phase of Dewey silty clay loam chiefly in being more eroded. It is similar in degree of erosion to the eroded hilly phase of Dewey silty clay loam, but it differs from that soil in having a steeper slope—generally 25 to 45 percent, although in some places it is steeper than 45 percent. All or nearly all of the original surface soil has been lost, and the brownish-red to red firm subsoil is exposed in many places. A few gullies, from 1 to 3 feet deep, have formed in many of the areas. A sandy variation, similar to the one included with the eroded steep phase except for the severely eroded condition, has also been included with this soil. It constitutes about one-fourth of the total area.

This soil has a total area of only 256 acres. It is similar in distribution to the eroded steep phase of Dewey silty clay loam.

Crops are grown on only a very small part of this soil. Some of it is used for pasture, but much of it is lying idle and is covered by brush and weeds. The physical condition, which is similar to that of the severely eroded hilly phase of Dewey silty clay loam, is unfavorable. This handicap, together with the steep slope, makes the soil extremely poorly suited to the production of crops and poorly suited even to pasture. In its present condition forestry is probably its physically best adapted use. Pastures can be obtained, but at considerable expense and risk of failure. Lime and phosphate obviously will be required, some of the gullies may have to be leveled, and a few check dams may have to be constructed. Because of the unfavorable tilth, the establishment of a good pasture may be difficult

and may fail altogether; but, once good pastures are established and if they are subsequently well managed, this soil would be expected to support them well. The fact that most of this soil is on slopes facing the east is a favorable condition for pastures.

FULLERTON SERIES

The Fullerton soils are related to the Dewey soils but differ from them chiefly in that the surface soils are lighter colored and the subsoils are a paler red. Also, the parent rock material of the Fullerton soils is more cherty than that of the Dewey soils. The Fullerton soils are developed from cherty dolomitic limestone materials and in some places from sandy dolomitic limestone materials. They generally have brownish-gray friable or loose surface soils from 8 to 12 inches thick, and yellowish-red to reddish-yellow firm but friable subsoils extending to a depth of 35 to 50 inches. The substratum consists of tough cherty silty clay, predominantly reddish yellow but spotted and mottled with reddish brown, pale yellow, and some gray. Depth to bedrock in most places is thought to be more than 30 feet. Many of the Fullerton soils in this county contain enough fragments of chert to interfere materially with cultivation. The relief is predominantly rolling and hilly, but it ranges from undulating to steep. The Fullerton soils, which occupy about 30 percent of the area of the county, are by far the most extensive series in this county, predominating in a wide belt through the middle.

The Fullerton soils are very important in the agriculture of the county. It is estimated that about 90 percent of the land is cleared. Most of the cleared land is used for crops and pastures, and most of it is slightly to moderately eroded. Generally speaking, these soils are less productive than the Dewey soils. Nevertheless they are responsive to management, and some of them have a wide range in adaptation. Hilly areas can be made to support good pasture (pl. 8, A). They differ from one another in their relative suitability for use in the present agriculture, largely because of differences in slope, erosion, texture, and content of chert.

The soils included in the Fullerton series are classified and mapped in 3 soil types and 13 phases, as follows: Fullerton silt loam; Fullerton silt loam, eroded phase; Fullerton silt loam, hilly phase; Fullerton silt loam, eroded hilly phase; Fullerton cherty silt loam; Fullerton cherty silt loam, eroded phase; Fullerton cherty silt loam, hilly phase; Fullerton cherty silt loam, eroded hilly phase; Fullerton cherty silty clay loam, severely eroded phase; Fullerton cherty silt loam, steep phase; Fullerton cherty silt loam, eroded steep phase; Fullerton cherty silty clay loam, severely eroded steep phase; Fullerton fine sandy loam; Fullerton fine sandy loam, eroded phase; Fullerton fine sandy loam, hilly phase; and Fullerton fine sandy loam, eroded hilly phase.

Fullerton silt loam.—This soil differs from Dewey silt loam primarily in having a lighter colored surface soil, a slightly less red subsoil, a larger content of chert, and a somewhat greater slope. Fullerton silt loam is also less productive and somewhat lower in both humus and mineral plant nutrients, including organic matter and lime (available calcium).

In the virgin state the surface soil, to a depth of 9 to 12 inches, is brownish-gray loose silt loam, stained dark in the topmost 2 inches with organic matter. The subsoil is yellowish-red or reddish-yellow moderately firm to somewhat tight silty clay loam that is rather hard when dry and moderately sticky when wet but fairly friable under favorable moisture conditions. The subsoil extends to a depth of 40 to 50 inches, where it grades into tight silty clay that is dominantly yellowish red but is splotched with bright yellow, brown, and gray. In many places the upper part of the subsoil is reddish yellow and the lower part is yellowish red, and in such places the upper part is generally more friable than the lower part. Fragments of chert are generally scattered throughout the soil mass, but these are not numerous enough to interfere materially with cultivation. The predominant slope ranges between 5 and 12 percent, but in some places the gradient is more gentle.

As compared with those features of Dewey silt loam, the content of plant nutrients and the productivity are lower. The surface soil rapidly takes on a lighter color under cultivation. Till is slightly inferior and chert fragments are more plentiful both on the surface and throughout the deeper soil mass as compared with the Dewey soil. Both soils are well drained and penetrable to a great depth by water and the roots of plants.

Fullerton silt loam has developed from materials derived from the moderately cherty beds of Knox dolomite. Depth to bedrock is generally thought to be 30 or more feet.

In some places the subsoil is rather compact, more so than is typical. In other places the color of the surface soil is darker than typical; it approaches the grayish-brown color of the Dewey surface soils. In still other places the upper part of the subsoil is predominantly yellow, resembling somewhat the subsoils of the Clarksville soils.

Fullerton silt loam has a total area of only 512 acres. It occurs in the gently rolling uplands throughout the middle of the county, and it is associated chiefly with the other Fullerton soils, the Dewey soils, and to a less extent the Clarksville and Bolton soils.

At present nearly all of the typical Fullerton silt loam in this county is covered with timber, as most of the soil that originally was Fullerton silt loam has been cleared and has been eroded so that it is mapped as one of the eroded phases of this type. Physically, however, this soil is well suited to the production of nearly all of the crops common to the area, but it is somewhat less productive than Dewey silt loam. If it were cleared and put into cultivation it would be similar to the eroded phase of Fullerton silt loam, subsequently discussed, as regards crop adaptation and management requirements; but very likely it would return somewhat higher yields, at least for a few years.

Fullerton silt loam, eroded phase.—This extensive soil differs from Fullerton silt loam chiefly in having lost a part of the original surface soil by erosion. In many places this loss has not been great and as much as 8 inches of the original surface soil remains. For the most part, however, the loss has been somewhat greater. In some places a small amount of the topmost part of the subsoil has been brought up and mixed with the remaining part of the original surface soil,

thereby imparting a light reddish-yellow cast to this layer. Generally, however, the quantity of the subsoil mixed with the original surface soil has not been enough to affect materially either the texture or the consistence. This soil differs from the eroded phase of Dewey silty clay loam chiefly in being lighter colored throughout, but it is also slightly less eroded.

In general, the surface soil consists of brownish-gray friable silt loam, from 5 to 8 inches in thickness, and the subsoil is yellowish-red to reddish-yellow firm but fairly friable silty clay extending to a depth of 35 to 50 inches. The substratum is generally fairly compact silty clay that is chiefly yellowish red but contains splotches of red, yellow, brown, and gray. Fragments of chert are scattered throughout the soil material, but in most places they are not numerous enough to interfere materially with cultivation. The slope is rather gentle, ranging between 5 and 12 percent, although on many small areas it is somewhat less than 5 percent.

In many places the subsoil, especially the upper part, contains mottles of gray and grayish yellow that appear to be due to infiltration of a lighter colored material from above. In some places a few splotches of yellow and gray are present in the lower part of the subsoil. In a few areas the surface soil is darker colored than is typical; in others the subsoil, especially the upper part, is lighter colored than is typical; and in still others the subsoil is rather compact and tough.

The eroded phase of Fullerton silt loam is a fairly extensive soil, occupying 6,784 acres. Comparatively large areas are scattered in a wide belt through the middle of the county, including about two-thirds of its area. The soil is associated chiefly with the other Fullerton soils, but it also occurs in association with the Dewey, Bolton, and Clarksville soils.

All the land is cleared, and it is used principally for the production of the field crops common to the area, although fruits and vegetables are also grown with success. Corn is one of the more important crops, and yields of 20 to 30 bushels an acre are commonly obtained. Yields of 12 to 18 bushels of wheat are commonly reported. Tobacco of excellent quality is produced, but the yields are lower than those obtained on Dewey silt loam, ranging from 1,000 to 1,200 pounds. Yields of lespedeza are comparatively high. If lime and phosphate are applied, alfalfa and red clover can be grown successfully, although this soil is generally not so well suited to alfalfa as Dewey silt loam or Decatur silt loam (pl. 7, *B*). Yields of 2 to 3 tons of alfalfa are reported, and yields of red clover or mixtures of red clover and grass are somewhat lower.

This soil is managed in much the same way as the eroded phase of Dewey silty clay loam. Crops are commonly alternated, but they are not everywhere alternated systematically. A common rotation consists of corn or tobacco for 1 year, followed by a small grain, generally wheat, and 1 or 2 years of lespedeza, clover, or clover and grass mixtures for hay or pasture.

The management requirements of this soil are also similar to those of the eroded phase of Dewey silty clay loam, although this Fullerton soil is in greater need of fertilization and requires less attention for the maintenance of tilth. Both soils need a moderately long rotation

that includes legumes and grasses, and both soils need lime, phosphate, and, very likely, potash. The Fullerton soil, which contains less organic matter, is in greater need of this constituent. The practice of plowing under leguminous green manures should prove especially beneficial on this Fullerton soil. So far as practicable, cultivation should be on the contour. Engineering measures for the control of water should not be necessary if the management is otherwise good and if row crops are not grown too frequently.

Fullerton silt loam, hilly phase.—As the name implies, the relief of this soil is more pronounced than that of the two Fullerton soils just discussed. In other characteristics this phase is similar to normal Fullerton silt loam, although the soil layers in places are slightly thinner; but it differs from the eroded phase of Fullerton silt loam in having lost little or none of the original surface soil by accelerated erosion. The gradient ranges from about 12 to 25 percent. The surface soil is brownish-gray friable silt loam, and the subsoil is pale-red to reddish-yellow firm but moderately friable silty clay or silty clay loam.

About 576 acres of this soil is mapped. Like the other Fullerton soils, with which it is chiefly associated, it is widely distributed over the middle two-thirds of the county.

Nearly all of this soil is still in woods, as most of the cleared areas over which it originally extended are now more or less eroded and are mapped as one of the eroded phases. Chiefly because the slope is rather steep, this soil is physically much inferior for the production of field crops to the two Fullerton soils previously discussed. Under good management, however, including especially the selection of suitable crops, the growing of crops in a suitable rotation, proper fertilization, and careful tillage, this soil is physically suitable for the production of crops. Under such use its management requirements are similar to those of the eroded hilly phase of Fullerton silt loam, subsequently discussed; but somewhat higher yields are to be expected, at least for a number of years.

Fullerton silt loam, eroded hilly phase.—This soil differs from the hilly phase of Fullerton silt loam chiefly in having lost a part of the original surface soil. In degree of erosion it resembles the eroded phase of Fullerton silt loam, but it differs from that soil in having a more pronounced relief, although in general it is also slightly more eroded. In a number of places the topmost part of the subsoil has been mixed with the remainder of the original surface soil, thereby imparting a light reddish-yellow cast to the present surface layer; but in most places the amount of subsoil material that has been incorporated into the surface layer is not enough to affect materially the texture or consistence, although both are slightly heavier in some places.

The surface soil consists of friable light to heavy silt loam ranging in color from brownish gray to light reddish yellow and in depth from about 4 to 8 inches. The subsoil is yellowish-red to reddish-yellow firm but moderately friable silty clay or silty clay loam, which extends to a depth of 30 to 40 inches; and the substratum, reaching to bedrock, consists of tight, plastic silty clay that is chiefly yellowish red but is splotted and mottled with red, yellow, brown, and gray.

A few chert fragments throughout the entire soil mass are characteristic. Variations in the subsoil described for Fullerton silt loam are also included in mapping this soil. The slopes range from about 12 to 25 percent.

Fullerton silt loam, eroded hilly phase, has a total area of 5,376 acres. It is widely distributed over the middle two-thirds of the county, where it is associated chiefly with the other Fullerton soils; but it is also associated with the Dewey, Clarksville, and Bolton soils. It occurs in the hilly uplands, some of which are characterized by numerous sinkholes.

All the land is cleared. The greater part is used for crops common to the area, but a large part is in pasture and some is lying idle. Yields of most crops are generally somewhat lower than on Fullerton silt loam, eroded phase, which has a gentler slope. They are also lower than on Dewey silty clay loam, eroded hilly phase, to which this soil is similar in requirements for management.

In view of the fact that areas of this soil are rather steep, somewhat difficult to work, and rather highly susceptible to erosion, this soil obviously is not well suited to crops requiring tillage. On the other hand, the slope is not steep enough nor is the degree of erosion great enough to preclude feasible tillage. The continued use of this soil for the production of crops, however, requires careful management, including especially the careful selection of crops, growing them in the proper sequence, proper fertilization, and careful tillage. Row crops should be grown infrequently, if at all; close-growing crops, especially grasses and legumes, should be grown a large part of the time. The soil should not be allowed to lie bare for extended periods. Lime, phosphate, and very likely potash are necessary; and nitrogen presumably is necessary except for legumes and crops immediately following legumes. Cultivation needs to be on the contour. Contour strip cropping deserves consideration where the slopes are favorable. This soil is responsive to fertilization and other good management practices, and increased yields are to be expected from such practices; but under similar management it is expected that the yields would be slightly lower than those obtained on the eroded hilly phase of Dewey silty clay loam, to which this soil is similar in requirements for management.

Fullerton cherty silt loam.—A characteristic feature of this soil is that it contains enough fragments of chert, locally called white gravel, to interfere materially with cultivation but not enough to prevent feasible tillage. Except for containing more chert, this soil is similar to Fullerton silt loam, but it generally has a somewhat lighter colored surface soil, is more severely leached, is lower in fertility, and is slightly less productive.

In woods, the 9- to 14-inch surface soil consists of loose cherty silt loam, the topmost 1 or 2 inches of which is stained dark with organic matter. The subsoil, extending to a depth between 35 and 50 inches, is reddish-yellow to yellowish-red firm but moderately friable silty clay loam or silty clay containing numerous fragments of chert. The upper part of the subsoil in most places is reddish yellow, and the lower part is yellowish red or pale red; the upper part is also generally somewhat more friable and coarser textured than the lower part. The substratum, extending to bedrock, which is thought to lie more

than 30 feet below the surface in most places, consists of tight, plastic cherty silty clay loam or silty clay that is chiefly yellowish red but is splotched with red, yellow, and gray. The predominant slope ranges from about 5 to 12 percent, but the gradient is less than 5 percent in some places.

Variations mapped include one with a finer textured subsoil and one having a coarser color in the surface soil and in the upper part of the subsoil, the color of these layers approaching that of the Clarksville soils. In a few small areas the fragments of chert are especially numerous, and such areas are indicated on the map by special symbol.

A total area of 832 acres is mapped in widely scattered areas over the middle part of the county, where the soil is associated chiefly with the other Fullerton soils and to a less extent with the Bolton and Clarksville soils.

Most of this soil is still in woods, as most of the cleared areas originally covered by this soil have been more or less eroded and are mapped as the eroded phase. The timber consists chiefly of deciduous trees, among which oaks are especially numerous. Physically, this soil is suitable for the production of crops common to the area, but it is inherently less productive than Fullerton silt loam. If it were cleared and used for crops its requirements for management would be similar to those of the eroded phase of Fullerton cherty silt loam; but yields would probably be higher, at least for a period of years.

Fullerton cherty silt loam, eroded phase.—The relation of this soil to Fullerton cherty silt loam is similar to that of the eroded phase of Fullerton silt loam to normal Fullerton silt loam. This soil differs from the Fullerton cherty silt loam chiefly in being eroded; in other characteristics, including slope, the two soils are very similar. In degree of erosion this soil resembles the eroded phase of Fullerton silt loam. A large part of the original surface soil has been lost; in some places so much has been lost that the topmost part of the subsoil has been brought up by tillage and mixed with the remaining original surface soil. In most places the amount of the subsoil material incorporated into the surface layer has not been enough to alter materially either the texture or the consistence, but it has been enough to impart a light reddish-yellow color in many places. Although a few gullies have formed, they generally occur only in idle fields, where they have not been obliterated by tillage.

The present surface soil ranges from about 4 to 8 inches in thickness and consists of brownish-gray to light reddish-yellow loose and friable cherty silt loam. The subsoil, like that of Fullerton cherty silt loam, is reddish-yellow to yellowish-red firm but moderately friable silty clay loam or silty clay containing considerable chert. Variations in both the subsoil and the surface soil similar to those mapped as Fullerton cherty silt loam are included in this eroded phase, but in addition a few severely eroded areas are included in which practically all of the original surface soil has been lost, so that tillage is now performed almost entirely in the topmost part of the original subsoil. The gradient generally ranges from 5 to 12 percent, although it is less than 5 percent in some places.

Fullerton cherty silt loam, eroded phase, occupies 3,904 acres. It is

widely distributed over a broad northeast-southwest belt including more than two-thirds of the county, although a few areas are in a narrow belt through the middle in which the Dewey soils predominate. It is associated chiefly with the other Fullerton soils and to a less extent with the Clarksville, Bolton, and Dewey soils.

Practically all of the land is cleared, and most of it is used for the production of crops common to the area, although some is lying idle or is used for pasture. About the same proportions are used for the various crops as of the eroded phase of Fullerton silt loam, and about the same management is practiced, but the yields are generally somewhat lower.

Owing largely to the interference of numerous fragments of chert, this soil is less desirable than the eroded phase of Fullerton silt loam for the production of most crops; but the lower fertility and the lower water-holding capacity also contribute to this difference. It is also true that the cherty soil appears to leach more readily and to retain improvements for a shorter period. On the other hand, owing largely to the presence of these fragments, this cherty soil is less erodible than the noncherty soil; and this is a compensating factor so far as its suitability for the crop production is concerned. As compared with the noncherty soil, this soil is apparently not so well suited to alfalfa or to other crops having a high requirement for nutrients, but observations indicate that it is somewhat better suited to certain special crops, such as strawberries.

The requirements for management of this eroded cherty soil are similar to those of the eroded phase of Fullerton silt loam, but there are some differences. This cherty soil is in greater need of fertilizers, lime, and organic matter; and, in view of the fact that it leaches more readily than the noncherty soil, some of these amendments may need to be applied more frequently. It might be well to avoid the selection of alfalfa. Although this crop has been grown successfully on this soil, it is not especially well suited, and its successful production requires heavy applications of lime, phosphate, and potash. If fertilizers need to be held to a minimum, it might be well to select crops that will grow successfully on soils of relatively low fertility in preference to those requiring soils of medium or high fertility. Under such a restriction, lespedeza, for example, should be selected in preference to red clover. If moderate quantities of fertilizers can be afforded, however, red clover will grow well. Grasses should be included with the legumes as one of the means of maintaining or increasing the supply of organic matter, which is rather low. The application of green manures or barnyard manures would also be highly beneficial.

Although this soil is less erodible than the eroded phase of Fullerton silt loam and therefore requires less attention to the control of erosion, this phase of management must not be neglected. So far as practicable, cultivation should be on the contour. Engineering measures for the control of water, such as terracing or subsoiling, might prove beneficial, but they should not be necessary if row crops are not grown frequently and the management is otherwise good. Contour strip cropping would be a good practice where the slope is favorable. The rotation should be moderately long, not only in order to control erosion but also to maintain or increase the productivity. Legumes and grasses should be included in the rotation.

Fullerton cherty silt loam, hilly phase.—This soil occupies hilly areas ranging in gradient from about 12 to 25 percent. It differs from Fullerton cherty silt loam chiefly in having a steeper slope, from the eroded phase of Fullerton cherty silty loam in having a steeper slope and also in retaining practically all of its original surface soil, and from the hilly phase of Fullerton silt loam chiefly in being cherty but also in being somewhat lower in productivity.

In wooded areas the surface soil consists of brownish-gray friable cherty silt loam from 8 to 12 inches thick. The topmost 1 or 2 inches of this material is stained dark with organic matter. The subsoil, also cherty, consists of reddish-yellow to yellowish-red firm but moderately friable silty clay loam to silty clay. Variations similar to those included in Fullerton cherty silt loam are also mapped with this soil.

This soil covers a total area of 1,344 acres. Like the other Fullerton soils, it is distributed over a wide belt running through the middle of the county and is associated chiefly with the other Fullerton soils. Nearly all of the soil of this phase is in woods, as the cleared areas originally occupied by it have been eroded and are mapped as eroded phases.

Owing chiefly to the steeper slope, this soil is not so well suited physically to the production of field crops as Fullerton cherty silt loam; it is, in fact, rather poorly suited, although its use for that purpose is feasible. It is similar in adaptation to crops and in requirements for management to the eroded hilly phase of Fullerton cherty silt loam, subsequently described; but, if the soil were cleared and put into cultivation, somewhat higher yields might be expected under similar management, at least for a few years.

Fullerton cherty silt loam, eroded hilly phase.—This soil differs from the hilly phase of Fullerton cherty silt loam chiefly in having lost a large part of its original surface soil. It is similar in degree of erosion to the eroded phase of Fullerton cherty silt loam but differs in being more strongly sloping; and it is similar in degree of both slope and erosion to the eroded hilly phase of Fullerton silt loam but differs in being cherty. It is physically inferior for agricultural uses to all the other Fullerton soils previously discussed, although it is but slightly inferior to the hilly phase of Fullerton cherty silt loam and the eroded hilly phase of Fullerton silt loam. In many places so much of the original surface soil has been lost that the topmost part of the subsoil has been mixed with the remaining surface soil, thereby giving the surface layer a light reddish-yellow cast; but in most places neither the texture nor the consistence has been affected materially.

The present surface soil consists of friable cherty silt loam ranging from about 4 to 8 inches in thickness and from brownish gray to light reddish yellow in color. The subsoil, also cherty, consists of reddish-yellow to yellowish-red firm but moderately friable silty clay loam to silty clay. Variations similar to those included in the Fullerton cherty silt loam are also included in this eroded hilly phase.

This soil covers a total area of 5,312 acres. Most of it is associated with the other Fullerton soils within the wide belt extending across the greater part of the county. Some of it is also associated with the Dewey, Bolton, and Clarksville soils.

Practically all of the land is cleared and has been used for the pro-

duction of crops, including intertilled crops. At present the greater part is still used for crops, but some is used for pasture, and a large part is lying idle. Where crops are grown, it is managed in much the same way as the eroded phase of Fullerton silt loam, but the yields obtained are generally lower. Yields are also generally somewhat lower than those obtained on the eroded hilly phase of Fullerton silt loam, which is similar in degree of erosion and slope but considerably lower in content of chert.

In regard to physical suitability for use, this soil ranks somewhat below the eroded phase of Fullerton cherty silt loam, chiefly because of the steeper slope, and somewhat below the eroded hilly phase of Fullerton silt loam, chiefly because of the chertiness but also because of the lower fertility and lower water-holding capacity. Physically, it is rather poorly suited to crops requiring tillage, for several reasons, among which are rather steep slope, relative low level of natural fertility, chertiness, rather low water-holding capacity, moderately eroded condition, and moderate to high susceptibility to further erosion. Under suitable management the use of this soil for the production of crops is feasible on many farms; nevertheless it is considered to be relatively better suited physically to permanent pasture. Lime and phosphate are required for the establishment and maintenance of good pastures. Where it is used for crops the requirements for management are similar to those of the eroded phase of Fullerton cherty silt loam; but in order to control erosion the rotation should be longer than on that soil, a cover of close-growing plants should be maintained most of the time, and soil should not be allowed to lie bare for extended periods.

Fullerton cherty silty clay loam, severely eroded phase.—This phase differs from the eroded hilly phase of Fullerton cherty silt loam, chiefly in having lost nearly all of the original surface soil by accelerated erosion. In degree of erosion and slope this soil is similar to the severely eroded hilly phase of Dewey silty clay loam, but it differs from that soil in being cherty and lighter in color. This soil is generally unevenly eroded. Gullies from 1 to 2 feet in depth are rather common. In many areas practically all of the original surface soil and even the upper part of the original subsoil have been lost, and tillage must now be performed in the exposed part of the remaining subsoil. In other places several inches of the original surface soil remains. Areas having such differences in erosion are generally so intricately associated that ordinarily it would be impracticable for farmers to treat them separately. The gradient of this eroded soil ranges from about 12 to 25 percent. Included are some areas in which the soil is relatively free from chert and other areas in which the soil contains more sand than is typical and also some small sandstone fragments.

For numerous reasons, but chiefly because of the severe eroded condition and the hilly slope, this soil in its present state is physically very poorly suited for the production of field crops. Physically, it is thought to be relatively better suited to pasture, but pastures may be rather difficult to establish. If crops are grown, the requirements of the soil and the selection of crops are similar to those features of the severely eroded hilly phase of Dewey silty clay loam, but somewhat less response from similar management practices is to be expected.

This soil, which is mapped on a total of 2,112 acres, is well distributed throughout the wide belt of the county in which the Fullerton soils predominate. It is associated chiefly with the other Fullerton soils but also with the Dewey, Bolton, and Clarksville soils. Some of it is still used for the production of field crops, but the yields obtained are generally low, and occasionally no stand, especially of clovers, is obtained. Some of this soil is in pasture, and a large part is lying idle or is abandoned and is covered sparsely with weeds and brush. Pines tend to establish themselves on such idle or abandoned areas.

Fullerton cherty silt loam, steep phase.—This soil occupies even steeper areas than the hilly phase of Fullerton cherty silt loam, in fact steeper areas than any Fullerton soil previously discussed. This is the chief difference between these two soils. The gradient of the steep phase generally exceeds 25 percent and in some places is as much as 60 percent. It is similar in slope to the eroded steep phase of Dewey silty clay loam. Like the hilly phase of Fullerton cherty silt loam, this soil has a brownish-gray friable and loose cherty silt loam surface soil and a firm but moderately friable reddish-yellow to yellowish-red silty clay loam or silty clay subsoil, which is also cherty. The soil layers, however, are more variable in thickness and probably are somewhat thinner than the layers of that soil. Considerable variation in color, depth, consistence, and chertiness occurs in this steep phase. The chief variations, however, consist of about 25 acres where the soil material is relatively free from chert, and about 30 acres where the soil contains more sand than is typical and also some small fragments of sandstone.

Only 704 acres of this soil is mapped, throughout the wide belt in which Fullerton soils predominate, especially west of Morristown. It is associated chiefly with the other Fullerton soils and the Bolton and Clarksville soils.

Most of this soil is still in woods, as most of the cleared areas where it originally occurred have been more or less eroded and are mapped as one of the eroded phases. The woodland consists chiefly of deciduous trees, among which oaks are dominant in many areas.

Ordinarily this soil is considered too steep for feasible production of field crops over a long or indefinite period, but other factors contribute toward its physical unfitness for this use, such as chertiness, relatively high susceptibility to erosion on such steep slopes, and rather easily depleted virgin fertility, which in the first place is only moderate. Although this soil is not especially productive of pasture plants, it is physically suitable for pasture, but lime and phosphate are definitely required in order to establish and maintain reasonably good pastures. Where this soil is to be cleared and put into pasture it should not be used for crops and allowed to erode and to become depleted in plant nutrients before the establishment of pastures is attempted. Under present conditions, it is thought to be better suited physically to forestry, and for that reason the shifting of this soil from forest to pasture is not encouraged.

Fullerton cherty silt loam, eroded steep phase.—This soil differs from the steep phase of Fullerton cherty silt loam chiefly in having lost a large part of the original surface soil. They are similar in slope, the gradient being 25 percent or more. This eroded steep

phase is similar in slope and erosion to the eroded steep phase of Dewey silty clay loam, from which it differs chiefly in being lighter in color, in containing more chert, and in being lower in natural fertility.

The surface soil consists of brownish-gray friable cherty silt loam from about 3 to 8 inches thick. In some places where it has been tilled the surface soil has a light reddish-yellow cast, owing to the incorporation of the topmost part of the subsoil. The subsoil is yellowish-red to reddish-yellow firm but moderately friable silty clay loam or silty clay that is also cherty. Variations similar to those mapped with the steep phase of Fullerton cherty silt loam are also mapped with this eroded steep phase. The nearly chert-free variation is estimated to total between 250 and 300 acres and the sandy variation between 300 and 400 acres.

This soil covers a total area of 1,152 acres. It occurs chiefly in the wide belt dominated by the Fullerton soils, and it is associated chiefly with the other Fullerton soils, although it is also associated with the Dewey, Bolton, and Clarksville soils.

Like the steep phase of the Fullerton cherty silt loam, this soil is physically very poorly suited to the production of crops, only moderately suited to permanent pasture, but relatively best suited to forestry. Some of it is now used for field crops, however, but the greater part is used for pasture, and much is lying idle. In most places where crops, especially row crops, are being grown, the soil is eroding rather rapidly; and on such steep slopes erosion is indeed difficult to control if the soil is used for crops. Areas occupied by this soil are too steep for the use of most of the modern labor-saving machinery, and it is difficult to cultivate them with any kind of machinery. Generally, the pastures are not good, but some of the farmers have demonstrated that fairly good pastures can be obtained and maintained by proper management, including especially the application of lime and phosphate.

Fullerton cherty silty clay loam, severely eroded steep phase.—

This soil differs from the eroded steep phase of Fullerton cherty silt loam chiefly in being more eroded. In degree of erosion it is similar to the severely eroded phase of Fullerton cherty silty clay loam, from which it differs largely in occupying steeper areas. Most of the original surface soil has been lost, although several inches of it remain in some places; and in many places the topmost part of the original subsoil has been lost. The yellowish-red to reddish-yellow subsoil is exposed in most places, but the erosion is uneven, so that areas of exposed subsoil adjoin small patches retaining several inches of the original surface soil. Gullies, some of which are more than 2 feet deep, are fairly common on areas of this severely eroded steep phase. Included with this phase are areas in which the soil contains less chert than is typical and areas in which the soil contains more sand than is typical and also some small fragments of sandstone.

Only 512 acres of this soil is mapped. It occurs in small but conspicuous areas scattered throughout the wide belt in which Fullerton soils predominate and which crosses the middle of the county. It is associated chiefly with the other Fullerton soils, but it is also associated with the Dewey, Bolton, and Clarksville soils.

Most of this soil is temporarily idle or has been abandoned altogether for pasture as well as for crops. Obviously in its present

condition it is extremely poorly suited to these uses. The physically best adapted use is thought to be forestry, and pines are establishing themselves on many of the abandoned areas. Black locust appears to grow well in the few places where it has been planted. There is some evidence indicating that pastures can be established and maintained on this soil, but the expense is likely to be comparatively high, and the risk of failing to obtain a satisfactory stand is likewise high. For pastures, applications of lime and phosphate are obviously required, engineering measures such as check dams and diversion ditches may be necessary, and plants that are comparatively easy to establish and are also rather resistant to drought should be selected.

Fullerton fine sandy loam.—This type differs from Fullerton silt loam chiefly in being lighter textured, both in the surface soil and in the subsoil; but the surface soil is generally somewhat lighter colored and lower in organic matter and the soil itself is somewhat lower in productivity. It differs from Fullerton cherty silt loam chiefly in containing more sand and less chert. Although a few chert fragments are characteristic in this soil, they are not sufficiently numerous in most areas to interfere materially with cultivation. Fragments of sandstone are generally scattered over and throughout this soil. All three of the Fullerton soils mentioned above have a similar range in slope—from about 5 to 12 percent—although the gradient is less than 5 percent in some places.

Fullerton fine sandy loam, which many of the local farmers call white sandy land, has a light brownish-gray loose fine sandy loam surface soil ranging in thickness from about 10 to 14 inches. In woods the topmost 1 or 2 inches of this layer is stained dark with organic matter. The subsoil consists of fine sandy clay to a depth of 35 to 50 inches. The upper part of this layer is generally reddish yellow and friable, and the lower part is generally yellowish red or red and firm. The substratum consists of firm to moderately tight fine sandy clay that is chiefly yellowish red but is spotted with red, yellow, and gray, and it extends to bedrock, which is thought to lie 30 or more feet below the surface. Fragments of sandstone are scattered throughout the soil mass. Most of those on the surface or in the surface layer are small, but some in the substratum are as much as 1 foot or slightly more in diameter. A few fragments of chert are also scattered throughout the soil in most areas. The fragments of chert and sandstone, however, are generally not numerous enough to interfere materially with cultivation; and the soil, because of its sandy texture, is light to work. The underlying rock is sandy dolomitic limestone and also generally contains scattered layers of sandstone.

Considerable variation occurs, chiefly in texture of the surface soil. In some places the texture is as coarse as loamy fine sand; in others it is as fine as loam; but in most places it is fine sandy loam. Another variation is in the color of the surface soil, which in some places is light gray. Fragments of sandstone were numerous enough in some places to interfere with cultivation, but such areas are indicated on the map by stone symbol. The loamy fine sand surface soil variation generally is associated with these areas. Pockets of sandy material, probably the products of recently disintegrated sandstone, occur here and there throughout the subsoil, thereby causing the subsoil to be rather variable in texture and consistence.

Fullerton fine sandy loam occupies only 256 acres, as most of the cleared areas formerly occupied by this soil have been eroded somewhat and are mapped as an eroded phase. It occurs on rolling areas in the uplands, some of which are characterized by numerous sinkholes. Most of it occurs in association with the other sandy Fullerton soils and the Bolton soils, which are the predominant soils in narrow northeast-southwest belts throughout the middle two-thirds of the county. Some of the larger areas extend northeastward from a point midway between Witt and Valley Home, both of which are south of Morristown.

Most of this soil is still in woods, but it is physically suitable for the production of general field crops. Requirements for management for use as cropland would be similar to those of the eroded phase of Fullerton fine sandy loam, subsequently described, but the yields may be slightly higher, at least for a few years after clearing. This soil, however, tends to be more sandy than the eroded phase, and this fact is one of the reasons why these areas have not been cleared. Because of this fact the yields may be lower in places.

Fullerton fine sandy loam, eroded phase.—This soil differs from Fullerton fine sandy loam chiefly in having lost a large part of the original surface soil. In some places the topmost part of the subsoil has been reached by tillage implements and has been mixed with the remainder of the original surface soil, thereby giving a light reddish-yellow color to the present surface soil; but in most places little or none of the subsoil has been mixed with the remainder of the original surface soil. As regards both slope and eroded condition, this soil is similar to the eroded phase of Fullerton silt loam and Fullerton cherty silt loam; but it differs from those soils in the same characteristics that typical Fullerton fine sandy loam differs from typical Fullerton silt loam and typical Fullerton cherty silt loam.

The surface soil generally is light brownish-gray or, in some places, light reddish-yellow loose fine sandy loam, ranging in thickness from about 6 to 9 inches. The subsoil, extending to a depth of 30 to 45 inches, is generally reddish-yellow and friable in the upper part and yellowish red or pale red and moderately firm in the lower part. Variations similar to those included with Fullerton fine sandy loam except for an eroded condition are included with this phase. An additional variation, consisting of areas in which all or nearly all of the original surface soil has been lost, is also included. Most of these severely eroded areas occur on small knobs and other areas having a convex slope.

A total area of 2,432 acres is mapped. Like Fullerton fine sandy loam, this soil occurs chiefly in association with the other sandy Fullerton soils and the Bolton soils, which form narrow northeast-southwest belts throughout the middle two-thirds of the county. Most of it is used for the production of the common field crops, although a little is used for pasture and some is lying idle. Yields of most crops are lower than those obtained on the eroded phase of Fullerton silt loam but are approximately equal or slightly higher than those obtained on the eroded phase of Fullerton cherty silt loam.

As regards fertility and productivity, this soil ranks below the eroded phase of Fullerton silt loam. It absorbs water more rapidly, but it retains less; consequently plants are more susceptible to injury

from drought. Owing to its lighter texture, it is easier to work and can be safely worked between a wider range in moisture content than the silt loam. Indications are that it responds more quickly to fertilizer applications, but such response is not so lasting; hence fertilizer should be applied more frequently. Observations in other counties indicate that alfalfa, a crop having a high nutrient requirement, does not succeed so well on this soil as on Fullerton silt loam.

As compared with the eroded phase of Fullerton cherty silt loam, this soil is approximately equal in fertility and productivity, but it is considerably easier to work because of the lighter texture and the absence of interfering chert fragments. It is probably somewhat more susceptible to erosion, however. General observations indicate that it is somewhat more responsive to fertilization. In regard to the relative suitability for various crops, however, and also in regard to requirements for management, the two soils are similar, although the sandy member is considered somewhat better suited to root crops.

Fullerton fine sandy loam, hilly phase.—As might be inferred from the phase designation, this soil differs from Fullerton fine sandy loam chiefly in having a steeper slope—from about 12 to 25 percent. It differs from the eroded phase of Fullerton fine sandy loam in retaining all or nearly all of its original surface soil despite the steeper slope. It is similar in this respect to the hilly phases of Fullerton silt loam and Fullerton cherty silt loam; and it differs from these soils in the same characteristics that Fullerton fine sandy loam differs from Fullerton silt loam and Fullerton cherty silt loam.

The surface soil is light brownish-gray loose fine sandy loam extending to a depth of 8 to 12 inches. The subsoil is reddish-yellow to yellowish-red fine sandy clay that is generally friable, at least in the upper part. Variations similar except in slope to those included with Fullerton fine sandy loam are mapped with this hilly phase. Probably the most important variation totals about 300 acres and occurs mostly about half a mile west of Central Church. Here the surface soil is light gray and the subsoil is yellow to reddish yellow, resembling the Clarksville soils in color of these two layers.

An area of 704 acres of this soil is mapped. Like Fullerton fine sandy loam, this soil occurs in narrow northeast-southwest belts and is associated chiefly with the other sandy Fullerton soils and the Bolton soils.

Most of this soil is in woods, as most of the cleared cultivated areas originally occupied by it have since become eroded and are mapped as the eroded hilly phase. Physically, this soil is poorly suited to the production of field crops, chiefly because of the decided slope and the high susceptibility to erosion on such a slope; but there are other contributing factors, such as the rather low natural fertility that is easily depleted and the inability to retain improvements for a long time. If it were cleared and used for the production of crops, the yields obtained would be expected to be slightly greater, at least for a few years, than those obtained on the eroded hilly phase of Fullerton fine sandy loam, subsequently discussed. These two soils are similar in their adaptation to different crops and in requirements for management, the latter being similar to those for the eroded hilly phase of Fullerton cherty silt loam.

Fullerton fine sandy loam, eroded hilly phase.—As the phase designation indicates, this soil is eroded, and this is the chief characteristic in which it differs from the hilly phase of Fullerton fine sandy loam. These two soils have about the same range in slope—from about 12 to 25 percent. This eroded hilly phase has lost about 4 or 5 inches of its original surface soil, and the remaining surface soil ranges in thickness from about 4 to 8 inches. In some places the topmost part of the subsoil has been mixed with the remaining original surface soil, giving it a light reddish-yellow cast; and the color of the present surface soil therefore ranges from light brownish gray to light reddish yellow. It is predominantly fine sandy loam in texture and rather loose in consistence. The subsoil is reddish-yellow to yellowish-red fine sandy clay that is generally friable, at least in the upper part. Except in slope and eroded condition, the variations mapped in this separation are similar to those included with Fullerton fine sandy loam.

This soil occupies a total area of 2,624 acres. It is associated chiefly with the other sandy Fullerton soils and the Bolton soils and with them forms narrow northeast-southwest belts. It is also associated with the silt loams and cherty silt loams of the Fullerton series and with the Clarksville soils.

Practically all of the land has been cleared and has been used for the production of field crops even though it is not well suited to this purpose. Most of it is still thus used, but much is lying idle and some is used for pasture. Unless the pasture is well managed, however, it has low value (pl. 8, *B*). This soil is managed in about the same way as most of the other Fullerton soils that are devoted to crops. Yields are generally slightly lower than those obtained on the eroded phase of Fullerton fine sandy loam. Some of the reasons this soil is not suitable for crops are the steep slope, high susceptibility to erosion, relatively low natural fertility, and inability to retain improvements for a long time. The steep slope greatly impairs the workability of the soil, but the sandy texture makes it rather light to work. Although it is similar in productivity to the eroded hilly phase of Fullerton cherty silt loam, it is easier to work because of the coarser texture and the scarcity of interfering chert fragments; on the other hand it appears to be slightly more susceptible to erosion. As regards the adaptability to various crops and to pasture and the requirements for management, however, the two soils are similar.

CLARKSVILLE SERIES

The Clarksville soils are developed from the weathered products of very cherty dolomitic limestone. They are associated with and resemble the Fullerton soils in several respects, but they differ from those soils chiefly in having lighter colored surface soils and yellow subsoils. Of all the soils in the county developed from limestone materials, only the Clarksville have yellow subsoils. The surface soils are very light gray or almost white loose silt loam, characteristically cherty. The subsoils are yellow friable silty clay loam and are generally cherty. At a depth of 25 to 35 inches the material becomes reddish yellow lightly splotched with red, gray, and yellow; and at a depth of about 40 inches the material is dense or tough variegated cherty silty clay, similar to that underlying the Fullerton

soils. In most places this material rests on solid cherty dolomitic limestone at a depth of more than 30 feet. The Clarksville soils are strongly to very strongly acid in reaction, are low in natural fertility and productivity, and contain enough chert to interfere materially with tillage. They occupy predominantly hilly areas with slopes facing the west, and the areas range from rolling to steep. They are poorly suited to the production of crops even where the slope is rather gentle, and where it is steep they are considered to be relatively better suited to forestry than to either crops or pasture. The soils in this county classified as members of the Clarksville series are probably slightly more productive than the corresponding types and phases in many other parts of the State.

The Clarksville soils are much less extensive than the Fullerton soils in this county. They are mapped in one type and three phases, namely, Clarksville cherty silt loam; Clarksville cherty silt loam, hilly phase; Clarksville cherty silt loam, eroded hilly phase; and Clarksville cherty silt loam, steep phase.

Clarksville cherty silt loam.—This soil, locally referred to as white gravelly land, consists of a very light gray or almost white to yellowish-gray cherty silt loam surface soil, ranging from 8 to 12 inches in thickness. In the virgin state the topmost inch of soil is stained dark with loosely combined organic matter, which rapidly disappears under cultivation, thereby leaving the plowed soil nearly white when dry. The subsoil is friable cherty silty clay loam that is chiefly yellow but ranges from grayish yellow to pale reddish yellow and extends to a depth of 25 to 35 inches. Below this the material becomes lightly splotted with red and gray and is gradational in character to the variegated tight and tough silty clay that generally lies from 40 to 50 inches below the surface. This latter material extends to the underlying bedrock, which lies generally at a depth of more than 30 feet.

Angular chert fragments, ranging in size from $\frac{1}{2}$ to 5 inches, are characteristic on the surface and throughout the entire soil mass. They are generally numerous enough to interfere materially with tillage. The slope ranges from about 5 to 12 percent. The soil is strongly to very strongly acid in reaction and low in natural fertility.

Clarksville cherty silt loam is developed from material weathered from the poorest grade or most cherty phase of dolomitic limestone. With some exceptions this soil occupies slopes and tops of the higher ridges, where natural drainage is well established. A total area of 768 acres is mapped, in association with the Fullerton and Bolton soils and the other Clarksville soils throughout the wide belt of these soils that includes more than two-thirds of the county. It is more commonly found on west-facing slopes.

In some places this soil grades into the Fullerton soils with which it is closely associated in most localities. It also varies in the degree of chertiness and to a less extent in thickness of the soil layers. In some of the cultivated areas a part of the surface soil has been lost by erosion.

Of all the well-drained soils on the uplands underlain by limestone, only Clarksville cherty silt loam and the other Clarksville soils are characterized by yellow subsoils. Field observations and experi-

mental and analytical investigations indicate that Clarksville cherty silt loam is the lowest in plant nutrients of all the soils in the county developed from residual products of limestone. This deficiency alone causes it to be poorly suited to the production of ordinary crops, but in addition it contains enough chert to interfere somewhat with tillage, has a low water-holding capacity, and retains improvements for a shorter period than most of the soils. Farmers generally claim that it does not show any beneficial effects from applications of manure longer than 1 or 2 years, whereas they observe a beneficial effect on the Fullerton and Dewey soils for a much longer period. On the other hand, this soil is resistant to erosion, more so than any other soil in the county having a similar slope. Even though it does not appear to show beneficial effects from fertilization or manuring for a long period, the immediate response to such treatment has been observed to be good.

The greater part of the land is being used for the production of field crops common to the area, including corn, wheat and other small grains, hay, fruits, and vegetables; but much is lying idle, some is in pasture, and some is still in woods. The management, including the rotation of crops, is similar to that practiced on the eroded phase of Fullerton cherty silt loam. Yields of crops are generally low. It is commonly reported that corn yields about 15 bushels to the acre, wheat 10 to 12 bushels, and hay, chiefly lespedeza, $\frac{1}{2}$ to 1 ton. Very little tobacco is grown, as the more fertile and productive soils are generally selected for this cash crop; but an estimated yield of 600 to 900 pounds of a fairly good quality of tobacco might be expected if the soil were well fertilized. Fruits and vegetables can be grown with considerable success. In certain parts of the State this soil is used successfully for the production of strawberries.

The requirements for management of this soil are similar to those of the eroded phase of Fullerton cherty silt loam, but the soil is in greater need of fertilization, liming, and the addition of organic matter, and the selection of crops that can withstand drought is somewhat more important. Although this soil is less susceptible to erosion and less attention need be given to the control of erosion, this phase of management must not be neglected altogether. In view of the fact that this soil is low in fertility, it may be advantageous to adopt a long rotation, but if liberal fertilization can be afforded a rotation of moderate length is suggested. Grasses and legumes should be included in the rotations.

Clarksville cherty silt loam, hilly phase.—This phase is similar to Clarksville cherty silt loam except that it has a steeper slope—from 12 to 25 percent. The surface soil is very light gray or almost white loose cherty silt loam, and the subsoil is yellow moderately friable cherty silty clay loam. Like the other Clarksville soils, this soil is strongly to very strongly acid in reaction, low in content of plant nutrients, and low in organic matter. Chert fragments range from about 1 to 10 inches in diameter and are probably more numerous on the hilly phase. Similar variations are allowed in mapping both soils.

Only 384 acres of this phase is mapped. It is similar to the normal phase in distribution, and it also occurs predominantly on west-facing slopes. Nearly all of it is used for woodland, to which it is

well suited. It is poorly suited to either crops or pasture, although it is thought to be relatively better suited to pasture than to field crops. If it were cleared and put into either crops or pasture, the requirements for management, including the selection of plants, would be similar to those of the eroded hilly phase of Clarksville cherty silt loam, subsequently described; but presumably the yields would be slightly greater, at least for a few years.

Clarksville cherty silt loam, eroded hilly phase.—This eroded hilly phase differs from the hilly phase of Clarksville cherty silt loam chiefly in having lost a part of the original surface soil and in being depleted of its virgin organic matter so that it is very low in that constituent. It differs from typical Clarksville cherty silt loam chiefly in having a steeper slope and in being slightly to moderately eroded. The gradient ranges from about 12 to 25 percent. This soil is eroded unevenly, however. As a result, the depth of the surface layer varies greatly; but in most places the remaining surface soil ranges from about 5 to 9 inches in thickness. In some places a part of the original surface soil has been lost so that the topmost part of the subsoil has been reached by tillage implements and incorporated into the surface soil, thereby giving to it a light-yellow color. Chert fragments tend to remain and accumulate on the surface as the soil becomes eroded. The subsoil consists of a yellow moderately friable cherty silty clay loam. Variations in color and chertiness similar to those included with Clarksville cherty silt loam are included with this eroded hilly phase.

An area of 704 acres is mapped. This phase is associated chiefly with the Fullerton and Bolton soils and the other Clarksville soils, and it is distributed over a wide belt including more than two-thirds of the county. Most of it occurs on west-facing slopes.

All the land has been cleared and is used for the production of common field crops, such as corn, wheat, and hay. At present much of it is still thus used, but much is lying idle and some is used for pasture. The yields of both crops and pasturage are generally very low.

Like the normal phase, this soil is low in plant nutrients, organic matter, and water-holding capacity; is strongly to very strongly acid; contains enough cherty fragments to interfere materially with tillage; and shows the beneficial effects from fertilization and manuring for a shorter period than most other soils—all conditions that are unfavorable for the production of crops. The soil is further impaired by the steep slope and the slightly to moderately eroded condition. It is evident, therefore, that it is very poorly suited to the production of field crops common to the area, though it is not entirely unsuitable for such use. Even though the soil is cherty and rather steep, it can be cultivated; and though its response to fertilization and manuring is not lasting, it appears to respond quickly to such treatment. Furthermore, it is less susceptible to erosion than any other soil of similar slope in the county. When used for crops, the requirements for management are similar to those of the eroded hilly phase of Fullerton cherty silt loam; but it is in greater need of fertilizers and organic matter, hence the rotation may need to be somewhat longer; and as the water-holding capacity is lower, the selection of drought-resistant plants is more important.

Physically, this soil is considered to be better suited to pasture than to crops, but it is not naturally productive of pasture plants. Lime and phosphate are required for the establishment and maintenance of pasture. By good management, including especially the application of these amendments, fairly good pastures have been obtained in a few places. As the soil has a low water-holding capacity, however, and as much of it occurs on west-facing slopes, the growth of pasture plants ordinarily is greatly retarded during extended warm, dry periods.

Clarksville cherty silt loam, steep phase.—Like the other Clarksville soils, this soil is characterized by a very light-gray or almost white loose cherty silt loam surface soil and a yellow friable cherty silty clay loam subsoil. The slope is steeper than that of the other Clarksville soils, generally ranging between 25 and 55 percent. This phase also includes similar but greater variations in color and chertiness. A large part, probably about one-third of the total area, is eroded to the same degree as Clarksville cherty silt loam, eroded hilly phase, and a small total area is severely eroded.

Only 256 acres of this soil is mapped. It is associated with the Fullerton and Bolton soils and the other Clarksville soils and occurs predominantly on west- and southwest-facing slopes. It is distributed in small areas throughout the county where the Fullerton soils are extensive.

More than half of the land is in woods; much has been cleared but is now idle; some is in pasture; and a small part is used for the production of field crops. Yields are ordinarily very low. Most of the pastures have a low carrying capacity and are overrun with undesirable plants, such as broomsedge, smilax, poverty oatgrass, cinquefoil, and dewberry and blackberry briars.

Physically, this soil is obviously extremely poorly suited to the production of field crops, and it is also poorly suited to pasture. By good management, including especially the application of lime and phosphate, fairly good pastures have been obtained in a few places; but highly productive pastures are not to be expected on such steep land. Under present conditions its best use on most farms is thought to be for forest.

BOLTON SERIES

The Bolton soils in this county are distinguished from the Dewey soils chiefly by the higher content of sand, the presence of small sandstone fragments, and the somewhat more friable consistence of the entire soil mass. They also differ rather consistently in their geographic associations. The Dewey soils are associated chiefly with the Decatur soils and the Fullerton silt loams, whereas the Bolton soils are associated chiefly with the Fullerton fine sandy loams. The Bolton soils occur predominantly on east- and northeast-facing slopes.

The soils classified as members of the Bolton series in this county vary from the Bolton soils as developed elsewhere in being less friable in the subsoil and more susceptible to erosion. The typical Bolton soils, which occur on the high and broad cherty ridges in other parts of east Tennessee and in southwest Virginia, are characterized by marked friability and softness of both the surface soils and the subsoils and are very resistant to erosion.

The Bolton soils in this county are characterized by a brown mellow to friable loam surface soil, about 9 to 12 inches in thickness, and a brownish-red to yellowish-brown moderately firm but friable silty clay loam subsoil, about 40 to 60 inches in thickness. In some places the subsoil appears to be even thicker than 60 inches. The underlying material consists of firm silty clay loam that is chiefly red but contains some splotches of brown, yellow, and gray. Tiny black concretions are generally numerous in the subsoil.

A few fragments of sandstone and also of chert are characteristic of the entire soil mass. Depth to bedrock is great, generally more than 30 feet. Bedrock consists of dolomitic limestone or dolomite containing some sand and chert. These soils are rolling to hilly and are very well drained. They are generally strongly acid, but they are relatively well supplied with organic matter and are moderately to relatively high in natural fertility. In productivity they generally rank between the Dewey and the Fullerton soils. They are fairly well suited to crops and pasture, although they vary somewhat from one another, owing mainly to differences in slope and erosion.

The Bolton soils in this county occupy only 1,728 acres. Only two phases are mapped, namely, Bolton loam, eroded phase, and Bolton loam, eroded rolling phase.

Bolton loam, eroded phase.—This soil is similar to the eroded hilly phase of Dewey silty clay loam in color, slope, and degree of erosion. It differs from that soil chiefly in being lighter in texture, in containing a few small fragments of sandstone, in being slightly more friable and permeable, and in being slightly less productive. Also, it is developed from material that is residual from a kind of limestone different from that underlying the Dewey soil, being a dolomitic limestone or dolomite that contains some sand or sandstone and chert, or possibly being a mixture of dolomitic limestone and sandstone.

The slopes range from about 12 to 25 percent. A large part of the original brown mellow loam surface soil has been lost by accelerated erosion, and the remainder ranges from 5 to 9 inches in thickness. In some places the topmost part of the subsoil has been incorporated into the present surface soil, making it reddish brown or yellowish brown. The subsoil is moderately firm but friable silty clay loam ranging in color from yellowish brown to brown or brownish red and in thickness from 40 to 60 inches. In most places the upper part of the subsoil is lighter colored and more friable than the lower part. The substratum, resting on bedrock generally more than 30 feet below the surface, consists of firm silty clay loam that is chiefly red but is splotched with brown, yellow, and gray. A few fragments of sandstone and chert are generally scattered over the surface and throughout the soil mass, but those in the surface are neither numerous enough nor large enough to interfere materially with cultivation. Tiny black concretions are generally numerous in the subsoil.

Included is a variation that is darker in color, resembling the Decatur soils in this characteristic. Also included are areas in which sandstone fragments are numerous enough to interfere with cultivation, and the texture is lighter. Such stony areas are indicated on the map by special symbol. Also included are a few areas in which

there has been little or no erosion and the surface soil is as much as 12 inches thick.

The total area is 960 acres. Nearly all of the soil occurs on east-facing slopes and is associated with the sandy members of the Fullerton series, which occur on the opposite slopes, and from which this Bolton soil is easily differentiated by its darker color. It occurs in narrow northeast-southwest belts in the middle two-thirds of the county.

The present use and management of this soil are similar to those of the eroded hilly phase of Dewey silty clay loam, but the yields of most crops are thought to be slightly less. Its physical suitability for use and also its requirements for management are similar to those features of the eroded hilly phase of Dewey silty clay loam. Owing to the lighter texture, however, this Bolton soil is somewhat lighter to work and is less susceptible to puddling than the Dewey soil; on the other hand, some difficulty is occasionally encountered in getting the surface soil to shed off the plow. This soil is also somewhat more permeable and hence is less susceptible to erosion than the Dewey soil, but its advantage in this respect in this county is only slight. This soil is apparently not so well suited to alfalfa as the Dewey soil, although alfalfa can be successfully grown. Under similar management this soil would be expected to be slightly less productive than the eroded hilly phase of Dewey silty clay loam but significantly more productive than the associated eroded hilly phase of Fullerton fine sandy loam.

Bolton loam, eroded rolling phase.—This phase differs from the eroded phase of Bolton loam chiefly in having a gentler slope, which ranges from about 5 to 12 percent. It is similar to the eroded phase of Dewey silty clay loam in color, slope, and eroded condition; but it differs from that soil in being lighter in texture, in containing some fragments of sandstone, in being slightly more friable and permeable, and in being geographically associated with the Fullerton fine sandy loams instead of the Decatur soils and the Fullerton silt loams.

The present surface layer consists of brown mellow friable loam, about 5 to 10 inches thick. In some places some of the surface soil has been lost so that the topmost part of the subsoil has been reached by tillage implements and incorporated into the surface soil, thereby making it yellowish brown or reddish brown. The subsoil, extending to a depth of 4 to 6 feet, consists of reddish-brown to yellowish-brown moderately firm but friable silty clay loam. Fragments of sandstone and chert are scattered over the surface and throughout the soil mass, but in the surface soil these are neither numerous enough nor large enough to interfere materially with cultivation. Drainage, both internal and external, is good; and the soil is penetrable to a great depth by water, air, and plant roots. The reaction is acid, probably predominantly strongly acid. As compared with other soils in the county, it is fairly well supplied with organic matter and is moderately to relatively high in natural fertility.

Several variations are included in mapping. In some places little or no erosion has taken place and the surface soil is as much as 12 inches thick. In other areas sandstone fragments are more numerous and the texture is lighter than is typical, and such areas are indicated

on the map by special symbol. In a few places the color is darker than is typical, resembling that of the Decatur soils.

The total area is 768 acres. Most of it occurs in narrow northeast-southwest belts scattered throughout the middle two-thirds of the county, where it is associated chiefly with Fullerton fine sandy loam and phases of that soil. In this association the Bolton soils predominate on the east-facing slopes and the Fullerton soils on the west-facing slopes.

This Bolton soil is used and managed in about the same way as the eroded phase of Dewey silty clay loam, but the yields obtained are thought to be slightly less. It is also similar to this Dewey soil in physical suitability for use and requirements for management, although there are some minor differences. For example, owing to the lighter texture, this Bolton soil is somewhat lighter to work and is less susceptible to puddling; on the other hand, some difficulty is occasionally encountered in getting the surface soil to shed off the plow. This soil is somewhat more permeable and hence is less susceptible to accelerated erosion, but this difference in Hamblen County is slight. This soil is apparently not so well suited to alfalfa as the Dewey soil, but alfalfa can be successfully grown. It is better suited to this crop than the associated sandy Fullerton soils. Under similar management the yields would be expected to be slightly lower than on the eroded phase of Dewey silty clay loam, but significantly higher than on the associated eroded phase of Fullerton fine sandy loam.

TALBOTT SERIES

The Talbott soils are readily distinguished from the other soils developed over limestone by their heavy-textured subsoils, their comparative shallowness over bedrock, and the presence of a few outcrops of bedrock. In uneroded areas, which are few in this county, the 6- to 8-inch surface soil of light grayish-brown mellow silt loam is underlain by a subsoil of yellowish-red tough, plastic, slowly pervious silty clay from 12 to 18 inches thick. A few splotches of gray and yellow are generally present in the lower part of the subsoil, and a very few are also present in the upper part in some areas. The parent soil material under the subsoil consists of plastic sticky silty clay, predominantly yellow, splotched with brown, gray, red, and pale yellow. This material rests on an uneven or jagged bedrock floor, which generally lies from 4 to 10 feet below the surface. Small outcrops of limestone are common, especially where the soil has been eroded. The limestone is generally clayey, in contrast with the relatively clay-free limestone underlying the Decatur, Dewey, and Fullerton soils.

The Talbott soils resemble the Dewey soils in topographic position, although they generally occur at slightly lower elevations; and they also resemble both the Dewey and the Fullerton soils in color; but they are easily differentiated from those soils by the tough consistence of the subsoil, the shallowness over bedrock, and the few outcrops of bedrock. In some places the Talbott soils closely resemble the Sequoia soils and are difficult to distinguish from them on the surface, but they can be differentiated by the character of the parent rocks, as those under the Talbott soils consist of clayey limestone and those under the Sequoia of interbedded shale and limestone.

Highly susceptible to accelerated erosion, the Talbott soils in this county are nearly everywhere more or less eroded. In cultivated fields the yellowish-red subsoil material is being brought to the surface, making the surface soil appear somewhat red.

The reaction is acid, ranging from medium to very strongly acid. As compared with other soils of the county, the Talbott soils are thought to be relatively fertile, but they are less productive than many of the others, owing largely to the unfavorable consistence of the subsoil. In this county the land is predominantly rolling, but a large part of it is hilly and a small part is steep. The Talbott soils are most commonly associated with the miscellaneous land types characterized by numerous limestone outcrops, chiefly southwest of Morristown and along the Holston River and to a less extent elsewhere in narrow strips between the wide belts of Fullerton soils on one side and Litz or Dandridge soils or stony land on the other.

These soils differ from one another in their relative suitability for agricultural use, largely because of differences in slope or erosion or both. Where the soils occupy gently sloping areas and are only slightly or moderately eroded they are fairly well suited to the production of crops, but where they occupy steep areas and are severely eroded they are unsuitable for this purpose and poorly suited even to pasture.

The Talbott soils in Hamblen County are classified and mapped into the following five phases: Talbott silty clay loam, eroded phase; Talbott silty clay loam, severely eroded phase; Talbott silty clay loam, eroded hilly phase; Talbott silty clay loam, severely eroded hilly phase; and Talbott silty clay loam, eroded steep phase.

Talbott silty clay loam, eroded phase.—This phase occurs in gently rolling areas and is characterized by a heavy-textured subsoil and a comparatively slight depth to the underlying clayey limestone bedrock from which the parent material of this soil was weathered. It is well drained, although internal drainage is retarded by the heavy subsoil; and as compared with the other soils in the county it is considered to be medium to high in plant nutrients. Moderately productive, it is used chiefly for the production of crops. It is rather highly susceptible to erosion, and in most of the areas a part of the original surface soil has been lost by accelerated erosion.

The present surface soil consists of light grayish-brown to light yellowish-brown friable silty clay loam, from 4 to 7 inches thick. The subsoil, extending to a depth of 18 to 24 inches, consists of yellowish-red tight tough plastic silty clay. It is generally lightly splotched with red, yellow, and gray in the lower part; and in some places a few of these splotches also occur in the upper part. In many places the upper part of the subsoil is slightly less tough and plastic than the lower part. The structure is characteristically blocky, the aggregates ranging from about $\frac{1}{2}$ to 1 inch in diameter. The substratum is similar to the subsoil in texture and consistence, although it is slightly less plastic in many places. It differs from the subsoil in being highly splotched and mottled with gray, yellow, and red. This material extends to the clayey limestone bedrock, which in most places lies from 4 to 10 feet below the surface; but outcrops of limestone occur here and there. The predominant slope ranges from about 5 to 12 percent, but the gradient is less than 5 percent in a few areas.

Several variations are included with the eroded phase of Talbott silty clay loam. The chief one of these is mapped along the Holston River, where the subsoil is redder and deeper than elsewhere. Here the subsoil resembles the corresponding layer of the Dewey soils in color and depth, but it differs in being heavier in consistence. This red-subsoil variation, which incidentally is associated with Maryville limestone, is somewhat more productive than the eroded soil with which it is mapped. Another variation, of considerably less extent, has a reddish-yellow to yellow subsoil. This variation is less productive than the soil with which it is mapped. Also included are areas in which a small amount of shale is interbedded with the limestone; here the soil resembles the Sequoia soils. Still other inclusions represent a few areas that have lost little or none of the original surface soil by erosion.

This soil occupies a total area of 2,624 acres. Typically associated with the miscellaneous land types characterized by limestone outcrops, the greater part occurs southwest of Morristown and along the Holston River; and it is also rather widely distributed over other parts of the county, where, together with the other Talbott soils, it forms narrow strips between the wide belts of the other soils developed over limestones on the one side and the wide belts of soils developed over shales or over interbedded shales and limestones on the other side.

The unfavorable features of tightness and impaired permeability of the subsoil greatly handicap this soil for the production of crops. This physical condition inhibits the absorption and percolation of water, retards the movement of moisture, and ultimately results in a tendency toward extreme alternate wet and dry conditions of the surface soil; consequently, injury to crops in both wet and dry periods is more severe than on other soils. Restricted absorption of water naturally increases surface runoff, particularly during heavy rainfall; and this probably more than any other factor accounts for the erodibility of this soil.

Most of the land is used for the production of field crops common to the area, but some is used for pasture, some is lying idle, and a very small proportion is in woods. Yields vary considerably, depending to a large extent on the amount and distribution of rainfall; but commonly reported yields of the main crops grown are as follows: Corn, about 25 bushels an acre; wheat, 10 to 15 bushels; hay, chiefly lespedeza or red clover and timothy, about 1 ton; and alfalfa, 2 to 3 tons. Yields of tobacco are generally rather low, although fair to high yields are occasionally obtained.

The requirements for management of this soil are similar in most respects to those of the eroded phase of Dewey silty clay loam, but there are some important differences. Because this soil is considerably more susceptible to erosion than the Dewey soil, the rotation should be longer and should include close-growing crops, especially grasses and legumes, a larger proportion of the time. A longer rotation may also be necessary in order to maintain a fairly good tilth, as the tilth is naturally less favorable and more difficult to maintain than that of the Dewey soil. Where feasible, deep-rooted crops, such as alfalfa and sweetclover, should be grown periodically in order to improve the permeability of the subsoil. Cultivation needs to be avoided when the soil is wet or dry. Tillage should be performed on the contour, although that is not practicable in some areas where

sinkholes are abundant. In such areas the rotation should be even longer. Engineering measures, such as terraces, may help to control runoff and erosion; but, in view of the unfavorable consistence of the subsoil, the practicability of terracing and of maintaining the terraces for a long period of years is doubtful. For similar crops, the fertilizer requirements are thought to be approximately similar to those of the Dewey soil; but somewhat less response is to be expected because of the unfavorable subsoil. Lime and phosphate are known to be required, and potash may be required. Nitrogen is required for all crops except legumes and those crops immediately following legumes, although it may aid in getting certain legumes started, especially alfalfa.

Talbott silty clay loam, severely eroded phase.—The difference between this soil and the eroded phase of Talbott silty clay loam is chiefly in the degree of erosion. The severely eroded soil has lost most of its original surface soil and in some places also a part of the original subsoil. In most places the present surface soil consists of the upper part of the original subsoil mixed with the remaining part of the original surface soil, making it a light yellowish-red to light brownish-yellow moderately sticky and plastic silty clay loam. The subsoil, like that of the other Talbott soils, is yellowish-red tough sticky plastic silty clay. The variations in color and depth of the subsoil included with the eroded phase are also mapped with the severely eroded phase. The range in slope of the two soils is about the same—from 5 to 12 percent.

This severely eroded soil has a total area of only 256 acres. It occurs in the same general localities and is associated with similar soils as the less eroded soil.

All the land has been used for the production of crops, including row crops; but the greater part of it is now lying idle. Some, however, is still used for crops, and some is used for pasture. Yields of crops are generally low. Its present severely eroded condition indicates that use or management, but most likely both, were not adjusted to the physical limitations of this soil.

Chiefly because it is more eroded, this soil is physically much inferior to the previously discussed Talbott soil for the production of crops. The tilth is especially unfavorable. Highly susceptible to puddling and clodding, the soil may be safely tilled only within a narrow range in moisture content. A rather hard crust tends to form on the surface when the soil dries after heavy rains; and this crust sometimes greatly interferes with the upward penetration of sprouts of alfalfa, red clover, and other plants and accounts for most of the difficulty experienced in establishing many crops. When the soil becomes very dry it generally also becomes very hard and cloddy, developing deep cracks as much as half an inch in width. The very fine textured subsoil retards the downward penetration of roots, and the loss of so much of the original surface soil has lowered the water-absorbing capacity, thus inducing rapid runoff, especially after heavy rains. These conditions also seriously handicap the effective control of runoff and erosion.

In its present condition this soil is considered physically better suited to pasture or more or less permanent hay land than to the production of crops requiring tillage, although it seems likely that, after an ex-

tended period in hay or pasture, it would again become suitable for cultivated crops under good management. Alfalfa has been observed to grow fairly well on this severely eroded soil, but a good stand is difficult to establish, owing to the unfavorable tilth of the surface soil. The same is also true to some extent of red clover and grass. Lime and phosphate are especially necessary where alfalfa or red clover is to be grown; the seedbed needs to be carefully prepared, and care must be taken to break the crust on the surface if one forms before the sprouts have penetrated the surface. Lespedeza is easier to establish and can be grown with less lime and phosphate. *Sericea lespedeza* and sweetclover would likewise be expected to be easier to establish. With adequate lime and phosphate, bluegrass should succeed fairly well; with less lime and phosphate, redbud and orchard grass should do fairly well. The growing of deep-rooted plants, such as alfalfa and sweetclover and fibrous-rooted plants, such as grasses, should be especially beneficial to this soil because of the favorable effect that such roots have on the physical condition of the soil.

Talbott silty clay loam, eroded hilly phase.—This soil has a steeper slope—from 12 to 25 percent—than either of the Talbott soils just discussed. It differs from the eroded phase of Talbott silty clay loam chiefly in having a steeper slope and from the severely eroded phase of Talbott silty clay loam in being less eroded despite the steeper slope. It is similar in degree of slope and erosion to the eroded hilly phase of Dewey silty clay loam, but it is readily distinguished from that soil by its very fine textured and lighter colored subsoil.

The present surface soil consists of light grayish-brown to light yellowish-brown friable silty clay loam, from 3 to 6 inches thick. The subsoil, extending to a depth of 18 to 24 inches, consists of yellowish-red tight tough plastic silty clay. Variations in color and depth of subsoil similar to those included in the eroded phase of Talbott silty clay loam are also included in the eroded hilly phase. In some places a considerable part of the present surface soil consists of what used to be the upper layer of the original subsoil; in such places this layer has a reddish cast and is somewhat less friable than elsewhere. Low outcrops of limestone occur here and there. In a few places little or no erosion has taken place; here the surface soil is as much as 7 or 8 inches thick.

This phase has a total area of 1,152 acres. It occurs in the same general localities as the other Talbott soils, and it is most commonly associated with the miscellaneous land types characterized by limestone outcrops. Some of the larger areas are southwest of Morristown and along the Holston River; but it is rather widely distributed over the county, where, in association with the other Talbott soils, it occurs in narrow belts between wide belts of predominantly Fullerton soils on the one side and predominantly Litz or Dandridge soils on the other.

Nearly all of the land has been cleared and has been used for the production of the crops common to the area. At present the greater part is still thus used, but much is lying idle and a large part is in pasture. Yields of crops vary considerably, but they are generally rather low, lower than the yields obtained on the eroded phase of

Talbott silty clay loam. If the distribution and amount of rainfall are favorable the yields are likely to be moderate to good, but if moisture conditions are unfavorable they are generally very low.

Physically, this soil is poorly suited to the production of crops requiring tillage. There are several reasons for this, among which the very high susceptibility to injury from erosion and the difficulty in controlling erosion are very important. Furthermore, the slope is steep enough to impair tillage, and yields of crops are likely to vary considerably, even under good management. In view of these conditions, this soil is considered to be physically better suited to pasture. As long as it retains a considerable part of the original surface soil, good pastures can be established and maintained with relative ease if lime and phosphate are applied.

Where used for crops, this soil has general requirements for management similar to those of the eroded hilly phase of Dewey silty clay loam, but the rotation should be longer and should include close-growing crops, preferably grasses and legumes, a greater proportion of the time. Row crops should be grown sparingly if at all, and cultivation should be performed between a narrower range in moisture content. Indications are that legumes, including alfalfa, and grasses can be grown successfully if the soil is adequately fertilized and otherwise well managed.

Talbott silty clay loam, severely eroded hilly phase.—In slope this soil is similar to the eroded hilly phase of Talbott silty clay loam, and in degree of erosion it is similar to the severely eroded phase. In other characteristics, including variations in the color and depth of the subsoil, this soil is similar to the other Talbott soils. The gradient ranges from about 12 to 25 percent.

Most of the original surface soil has been lost, and the present surface soil consists of the upper layer of the original yellowish-red tough plastic subsoil mixed with the remainder of the original surface soil. Gullies from 1 to 3 feet deep are rather common, and outcrops of limestone occur here and there.

An area of 768 acres is mapped. This soil is associated chiefly with the other Talbott soils and the miscellaneous land types characterized by limestone outcrops.

All the land has been cleared and has been used for the production of the crops common to the area, but at present most of it is lying idle or is abandoned, some is used for pasture, and a small acreage is used for crops. Yields of crops are generally low, and failure to obtain a good stand is rather common.

In view of the fact that the slope is steeper and the physical condition is equally unfavorable, as compared with those features of the severely eroded phase of Talbott silty clay loam, it is evident that this soil is very poorly suited to the production of crops requiring tillage and is also rather poorly suited to pasture. In its present condition it is best suited to forestry. Although it has been demonstrated on a few farms that pastures can be established, the expense and risk involved are high. Lime and phosphate are required; engineering measures, such as diversion ditches and check dams, may be necessary; and drought-resistant plants need to be selected. After the pastures are once established, however, they tend to improve with age if an adequate supply of lime and phosphate is maintained and

if the management is otherwise good. Under such conditions bluegrass and white clover would be expected to establish themselves and alfalfa and other hay crops should succeed fairly well, once the difficulty of obtaining a good stand is overcome.

Talbott silty clay loam, eroded steep phase.—This soil occupies steeper areas than any of the other Talbott soils previously discussed. The gradient ranges from about 25 to 55 percent, although it is more than 55 percent in some places. It differs from the eroded hilly phase of Talbott silty clay loam chiefly in having a steeper slope; otherwise the two soils are similar. The surface soil is light grayish-brown to light yellowish-brown friable silty clay loam, and the subsoil is yellowish-red tough sticky plastic silty clay. Included with this soil are numerous severely eroded areas, which comprise about 40 percent of the total area.

Only 64 acres of this soil is mapped, mainly in association with the other Talbott soils.

As this soil is inextensive, it is of little importance to agriculture. Nearly all of the land has been cleared, however, and at one time or another it has been used for the production of crops and for pasture. At present much of it is lying idle and some is used for pasture. Only a few acres are used occasionally for crops, for which purpose it is physically very poorly suited. Although it is not very well suited even to pasture, its use for this purpose is feasible except in the severely eroded areas, where forestry is apparently the best adapted use.

SOILS DEVELOPED OVER CALCAREOUS SHALES

Soils developed over calcareous shales, locally called black slate, predominate in a dissected belt along the southeastern boundary of the county. They are classified into two series, namely, the Needmore and the Dandridge. The soils of these series are easily differentiated. The Needmore soils occupy gently sloping areas and are fairly deep over shale, generally free from shale, and acid in reaction; whereas Dandridge soils, which are many times more extensive than the Needmore, occupy prevailing hilly and steep areas and are shallow over shale, generally shaly, and high in lime. The former have well-defined surface soil and subsoil layers; the latter have very poorly developed layers. In agricultural use the soils of these two series differ in that the Needmore are not especially productive of pasture but are fairly well suited to field crops, whereas the Dandridge are especially good for pasture but are generally poorly suited to field crops.

NEEDMORE SERIES

The soils of the Needmore series are readily distinguished from all other soils in the county except those of the Dandridge series by the underlying parent rock—a gray calcareous shale. The Needmore soils, however, are easily differentiated from the Dandridge soils by having a gentler slope, greater depth over shale, and well-developed surface soil and subsoil layers. On the surface they more closely resemble the Sequoia soils, but they can be differentiated readily from those soils by the parent rocks, which for the Sequoia soils consist of interbedded noncalcareous shales and limestones.

The Needmore soils are characterized by a 7- to 8-inch surface layer of yellowish-gray friable silt loam and a brownish-yellow to reddish-yellow firm tough silty clay subsoil extending to a depth of 18 to 24 inches. Below this the material is firm and fine-textured, is rather highly spotted with gray, and contains a few fragments of soft shale, some of which are calcareous. This material extends to the slightly weathered calcareous shale, which generally lies at a depth of 20 to 30 inches. The land is gently undulating to rolling. Surface drainage is good, but internal drainage is rather slow, though adequate for the crops common to the locality. The reaction of the surface soils and subsoils is acid, probably very strongly acid in many places. In general the Needmore soils are moderate to low in productivity of the crops common to the locality, but they differ somewhat in their relative suitability for crop production because of differences in slope and in degree of erosion.

Needmore soils, which occur chiefly in the vicinity of Whitesburg, have a total area of 512 acres. Only one type and one phase are mapped, namely, Needmore silt loam, and Needmore silty clay loam, eroded rolling phase.

Needmore silt loam.—This light-colored soil of gently sloping areas has developed from material that is residual from the weathering of calcareous shale, which lies from 20 to 30 inches below the surface. Drainage is fairly good, although internal drainage is rather slow. The reaction of the surface soil and the subsoil is acid, probably ranging from strongly to very strongly acid; and the subsoil is fine to very fine textured. This soil type is moderate in productivity of most crops common to the locality, and most of it is cropped.

The surface soil, from 6 to 8 inches thick, consists of yellowish-gray to brownish-gray friable silt loam to silty clay loam. In woods the topmost 1 or 2 inches is stained dark with organic matter, which disappears under cultivation. The subsoil consists of firm tough moderately plastic sticky silty clay ranging in most places from brownish yellow to reddish yellow, although in some places it is yellowish red. A few faint splotches of pale yellow, gray, and olive green, some of which are apparently due to recently disintegrated shale fragments, are generally present in the lower part of the subsoil. The structure is blocky and is similar to that of the subsoils of the Talbott series. At a depth of 18 to 24 inches the subsoil is underlain by similarly firm material that is highly spotted with gray, olive green, and yellow and contains a few fragments of soft shale, some of which are calcareous and effervesce with dilute acid. This substratum is generally not thick. It rests on calcareous shale at a depth of 20 and 30 inches, or more in some places. This shale effervesces freely with dilute acid.

The slope is generally less than 5 percent, and the soil therefore lies well for cultivation. Surface runoff is sufficient, but it is so slow that there is not much danger of accelerated erosion. Because of the retarding effect of the fine-textured subsoil and the underlying shale, internal drainage is slow, but it is adequate for the production of the crops common to the locality. Owing to this retarded internal drainage, however, the soil warms slowly in the spring. As indicated by the color of the surface soil, the content of organic matter is comparatively low. Despite the slight depth to calcareous shale, the

surface soil and the subsoil are highly leached and are generally strongly acid in reaction. The consistence of the subsoil, similar to that of the Talbott and Sequoia soils, is unfavorable; both water and roots penetrate with difficulty. Partly because of this condition, the crops are rather susceptible to injury from drought. The tilth of the surface soil is generally good, although the soil will puddle if tilled when wet.

Needmore silt loam occupies only 256 acres. Small areas occur here and there wherever the Dandridge soils are distributed, but the largest ones are in the vicinity of Whitesburg. It is also commonly associated with the Leadvale soils.

Nearly all of the land is cleared and is used for the production of crops, including mainly corn, wheat, oats, barley, clover, alfalfa, tobacco, and vegetables, especially tomatoes. It is managed in much the same way as other soils of the gently sloping uplands. The usual rotation consists of corn, small grain (generally wheat or oats), and mixed clover and grass for 1 or 2 years. The yields of crops vary considerably, but commonly reported yields are as follows: Corn, 15 to 20 bushels an acre; wheat, 12 to 15 bushels; oats, 20 to 25 bushels; barley, 15 bushels; alfalfa, 2 to 3 tons; other hays, about 1 ton; and tobacco, 600 to 800 pounds.

The requirements for management of this soil are somewhat similar to those of the eroded phase of Talbott silty clay loam; but as this Needmore soil has a gentler slope, considerably less attention needs to be given to the prevention of erosion and crop rotations may be shorter. In regard to the selection of crops, however, the two soils are similar in their requirements. Deep-rooted crops, such as alfalfa and sweetclover, need to be grown periodically in order to improve the physical condition of the subsoil; and grasses and legumes need to be grown to increase or maintain the supply of organic matter. Lime is required in order to get most of the legumes established, but it seems likely that after being established, deep-rooted legumes could get most of their lime from the underlying shale. Phosphate is a general requirement for most crops, especially for legumes. Potash may also be required. The meager information at hand indicates that the underlying shale is fairly high in potash, although doubtless much of this is not available to plants; nevertheless the potash requirement may be less than that of the soils developed over limestone. Farmers report that this soil responds fairly well to applications of manure and lime.

Needmore silty clay loam, eroded rolling phase.—This soil differs from Needmore silt loam chiefly in having a steeper slope and in having lost a considerable part of the original surface soil. The gradient ranges from about 5 to 12 percent. In many places the topmost part of the original subsoil, mixed by plowing with the remainder of the original surface soil, constitutes the present surface soil, which consists of grayish-yellow moderately friable silty clay loam from 4 to 6 inches thick. The subsoil is brownish-yellow to reddish-yellow firm tough silty clay, and it grades into calcareous shale at a depth of 15 to 25 inches in most places. Included with this soil, as mapped, however, are areas that have undergone little or no accelerated erosion; these areas comprise between one-fourth and one-half of the total area.

Only 256 acres of this soil is mapped. Like the other Needmore soil, it is associated chiefly with the Dandridge soils, especially in the vicinity of Whitesburg. It is also commonly associated with the Leadvale soils.

Wooded areas, constituting most of the less-eroded variation, comprise between one-fourth and one-half of the total area. Where cleared, the soil is used and managed in about the same way as Needmore silt loam, but the yields of most crops are generally somewhat lower. The requirements for management of this eroded soil are similar to those of the silt loam, except that more attention needs to be given to the control of runoff and erosion. In requirements for management this soil is also very similar to the eroded phase of Talbott silty clay loam, which also has a fine-textured subsoil; but it is probably slightly better suited to legumes and grasses.

DANDRIDGE SERIES

The Dandridge soils are characterized by shallowness over calcareous shales and pronounced relief. In these characteristics they are similar to the Litz and Armuchee soils, but they are readily differentiated from those soils by the parent rocks. Those under Dandridge soils consist of calcareous (high-lime) shales, whereas those under the Litz and the Armuchee soils consist of interbedded noncalcareous shales and limestones. The parent rock of the gravelly Dandridge soils is interbedded with gravelly and nodular limestone, whereas that of the nongravelly Dandridge soils is comparatively free from limestone (pl. 9, *A*). Well-defined surface soil and subsoil layers, such as are ordinarily present in the soils of the county, have not developed in the Dandridge soils, and tillage and accelerated erosion have obliterated most of the minor differences between such layers. The depth to the shale bedrock ranges from about 3 to 20 inches, but in many places the shale outcrops. The soil material is predominantly light brownish-yellow moderately friable silty clay loam, but it varies considerably in color, texture, and consistence. Numerous fragments of shale, which are generally calcareous, are scattered through the soil material; hence this material, being very well supplied with lime, is generally about neutral in reaction. In the few remaining wooded areas and in the relatively old pastures the topmost 1 or 2 inches of the soil is stained dark with organic matter, and in some places a yellowish-gray friable surface layer and a brownish-yellow firm subsoil layer are developed.

The Dandridge soils are recognized as being naturally productive of pasture plants, especially bluegrass and white clover. Although they are used extensively for pasture, they are also used considerably for field crops. Where they occupy decidedly sloping areas, however, they are physically poorly suited to crops and have become more or less eroded (pl. 9, *B*). The Dandridge soils mapped northwest of Bent Creek differ from most of the Dandridge soils mapped elsewhere in being more productive.

The Dandridge soils predominate in a belt of highly dissected land extending along the southeastern boundary of the county, although they occur in a few other places in the county. They have a total of 11,392 acres, nearly all of which has been cleared and cropped and is now more or less eroded. Five phases are mapped—Dan-

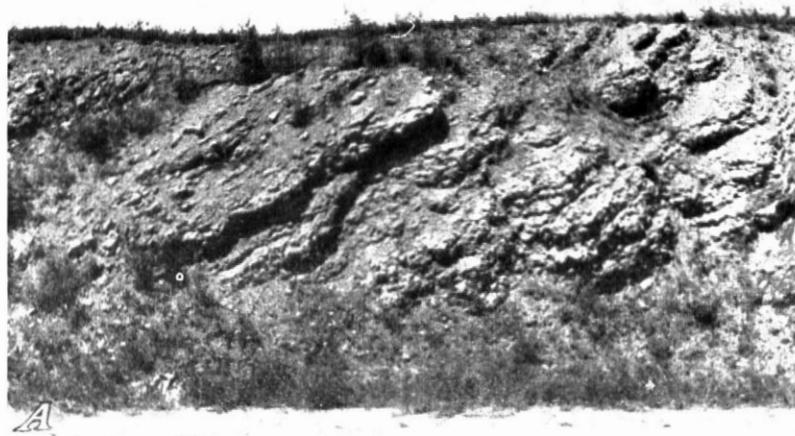
dridge shaly silty clay loam, eroded phase; Dandridge shaly silty clay loam, eroded rolling phase; Dandridge shaly silty clay loam, eroded steep phase; Dandridge gravelly silty clay loam, eroded phase; and Dandridge gravelly silty clay loam, eroded steep phase.

Dandridge shaly silty clay loam, eroded phase.—This soil, the most extensive member of the Dandridge series, is shaly and shallow and occupies hilly areas, having a gradient of 12 to 25 percent. The total depth over shale ranges from about 3 to 18 inches, but low outcrops of shale bedrock are common. In most places the soil material contains numerous shale fragments, many of which are calcareous and effervesce with dilute hydrochloric acid. The soil material is therefore about neutral in reaction and well supplied with lime. No well-defined surface soil and subsoil layers have developed, and tillage and accelerated erosion have tended to obliterate the minor differences that had existed between these layers. In its present condition the soil material, most of which is shaly, is predominantly moderately friable silty clay loam, though ranging from friable silt loam to firm and tough silty clay, and is predominantly brownish yellow, ranging from yellowish gray to reddish yellow. In the few remaining wooded areas and in the older pastures the topmost 2-inch layer is stained dark with organic matter and in some places a friable yellowish-gray surface soil and a brownish yellow firm subsoil are discernible.

As erosion advances on this soil, the topmost part of the bedrock shale comes nearer the surface and is turned up by the plow. On exposure the shale soon breaks down and becomes an integral part of the soil. For this reason it is difficult to ascertain the loss of soil material, although undoubtedly some has been lost nearly everywhere. Furthermore, apparently little or no decline in productivity has taken place because of increased erosion except in the places where recent accelerated erosion has been especially severe. In fact, farmers have reported that yields have increased where slight erosion has brought the calcareous shale bedrock within reach of the plow. To allow this soil to become severely eroded so that the plow layer consists almost entirely of shale fragments, however, is decidedly harmful and should be prevented. A few such areas are included with this separation.

In many cultivated areas, especially where erosion is severe, rather large shale fragments, some as large as 4 inches in thickness and 18 inches in diameter, are numerous on the surface, especially southeast of Bent Creek. Many farmers make a practice of removing the fragments; but merely shattering them with a hammer or a sledge is all that should be necessary.

Most of the soil mapped as Dandridge shaly silty clay loam, eroded phase, northwest of Bent Creek consists of a variation that is about 10 percent more productive than the typical soil of this phase, although some of it, especially those areas lying east of Holloway School, is more nearly like this soil. The variation appears to contain more dark gray and red material. After rains freshly plowed fields present an intricate color pattern of dark gray and yellowish red, whereas the color of the more or less typical Dandridge soils under similar conditions is predominantly dark grayish yellow. This variation also differs from the soil with which it is mapped in having deteriorated



A, Parent rock of the gravelly Dandridge soils, consisting of calcareous shale in which gravelly and nodular limestone is interbedded. Note shallowness of soil material and the larger nodules. In contrast, the parent rock of the nongravelly Dandridge soils is predominantly calcareous shale and is comparatively free from limestone. B, Representative landscape of the Dandridge soils, showing eroded condition of slopes injudiciously used at some time for cultivated crops. The good pasture in the foreground is on the nongravelly Dandridge soils, whereas the poorer pasture in the background is on the gravelly Dandridge soils.



A, Typical landscape of the Litz soils, which occupy steep areas and are shallow and highly erodible. Note the severely eroded condition of the area in the middle ground, common where these soils have been cultivated. *B*, Field on Litz shaly silt loam, eroded rolling phase, on the smooth, low ridges, and Litz shaly silt loam, eroded hilly phase, showing active erosion on the latter soil, which occupies slopes facing drainageways. Fairly good pastures have recently been established on steep slopes of these soils by the application of lime and phosphate, contour subsoiling or deep contour plowing, and proper control of grazing. *C*, Rough gullied land (Litz soil material). Wherever the highly erodible Litz soils have been cultivated, gullied areas such as this one are conspicuous.

less from accelerated erosion. The shale fragments turned up by the plow are generally smaller and disintegrate more rapidly than those turned up in the more typical Dandridge soils, and probably this difference accounts for much of the advantage in productivity.

Other less important variations are also included. In some places the depth to shale is more than 20 inches and the soil resembles the Needmore soils. In other places the shale and the soil material contain a noticeable quantity of very fine sand. Most of this latter variation is south of Bent Creek, and the larger areas are indicated on the map by symbols. In still other places the soil and even the upper part of the parent shale has been leached of most of its lime and is therefore rather low in this constituent. Other small areas of variations resembling the Armuchee and Sequoia soils are mapped as this soil southeast of Morristown.

Dandridge shaly silty clay loam, eroded phase, as mapped, has a total area of 3,712 acres. Most of it occurs in association with the other Dandridge soils in a belt of highly dissected land lying along the eastern boundary of the county.

This soil is used chiefly for pasture and field crops. Corn, small grains, and clover and grass mixed, commonly grown in rotation, are the principal crops. Yields vary greatly, depending to a large extent on the distribution and amount of rainfall during the growing season, as the soil, although relatively fertile, has a low water-holding capacity. When moisture conditions are especially favorable, relatively high yields are frequently obtained; but, when moisture conditions are unfavorable, yields are generally low. Under ordinary management the average yields over a period of years are moderate to low. Pastures on this soil, however, are generally good.

Physically, this soil is considered to be very well suited to permanent pasture and rather poorly suited to field crops. Shallowness (resulting in a low water-holding capacity), hilly slope, and extremely high susceptibility to erosion are among the chief limiting factors. By very careful management, however, a number of farmers have used this soil, especially the more productive variation in it, for the production of crops for a number of years.

In the use of the soil for crops the rotation needs to be relatively long and should include chiefly close-growing crops, especially grasses and legumes. This soil appears to be well adapted to grasses and legumes, including alfalfa, probably because of its high supply of lime. Phosphate is ordinarily required for grasses and legumes, but lime is not required in the places where some of the parent calcareous shale is plowed up occasionally. As there is some evidence indicating that the shale is fairly high in potash, this fertilizing element may not be required, at least not in large quantities. Cultivation should be on the contour. A practice that has proved beneficial in some places, especially where there has been considerable erosion, is subsoiling on the contour to a depth between 15 and 20 inches. Subsoiling would be expected to decrease surface runoff and to increase the water-holding capacity. Pastures need phosphate, but they do not usually need lime. They would ordinarily be benefited by subsoiling.

Dandridge shaly silty clay loam, eroded rolling phase.—This soil differs from the eroded phase of Dandridge shaly silty clay loam chiefly in having a gentler slope—from 5 to 12 percent. Like the

other Dandridge soils, this soil ranges from about 3 to 20 inches in depth over calcareous shale, is more or less eroded, contains numerous outcrops of calcareous shale and a great many fragments of shale, and is well supplied with lime. The soil material overlying the shale is predominantly grayish-yellow to brownish-yellow moderately friable shaly silty clay loam. Variations similar to those included with other Dandridge soils except for slope are included with this soil. The most extensive and important variation is the more productive one, which comprises most of the soil as mapped northwest of Bent Creek.

Dandridge shaly silty clay loam, eroded rolling phase, aggregates 1,920 acres. Most of the soil is mapped in association with the other Dandridge soils in a belt of highly dissected land near the southeastern boundary of the county, but a few areas occur in other parts of the county. Typically, the areas are narrow, lying on low winding ridges.

Practically all of the land has been cleared and has been used for crops and pasture. At present most of it is still being used for general field crops, but a large part is used for pasture. Recognized as a good soil for pasture, it supports a good stand of bluegrass and other pasture plants in many areas, especially where phosphate has been applied. Among the crops grown successfully are corn, wheat, barley, alfalfa, lespedeza, clover, and grasses. When corn is grown only once in 3 or 4 years, yields between 20 and 30 bushels an acre are frequently reported. Yields of the other crops commonly grown are as follows: Wheat, 12 to 18 bushels; barley, 15 to 25 bushels; alfalfa, 2 to 3 tons; and other hay crops, about 1 ton. Only a small total acreage of tobacco is grown, and both quality and yield are generally low as compared with tobacco grown on the Dewey and Decatur soils. Yields of 500 to 700 pounds an acre of tobacco have been reported.

The requirements for management of this soil are similar to those of the eroded phase of Dandridge shaly silty clay loam; but this soil, because of the gentler slope, requires somewhat less attention to control erosion. This difference between the two soils, however, is not great. The gentler slope also makes this soil somewhat easier to work and physically better suited to the production of crops as compared with Dandridge shaly silty clay loam, eroded phase; nevertheless, because of its shallowness, the soil cannot be said to be physically well suited to such use; but it supports good pasture, especially where phosphate has been applied.

Dandridge shaly silty clay loam, eroded steep phase.—Unlike the eroded rolling phase, which differs from the eroded phase of Dandridge shaly silty clay loam chiefly in having a gentler slope, this eroded steep phase differs from the same soil chiefly in having a steeper slope, in most places ranging from 25 to 60 percent. As this soil is more eroded, the depth to shale is somewhat less than in the other two Dandridge soils just discussed, ranging from about 2 to 15 inches, and outcrops of calcareous bedrock shale are common. The soil material consists of moderately friable grayish-yellow to brownish-yellow shaly silty clay loam. Variations similar to those included with the eroded phase of Dandridge shaly silty clay loam except for slope are included with this soil. The most important of

these is the more productive variation, comprising most of this soil mapped northwest of Bent Creek.

Dandridge shaly silty clay loam, eroded steep phase, has a total area of 3,584 acres. Most of it occurs in association with the other Dandridge soils within a belt of highly dissected land along the southeastern boundary of the county, where it generally occupies the steep and rather short slopes leading from the narrow ridge crests to the stream bottoms.

Nearly all of the land is cleared, and most of the cleared land is used for pasture, which is considered to be the use to which it is physically best adapted. Some of the land is used for crops, and some is virtually idle. Chiefly because of shallowness, steep slope, and high degree of erodibility, the soil is very poorly suited to the production of crops. It is productive of pasture plants, however, especially where phosphate has been applied, and in most places it is physically fairly well suited to pasture. On the severely eroded areas the present productivity for pasture plants is low, although such areas can probably be made reasonably productive if a vegetative cover is established and maintained. Deep subsoiling on the contour, application of phosphates, and restricted grazing would be expected to aid materially in establishing pasture on such areas. These practices also should be beneficial to some of the less eroded areas where the present pasture stand is thin. Very likely phosphorus is the only fertilizer needed for pastures, as excellent pasturage has been obtained where phosphate alone has been applied and the management has been good in other respects. Lime is not needed in most places.

Dandridge gravelly silty clay loam, eroded phase.—This soil differs from the eroded phase of Dandridge shaly silty clay loam chiefly in containing numerous disk-shaped pieces of limestone gravel and in being underlain by calcareous shale interbedded with layers of nodular limestone. The two soils are similar in having a hilly relief, in being shallow, and in having a high content of lime. The gradient generally ranges from 12 to 25 percent, but in some included areas it is less than 12 percent.

In virgin areas this gravelly soil has a very dark grayish-brown silty clay loam surface soil about 4 inches thick. The subsoil is grayish-brown to pale-yellow plastic silty clay, extending to the dark-gray interbedded calcareous shale and limestone, which generally lies at a depth of 10 to 14 inches.

At one time or another most of this soil has been cultivated and has become more or less eroded, and as a consequence most of the dark surface layer has been lost and the remainder has been mixed with the subsoil layer by the plow. What soil is left consists of brownish-yellow to grayish-yellow moderately plastic silty clay loam to silty clay. Limestone gravel is abundant on the surface and in the soil material. Most of the pieces of gravel are disk-shaped and range from 1 to 3 inches in thickness and from 2 to 8 inches in diameter. Along Bent Creek the pieces of gravel are generally somewhat larger than elsewhere.

About 1,728 acres of this soil is mapped. It is associated chiefly with the other gravelly Dandridge soil and with the miscellaneous land types characterized by limestone outcrops in narrow belts lying between the nongravelly Dandridge soils on the one side and the Ful-

lerton, Dewey, Decatur, and Talbott soils on the other. These gravelly Dandridge soils generally predominate on the side bordering the nongravelly Dandridge soils, whereas the stony land types predominate on the other side. Some areas of the gravelly soils are also associated with the Sequoia soils.

Nearly all of the land has been cleared at one time or another, but some of it has been allowed to reforest. The greater part is used for pasture, but some is used for crops and some is virtually idle. Crop yields are generally low, although fairly high yields are obtained now and then. Pastures are generally inferior to those on the eroded phase of Dandridge shaly silty clay loam.

Compared with the nongravelly Dandridge soil, this soil deteriorates much more from accelerated erosion because of the abundance of limestone gravel. As the soil material is removed by erosion, the gravel remains and accumulates on the surface, and eventually the soil becomes very difficult to work and very low in productivity because of the predominance of gravel. For this reason and others, the use of this soil for cultivated crops seems unwise. Where the soil has remained in pasture and consequently has not been greatly thinned by erosion, it supports a good stand of bluegrass and white clover; but where it has been cultivated and has become severely eroded the pastures are only about half as productive as those on Dandridge shaly silty clay loam, eroded phase. Phosphate is thought to be the only fertilizer required by these two soils when used for pasture.

Dandridge gravelly silty clay loam, eroded steep phase.—This soil differs from the eroded phase of Dandridge gravelly silty clay loam chiefly in having a steeper slope (from 25 to 60 percent), and for this reason it is more poorly suited to pasture. In degree of erosion the two soils are similar, although this soil is more eroded in some places. The soil material, ranging from 2 to about 12 inches in depth, consists of grayish-yellow to brownish-yellow moderately plastic silty clay loam to silty clay. Disk-shaped pieces of limestone gravel are numerous over the surface and throughout the soil material, and outcrops of interbedded shale and limestone are common.

This soil has an aggregate area of 448 acres and is similar in distribution and association to the other gravelly Dandridge soil. Most of it has been cleared, but some of the cleared land has been allowed to reforest. The greater part of the land is in pasture, much of which is rather poor. A fairly large part is virtually idle. Physically, this soil is unsuitable for the production of tilled crops and also is rather poorly suited to pasture, although moderately good pastures can apparently be obtained in the less eroded and less gravelly areas. In many places this soil is considered to be physically suited only to forestry.

SOILS DEVELOPED OVER INTERBEDDED SHALES AND LIMESTONES

The soils developed over interbedded shales and limestones are classified into three series—Sequoia, Armuchee, and Litz.

The Sequoia soils are readily differentiated from the Armuchee and Litz soils by the gentle slope, the well-defined surface soil and subsoil layers, and the greater depth over bedrock. The Armuchee and Litz soils occupy hilly and steep areas, are shallow over bedrock, are generally shaly, and ordinarily have not developed well-defined surface

soil and subsoil layers. The Armuchee soils are differentiated from the Litz soils chiefly by differences in the relative proportion of limestone interbedded with the shale in the parent rocks. Limestone is estimated to constitute between 30 and 60 percent of the parent rocks of the Armuchee soils and between 5 and 15 percent of the parent rocks of the Litz soils. The Armuchee soils are also generally deeper over shale, less shaly, and more productive than the Litz soils. The shale in the parent rocks of both series, at least the topmost few feet, is generally acid; and in many places, especially under the Litz soils, most of the lime has been leached out of the upper 1 or 2 feet.

Also included with this group are the Upshur soils, which are of small extent and are mapped in a complex with one of the Litz soils. The Upshur soils are characterized by their purple color. They are developed from material that is residual from the weathering of reddish-purple to Indian-red shales. These shales are generally slightly calcareous; although they are commonly acid near the surface, and in a few places they contain beds of sandstone. The soils classified as Upshur in this county occupy steep areas and are shallow.

Most of the soils of this group, except the Sequoia soils, are physically very poorly suited or wholly unsuited for the production of crops requiring tillage, and even the Sequoia soils are not especially well suited to such use. The Litz and Armuchee soils occupy hilly or steep areas and are shallow and highly erodible; therefore they are physically better suited to pasture than to crops, although some are unsuitable even for pasture. The greater part of the land is cleared and used principally for pasture, a considerable part is used for crops, and a large part is idle. These soils constitute 10.7 percent of the area of the county.

SEQUOIA SERIES

The Sequoia soils have developed from material that is residual from the weathering of interbedded shale and limestone. The shale is generally acid, at least in the upper part. Although the parent rock is similar to that underlying the related Armuchee soils, the Sequoia soils differ from the Armuchee in having a gentle slope, well-developed surface soil and subsoil layers, and a greater depth to bedrock. In some characteristics of the subsoil the Sequoia soils resemble the Talbott soils, which are developed over clayey limestone, and the Needmore soils, which are developed over calcareous shale, as all have a heavy slowly permeable subsoil. The Sequoia soils are acid in reaction, rather low in organic matter, and medium to low in productivity of general farm crops. Surface drainage is good. Internal drainage is retarded by the compact subsoil but is adequate for the common crops grown in the county.

Practically all of the areas of the Sequoia soils in this county have been used for crops and have become more or less eroded. Only Sequoia silty clay loam, eroded phase, is mapped.

Sequoia silty clay loam, eroded phase.—This soil is similar to the eroded rolling phase of Needmore silty clay loam and the eroded phase of Talbott silty clay loam in being moderate to rather low in productivity of general farm crops, in being rather heavy to work, in having a very fine textured subsoil, and in having an undulating to gently rolling relief. It is readily differentiated from these soils, however, by the parent rocks. The parent rocks of Sequoia soil are

similar to those of the Armuchee soils; but the Sequoia soil is readily differentiated from the Armuchee soils by a gentler slope (from 5 to 12 percent), well-defined surface soil and subsoil layers, and a greater depth over the parent rock.

A part of the original surface soil has been lost by accelerated erosion. In most places the topmost part of the original subsoil has been mixed with the remaining surface layer in plowing, and the surface soil now consists of brownish-gray to grayish-yellow fairly friable silty clay loam, ranging in thickness from about 4 to 7 inches. The subsoil consists of yellowish-red to reddish-yellow compact tough moderately plastic silty clay, from about 12 to 15 inches thick. The structure is blocky, and the soil aggregates range from about $\frac{1}{2}$ to 1 inch in diameter. Below the subsoil the substratum is similarly compact, although it is generally less compact and less plastic. It is highly splotched with yellow and gray and contains a few "rotten" fragments of yellow and olive-green shale. The substratum extends to bedrock, which generally lies at a depth of 2 to 4 feet but in those areas associated with the Dandridge soil at a depth of 4 to 10 feet. The reaction is acid, and the supply of organic matter is comparatively low.

Bedrock generally consists of interbedded shale and limestone. The shale is generally acid, at least in the upper part, as the calcareous material has been leached out of the upper 1 or 2 feet in most places. In some places, however, the shale is calcareous; in other places bedrock consists of interbedded acid and calcareous shales and little or no limestone; in still other places, chiefly in association with the Litz soils in the northwestern part of the county, bedrock is predominantly acid shale and contains only a small amount of limestone.

Several variations, not only in the parent rock but also in the soil itself, are included in this separation as mapped. In the vicinity of Witt about 50 acres of this soil is more gentle in slope and less eroded than elsewhere; here the surface layer is about 8 inches deep and more friable. Included also are areas, totaling about 80 acres, that have lost nearly all of the original surface soil by erosion, even though the slope is gentle. In some places the subsoil of the included soils is yellow, and in a few places it is light red.

Sequoia silty clay loam, eroded phase, has a total area of 1,344 acres. It occurs on gently sloping areas in association with the Armuchee, Litz, and Dandridge soils and the miscellaneous land types characterized by limestone outcrops. Some of the larger areas are south of Witt, southwest of Whitesburg, and south of Morristown.

Nearly all of the land is cleared and is used for the production of the common field crops, but a few areas are idle. In general the management of this soil is similar to that of other soils in gently rolling areas. Commonly reported acre yields for the main crops grown are as follows: Corn, 20 to 25 bushels; wheat, 12 bushels; alfalfa, 2 to 3 tons; and other hay crops, about 1 ton. Tobacco is reported to yield between 700 and 900 pounds. Because of the compactness of the subsoil, crops on this soil are affected by adverse moisture conditions, especially drought; therefore yields fluctuate greatly, more than is indicated by the ranges given.

In management this soil requires much the same treatment as the eroded phase of Talbott silty clay loam, which it resembles in having

a very fine textured subsoil. The requirements for management of the severely eroded variation included with this soil are similar to those of the severely eroded phase of Talbott silty clay loam.

ARMUCHEE SERIES

Like the Sequoia soil, the Armuchee soils have developed from material that is residual from the weathering of interbedded shales and limestones. They differ from the Sequoia soil, however, in having a steeper slope and poorly developed surface soil and subsoil layers and in slighter depth over bedrock. Furthermore, in general they are poorly suited physically to the production of crops requiring tillage, although they are fairly well suited to the production of pasture. They are similar to the Dandridge soils and Litz soils in slope and depth, although on the whole they are slightly deeper than those soils. They are separated from the Dandridge and Litz soils largely on the basis of differences in parent rocks. The Armuchee soils are developed from interbedded shale and limestone with limestone probably constituting between 30 and 60 percent of the beds, whereas the Litz soils are developed from interbedded shale and limestone with limestone constituting only a small part of the beds. The Dandridge soils have developed from weathered calcareous shale material.

As mapped in this county, the Armuchee soils are from about 6 to 24 inches thick over shale and consist of moderately friable silty clay loam that is predominantly reddish yellow but ranges from yellowish red to brownish gray. The reaction is everywhere acid, and the calcareous material has been leached out of the upper part of the parent rock in many places. Limestone generally lies at a depth between 2 and 3 feet, but in some places both limestone and shale outcrop. The Armuchee soils occupy predominantly hilly areas and are highly susceptible to erosion when bare. Nearly all of these soils have been cleared and cultivated at some time, and practically all of the cleared areas are more or less eroded. The soils are rather poorly suited to cultivation but are fairly well suited to pasture.

The Armuchee soils, which total 1,536 acres in this county, are classified in two phases, namely, Armuchee silty clay loam, eroded phase, and Armuchee silty clay loam, severely eroded phase.

Armuchee silty clay loam, eroded phase.—This soil is related to Sequoia silty clay loam, eroded phase, but it occupies more sloping areas, has poorly developed surface soil and subsoil layers, is shallower over bedrock, and is considerably less suitable for cultivation. Both soils, however, are developed from material that is residual from the weathering of interbedded shales and limestones. In slope, erosion, and depth it is similar to the eroded hilly phase of Litz shaly silt loam and the eroded phase of Dandridge shaly silty clay loam, although its average depth is slightly greater than that of either of these soils. It is differentiated from these soils chiefly on the basis of the character of the parent rocks, although other differences exist. The parent rocks of this Armuchee soil consist of interbedded limestones and shales in which limestones constitute about 30 to 60 percent of the formation; whereas those of the Litz soils consist of interbedded shales and limestones in which limestones constitute but a very small proportion; and those of the Dandridge soils consist of calcareous shales.

Nearly all of the land has been cleared and cultivated, and in most places it has lost a few inches of surface soil material through erosion. Although the soil is thought to have had originally no well-developed surface soil and subsoil layers, cultivation and erosion have tended to obliterate whatever differences formerly existed between these layers. In most places this soil consists of reddish-yellow moderately friable silty clay loam extending to bedrock, which generally lies at a depth of between 6 and 24 inches. In places where the surface soil and subsoil layers are discernible the surface soil is brownish-gray friable silt loam and the subsoil reddish-yellow to yellowish-red firm silty clay. Fragments of shale are distributed throughout the soil mass in most places. In many places the limestone has been leached out of the upper 1 to 2 feet of the underlying rocks, but in other places it outcrops with the shale.

An area of 1,152 acres of this soil is mapped, and in typical areas it occupies cordons of symmetrical hills. It is associated with the Sequoia, Litz, and Dandridge soils and with the miscellaneous land types characterized by limestone outcrops. Some of the larger areas are southwest of Morristown, south of Witt, and west of Whitesburg.

Nearly all of the land is cleared and is used chiefly for pasture and the production of crops. Nevertheless, it is not well suited to the production of crops, especially row crops, because it is too highly susceptible to erosion; furthermore, it is so steep that the slope alone impairs tillage, and the soil is so shallow that crops are highly sensitive to adverse moisture conditions, especially drought. On the other hand, it is well suited to pasture, and good pastures can be established and maintained with relative ease. Phosphate and a little lime are ordinarily required for pastures.

Armuchee silty clay loam, severely eroded phase.—As the phase designation implies, this soil is more eroded than Armuchee silty clay loam, eroded phase, and the condition of erosion is the chief difference between the two soils. Considerably more of the soil material has been lost, practically none of the thin layer of original surface soil remains, and the heavy reddish-yellow to yellowish-red soil material is exposed over the greater part of the surface. This material is shaly in many places, and shallow outcrops of shale and, in some places, of limestone and shale together are rather common. Gullies between 1 and 2 feet deep occur in some areas. The depth of the silty clay loam or silty clay soil material ranges from about 1 to 15 inches. The gradient ranges from about 12 to 25 percent.

This soil has a total area of 384 acres. It occurs in the same general localities as the other Armuchee soil. In some places the soil is also associated with the Sequoia, Litz, and Dandridge soils and with the stony land types.

All the land has been cleared. Much of the cleared land is idle; a large part is used for pasture, which is generally low in quality; and a very small proportion is used occasionally for crops, the yields of which are generally very low.

Owing chiefly to its severely eroded condition, this soil is physically less suited to crops and to pasture than the other Armuchee soil, and in its present condition it is probably better suited to for-

estry than to pasture in many places. Indications are, however, that fairly good pastures can be established and maintained. Phosphate and lime are generally required, drought-resistant plants need to be selected, and certain engineering measures, such as check dams or diversion ditches, may be necessary for the successful establishment of pastures.

LITZ SERIES

The Litz soils are shallow and shaly and occupy predominantly hilly and steep areas (pl. 10, *A*). They are developed from soft decomposed acid shale of a shale formation that contains widely spaced beds of limestone. They resemble the Armuchee and the Dandridge soils, but they can be easily distinguished by the character of the parent rocks, as those under the Armuchee soils contain much more limestone and those under the Dandridge soils consist of calcareous shales.

The Litz soils range from about 3 to 16 inches in depth to shale. In most places well-defined surface soil and subsoil layers have not developed and the soil material from the surface to the underlying rock consists of grayish-yellow to yellowish-brown moderately friable silt loam to silty clay loam. Shale fragments are numerous throughout. In woods and in old pastures the topmost 1 or 2 inches is stained dark by organic matter. The soils are acid in reaction. Between 25 and 40 percent of the land is woodland, much of which was cleared at one time. Because they are highly susceptible to erosion and have a low water-holding capacity, these soils in most places are physically unsuitable for the production of crops under ordinary management and in many places they are also unsuitable for pasture.

Included with this group are two complexes of soils consisting of Litz soil and one or more other soils. These separations are (1) Litz-Holston complex and (2) Upshur-Litz silt loams. The Holston soils are developed from old stream-deposited material and are characterized by a gray surface soil and a yellow subsoil. The Upshur soils have developed from residual material of weathered slightly calcareous reddish-purple to Indian-red shales and are characterized by a purple color, shallowness, and steep slope.

The Litz soils occur mainly in a discontinuous belt lying along the Holston River, although they also occur in other parts of the county. They are classified and mapped into four phases and the two complexes mentioned above, making a total of six separations, as follows: Litz shaly silt loam, eroded phase; Litz shaly silty clay loam, severely eroded phase; Litz shaly silt loam, eroded hilly phase; Litz shaly silt loam, eroded rolling phase; Litz-Holston complex; and Upshur-Litz silt loams.

Litz shaly silt loam, eroded phase.—This is a shaly and shallow soil of steep areas. It is physically unsuitable for the ordinary production of crops and is poorly suited to pasture. It is similar in slope and degree of erosion to the eroded steep phase of Dandridge shaly silty clay loam, from which it is readily distinguished by the difference in parent rocks. The Dandridge soils are developed from weathered material of calcareous shales, whereas the Litz soils are developed from weathered material of acid shales that contain widely spaced thin beds of limestone or, in some places, calcareous shale. The gradient ranges from about 25 to 60 percent.

In most places this soil consists of grayish-yellow to yellowish-brown moderately friable silt loam to silty clay loam, which rests on soft grayish-yellow shale from 4 to 10 inches below the surface. Fragments of shale are numerous on the surface and in the soil material. In the wooded areas and in well-established pastures the topmost 1 or 2 inches of the material is stained dark with organic matter. The soil and also the shale are generally acid.

This is the most extensive soil of the Litz series. An area of 3,904 acres is mapped, mainly in a discontinuous belt of highly dissected land near the Holston River, and a number of areas lie south of Morristown. The soil generally occurs on the steep slopes of cordons of sharply pointed, symmetrical hills or knobs. It is associated chiefly with the other Litz soils, but it is also associated in places with rough stony land (Talbot soil material) and the Armuchee and Sequoia soils.

About 40 percent of this land is in forest, but apparently much of this was cleared at one time or another and was subsequently allowed to revert to forest, probably after becoming eroded. Much of the cleared land is idle, and much is used for pasture. Physically, this soil is considered to be best adapted to forestry, although its use for pasture may be feasible under certain conditions. Because of steep slope, excessive external drainage, extremely high susceptibility to erosion, and high acidity in most places, it is unsuitable for the production of crops requiring tillage. For these same reasons it is poorly suited to pasture, but if lime and phosphate are applied fairly good pastures can possibly be established and maintained. Contour subsoiling would also be expected to aid materially in establishing and maintaining pastures, and drought-resistant plants would need to be selected. As moisture conditions generally appear to be more favorable, and as the soil material is generally somewhat darker, the probability of successfully establishing and maintaining good pastures is better on the northeast- and east-facing slopes than on the southwest- and west-facing slopes.

Litz shaly silty clay loam, severely eroded phase.—This soil differs from the eroded phase of Litz shaly silt loam chiefly in being more eroded and in having a wider range in slope (from about 12 to 60 percent). Probably somewhat less than half of the total area has a slope of 12 to 25 percent. The depth of the soil material ranges from about 1 to 6 inches, and it consists of grayish-yellow to yellowish-brown moderately friable silty clay loam that is generally very shaly. Gullies between 1 and 2 feet deep are common in the soil.

A total of 2,496 acres of this severely eroded soil is mapped, all in association with the Litz soil just discussed.

Most of the land is idle, although some is reverting to woodland and supports a stand of young pine. Some of the soil is used for pasture, and only a few acres are used for crops.

Like the less eroded soil, this soil is considered to be physically best suited to forestry. On the gentler slopes, however, there is a possibility that moderately good pastures can be established and maintained, provided both lime and phosphate are applied and drought-resistant plants are selected. As the shale is soft, subsoiling to a depth between 12 and 18 inches may be feasible and beneficial on the

gentler slopes. In a few areas where the shale has been broken to a depth of 8 inches or more, crops have been grown with moderate success, but the use of this soil for crops, even where the shale has been broken to considerable depth, is not encouraged.

Litz shaly silt loam, eroded hilly phase.—This soil differs from the eroded phase of Litz shaly silt loam chiefly in having a gentler slope (from about 12 to 25 percent). The soil material, consisting of grayish-yellow to yellowish-brown moderately friable silt loam to silty clay loam, ranges from about 4 to 8 inches in thickness, but in some places it is as thick as 15 inches. This greater thickness is generally near the boundary between this soil and hilly or rough stony land (Talbot soil material) or in places where the parent shale originally contained a bed of limestone that was thicker than elsewhere. Fragments of shale are numerous throughout the soil material.

This soil, which comprises a total area of 1,344 acres, occurs in the same general localities as the eroded phase of Litz shaly silt loam. From 15 to 20 percent of the land is in forest, but much of this forested land appears to have been cleared land at one time. Much of the cleared area is idle, much is used for pasture, and some is used for the common field crops. Crop yields are generally low, although moderately high yields are occasionally obtained when the distribution of rainfall is unusually good.

Because of the gentler slope, this soil is somewhat better suited to agriculture than the severely eroded Litz soil, although it is not well suited to such use. Nevertheless, the slope is rather steep and the soil is shallow and highly susceptible to erosion; therefore the soil is physically very poorly suited to the production of tilled crops (pl. 10, *B*). A few fairly good pastures have been established by treating the soil with lime and phosphate, which indicates that under good management, including especially the use of phosphate and lime, moderately good pastures can be established and maintained. Deep subsoiling on the contour would break up the shale, thereby increasing the water-holding capacity, reducing the amount of runoff, and making the penetration of roots easier. If crops must be grown on this soil, the rotation should be long and the growing of row crops should be avoided if possible. Small grains, legumes, and grasses might do fairly well, but high yields would not be expected. There is some evidence that alfalfa can be grown with moderate success with the use of lime and phosphate, which are also necessary for most other legumes. Cultivation, of course, should be on the contour, and the soil should not be allowed to lie bare for extended periods.

Litz shaly silt loam, eroded rolling phase.—As compared with other members of the Litz series, this soil has the most gentle slope—from about 5 to 12 percent. Like the other members of the series, however, it is shallow and shaly, even though generally it is slightly deeper than the others. In most places the soil consists of grayish-yellow to yellowish-brown moderately friable silt loam to silty clay loam extending to the bedrock shale, which generally lies at a depth of 5 to 12 inches. In some places, however, the soil material is as much as 16 inches thick. A variation included with mapped areas of this soil consists of a soil that grades toward the Sequoia soil, having a

brownish-gray surface soil and a reddish-yellow subsoil extending to a depth of as much as 20 inches in some places.

This shaly Litz soil is chiefly associated with the other Litz soils and in places with the Sequoia and Armuchee soils and rolling and hilly stony land (Talbot soil material). It is also associated with the Leadvale soils in some areas. A total area of 704 acres is mapped, mostly in the belt of the Litz soils lying near the Holston River and in the areas of the Litz and Armuchee soils south of Morristown.

Practically all of the land is cleared and has been used for the production of crops (pl. 10, *B*). At present the greater part is used for crops, much is used for pasture, and a large part is idle land. It is a rather common practice in some places to let this soil lie idle or "rest" periodically, during which time it generally becomes covered with broomsedge, weeds, and some briars and bushes. Ordinarily yields of crops are low, a fact that partly accounts for some of this land being idle; but occasionally when the rainfall is well distributed yields are moderately high. Corn yields about 20 bushels an acre and wheat about 10 bushels, although the yields are considerably higher in some years and lower in others.

If this soil is used for crops, the requirements for management are similar to those of the eroded rolling phase of Dandridge shaly silty clay loam except for at least one important difference. The Dandridge soil is naturally well supplied with lime, whereas this Litz soil in most places is poorly supplied with it. Both soils are shaly and shallow and occupy gently rolling areas; therefore both have a low water-holding capacity, which is undoubtedly one of the important factors limiting the growth of plants. Deep contour subsoiling should be highly beneficial to both soils, chiefly by increasing the water-holding capacity. This practice also lessens runoff, retards erosion, and enables the roots of most plants to penetrate more deeply. Both soils need phosphate, but it is somewhat doubtful whether they need much potash. The Litz soil, of course, needs lime. The crop rotations should be rather long and should include chiefly close-growing crops, especially grasses and legumes. Row crops should be grown sparingly in most places. Cultivation needs to be on the contour and needs to be deep, especially where the soil has not been subsoiled, in order to break up the bedrock shale to as great a depth as possible. Under similar soil management grasses and legumes may not do so well on this Litz soil as on the Dandridge soil, but they can, nevertheless, be grown with moderate success. There is a little evidence that even alfalfa can be grown with moderate success if enough lime and phosphate are applied. Deep-rooted crops, such as alfalfa and sweetclover, should improve the productivity of this soil for other crops. Under use for pasture the requirements for management are similar to those of the eroded hilly phase of Litz shaly silt loam.

Litz-Holston complex.—This separation includes areas of the Litz and Holston soils so intricately associated that it is impracticable to separate them. The predominant gradient ranges between 12 and 25 percent, and the soils are nearly everywhere moderately eroded.

The Litz soils in the complex consist mostly of the eroded hilly phase of Litz shaly silt loam, which is grayish-yellow to yellowish-brown moderately friable silt loam to silty clay loam, resting on bedrock at a depth of 4 to 15 inches. Bedrock consists of acid shale con-

taining a few thin widely spaced layers of limestone. Small areas of the other Litz soils are included as well.

The Holston soils in this complex are shallower than the typical Holston soils and occupy predominantly steeper areas. They have developed from old stream-deposited material, most of which is thought to have come from the uplands underlain by sandstone and shale. Where uneroded, the Holston soils in this complex have a yellowish-gray to light-gray loose very fine sandy loam surface layer about 10 inches thick. The subsoil is yellow firm but friable very fine sandy clay, ranging from about 10 to 20 inches in thickness. Nearly everywhere this subsoil layer rests on shale or on fine-textured material derived from weathered shale. A few sandstone cobbles are scattered over the surface and mixed with the soil material. The thickness of the Holstonlike soil material ranges from about an inch at the boundaries between the Holston and Litz soils to 4 feet in the deepest places. The Holston soils in this complex are severely leached, strongly to very strongly acid, low in fertility and organic matter, and eroded in most places.

Included in this complex as mapped are areas in which the Dandridge instead of the Litz soils are intricately associated with the Holston soils. The main Dandridge soil is the eroded rolling phase of Dandridge shaly silty clay loam. Included also are a few areas of a severely eroded Dandridge soil.

Generally, the Holston soils occur on mildly sloping remnants of high terraces and the Litz soils and Dandridge soils on the steeper slopes facing drains. A total area of 448 acres is mapped. The largest bodies are along the Holston and Nolichucky Rivers, but some areas are along Bent Creek. It is along Nolichucky River and Bent Creek that the areas including the Dandridge soils are mapped. In places the Waynesboro and Monongahela soils, rather than the Litz and Dandridge, are associates of this soil complex.

Practically all of the areas have been cleared and have been used for the production of crops and for pasture. This soil complex is considered to be physically better suited to pasture than to field crops, largely because of high susceptibility to erosion and rather low productivity. Applications of lime and phosphate will ordinarily be necessary on the Holston and Litz soils, but lime should not be necessary on the included Dandridge soils, as the underlying parent rock is calcareous and near the surface.

Upshur-Litz silt loams.—This soil complex consists of two soils, Upshur silt loam and Litz silt loam, so intricately associated that it is impracticable to separate them on a map of the scale used. The Upshur soil is chiefly purple and the Litz soil is chiefly yellow. Bare fields of these closely associated soils present an intricate color pattern of purple and yellow. In most of the areas the gradient ranges between 25 and 60 percent.

Upshur silt loam, which is the more extensive of the two soils, has developed from reddish-purple to Indian-red slightly calcareous shale and shaly sandstone. In most places purplish-gray to grayish-purple friable silt loam rests on leached shale at a depth of 8 to 14 inches. In woods the topmost 1 or 2 inches is stained dark with organic matter derived from decayed leaves and twigs. Nearly

everywhere lime has been leached from the soil and the upper part of the bedrock shale, but below a depth of 2 or 3 feet the bedrock is generally slightly calcareous. In most places widely spaced beds of sandstone are present in the shale beds.

Litz silt loam is similar to the other Litz soils in the county, but it is slightly deeper and less shaly and has developed from weathered material of a shale that is apparently slightly coarser in texture than the parent rock of the other Litz soils. The layers of limestone are few and far apart, and some of the shale is calcareous below a depth of 2 or 3 feet. The soil material consists of grayish-yellow to brownish-yellow friable silt loam resting on bedrock shale at a depth of 8 to 15 inches.

Considerable variation exists in this soil complex as mapped. In many places the underlying shales outcrop, and in a few places the outcrops are calcareous. The most conspicuous variation, however, generally occurs on the very top of the ridge on which the complex is mapped and consists of areas in which yellow, gray, and white sandstone boulders and outcrops of sandstone bedrock are common. In these areas the soils are nearly everywhere lighter in color and in texture than elsewhere. In some places fragments of sandstone have rolled from steep slopes nearby and are thinly scattered over the surface of the more nearly typical Litz and Upshur soils of this complex.

Upshur-Litz silt loams comprise only 320 acres, all in the southeastern corner of the county. This soil complex is mapped on the ridge that includes a part of Bays Mountains.

About 60 percent of the land is in forest, which is considered the use to which it is physically best adapted. It is also physically suited to pasture, and its use for pasture is feasible on the lower slopes, most of which is cleared. Most of the cleared areas are used for pasture; many are lying idle; and a few are used for crops, gardens, and home orchards. The soils in this complex occupy too steep areas in most places and are too highly erodible for the feasible production of crops.

SOILS DEVELOPED OVER INTERBEDDED SHALES AND SANDSTONES

The soils developed over interbedded shales and sandstones are of small total extent, hence they are of very little importance in the agriculture of the county. The soils developed over these rocks were classified into one series—the Lebew.

LEHEW SERIES

Like the Upshur soils, the Lebew soils are conspicuous because of the purple color of the soil and parent rock. The soils of both series occupy steep areas and are shallow; but ordinarily they can be readily distinguished by their parent rocks, as those of the Upshur are predominantly slightly calcareous shales and those of the Lebew are predominantly interbedded acid shales and sandstones. The Lebew soils are also generally coarser textured and less productive. The Lebew soils, which occur only in the northeastern corner of the county, are inextensive and not very important in the agriculture of the county. Only one type is mapped—Lebew very fine sandy loam.

Lebew very fine sandy loam.—This is a sandy, shallow, acid soil of steep areas, mapped only in the extreme northeastern corner of the county, where it comprises 384 acres. It has developed from material

weathered from interbedded shale and sandstone, both of which differ in color from layer to layer. Light grayish purple and light reddish purple are the most common colors; but gray, brown, and yellow are conspicuous in places. In general the color varies according to the color of the outcropping rocks, but in most places the soil has a noticeable purplish cast. The soil material of loose very fine sandy loam ranges from about 8 to 14 inches in depth over bedrock. It contains small fragments of sandstone and shale. Outcrops of sandstone bedrock are common. The slope is generally steep, and its predominant range is between 40 and 70 percent.

Nearly all of the land is in forest, and forestry is considered to be the use to which the soil is physically best adapted. The soil is very poorly suited to pasture and wholly unsuitable for ordinary production of crops because of several unfavorable conditions, including steepness, shallowness, presence of bedrock outcrops, strong to very strong acidity, low fertility, and high susceptibility to erosion.

MISCELLANEOUS LAND TYPES

As explained elsewhere in this report, in mapping it is necessary to recognize in some places certain physical land conditions or miscellaneous land types. Six of these classifications are mapped in this county, as follows: Rough gullied land (limestone residuum); rough gullied land (Litz soil material); rolling stony land (Talbot soil material); hilly stony land (Talbot soil material); rough stony land (Talbot soil material); and limestone outcrop. Limestone outcrops characterize four of these types, comprising 10,432 acres, and gullies characterize two, comprising 1,024 acres.

Rough gullied land (limestone residuum).—This land type includes badly gullied areas that originally were covered by one of the soils developed from limestone residuum, such as the Fullerton, Dewey, Decatur, or Talbot. This land has been mutilated or practically destroyed by erosion, being reduced to an intricate pattern of gullies in which little or no trace of the former soil layers remain. The silty clay parent material of the soils is nearly everywhere exposed. This material is light red, and the color, in addition to the gullies themselves, make these areas conspicuous, even though most of them are small. The parent material generally contains numerous splotches of yellow and gray, but in a few places it is predominantly gray. When wet it is generally sticky and plastic, and when dry it is hard, cloddy, and full of cracks. Outcrops of limestone are common in some of the places, but the soil material is several feet in thickness over bedrock in most places. The gradient ranges from about 10 to 35 percent, but in some areas it is gentler and in some steeper.

Only 320 acres of this land is mapped. Most of it occurs in small but conspicuous areas throughout the middle two-thirds of the county. It is associated with the Fullerton, Dewey, Decatur, and Talbot soils.

At one time this land was productive, but when cleared and cultivated it was allowed to erode to the extent that it was practically destroyed. As a result the land has been abandoned to nearly worthless pasture and is practically idle, or it has been allowed to grow up to pines and, to a less extent, other trees.

In its present condition this land cannot be profitably reclaimed by the owner except through the slow process of reforestation.

Shortleaf pine, which tends to establish itself by natural reproduction, or black locust, which has to be planted, are the most useful trees with which to reforest the land for this purpose. In a few places reclamation has been attempted by planting especially vigorous plants, such as Bermuda grass or sericea lespedeza, and has met with varying success. Kudzu also might be worth trying. Check dams are generally needed in these areas, and certain other engineering measures may be necessary in order to stabilize the soil and establish a vegetative cover.

Rough gullied land (Litz soil material).—Like the land just described, this land is dissected by an intricate pattern of gullies, but it differs from that land in that the exposed material is shaly and is similar to that from which the Litz soils are developed. Small but conspicuous areas are mapped chiefly in association with those soils (pl. 10, *C*). The gullies, which cover between 40 and 100 percent of the surface, range between 2 and 10 feet in depth, although most of them are from 3 to 5 feet deep. The soft yellow acid bedrock shale is exposed in most of the areas, and little soil material remains. The gradient ranges from about 10 to 40 percent. Most of this land is virtually idle, as it has been abandoned both for the production of crops and for pasture; and it supports a very sparse covering of weeds and briars. Pines are establishing themselves in some areas.

Under ordinary conditions it would seem to be unwise to attempt to reclaim this land for either pasture or cropland; it should be allowed to revert to woodland, and thereafter should be maintained in woodland, if that is reasonably possible. As the shale is generally acid, pine would be expected to succeed better than black locust.

Included with this separation is an important variation, totaling about 150 acres, in the areas of which calcareous shales rather than acid shales are exposed. Also the gullies are usually less than 3 feet deep. This variation is easy to identify because practically all of it is associated with the Dandridge soils instead of the Litz soils. Because the shale is calcareous, black locust would be expected to succeed much better on areas of this variation.

Rough gullied land (Litz soil material) has a total area of 704 acres. Except for the variation described, which occurs in association with the Dandridge soils along the southeastern boundary of the county, nearly all of the areas of this land are associated with areas of the Litz soils along the Holston River.

Rolling stony land (Talbot soil material).—This land is commonly referred to as rock land, limestone rock land, and glady land. In most places from 10 to 50 percent of it consists of outcrops of limestone. Although it varies greatly from place to place, the soil material filling the spaces between the outcrops in most areas is similar to that of the Talbot soils, ranging in texture from silt loam to silty clay and in depth to rock from a few inches to several feet. The color ranges from red to brown and yellow. The consistence is generally heavy but ranges from tough, sticky, and plastic to moderately friable. The underlying rock strata have a nearly horizontal to nearly vertical dip, but a dip of about 45 percent is thought to predominate. Where the dip is great, the rock outcrops tend to protrude farther and the soil material between them tends to be deeper; and where the dip is slight the outcrops are generally low and the soil

material between them is shallow. The land is prevailingly undulating to rolling, having a gradient of 5 to 15 percent. Most of the surface water drains into the numerous sinkholes and thence into underground channels.

Several variations are mapped with this miscellaneous type, of which the most prominent consists of areas where the soil material between the outcrops has a grayish-brown 6- to 8-inch surface layer and a yellow waxy silty clay or clay subsoil. This variation is sometimes referred to locally as waxy land. It occurs chiefly in association with the gravelly Dandridge soils. Other variations consist of areas in which the soil material between the outcrops is similar to the Fullerton, Dewey, and Decatur soils and areas that have undergone considerable accelerated erosion.

This land type has a total area of 2,560 acres. Rather large areas occur along the Holston River in association with the Talbott and Litz soils, and also southwest of Morristown in association with the Talbott, Litz, and Armuchee soils. Many small areas are present in narrow belts in other stony land types and in areas of the Talbott soils that lie between the wide belts of soils overlying limestone on the one side and the soils overlying shale on the other. This type also occurs in similar belts in association with the gravelly Dandridge soils. Small isolated areas occur here and there in association with areas of the Fullerton, Dewey, and Decatur soils.

Most of this land is cleared and used for pasture (pl. 5, A), although a few areas are still in woods. Redcedar is generally conspicuous in the wooded areas and tends to predominate on the waxy land variation. The pastures vary considerably in carrying capacity.

Stoniness precludes use of this land for cultivating crops, but the land is reported to produce the earliest spring pasture in the county. Bluegrass does well and is at its best in spring, early summer, and late fall but is scant in midsummer and early fall. Lime is necessary for good growth of grass in many areas, and phosphate would improve the growth nearly everywhere. The rocky surface, which does not allow the use of mowing machines for cutting the weeds, is a real handicap in using the land for pasture.

Hilly stony land (Talbott soil material).—This land differs from that just described chiefly in having a steeper slope (from 12 to 25 percent) and in being generally less productive of pasturage. The soil material between the rocks of the two lands is similar, but more of the original surface soil in the hilly stony land has been lost by erosion. Variations similar except in slope to those included in the rolling land are mapped, together with an additional one consisting of areas in which the soil material between the outcrops is shaly, resembling the material composing the Litz soils. This variation, which is associated with the Litz soils, is considerably less productive than the typical land.

A total area of 5,632 acres is mapped, mainly in a discontinuous belt along the Holston River and in the vicinity southwest of Morristown. Smaller areas are distributed here and there over the middle two-thirds of the county. The associations of this separation are similar to those of rolling stony land (Talbott soil material), and, like that land, it is locally referred to as rock land or limestone rock land.

Most of this hilly stony land is cleared and used for pasture, but some of it is in woods in which redcedar trees are generally conspicuous. Chiefly because of the steeper slope, this land is generally somewhat inferior to the rolling stony land for pastures and is likewise unsuitable for feasible tillage. It varies considerably, however, in the quality of the pasturage it affords.

Rough stony land (Talbot soil material):—This land has many characteristics in common with the hilly stony land just described, but there are important differences. The slope is significantly steeper, ranging from 25 to as much as 70 percent. None of the waxy land variation is included, and sinkholes are not characteristic. Furthermore, the soil material between the outcrops is predominantly shaly, resembling the Litz soils, though in some places it is like the soil material of the Talbot series. In contrast with the previously discussed stony lands, which occur in low-lying areas relative to the associated soils, much of this rough stony land occurs on or near the crests of hills and ridges.

About 1,728 acres of this land is mapped, mostly in association with the Litz soils in the belt of those soils extending along the Holston River. Nearly all of this rough land is in forest, the stand of which is only fair. Nevertheless, use of the land is limited physically to forestry under present conditions, as the land is definitely unsuitable for pasture.

Limestone outcrop.—This designation is given to areas in which outcrops of limestone predominate. Exposures of limestone are estimated to occupy from about 50 to 100 percent of the land surface. Most of the areas consist of bluffs along the Holston River, although other areas occur here and there throughout those parts of the county that are underlain by limestone. The slope is very steep, precipitous in some places and less steep in a few places. Included with limestone outcrop is an area in the extreme northeastern part of the county in which the rock outcrops consist of interbedded sandstone and shale. A total of 512 acres is mapped as limestone outcrop, including the variation, and practically all the land is nearly worthless for the growth of useful plants. Limestone outcrop is bare in many places, but it supports a sparse and scrubby stand of trees in most places.

SOILS OF THE COLLUVIAL LANDS

Soils of the so-called colluvial lands might be more properly designated as local alluvium. In reality they represent a combination of local alluvium and colluvium, consisting of accumulations formed at the base of slopes, particularly the longer slopes on which erosion has been active. On these accumulations members of six soil series are mapped, namely, the Emory, Abernathy, Ooltewah, Greendale, Leadvale, and Whitesburg series. Members of the Emory, Abernathy, Ooltewah, and Greendale series are developed from material washed from soils overlying limestones, and members of the Leadvale and Whitesburg series are developed from material washed from soils overlying shales. Profile development in these soils has not reached an advanced stage, consequently the profiles vary considerably. The total area of the soils is small, and the individual bodies are characteristically small. Even though the bodies are small, the soils are very important on many farms because most of them are productive and physically well suited to crops.

SOILS DEVELOPED FROM MATERIAL DERIVED CHIEFLY FROM LIMESTONES

Soils of colluvial lands developed from material derived chiefly from limestones are members of the Emory, Abernathy, Ooltewah, and Greendale series. Both the Emory and Abernathy soils are brown, friable, and well drained; but the Emory soils occupy gentle slopes having good surface drainage, whereas the Abernathy soils occupy depressions having little or no surface drainage. These soils occur chiefly in association with the Dewey, Bolton, Decatur, and Talbott soils and with Fullerton silt loam and are developed from material washed from those soils. Like the Abernathy soils, the Ooltewah soils occur in depressions and differ from the Abernathy soils chiefly in being imperfectly drained. The Greendale and Emory soils occupy similar positions, but the Greendale are chiefly yellow instead of brown and are associated mainly with the cherty Clarksville and Fullerton soils, from which their material has been washed.

EMORY SERIES

The Emory soils are brown, mellow, and well drained and occupy foot slopes where the gradient is enough for good surface drainage. They show very little consistent development of well-defined surface soil and subsoil layers and are predominantly brown to a depth of 3 to 4 feet. They are developed chiefly from materials washed from the associated Decatur, Dewey, Bolton, Fullerton, and Talbott soils, and they vary somewhat from place to place according to the character of the soils of the uplands from which the parent materials were washed. They are highly productive and physically very well suited to the growing of crops. Only one member of the series—Emory silt loam—is mapped in this county. Its total area is 2,240 acres.

Emory silt loam.—This is a brown, well-drained, highly productive soil. Occurring in small areas at the foot of slopes occupied by the Decatur, Dewey, Bolton, Fullerton, and Talbott soils, it has developed from material washed from those soils (pl. 11, A). The soil is young, and no well-defined surface soil and subsoil layers have developed. It is predominantly brown to a depth of 3 to 4 feet. In many places, however, it has a surface soil, extending to a depth of 15 to 24 inches, of dark-brown to reddish-brown friable silt loam, and a subsoil layer, extending to a depth of 35 to 50 inches, of reddish-brown to yellowish-brown friable silt loam to silty clay loam. A few yellow splotches are generally present in the lower part, and the underlying material is generally highly splotched with gray and yellow.

As mapped in this county, Emory silt loam varies somewhat from place to place, its character depending largely on the kind of soil from which the parent material was washed. In association with the Decatur soils it is redder than is typical; in association with the Bolton soils it contains more sand than is typical; and in association with the Fullerton soils it is yellowish brown in most places and brownish-yellow in some places, somewhat like the Greendale soils. Where associated with the Bolton and Fullerton soils, it is slightly less productive in most places than the typical soil.

Most areas of Emory silt loam are small, few containing more than 5 acres. The greater part of the soil occurs in a narrow belt in which the Dewey soils predominate and which extends approximately through

the middle of the county. Other areas of the soil are scattered over all those parts of the county underlain by limestone.

In most places the gradient ranges between 2 and 7 percent, but in some areas the slope is greater than 7 percent. Both surface drainage and internal drainage are good. The soil retains water well, and its moisture relations are very favorable for the growth of plants. Tilt is naturally good and is easy to maintain in a good condition. The soil is relatively high in fertility and is moderately well supplied with organic matter. Although generally acid, the reaction is not very acid. Erosion is not a problem in most places, and flooding does not occur. The productivity, workability, and conservability of this soil are all favorable. Physically, it is one of the best soils in the county for the crops commonly grown.

Nearly all of this soil is used for growing practically all of the crops common to the county. Yields are generally high. Corn commonly returns from 40 to 60 bushels an acre, and tobacco is reported to return as much as 2,000 pounds. In comparison, the yields of wheat are generally not so high, although yields of 20 to 25 bushels an acre are common. The yields of hay are relatively high.

This soil is easily managed, and its requirements for management are simple. Ordinarily, good yields of many crops can be obtained without fertilization or systematic rotation, but increased yields are to be expected from both of these practices. The rotation may be short, and for maximum production a corn-hay rotation is suggested, although many other rotations are suitable. Practically all of the hay crops common to the locality do well on this soil, although there is a little evidence indicating that alfalfa is somewhat better suited to soils such as Decatur silt loam and Dewey silt loam than to this soil. Lime and phosphate ordinarily should be applied to this soil for legumes and grasses. In general, protection is not necessary against either erosion or flooding. In a few places, however, some precaution needs to be taken to prevent erosion; and in other places, especially at the foot of rapidly eroding slopes, some precaution may be necessary to prevent excessive deposition of material washed from the slopes above. A light deposit of such material, however, is ordinarily beneficial to the soil.

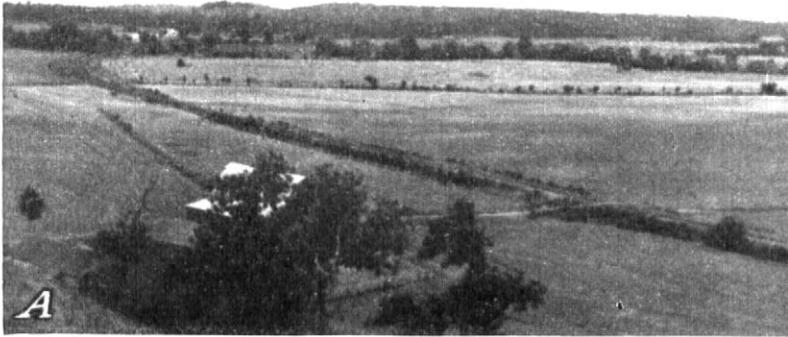
ABERNATHY SERIES

The Abernathy soils occur in depressions where there is little or no surface drainage. This is the chief difference between them and the Emory soils. Like the Emory soils, they have good internal drainage, are predominantly brown, are developed from material washed from soils of the sloping uplands overlying limestones, and are fertile and productive. Only one type, Abernathy silt loam, is mapped in this county.

Abernathy silt loam.—This is the brown, well-drained, highly productive soil that occurs in depressions or sinks. It has developed from material washed into these sinks from the surrounding soils, which in most places are the Dewey soils and Decatur soils but in some places are the Bolton, Fullerton, or Talbott soils. Like Emory silt loam, Abernathy silt loam is young, lacks well-defined surface soil and subsoil layers, and is predominantly brown and friable to a depth of at least 30 inches. In many places, however, it is reddish-brown



A, Emory silt loam (low area in the middle ground), developed from material washed from surrounding soils—Dandridge soils on hilly area (left) and Dewey and Fullerton soils on gently undulating to rolling area (right). Bays Mountains (Hawkins County) rise in the background. Fertile and productive, the Emory soil is suited to the intensive production of commonly grown crops, especially row crops. *B*, Winter wheat harvest on Monongahela very fine sandy loam. This soil is inherently low in fertility and strongly to very strongly acid in reaction. Small grains, especially wheat and rye, appear to succeed as well or better than most of the other crops, but alfalfa and tobacco are not adapted. Fertilization and liming are necessary if the soil is used for crops.



- A**, Visible boundary between soils—the dark-colored Whitesburg silt loam (foreground) and the light-colored Tyler silt loam (background). Ordinarily, soil boundaries are not so apparent. **B**, Good stand of red clover and grass on Whitesburg silt loam. This mixture, well suited to many soils, is one of the hay crops in the county. As this soil is well supplied with lime, it does not need lime for clovers and grasses as most of the other soils do. Phosphate, however, is generally required on all soils.

mellow silt loam to silty clay loam to a depth of 12 to 18 inches, below which the material is yellowish-brown to reddish-brown friable silt loam to silty clay loam. At a depth of 2 to 3 feet a very dark layer is reached in some places, which probably was the surface soil before the surrounding land was cleared. Yellow, brown, and gray splotches appear at a depth of 3 to 4 feet, and the deeper material is generally silty clay. Variations similar to those included with Emory silt loam are included with this soil.

By occupying depressions, this soil not only maintains its productivity but also receives new materials, highly important to plant growth, which are washed in from the surrounding areas of Decatur and Dewey soils. Such materials accumulate not only through the washing of organic and other solid matter but also through seepage, carrying materials in solution. Although this soil is not susceptible to erosion, it may be injured by an excess of materials washed in from deeply gullied and otherwise severely eroded slopes.

In its relation to agriculture, Abernathy silt loam is similar to Emory silt loam, but there is at least one important difference. Because it has no surface drainage, the Abernathy soil is sometimes flooded after heavy rains, and summer crops, sensitive to restricted drainage, are thereby occasionally injured. Also, the soil is not well suited to sensitive perennial crops, such as alfalfa, or sensitive biennials or winter annuals.

Abernathy silt loam occupies a total area of only 192 acres, mostly in association with the Dewey and the Decatur soils, although it is also associated with other soils overlying limestones. Many of the areas are too small to be put to a use different from that of the associated soils, but the areas large enough to receive individual attention are used largely for growing corn. Yields of 40 to 60 bushels of corn to the acre are commonly reported. Tobacco is grown on some areas, and although the yields are generally high, the quality is frequently rather poor.

OOLTEWAH SERIES

Like the Abernathy soils, the Ooltewah soils occupy limestone sinks and are developed from material washed into these sinks from the surrounding soil developed from limestone residuum. They differ from the Abernathy chiefly in being imperfectly drained, and they are readily differentiated in the field by the lighter colored and mottled subsoil. To a depth of 10 to 15 inches the Ooltewah soils consist of grayish-brown friable silt loam. Below this the material becomes highly mottled with gray and yellow, and it generally becomes heavier and less friable with increasing depth. Only one type, Ooltewah silt loam, is mapped in this county.

Ooltewah silt loam.—This soil differs from Abernathy silt loam chiefly in being inferior in drainage, and because of that difference it has a narrower range in adaptation. Like the Abernathy soil, this soil occurs in sinks and has developed from material recently washed into these sinks from the surrounding soils developed from limestone residuum, that is, from the Decatur, Dewey, Fullerton, Bolton, Clarksville, and Talbott soils. Considerable variation occurs in Ooltewah silt loam as mapped in this county, but in general it has a surface layer, from 10 to 15 inches thick, consisting of grayish-brown mellow silt

loam. Below this, gray and yellow mottlings appear and become more numerous with increasing depth, and the predominant color changes from light brown to gray. The texture generally becomes finer and the consistence less friable with increasing depth, and in some places a compact silty clay lies at a depth of 2 to 3 feet.

The soil is generally acid, but it ranges from neutral to strongly acid. It is considered relatively fertile. As it occurs in depressions with no surface outlets, it is subject to flooding after heavy rains. Included are a few very poorly drained areas, indicated on the map by wet-spot symbols.

Ooltewah silt loam aggregates only 128 acres. Small areas are distributed over the county in association with areas of soils developed from limestone residuum. As the areas are small, many of them are not given individual attention; instead they are treated in much the same way as surrounding areas of more extensive soils. Where they are given individual attention, they are used chiefly for the production of corn and of hay and for pasture. Ordinarily they are inadequately drained for the successful production of alfalfa, small grains, and tobacco, but corn and most of the hay crops are grown successfully. Yields of corn are generally somewhat below those obtained on Abernathy silt loam. A few farmers have attempted to improve the drainage of this soil by exploding dynamite at various depths in the substratum, a measure that apparently has been successful in some places.

GREENDALE SERIES

Like the Emory soils, the Greendale soils occupy gently sloping areas at the foot of slopes. They are differentiated from the Emory soils chiefly by their lighter color, but they also differ in being less fertile and less productive and in containing fragments of chert. The Greendale soils are associated chiefly with the cherty and sandy members of the Fullerton series, the Clarksville soils, and, to a less extent, the Talbott soils, and they are developed from material washed down from these associated soils. Although the Greendale soils vary considerably in degree of profile development, in most places they have a light grayish-brown friable surface soil and a brownish-yellow friable subsoil. They are generally acid in reaction, moderate to relatively low in content of organic matter and plant nutrients, physically well suited to the production of crops, and important in the agriculture where they occur. They have a total area of 1,920 acres. They are classified and mapped in one type and one phase, namely, Greendale silt loam, and Greendale cherty silt loam, sloping phase.

Greendale silt loam.—This soil occurs in very gently sloping areas lying at the foot of slopes occupied by the Fullerton, Clarksville, or, in some places, Talbott soils. Greendale silt loam has developed from material washed from these soils. In some places this material is of recent deposition, so that well-defined surface soil and subsoil layers have not yet developed; but in most places the soil has a light grayish-brown friable silt loam surface soil from 8 to 10 inches thick and a brownish-yellow friable silty clay loam subsoil 12 to 18 inches thick. The material below the subsoil is generally firm but moderately friable silty clay loam highly mottled with gray and yellow and faintly mottled with red and brown. Fragments of chert are common through-

out. The gradient ranges from about 2 to 5 percent; and drainage, both external and internal, is generally good, although the drainage of the substratum is not everywhere good. The soil is normally acid in reaction and about medium in content of organic matter and plant nutrients.

An area of 960 acres of Greendale silt loam is mapped. Most of it is associated with the Fullerton soils, but some is associated with the Clarksville and Talbott soils. Individual areas generally do not exceed 5 acres in size.

Included with this soil are several variations. In many places fragments of chert are numerous enough to interfere materially with cultivation. In association with the sandy members of the Fullerton series this soil contains more sand than is typical, and in association with the Talbott soils it is heavier textured than is typical. In a few places the lower part of the subsoil is mottled, indicating inferior drainage; and in a few places this soil grades toward the Emory soils in color.

Greendale silt loam and Emory silt loam occur in similar positions, but they are easily differentiated by their differences in color and associated soils. The Greendale soil is predominantly yellow and is associated chiefly with the Fullerton and Clarksville soils; whereas the Emory soil is predominantly brown and is associated chiefly with the Dewey and Decatur soils. Although this soil is considerably less fertile and less productive than Emory silt loam, both soils are easy to work and are physically well suited to crops.

Most of the land is used for the production of crops, but some is used for pasture. Greendale silt loam is an especially important soil on many farms, because it generally occurs where soils well suited to crop production are relatively scarce. The yields obtained are about 15 to 25 percent lower than those obtained on Emory silt loam; but this Greendale soil is highly responsive to fertilization and other good management practices, whereby yields can be increased. Corn, small grains, hay, tobacco, and vegetables are important crops grown on this soil. It is reported to produce tobacco of excellent quality, which is better than the quality of the tobacco produced on many of the other soils; but the yields are generally lower than those obtained on the more fertile soils.

The requirements for management of this soil are similar to those of Emory silt loam except for certain differences. The chief one is that fertilization and the addition of organic matter are more necessary; and, in order to make the best use of the fertilizers and to increase the content of organic matter, rotation of crops is more necessary. The rotation may be short, however. Good response is to be expected from fertilizing, green manuring, and rotating crops properly.

Greendale cherty silt loam, sloping phase.—This soil differs from Greendale silt loam chiefly (1) in occupying more sloping areas and (2) in containing enough fragments of chert to interfere materially with cultivation. The gradient ranges from about 5 to 12 percent. The soil is also slightly lower in fertility and productivity. Well-defined surface soil and subsoil layers have not developed everywhere; but in most places this soil has a light grayish-brown to brownish-gray friable silt loam surface soil about 10 inches thick and a brownish-yellow to yellow friable cherty silty clay loam subsoil from 12 to 18

inches thick. Fragments of chert are generally numerous enough on the surface and in the soil to interfere somewhat with cultivation, although some areas are practically free from chert fragments. Included also are variations in color and texture similar to those included with Greendale silt loam.

This soil is mapped on a total of 960 acres. It is similar to Greendale silt loam in its distribution and is associated with similar soils. The two soils are also similar in present use and management, but this soil is thought to be slightly less productive. The adaptations of the two soils are also similar, but the sloping phase is less easy to work because of the steeper slope and chert fragments. The requirements for management of the two soils are similar, but the cherty phase is generally in somewhat greater need of fertilizers and in some places in need of protection against erosion, although that is generally a minor requirement.

SOILS DEVELOPED FROM MATERIAL DERIVED CHIEFLY FROM SHALES

Members of two series, the Leadvale and the Whitesburg, have developed from material washed onto the foot of slopes of the soils of the uplands overlying shales. The Leadvale soils are predominantly yellow and strongly to very strongly acid in reaction; whereas the Whitesburg soils are considerably darker and approximately neutral. Associated only with the Dandridge soils, the Whitesburg soils consist of recent local wash from those soils. The Leadvale soils are associated chiefly with the Litz soils but are also associated with the Armuchee, Sequoia, Needmore, and Dandridge soils.

LEADVALE SERIES

Members of the Leadvale series have developed from material washed from the soils of the uplands underlain chiefly by shale, although limestone is interbedded with the shale in many areas. In areas outside of Hamblen County, soils developed from material washed from soils of the uplands underlain by interbedded shales and sandstones are also included in the Leadvale series.

In this county the Leadvale soils are generally strongly to very strongly acid. Surface drainage is good, and internal drainage is fair but rather slow. In many places well-defined surface soil and subsoil layers have not developed, but in general the soil has a gray to light grayish-brown friable silt loam surface soil from 10 to 15 inches in thickness and a yellow firm silty clay to silty clay loam subsoil 7 to 10 inches thick. Below the subsoil the material is similarly heavy and firm. Shale ordinarily lies from 3 to 5 feet below the surface. Although physically well suited to the ordinary production of crops, the Leadvale soils are only moderately productive. They cover a total of 2,112 acres and are mapped in one type and one phase, namely, Leadvale silt loam, and Leadvale silt loam, sloping phase.

Leadvale silt loam.—This soil is developed from material washed from the adjacent slopes occupied mainly by the Litz, Sequoia, and Needmore soils and to a less extent the Armuchee and Dandridge soils. A total area of 768 acres is mapped.

In some places this soil has not yet developed well-defined surface soil and subsoil layers, but in general it has a 10- to 15-inch surface soil of gray to light grayish-brown friable silt loam and a 7- to 10-inch

subsoil of firm yellow silty clay to silty clay loam. The material below the subsoil is similarly firm and heavy but is profusely mottled with gray and yellow; and this material extends to the underlying shale, which is ordinarily reached at a depth of 3 to 5 feet. In some places the subsoil is quite tough, and in some places it contains a few splotches of gray. In some places, especially where the material has been washed from northeast- and east-facing slopes, the surface soil is darker than is typical. A few "rotten" shale fragments are present in some areas, generally those associated with the Litz soils.

Leadvale silt loam has a gentle slope—from about 2 to 5 percent. External drainage is good. Internal drainage is fair but rather slow owing to the heavy-textured subsoil and substratum. Because of this drainage condition, the soil warms slowly in the spring. The reaction is generally strongly to very strongly acid, although in some places, especially where the soil is associated with the Dandridge and Needmore soils, it is less acid. Although the fertility generally is not considered to be high, it is not especially low. The productivity is only fair.

Small areas of this soil are distributed over the belts where the Litz, Sequoia, Needmore, and Dandridge soils occur, except in the area of the Dandridge soils northeast of Bent Creek. The Dandridge soils in this area, it is recalled, are more productive than elsewhere.

Most of this soil is cleared and used in much the same way as the Needmore and Sequoia soils, but somewhat greater yields are obtained. It is similar to these soils in adaptation, except that alfalfa would be expected not to succeed so well because of the inferior drainage of the substratum. For similar crops, the fertilizer requirements of all these soils are likely to be similar; but, as Leadvale silt loam is not significantly susceptible to erosion, the rotation may be shorter and row crops may be grown more frequently. Indications are that this soil responds fairly well to fertilization, but not so well as certain other soils, such as the Greendale, Fullerton, and Dewey.

Leadvale silt loam, sloping phase.—This soil differs from the typical Leadvale silt loam chiefly in occupying more sloping areas. It ranges in gradient from about 5 to 12 percent. It is also somewhat more variable in color, depth, and other characteristics, but in general it has a similar gray to light grayish-brown friable surface soil and a yellow firm subsoil. About the same variations are included in mapping both soils. Internal drainage is rather slow in both soils, but it is adequate for most crops common to the locality. External drainage of the soil of the sloping phase, however, is more rapid.

The soil is more extensive than the typical Leadvale silt loam, as a total of 1,344 acres is mapped. The two soils are similar in distribution, however, and occur chiefly in association with the Litz, Sequoia, and Needmore soils and to a less extent with the Armuchee and Dandridge soils. Both soils lie at the foot of slopes, generally between the upland slopes and the bottom land.

Like the normal phase, this soil is cleared and is used chiefly for the production of the crops common to the locality and to a less extent for pasture, but the yields are generally thought to be somewhat lower. Physically, it is fairly well suited to such crops. Its requirements for management are similar to those of the Leadvale silt loam, but in some places it appears to be somewhat

susceptible to gully erosion and therefore needs to be protected against such erosion. The fertilizer and rotation needs are similar to those of the Needmore and Sequoia soils, although a somewhat shorter rotation may generally be feasible. Alfalfa is unlikely to grow as well on this soil as on the Sequoia and Needmore soils, but the other crops would be expected to do about as well or better.

WHITESBURG SERIES

Members of the Whitesburg series are differentiated from those of the Leadvale series largely on the basis of color and reaction. The Whitesburg soils are darker, considerably less acid, and also considerably more fertile and productive than the Leadvale soils. They are also generally younger and show less consistent profile development. The Whitesburg soils occur at the foot of slopes occupied only by the Dandridge soils, and they are developed entirely or almost entirely from material washed from the Dandridge soils and their underlying calcareous shales. In many places well-defined surface soil and subsoil layers have not developed and the soils consist of dark grayish-brown or yellowish-brown friable silt loam to silty clay loam to a depth of as much as 25 inches; but in many places there is a dark grayish-brown surface layer and a yellowish-brown subsoil. The slope is generally gentle, and external drainage is good. Internal drainage, however, is rather slow and in some places is imperfect. The Whitesburg soils are well suited to cultivation and are highly productive of many of the crops common to the locality. Only one type, Whitesburg silt loam, is mapped in this county.

Whitesburg silt loam.—This soil is developed on accumulations of local wash at the foot of slopes occupied only by the Dandridge soils, which are underlain by calcareous shale. It differs from the Leadvale soil in being darker, less acid, more fertile, and more productive.

In many places the material is of such recent accumulation that no well-defined surface soil and subsoil layers have developed; here dark grayish-brown to yellowish-brown moderately friable silt loam to silty clay loam extends to a depth of as much as 24 inches. In most places, however, discernible layers have developed; and here there is a 10- to 15-inch surface soil of dark grayish-brown friable silt loam to silty clay loam and a 7- to 10-inch subsoil of moderately firm yellowish-brown silty clay loam to silty clay. A few splotches and mottlings of gray and yellow are generally scattered throughout the soil mass; some of these are very likely due to recently disintegrated shale fragments. The material below the subsoil is equally heavy textured, but it is highly mottled and splotched with gray and yellow. In some places calcareous shale lies at a depth of 30 inches, but in most places it lies at a greater depth. The color varies from place to place, being lighter than typical in some places, approaching that of the Leadvale soils, and darker than typical in others.

Whitesburg silt loam ranges from about neutral to medium acid in reaction. It is fairly well supplied with organic matter and is high in natural fertility. The tilth is moderately good and is fairly easy to maintain in such a condition. The gradient, which is gentle, ranges from about 2 to 7 percent. External drainage is good, but internal drainage is only fair, although it is apparently adequate for most commonly grown crops. Increased yields, however, have been obtained after tile drainage has been provided.

This soil has a total area of 640 acres. Although the individual areas are small, they are important because they are associated with larger bodies of the Dandridge soils in localities where soils well suited to cultivation are comparatively scarce. Where this soil adjoins areas of the light-colored Tyler soil, boundaries are distinct (pl. 12, A).

Whitesburg silt loam is utilized for the production of the common field crops of the area, and relatively high yields are usually obtained. It appears to be especially well suited to corn, which commonly yields from 40 to 60 bushels an acre. Wheat yields between 15 and 20 bushels, but wheat and other small grains are subject to lodging on this soil. Alfalfa is grown successfully on some areas, but the internal drainage is hardly sufficient for this crop. Most of the other hay crops are very well suited to this soil and produce high yields. Tobacco would not be expected to succeed well, although it should do as well as or better than on the Dandridge soils. Lime is not ordinarily required on this soil for hay or other crops, although some farmers have reported favorable results from its use; but phosphate is a general requirement for most crops, especially legumes (pl. 12, B). This soil should be especially well suited to a corn-hay rotation, but it is not exacting as to rotation requirements. It is not subject to erosion, but in some places it is subject to injury from excessive deposition of material washed from the slope above.

An important variation, amounting to between 150 and 200 acres, comprises a soil that is darker in color, finer in texture, and much more sticky and plastic in consistence than the typical soil. It occurs chiefly in association with the gravelly Dandridge soils, from which most of its parent material was washed. The larger areas are in the vicinity of Lowland. The surface soil of this variation is dark grayish-brown to nearly black silty clay loam to silty clay that is plastic when wet and rather hard and intractable when dry. At a depth of 8 to 12 inches this material is underlain by mottled dark bluish-gray to yellowish-brown silty clay to clay that is tough, sticky, and plastic. The tilth of this soil is especially unfavorable, and it is difficult to improve and to maintain in an improved condition. When the soil dries it becomes hard and cloddy, and large cracks, some as much as 3 or 4 feet deep, develop. Farmers generally have to plow this soil in the fall, thereby subjecting it to alternate freezing and thawing, in order to prepare a suitable seedbed in the spring. This soil is used chiefly for the production of corn and hay, mostly red clover and grasses. The yields are generally good. A corn-hay rotation is probably one of the rotations to which this soil is best suited. The content of lime and of organic matter is relatively high, and the supply of most plant nutrients, except phosphorus, is probably relatively high. Little or no lime is used, and fertilizers are used sparingly. Improvement of tilth and internal drainage are the main management problems in areas of this variation.

SOILS OF THE TERRACES

Soils of the terraces comprise former flood plains of the present rivers and creeks, which in the geologic past flowed at considerably higher levels. At those levels they deposited gravel, sand, and clay on their flood plains in the same manner as they are doing now. During the progress of stream cutting over a great number of years the channel was gradually deepened and new flood plains were formed at

the lower levels, but remnants of the older higher lying flood plains were left. These areas are now above the overflow stage of the present streams, and they constitute what are referred to in this report as the terraces. In brief, geologically, they consist of general stream alluvium that now lies above the overflow stage of the present streams. They are frequently referred to as second bottoms or benches.

For the most part these terraces adjoin the present flood plains or bottom lands. Typically the land is nearly level to gently sloping, but some areas have become dissected by recent stream action and now have an undulating or rolling relief.

In Hamblen County the soils on the terraces are classified into eight series. The soils of six of these series—the Waynesboro, Holston, Monongahela, Tyler, Purdy, and Sequatchie—are developed from material most of which is thought to have been washed from uplands underlain by sandstone and shale; and two—the State and Altavista—are developed from material most of which is thought to have been washed from uplands underlain by granite, gneiss, schist, slate, and quartzite. The Waynesboro, Holston, Monongahela, Tyler, and Purdy series constitute a catena⁸ in which the red Waynesboro soils are well-drained and the mottled-gray Purdy soils are poorly drained. All these soils generally occur on the higher, older terraces. The State and Sequatchie soils are similar in that they lie on low terraces and are young and are chiefly brown in color; but they differ in parent materials, and the State soils are more productive. The Altavista soils are approximately similar in drainage condition and in the color of the subsoil to the Holston and Monongahela soils, but the parent materials are different. The Altavista soils occur on low rather than on high terraces and are more productive.

SOILS DEVELOPED FROM ALLUVIUM DERIVED CHIEFLY FROM SANDSTONES AND SHALES

The soils of the terraces developed from alluvium most of which has been washed from uplands underlain by sandstones and shales are classified into six series, namely, Waynesboro, Holston, Monongahela, Tyler, Purdy, and Sequatchie. The first five of these occur on the higher, older terraces and constitute a group of soils in which the drainage becomes progressively poorer in the order named. The Waynesboro soils, which are very well drained, are easily identified by the red color of their subsoil. The Holston soils, which are slightly inferior to the Waynesboro soils in drainage but are nevertheless fairly well drained, have yellow and relatively deep subsoils. The Monongahela soils, which are inferior in drainage to the Holston soils, have similar yellow subsoils, but these layers are generally thinner, are less friable, and are underlain by compact layers. The Tyler soils, which are poorly drained, have subsoils that are predominantly grayish yellow but are highly mottled with gray and are tight and compact; and the Purdy soils, which are very poorly drained, have subsoils that are predominantly light gray highly mottled with other colors. In contrast with these soils, which generally lie on the higher and older terraces, the Sequatchie soils generally lie on the lower and younger terraces and are sandy, brown, and well drained in nearly all places.

⁸ A catena is a group of soils within one zonal region, developed from similar parent material, but differing in characteristics of the solum (surface soil and subsoil) owing to differences in relief or drainage.

WAYNESBORO SERIES

The Waynesboro soils are easily identified, as they are the only soils on terraces in this county having red subsoils. They lie on the older, higher terraces along the Holston and Nolichucky Rivers and are developed from old alluvium most of which has come from uplands underlain by sandstone and shale but some of which has come from uplands underlain by other rocks. They are light-textured, friable, well drained, acid, moderately fertile, and are generally fairly well suited to crop production. They occupy gently to strongly sloping areas. The surface soil is a loose very fine sandy loam ranging from about 6 to 10 inches in thickness, and the subsoil is light-red friable very fine sandy clay ranging from 18 to 26 inches in thickness. The underlying material is generally heavier and is splotched and mottled with gray and yellow. Only one type, Waynesboro very fine sandy loam, is mapped in this county.

Waynesboro very fine sandy loam.—This is a sloping, well-drained, red soil of the higher and older terraces along the Holston and Nolichucky Rivers. Most of the material from which it is developed is thought to have been washed from the uplands underlain by sandstones and shales, but some undoubtedly has come from the uplands underlain by other rocks. In uneroded or only slightly eroded fields the surface soil consists of light-brown very friable very fine sandy loam and ranges in thickness from about 6 to 10 inches. The subsoil, extending to a depth between 24 and 36 inches, is friable very fine sandy clay that is predominantly light red but ranges from brownish red to yellowish red. The subsoil becomes somewhat heavier and less friable with increasing depth. Below the subsoil the material is generally light-red silty clay splotched with gray and yellow. In some places the subsoil rests upon material similar to that from which the Talbott soils have developed. A few sandstone cobbles and pieces of gravel are common on the surface and in the soil.

The gradient ranges from about 3 to 12 percent. Drainage, both internal and external, is very good. The soil is acid in reaction, but it is moderately well supplied with organic matter and is moderately fertile. The tilth is good and is easily maintained in such a condition. The soil is fairly light to work, can be conserved by ordinary management, and is moderately productive of nearly all of the crops common to the area.

Included with this soil as mapped are a few significant variations, chiefly in slope and erosion. Areas totaling about 175 acres range in slope from about 12 to 25 percent and these areas are slightly to moderately eroded. This variation is physically rather poorly suited to the production of crops, but it is fairly well suited to pasture. Included also are severely eroded areas totaling about 100 acres and ranging in slope from about 12 to 25 percent. In its present condition this variation is physically very poorly suited to field crops and also rather poorly suited to pasture. Other variations of less significance are also included, some of which are typical in slope, for example, but are more eroded than is typical. In some areas the soil is coarser textured and in others it is somewhat finer textured than in the typical areas.

Including the variations, Waynesboro very fine sandy loam has an aggregate area of 1,152 acres. Most of it occurs along the Holston River, especially northwest of Morristown, in association with the Sequatchie, Talbott, Fullerton, and Dewey soils, and some of it occurs along the Nolichucky River. Very few areas are along the smaller streams.

Nearly all of the land is cleared. Most of it is used for the production of crops, some is used for pasture, and a little is lying idle. The steeper and more eroded variations include most of the soil that is in pasture and that is lying idle. This soil is generally managed similarly to the other red soils of similar slope, such as the eroded phase of Dewey silty clay loam, but the yields are probably 15 percent lower than those obtained on this Dewey soil. The adaptations of these two soils are similar, but the Waynesboro soil is somewhat less well adapted to grasses and legumes and is better adapted to truck crops. The management requirements of the two soils are similar, although there are some differences. The Waynesboro soil is in greater need of fertilizer, and, as it leaches more readily than the Dewey soil, it may require more frequent application of certain fertilizers. The immediate response from fertilization is likely to be greater on the Waynesboro soil, but the response is unlikely to be as lasting. The tilth of the Waynesboro soil, however, is somewhat easier to maintain in a good condition than that of the Dewey soil.

HOLSTON SERIES

Like the Waynesboro soils, the Holston soils lie on the higher and older terraces and have developed from old alluvium most of which is thought to have been washed from uplands underlain by sandstone and shale. The Holston soils, however, have apparently developed under conditions of inferior internal drainage, and they are readily differentiated from the Waynesboro soils by the yellow color of the subsoils. The Holston soils differ from the associated Monongahela soils in being somewhat better drained and more friable. They are characterized by a yellowish-gray to light-gray friable very fine sandy loam surface soil about 10 inches thick and a yellow firm but friable very fine sandy clay subsoil between 15 and 20 inches thick. The underlying parent material is generally highly mottled with gray and yellow and is moderately compact. Shale generally underlies the parent material in most places at a depth of 30 to 50 inches. The Holston soils are highly leached and are therefore strongly to very strongly acid in reaction and low in fertility. They occupy gently sloping areas, have good tilth, and are therefore easy to work. External drainage is good, and internal drainage is likewise good, though inferior to that of the Waynesboro soils. Only one type of the Holston series—Holston very fine sandy loam—is mapped in this county.

Holston very fine sandy loam.—This is a soil of low natural fertility but good workability, occupying the older and higher terraces. In uneroded fields it has a 10- to 12-inch yellowish-gray to gray friable very fine sandy loam surface soil. The subsoil is yellow firm but friable very fine sandy clay from 15 to 20 inches thick. There are a few gray splotches in the lower part of the subsoil in some places. The substratum material is moderately compact silty clay to silty clay

loam highly mottled with gray, yellow, and red. In most places this material rests on shale generally at a depth of 30 and 50 inches. Pieces of gravel and cobblestones are generally scattered over the surface and throughout the soil material.

This soil has developed from old stream-deposited material most of which originated in the uplands underlain by sandstone and shale. In source of parent material this soil is similar to the Waynesboro and Monongahela soils. It is readily differentiated from the Waynesboro soils, however, by the difference in the color of the subsoils, as the Waynesboro subsoil is predominantly red. Apparently this Holston soil has developed under less favorable conditions of internal drainage than the Waynesboro soils. On the other hand, the Holston soil is better drained and more friable than the Monongahela soils, which also have a yellow subsoil but one that is somewhat thinner.

The maximum range in gradient is between 2 and 12 percent, although in most places the slope ranges between 4 and 9 percent. External drainage is very good; and internal drainage is good, although inferior to that of the Waynesboro soil. Severely leached, this soil is normally strongly to very strongly acid and low in natural fertility. It is also normally low in organic matter. The tilth is good and is easily maintained in that condition. The soil is easy to work, and, although low in fertility, it responds well to fertilization. It is also physically well suited to cultivation.

In most places erosion has removed a part of the original surface soil, so that the present surface soil is not more than 7 inches thick, and in a few places nearly all of the original surface soil is gone. In a few places gravel and cobblestones are fairly abundant. Here and there the depth to the underlying shale is less than 30 inches, and there are few outcrops of shale.

Holston very fine sandy loam has a total area of 704 acres. It occurs mainly along the Nolichucky and Holston Rivers. Along the Nolichucky River it is associated with the Monongahela, Tyler, and Purdy soils, and along the Holston River it is associated chiefly with the Waynesboro and Monongahela soils.

Most of this soil is used for the production of crops and is managed in almost the same way as most of the other soils of gentle slopes. As a rule yields are rather low, although fairly high yields are obtained where the management is better than average. This soil appears to be well suited to the production of small grains, such as wheat. Corn is grown with fair success, but the yields are generally low. Hay crops can be successfully grown, although this soil is not productive of alfalfa unless heavily fertilized. Truck crops, such as potatoes, grow well on the soil. Good tobacco can be produced if the land is adequately fertilized.

For the successful production of crops, fertilization is very necessary, as the soil is low in organic matter, lime, and phosphate and probably in potash and in most other elements necessary to normal plant growth. In most places the soil is somewhat susceptible to erosion, and cultivation therefore needs to be on the contour. Under ordinary conditions a rotation of at least moderate length is needed. Plowing under green manures in the spring should be especially beneficial to this soil.

MONONGAHELA SERIES

The Monongahela soils are closely associated with the Holston and the Tyler soils, but they have poorer drainage than the Holston and better drainage than the Tyler soils. They resemble the Holston soils in color but differ from them in having a compact and slowly pervious layer at a depth of about 2 feet. Like the Holston soils, these soils occupy the higher and older terraces and have developed from stream-deposited material most of which is thought to have been washed from the uplands underlain by sandstones and shales. In uneroded fields the surface soil is grayish-yellow to light-gray friable very fine sandy loam 10 to 12 inches thick; and the subsoil is firm but moderately friable very fine sandy clay to a depth of 20 to 24 inches. The subsoil generally has a few gray splotches in its lower part. It is underlain by compact slowly pervious silty clay that is highly mottled with gray and yellow and some red and brown. In general the slope of these soils is gentle. For the most part the Monongahela soils are strongly to very strongly acid in reaction and low in fertility and in content of organic matter. They are generally used for the production of crops, a use to which they are physically suited, even though they are of relatively low productivity. One type and one phase with a total area of 960 acres are mapped. These are Monongahela very fine sandy loam and Monongahela very fine sandy loam, eroded sloping phase.

Monongahela very fine sandy loam.—This soil occurs on the gently sloping higher and older terraces in association with the Holston, Tyler, and Purdy soils. It is not so well drained as the Holston soils but is better drained than the Tyler soils; and, like those soils, it has developed from old alluvium most of which is thought to have been washed from the uplands underlain by sandstones and shales. It differs from the Holston soil chiefly in having a compact and slowly pervious layer at a depth of about 2 feet, but it also generally has a milder slope, inferior drainage, and lower productivity.

The surface soil is grayish-yellow to light-gray friable very fine sandy loam. The subsoil is yellow firm but moderately friable very fine sandy clay, extending to a depth of 20 to 24 inches. There are generally a few splotches of gray in this layer. The subsoil is underlain by compact slowly pervious silty clay highly mottled with gray and yellow and some red and brown. A few sandstone and quartzite cobbles and pieces of gravel are generally present in the soil. Like the Holston soil, this soil is underlain by shale in most places.

The gradient, which ranges from about 2 to 5 percent, is generally enough for adequate surface drainage, although runoff in some places is rather slow. Internal drainage, retarded by the compact layer, is slow but is apparently adequate for the production of most crops common to the area. Owing to the slow drainage, however, the soil warms late in the spring. Like the Holston soil, this one is generally strongly to very strongly acid in reaction and low in content of organic matter and plant nutrients.

A total area of 768 acres is mapped as Monongahela very fine sandy loam, in close association with Holston very fine sandy loam and Tyler silt loam, chiefly along the Nolichucky River, the Holston River, and Bent Creek. Along Bent Creek the soil varies from the typical

in having predominantly a silt loam surface soil and a silty clay loam subsoil.

About 70 percent of the land has been cleared, and most of this is used for crops and pasture. The yields of most crops are generally low—lower than those obtained on Holston very fine sandy loam, but moderate yields of wheat have been reported. Because of its low fertility and somewhat unfavorable internal moisture condition, this soil is not well suited to the production of crops, although it is easy to work and the tilth of the surface soil is generally good. The soil responds fairly well to fertilization, but its response is generally less than that of the soils having the better internal moisture relations, such as Holston very fine sandy loam. Like the Holston soil, it is in great need of fertilization. Most crops common to the area have been grown on this soil, but it is not well suited to alfalfa or to tobacco, and it is not highly productive of the other crops, although fair yields can be obtained, especially of wheat (pl. 11, *B*) and rye. In view of its low natural fertility and somewhat unfavorable internal moisture condition, which apparently impairs its responsiveness to fertilization, it would be best to select crops that will grow on soils with a low nutrient level in order to minimize the required fertilization. Liming is essential. The control of erosion on this soil is no problem because of the gentle slope.

Monongahela very fine sandy loam, eroded sloping phase.—This soil differs from typical Monongahela very fine sandy loam chiefly in having a steeper slope—from 5 to 12 percent—and in having lost a part of the original surface soil. The thickness of the present surface soil generally ranges from about 4 to 8 inches, although in a few places nearly all of the original surface soil has been lost. The subsoil of yellow and firm but moderately friable very fine sandy clay and the compact and slowly permeable material below the subsoil are similar to the corresponding layers of the normal phase. Along Bent Creek this soil is somewhat finer textured than is typical elsewhere. Also included are a few areas that have undergone little or no erosion. Water-worn gravel and cobblestones are characteristic over the surface and throughout the soil mass.

Only 192 acres of this soil are mapped. It occurs along the Nolichucky River, the Holston River, and Bent Creek, in association chiefly with the other Monongahela soil. Most of the land has been cleared, and the greater part is now in pasture, though some is used for field crops. Yields are generally low. In contrast to the other Monongahela soil, on which erosion is not a problem, the control of erosion must be considered in using this soil for the production of crops. As cropland it is very nearly marginal, and its use for this purpose is not recommended under most conditions. If it is used for crops the management requirements will be similar to those of the eroded phase of Sequoia silty clay loam, although the selection of alfalfa should be avoided.

TYLER SERIES

The Tyler soils are intermediate in drainage condition between the imperfectly drained Monongahela soils and the very poorly drained Purdy soils. They occur on the nearly level terraces and have developed from old stream-deposited material most of which doubtless was washed from the uplands underlain by sandstones and shales. The

8- to 12-inch surface soil is floury silt loam, light gray slightly mottled with light brown, dark gray, and yellow. In most places the subsoil is compact plastic silty clay, chiefly yellow highly mottled with gray. The Tyler soils are generally strongly acid to very strongly acid, low in fertility, and low in productivity. Only one type, Tyler silt loam, with a total area of only 384 acres, is mapped.

Tyler silt loam.—This soil is generally associated with the Monongahela and Purdy soils along the Nolichucky River and Bent Creek. Intermediate in drainage between the imperfectly drained Monongahela soil and the very poorly drained Purdy soil, Tyler silt loam is characterized by poor drainage and heavy texture in the subsoil and the substratum. Like these associated soils, it has developed from water-deposited material most of which probably was washed from uplands underlain by shales and sandstones. In places it adjoins the darker Whitesburg soil (pl. 12, A).

The surface soil is floury silt loam from about 8 to 12 inches thick. It is light gray, slightly mottled with dark gray, light brown, and yellow. In woods the topmost inch of this layer is stained dark with organic matter. In most places the subsoil is compact plastic silty clay, predominantly grayish yellow highly mottled with gray. It ranges from about 10 to 15 inches in thickness and is underlain by gray tight compact silty clay mottled with bluish gray and yellow.

The principal variations in this soil as mapped are in the compactness of the subsoil, which in some places is only moderate and in others is extreme. Included also are areas in which the soil is better drained and approaches the Monongahela soils in color.

This soil, including the variations, is generally strongly to very strongly acid in reaction. The land is nearly level to undulating, and surface drainage in most places is slow. Internal drainage is likewise slow and is inadequate for the production of many of the crops unless improved by artificial means, such as tile drainage, which is practiced on this soil in some places.

Nearly all of the land is cleared and is used for pasture and crops. Corn, wheat, and hay are the chief crops grown. Where this soil is artificially drained, yields of these crops are fair; and where it is not, yields are generally low. Owing largely to the unfavorable consistence of the subsoil and to the unfavorable drainage condition, the response to fertilization may be considerably less than on many of the other soils, and even under very good management only moderate yields of most crops can be expected. Under ordinary conditions, therefore, the best use for this soil appears to be for pasture and for hay crops.

PURDY SERIES

The Purdy soils are even more poorly drained than the associated Tyler soils. Like the Tyler soils, they have developed from stream-deposited material most of which evidently came from the uplands underlain by shales and sandstones. These soils are strongly to very strongly acid in reaction and low in content of organic matter and of plant nutrients. They occupy nearly level areas and slight depressions in which there is little or no surface drainage. They are pre-vaillingly light colored. The substratum and in many places the overlying subsoil are compact and slowly pervious to water. The Purdy

soils are generally unsuitable for successful production of crops requiring tillage. Only one type is mapped—Purdy silt loam.

Purdy silt loam.—This light-colored soil is associated with Tyler silt loam, from which it differs chiefly in being even more poorly drained, and also with the Monongahela and Holston soils. It is mapped only along the Nolichucky River and Bent Creek. Like the associated soils, it is developed from alluvial material, most of which apparently was derived from the uplands underlain by sandstones and shales; and, like these soils, it is strongly acid to very strongly acid in reaction and low in content of plant nutrients.

In most places Purdy silt loam has a surface soil about 6 inches thick consisting of floury silt loam that is very light gray and mottled with various shades of gray, yellow, and light brown. The subsoil is generally light-gray firm but moderately friable silty clay loam to silty clay highly mottled with gray and different shades of yellow. The subsoil is underlain at a depth of 20 to 24 inches by compact highly mottled gray clay or silty clay. In some places the subsoil also is very compact.

This soil occurs on nearly level and slightly depressed areas having little or no surface drainage. Internal drainage also is very poor, and water stands on the surface for several days after heavy rains. When dry the soil is hard, and deep cracks form in it. The lower parts of the roots of plants appear to be confined to such cracks.

Purdy silt loam occupies 512 acres, and about 40 percent of this is in woods. Much of the cleared land is used for pasture, much is lying idle, and some is used for crops. Yields of crops are generally low, and total failures of crops are common. The production of crops has been attempted on many areas at various times, but generally it has proved unsuccessful and the areas were later returned to pasture or were abandoned. Because of the nature of the subsoil and the substratum, the improvement of drainage by artificial means is very difficult, and the practicability of incurring much expense to improve the drainage is somewhat doubtful. Under ordinary conditions pasture or forestry is quite likely the best use to which this soil is adapted.

SEQUATCHIE SERIES

The brown coarse-textured well-drained soils on the low terraces along the Holston River and some of its tributary streams are members of the Sequatchie series. They are generally lower lying and considerably younger than the Waynesboro and Holston soils; but, like those soils, they have also developed from material most of which has been washed from the uplands underlain by sandstone and shale. The Sequatchie soils occupy gently sloping areas, are easy to work, and are moderately productive. Only one type is mapped in this county, Sequatchie fine sandy loam, which has a small total area.

Sequatchie fine sandy loam.—This soil has a total area of 512 acres, chiefly on the low gently sloping terraces along the Holston River. It is a well-drained moderately productive soil that is coarse in texture and easy to work. It is younger and generally lies on lower terraces than the Waynesboro and Holston soils, but like these soils it has developed from stream-deposited material, most of which

probably came from the uplands underlain by sandstones and shales, although some very likely came from the uplands underlain by limestones.

Well-defined surface soil and subsoil layers have not developed, but generally the soil has a light-brown loose fine sandy loam surface soil about 6 to 10 inches thick and a yellowish-brown friable clay loam subsoil 10 to 20 inches thick. The underlying material is friable in most places and is splotched and mottled with gray, brown, and yellow. Variations are numerous. In some places the texture is coarser and in others finer than in the typical areas; in other places the subsoil is brownish yellow; and in still others the lower part of the subsoil and the substratum are slightly compact.

Sequatchie fine sandy loam is generally acid in reaction, moderate in fertility, and responsive to fertilization. The slope is gentle, and the soil is easy to work. Its tilth is naturally good and is easily kept in good condition. Both internal and external drainage are good.

This soil is well suited to the production of crops, and most of it is so used. Frequently reported acre yields of the common crops are as follows: Corn, 35 bushels; wheat, 15 bushels; hay crops, such as red clover, 1 ton; and burley tobacco, 1,000 pounds. The management of this soil is relatively easy, but fertilization and liming are necessary. Favorable results are reported from fertilizing and liming.

SOILS DEVELOPED FROM ALLUVIUM DERIVED CHIEFLY FROM GRANITES, GNEISSES, SCHISTS, SLATES, AND QUARTZITES

The alluvial material on the low terraces along the Nolichucky River is thought to have come chiefly from areas in the Great Smoky Mountains in which the uplands are underlain by granites, gneisses, schists, slates, and quartzites. Most of this material is characterized by the presence of small flakes of mica. The soils on these low terraces are classified into two series, the State and the Altavista. The soils of these series differ chiefly in drainage, the State soils being very well drained and the Altavista soils being less well drained. The State soils are predominantly dark brown in the surface soils and yellowish brown in the subsoils, whereas the Altavista soils are predominantly grayish brown in the surface soils and grayish yellow in the subsoils. The soils of both series are fertile and productive, but the State soils are the more productive of the two.

STATE SERIES

The soils in this county classified as the State series occur only on the low terraces along the Nolichucky River. They are nearly level, well drained, predominantly brown, high in fertility, and very well suited to the production of crops. They have developed from water-deposited material most of which was washed from the uplands underlain by granites, gneisses, schists, slates, and quartzites. They are similar in color, drainage, and position to the Sequatchie soils mapped along the Holston River, but they differ in parent materials, and they are also more productive. In this county only one member of the State series is mapped—State loam.

State loam.—Only 384 acres of this soil are mapped, on the low terraces along the Nolichucky River, chiefly in association with the Altavista soil, which also occurs on low terraces, and the Congaree soils, which occur in the adjacent bottom lands. It occupies nearly level to gently sloping areas and is well drained, fertile, and highly productive.

Being young, this soil has not developed well-defined surface soil and subsoil layers, but it generally has a dark-brown friable loam surface soil between 8 and 16 inches thick and a yellowish-brown silty clay loam subsoil between 18 and 24 inches thick. The material below the subsoil is generally mottled with gray and yellow. Tiny flakes of mica are present in the soil material. This soil has developed from stream-deposited material, most of which has come from the uplands underlain by granite, gneiss, schist, slate, and quartzite.

State loam is similar in color, position, and drainage to Sequatchie fine sandy loam mapped along the Holston River, but the two soils are developed from different parent materials, and the State loam is more fertile and productive.

Practically all of the land is used for the growing of crops, a use to which it is very well suited. Yields are generally relatively high. Yields of 40 to 50 bushels an acre of corn and 15 to 20 bushels of wheat are commonly reported. Vegetables are grown successfully on some areas. Alfalfa is also grown with success in some places. Lime and phosphate are generally required for alfalfa, and these amendments also benefit other crops. State loam is easy to manage and has a wide range in adaptability. Its moisture relations are very favorable, its tilth condition is good, and it has no problem of erosion control.

ALTAVISTA SERIES

Although the Altavista soils, as mapped in this county, are less well drained than the State soils, they appear to be adequately drained for the production of most crops common to the area. Like the State soils, they occur on the low terraces along the Nolichucky River and have developed from stream-deposited material most of which has come from uplands underlain by granite, gneiss, schist, slate, and quartzite. These soils are similar in drainage condition to the Holston and Monongahela soils, but they have developed from different parent materials, are younger, are more fertile, and have no compact layers such as those in the Monongahela soils. As mapped in this county, the Altavista soils have a friable grayish-brown surface soil and a friable grayish-yellow subsoil that is lightly spotted with brown, gray, and yellow. Only one type, Altavista loam, is mapped.

Altavista loam.—This soil occupies 384 acres on the low terraces along the Nolichucky River, chiefly in association with State loam, from which it differs mainly in being somewhat inferior in drainage. In most places it has a surface layer, between 8 and 10 inches thick, consisting of grayish-brown friable loam, and a subsoil layer, between 8 and 15 inches thick, consisting of friable silty clay loam that is predominantly grayish yellow but is lightly spotted with brown, yellow, and gray. In many places the texture becomes finer and the splotches become more numerous as the depth of the subsoil increases, but there is no serious compaction. The material below the subsoil

is generally highly mottled with gray and yellow and in many places is firm but not compact. Tiny flakes of mica are generally discernible in the soil material. The chief variations are in the color and depth of the surface layer. A few small areas of State loam are included in some areas mapped as Altavista loam. Both soils, it is to be recalled, have developed from stream-deposited material most of which has been washed from the uplands underlain by granites, gneisses, schists, slates, and quartzites.

Although Altavista loam is inferior in drainage to State loam, it is well suited to the production of most crops common to the area, and nearly all of it is so used. Yields, however, are somewhat lower, being probably about 10 percent lower than on the State soil. The range in adaptation is narrower; alfalfa, for example, would not be expected to do well on the Altavista soil, unless, of course, it were artificially drained. Altavista loam has a nearly level surface and good tilth and is easy to work. It presents no problem for the control of erosion.

SOILS OF THE BOTTOM LANDS

Soils of the bottom lands occupy the flood plains, those nearly level areas along the streams. Although the rivers do not flood frequently, floods like the one shown in plate 13, *A*, occasionally occur. Such floods generally come in winter and in spring, but they may come at any time of the year when the rainfall over a short period is abnormally heavy. The material giving rise to all the soils in the bottom lands has been carried there by the streams, and its character depends largely on the source in the higher lying lands and the rate at which the water was moving when the material was deposited. The soils of the bottom lands are young. These materials have not lain in place long enough to develop well-defined surface soil and sub-soil layers such as those in most of the soils of the uplands and terraces. In a sense, therefore, these soils are essentially parent materials that have undergone but little change since deposition.

As a group, the soils of the bottom lands are considered to be especially well adapted to the production of corn, and by far the greater part of them is so used. They are also well suited to hay crops, except for alfalfa (pl. 13, *B*), and to several other crops commonly grown in the county. Not all the soils of the bottom land, however, are suitable for corn, and those that are differ from one another in their productivity of this crop. The adaptability of all soils of the bottom lands is limited by the danger of flooding, and in most places they are flooded one or more times a year. Although flooding occasionally injures corn and injures the soils by excessive deposition of coarse material or by scouring (excessive removal of material), it also serves to maintain the fertility of the soils (pl. 13, *C*).

The soils of the bottom lands differ chiefly in the character of alluvium composing them and in drainage conditions. The character of the alluvium, in turn, is closely associated with the uplands, whence the material has been washed. On the basis of differences in source of material, these soils can be placed into two groups, namely, (1) those consisting of alluvium most of which has been washed from uplands underlain by shales, limestones, and sandstones, and (2) those consist-

ing of alluvium washed from uplands underlain by granites, gneisses, schists, slates, and quartzites. Within each group the soil series differ chiefly in condition of drainage. The soils of the first group are classified into six series, namely, Staser, which is well drained; Hamblen and Lindside, which are imperfectly drained; Melvin and Atkins, which are poorly drained; and Roane, which is fairly well drained but is characterized by its chertiness. The soils of the second group have been classified into two series, namely, the Congaree, which is well drained, and the Chewacla, which is imperfectly drained.

SOILS DEVELOPED FROM ALLUVIUM DERIVED CHIEFLY FROM SHALES, LIMESTONES, AND SANDSTONES

Soils developed from alluvium washed from uplands underlain by sedimentary rocks—shales, limestones, and sandstones—differ from one another according to the kinds of rocks underlying the uplands from which most of the material has been washed. Members of six series belong to this group. Three of these, the Staser, Hamblen, and Atkins soils, have developed from material washed chiefly from uplands underlain by shale and to a less extent limestone and sandstone. The Staser soils are well drained, the Hamblen soils are imperfectly drained, and the Atkins soils are poorly drained. The Staser and the Hamblen soils are well supplied with lime, but the Atkins soils are generally recognized as being acid. The other three of this group, the Roane, Lindside, and Melvin soils, have developed from material washed chiefly from uplands underlain by calcareous rocks, chiefly limestones. The Roane soils are generally fairly well drained, and they contain numerous chert fragments. The Lindside soils are imperfectly drained, resembling the Hamblen soils in this respect. The Melvin soils are poorly drained and are similar in drainage to the Atkins soils. The members of the Lindside and Roane series and the members of the Melvin and Atkins series are mapped as complexes and are subsequently discussed under names of complexes.

STASER SERIES

The soils of the Staser series are fairly well drained and productive and are characterized by a brown color to a depth of 25 to 40 inches. They are mapped chiefly along the Holston River and Bent Creek. Along the Holston River the soil is mainly fine sandy loam, consisting of alluvium that has been washed from uplands underlain by sandstones, shales, and limestones; whereas along Bent Creek the soil is chiefly silt loam, consisting of alluvium that has been washed mainly from uplands underlain by calcareous shales. The Staser soils along both streams are neutral to slightly acid, indicating that they are well supplied with lime. Two types are mapped, namely, Staser silt loam and Staser fine sandy loam.

Staser silt loam.—This soil, mapped chiefly along Bent Creek, has developed from stream-deposited material that has been washed chiefly from uplands underlain by calcareous shales—uplands on which the Dandridge soils predominate. Staser silt loam does not have well-defined surface soil and subsoil layers but is predominantly brown friable silt loam to a depth of 25 to 40 inches. In many places, however, it consists of brown friable silt loam to a depth of 12 to 18

inches, below which the soil is yellowish brown and slightly finer textured and less friable. In many places the soil is faintly mottled with yellow and gray below a depth of 20 inches, and in most places it is highly mottled with gray and yellow below a depth of 25 to 40 inches.

An important property of Staser silt loam is its neutral to slightly acid reaction, indicating that it is well supplied with lime (available calcium). It is also thought to be well supplied with most other elements necessary for plant growth, except phosphorus, the content of which is probably relatively low in many places. As this soil occupies nearly level areas, surface drainage is rather slow but is adequate. Internal drainage is good. The tilth is good and is fairly easily maintained in such a condition. The soil is easy to work and is productive of adapted crops. Flooding is likely to occur one or more times during the year; but, as it does not generally occur in summer and early in fall, injury to summer crops is not common, although it happens occasionally. This susceptibility to flooding restricts the adaptability of this soil, but at the same time flooding also serves to maintain the fertility by deposition of material high in plant nutrients.

Only 512 acres of Staser silt loam is mapped, mostly on the bottoms of Bent Creek and in association with Hamblen silt loam and with the Monongahela, Tyler, and Purdy soils of the terraces.

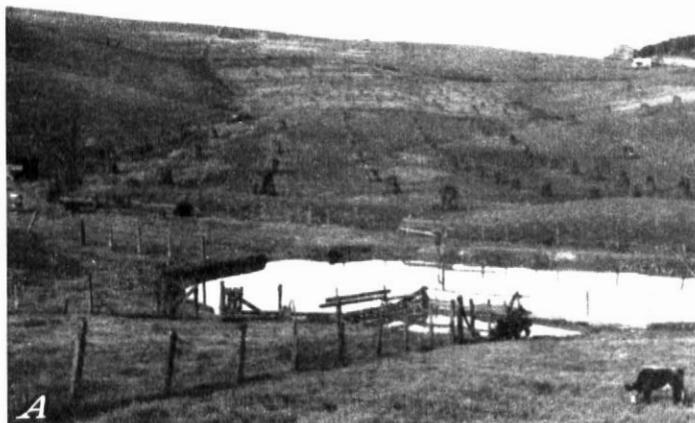
Well suited to the production of corn, this soil is used chiefly and in many places continuously for that crop. Fertilizers are not ordinarily applied. Corn commonly yields between 40 and 60 bushels an acre. This soil is also used to some extent for the production of hay, to which it is also very well suited. Wheat and oats are grown on a few areas, but small grains tend to lodge more, to mature later, and to be more susceptible to disease on Staser silt loam than on the adapted soils of the terraces and uplands. Grasses, clovers, and lespedeza grow luxuriantly. Though successful in a few places, the growing of alfalfa on this soil entails considerable risk of injury or failure from temporary wet conditions resulting from flooding. For this reason it is generally wise to select other hay crops, such as red clover and grass, instead of alfalfa. Although the productivity of this soil is relatively high, increased yields would be expected from the systematic rotation of crops and the application of phosphates. As this soil is especially well suited to hay and corn, a corn-hay rotation is suggested.

Staser fine sandy loam.—This soil differs from Staser silt loam chiefly in being coarser in texture, indicating that uplands underlain by sandstones have contributed more of the material composing it. It is also lower in productivity and in many places is lower in lime. Nearly all of it is mapped along the Holston River, where it is associated chiefly with Sequatchie fine sandy loam of the low terraces. An area of 704 acres is mapped.

Like Staser silt loam, this soil does not have well-defined surface soil and subsoil layers but is predominantly brown and friable to a depth of at least 30 inches. In some places, however, it has an 8- to 12-inch surface layer consisting of a light-brown loose fine sandy loam and a grayish-brown to yellowish-brown friable light clay loam



A, Floods such as this occur occasionally in the winter and spring or at any time of the year when the rainfall over a short period is abnormally high. B, Alfalfa on Lindside-Roane silt loams of the bottom lands. Ordinarily this crop is not grown on the bottoms, because of great risk of injury from flooding. Corn (growing in the background) and hay crops that are at least moderately tolerant of wet conditions are the best adapted crops. C, Corn, the chief crop on the bottoms, severely injured by flood, as occasionally happens. In addition the soils are sometimes injured by excessive deposition or removal (scouring) of coarse material. Generally, however, floods benefit the soils, as they deposit silty material high in plant nutrients.



A, Hummocky or karst relief typical of areas of the Fullerton-Dewey-Clarksville soil association. Such areas are prevailingly hilly and contain many sinkholes. *B*, Typical farmstead where the Fullerton soils predominate and where the soils of the colluvial lands and bottom lands are scarce. The farms in these areas are largely self-sufficient. Note the fruit trees in front of the house and the large tobacco shed on the left. *C*, Representative farmstead in areas where the Fullerton soils predominate but where significant areas of alluvial and colluvial soils also occur. The higher productivity of the latter soils is generally reflected in the improved condition of the farmstead.

subsoil layer extending to a depth of 20 to 25 inches. This, in turn, is underlain by light-brown fine sandy loam to light clay loam, which in some places is loose and in which a few faint splotches of gray and yellow appear in the upper part and become somewhat more numerous with increasing depth. Below a depth of 40 inches the material is generally highly mottled with brown, gray, and yellow.

A coarser textured and less productive variation is included in mapping. This variation, which also occurs chiefly along the Holston River, ranges from loamy fine sand to fine sand, and, owing to the light texture, the internal drainage is excessive, the water-holding capacity is low, and crops suffer readily from drought.

Like the other soils of the bottoms, this soil is nearly level, but it is characterized by some variations in relief. Low escarpments, 1 to 5 feet in height, are characteristic in many areas. These escarpments are shown on the map by special symbols. Surface drainage, although rather slow, is adequate. Internal drainage is good, but, as it is more rapid than that of Staser silt loam, the water-holding capacity of this sandy Staser soil is lower.

Like Staser silt loam, this soil is used chiefly for the production of corn, although other crops are also grown to some extent. Yields of crops, however, are somewhat lower, probably about 15 percent lower, than those obtained on the silt loam. This difference is apparently due chiefly to the lower water-holding capacity and the lower fertility of the fine sandy loam. The present management of the two soils is similar, and the management requirements are likewise similar.

HAMBLÉN SERIES

The Hamblén soils occur in stream bottoms. They are related to the Staser soils, from which they differ chiefly in being inferior in drainage and consequently narrower in crop adaptations. The Hamblén soils are intermediate in drainage condition between the well-drained Staser soils and the poorly drained Melvin and Atkins soils. In general they consist of grayish-brown friable silt loam to a depth of 8 to 16 inches, below which they are generally gray mottled with yellow and light brown. In this county the Hamblén soils consist of material washed mostly from uplands underlain by shale. Typically the reaction is neutral to slightly acid, although areas are included in which it is medium to strongly acid. These soils are used chiefly for corn, hay, and pasture. Only one type is mapped in this county—Hamblén silt loam.

Hamblén silt loam.—This is an imperfectly drained soil mapped in the narrower bottoms in areas where the predominant soils of the adjacent uplands are the Dandridge, Litz, Sequoia, and Needmore. This Hamblén soil consists of material that has been washed from those soils of the uplands and their underlying rocks—shales and interbedded shales and limestones. Hamblén silt loam differs from Staser silt loam chiefly in being inferior in drainage.

To a depth of 8 to 16 inches, Hamblén silt loam consists of grayish-brown to dark grayish-brown friable silt loam. Below this the material becomes mottled with gray, yellow, and brown. The number of mottlings, especially of gray mottlings, increases with depth, and the prevailing color gradually changes from brown to gray. The subsoil

is generally friable, although it is firm in some areas; and the texture is generally silty clay loam or heavy silt loam. In typical areas the reaction is neutral to medium acid.

Several variations were included with this type, but the principal one consists of areas in which the subsoil material is compact plastic silty clay that is but slowly pervious to water. Generally the reaction in these areas is also more acid than is typical, although other areas are included in which the reaction is more acid than is typical but the subsoil is friable. Most of this acid heavy-subsoil variation and the other acid variations lie in those bottoms adjacent to the uplands where the predominant soils are the Litz and Sequoia. These variations are underlain by rocks that are relatively low in calcareous material. Included also are small areas of Staser silt loam and Whitesburg silt loam. Such inclusions were generally made in the upper drainageways where the Dandridge soils predominate on the uplands.

Including the variations, Hamblen silt loam has a total area of 2,624 acres. It is the predominant soil on the bottoms of small streams in areas surrounded by the Dandridge, Needmore, Litz, or Sequoia soils, although it occurs also on the bottoms of larger streams.

Nearly all of the land is cleared. It is used chiefly for growing corn but also to some extent for hay and for pasture. Yields of crops are generally lower by 10 to 20 percent than those obtained on Staser silt loam.

Chiefly because of the inferior drainage, this soil is not so well suited to the production of crops as Staser silt loam. Corn frequently has to be planted later in the spring, and it is more susceptible to injury from wet conditions. Hay crops that are moderately tolerant of wet conditions are about equally well suited to both soils, and this is also true of pasture plants. Hamblen silt loam is especially valuable for pasture in some areas, because it remains moist and productive through extended dry periods when the pastures on the uplands become scant. Drainage is generally inadequate for alfalfa, and the risk of loss of this crop from flooding is rather great. Alfalfa, however, has been successfully grown in a few places where the soil has been artificially drained. Although wheat and other small grains are occasionally grown, this soil is not considered well suited to these crops. Artificial drainage would improve this soil for both corn and small grains. Lime is not ordinarily needed except on the acid variations; phosphorus and nitrogen are most likely to be the elements needed.

LINDSIDE-ROANE COMPLEX

The Lindsides-Roane complex includes the members of two series, the Lindsides and the Roane, both soils of the bottoms.

Lindsides-Roane silt loams.—This complex includes two soils, Lindsides silt loam and Roane silt loam, generally intricately associated on the bottoms in those parts of the county underlain by limestones. Both of these soils are developed from alluvium washed from uplands underlain by limestone. Both are suitable for hay, pasture, and certain crops, including corn in particular.

Lindside silt loam is imperfectly drained, in this respect resembling Hamblen silt loam. It varies considerably from place to place, but in general it consists of grayish-brown to yellowish-brown friable silt loam that extends to a depth of 10 to 18 inches. A few mottlings of gray and yellow are present in places in this layer, especially in the lower part. Below this layer gray mottlings increase and the dominant color changes from brown to gray mottled with yellow and light brown. This material is generally friable silt loam to silty clay loam, although in some places it is heavy and plastic.

Roane silt loam is characterized by chert fragments, which are generally scarce or absent in the Lindside soil, and by a partly cemented layer of chert fragments at a depth of about 2 feet. Drainage is generally slightly better than that of the Lindside soil. The Roane soil, to a depth between 15 and 30 inches, consists of light grayish-brown to brownish-yellow friable silt loam in which fragments of chert are common. This is underlain by a 6- to 10-inch layer of chert fragments that in most places is more or less cemented but in some places is merely tightly embedded. The material underlying the cherty layer is variable, but generally it is gray mottled with yellow and light brown and contains numerous fragments of chert. Typically the reaction is medium to strongly acid. The soil has developed from material washed chiefly from the cherty Fullerton and Clarksville soils of the uplands.

Several variations are included in areas mapped as Lindside-Roane silt loams, but probably the most important consists of about 100 acres of soil that would be mapped as Huntington silt loam if it were more extensive. This inclusion is better drained than the Lindside soil and is also more productive. It is similar to the Staser and the Congaree soils in drainage, color, and productivity, but it has developed from parent material similar to that of the Lindside soil. Most of this variation occurs in the small bottoms in association with Lindside silt loam, but some areas occur along the Holston River in association with Staser fine sandy loam, and some along the Nolichucky River in association with the Congaree soils.

Other variations comprise areas in which limestone bedrock lies from 2 to 3 feet below the surface. These areas generally occur where the downstream slope of the bottoms is greater than is typical. In some areas, especially in those associated with areas of the sandy Fullerton soils, these soils contain more sand than is typical.

Lindside-Roane silt loams, including the variations, comprise 1,280 acres. Nearly all of the areas are along the small streams where the underlying rock is limestone, but a few small areas are along the Holston River. In most areas both Lindside silt loam and Roane silt loam occur, but a few areas consist only of Lindside silt loam and a few only of Roane silt loam. Lindside silt loam generally predominates on the bottoms in the areas where the Dewey soils and Fullerton silt loams are the predominant soils of the uplands, and Roane silt loam predominates on the bottoms in the areas where the cherty Fullerton and cherty Clarksville soils are the predominant soils of the uplands.

This soil complex is used chiefly for the production of corn and hay and for pasture, to which uses it is well suited. Although drainage in the Lindside soil is imperfect, it is generally adequate for the pro-

duction of corn and most of the common hay crops except alfalfa (pl. 13, *B*). Drainage is slightly better in the Roane soil than in the Lindsides, but crops on the Roane soil are more likely to suffer from drought, probably because of the partly cemented cherty layer in the soil. Yields of the crops grown are generally good, however, though lower than those obtained on Staser silt loam. Both members of this complex, especially the Lindsides soil, are excellent soils for hay and pasture; and in certain areas the Lindsides soil is especially valuable for pasture, because it remains moist and productive throughout hot and dry periods when pastures on the uplands begin to fail. Commercial fertilizers are not generally applied, but here and there some lime is used, which appears to be beneficial, although the Lindsides soil ordinarily should not need much lime. Phosphate should prove beneficial.

MELVIN-ATKINS COMPLEX

The poorly drained soils of the bottoms are mapped as a complex of the Melvin and Atkins soils, partly because these soils are intricately associated in some areas and partly because they are inextensive. Furthermore, both the Melvin and Atkins soils are poorly drained and are suited to similar uses. They differ chiefly in source of material and in acidity.

Melvin-Atkins silt loams.—This complex consists of two soils, Melvin silt loam and Atkins silt loam, both of which are light-colored and poorly drained, but the Atkins soil is strongly acid and the Melvin soil is nearly neutral. In many places these two soils are intricately associated, but several areas contain only one of them.

Melvin silt loam consists of alluvial material that has been washed chiefly from the uplands underlain by limestones or other highly calcareous rocks. It is gray mottled with yellow and rust brown, from the surface downward. In many places it has a 6- to 12-inch surface layer of friable silt loam that is brownish gray mottled with brown, gray, and yellow. This is underlain by variable material that is light gray highly mottled with yellow and light brown. In some places it is friable silt loam and in others it is plastic clay, but in most places it is intermediate between these extremes. The reaction is generally neutral to medium acid.

Atkins silt loam is medium to very strongly acid in reaction in most places, consisting chiefly of alluvial material that has been washed from the uplands underlain by slightly calcareous to non-calcareous rocks, such as acid shales and sandstones. It is similar in color and consistence to Melvin silt loam, although in many places it contains less brown material and in some places is lighter textured.

Occurring in nearly level areas or depressions, both these soils are poorly drained, internally as well as externally. They are subject to flooding, and during rainy periods they generally remain waterlogged.

Only 192 acres of this soil is mapped. Most of the areas are on the smaller bottoms throughout the county, especially where the Litz, Armuchee, Sequoia, Dandridge, or Needmore soils are the predominant soils of the uplands.

These soils are used chiefly for forestry and pasture, both being uses to which they are physically suited. Crops such as corn are

grown occasionally, but the yields are generally low; total failures of corn, owing to drowning, are common. Water-tolerant hay crops can be grown with moderate success, especially on the Melvin soil, which is well supplied with lime. Artificial drainage would improve these soils for hay and pasture and would widen their range in adaptation so as to include corn and some of the other crops. These soils, however, are very difficult to drain. In their natural poorly drained condition these soils would not be expected to respond well to fertilization.

SOILS DEVELOPED FROM ALLUVIUM DERIVED CHIEFLY FROM GRANITES, GNEISSES, SCHISTS, SLATES, AND QUARTZITES

Along the Nolichucky River the alluvial material of the first bottoms and also of the low terraces has been washed chiefly from the Great Smoky Mountains, i. e., from uplands underlain by igneous and metamorphic rocks. In the basin of this river these rocks are thought to be chiefly granite, gneiss, schist, slate, and quartzite. The soils on this alluvial material of the first bottoms in Hamblen County are classified into two series, the Congaree and the Chewacla. Tiny flakes of mica are characteristic of the soils of both these series. The Congaree soils are well drained, being similar in drainage condition to the Staser soils, and, like those soils, are predominantly brown and friable to a depth of 30 or more inches. The Chewacla soils are imperfectly drained and are similar in drainage to the Hamblen and Lindside soils. Friable and brown material extends to a depth of 7 to 20 inches, below the material is heavy-textured and bluish gray mottled with gray and yellow.

CONGAREE SERIES

The soils of this series are well drained, although they are subject to occasional flooding, they are highly fertile and productive, and are well suited to cultivation. They are predominantly brown and friable to a depth of 30 or more inches. They occur only on the bottoms of the Nolichucky River and consist of alluvium that has been washed chiefly from the uplands underlain by granite, gneiss, schist, slate, and quartzite. Mica flakes, derived from these rocks, characterize the Congaree soils, which are classified and mapped into two types, namely, Congaree very fine sandy loam and Congaree loamy fine sand.

Congaree very fine sandy loam.—This is a well-drained soil of the first bottoms along the Nolichucky River. It is fertile and productive and consists of alluvium most of which has been washed from the uplands underlain by granite, gneiss, schist, slate, and quartzite. It is similar in color and drainage to Staser fine sandy loam mapped along the Holston River, but the two soils consist of alluvium derived from different kinds of material.

Showing but very little differentiation between the surface soil and the subsoil, Congaree very fine sandy loam is predominantly brown and friable to a depth of 30 or more inches. In many places, however, it has a 10- to 16-inch dark grayish-brown to brown friable very fine sandy loam surface layer, underlain by brown to dark-brown

friable loam to silt loam to a depth of 30 to 40 inches. Below this the material generally is mottled and splotched with gray and yellow and in many places it is coarser in texture. Small mica flakes or scales are common throughout the soil material.

Considerable variation in texture and color occurs from place to place. In the areas nearer the river the texture is generally coarser, and in the areas away from the river and near the low terraces the texture is generally finer. In general, where the texture is coarser the color is lighter than is typical, and where the texture is finer the color is darker than is typical.

Congaree very fine sandy loam occupies a total area of 704 acres. All of it occurs on the first bottom along the Nolichucky River, and it is associated chiefly with Congaree loamy fine sand and Chewacla loam and with the State and Altavista soils. All these associated soils except Congaree loamy fine sand are well suited to the production of crops.

Congaree very fine sandy loam is one of the best soils in the county for the production of crops. It is easy to work, easy to conserve, and productive of a number of crops. Its adaptation is limited somewhat by the fact that it is occasionally flooded, but usually it is not flooded in the summer or fall. It is used and managed in much the same way as the Staser soils. Corn, the chief crop, returns high yields. Hay crops are also grown to some extent, and most of them yield well. Truck crops are grown with considerable success in a few places. Lime, commercial fertilizers, and manure are used for truck crops, but ordinarily no such amendments are applied for corn or hay crops.

Congaree loamy fine sand.—This soil differs from Congaree very fine sandy loam chiefly in being coarser in texture and lower in productivity. It occurs in narrow strips along the Nolichucky River and is bordered by Congaree very fine sandy loam on the side away from the river. It is also mapped on the island in this river. In general the land is nearly level, but there are many small undulations and escarpments, which contrast with the smooth surface of Congaree very fine sandy loam. It is an inextensive soil, only 320 acres being mapped.

Congaree loamy fine sand consists of brown to light-brown loose loamy fine sand to a depth of 30 or more inches with little or no change. In a few places the subsoil is slightly finer textured than the surface soil. Internal drainage is rapid, and the water-holding capacity is low. Because of these unfavorable features, crops are more likely to suffer from drought on this soil than on Congaree very fine sandy loam. These two soils are used and managed similarly, but yields of most crops on Congaree loamy fine sand are considerably lower.

CHEWACLA SERIES

The Chewacla soils, like the Congaree soils, occur on the first bottoms along the Nolichucky River and consist of alluvium most of which has been washed from the uplands underlain by granite, gneiss, schist, slate, and quartzite. The soils differ from the Congaree soils chiefly in being imperfectly drained, and though similar in drainage condition to the Hamblen and Lindsides soils, they have different parent materials. Tiny flakes of mica are scattered throughout the soil material. Only one type of this series is mapped—Chewacla loam.

Chewacla loam.—This imperfectly drained soil is associated with the Congaree soils on the first bottoms of the Nolichucky River and with the State and Altavista soils of the low terraces. Chewacla loam differs from the Congaree soils chiefly in being inferior in drainage; but, like them, it consists of stream alluvium most of which has been washed from the uplands underlain by granite, gneiss, schist, slate, and quartzite.

Most of the Chewacla loam occurs in narrow, winding, and slightly depressed areas that are probably old river channels, and the surface layer appears to consist of material that has been deposited recently by floodwaters. This surface material is very similar to that composing the Congaree soils and consists of brown to dark-brown loam that is characteristically micaceous. The thickness of this layer is variable, ranging from as little as 2 inches to as much as 16 inches. The layer is underlain by a grayish-brown silty clay loam layer about 6 inches thick, and this in turn grades into grayish-blue to bluish-gray clay mottled with yellow and brown. The clay is rather impervious to water and is plastic when wet. Depth to the water table varies but it probably averages between 30 and 40 inches.

Only 128 acres of Chewacla loam is mapped. It is used for pasture, hay crops, and corn. Many of the areas having the shallower surface layer are used chiefly for pasture and hay. The other areas are used principally for corn and hay, and the yields of crops are somewhat lower than those obtained on Congaree very fine sandy loam. Fertilizers or manures are not ordinarily used.

PRODUCTIVITY RATINGS AND PHYSICAL LAND CLASSIFICATION

In table 7 the soils of Hamblen County are listed alphabetically and estimated average acre yields of the principal crops are given for each soil.

The estimates in table 7 are based primarily on observations and on interviews with farmers, the county agricultural agent, members of the staffs of the Tennessee Agricultural Experiment Station and the College of Agriculture, and others who have had experience in the agriculture of the county. Because of a lack of specific data by soil types, the yields are presented only as estimates. This is especially true of the yields of hay crops, and the carrying capacity of pasture. It is also realized that the estimates may not apply directly to specific tracts of land for any particular year, as the soils shown on the map may vary slightly from place to place, management practices differ somewhat from farm to farm, and climatic conditions fluctuate from year to year. The soils of this county differ widely in productivity, and the methods of managing them vary considerably. For this reason average yields to be expected under three different kinds of treatment are given.

Column A gives the average yields to be expected under a minimum of management, including no fertilizers, lime, or other amendments and no special soil-improvement practices. These yields were arrived at largely inductively, as the soils are not usually handled in this way except some in the first bottoms.

Fullerton cherty silt loam, eroded billy phase	18	22	35	12	14	20	20	27	38	15	20	29	13	15	20	.51	01.5	71.1	11	4	(7)	2.0	2.0	6	400	1,100	1,300	105	125	160	80	90	110	35	50	50			
Fullerton cherty silt loam, eroded billy phase	13	18	30	9	11	15	20	30	12	15	23	10	12	16	(7)	.81	4	5	9	1.3	(7)	1.5	2.0	0	300	750	1,000	65	80	100	55	70	80	25	40	70			
Fullerton cherty silt loam, eroded phase	17	20	36	11	13	18	25	35	14	18	26	12	13	18	(7)	.81	4	6	1.0	1.4	(7)	1.8	2.0	0	300	900	1,100	80	100	130	70	80	100	30	45	80			
Fullerton cherty silt loam, eroded steep phase	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	
Fullerton cherty silt loam, hilly phase	15	20	32	11	13	17	18	22	32	14	18	26	11	13	18	(7)	.81	4	6	1.0	1.4	(7)	1.7	2.0	0	300	900	1,100	70	85	115	60	75	90	30	40	75		
Fullerton cherty silt loam, steep phase	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	
Fullerton cherty silty clay loam, severely eroded phase	10	15	20	5	7	10	9	12	15	6	8	12	15	6	8	12	(7)	4	9	3	6	1.0	(7)	.8	2	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)
Fullerton cherty silty clay loam, severely eroded steep phase	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	
Fullerton fine sandy loam	18	22	35	12	14	20	27	35	15	20	29	13	15	20	.51	01.5	71.1	11	4	(7)	2.0	2.0	6	450	1,100	1,300	120	140	170	95	105	125	35	50	50				
Fullerton fine sandy loam, eroded billy phase	13	18	30	9	11	13	18	25	30	12	15	23	10	12	16	(7)	.71	3	5	9	1.3	(7)	1.5	2.0	0	300	700	1,000	70	85	115	60	75	90	25	35	70		
Fullerton fine sandy loam, eroded phase	15	20	32	11	13	17	18	22	32	14	18	26	11	13	18	(7)	.91	4	6	1.0	1.3	(7)	1.8	2.0	0	300	900	1,200	100	115	150	90	100	120	30	45	80		
Fullerton silty loam, hilly phase	20	25	40	14	16	21	22	30	16	20	30	14	16	21	22	.61	2.1	8.1	6	1.3	(7)	1.7	2.3	0	500	1,200	1,400	120	140	170	95	105	125	30	40	75			
Fullerton silty loam, eroded phase	15	20	32	10	14	18	15	25	35	18	24	11	14	18	(7)	.91	4	6	1.0	1.3	(7)	2.0	2.8	0	300	800	1,100	70	90	110	60	75	90	40	50	75			
Fullerton silty loam, eroded hilly phase	18	22	35	12	15	20	27	38	15	20	29	13	15	20	.51	01.5	71.1	11	4	(7)	2.0	2.3	0	400	1,100	1,300	100	120	150	90	100	120	45	60	85				
Fullerton silty loam, hilly phase	16	21	35	11	15	19	26	36	14	19	26	12	14	19	22	.81	3.2	11.2	1	4	(7)	2.3	0	400	1,000	1,200	80	100	130	70	85	100	120	45	60	85			
Greendale silty loam	25	30	45	15	18	22	30	43	20	24	35	15	18	22	.81	3.2	11.2	1	4	(7)	2.3	0	600	1,400	1,600	130	150	180	110	115	135	60	75	100	75	100			
Greendale cherty silt loam, sloping phase	20	25	40	12	14	18	22	25	40	18	21	30	13	15	18	61.2	1.81	11	31	6	(7)	2.0	2.8	500	1,100	1,500	110	130	160	90	105	120	45	60	90				
Hamblen silt loam	30	35	40	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)		
Hilly stony land (Talbot soil material)	15	20	35	10	12	18	20	30	12	16	24	11	14	15	(7)	1.0	1.4	6	8	1.2	(7)	1.2	0	300	700	1,000	90	110	140	75	95	130	30	40	60				
Holston very fine sandy loam	20	25	35	10	12	17	20	25	32	16	20	27	10	12	17	.61	2.1	8.1	6	1.2	(7)	1.2	0	400	800	1,000	70	85	100	50	60	80	50	60	80	60	80		
Lead vale silt loam	18	22	32	9	11	16	18	23	30	15	18	25	9	11	16	61.2	1.6	8	1	3	(7)	1.2	0	400	500	1,000	60	70	90	50	60	75	45	55	75				
Lehigh very fine sandy loam	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)		
Limestone outcrop	28	33	35	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	
Limestone-Roane silt loams	7	10	15	5	7	9	10	13	18	8	10	14	6	8	10	3	6	8	5	7	9	1.0	1.2	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)
Lutz shaly silt loam, eroded hilly phase	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	
Lutz shaly silt loam, eroded phase	12	15	20	6	8	11	12	15	20	9	12	15	7	9	15	4	7	1.0	5	7	9	1.5	1.8	300	500	700	40	60	80	35	55	75	20	35	60				
Lutz shaly silt loam, eroded rolling phase	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	
Lutz shaly silty clay loam, severely eroded phase	8	12	15	6	7	10	11	14	20	9	12	15	7	9	13	3	6	8	5	7	9	1.5	1.8	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)
Melvin-Atkins silt loams	14	18	30	9	11	16	18	27	10	14	20	10	12	16	(7)	1.1	5	6	1.0	1.5	(7)	1.0	1.5	200	600	800	70	90	120	60	75	100	20	30	55				
Mnongahela very fine sandy loam	12	15	20	7	9	12	13	16	21	8	12	15	9	11	15	(7)	6.1	4	6	9	(7)	8.1	3	(7)	500	700	900	60	80	95	45	60	75	20	30	50			
Mnongahela very fine sandy loam, eroded sloping phase	18	22	30	12	15	20	25	35	12	16	24	12	15	20	.81	0.1	5	7	8	1.2	(7)	4	3.2	0	500	700	900	50	60	80	55	70	90	30	40	70			
Needmore silty clay loam, eroded rolling phase	35	40	45	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)		
Ooliewah silt loam	16	20	25	10	13	18	17	22	30	10	13	20	10	13	18	7	9	1	6	7	1.1	1.4	2.3	300	500	700	50	70	90	45	65	80	25	35	70				
Purdy silt loam	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)		
Rolling stony land (Talbot soil material)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)		

See footnotes at end of table.

In column B the index refers to the expected yields under the most common system of management, or at least one of the most common systems, practiced in this county. This system includes (1) rotation of crops, (2) light fertilization, and liming, and (3) moderately careful tillage, but (4) no special engineering measures such as terracing or subsoiling. Although crops are rotated, neither the selection nor the rotation of crops is especially well adjusted to the needs of the soils, generally speaking. The most common rotation, and the one assumed for the management under column B, consists of corn, 1 year; small grain, 1 year; and legume and grasses mixed, 1 or 2 years. The most common legume-and-grass mixture is lespedeza and redtop, although lespedeza is grown alone in a great many places. Red clover and timothy is the next most common mixture. Light applications of phosphate alone or phosphate and potash are used for small grains. Lime is used on soils of the terraces and uplands, but the applications are generally insufficient for the most practical results. Green manuring and the growing of winter cover crops are uncommon. Cultivation is generally not performed on the contour except on the steep slopes, and special measures such as terracing or deep subsoiling are not common. On soils of the bottoms the occasional alternation of corn and hay is assumed as the rotation.

Although the above paragraph points out the most common system of management or at least one of the most common systems, it should be remembered that the actual management of the soils varies more than is indicated. In many places the management is intermediate between the systems specified for the ratings in columns A and B, whereas in other places the management is intermediate between the systems specified for the ratings in columns B and C.

Column C gives the average yields that may be expected under what is considered to be the best practicable management. Practices of management include the use of lime and commercial fertilizers when and where needed; proper handling and return of manure and crop residues; careful selection and rotation of crops, including the use of legumes and cover crops; adequate drainage; the use of engineering devices or other means for control of water when necessary; and proper tillage methods. Further details on these best practices for each of the soils are given in the sections on Soils and Crops and Land Use and Soil Management. Only a small proportion of the soils are being managed in this way now, and the yields given are mainly estimates. Although accurate data are not sufficient to support these yields adequately, the relative response of each soil to management practices is brought out by comparing these yields with those in columns A and B.

Only yields for conditions of no protection from flooding have been given for the soils of the flood plains, as no areas are definitely protected by dikes or levees. The floods generally occur in winter and early in spring, and their chief danger is to winter crops. Only yields for the undrained condition are given for the poorly drained soils.

In order to compare directly the yields obtained in Hamblen County with those obtained in other parts of the country, the yields have been converted in table 8 to indexes based on standard yields.

The soils are listed in the approximate order of their general productivity for the crops commonly grown under the prevailing farming practices, but the order is modified in some degree to show the com-

parative suitability of the soils for use as influenced by workability of the soils and the problems they offer in conservation. No attempt is made to group the soils best suited to particular crops, and the differences in the quality of the crops are not given full consideration.

The rating compares the productivity of each of the soils for each crop to a standard of 100. This standard represents the approximate average yield obtained without the use of fertilizer and other amendments on the more extensive and better soils of the regions of the United States where the crop is most widely grown. An index of 50 indicates that the soil is about half as productive for the specified crop as the soil with the standard index. The standard yield for each crop shown in table 8 is given at the head of each respective column. Soils given amendments, such as commercial fertilizers and lime, or special practices, such as irrigation, and unusually productive soils may have productivity indexes of more than 100 for some crops.

Factors influencing the productivity of the land are mainly climate, soil (including drainage and relief), and management. No one of these factors operates separately from the others, although some one may dominate. Crop yields over a long period of years furnish the best available summation of these factors contributing to productivity, and they are used whenever available. Productivity tables cannot present the relative roles that separate soil areas play in the agriculture of the county, because of the variable associations in which they occur. The tables give a characterization to the productivity of individual soil types and phases. They cannot picture the total quantitative production of crops by soil areas without the additional knowledge of the acreage of the individual soil types planted to each of the specified crops. Economic considerations play no part in determining the productivity ratings; therefore the ratings cannot be interpreted directly into land values except in a very general way. Distance to market, relative prices of farm products, and other factors influence the value of land.

In the column headed "Physical land classification" in table 8 the soil types, phases, and complexes and miscellaneous land types of the county are grouped according to their relative physical suitability for use into First-class soils, Second-class soils, Third-class soils, Fourth-class soils, and Fifth-class soils. This grouping is on the county-wide basis, not a regional or Nation-wide basis, and for that reason the various groups may not be exactly comparable to corresponding groups in other areas, although the groups in general are fairly consistent throughout the entire Great Valley of East Tennessee. This grouping of the soils is not to be taken as a recommendation for use. The purpose of the information provided is to show the relative physical adaptability of the various soils in the present agriculture of the county. It is fully recognized that information on a number of additional factors is necessary in order to make general recommendations for land use, and specific recommendations to apply on any one farm would require additional knowledge and consideration of a number of factors applying to that farm.

The soils of Hamblen County differ widely in physical characteristics and consequently in capabilities for use and requirements for management. Such differences are the results of a number of internal and external soil features, such as texture, structure, consistence, quantity and character of organic matter, chemical character (including

reaction), moisture conditions, depth, erosion, stoniness, and slope or lay of the land. These physical soil characteristics determine the productivity,⁹ workability,¹⁰ and conservability¹¹ of each soil type and phase. These three conditions, in turn, determine the degree to which each soil is adapted physically to the production of useful plants common to the region. The soil types and phases have been arranged in five groups according to their degree of physical adaptation and are referred to as First-class soils, Second-class soils, Third-class soils, Fourth-class soils, and Fifth-class soils, and the class designations for each of the soils are given in the column headed "Physical land classification in table 8.

An ideal soil for the production of crops is one that is very productive, is easily worked, and is capable of being conserved with minimum effort. A soil with such an ideal combination of features is very rare, if it exists at all. Such a perfect soil for the production of crops is more nearly an ideal, therefore, and rarely if ever an actuality. All the soil types and phases in Hamblen County fall short of this ideal, but they differ in degree of shortcoming. On the basis of this degree of shortcoming they are placed in five groups or classes for convenience in discussing their relationship to agriculture. These in order of their desirability are, as previously mentioned, First-class soils, Second-class soils, Third-class soils, Fourth-class soils, and Fifth-class soils.

First-, Second-, and Third-class soils, in general, are used for the production of crops requiring tillage and are considered physically adapted to this use under most conditions. Under average conditions only a small part of the Fourth-class soils and practically none of the Fifth-class soils are used continuously for the ordinary production of crops, and they are not considered to be physically adapted to such use. Although the First-, Second-, and Third-class soils are generally thought of as physically adapted to these crops, the First-class soils are very well adapted, whereas the Third-class soils are poorly adapted and the Second-class soils are intermediate in this respect. The Fourth-class soils in general are poorly adapted to crops requiring tillage but are sufficiently productive to justify their use for pasture under most conditions. Although they are fairly to moderately productive, they are difficult to work or difficult to conserve, or both. The Fifth-class soils generally are less productive, less easily worked, and more difficult to conserve than the soils of any of the other four groups; therefore they are poorly adapted either to crops requiring tillage or to pasture and are considered to be physically adapted only to forestry.

FIRST-CLASS SOILS

The First-class soils comprise the following: Emory silt loam, State loam, Decatur silt loam, Dewey silt loam, Abernathy silt loam, Congaree very fine sandy loam, and Staser silt loam.

⁹ Productivity as used here refers to the capacity of the soil to produce crops under the prevailing farming practices. The soil may be productive of a crop but not well adapted to it because of poor workability or poor conservability or both.

¹⁰ Workability as used here refers to the ease of tillage, harvesting, and other field operations. The following characteristics affect workability: Texture, structure, consistence, content of organic matter, stoniness, and slope or lay of the land.

¹¹ Conservability as used here refers to the relative ease of maintenance or improvement of the productivity and workability of the soil, including the control of water. The degree to which the soil responds to management practices is reflected in conservability.

These soils are productive, easy to work, and easy to conserve; hence they are physically very well suited to the production of crops common to the area. The seven soils of this group are of small extent, as their total area is only 3.9 percent of the area of the county; but they are important in the local agriculture.

These soils are characterized by diversity in degree of profile development, in kind of parent materials, and in other characteristics, but they are similar as regards conditions of productivity, workability, and conservability. All these soils are relatively well supplied with plant nutrients, although they differ somewhat in this respect. The less fertile of them are very responsive to applications of needed amendments. None of them are very poor in lime; the Staser and Abernathy soils are well supplied, although the others are generally acid in reaction. All the soils of this group are well drained, yet their physical properties are such that moisture is well retained, tending to insure an equable supply for plant growth; that is, the physical character of these soils is such that growing crops are relatively resistant to extreme amounts of rainfall. Tilt is favorable, and the soils may be tilled under a comparatively wide range in moisture content. Organic matter is comparatively abundant. The fact that most of the organic matter has become an integral part of the soils shows that their character is favorable to humifying processes. Because of the favorable physical properties of these soils, air and moisture circulate normally and roots freely penetrate all parts of the subsoil.

None of these soils is characterized by any important adverse external soil or land condition; that is, stones are practically absent, slope or lay of the land is favorable to soil conservation and cultural operations, and severe erosion has not been and is not likely to be a problem. To summarize, these soils have a relatively high natural fertility, favorable working qualities, and comparatively simple problems of conservation both for the continued fertility of the soil and for the soil material itself. No detrimental characteristics, such as poverty of organic matter and plant nutrients or adverse conditions of texture, structure, consistence, erosion, stoniness, or moisture, are prominent in any of these soils; and they are all well adapted to most of the exacting and intensive crops of the locality.

SECOND-CLASS SOILS

The Second-class is made up of the following soils: Decatur silty clay loam, eroded phase; Dewey silty clay loam, eroded phase; Bolton loam, eroded rolling phase; Altavista loam; Whitesburg silt loam; Sequatchie fine sandy loam; Staser fine sandy loam; Ooltewah silt loam; Hamblen silt loam; Greendale silt loam; Waynesboro very fine sandy loam; Fullerton silt loam; Fullerton silt loam, eroded phase; Lindsie-Roane silt loams; Chewacla loam; Fullerton fine sandy loam; and Fullerton fine sandy loam, eroded phase.

As compared with the First-class soils, the Second-class soils are less favorable in productivity, workability, or conservability; nevertheless they are well suited to the production of crops common to the area. The 17 soils of this group comprise 24.5 percent of the area of the county.

The Second-class soils differ from one another in a number of respects, although they do not differ widely as regards conditions of

productivity, workability, and conservability. Each soil of this division partakes of one or more detrimental or unfavorable characteristics and conditions, such as natural poverty of plant nutrients, scarcity or poor assimilation of organic matter, severe leaching, unfavorable physical properties, or injurious degree of stoniness and erosion. The detrimental effect of some one or some combination of such undesirable characteristics on the productivity or suitability for cultivation of each of these soils is greater than for any soil of the First class, but less than that of any soil in the Third class. The Second-class soils are moderately productive of most of the crops commonly grown. Their physical properties are moderately favorable to tillage and normal circulation and retention of moisture. None of these soils has a pronounced relief, and none is extremely stony or severely eroded. In short, they are all reasonably well adapted to most of the important crops of the county.

THIRD-CLASS SOILS

The following soils are placed in the Third class: Talbott silty clay loam, eroded phase; Greendale cherty silt loam, sloping phase; Fullerton cherty silt loam; Fullerton cherty silt loam, eroded phase; Decatur silty clay loam, eroded hilly phase; Dewey silty clay loam, eroded hilly phase; Bolton loam, eroded phase; Needmore silt loam; Dandridge shaly silty clay loam, eroded rolling phase; Needmore silty clay loam, eroded rolling phase; Leadvale silt loam; Sequoia silty clay loam, eroded phase; Holston very fine sandy loam; Leadvale silt loam, sloping phase; Monongahela very fine sandy loam; Congaree loamy fine sand; Fullerton silt loam, hilly phase; Fullerton silt loam, eroded hilly phase; Fullerton fine sandy loam, hilly phase; Fullerton fine sandy loam, eroded hilly phase; Clarksville cherty silt loam; Litz shaly silt loam, eroded rolling phase; and Monongahela very fine sandy loam, eroded sloping phase.

The Third-class soils are characterized by one or more rather prominent and detrimental features, such as poverty of plant nutrients, undesirable physical properties, shallowness over bedrock, scarcity of organic matter, steep slope, stoniness, and eroded condition. The degree of prominence of these features not only determines the class of the 23 Third-class soils but also provides the chief bases on which they are separated from one another. Because these detrimental characteristics affect the capabilities for use and the requirements for management of these soils through the conditions of productivity, workability, and conservability, it is equally true that these three factors are more adverse in Third-class soils than in the First- and Second-class soils, but less adverse than in the Fourth- and Fifth-class soils. Under ordinary conditions the use of these soils for the production of crops requiring tillage is considered feasible so far as the soils themselves are concerned. The soils of this group include 28.1 percent of the area of the county.

FOURTH-CLASS SOILS

The Fourth-class soils comprise the following: Fullerton cherty silt loam, hilly phase; Fullerton cherty silt loam, eroded hilly phase; Dandridge shaly silty clay loam, eroded phase; Talbott silty clay loam, severely eroded phase; Talbott silty clay loam, eroded hilly

phase; Armuchee silty clay loam, eroded phase; Clarksville cherty silt loam, hilly phase; Clarksville cherty silt loam, eroded hilly phase; rolling stony land (Talbot soil material); hilly stony land (Talbot soil material); Tyler silt loam; Melvin-Atkins silt loams; Purdy silt loam; Dewey silty clay loam, severely eroded hilly phase; Dewey silty clay loam, eroded steep phase; Dandridge shaly silty clay loam, eroded steep phase; Dandridge gravelly silty clay loam, eroded phase; Litz-Holston complex; Litz shaly silt loam, eroded hilly phase; and Fullerton cherty silty clay loam, severely eroded phase.

None of the soils previously discussed in this section on Productivity Ratings and Physical Land Classification is characterized by extreme development of any of those soil or land features that are unfavorable for the growth of crops, whereas the Fourth- and Fifth-class soils are characterized by extremely adverse conditions of productivity, workability, or conservability. The Fourth-class soils are, however, at least moderately productive of pasture grasses, as they have at least moderate natural fertility and moderate to high content of moisture. Aside from these common features, they differ widely from one another as regards the kind, number, combination, and extent of the development of both internal and external soil characteristics. The 20 members of this group make up 30.3 percent of the area of the county.

FIFTH-CLASS SOILS

The following soils are placed in the Fifth class: Fullerton cherty silt loam, steep phase; Fullerton cherty silt loam, eroded steep phase; Armuchee silty clay loam, severely eroded phase; Talbot silty clay loam, severely eroded hilly phase; Talbot silty clay loam, eroded steep phase; Clarksville cherty silt loam, steep phase; Dandridge gravelly silty clay loam, eroded steep phase; Dewey silty clay loam, severely eroded steep phase; Fullerton cherty silty clay loam, severely eroded steep phase; Litz shaly silt loam, eroded phase; Upshur-Litz silt loams; Litz shaly silty clay loam, severely eroded phase; Lebew very fine sandy loam; rough gullied land (limestone residuum); rough gullied land (Litz soil material); rough stony land (Talbot soil material); and limestone outcrop.

Like the soils of the Fourth class, each of the soils of the Fifth class is characterized by one or more very unfavorable or detrimental soil or land features that make them physically unsuitable for growing cultivated crops, and in addition they are so low in inherent fertility or moisture supply that they are not even suited to pasture. Each of them is very low in productivity, although they vary somewhat from one another as regards condition of workability and conservability. Although these soils grow forest trees more slowly than any other group of soils in the county, they may be considered as physically adapted to forest in the broad sense that implies the use of land that best serves conditions as they exist. It is clearly understood, however, that factors arising from other existing conditions either of the locality or of the individual farm unit may overshadow physical land adaptations.

Although the Fifth-class soils are similar in that they are all characterized by features that disqualify them for any of the preceding classes, they differ from one another in many respects, and on the bases of such differences they are classified and mapped into 12 distinct

soil types and phases, 1 complex, and 4 miscellaneous land types, constituting 13.2 percent of the area of the county.

SOIL ASSOCIATIONS

Several kinds of useful generalized maps can be made from the master soil map. Figure 2, a generalized map showing the areas dominated by various groups of geographically associated series of soils, is one of these. Each soil-association area consists predominantly of soils of the series included in the name designated for the area. For example, the areas designated as the Dewey-Decatur association

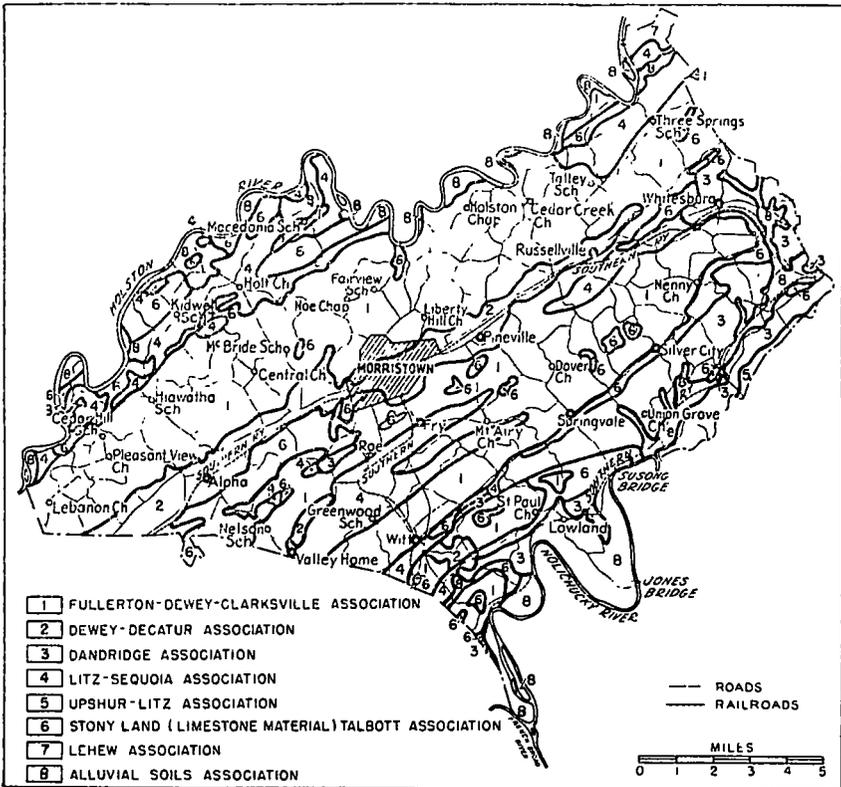


FIGURE 2.—Generalized map of soil associations in Hamblen County, Tenn.

consist chiefly of the various members of the Dewey and Decatur series; but, as this is a generalized map, less extensive areas of a number of other soils are also included. This is also true of the other soil-association areas.

The soils in each kind of soil-association area generally manifest a characteristic pattern of distribution. These patterns can be determined from the detailed soil map from which this generalized map was prepared. In many places, patterns of soil use are closely correlated with patterns of soil distribution within each soil-association area, especially where the soils differ widely from one another in their physical suitability for agricultural use. The fact that soils are closely associated geographically does not imply that they are similar

in their characteristics or in their physical suitability for agricultural use. The members of an association differ from one another, some widely, others only slightly.

The particular association in which a soil occurs may have a great influence on the present as well as the potential use of that soil, and also on the relative importance of that soil to the agriculture of the area. Whether a soil physically suitable for the production of crops, for example, is associated with other soils also physically suitable for such use, or with soils physically unsuitable for such use, has great influence on the relation of that soil to the agriculture of the area.

From the foregoing, it is apparent that in order to use the soil survey to good advantage for general land planning and for similar uses it is important to know not only the physical characteristics of the soils and their physical suitability for various uses but also what is here referred to as soil associations. Knowledge of the soil associations is also useful in learning to identify the soils of an area, to understand their distribution, and to interpret and predict their relations to agriculture.

A brief discussion of each soil association follows. More detailed information can be obtained from the discussions of the various soils in the section on Soils and Crops.

FULLERTON-DEWEY-CLARKSVILLE ASSOCIATION

The Fullerton-Dewey-Clarksville association is by far the most extensive. It includes between 40 and 50 percent of the total area and is the predominating association in a northeast-southwest belt that includes more than two-thirds of the county. In this association the Fullerton soils are by far the most extensive and predominate over the others; the Dewey soils and the Clarksville soils are considerably less extensive. Other inextensive but important soils are members of the Bolton, Greendale, Lindside, and Roane series. The relief is prevailing rolling to hilly, and drainage is well established. Numerous sinkholes give the association a hummocky or karst relief (pl. 14, *A*).

The Fullerton-Dewey-Clarksville areas consist chiefly of Second-, Third-, Fourth-, and Fifth-class soils. Nearly all of the land is in small farms, a large proportion of them being less than 50 acres in size. The rural population in these areas is therefore rather high—higher than in most other rural parts of the county. Most of the farm homes are modest. The agriculture is generally highly diversified and entails chiefly the production of grain and livestock for home use. Tobacco, the chief cash crop, is grown in small patches on most farms. The relative extent of the alluvial and colluvial associates of the Fullerton soil greatly influences the prosperity of farms on these soils. Where areas of these soils are scarce, the farms are largely self-sufficing and tobacco, the chief crop, is grown in patches (pl. 14, *B*). Where the areas are relatively significant their greater productivity of corn and hay is generally reflected in the improved condition of the farmstead (pl. 14, *C*). As a group the soils are only moderately productive; but they are responsive to management, especially fertilization, and their productivity can therefore be increased where improved management is feasible.

DEWEY-DECATUR ASSOCIATION

The Dewey-Decatur association is relatively inextensive, occupying between 5 and 10 percent of the area of the county. The main area

is a narrow northeast-southwest belt through the middle of the county, parallel to United States Highway No. 11E. A small area occurs about 4 miles southwest of Morristown, and another lies in the southern part of the county just southeast of Witt. Although the Dewey and Decatur soils predominate in these areas, the Fullerton, Talbott, Emory, Abernathy, and Ooltewah soils, rolling stony land (Talbott soil material), and hilly stony land (Talbott soil material) are of significant extent. The relief, which is characterized by sinkholes, is predominantly undulating to rolling, and drainage is good.

The Second-class soils predominate in this association, but First-class soils are also relatively extensive. The Third- and Fourth-class soils are of significant extent, but Fifth-class soils are generally absent. All areas of the Dewey-Decatur association are in farms. Judging by the high proportion of well-built and well-maintained farm buildings and fences, the agriculture of these areas is the most prosperous in the county. As compared with the Fullerton-Dewey-Clarksville areas, the farms in the Dewey-Decatur areas are generally larger, and the density of the rural population is less except in the immediate vicinity of Morristown. The agriculture is highly diversified, and corn, small grains, livestock (pl. 5, *B*), and livestock products are produced for sale as well as for consumption in the home, but burley tobacco and livestock are the chief products produced for sale. As a group, the soils are productive and physically well suited to the agriculture of the area. They also are responsive to good management.

DANDRIDGE ASSOCIATION

The association of Dandridge soils, which includes about 10 percent of the area of the county, occurs chiefly in a belt along the southeastern boundary. The belt is highly dissected by a fingerlike drainage pattern, and the relief is prevailingly hilly (pl. 15, *A*). The Dandridge soils greatly predominate, although small but important areas of the Hamblen, Staser, and Whitesburg soils (pl. 15, *B*) are scattered throughout the belt and areas of the Needmore soils occur in some places.

The Fourth-class soils are by far the most extensive in this association, although there are significant areas of Second-, Third-, and Fifth-class soils. Nearly all of the areas are cleared and in agricultural use. The agriculture is diversified, but it centers largely on livestock raising. Largely because of their steep slope and shallowness, the Dandridge soils are physically poorly suited to the production of general field crops, hence the proportion of soils physically well suited to crops such as corn is small. On the other hand, the proportion that is well suited to permanent pasture and certain hay crops is large. On many farms there is a dearth of soils physically well suited to cultivated crops, and in order to produce sufficient feed and cash in the type of farming practiced in these areas, farmers have had to cultivate the Dandridge soils instead of utilizing them chiefly for pasture. As a result, these soils in most places are more or less eroded and are continuing to erode in many places at a rate rapid enough to cause serious concern. In view of this, a shift in the use of these soils from crops to pasture, or at least some alteration of the present management of them, should be considered. The Dandridge soils north of Bent Creek are more productive and better

suited to farming than the typical soils, and this fact is reflected in the agriculture of this locality, which appears to be more prosperous than is usual for extensive areas of the Dandridge soils.

LITZ-SEQUOIA ASSOCIATION

The Litz-Sequoia association includes between 10 and 15 percent of the area of the county. The Litz soils predominate in most places, especially in the larger areas along the Holston River and south of Morristown; the Sequoia soils predominate in the smaller areas south of Witt; and the Sequoia and Armuchee soils predominate in the areas west of Whitesburg. Other soils commonly occurring in this association are members of the Leadvale, Hamblen, Atkins, and Melvin series and in many places the miscellaneous land types characterized by limestone outcrops. Most areas are rather thoroughly dissected by a fingerlike drainage pattern. The relief in the places where the Litz soils predominate is prevailingly hilly and steep; where the Sequoia soils predominate it is rolling, and where the Armuchee and Sequoia soils predominate it is hilly.

The Fifth-class soils greatly predominate in the larger and more typical areas, the Fourth-class soils in the area west of Whitesburg, and Third-class soils in the areas south of Witt. The large and more typical areas are poorly suited to farming, and prosperous-looking farms are few. Between 60 and 75 percent of the total area of the Litz soils, however, is cleared and is used for crops and pasture, although a large proportion of the cleared land is idle. The areas in which the Sequoia and Armuchee soils predominate are much better suited to farming than the areas in which the Litz soils predominate, although they are not especially well suited to such use.

UPSHUR-LITZ ASSOCIATION

The Upshur-Litz association is of small extent and of little importance in the agriculture of this county. It covers less than 1 percent of the area of the county, in the southeastern part, on the ridge of Bays Mountains that forms the boundary between Hamblen and Greene Counties. The Litz and Upshur soils, which comprise a complex, are the only soils mapped in this area, although included with them is a variation characterized by sandstones. The greater part of the soils of this association is in forest, which is apparently the use to which it is physically best adapted under present conditions; but much of it is potential pasture land, although the soil is not well suited to such use.

STONY LAND (LIMESTONE MATERIAL)—TALBOTT ASSOCIATION

The stony land (limestone material)-Talbot association, which includes about 10 percent of the area of the county, consists chiefly of the miscellaneous land types characterized by limestone outcrops with which are intermixed less extensive areas of Talbot soils. Rolling stony land (Talbot soil material) and hilly stony land (Talbot soil material) predominate. A small quantity of Dandridge and Litz soils are included. The largest single area of this association lies west of Morristown and south of the belt of the Dewey-Decatur association. Extensive areas also occur along both the Holston and



A, Typical dissected and steep areas of the Dandridge soils, showing many eroded spots. Whitesburg silt loam, a productive soil, occurs at the immediate foot of these hills, and the less productive Tyler and Monongahela soils occupy the flat, light-colored stream terraces. *B*, On farms like this, in areas of the Dandridge soil association, a significant acreage of colluvial and alluvial soils, such as the Whitesburg, Staser, and Hamblen, is of great importance. The necessary hay and feed can be grown on these comparatively productive soils, thereby allowing the Dandridge soils, which make poor cropland but good pasture land, to be used almost exclusively for pasture. Otherwise it might be necessary to cultivate the Dandridge soils and thus subject them to erosion.



- A, Soybeans and millet on eroded Dewey silty clay loam. Soybeans can be grown successfully on this soil, but because they tend to loosen the surface soil and increase the susceptibility to erosion they should be grown sparingly if at all on slopes and should be followed by a winter cover crop. Soybeans are better adapted to soils of gently undulating to nearly level areas, such as Monongahela very fine sandy loam, Tyler silt loam, and State silt loam. B, Pasture on Dandridge silty clay loam, eroded phase, improved by deep subsoiling. Areas of this soil that have been used extensively for growing crops often become severely eroded. The establishment of a good stand of bluegrass requires application of phosphates and restricted grazing in addition to deep subsoiling on the contour.

the Nolichucky Rivers, and many small areas are scattered throughout other parts of the county underlain by limestone.

The surface is rolling to hilly and is characterized by many sink-holes. Areas of this association are not well suited to agriculture. A large part of the acreage is of Fourth-class soils that are too stony to cultivate and are used for permanent pasture. The scattered areas of Talbott soils are predominantly Second- and Third-class soils, and the steepest and most rocky areas are Fifth-class soils.

LEHEW ASSOCIATION

In the Lelew association, Lelew very fine sandy loam is most important, although a few small areas of the Litz soils are included. This association is of small extent, covering less than 1 percent of the area of the county, in the extreme northeastern corner, and it is of little importance agriculturally. Nearly all of the land is in forest, which apparently is the use to which it is physically best adapted under present conditions, as the land is unsuitable for feasible farming.

ALLUVIAL SOILS ASSOCIATION

The alluvial association includes the soils of the stream bottoms and stream terraces along the Nolichucky and Holston Rivers and along Bent Creek, comprising about 10 percent of the area of the county. Along the Holston River the main soils are Staser fine sandy loam of the bottom lands, Sequatchie fine sandy loam of the low terraces, and the Waynesboro and the Monongahela soils of the high terraces. Along the Nolichucky River the main soils are the Congaree and Chewacla of the bottom lands, the State and Altavista soils of the low terraces, and the Purdy, Tyler, and Monongahela soils of the high terraces. Along Bent Creek the predominant soils are Staser silt loam and Hamblen silt loam of the bottom lands and the Monongahela soils of the terraces. Small areas of soils of the adjoining col-luvial land and uplands are also included in many places.

In this association of alluvial soils, First- and Second-class soils predominate, Third-class soils are of considerable extent, Fourth-class soils are of small extent, and Fifth-class soils are absent. The soils of the bottoms are used chiefly for the production of corn, to which they are very well suited, and from which relatively high yields are obtained. The soils of the terraces are used chiefly for the production of the various commonly grown crops, although a large part of the area of the Purdy and Tyler soils, which are physically poorly suited to crop production, is used for other purposes.

LAND USE AND SOIL MANAGEMENT ¹²

The use of the different soils on a farm is determined by a number of factors—physical, economic, and social. As the use of land is determined in part by economic and social factors, in many places such use cannot be brought into full accord with the physical limitations of the soils. Nevertheless, one of the aims in the operation of a farm

¹² This section was prepared by A. C. Orvedal, Division of Soil Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture

is to adjust the use of the soils as nearly as practicable to their physical limitations.

In the section on Productivity Ratings and Physical Land Classification, the soils in the county are placed in five groups, referred to as First-class, Second-class, Third-class, Fourth-class, and Fifth-class soils. This grouping was made on a basis of the relative physical suitability of the various soils for the different major common farm uses, including (1) the production of both intertilled and close-growing crops in some rotation, (2) the maintenance of permanent pasture, and (3) the maintenance of farm forests.

It may be said in general that the physical characteristics of the First-, Second-, and Third-class soils more or less favor their use for the production of farm crops in various kinds and lengths of rotations. These soils represent 56 percent of the area of the county, as compared with 42 percent actually used for cropland in 1939, according to the United States census for 1940. So far as the soils themselves are concerned, the First-class soils are the best suited for this purpose, the Second-class soils are not so well suited, and the Third-class soils are even less well adapted to this use.

The Fourth-class soils, which are not considered physically well adapted to the production of farm crops requiring tillage, for reasons such as steep slope, eroded condition, stoniness, low fertility, and poor drainage, but are considered sufficiently productive of pasture plants to warrant their feasible use for permanent pasture, cover 30.3 percent of the area of the county. This is close to the percentage reported as plowable pasture in 1939, namely, 31 percent; although some of the land reported as other land in farms, covering 8 percent of the area of the county, undoubtedly was also used as pasture.

The Fifth-class soils are by no means physically suited for the production of crops requiring tillage, and they are generally too low in productivity for feasible use for pasture. Many areas of these soils are used for forestry, many are lying idle, and some are used for pasture. Chiefly because of features such as very steep slope, extreme stoniness, and severe erosion, the physical character of these soils suggests consideration of their use for forestry. In all, these soils represent 13.2 percent of the area of the county. Although only 13 percent of the area of the county was used as farm woodland in 1939, part of the area not in farms, about 6 percent, probably was forested.

In many instances due consideration of the social and economic conditions of the surrounding locality, and particularly those arising within the boundaries of the individual farm, may necessitate at times the use of soils that is out of accord with the physical limitations of those soils. As all the relevant social and economic factors, both outside and on the individual farms, must be considered in recommending soil use, it is not within the scope of this report to recommend specific uses of specific soils; the soil survey report and map deal primarily with the relative physical differences of the various soils as related to agriculture.

After the farmer has assigned suitable uses to his land—that is, for crops requiring tillage, for pasture, or for farm forests—the matter of management of each soil logically follows. The term “soil management,” as used here, refers to such practices as (1) choice and rotation of crops, (2) application of amendments, (3) tillage

practices, and (4) engineering measures of control of water on the farm.

The soils of Hamblen County differ widely in their requirements for management, but in many instances under ordinary farm conditions it may not be practicable to make complete adjustment of the practices of management to the physical needs of the soil. For this reason the discussion of the requirements for management of the various soils in Hamblen County, as given in this section, is not intended to be and should not be interpreted as specific recommendations.

The Tennessee Agricultural Experiment Station and the College of Agriculture have issued numerous publications dealing with specific problems in growing crops on the soils of Tennessee. A selected list of such publications follows.

Tennessee Agricultural Experiment Station Bulletins 102, The Rational Improvement of Highland Rim Soils; 112, The Small Grains in Tennessee; 119, Ground Limestone and Prosperity on the Farm; 126, Varieties of Corn and Their Adaptability to Different Soils; 129, Dark Tobacco Fertility Experiments at the Clarksville Station—Results from a Ten-Year Period—1913-1922; 136, The Oat Crop; 141, The Comparative Value of Different Phosphates (revised); 142 The Effects of Various Legumes on the Yield of Corn; 149, Fertilizers and Manure for Corn; 154, Lespedeza Sericea; and 165, Clovers and Grasses for Hay and Pasture.

Tennessee Agricultural Experiment Station Circulars 9, Nitrogenous Fertilizer Materials; 10, A Select List of Varieties of Farm Crops (revised); 11, Rates and Dates of Planting for Tennessee Farm and Garden Crops (revised); 12, Alfalfa and Sweet Clover Culture; 34, Increasing the Profits from Phosphates for Tennessee Soils; 45, Balho Rye; 49, Korean Lespedeza; 52, Rye for Pasture and Seed in Tennessee; and 60, Fertilizers for Tennessee Soils

Tennessee Agricultural Experiment Station Circular of Information 14, Austrian Winter Peas (mimeographed)

Tennessee Agricultural College Extension Publications 144, The Farm Woodland in Tennessee (revised); and 214, Small Grain in Contour Furrows on Lespedeza Sod.

Although each soil type and phase mapped in the county has its individuality as regards features affecting management requirements, the soils may be placed in a few groups, the members of which are closely related. Therefore, the 84 soil types, phases, and complexes and miscellaneous land types mapped in this county are placed in 11 groups in general on the basis of increasing difficulty in management.

GROUP 1

Group 1 includes the Abernathy, Chewacla, Congaree, Hamblen, Ooltewah, and Staser soils and the soil complex Lindside-Roane silt loams. The soils of this group are well suited to the production of crops, especially corn and hay. They are generally fertile and productive, easy to work, and easy to conserve; and their management requirements are simple as compared with the requirements of most of the soils of the uplands. All the soils of this group are on the stream bottoms except the Abernathy and Ooltewah, which lie in depressions or sinks. All are well drained except the Chewacla, Lindside, and Ooltewah soils, which are imperfectly drained and would be improved by artificial drainage. All have a favorable tilth, which is easily maintained in a good condition. None is especially low in lime, although the Congaree and Chewacla soils are definitely acid. The Staser and Hamblen soils, on the other hand, are high in lime.

Fertilizers are not ordinarily used on these soils, except where truck crops are grown on the Congaree soils. As the members of this group

are generally fertile, and as they are more or less enriched by periodic flooding, corn and hay crops have been and are being produced successfully without the addition of commercial fertilizers and without the benefits of systematic rotations. Increased yields, however, are to be expected from the systematic rotation of crops and also from fertilization, especially the application of phosphate. Benefits to crops, particularly hay crops, are to be expected from the application of lime on the Congaree and Chewacla soils, and also on the Lindside-Roane silt loams in some places. Where corn is grown year after year without having a winter legume turned under for green manure, nitrogen is quite likely to be a general requirement.

The selection of crops is important because the adaptation of these soils is restricted by danger of flooding, especially in the winter and spring, and also by imperfect internal drainage in some—the Chewacla, Lindside, and Hamblen. The selection of crops highly susceptible to injury from wet conditions therefore should be avoided. Among such crops is alfalfa, although it is successfully grown in some places. Small grains are generally more susceptible to lodging and to disease and generally mature later than on the soils of the uplands; for these reasons the selection of small grains seems unwise, unless they are grown for hay. Tobacco also appears to be poorly suited to these soils. Corn, on the other hand, is especially well suited to them even though it may be injured now and then by too much moisture. Numerous hay crops, including red clover, lespedeza, soybeans, cowpeas, and numerous grasses, are also well suited to these soils.

As the inclusion of grasses and legumes in the rotation is nearly always beneficial to the corn, a corn-hay rotation should be especially well suited to the soils of this group and should be selected, where it is otherwise consistent with good farm management, in preference to most other rotations common to the area. Growing winter legumes and plowing them under as green manures in spring before corn is planted should generally prove beneficial, especially where corn is grown every summer.

It is significant that these soils are also highly productive of pasture, and the fact that they generally remain moist and productive throughout hot, dry periods makes them especially valuable for pasture in certain areas. This is particularly true of the Hamblen and Lindside soils. Under use for permanent pasture, phosphate is the chief requirement, although lime will be needed on the Congaree and Chewacla soils and also in many places on Lindside-Roane silt loams.

GROUP 2

The Altavista, Emory, Greendale, Squatchie, State, and Whitesburg soils make up group 2. The requirements for management of the soils in this group are similar to those of the soils in group 1, but there are certain important differences. The soils of this group are not ordinarily susceptible to inundation by floodwater. They therefore have a wider range in adaptation and are less exacting in regard to the selection of crops. Several of the soils are also in greater need of fertilization.

The Emory, Greendale, and Whitesburg soils occur on accumulations of local wash at the foot of slopes; and the Altavista, State, and

Sequatchie soils occur on low terraces along the rivers. These soils are well drained, except the Altavista and Whitesburg, which are imperfectly drained. The slope is everywhere enough for good surface drainage except on the Altavista; in fact in a few places it is as much as 12 percent. All have good tilth, which is easy to maintain, and all are easy to work, although the sloping phase of Greendale cherty silt loam contains enough chert in many places to interfere somewhat with cultivation. As compared with other soils of the county, the fertility of the members of group 2 is high, except that of Greendale soils, which is about medium. The Emory and Whitesburg soils are generally about neutral in reaction and hence are well supplied with lime; the other soils are definitely acid and therefore generally deficient in lime, but they are not especially low in this constituent.

Fertilization of these soils is not common, although the Sequatchie and Greendale soils need it and the others also would likely benefit from it. Nitrogen is a general fertilizer requirement of these soils, except where this element is supplied by legumes. Phosphate is also considered a general requirement. Potash is less likely to be needed on the Altavista, State, and Whitesburg soils than on the others. Although none of them is especially low in lime, the application of this amendment generally would prove beneficial, except to the Whitesburg and Emory soils, which in most places are generally well supplied with lime. The Greendale soils definitely need lime.

No special attention is ordinarily required for either tillage or the control of water. The control of runoff is not a problem except in a few places where some of these soils receive excess runoff from the slopes above. In such places there is danger of injury by erosion and also by heavy deposition of material washed from the slopes above if they are eroding rapidly. Diversion of a part of the runoff from such slopes may therefore be necessary in a few places. A thin deposition of material from the slopes above, however, will generally be beneficial. Cultivation preferably should be on the contour, especially on the sloping phase of Greendale cherty silt loam, in which gullies have developed in a few places.

These soils are adapted to a large number of crops, and their requirements in regard to the selection of crops are not exacting. They are all suited to corn, small grains, and hay, although the Whitesburg and Altavista soils are not especially well adapted to small grains. Small grains have been observed to lodge rather heavily on the soils of this group, except on the Greendale and Sequatchie soils, which are very well suited to small grains. Alfalfa can be successfully grown. Natural drainage of the Altavista and Whitesburg soils, however, is barely adequate for this crop, and improvement of their drainage by artificial means should receive consideration where alfalfa is to be grown. State loam is probably the soil of this group best suited to alfalfa. Although this crop is successfully grown on these soils, there is some evidence indicating that it is better suited to certain other soils, such as the Dewey and Decatur. Nearly all of the other hay crops common to the area are well suited to the members of group 2. Tobacco is well suited to all members of this group except the Altavista and Whitesburg. High yields are normally obtained on Emory silt loam, and the Greendale soils are reported to produce tobacco of excellent quality. A rotation of corn and hay would be well suited to all the soils of this

group. One of corn, small grain, and hay might be equally well suited to all the soils except Altavista loam and Whitesburg silt loam.

GROUP 3

Group 3 includes the following soils: Bolton loam, eroded rolling phase; Decatur silt loam; Decatur silty clay loam, eroded phase; Dewey silt loam; Dewey silty clay loam, eroded phase; Fullerton silt loam; and Fullerton silt loam, eroded phase. The soils of this group have somewhat more exacting requirements for management than the soils of group 2, especially in regard to fertilization and the choice and rotation of crops, but less exacting ones than the soils of the subsequent groups.

All the soils of this group are physically very well suited to the production of crops, and they are chiefly used for that purpose. They have developed from limestone residuum on the undulating to gently rolling uplands, where the gradient generally ranges between 4 and 12 percent. All are well drained, are at least several feet deep over bedrock, are acid in reaction, and have firm but moderately friable subsoils. The tilth is good and is fairly easy to maintain in such a condition. Moderately susceptible to erosion, some of the soils have lost a part of their original surface soil, but generally not enough to injure them greatly or to change their requirements for management.

So far as practicable, tillage should be on the contour. Where numerous sinkholes make this impracticable, the rotation needs to be longer. Tillage should ordinarily be avoided when the soils are very wet or very dry, although the range in moisture content that will allow safe tillage is fairly wide.

Control of runoff is important but not difficult, and special engineering measures ordinarily should not be needed, although they may be needed under special conditions. Ordinarily, reasonable care in tillage, fertilization, and the selection of rotations will provide the necessary control of runoff.

Fertilization and liming are of great importance, as all these soils need fertilizers for the continued production of medium to high yields of crops. Lime and phosphate are needed, especially for legumes and grasses. Nitrogen is a general requirement except where it is supplied by legumes. Potash also is likely to be a general requirement for such soils. Green manuring or the growing of grasses is necessary for the maintenance of the content of organic matter. Having favorable physical characteristics, these soils generally respond very well to fertilization, green manuring, and other good management practices.

The members of this group have a wide range in adaptability to various kinds of crops, and their requirements as regards the selection of crops are therefore not exacting. It is important, however, to grow the selected crops in the proper rotation if the productivity of the soils is to be maintained or increased. Row crops need to be alternated with close-growing crops, and the periodic growth of deep-rooted crops is beneficial. The rotation, however, may be fairly short. Observations indicate that a row crop may safely be grown once every 3 years if fertilization and other management practices are good. A rotation consisting of corn 1 year, small grain 1 year, and clover or clover and grass 1 year appears to be well suited to these soils. In general, the growing of soybeans and cowpeas loosens

the surface soil, thereby increasing the susceptibility to erosion. They should be grown sparingly if at all on soils having a slope, and then they should be followed by a winter cover crop (pl. 16, A). Soybeans and cowpeas are better adapted to Monongahela very fine sandy loam of group 7 and the Tyler and Purdy soils of group 10. If clover is grown alone, it should be followed by a winter cover crop to be plowed under the next spring, preceding the planting of the corn. If the land is adequately fertilized, alfalfa does very well, and as it is a deep-rooted crop, its periodic production is to be encouraged. The growing of sweetclover, another deep-rooted plant, should have beneficial effects. Grass needs to be grown periodically in order to maintain the supply of organic matter. If grass is not included in the rotation, green manuring needs to be practiced.

GROUP 4

The soils considered together as group 4 are as follows: Decatur silty clay loam, eroded hilly phase; Bolton loam, eroded phase; Dewey silty clay loam, eroded hilly phase; Fullerton silt loam, hilly phase; Fullerton silt loam, eroded hilly phase; and Waynesboro very fine sandy loam. The requirements for management of these soils are more exacting than those of the members of group 3, chiefly because of steeper slope, which makes them more susceptible to erosion. They require longer rotations and greater care in tillage, but requirements for fertilizing and liming are similar for similar crops on the two groups of soils.

It is important that tillage be on the contour. Where this is not feasible because of the abundance of sinkholes, the rotation needs to be longer, and the omission of row crops altogether should be considered. Where the slopes are suitable, contour strip cropping deserves consideration. Engineering measures for the control of runoff and erosion may prove beneficial, but the slope is rather steep for terracing, which is the most common of such measures in this area.

Like the members of group 3, the members of group 4 are physically suited to the production of a wide variety of crops, but the growing of the selected crops in the proper rotation is more important on these soils. Under ordinary conditions row crops should be grown less frequently if at all, and the rotation therefore should be longer. The growth of grasses and deep-rooted legumes is important to both groups.

GROUP 5

Group 5 includes all but the steep areas of the Clarksville soils, all the sandy members of the Fullerton soils, and all but the severely eroded and steep areas of the cherty Fullerton soils.

As compared with the soils of groups 3 and 4, the soils of this group are naturally lower in fertility and productivity, contain less organic matter, and have a lower water-holding capacity, although, on the other hand, they are somewhat less susceptible to erosion on similar slopes. All occur in the uplands. The slope ranges from about 5 to 25 percent, although the predominant range is probably between 10 and 25 percent. Most of the soils are somewhat eroded but not enough to alter greatly the requirements for management.

Cultivation generally needs to be on the contour. The soils do not puddle or become cloddy readily, and the range in moisture content in which they can be safely worked is wide.

As these soils are susceptible, although not highly susceptible, to erosion, the control of runoff is important in their management. Control of runoff is also important in order to maintain a more equable supply of moisture, because these soils, it will be recalled, retain less moisture than the soils of the groups previously discussed. However, if tillage is on the contour and the proper rotation is followed and the fertilization is adequate, engineering measures, such as terracing or contour ditching, should not be necessary. Such measures, however, may prove beneficial or may be necessary where row crops are grown frequently. Where the slopes are suitable, contour strip cropping would be expected to be an effective practice.

As these soils are rather low in fertility, acid in reaction, and rather low in organic matter, the application of fertilizers and lime and the addition of organic matter are especially necessary and important. Practically all of the common fertilizer elements except nitrogen are needed for most crops. Nitrogen would not ordinarily be necessary for legumes or for crops immediately following legumes that have been turned under, but it might aid in getting certain legumes started.

Like the soils of groups 3 and 4, the soils of group 5 are suitable to the production of a wide variety of crops; but owing to lower fertility and lower water-holding capacity, the selection of crops needs to be somewhat different. If fertilization is to be held to a minimum, crops that have a low requirement for plant nutrients need to be selected. Under such conditions the selection of alfalfa, for example, needs to be avoided, and the substitution of lespedeza for red clover as the legume-grass mixture may be advisable. In view of the low moisture-holding capacity, crops that are resistant to drought or crops that make their maximum growth during seasons of high rainfall need to be selected; and in order to maintain or to replenish the supply of organic matter, grasses and green-manure crops need to be grown. The following rotation meets these conditions: Corn 1 year, wheat 1 year, and lespedeza and grass 2 or 3 years. If heavier applications of fertilizers are used, the substitution of red clover for lespedeza would probably prove beneficial.

A practice worth serious consideration on most soils of the uplands and terraces, but especially the soils of this group, is the production of small grains in contour furrows on lespedeza sod by the use of the furrow seeder (12). As yet this is not a common practice, but available evidence indicates that it is well adapted to a wide variety of soils, especially those of this group. By adopting this practice a crop of small grains and a crop of lespedeza hay can be obtained each year on the same field for a period of at least several years in a row. Although yields are increased by heavy fertilization, moderate yields are obtained even by comparatively light fertilization. Runoff and erosion appear to be adequately controlled by contour furrowing.

GROUP 6

The Needmore and Sequoia soils and Talbott silty clay loam, eroded phase, make up group 6. Heavy-textured subsoils exert considerable influence on the requirements for management of the soils in this group. Three of these soils have a gently rolling relief, similar to the prevail-

ing relief of the soils of group 3; but one soil—Needmore silt loam—has a gently undulating relief. All occur on the uplands, and all except Needmore silt loam are slightly to moderately eroded. As compared with the other soils of the county, the soils of this group are medium to low in productivity.

The tillage requirements of the soils of this group are similar to those of groups 3 and 4, but the range in moisture content at which they can be safely worked is narrower because they are more susceptible to puddling and clodding. Cultivation, of course, needs to be on the contour.

Even though the prevailing slope of these soils is similar to that of the members of group 3, these soils are considerably more susceptible to erosion, and the control of runoff and erosion is not only more necessary but is also more difficult. Engineering measures, such as terracing, are unlikely to be as successful as they might be on the soils of the groups previously discussed. In most places the adequate control of runoff and erosion must be effected by the maintenance of a vegetative cover most of the time. Contour strip cropping may be feasible in a few places, but many of the slopes are rather short for such a practice.

Like the soils of groups 3, 4, and 5, these soils need fertilizers, lime, and organic matter; but, owing to the heavy-textured subsoil, the response to fertilization may generally be somewhat lower.

In regard to the selection of crops and the sequence in which they need to be grown, these soils are similar to the soils of groups 3, 4, and 5; but they are in greater need of deep-rooted crops, chiefly in order to increase the permeability of the subsoil and to bring nutrients to the surface from the substratum. Deep-rooted crops, such as alfalfa or sweetclover, therefore need to be grown periodically, and preferably they should be grown in a regular rotation with shallow-rooted crops. Grasses need to be grown in order to maintain or increase the supply of organic matter and also to control runoff and erosion. The soils should not be allowed to lie bare for extended periods. The growing of winter cover crops is important, not only to maintain a vegetative cover, but also for turning under to help in maintaining the supply of organic matter, especially if grasses are not grown in the regular rotation. In short, these soils need a moderate to long rotation that includes deep-rooted legumes and grasses.

GROUP 7

Group 7 includes the Holston, Leadvale, and Monongahela soils. The requirements for management are similar in many respects to those of the soils in group 6, but there are certain differences, especially in regard to the selection of crops.

The members of this group are generally low in natural fertility, organic matter, and plant nutrients, and they are strongly to very strongly acid in reaction, although the Leadvale soils are more favorable in these respects than the Holston or Monongahela soils. Internal drainage is generally rather slow, and the soils, except the better drained Holston soil, warm rather slowly in the spring.

The tith is generally fairly good and can be maintained in such a condition by ordinary methods of tillage. Cultivation should be avoided, however, when the soil is especially wet or dry. The tith of the eroded sloping phase of Monongahela very fine sandy loam is

less favorable than that of the others, and its maintenance in a good condition requires somewhat more care. Increasing the supply of organic matter would improve the tilth, especially of the eroded Monongahela soil.

Ordinarily the control of water is a minor problem except on the eroded sloping phase of Monongahela very fine sandy loam and the more sloping areas of Holston very fine sandy loam, where the control of runoff and erosion is significant. In a few places the Leadvale soils receive excessive runoff from the slopes above and may receive injurious depositions of material from such slopes if they are eroding rapidly. In some places, therefore, the diversion of at least a part of such runoff may be necessary, but that is not a general requirement. Tillage should ordinarily be on the contour, at least on the sloping areas.

The members of this group, especially the Holston and Monongahela soils, are very low in plant nutrients and require fertilization, including the addition of organic matter, and liming. They are in greater need of such amendments than most of the soils previously discussed, except several members of group 5. The Holston soil responds well to fertilization, but the response of the Monongahela and Leadvale soils is not so good as that of the soils of groups 3, 4, and 5 and is about equal to or slightly below that of the soils in group 6.

In regard to the selection of crops, the soils are similar in their requirements to those in the preceding groups in that grasses need to be grown in order to maintain or increase the supply of durable organic matter and legumes need to be grown in order to add nitrogen, an element greatly needed by these soils. Although the members of this group would be benefited by the growing of deep-rooted crops, such as alfalfa, internal drainage is hardly adequate for the successful production of this crop, and heavy fertilization would be required. The selection of alfalfa therefore should ordinarily be avoided, although it has been successfully grown in some places. It would probably be more practicable to select sweetclover instead of alfalfa, even though this crop may not be especially well suited either. Although tobacco is grown to some extent on these soils, it is considered well suited only to the Holston soil, which produces excellent tobacco if it is adequately fertilized. Small grains appear to grow successfully, and also grasses such as orchard grass and redtop, and legumes such as lespedeza. With moderate applications of lime, phosphate, and probably potash, red clover can be grown successfully. Although the yields of corn are generally low, moderate yields of this crop would be obtainable under good management. Soybeans should do well on Monongahela very fine sandy loam (pl. 16, A). In view of the foregoing conditions, the selection of a moderately long rotation that includes grasses and legumes is advisable.

GROUP 8

The following soils are considered together in group 8: Dewey silty clay loam, severely eroded hilly phase; Dewey silty clay loam, eroded steep phase; Fullerton cherty silty clay loam, severely eroded phase; Talbott silty clay loam, severely eroded phase; Talbott silty clay loam, eroded hilly phase; and Talbott silty clay loam, eroded steep phase. The members of this group are physically poorly suited to the production of crops requiring tillage, chiefly because of injury from

erosion, steep slope, and high susceptibility to further erosion. Wherever feasible, therefore, they should be used for pasture or returned to forestry.

Where used for pasture and the pasture is already well established, the requirements are chiefly the periodic application of lime and phosphate and the necessary mowing in order to control weeds. Occasional replanting may be necessary. If the fertilization is adequate, the grazing is properly controlled, and the weeds are systematically eradicated, reseeding should ordinarily be unnecessary; on the contrary, the pastures would be expected to improve with age. Where pastures are not yet established, the soils present a difficult problem in management. Owing largely to unfavorable tilth, tendency to clod and bake, slow absorption of moisture, and extreme deficiency in organic matter of these soils, the establishment of pastures is difficult. Where there are gullies, check dams may be necessary; and in other places engineering measures, such as diversion ditches or contour ditches, may be advisable. Lime and phosphate are necessary, potash may be necessary, and nitrogen may aid in getting a desirable vegetation established. Pasture mixtures should contain a considerable proportion of drought-resistant plants.

If these soils are to be used for the production of crops requiring tillage, a use to which they are poorly suited, exacting requirements for management must be met. A vegetative cover needs to be maintained all or nearly all of the time, and the selection of row crops needs to be avoided altogether. Biennial and perennial close-growing crops should be selected in preference to annual crops that require preparation of the seedbed every year. Grasses and legumes should constitute the chief crops in the rotation. It is essential that cultivation be on the contour. Because of the steep slope and, in some of the members, a heavy-textured subsoil, terracing is unlikely to be practicable; but digging of contour ditches or diversion ditches may be beneficial, and the construction of a few check dams in some of the deeper gullies may be necessary. Fertilization, the addition of organic matter, and liming are also essential.

GROUP 9

Group 9 includes the following soils: Armuchee silty clay loam, eroded phase; Dandridge gravelly silty clay loam, eroded phase; Dandridge shaly silty clay loam, eroded phase; Dandridge shaly silty clay loam, eroded rolling phase; Litz shaly silt loam, eroded hilly phase; Litz shaly silt loam, eroded rolling phase; and Litz-Holston complex. Like the soils of group 8, the soils of this group are physically poorly suited to the production of crops requiring tillage, except the soils of the two eroded rolling phases, which may be used for this purpose more feasibly than the others.

Like the soils of group 8, the soils of this group also are physically suitable for pasture. The soils of the two groups, however, differ greatly in character, and as a result they differ in their requirements for management, even under use for pasture. The soils of group 9 are shaly and shallow over bedrock shales. An exception is the Holston soil, which is of small extent, in the Litz-Holston complex. On the other hand, the soils of group 8 are generally deep, at least several feet, over bedrock limestones.

In pastures contour subsoiling (pl. 16, *B*) to a depth of 15 to 24 inches would be expected to be especially beneficial to the Dandridge and Litz soils, particularly where pastures are not well established. This practice (1) increases the water-holding capacity, normally very low in these soils because of their shallowness; (2) reduces the amount of runoff and hence the susceptibility to erosion, which is high; (3) facilitates deeper penetration of plant roots; and (4) has the same effect as fertilization, as the underlying slightly weathered fragments of shale, brought to the surface, disintegrate rapidly on exposure, thus releasing plant nutrients.

The application of phosphate is a general requirement on all these soils, but they differ markedly in their requirement for lime. The Dandridge soils, underlain by calcareous shales, generally do not require the application of lime. The Litz and Armuchee soils, on the other hand, generally low in lime, definitely require the application of this amendment. In view of the fact that shale is generally high in potash and that these soils generally contain much shale, it seems probable that potash may not generally be required, at least not in large quantities.

Where pastures are not established on these soils, pasture mixtures should contain a moderate to high proportion of drought-resistant plants. Indications are that, after a vegetative cover is once established, bluegrass and white clover will predominate eventually, especially on the Dandridge soils, if the management is good.

For the production of field crops, to which these soils are generally not well suited, the requirements for management are exacting for various reasons, including the shallowness, the low water-holding capacity, and the high susceptibility to erosion of the soils. Subsoiling would be expected to be fully as beneficial, if not more so, to these soils when used for crops as when used for pasture, and this practice should receive consideration wherever crops are grown.

If crops are grown, they should be chiefly close growing and preferably biennial or perennial. The selection of corn or other row crops should generally be avoided, although such crops can apparently be successfully grown on the eroded rolling phases of the Litz and Dandridge series. The high yields of corn occasionally obtained on the soils of this group, especially on the Dandridge soils, encourages farmers in some areas to grow such crops rather frequently; but in view of the serious risk of injury to the soils from excessive erosion when planted to row crops, the frequent production of such crops seems unwise. The growing of soybeans and cowpeas should also be avoided, even though they grow reasonably well on these soils, because they leave the soil material in a loose and highly erodible condition. Hay crops, such as red clover and grass, lespedeza and grass, sweetclover, and alfalfa, appear to be among the crops best suited to these soils. Small grains also succeed fairly well. Planting small grains in contour furrows on lespedeza sod by means of the furrow seeder, as discussed under group 5, might also be well suited to the soils of this group. The fertilizer requirements when the land is used for crops, chiefly hay crops, would be similar to those when the land is in pasture. Ordinarily the Dandridge soil does not require lime, but the others do.

GROUP 10

Melvin-Atkins silt loams, Purdy silt loam, and Tyler silt loam make up group 10, which is characterized by poor drainage. Chiefly because of this unfavorable feature, these soils are very poorly suited to the production of crops requiring tillage. They are generally best suited to pasture, and the greater proportion of the land is used for that purpose.

Melvin-Atkins silt loams occur on bottoms and are susceptible to frequent flooding, whereas the Purdy and Tyler soils occur on the nearly level but generally high stream terraces. The Tyler and Purdy soils have compact slowly pervious subsoils or substrata, and in some places Melvin-Atkins silt loams also contain fine-textured material in the subsoils.

If these soils are used for pasture, their management entails chiefly the selection of water-tolerant plants and the eradication of weeds. All the soils of this group are rather low in organic matter, and whatever organic matter is present is rather poorly combined with the mineral soil material; therefore these soils would be improved by the addition of organic matter. All except Melvin silt loam are in great need of lime and would be improved by the application of lime. Furthermore, all members are generally low in phosphate, and it is not improbable that some might be low in potash; and in view of this, the application of these amendments should be beneficial. Because of the poor drainage and the unfavorable physical condition of the subsoils and substrata, the response to fertilization may be low, probably too low in many places to justify fertilization.

Improvement of the drainage by artificial means would increase the productivity of these soils for pasture and also their response to fertilization. Artificial drainage is essential if the soils are to be used for crops. This may be rather difficult, especially on the Purdy and Tyler soils, because of the unfavorable physical condition of the subsoils. Fertilization and liming will also be required on all the soils except Melvin silt loam, which is ordinarily well supplied with lime.

Unless very thorough artificial drainage is provided, crops that are at least moderately tolerant to wet conditions should be selected. Under somewhat improved drainage conditions, crops such as sorghum, lespedeza, grasses, cowpeas, and soybeans (pl. 16, A) are adapted to these soils. Small grains also grow with moderate success on the Tyler and Purdy soils. Neither alfalfa nor tobacco would be expected to succeed well.

GROUP 11 (MISCELLANEOUS)

Group 11 (miscellaneous) includes the soils not previously discussed in this section, as follows: Armuchee silty clay loam, severely eroded phase; Clarksville cherty silt loam, steep phase; Dandridge shaly silty clay loam, eroded steep phase; Dandridge gravelly silty clay loam, eroded steep phase; Dewey silty clay loam, severely eroded steep phase; Fullerton cherty silt loam, steep phase; Fullerton cherty silt loam, eroded steep phase; Fullerton cherty silty clay loam, severely eroded steep phase; hilly stony land (Talbot soil material); Lehew very fine sandy loam; limestone outcrop; Litz shaly silt loam, eroded phase; Litz shaly silty clay loam, severely eroded phase; rolling stony land (Talbot soil material); rough stony land (Talbot soil

material); rough gullied land (Litz soil material); rough gullied land (limestone residuum); Talbott silty clay loam, severely eroded hilly phase; and Upshur-Litz silt loams.

Although the members of this group differ greatly from one another, they are, with few exceptions, physically unsuitable for the production of crops requiring tillage, poorly suited for pasture, and under present conditions best suited in most places to forestry. Most of them are Fifth-class soils. The eroded steep phase of Dandridge shaly silty clay loam, rolling stony land (Talbott soil material), and hilly stony land (Talbott soil material) are generally considered suitable for pasture, and they are used chiefly for that purpose. Limestone outcrop and rough stony land (Talbott soil material) are wholly unsuitable for pasture. The remaining members of this group are potentially usable for pasture, although their use for such a purpose in the present agriculture is hardly feasible in most places. In general where the Clarksville and Fullerton soils of this group need to be used for pasture their requirements for management are similar to those of group 7, and where the Armuchee, Dandridge, Litz, and Upshur-Litz soils are used for pasture their requirements for management are similar to those of group 8.

The requirements for management of rolling stony land (Talbott soil material) and hilly stony land (Talbott soil material) entail chiefly the application of lime and phosphate (although lime is not needed everywhere), the eradication of weeds, and the proper control of grazing. Weeds are generally difficult to eradicate or control because in most places the outcrops protrude enough to make the use of mowers generally impossible.

WATER CONTROL ON THE LAND

Water control on the land consists of the regulation of runoff and the maintenance of favorable conditions of soil moisture by measures grouped as follows: (1) Control of runoff, (2) protection from floods, (3) drainage, and (4) irrigation. In Hamblen County the control of runoff is the most important of these measures, although artificial drainage is of some importance. Irrigation and protection from overflow are of little or no importance at present, although irrigation doubtless would increase the yields of crops in dry seasons. The use of irrigation water to supplement rainfall might prove economically feasible at times, especially on gardens and on small areas of high-priced crops, such as vegetables, fruits, and tobacco.

Soil erosion is of two kinds—normal and accelerated. Normal erosion is that erosion “characteristic of the land surface in its natural environment, undisturbed by human activity, as under the protective cover of the native vegetation,” and accelerated erosion is that “Erosion of the soil or rock over and above normal erosion brought about by changes in the natural cover or ground conditions, including changes due to human activity and those caused by lightning or rodent invasion” (14, p. 1167). As water is the only active natural agent of soil erosion in Hamblen County, and as we are concerned here primarily with man-induced accelerated erosion, the simple term “erosion” as used hereafter in this section refers to accelerated erosion by water.

Because water is the chief agent of erosion here, the farmer's problem may be more correctly that of the proper use, conservation, and control of water on the fields, pastures, and woodland where it falls. Proper use and control of water where it falls is an effective measure of conserving the soil. Such control of the water brings about a number of desirable effects. One of these is the checking of erosion; others include a more uniform and adequate supply of moisture for growing crops; improved tillage conditions or working properties of the soil, particularly during periods of low rainfall; better conditions for biological activity; improved conditions for the formation and conservation of humus. These desirable effects in turn facilitate the problem of further conservation and control of the water.

Most of the land in the county well suited to cultivation apparently has been cleared at least 100 years. During this time erosion has been active in the cultivated uplands, encouraged by a fairly heavy annual rainfall and prevailingly undulating to hilly relief. It is estimated that more than 90 percent of this land has become sufficiently eroded to injure the productivity, workability, or conservability of the soil.

Between 0.5 and 1 percent of the area of the county has been reduced to an intricate pattern of destructive gullies, incapacitating the land for use as cropland or pasture land, at least for the present. Between 3 and 4 percent of the area of the county has lost practically all of the original surface soil, and tillage is now performed in the topmost part of the original subsoil. The tilth in nearly all of such areas is unfavorable for growth of plants, and the productivity is considerably lower than on corresponding uneroded areas. About 70 percent of the area of the county has been eroded to the extent that ordinary tillage reaches the topmost part of the subsoil and brings it to the surface. Here, the soils apparently have not yet been greatly injured by erosion; nevertheless further erosion generally will be definitely harmful. About 25 percent of the area of the county has been eroded only slightly or none at all.

It should be emphasized that soil erosion in Hamblen County is not an isolated problem; it cannot be treated or dealt with as such. It is a conspicuous symptom of more deeply seated disorders in land use and soil management.¹³

Failure to control water on the land and consequent soil erosion have resulted from the failure to adjust land use and soil management to the physical limitations of the soils. That such adjustments have not been made is evidenced by the conspicuous symptom, erosion. As losses of water and soil by erosion have resulted from such maladjustments, the remedy is to be sought through corrective redirection of land use and soil management.

The land in this county is divided into relatively small farming units. Readjustments must be effected, therefore, on these individual farms, and the approach is through each individual operator. It may be said, therefore, that in the last analysis the problem of control of water erosion is one of farm operation.

The farmer who attempts to readjust the use and management of his soils in order to control water and erosion is confronted with a number

¹³ The terms "land use" and "soil management" as used here refer to the use and management of the land for the production of plants only. Soil use refers to broad farm uses such as growing intertilled or clean-cultivated crops, growing close-growing crops (small grains, grasses, and legumes), permanent pasture, and forest. Soil management includes such practices as the choice and sequence of crops, tillage practices, green manuring, liming, fertilization, and mechanical measures for water control.

of problems, over some of which he as an individual has no control. Among such factors to be dealt with are the size and type of farm; the physical character of his land, including the soil pattern of the farm; surrounding social and economic conditions, such as transportation, market, church, and school facilities; the immediate cash demand on the farm income for such items as taxes, indebtedness, and support of family; the relation between prices of farm products and other commodities; the farm operator's facilities and resources for operating purposes, including buildings, farm equipment, seed, kind and number of livestock, cash, and credit; the farm operator's ability, aptitude, versatility, and preferences; community cooperation, labor, farm machinery, drainage, water disposal, marketing, and buying; and farm tenure and labor conditions.

As important as it may be that land use and soil management be adjusted to the physical limitations of the soils, it is apparent that such adjustments cannot be effected rapidly on all farms under existing conditions. On some farms the physical capabilities for use and requirements for management of the soils conflict with immediate requirements of the farm, which are determined by other factors. Compromises are not only expedient but inevitable on many such farms. Readjustment of land use and soil management in order to effect water control better and thus check erosion are involved and complicated undertakings, and thorough familiarity with all factors involved is essential to any rational approach.

Certain mechanical means of controlling runoff and erosion, such as contour tillage, terracing, or strip cropping, should be resorted to if steep erodible land is to be cultivated, but wherever feasible such land should be used for close-growing crops, pasture plants, or trees.

As compared with the problem of controlling runoff, the problem of drainage is less important but nevertheless of some significance. About 1 percent of the area of the county is poorly drained and needs artificial drainage in order to make the soils suitable for ordinary production of crops. About 3 percent of the area of the county is imperfectly drained; and although the soils in this area can be used for the production of several crops common to the locality, their adaptability is limited to those crops that are at least moderately tolerant to wet conditions. Both the poorly drained and the imperfectly drained soils would be improved by artificial drainage. As artificial drainage, like the control of erosion, involves changes in land use and soil management, and as such changes must be made by farmers on individual farms, the feasibility of providing artificial drainage depends on many factors arising both within and outside of the individual farms.

FORESTS ¹¹

The first settlers in this part of the valley found it densely wooded. This area was considered a common hunting and fighting ground by the Indians, abounding in game (2), such as elk, buffalo, bear, deer, turkeys, and many smaller varieties of animals. There appears to be little doubt that in the beginning much of the timber, even choice logs above those needed in the construction of the first houses, was rolled into piles and burned as the land was gradually cleared for

¹¹ This section was prepared by G. B. Shilvery, farm forest specialist, Division of Extension, Tennessee College of Agriculture.

crops. At a later period it was customary to raft logs to the market at Knoxville during periods of high water in the rivers.

The proportion of forest land is now relatively small, and the entire acreage is included in farms. This woodland on farms in 1939 showed a total return of \$5,756 from the sale of forest products, according to the United States census. The average number of acres in woodland on farms has been decreasing until, according to the census, only 14 percent of the farm land area was wooded in 1939, as compared with 25 percent in 1910. Since the economy of the county is primarily agricultural, practically all of the soils suitable for crops have been cleared.

The distribution of forest is largely an expression of unfavorable soil conditions, such as severe erosion, steep relief, and excessive stoniness. Forests cover many areas of the hilly and steep phases of the Fullerton and Clarksville series. Many of the small woodland tracts are on these soils, and this is a result of clearing and using for crops or pasture the associated soils physically better suited to crops and pasture. A more vigorous forest growth, expressed in long-bodied, high-quality timber that is free from defects, exists on the few wooded areas of Dewey silty clay loam, eroded steep phase, than on Clarksville cherty silt loam, steep phase. Between 25 and 40 percent of the area of extensive Litz soils is forested. Upshur-Litz silt loams of Bays Mountains are chiefly in forest, in which there is a variety of species, including the common hardwoods along with Virginia pine, redcedar, and black locust. Lelew very fine sandy loam bordering the Holston River in the northeastern corner of the county likewise supports a forest, chiefly of hickories, black locust, Virginia pine, scarlet oak, black oak, sourwood, black tupelo (blackgum), redbud, dogwood, southern red oak, white oak, chestnut oak, and persimmon. In hollows and ravines and on northern and eastern exposures on Upshur-Litz silt loams and on the Lelew soil, more exacting trees, such as northern red oak, tuliptree, white oak, sugar maple, black walnut, shortleaf pine, and in places white pine, are conspicuous.

The forests of the county consist chiefly of deciduous trees or hardwoods, although redcedar, shortleaf pine, Virginia pine, and a few pitch pines grow. Dominant hardwoods in the few wooded areas of Dewey and Fullerton soils included in the Second- or Third-class groups of soils are the white oak, black oak, northern red oak (water oak), and southern red oak, along with shagbark hickory (scalybark hickory), dogwood, second-growth tuliptree, and some black walnut, together with scattered linden and a variety of less important associates. The cherty Clarksville soils are characterized by the presence of sourwood, blackgum, scarlet oak, and post oak. The better drained more productive soils of the stream terraces have been cleared for use as cropland, but a considerable proportion of the poorly drained Tyler silt loam and an even greater proportion of the wet Purdy silt loam are in woods. The characteristic species on these soils consist chiefly of blackgum, sweetgum, willow oak, red maple, and holly; but on the intermingled better drained areas there are beech, shortleaf pine, white oak, black oak, and high-quality southern red oak.

Redcedar is conspicuous on land underlain by limestone and calcareous shales at a slight depth, such as Dandridge gravelly silty clay

loam, eroded phase, rolling stony land (Talbot soil material), hilly stony land (Talbot soil material), rough stony land (Talbot soil material), and limestone outcrop. Shortleaf pine seeds wherever a few large trees of cone-bearing age occur; comparatively small clumps of this tree are associated to a large degree with abandoned badly gullied and severely eroded Dewey and Fullerton soils. Virginia pine is suited to still more difficult sites and has been observed in pure stands on eroded and severely eroded phases of the Litz series. On the other hand, deeper, less eroded phases of Litz grow high-quality shortleaf pines in mixture with hardwoods, and post oaks sometimes have a dominant position in the stand along with the pines. Black locust produces durable fence-post material on much of the land underlain by limestone and calcareous shales, which was once in cultivation but has since been abandoned.

There are a stave mill and 13 small sawmills in Hamblen County. In 1939 the production of lumber amounted to 460 million board feet of pine and 660 million feet of hardwood.¹⁵ Records in 1921 show but 6 mills operating in the county, all small, no one of which produced as much as a million board feet a year (11). The current marketing practice is to truck the few choice clear logs to nearby cities or permanent wood-using centers and to depend on the small portable mills to process the rougher, smaller timber largely for local needs, and a limited number of cross ties and dimension stock for outside markets. The local demand is largely for pine lumber for farm use and oak for bridge purposes. The very few mills that operate when conditions are favorable are forced to saw to fill specific orders in order to avoid accumulating unmarketable surpluses. The fact that a potential supply exists within a county, even in the form of scattered trees, keeps local prices within reach of the local people, in contrast with prices at least twice as high in areas that have no local supply and depend on higher grade material shipped from a distance. For instance, the high prices paid in central Illinois illustrate such a contrast. A supply of locust posts for fences likewise keeps down costs on the farm.

No old or virgin growth of timber remains in this county. At present the principal commercial species are mixed oak, with some tuliptree, native yellow pine, hickories, and other hardwoods. Of the timber-producing areas, 41 percent are upland hardwoods, 1 percent yellow pine, 37 percent yellow pine-hardwoods, and 21 percent cedar-hardwoods.¹⁶ As a further indication of the size and stage of development of the timber resources of the county, 12 percent of the total area in forest is classified as saw timber, 81 percent as cordwood, and 7 percent as below cordwood.¹⁷

¹⁵ Information obtained from the Department of Forestry Relations, Tennessee Valley Authority.

¹⁶ Forest types: (1) Upland hardwoods—stands of mixed oak and other hardwoods in which hardwoods constitute 75 percent or more of the dominant and codominant trees; (2) yellow pine—stands in which pines of all species make up at least 75 percent of the total number of dominant and codominant trees; (3) yellow pine-hardwoods—stands of mixed yellow pines and hardwoods in which all pines in the stand represent between 25 and 74 percent by number of dominant and codominant trees; (4) cedar-hardwoods—mixed stands in which cedar represents between 25 and 74 percent by number of the dominant and more numerous trees.

¹⁷ These sizes are defined as follows: (1) Saw timber—stands in which large trees predominate, having an average of at least 500 board feet to the acre of sound live hardwoods over 13 inches d. b. h. (diameter breast high—about 4.5 feet above the ground) and conifers over 9 inches d. b. h.; (2) cordwood—stands containing trees merchantable for cordwood-sized products, such as fuel wood, pulpwood, mine timber, and posts; (3) below cordwood—nonmerchantable stands containing less than 4 standard cords of small material to the acre. Percentages of forest types and sizes from information furnished by the Department of Agricultural Relations, Tennessee Valley Authority.

The woodland, then, is of two general types, (1) cut-over hardwood, and (2) second-growth thickets coming in on previously cropped and later eroded and abandoned land. The cut-over hardwood contains much cull timber, which hinders the development of promising young trees by overtopping. Farm woodlands can be materially improved by using such inferior trees for fuel and other minor farm needs. Such improvement resolves itself into systematic cutting and use of crooked trees—short, bushy-topped ones, unsound culls, slow growers, and poor kinds—reserving the straight, tall, well-crowned individuals that are free from defects for growth into final crop timber.

The second-growth thickets are composed largely of shortleaf pine, with Virginia pine on the drier and less favorable sites. Shortleaf pines seeded by natural means display a remarkable ability to establish themselves on such situations where the mineral soil is exposed, provided seed trees are present and so spaced that the wind can disseminate the seeds properly at the time the cones open during the early fall. Stands of this kind can be improved by judicious thinning during their early life, in that the rate of growth is increased and risk from damage by the southern pine beetle is decreased. Erosion in such thickets is checked, and the litter and humus accumulated begin to rebuild the soil.

Occasionally it is necessary to resort to planting the forest trees, particularly on the Fourth- and Fifth-class soils that are severely eroded. Every particular situation presents a specific problem to be solved. The technique of tree planting to insure success includes certain essential advance preparation agreed on with the landowner at the time a preliminary examination of the area is made. This preparation includes such measures as breaking and mulching galled areas, building simple low-brush check dams in gullies, and plowing contour furrows. The preparation of severely gullied areas, which generally involves a great deal of labor, has been facilitated by labor supplied by the Tennessee Valley Authority and Civilian Conservation Corps camps, with the result that during the period 1936-41 a total of 59 projects involving 347 acres had been reclaimed with seedling stocks of black locust and shortleaf pine. On areas involving advance preparation the landowner himself is encouraged to do the entire job without labor from such camps, using forest tree seedlings provided without cost by the Tennessee Valley Authority. Under this arrangement, through the medium of county agricultural agents, during the 1936-41 period a total of 33 projects involving 71 acres were successfully completed.

In planting trees it is important that pioneer species be selected that suit the characteristics of the particular soil, including degree of erosion and other local features, such as exposure. Although farmers many times specify locust because of their farm needs for fence posts, pine, generally shortleaf pine, is better adapted to the severe growing conditions on lands designated for use as forest. Black locust does well in gullies in the moist well-aerated soil material accumulated behind the simply constructed check dams; it follows, therefore, that a large proportion of areas need black locust for the silting basins in the gully bottoms and shortleaf pine for the sheet-eroded flats and irregular spots of land between gullies. Heavy dependence must be placed

on shortleaf pine, however, on most of the eroded lands, except where intensive land preparation and fertilization with phosphate warrant the use of black locust.

Shortleaf pine should be the principal species, and black locust an alternate under certain favorable conditions of preparation and exposure, for use on Dewey silty clay loam, severely eroded steep phase; Fullerton cherty silty clay loam, severely eroded phase; Fullerton cherty silty clay loam, severely eroded steep phase; and Clarksville cherty silt loam, steep phase. Talbott silty clay loam, severely eroded hilly phase; and Talbott silty clay loam, eroded steep phase, furnish still more handicaps for growing locust to fence-post size. In general, the Litz soils included in the Fifth-class group should be planted to shortleaf pine, except on north- and east-facing slopes, where hardwood species could be grown. Black locust appears to be suited to Dandridge gravelly silty clay loam, eroded steep phase. Rough gullied land (limestone residuum) and the variation of rough gullied land (Litz soil material) occurring in association with the Dandridge soils present primarily land-reclamation problems in the solution of which black locust is a valuable ally. On the typical rough gullied land (Litz soil material), pine, in some instances Virginia pine, must be used, as black locust will grow successfully only in the bottoms of the gullies.

Forest has important indirect benefits aside from the production of wood products, especially on critical areas subject to erosion. An experiment (3) conducted for a period of 1 year by the University of Georgia shows a soil loss on an exposed subsoil or badly eroded plot of 112,316 pounds an acre; whereas the loss on the wooded area was only 115 pounds, and this loss was attributed largely to disturbance of the plant root systems by insertion of the galvanized iron band used to enclose the area. Results obtained at the erosion station near Statesville, N. C.,¹⁸ show a loss of only 0.0021 of a ton of soil and 0.122 percent of the rainfall from virgin woods. Furthermore, a nearby wooded plot burned twice yearly showed progressively larger losses, both in erosion and in percentage of runoff. Therefore, both control of erosion and maximum absorption result from complete forest cover, as a soil forested with old growth is more porous and absorbs water much more rapidly than the soil in cultivated fields (1). Where the forest cover is properly maintained, a soil forested with second growth does not lose its porosity unless it is overgrazed or the litter is destroyed by fire.

Control of fire is necessary not only for satisfactory forest production but also to maintain maximum soil porosity and erosion control. Prevention of overgrazing is necessary for similar reasons. Experiments in Indiana (4) prove that such grazing does not pay, as woodland grazing under intensities of 2, 4, or even 6 acres allowed per animal unit without supplementary feeding resulted in serious deterioration of the animals over a 6-month season. The timber-producing capacity is gradually destroyed by the repeated browsing; finally the reproduction of trees is so curtailed that the natural regeneration of the stand is prevented. Compaction of the soil, disturbance of humus, and resulting interference with soil porosity lessen the absorption of water.

¹⁸ BAUTEL, F. O., and SLATER, C. S. PROGRESS REPORT OF THE CENTRAL PIEDMONT SOIL AND WATER CONSERVATION EXPERIMENT STATION, STATESVILLE, N. C., 1930-35. U. S. Soil Conserv. Serv. SCS-ERS-8, 134 pp., illus. 1938. [Mineographed.]

MORPHOLOGY AND GENESIS OF SOILS¹⁰

Soil is the product of the forces of weathering and soil development acting on the parent soil material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and has existed since accumulation, (3) the plant and animal life in and on the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of development have acted on the material. External climate, although important in its effects on soil development, is less so than internal soil climate, which depends not only on temperature, rainfall, and humidity, but on the physical characteristics of the soil or soil material and on the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind. As the soils are classified upon the basis of their characteristics determined by the factors just named, it follows that the development of the different series of soils should be explainable on the basis of differences in one or more of these factors.

Having developed in a humid, warm, continental climate, the mature soils are highly leached, are low in organic matter, and have well-developed podzolic features. The climate, however, is practically uniform over the entire county; and, owing to this uniformity, differences in soils within the county cannot be explained on the basis of broad differences in climate.

The forces of climate alone cannot bring about the development of soils. Operating alone, they can only produce the parent material from which the soils themselves can be developed. Without living organisms all soils would remain undeveloped and all would be azonal; they would be merely residual or transported products of rock weathering. The action of living organisms, therefore, is necessary for development to take place. Of the living organisms influencing soil development, plants and micro-organisms are the ones of primary importance. The general type of vegetation is to a large extent controlled by climate, and in this way climate exerts a powerful, indirect effect. A well-developed soil is the result of the concomitant attack of both climate and biological agents upon the parent material. Where the variation in vegetation has been significant, the morphology of the soil would be expected to vary accordingly. In Hamblen County, however, the same general type of vegetation occurred on all the well-developed, well-drained soils. Although quite likely there were differences as to the density of the stands and the relative proportion of each species, chiefly hardwoods prevailed over the entire area. Because no great differences in vegetation were manifest on the well-developed, well-drained soils of the county, differences in the soils ordinarily cannot be attributed to differences in vegetation.

By direct and indirect effects, climate tends to produce similar soils from different kinds of parent material; and if it were not for the inhibiting factors of parent material itself—relief, drainage, and, in some places, vegetation—the same kind of soil would prevail over the entire area. Although such a uniform soil obviously does not exist, some general descriptive statements apply to all the well-devel-

¹⁰ This section was prepared by A. C. Orvedal, Division of Soil Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture

oped, well-drained soils of the region. Under forest vegetation, they all have a dark A_1 horizon, and most of them have an A_2 horizon that is lighter in color than either the A_1 or the B; the B horizon is generally uniformly colored yellow or red and is finer textured than the A_1 or the A_2 horizons; and the C horizon is generally fine textured and variegated with red, yellow, gray, and olive.

According to some recent analyses by this Bureau of a number of soils of Jefferson County, which bounds Hamblen County on the southwest, the silica content decreases and the alumina and iron oxide contents increase with depth. The content of organic matter is moderate in the A_1 horizon, less in the A_2 horizon, and very low in the B and C horizons. All the soils are low in bases, particularly calcium and magnesium; and they are also low in phosphorus. In comparison with numerous analyses of soils in the United States given by Marbut (8), several soils of the limestone valley section of Jefferson County and presumably also of Hamblen County are high in manganese, particularly in the A_1 and A_2 horizons. The manganese content of these soils is highest in the surface layer and decreases as the depth increases. In general the ignition loss is relatively low, indicating that the bound-water content is not high. These soils are medium, strongly, or very strongly acid in reaction. In general the amount of silt decreases, whereas the amount of clay increases, with increase in depth from the A_1 horizon through the C horizon; and the colloid content is low in the A horizon, much higher in the B horizon, but highest in the C horizon.

The foregoing paragraphs have brought out the characteristics that all the well-developed, well-drained soils have in common, irrespective of parent material or relief. These characteristics, therefore, can be considered as those imposed by the forces of climate and vegetation and are characteristics that any well-developed soil under similar climatic and vegetative conditions will exhibit. They can therefore be considered zonal characteristics, and all soils that exhibit them can be considered zonal soils.

Hamblen County lies in the northern part of the zone of Red and Yellow Podzolic soils, near the southern boundary of the Gray-Brown Podzolic soils (13). The well-developed, well-drained soils of this county are generally considered as members of either the Red Podzolic group or the Yellow Podzolic group, but some of them are morphologically similar to some of the soils mapped in the southern part of the zone of Gray-Brown Podzolic soils, although red and yellow appear to be generally somewhat more prominent and brown less prominent than in representative Gray-Brown Podzolic soils.

Throughout the entire county a striking and consistent correlation exists between the soil and the kind of consolidated rock underlying the parent material. A less striking and less consistent correlation exists between the type of soil and the slope of the land. The present relief, however, has also been greatly influenced by the kind of consolidated rocks, which differ in rate of weathering and content of insoluble minerals, especially silica. Thus, not only the soils, but also the type of relief, are closely associated with the type of consolidated rock.

To illustrate: The extensive areas underlain by fairly high-grade²⁰ limestones or dolomites are generally undulating to gently rolling;

²⁰ High in carbonates, low in impurities, especially silica or clay.

extensive areas underlain by highly siliceous limestones and dolomites are generally strongly rolling or hilly; and extensive areas underlain by shales are generally hilly or steep. Therefore, by exerting both direct and indirect effects the character of the consolidated rocks that give rise to the parent materials of these soils is the main factor in bringing about the development of different types of soils in the county.

The general character of the rocks underlying the soils of the series is shown in table 5 (facing p. 25), and by referring to the column headed "Dominant relief" in this table the general character of the relief of areas underlain by the various rocks can be deduced.

The following tabulation gives the general correlation of the soil series of the uplands with the geologic formations according to the classification of the rocks contained in the Morrystown folio (15).

<i>Soil series</i>	<i>Geologic formation</i> ¹
Upshur-Litz (complex) ² -----	Bays sandstone.
Dandridge-----	Sevier shale.
Needmore } Dandridge } Sequoia } Armuchee }	----- Athens shale.
Stony land types ³ } Talbot }	----- Chickamauga limestone.
Decatur } Dewey } Fullerton } Clarksville } Bolton }	----- Knox dolomite.
Litz } Armuchee } Sequoia }	----- Nohchucky shale.
Stony land types ³ } Talbot }	----- Maryville limestone.
Lehew-----	Rome formation.

¹ The formations are in descending order according to age, the youngest first.

² A variation included in this complex consists of areas underlain by rocks classified as Clinch sandstone

³ Miscellaneous land types characterized by limestone outcrops

In the humid region, soils occurring in broad depressions or on level or nearly level areas are generally poorly or imperfectly drained. In the limestone valley section, however, where the underlying rocks are limestones or dolomites, subterranean drainage is good and the general relation of drainage condition to relief is not manifest. This good subterranean drainage is probably due to the marked dip that the rock strata have and to numerous subterranean caverns and crevices. Where underlain by limestones that have a marked dip, the soils are apparently just as well drained internally in nearly level areas as in hilly areas. This excellent subterranean drainage on all slopes reduces the influence of relief on the formation of soils and allows the consolidated rocks to dominate the other factors in determining the local differences in soils. In other words, the different responses of the different rocks to the forces of the similar climate and vegetation are responsible for the main differences in well-developed, well-drained soils in the county.

In Hamblen County, limestones and dolomites give rise to parent materials that in turn give rise to six series of soils, namely, the Talbott, Decatur, Dewey, Fullerton, Clarksville, and Bolton. In the sequence of series, Decatur, Dewey, Fullerton, Clarksville, the color of the surface soil changes from dark reddish brown to light gray and the subsoil from dark red to yellow. Generally speaking, the quantity of chert in the solum varies in the same sequence—the Decatur having least and the Clarksville most—as the dominant relief—the Decatur having the most gentle and the Clarksville the most pronounced. The range in relief for each series, however, overlaps considerably the relief range of adjoining series in this sequence. The Talbott series also belongs in this sequence ahead of the Decatur. Its variation from the Decatur, however, is in a different direction. The Talbott soils are much shallower and have a more plastic and sticky subsoil than the Decatur soils. The Bolton soils are similar to the Dewey soils in color, but they are coarser textured and more friable; and they are similar to the Fullerton soils in relief.

As the surface geology of this region is characterized by very old formations that were faulted and folded a very long time ago, it is fairly safe to assume that the present relief is a product of natural geologic weathering and erosion. Supporting this assumption is the fact that mountaintops are capped with the most resistant rocks and the valley floors are underlain by the least resistant rocks (5). In general, the mountains are capped with sandstones, conglomerates, and quartzites; the valley floors are underlain by limestones or dolomites; and the ridges or plains that are intermediate in altitude between the mountaintops and the valley floors are underlain by shale.

As an example, the area west of Morristown is underlain by limestone and dolomites. Just south of the highway, the lowest part of valley in this locality, there is an extensive area predominantly of rolling stony land (Talbott soil material) and the Talbott soils. Northward toward the highway the land increases slightly in altitude and the Decatur and Dewey soils are reached. Continuing northward the altitude further increases, and the Fullerton, Clarksville, and Bolton soils are reached. Owing apparently to the proximity of the Holston River, however, this relation is not evident in the lower and upper parts of Hamblen County. Although this sequence in altitudes—Talbott in the lowest positions, Dewey and Decatur in the intermediate, and Fullerton, Clarksville, and Bolton in the highest—is not everywhere evident where these soils occur side by side, it is evident in so many places throughout the Great Valley of East Tennessee that this may be considered a normal relation.

On the assumption that this whole section was a peneplain before the present relief was formed, it follows that the limestone underlying the Talbott soils was the most soluble and most easily weathered of all the limestones and dolomites in the county. Because the covering at present is thinner over the rocks underlying the Talbott than it is over the rocks underlying the Decatur, Dewey, Fullerton, and Clarksville soils, it is reasonable to assume that the limestone underlying the Talbott had the lowest concentrations of insoluble material, especially silica. Although the rock floor is uneven and rough, the average depth to bedrock probably increases in the sequence Talbott, Decatur, Dewey, Fullerton, Clarksville, Bolton. This indicates that the content of insoluble impurities of the underlying limestones and

dolomites increases in the same sequence. The insoluble impurities are mainly silica, alumina, and ferric oxide; but the one that appears to be chiefly responsible for the relation mentioned is silica, in the form of chert and sand.

Although some surface erosion has taken place and differences in the rate of such erosion may be partly responsible for differences in depth to bedrock, the differences in average depth to bedrock cannot be explained entirely on that basis, except for soils underlain by shales or sandstone. In the Talbott-Decatur-Dewey-Fullerton-Clarksville-Bolton sequence the depth to bedrock is more or less in direct opposition to what would be expected if differential natural erosion were responsible; that is, when the predominating slopes of the soils of the respective series are taken into consideration. Considering the high rainfall, the streams in the limestone areas are relatively scarce. Sinkholes everywhere dot the landscape, and much drainage water escapes through them into underground channels.

The prevalence of sinkholes indicates that the present relief is due mainly to differential dissolution and leaching of the underlying rock; and, if this is true, the present covering over the rocks is the insoluble residue left after hundreds of feet of limestones and dolomites have been dissolved and leached out. The deepest covering would therefore be expected where the limestones and dolomites had the highest concentrations of insoluble impurities, especially of chert and sand. As the covering became thicker, it served as an increasingly effective sponge in reducing the amount of water leaching through the underlying rocks; and hence as the higher altitudes are approached the content of insoluble impurities increases. Therefore the Talbott soils are the shallowest to bedrock and at the same time normally occupy the lowest positions in the valley; the Clarksville, Bolton, and Fullerton soils are the deepest to bedrock and occupy the highest positions; and the Decatur and Dewey soils are intermediate between these two extremes in depth to bedrock and in altitude. A fact of importance, however, is that the rocks underlying the Talbott soils contain some clayey material, and such rocks have been observed generally to leave fine-textured slowly permeable residual material. The natural erosion of such material therefore may be generally greater, and this quite likely accounts partly for the slight depth of soil material over such rocks.

As already pointed out, the Talbott soils are underlain by limestones that contain some clay but are low in siliceous material. A description of a representative profile of Talbott silty clay loam, eroded phase, is as follows:

- A. 0 to 1½ inches, grayish-brown friable mellow silt loam, slightly stained with organic matter.
- A₂. 1½ to 7 inches, light grayish-brown to pale yellowish-brown silt loam to silty clay loam. The color is not uniform, consisting of mangled gray, light brown, and pale yellow. The material readily falls apart into soft crumbs of various sizes and shapes. The darker colored aggregates are firmer than the light-colored ones. Roots are numerous.
- B. 7 to 20 inches, tight tough plastic sticky silty clay that is yellowish red to light brownish red and contains some minglings of olive, ochre yellow, and red. The material is difficult to disrupt and breaks into firm, angular, or blocky aggregates ranging from about ½ to 1½ inches in diameter. The predominant size of the aggregates increases somewhat from the upper to the lower part of this layer. Most of these are red or brownish red on the outside and yellow or olive on the inside, and

they have shiny or glossy surfaces. Fine roots are comparatively few, and they generally occur between the aggregates, indicating that they do not readily penetrate the aggregates. Large roots, however, are fairly numerous

- C₁ 20 to 24 inches, heavy silty clay similar to the layer above but more highly spotted and mottled with olive, yellow, red, and brown. It differs also in being less tough. Although the material is disrupted with difficulty, the disrupted pieces break readily into angular aggregates with glossy surfaces
- C₂ 24 inches to bedrock, very plastic clay or silty clay highly mottled and spotted with red, reddish brown, rust brown, yellow, gray, and olive. It contains a few small fragments of chert and limestone. This continues down to bedrock, which ordinarily lies at a depth between 4 and 10 feet.

As the rock floor is very uneven and jagged, depth to bedrock varies greatly from place to place, but it is generally only a few feet. Rock outcrops are common on all areas of the Talbott soils, and most stony land in the valley has material like the Talbott soils between the outcrops where some soil has developed. As a result of this variable depth to bedrock, the layers below the A₂ horizon differ greatly in depth and in many places are almost entirely absent.

Partly because of the very fine texture of the subsoil of the Talbott soils, they are highly susceptible to erosion even on gentle slopes; and after being cleared of the forest cover much of the soil has been eroded so that in many areas the present profile is truncated and practically devoid of an A horizon.

As has been pointed out, the Talbott soils are underlain by limestone that is low in insoluble impurities, especially silica; consequently the residual material from dissolution and leaching is relatively little. Apparently the quality of the residuum is responsible for the development of the Talbott soils.

Most of the Talbott soils occur in gently rolling areas, but some occur on hilly areas. It is not improbable that some of the Talbott soils in the steeper areas have developed from rocks that in gently sloping areas would give rise to the Dewey soils but have not done so, owing to rapid natural erosion. Under a forest vegetation, however, it is unlikely that rapid natural erosion has occurred.

The Decatur soils are the darkest red and have the deepest solum of the soils in the valley. In this county they have probably the best combination of soil characteristics for plant growth. A description of a typical profile of Decatur silt loam is as follows:

- A₁ 0 to 2 inches, dark-brown smooth mellow and very friable silt loam that falls readily into soft granules and contains many small roots, some insects, and a little leafmold
- A₂ 2 to 12 inches, dark reddish-brown soft smooth very friable silt loam that crumbles readily into small soft granules. These granules are very easily crushed.
- B₁ 12 to 30 inches, brownish-red moderately friable silty clay loam that crumbles easily into soft granular aggregates. These aggregates are easily crushed to a smooth uniform slightly plastic mass that is a little lighter colored than the uncrushed aggregates. Some of the aggregates are dark brown. Numerous tiny black concretions and a few tiny chert fragments are present. On exposed cuts this layer is dark red.
- B₂ 30 to 50 inches, maroon-red silty clay that is moderately firm and tight in place, although displaced pieces break readily into subangular aggregates from ¼ to ½ inch in diameter. Many of these are coated with black. The material contains numerous tiny black concretions and a few tiny chert fragments. The aggregates with moderate pressure break down to a lighter colored fairly smooth moderately plastic and moder-

- ately sticky mass. The aggregates have a shiny surface. A few small faint yellow splotches appear in the lower part.
- B. 50 to 80 inches, a layer that is similar to the B₁ but does not have so many black coatings on the aggregates, contains fewer concretions, and is a little tighter and more firm, and the color is a more brilliant maroon red. A few yellow splotches appear here and there.
 - C. 80 to 100 inches +, heavy plastic sticky tight clay that is considerably lighter red than the layer above and contains a few yellow and olive mottlings.

Mechanical analyses of Decatur silt loam are given in table 9.

TABLE 9—*Mechanical analyses of Decatur silt loam in Hamblen County, Tenn.*

Sample No.	Depth		Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	<i>Inches</i>	<i>Percent</i>							
403601.....	0-9	1 6	4 2	3 9	5 2	4 1	52 3	28 7	
403602.....	9-14	1 9	3 1	3 2	4 3	3 6	45 6	38 3	
403603.....	14-24	8	2 5	2 6	3 6	2 6	36 0	51 9	
403604.....	24-50	7	1 9	1 8	2 5	1 9	19 1	72 1	

As pointed out previously, the Decatur soils have developed from high-grade limestones and dolomites, which, however, are apparently a little higher in insoluble impurities, especially silica, than those underlying the Talbott soils. Most of the Decatur soils occur in undulating and gently rolling areas of the uplands. Rock outcrops are few, except in severely eroded places. The Decatur soils have the darkest A horizon of any well-developed soils in the valley, which indicates a higher content of organic matter. Because they are the most productive of all the well-developed soils in the valley, it is reasonable to expect that they supported the most luxuriant vegetation; and the natural result of this would be a dark A horizon. It is likely that forest undergrowth was heavy and that this helped to develop the granular structure of the A horizon. This luxuriant growth would also tend to inhibit erosion of the surface soil and develop a friable consistence of both the surface soil and the subsoil.

The Dewey soils are formed from limestones and dolomites that are apparently higher in insoluble impurities, particularly silica, than the rocks underlying the Decatur soils. Following is a description of a typical profile of Dewey silt loam:

- A₁. 0 to 1½ inches, dark-brown soft mellow silt loam that falls readily into soft granules. It is high in organic matter and contains a few small chert fragments.
- A₂. 1½ to 12 inches, light-brown friable mellow soft silt loam containing a good distribution of roots and a few small chert fragments.
- B₁. 12 to 18 inches, light reddish-brown friable heavy silty clay loam, breaking readily into small soft granules that are easily crushed into a smooth mass. The material is moderately sticky when wet and contains a few chert fragments.
- B₂. 18 to 40 inches, brownish-red to bright-red silty clay that is fairly firm but friable and breaks into irregular-sized subangular aggregates. These aggregates are fairly easily crushed into a light-red smooth mass and are generally glossy on the surface. The material is only slightly plastic when wet. It contains numerous small black round concretions and numerous chert fragments.
- B₃. 40 to 60 inches, light-red fairly stiff and tight silty clay containing a few splotches of yellow. This material is rather difficult to disrupt, but when displaced it breaks readily into angular and subangular aggregates of various sizes. Under moderate pressure these aggregates can be crushed to a yellowish-red smooth moderately plastic and sticky mass. Chert fragments are common.

C. 60 to 72 inches, heavy stiff plastic sticky clay. It is chiefly red but is highly mottled with yellow, olive, and gray. Like the material above, the displaced material breaks into more or less angular aggregates.

The predominating relief of the Dewey soils is rolling, but large areas are undulating and hilly. As this soil is very productive of crops, it is reasonable to assume that it supported a luxuriant vegetation before it was cleared; this assumption at least partly accounts for the brown color of the A horizons. As on the Decatur soils, the forest undergrowth on the Dewey soils was probably heavy.

The Fullerton soils are derived from dolomitic limestones and dolomites relatively high in impurities, particularly silica. The silica occurs in two forms—as chert and as fine sand grains in the dolomite. Three types are mapped—Fullerton silt loam, Fullerton cherty silt loam, and Fullerton fine sandy loam. Typically the relief of the Fullerton soils is rolling and hilly, as they occupy low ridges of dome-shaped hills. Judging by the abundance of dead chestnut trees and the number of local names of “Chestnut Ridge” where the Fullerton and Clarksville soils occur throughout the Great Valley, it is reasonable to suppose that chestnut trees were originally numerous on these soils. The Fullerton soils, particularly the cherty silt loam, are not nearly so susceptible to erosion as the Dewey, Decatur, and Talbott soils on corresponding slopes. Following is a description of a typical profile of Fullerton silt loam:

- A₁. 0 to 2 inches, dark-gray silt loam stained dark with organic matter. Roots and chert fragments numerous.
- A₂. 2 to 9 inches, brownish-gray soft mellow friable silt loam containing a few chert fragments
- A₃. 9 to 14 inches, pale-yellow very friable heavy silt loam, also containing a few chert fragments
- B. 14 to 40 inches, yellowish-red or salmon-colored silty clay loam, marked by a few splotches of yellow. This material is firm in place, but displaced lumps are friable. Displaced pieces easily break into irregular-sized and irregular-shaped aggregates that with moderate pressure crush into a slightly gritty mass. When wet the material is moderately sticky and plastic. Generally it contains numerous chert fragments, some of which are large.
- C₁. 40 to 70 inches, tight plastic sticky clay, reddish yellow mottled with some ocher yellow, olive, gray, and red. The material has a more angular structure than that in the layer above.
- C₂. 70 to 84 inches +, a tight tough plastic sticky clay, reddish yellow highly mottled with ocher yellow, gray, olive, and red.

Fullerton cherty silt loam differs from Fullerton silt loam chiefly in containing considerably more chert fragments, but the color throughout is generally somewhat lighter. This is especially true of the A₂ and A₃ horizons. In many places these layers are also somewhat thicker, and the B horizon is more variable in thickness. This soil has apparently developed from weathered materials of dolomites containing more chert than those underlying the Fullerton silt loam.

Fullerton fine sandy loam differs from Fullerton silt loam chiefly in having a coarser texture, and this difference in turn is due to the presence of sand and sandstone layers in the dolomite from which the parent material has weathered. In general the profiles of the two types are similar, although the A horizon of the sandy type is looser and in some places is lighter in color. The thickness of the various layers is approximately the same for the two soils, although it varies considerably in Fullerton fine sandy loam. In uneroded fields a typical profile of Fullerton fine sandy loam has an A₂ horizon, about 7 inches

thick, consisting of brownish-gray fine sandy loam; an A₃ horizon, about 7 inches thick, consisting of a light brownish-yellow heavy fine sandy loam; and a B horizon, extending to a depth of approximately 50 inches, of light-red to yellowish-red firm but friable very fine sandy clay.

The Clarksville soils are associated with the Fullerton soils. They are developed from dolomite higher in impurities, particularly chert, than the parent materials of the Fullerton soils. Like the Fullerton soils, the Clarksville soils generally occupy rolling and hilly areas on low ridges. They differ from the Fullerton soils primarily in being lighter colored in both the A and B horizons. The Clarksville soils in Hamblen County contain red in the lower B and C horizons and for that reason are not considered typical Clarksville soils, which are predominantly yellow throughout the B horizon. Following is a description of a profile of Clarksville cherty silt loam as developed in Hamblen County:

- A₁. 0 to 1½ inches, gray loose cherty loam stained dark with organic matter.
- A₂. 1½ to 10 inches, pale yellowish-gray silt loam containing considerable gritty material and chert fragments. It is loose and friable.
- B₁. 10 to 20 inches, yellow to pale brownish-yellow silty clay loam that is friable and breaks readily into successively smaller particles until a gritty mass is formed. There are numerous chert fragments and a few tiny black concretions
- B₂. 20 to 26 inches, gradational layer of fairly friable silty clay loam. The color is mingled ocher yellow, brownish yellow, brownish red, and light red. When crushed the material is light reddish yellow. The material in this layer is friable and also slightly brittle. It breaks readily into angular and subangular firm granules, some of which are red on the outside and yellow on the inside.
- C₁. 26 to 50 inches, mingled light-red, yellow, brownish-yellow, gray, and olive silty clay loam. The material is rather hard in places. Displaced pieces are rather brittle, though moderately friable. The material breaks readily into angular aggregates from ⅜ to ¼ inch in diameter. The red ones are firm. When crushed the material is yellowish red and fairly smooth.
- C₂. 50 to 70 inches, a rather stiff tight sticky plastic clay. Light reddish yellow is the prevailing color, but there are numerous mottlings of red, yellow, olive, and gray. The material contains rather large chert fragments.

The Bolton soils occur chiefly in association with the sandy members of the Fullerton series, but they are similar to the Dewey soils in color. They differ from the Dewey soils, however, in being more friable, lighter in texture, and more strongly sloping. The soils in Hamblen County classified as members of the Bolton series are somewhat less friable in the subsoils than is typical. In this county the phases of Bolton loam generally have an A horizon, about 10 inches thick, consisting of brown mellow friable loam, and a B horizon, extending to a depth of 50 to 70 inches, of brownish-red to yellowish-brown firm but friable silty clay loam. In some places the color is darker and resembles that of the Decatur soils.

The Bolton soils in this county are peculiar in that they nearly everywhere occur on the east- and north-facing slopes, generally in association with the sandy members of the Fullerton series on the south- and west-facing slopes. The development of soils on the north- and east-facing slopes that are so conspicuously different from those developed on the south- and west-facing slopes is difficult to explain. In this region it is a matter of common observation that soils, even of the same series, are generally darker and contain somewhat more organic matter on the former slopes than they do on the

latter. Such differences are particularly noticeable in hilly and mountainous areas. This is explainable by the fact that moisture conditions are somewhat more favorable on the north- and east-facing slopes, and this in turn aids biological activity, especially the growth of plants, and therefore retards leaching. Although these differences in moisture relations and biological conditions very likely have been quite influential in bringing about the development of the Bolton soils, it seems unlikely that these differences alone can account for the fact that the Bolton soils have developed on the north- and east-facing slopes whereas the sandy Fullerton soils have developed on the south- and west-facing slopes.

Where the differences in the soils are so great as they are between the sandy Fullerton members and the Bolton soils, one would ordinarily expect differences in the parent material and hence in the underlying rocks from which the parent material has weathered. But in view of the fact that the sandy dolomites underlying both the sandy Fullerton and the Bolton soils appear to be quite uniform over relatively long belts, it is difficult to explain any difference in the parent material of these soils. Small fragments of hematite and ferruginous sandstone have been observed in some places on the Bolton soils, however. The presence of these might indicate that the parent rocks under the Bolton soils for some reason or other were higher in iron than the parent rocks of the sandy members of the Fullerton series; or it might indicate no appreciable difference in parent rocks but critical differences in vegetation and leaching, even though such differences apparently were not great.

The soils of the Needmore, Dandridge, Sequoia, Armuchee, Litz, and Upshur soils are developed from the weathered materials of shales or interbedded shales and limestone. As compared with the soils developed over limestones, those developed over shales are generally shallower to bedrock; and all are azonal except the Needmore and Sequoia soils.

The Needmore and Sequoia soils are similar in profile characteristics, but they have developed from different parent materials. The Needmore soils have developed from the weathered products of calcareous shales, whereas the Sequoia soils have developed from the weathered products of interbedded shales and limestones. The soils of both these series have well-defined A, B, and C horizons. They have developed under conditions of a forest vegetation, a gentle relief, and fairly good but apparently rather slow internal drainage. Both the Needmore and the Sequoia have fine-textured subsoils; these layers resemble the subsoils of the Talbott soils in structure and consistency but are lighter in color.

The A horizon of Needmore silt loam is yellowish-gray friable silt loam about 7 or 8 inches thick. The B horizon is yellow to reddish-yellow firm tough compact silty clay 12 to 15 inches thick. The structure is generally blocky, and the aggregates range in size from about $\frac{1}{2}$ to $1\frac{1}{2}$ inches in diameter. A few splotches of gray are ordinarily present in the lower part of this layer. The C horizon is similar to the B horizon in texture and consistency, but it is rather highly splotched with gray and contains a few fragments of soft shale, some of which are calcareous. The C horizon extends to the slightly weathered calcareous shales, which are ordinarily 18 to 30 inches below the surface.

The A horizon of the Sequoia soils is brownish-gray friable silt loam 6 to 8 inches thick. The B horizon is reddish-yellow to yellowish-red compact and tough silty clay 12 to 15 inches thick. A few yellow and gray splotches are generally present in the lower part. The structure is blocky, and the aggregates range from about $\frac{1}{2}$ to $1\frac{1}{2}$ inches in diameter. The C horizon is similar to the B horizon except that it is highly splotched and mottled with yellow and gray and generally contains a few rotten fragments of shale. The C horizon extends to the bedrock, which is generally reached between a depth of 3 and 4 feet and in some places between 4 and 10 feet. The parent rock consists of shales interbedded with thin layers of limestone, but the limestones have been leached from the upper few feet of the parent rock in most places, and acid shales remain.

Well-defined A, B, and C horizons have not developed in the Dandridge, Armuchee, Litz, and Upshur soils, which are all considered as being azonal, and cultivation and accelerated erosion have tended to obliterate the incipient horizon differentiation that is probably manifest in virgin areas. All these soils occupy predominantly hilly and steep areas; and on such areas natural erosion apparently has been rapid enough to keep pace with soil development. Most of the soils contain a varying quantity of shale fragments. The series are differentiated chiefly on the basis of differences in the parent rocks.

The parent rocks of the Dandridge soils consist of calcareous shales. At a depth of several feet, where there has been little or no weathering, the shales are generally dark; in places they are blue, in some places brown, and in others yellow. On weathering, the color generally becomes lighter, and gray, yellow, and olive colors predominate. This shale is highly calcareous, and on exposure it disintegrates rather rapidly and becomes an integral part of the soil material. Nearly all of the Dandridge soils in Hamblen County have been cleared and plowed and have been more or less eroded. In this condition they range from about 3 to 20 inches in depth over shale, but in many places the shale outcrops. The soil material is predominantly light brownish-yellow moderately friable silty clay loam, but it varies considerably in texture, color, and consistence. In the few wooded areas the topmost 1 or 2 inches is stained dark with organic matter, and this is underlain by a brown-yellow silty clay loam extending to a depth of about 8 inches. Where this material does not rest on shale it is underlain by brownish-yellow silty clay that is rather hard when dry and sticky and plastic when wet. Even in wooded areas, however, the bedrock shale lies between a depth of 10 and 20 inches. Shale fragments, most of which are calcareous, are generally abundant in the soil material.

The Armuchee soils are developed from the weathered products of interbedded shales and limestones similar to those underlying the Sequoia soils. Like the Dandridge soils, the Armuchee soils occupy prevalingly hilly areas and lack consistent development of A and B horizons. They are, however, somewhat deeper over bedrock and contain less shale. In most places depth to bedrock ranges between 6 and 24 inches. The color of the soil, predominantly reddish yellow, ranges from yellowish red to brownish gray; and the texture, predominantly silty clay loam, ranges from silt loam to silty clay. A few fragments of shale are generally present throughout the soil material. In a number of places where a profile is weakly developed the

soils resemble the Sequoia soils. Carbonates generally have been leached out of the upper 1 or 2 feet of the parent rock, and acid shales therefore predominate.

The Litz soils are developed chiefly from soft acid shales interbedded with widely spaced layers of limestone. The parent rocks of the Litz soils differ from those of the Armuchee soils chiefly in containing much less limestone. The Litz soils are also prevailingly shallow and are shallower and lighter colored than the Armuchee soils. The Litz soils range from about 3 to 16 inches in depth to shale, and the soil material is predominantly grayish-yellow to light yellowish-brown moderately friable silt loam to silty clay loam. Shale fragments are generally very numerous throughout the soil mass. In woods and old pastures the topmost 1 or 2 inches of the soil is stained dark with organic matter. The soils are prevailingly strongly acid to very strongly acid, and the underlying shales are likewise acid, although at one time some of them may have contained calcium carbonate. The widely spaced layers of limestone have disappeared through weathering, and only shales remain at the surface. In a few places there is a weakly developed profile somewhat similar to that of the Sequoia soils.

The Upshur soils are conspicuous and easily identified by their purple color. Their parent materials consist of weathered shales or shaly sandstones that are generally slightly calcareous. As mapped in this county, the Upshur soils occupy hilly and steep areas, range between 8 and 14 inches in depth over leached shale, and consist of purplish-gray to grayish-purple friable silt loam. In woods the topmost 1 or 2 inches is stained dark with organic matter. The soil material and the upper part of the bedrock shale ordinarily have been leached of their lime, but below a depth of 2 or 3 feet the bedrock is generally slightly calcareous. Only one type of the Upshur series, Upshur silt loam, is recognized in this county, and as it occurs in intricate association with Litz silt loam, the two soils were mapped as a complex. Included in areas of this separation are small areas characterized by yellow, white, and gray sandstone, both as boulders and as bedrock outcrops.

The Lehew soils, which occur only in the extreme northeastern corner of the county, consist of materials weathered from interbedded sandstones and shales. Like the Upshur soils, they are conspicuous because of the purple color of their parent rocks as well as of the soil material. They are also similarly shallow and have a steep slope, but the Lehew soils are lighter textured. The soil material, ranging from about 10 to 14 inches in depth over bedrock, consists of grayish-purple to brownish-gray loose very fine sandy loam that contains small fragments of sandstone and shale. Outcrops of sandstone bedrock are common. In wooded areas the topmost 1 or 2 inches is stained black with organic matter and a leached incipient A_2 horizon is discernible. The soil as well as the parent rocks is generally strongly acid to very strongly acid.

As explained elsewhere, colluvial land, as used in this report, comprises those accumulations at the foot of slopes, particularly of the steep slopes, where geologic as well as accelerated erosion has been active. The material in most places is actually a combination of colluvium and local alluvium, but in some places it consists entirely of local alluvium. Many of the areas are small alluvial fans or cones

at the mouths of very short drains, and others are bottoms of limestone sinks. The soils of these so-called colluvial lands in Hamblen County are classified into six series—Emory, Abernathy, Ooltewah, Greendale, Leadvale, and Whitesburg. Although none of the soils in these series can be considered old or fully mature, in many areas they show considerable development and color profiles of zonal soils. The degree of profile development, however, ranges from practically none where the accumulations are very recent to fairly good where the accumulations have lain in place for a considerable length of time. The colluvial and alluvial materials giving rise to the Emory, Abernathy, Ooltewah, and Greendale soils have been washed chiefly from soils of the uplands overlain by limestone, whereas the materials giving rise to the Leadvale and Whitesburg soils have been washed from soils of the uplands underlain chiefly by shale.

The Emory soils are brown, mellow, and well drained, and they lie on the foot slopes where the gradient is enough for good surface drainage. They generally show but little profile development and are predominantly brown and friable to a depth between 3 and 4 feet. Indistinct layers, however, that are probably incipient A and B horizons have developed in many places. In such places the surface layer extends to a depth of 15 to 24 inches and consists of dark-brown to reddish-brown friable silt loam, and the subsoil layer extends to a depth of 35 to 50 inches and consists of reddish-brown to yellowish-brown friable silt loam to silty clay loam. The Emory soils are associated chiefly with the Decatur, Dewey, Bolton, Fullerton, and Talbott soils, all of which have developed from limestone residuum; and the Emory soils are developed on accumulations of colluvial and local alluvial material washed from these associated soils.

The Abernathy soils are similar to the Emory soils in that they consist of local alluvium washed from the Decatur, Dewey, Bolton, Fullerton, and Talbott soils of the uplands, are chiefly brown, and show very little consistent profile development. They differ from the Emory soils chiefly in occurring in depressions, where there is little or no surface drainage. Underdrainage, however, is good. Like the Emory soils, the Abernathy soils are predominately brown and friable to a depth of at least 30 inches. In many places the material composing them has been recently washed into these depressions, and in many places light depositions are received annually. This soil, therefore, is generally too young to have developed a genetic soil profile, but in a few places it appears that such a profile has begun to form. In such places there is a brown to reddish-brown mellow silt loam to silty clay loam surface layer from 12 to 18 inches thick and a yellowish-brown to reddish-brown friable silty clay loam subsoil 12 to 18 inches thick. In a few places a very dark-colored layer lies at a depth of about 2 to 3 feet. It seems quite probable that this dark layer might have been the surface soil before the surrounding land was cleared.

Like the Abernathy soils, the Ooltewah soils occur in depressions and consist of material washed into the depressions from the surrounding soils of the uplands underlain by limestone, which include the Dewey, Decatur, Bolton, Fullerton, and Talbott soils. The Ooltewah soils differ from the Abernathy soils chiefly in being inferior in drainage, and therefore in having a light-colored and variegated subsoil. As the parent material is generally young, the profiles of these soils are

also young and undeveloped, although they appear to vary considerably in degree of development. As mapped in this county, the Ooltewah soils consist of grayish-brown friable silt loam to a depth of 10 to 15 inches. Below this the material becomes highly mottled with gray and yellow, and it generally becomes finer textured and less friable with increasing depth. In some places compact silty clay is reached between 2 and 3 feet below the surface. Such compact layers are not likely the result of the development of the present profiles of the Ooltewah soils. More likely they represent the subsurface layers of poorly drained soils that occupied these areas before the surrounding soils of the uplands were cleared, thus increasing the rate at which material washes into these areas.

The local alluvial and colluvial materials from which the Greendale soils have developed have been washed chiefly from the Clarksville soils and the cherty and sandy members of the Fullerton series. The Greendale soils, like the Emory soils, lie on gently sloping areas at the foot of slopes. Although these soils vary greatly in degree of profile development, fairly well defined A, B, and C horizons have formed in most places. In such places the A horizon, about 9 inches thick, consists of light grayish-brown friable silt loam, and the B horizon, about 12 to 18 inches thick, consists of brownish-yellow friable silty clay loam. The C horizon is generally highly splotched and mottled with gray, yellow, red, and brown, but it is similar to the B horizon in texture and consistence, although the upper part in some places is generally somewhat brittle. Fragments of chert are generally present throughout the soil material, and the soils are generally medium to very strongly acid in reaction.

The soils classified as members of the Leadvale series in this county lie at foot of slopes and have developed from colluvial and local alluvial material washed chiefly from the Litz, Armuchee, Sequoia, and Needmore soils of the uplands. These soils, it will be recalled, are underlain by acid shales interbedded with varying amounts of limestone, except that the Needmore soils are underlain by calcareous shales. The Leadvale soils are medium acid to very strongly acid in reaction. Like the other soils developed on accumulations of colluvial and local alluvial materials, the Leadvale soils vary greatly in degree of profile development, but in most places fairly well defined A, B, and C horizons have formed. In such places the A horizon, consisting of gray to brownish-gray friable silt loam, ranges between 10 to 15 inches in thickness, and the B horizon, consisting of firm and moderately compact silty clay or silty clay loam, ranges from about 7 to 10 inches in thickness. This horizon is chiefly yellow, but it is lightly mottled with gray, indicating imperfect drainage and aeration. The C horizon is also firm and moderately compact, but it is highly mottled and splotched with gray and yellow. The Leadvale soil material is underlain by shale at a depth of 3 to 5 feet; and, as the shale does not allow good underdrainage, probably the somewhat imperfect drainage of the soils classified as Leadvale in this county is due to the character of the underlying material.

The Whitesburg soils differ from the Leadvale soils chiefly in being approximately neutral in reaction and in being predominantly darker. They are somewhat younger, however, and vary more in degree of profile development. They consist of colluvial and local alluvial material washed chiefly from the Dandridge soils, which are high in

lime, and from the shales underlying these soils. This fact and also the fact that the Whitesburg soils are young and not highly leached account for their approximate neutral reaction. In many places the material is of very recent origin and no genetic profile has developed; in other places such a profile apparently has developed. Here the A horizon consists of dark grayish-brown friable silt loam to silty clay loam between 10 and 15 inches thick, and the B horizon consists of firm silty clay loam between 7 and 10 inches thick, chiefly yellowish brown slightly mottled with gray and yellow. The C horizon is generally rather fine textured and is highly mottled with gray, yellow, and brown. Calcareous shale in most places underlies the soil material at a depth of 30 to 50 inches. The fact that the Whitesburg soils, like the Leadvale soils in this county, overlie shales that do not allow good under drainage, accounts at least partly for the slightly imperfect drainage of these soils.

The soils of the stream terraces are classified into eight series. Differences in the character of the alluvial material, drainage condition, and age account for most of the differences in these soils. The members of six series—Waynesboro, Holston, Monongahela, Tyler, Purdy, and Sequatchie—are developed from general stream alluvium, most of which is thought to have originated in the uplands underlain by sedimentary rocks, chiefly sandstones and shales. The first five of these series constitute a catena in which the drainage becomes progressively poorer from the Waynesboro soils, which are well drained, to the Purdy soils, which are very poorly drained. The soils of all five of these series lie on the older and high terraces. The Sequatchie soils, on the other hand, lie on the lower and younger terraces and have younger profiles.

The A horizon of the Waynesboro soils in this county is generally light-brown very fine sandy loam ranging between approximately 6 and 10 inches in thickness. The B horizon is generally light-red friable very fine sandy clay ranging between 18 and 26 inches in thickness. The underlying material is predominantly red but contains splotches and mottlings of gray and yellow. As just stated, most of the alluvium from which the Waynesboro soils have developed is thought to have come from uplands underlain by sandstones and shales. The fact that the Waynesboro soils have developed almost entirely in areas where the alluvium is underlain by limestones, whereas the other soils of the catena are developed where the alluvium is underlain by shales, indicates that the underlying limestones have influenced the development of the Waynesboro soils by allowing good underdrainage, which is apparently necessary for their development. The relief of the Waynesboro soils, however, is sloping, being generally more sloping than the relief of other soils of the catena, and this condition has also facilitated good drainage.

The Holston and Waynesboro soils have apparently developed from the same kind of stream alluvium, although it is not improbable that materials from uplands underlain by other rocks, especially by quartzites, constitutes a significant proportion of the Holston soil material, particularly in the areas along the Nolichucky River. As compared with the Waynesboro soil, the Holston soils have apparently developed under conditions of inferior drainage, because in most places they overlie shale instead of limestone and have a somewhat gentler slope. The Holston soils are highly leached and are strongly to very strongly acid. The A horizon is yellowish-gray to light-gray very fine sandy

loam about 10 inches thick. The B horizon is yellow firm but friable very fine sandy clay ranging between 15 and 20 inches in thickness. The underlying parent material is generally highly mottled with gray and is moderately compact. Shale generally underlies the parent material in most places at a depth of 30 to 50 inches.

The Monongahela soils are closely associated with the Holston soils and have developed from the same kind of stream alluvium, but they have developed under conditions of somewhat inferior drainage, owing to their generally milder slope. A compact layer has formed at a depth of approximately 2 feet, and because of it the Monongahela soils apparently belong to the Planosol group of intrazonal soils. The Monongahela soils mapped in this county have a surface layer consisting of yellowish-gray friable very fine sandy loam about 10 inches thick. This overlies a subsoil layer of firm but moderately friable very fine sandy clay about 12 inches thick that is chiefly yellow but is slightly splotted with gray, at least in the lower part. The subsoil is underlain by a compact slowly pervious silty clay highly mottled with gray and yellow and lightly mottled with red and brown. In a few places, especially in the more sloping areas, this compact layer probably consists partly of material that is residual from the weathering of the underlying shale.

Occurring mostly on areas that are nearly level and have slow surface drainage, the Tyler soils are more poorly drained than the Monongahela soils. The Tyler soils therefore have developed under conditions of poor external drainage as well as poor internal drainage. They are highly leached and strongly to very strongly acid. The surface layer, of floury silt loam, ranges from about 8 to 12 inches in thickness and is chiefly light gray but is slightly mottled with dark gray, light brown, and yellow. In most places the subsoil is compact plastic silty clay that is predominantly grayish yellow but is highly mottled with gray and ranges from about 10 to 15 inches in thickness. This is underlain by silty clay or clay that is also plastic and compact and chiefly gray mottled with bluish gray and yellow. In view of the compact subsoil, the Tyler soils, like the Monongahela soils, apparently should be considered as Planosols.

Closely associated with the Tyler soils, the Purdy soils are even more poorly drained, as they occur in nearly level to slightly depressed areas where surface drainage is very slow. They are also highly leached and strongly to very strongly acid. As mapped in this county, the Purdy soils have a floury silt loam surface layer about 6 inches thick that is very light gray mottled with various shades of gray, yellow, and brown, and a subsoil layer between 15 and 20 inches thick consisting of firm but moderately friable silty clay loam to silty clay that is very light gray and is highly mottled with various shades of gray and yellow. Below this the material is very compact silty clay or clay highly mottled with various shades of gray and yellow. In some places the subsoil layer is also compact. In view of the compact material below the subsoil, the Purdy soils, like the Tyler and Monongahela soils, should probably be considered as Planosols.

The Sequatchie soils, which are mapped chiefly on the low terraces along the Holston River, have developed from alluvium, most of which presumably originated in uplands underlain by shales and sandstones, but some of which apparently came from uplands under-

lain by limestones. The profiles are generally young, but surface and subsoil layers are generally discernible. The surface layer consists of light-brown loose fine sandy loam ranging from about 6 to 10 inches in thickness, and the subsoil is yellowish-brown friable clay loam ranging from about 10 to 20 inches in thickness. The underlying material is generally friable and is lightly splotched and mottled with gray, brown, and yellow.

The State and Altavista soils occur on the low terraces along the Nolichucky River. In contrast with the Waynesboro, Holston, Monongahela, Tyler, Purdy, and Sequatchie soils, all of which have developed from alluvium most of which is thought to have come chiefly from uplands underlain by sandstones and shales, the State and Altavista soils have developed from alluvium that has come chiefly from uplands underlain by granites, gneisses, schists, slates, and quartzites. Tiny flakes of mica characterize this alluvial material. As these soils occur on low young terraces, they have young profiles. These two series belong to the same catena, the State soils being well drained and the Altavista imperfectly drained.

The State soils are similar to the Sequatchie soils in degree of profile development. As mapped in Hamblen County, the State soils have an 8- to 16-inch dark-brown friable loam surface layer and an 18- to 24-inch yellowish-brown friable silty clay loam subsoil. The material below the subsoil is generally friable but is splotched and mottled with gray and yellow.

The Altavista soils as mapped in this county range in drainage condition from that of the Monongahela soils to that of the Holston soils; but the Altavista soils are younger and have not developed compact layers, although such layers can be expected to develop in time. As mapped in this county, the Altavista soils have a surface layer, 8 to 10 inches thick, of grayish-brown friable loam, and a subsoil layer, 8 to 15 inches thick, of friable silty clay loam that is grayish-yellow but is lightly splotched with brown, yellow, and gray. In many places the texture becomes finer and the splotches become more numerous as the depth of the subsoil increases, but there is no definite compaction of the subsoil material. The material below the subsoil is highly mottled with gray and yellow and in many places is firm but not compact. The Altavista soils occur in nearly level areas.

The soils of the stream bottoms or flood plains are classified into eight series, namely, the Staser, Hamblen, Lindside, Roane, Melvin, Atkins, Congaree, and Chewacla. All these soils are young and show little or no consistent profile development. They are differentiated largely on the basis of differences in the alluvial material and of differences in drainage. All these soils are flooded occasionally and thereby receive deposition of alluvial material more or less periodically.

The Staser and Congaree soils are well drained and are definitely brown to a depth of at least 30 inches, but they consist of alluvial material that originated from different sources. The Staser soils consist chiefly of alluvium washed from uplands underlain by shales, sandstones, and limestones and have an approximately neutral reaction. The Congaree soils, on the other hand, consist chiefly of alluvium that has been washed from uplands underlain by granites, gneisses, schists, slates, and quartzites. This material is generally acid in reaction and contains numerous tiny flakes of mica.

The Hamblen, Lindside, and Chewacla soils are all imperfectly drained, but they differ in the source from which the alluvium of each has been washed. All these soils are predominantly grayish-brown to light brown to a depth of 8 to 16 inches, below which the material is chiefly gray but is highly mottled with various shades of gray, yellow, and, in a few places, brown.

In this county the Hamblen soils consist of alluvial materials similar to those of the Staser soils, except that in most places little or none has come from uplands underlain by sandstones, but the material has come from uplands underlain by shales, chiefly calcareous shales, and by interbedded shales and limestones. The Hamblen soils, like the Staser soils, from which they differ chiefly in being inferior in drainage, are about neutral in reaction.

The Lindside soils occur in the small bottoms in those parts of the county underlain by limestones and consist of alluvial material washed from the adjoining uplands, that is, from uplands occupied by members of the Decatur, Dewey, Fullerton, Bolton, Clarksville, and Talbott series. Like the Hamblen soils, the Lindside soils are generally fairly well supplied with lime, although many areas of soil having an acid reaction are included with soils of the Lindside series as mapped.

The Chewacla soils are closely associated with the Congaree soils, from which they differ chiefly in being inferior in drainage. The soils mapped as Chewacla in this county occur in long, winding, slightly depressed areas that are probably former river channels. The surface layer, which ranges in thickness from about 7 to 20 inches and consists of brown friable loam, appears to have been deposited by recent floods. The underlying material, on the other hand, which is moderately sticky and compact silty clay or clay and which is bluish gray to grayish blue mottled with yellow and brown, appears to have been deposited a number of years ago when water probably remained in these areas for extended periods.

The Melvin soils and the Atkins soils in this county are so closely associated in most places that all the areas are mapped in the complex Melvin-Atkins silt loams. The soils are poorly drained and are predominantly gray mottled with yellow and brown from the surface downward. They differ chiefly in the source of the alluvial material of which they are composed and in reaction, although the Melvin soils contain a few more mottlings of brown in the surface material. The Melvin soils consist of alluvium derived chiefly from uplands underlain by limestones and calcareous shales and are approximately neutral in reaction. The Atkins soils, on the other hand, consist of alluvium derived chiefly from uplands underlain by acid shales and sandstones and are generally very strongly to medium acid in reaction. Melvin-Atkins silt loams are mapped chiefly in the small bottoms and vary considerably in texture and consistence, from friable silt loams to sticky plastic silty clays. In most places, however, they are intermediate between these extremes, and the topmost 6 to 12 inches is generally friable and the underlying material is generally moderately sticky and plastic.

The Roane soils are rather unusual in that they have a tightly bedded layer of chert from 15 to 30 inches below the surface. The alluvial material giving rise to these soils has been washed chiefly from the Clarksville soils and the cherty members of the Fullerton series—soils

that contain a lot of chert. The Roane soils occupy the narrow bottom land strips along the small streams flowing out of areas of the Clarksville soils and Fullerton soils. They are generally fairly well drained and are acid in reaction. To a depth of 15 to 30 inches they consist of grayish-brown loose and open silt loam containing a varying quantity of chert fragments. This rests on a 6- to 10-inch layer of chert in which the fragments are tightly embedded and in which the material generally appears to be somewhat cemented. This layer is underlain by variable material that is generally gray mottled with yellow and light brown and generally contains numerous fragments of chert. The Roane soils in this county in most places are closely associated with the Lindsides soils, and the soils of these two series are mapped as a complex.

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