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# Soil Survey

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## Henderson County North Carolina

By

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United States Department of Agriculture

and

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# SOIL SURVEY OF HENDERSON COUNTY NORTH CAROLINA

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## HOW TO USE THE SOIL SURVEY MAP AND REPORT

The soil survey map and report of Henderson County, N. C., contain information—both general and specific—about the soils, crops, and agriculture of the county. They are prepared for the general public and are designed to meet the needs of a wide variety of readers. The individual reader may be interested in some particular part of the report or in all of it. Ordinarily he will not have to read the whole report to gain the information he needs.

<sup>1</sup> The field work for this survey was done while the Division was a part of the Bureau of Chemistry and Soils.

<sup>2</sup> The Tennessee Valley Authority also cooperated by supplying a part of the funds and materials used in this survey.

Readers of soil survey reports may be considered to belong to three general groups: (1) Those interested in limited areas, such as communities, farms, and fields; (2) those interested in the county as a whole; and (3) students and teachers of soil science and related agricultural sciences. An attempt has been made to satisfy the needs of these three groups by making the report a comprehensive reference work on the soils and their relation to crops and agriculture.

The readers whose chief interest is in limited areas, such as some particular locality, farm, or field, include the 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. The first step of a reader in this group is to locate on the map the tract with which he is concerned. The second step is to identify the soils on the tract. This is done by locating in the legend on the margin of the map the symbols and colors that represent the soils in the area. The third is to locate the name of each soil in the table of contents, which refers the reader to the page or pages in the section on Soils and Crops, where each soil is discussed in detail. Under the soil type heading he will find a description of the soil and information as to its suitability for use and its relationships to crops and agriculture. He also will find useful information in the sections on Productivity Ratings and Physical Land Classification and Land Uses and Agricultural Methods.

The second group of readers includes persons interested in the county as a whole, such as those concerned with land use planning or the placement and development of highways, power lines, docks, urban sites, industries, community cooperatives, resettlement projects, private or public forest areas, recreational areas, and wildlife projects. The following sections are intended for such users: (1) County Surveyed, in which such topics as physiography, vegetation, water supply, population, and cultural developments are discussed; (2) Agricultural History and Statistics, in which a brief history of the agriculture of the county is given and the present agriculture is described; (3) Productivity Ratings and Physical Land Classification, in which the productivity of the soils is given and a grouping of soils according to their relative physical suitability for agricultural use is presented; and (4) Land Uses and Agricultural Methods, in which the present use and management of the soils are described, the management requirements of the soils are discussed, and suggestions for improvement in management are made.

The third group of readers includes students and teachers of soil science and allied subjects, such as crop production, forestry, animal husbandry, economics, rural sociology, geography, and geology. The teacher or student of soils will find the section on Morphology and Genesis of Soils of special interest. He will also find useful information in the section on Soils and Crops, the first part of which presents the general scheme of classification and a discussion of the soils from the point of view of the county as a whole, and the second part of which presents a detailed discussion of each soil. If he is not already familiar with the classification and mapping of soils he will find these subjects discussed under Soil Survey Methods and Definitions. The teachers of other subjects will find the sections on County Surveyed,

Agricultural History and Statistics, Productivity Ratings and Physical Land Classification, and the first part of the section on Soils and Crops of particular value in determining the relationships between their special subjects and the soils in the county. Soil scientists or students of soils as such will find their special interest in the section on Morphology and Genesis of Soils.

### COUNTY SURVEYED

Henderson County is in the southwestern part of North Carolina (fig. 1). About three-fourths of the county is included in the drainage basin of the Tennessee Valley. The county is bounded on the north by Buncombe and McDowell Counties, on the east by Rutherford and Polk Counties, on the south by the State of South Carolina, and on the west by Transylvania County. Hendersonville, the county seat, is 20 miles by air line south of Asheville and 90 miles west of Charlotte. The county has a total area of 229,120 acres, or 358 square miles.

The county lies within the Blue Ridge physiographic province, consisting of mountain

ranges, isolated peaks, large rolling upland valleys, and level areas of stream bottoms. The western end of the county touches Pisgah Ridge, and the eastern and southern sides lie along the Blue Ridge and Saluda Mountains. Following ridges and mountaintops in many places, the boundary is very irregular. The elevation ranges from 1,400 feet above sea level near Bat Cave to 5,200 feet on Little Pisgah Ridge; at Hendersonville it is 2,153 feet.

The most rugged topography is in the western and northeastern parts and along the Green and Hungry Rivers. Many of the mountains rise to an elevation of 4,000 feet or more. The more important peaks are Black Mountain and Johnson, Shell, and Stony Knobs in the western end of the county; Bearwallow Mountain in the northeastern part; Sugarloaf Mountain, which has an elevation of 4,060 feet, and represents the highest point in the Blue Ridge within the county, in the eastern part; and the Pinnacle and Stone Mountain in the southern part. In most places these mountains are steep and small streams have carved out deep, narrow gorges or valleys in their high falls to lower levels. Many areas are severely dissected, especially along the Green and Hungry Rivers in the northeastern corner and in the western part of the county. Several escarpments are near drainageways in the vicinity of the Pinnacle and Bat Cave, and almost perpendicular bare rock walls are conspicuous on the northwestern side of Sugarloaf Mountain.

One of the most noticeable features of the topography is the broad, rolling intermountain plateau or valley, covering 75 to 80 square miles, in the vicinities of Hendersonville and Flat Rock, northeast of Edney-

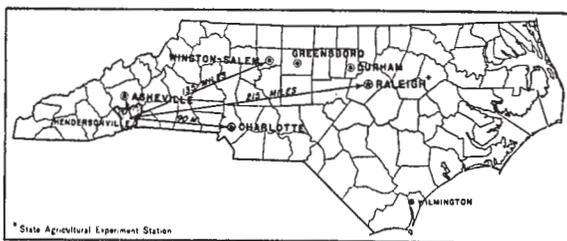


FIGURE 1.—Sketch map showing location of Henderson County, N. C.

ville, in the vicinity of Fletcher, along United States Highway No. 25 northward to the Henderson-Buncombe County line, and from the Mills River northward to that boundary. This plateau has an elevation of from 2,100 to 2,800 feet and in many respects resembles the Piedmont province of the State. It constitutes the greater part of the rolling uplands of the county. The French Broad River Valley, lying in the west-central part of the county, ranges from  $\frac{1}{4}$  to  $1\frac{1}{2}$  miles in width. Together with the valleys along the Mills River and Cane, Mud, Clear, and Hooper Creeks, this constitutes the greater part of the level bottom lands.

The general slope of all the western, central, and northern parts of the county is toward the French Broad River, leading into the drainage basin of the Tennessee Valley. In the northeastern corner the slope is toward the Broad River and in the south and southeastern parts it is toward the Green and Hungry Rivers.

Natural surface drainage is excellent because of the many rivers and creeks. The water over about three-fourths of the county makes its way into the drainage basin of the Tennessee Valley and ultimately into the Gulf of Mexico. The French Broad River, together with its tributaries—the Mills River and Boylston, Cane, Mud, Clear, and Hooper Creeks—drains the western and central parts of the county and flows into the drainage basin of the Tennessee Valley. The northeast corner of the county is drained through the Broad River and its tributaries, Hickory Nut and Reedy Patch Creeks; the extreme eastern part through the Green River; and the east-central part through the Hungry and Little Hungry Rivers. The rest of the county drains into the Atlantic Ocean. All these streams, except the French Broad River and Cane and Mud Creeks, are swift-flowing and are gradually deepening their channels. In many places there are beautiful waterfalls where much power could be developed. Two hydroelectric-power dams are in the county, one on the Green River and one on the Hungry River. Many of the gristmills and several sawmills operate by water power. Some of the farmhouses, especially those near the mountains, are supplied by gravity with spring water from the mountainsides, and many more houses could be supplied at small expense.

The forest growth throughout the county consists principally of hardwoods and a few pines. White oak, post oak, chestnut oak, southern red oak, black oak, red oak, hickory, locust, tuliptree or yellow poplar, maple, dogwood, sourwood, ash, sweetgum, and black tupelo or black gum constitute the hardwoods. Pitch pine represents the conifers in the mountains, and hemlock and white pine represent this forest in the foothills and upland valleys. A few old-field pine have come in where the land has been cleared, farmed, and abandoned.

The more common forest growth of the county and the botanical names are as follows: White oak (*Quercus alba* L.), post oak (*Q. stellata* Wang.), chestnut oak (*Q. montana* Willd.), northern red oak (*Q. borealis maxima* (Marsh.) Ashe), black oak (*Q. velutina* Lam.), American chestnut (*Castanea dentata* (Marsh.) Borkh.), tuliptree or yellow poplar (*Liriodendron tulipifera* L.), common locust or black locust (*Robinia pseudoacacia* L.), red maple (*Acer rubrum* L.), sourwood (*Oxydendrum arboreum* (L.) DC.), flowering dogwood (*Cornus florida* L.), hemlock (*Tsuga canadensis* (L.) Carr.), pitch pine (*Pinus rigida* Mill.), white pine (*P. strobus* L.). Most

of the merchantable timber in accessible localities has been or is rapidly being cut and sold.

White settlers first arrived in the area that is now Henderson County during the Revolutionary period.<sup>3</sup> Many of them came from the already settled parts of the Piedmont province and the Coastal Plain. They were pioneers from Virginia, South Carolina, other sections of North Carolina and from New Jersey, Pennsylvania, and the New England States. Henderson County was organized in 1838 from a part of Buncombe County.

The areas near Hendersonville and Flat Rock, northeast of Fruitland, and throughout the French Broad River Valley and the valleys of other streams in the county are fairly well settled. The remoter parts and the mountainous areas are very sparsely settled, and only a few inhabitants live in the extreme western part. The soil, climate, and other natural advantages of the county should attract settlers, and it could support a larger population than it now has.

According to the Federal census, Henderson County had a population of 26,049 in 1940; Hendersonville, the county seat, had 5,381 inhabitants, and East Flat Rock had 1,103. Flat Rock, Fletcher, Dana, Horse Shoe, Bat Cave, Tuxedo, Edneyville, Fruitland, and Gerton are smaller trading centers, and farm and forest products are shipped from sidings and stations along the railroad. In Hendersonville and in many other places in the county, especially in the vicinity of Flat Rock, there are many beautiful homes and summer resorts.

The Asheville and Spartanburg branch of the Southern Railway crosses the county in a general north-south direction. The Lake Toxaway branch of the same railroad leads from Hendersonville to Brevard. Seven hard-surfaced highways radiate from Hendersonville.

The public gravel and dirt roads are kept in good repair and are excellent during the summer and fall. United States Highway No. 25 extends in a southeast-northwest direction through Tuxedo and Mountain Home, No. 64 in a southwest-northeast direction through Etowah and Bat Cave, and No. 176 from Tryon through East Flat Rock to Hendersonville. These railroads and highways afford ample transportation facilities.

Hendersonville is a market for some cattle, hay, potatoes, fruits, chickens and eggs, and garden vegetables, all of which bring fair prices. Much of the farm products are sold during the summer at East Flat Rock and Balfour, at Saluda and Tryon in Polk County, and at Asheville in Buncombe County.

Most of the schools in recent years have been consolidated, and many of them are large brick structures with modern conveniences. In the mountainous districts and other isolated places the schoolhouses are small frame structures, although they are well built and are kept painted. Well-built churches are fairly numerous. Rural free delivery of mail is established throughout the entire county. Telephone lines extend to the more thickly populated parts.

<sup>3</sup> WHEELER, JOHN H. HISTORICAL SKETCHES OF NORTH CAROLINA FROM 1584 TO 1851. A reprint of the original edition as written in 1851, with a foreword by McK. Shuford. 2 v. in 1, 640 pp., illus. New York. 1925.

Many vacationists are attracted by the opportunities for hunting. Deer are plentiful in the Pisgah National Forest.

The industries in Henderson County consist of cotton mills, hosiery mills, brick and tile factories, and one lime quarry near Fletcher. Some revenue is derived from the sale of lumber, acid wood, cross ties, staves, tanbark, and medicinal herbs.

### CLIMATE

The climate of Henderson County is continental; that is, there are wide differences between the winter and summer temperatures. The temperature, as well as the rainfall, is influenced to a certain degree by the high altitude of the mountains. Most winters are comparatively mild, the summer days are not excessively hot, and pleasant weather prevails during the fall and spring. The nights during the summer are usually comfortably cool.

The amount of rainfall and the temperature differ widely from place to place, partly in relation to elevation, but no data are available except at Hendersonville. Here, the mean precipitation is 59.42 inches, and well distributed throughout the year, as most of the rain falls during the summer or during the growing season. The lightest precipitation occurs during the period from October 1 to November 30, although the period from April 1 to May 31 has a comparatively light rainfall.

The total amount of precipitation for the wettest year is 92.60 inches, and the total amount for the driest year is 32.55. The average snowfall is 8.6 inches. In some winters the snowfall is much heavier and remains on the ground for a long time; in other winters the snowfall is light.

The average date of the last killing frost in the spring is April 22, and the average date for the first killing frost in the fall is October 17, thus giving a frost-free season of 178 days. Frost has occurred, however, as late as May 15 and as early as September 22.

The climate and the soil favor the production of a wide range of crops. In addition to the staple crops—corn, wheat, oats, and hay—cabbages, potatoes, and apples are well suited to this climate. Cabbages, potatoes, sweet corn and other garden vegetables grow rapidly, are crisp, and have a fine flavor. Corn may not mature on some of the higher mountains, owing to the late planting season in the spring and early frost in the fall. The growing season is shorter on the mountains than in the valley. Snow may remain on the mountains in the early spring for several days or weeks after it has melted on the valley floor. Fogs are common during the summer and early fall, but they are usually dispelled before the morning is far advanced. This section is ideal for the production of good pasture grasses. Wheat, oats, clover, and rye grow during the winter. Occasionally a drought in July, August, or September damages crops, and occasionally much rain falls during the summer, especially in August.

The climate of Henderson County is generally favorable for general farming. The dry, invigorating air, together with the cool nights, makes this section ideal for summer resorts, and a large number of visitors come here each season. Good drinking water is plentiful, and excellent water from the mountain springs can be had easily for many of the farm homes.

Table 1, compiled from the records of the United States Weather Bureau station at Hendersonville, gives climatic data that are representative of the mountain valleys.

TABLE 1.—Normal monthly, seasonal, and annual temperature and precipitation at Hendersonville, Henderson County, N. C.

[Elevation, 2,153 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1925)	Total amount for the wettest year (1901)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December.....	39.6	77	-2	5.88	1.88	12.51	1.2
January.....	39.2	77	-8	4.55	6.79	3.39	3.0
February.....	40.3	84	-9	4.60	1.72	1.76	2.3
Winter.....	39.7	84	-9	15.03	10.39	17.66	6.5
March.....	47.6	88	5	5.31	2.46	6.55	1.6
April.....	54.8	90	16	4.23	2.59	8.52	( <sup>1</sup> )
May.....	63.0	93	29	4.86	2.11	8.94	.0
Spring.....	55.1	93	5	14.40	7.16	24.01	1.6
June.....	70.0	95	36	5.54	2.37	9.13	.0
July.....	72.8	99	45	6.07	1.82	5.22	.0
August.....	72.2	98	43	6.08	.49	26.58	.0
Summer.....	71.7	99	36	17.69	4.68	40.93	.0
September.....	67.3	88	32	4.75	1.06	5.78	.0
October.....	56.5	89	18	4.52	4.61	2.90	( <sup>1</sup> )
November.....	46.6	79	6	3.03	4.65	1.32	.5
Fall.....	56.8	89	6	12.30	10.32	10.00	.5
Year.....	55.8	99	-9	59.42	32.55	92.60	8.6

<sup>1</sup> Trace.

## AGRICULTURAL HISTORY AND STATISTICS

Originally this area was occupied by the Cherokee Indians, who produced some corn, tobacco, and pumpkins in small patches on the soils in the bottoms, although they lived mainly on the products of the hunt. The first white settlers came into Henderson County about 130 or 140 years ago. They found the valleys and mountains densely wooded and well stocked with wild game, such as bear, deer, elk, and turkey.

The first land to be cleared for crops was on the first and second bottoms and the smoother parts of the intermountain valley area. There was a dense forest of large hardwood trees. Some of these fine timbers were used in the construction of houses, barns, and fences; the rest was rolled into piles and burned when the land was cleared.

The crops grown by the early settlers were small grains, corn, and other subsistence crops, as well as tobacco and garden vegetables for home use. Grazing lands on the smoother slopes and ridges were cleared later, and cattle and sheep raising became of some importance.

What changes and what progress have been made in the last 60 years can best be seen by comparison of the acreages of principal

crops, compiled from the Federal census for the period 1879-1939 and given in table 2.

TABLE 2.—*Acreages of principal crops and number of fruit trees in Henderson County, N. C., in stated years*

Crop	1879	1880	1890	1900	1919	1929	1939
Corn.....	16,407	20,751	22,633	19,163	17,835	13,227	14,178
Rye.....	3,734	3,800	1,532	2,549	3,434	1,543	2,275
Wheat.....	2,598	633	654	933	2,092	638	749
Oats.....	2,908	3,807	1,242	274	356	64	120
Buckwheat.....	107	15	18	19	204	18	.....
Sorgho.....	.....	350	309	200	404	110	82
Beans (mostly soybeans).....	.....	.....	44	8	48	544	1,060
Peas.....	.....	.....	182	19	63	217	124
Potatoes.....	.....	349	910	1,669	1,215	1,449	1,166
Sweetpotatoes.....	40	160	150	177	128	192	205
Market vegetables.....	.....	.....	.....	.....	133	741	1,762
Hay.....	1,243	2,336	2,120	2,381	2,690	2,478	3,996
Timothy and timothy and clover.....	.....	.....	.....	.....	1,006	741	694
Clover alone.....	.....	.....	133	.....	297	369	(1)
Lespedeza.....	.....	.....	.....	.....	.....	123	1,280
Annual legumes.....	.....	.....	.....	.....	240	792	1,072
Other hay.....	.....	.....	1,987	.....	1,147	553	950
Apples <sup>2</sup> .....	<i>Trees</i>						
Peaches <sup>3</sup> .....	72,151	116,602	126,517	112,872	98,536	112,944	835
.....	25,741	9,300	13,380	20,245	9,431	.....	.....

<sup>1</sup> Included with timothy and timothy and clover.

<sup>2</sup> Includes some sweetclover.

<sup>3</sup> Fruit trees are for the years 1890, 1900, 1930, and 1940, respectively.

From this table it will be seen that corn is and has been the most important crop in acreage. During the last 60 years the acreage has decreased about 2,000 acres, and much less is grown now than at the turn of the century. Nearly every farmer grows some corn for feeding cattle and work animals, for fattening hogs, and for grinding into meal for home use. Wheat increased in acreage up to 1919 but dropped off considerably thereafter. The acreage in oats has dwindled to almost nothing. The production of potatoes and market vegetables has increased markedly. A large increase has also taken place in the acreage devoted to hay. The production of apples and peaches has not changed much in the last 40 years.

In table 3 are shown the agricultural products and their value by classes in Henderson County in 1939.

TABLE 3.—*Value of certain agricultural products by classes in Henderson County, N. C., in 1939*

Crops	Value	Livestock products	Value
Cereals.....	\$355,363	Honey produced.....	\$876
Other grains and seeds.....	2,634	Dairy products sold.....	229,643
Hay and forage.....	102,106	Poultry and eggs produced.....	147,757
Vegetables (including potatoes and sweetpotatoes)	181,375	Wool shorn.....	40
Fruits and nuts.....	111,071		
All other crops.....	14,111		
Farm garden vegetables (excluding potatoes and sweetpotatoes) for home use.	164,803		
Forest products for home use and for sale.....	7,481		

The agricultural development of the county for the last 100 years has been slow. No particular cash crop is grown as a dominant

enterprise. The farming is general, with emphasis on subsistence crops and livestock. The principal cash income is derived from the sale of cattle, apples, dairy products, hogs, poultry, eggs, and grain, together with lumber, cross ties, tanbark, acid wood, cabbage, potatoes, and some truck crops. Most of the hay, wheat, corn, and oats are consumed on the farm.

Practically every farm produces garden vegetables, cabbage, potatoes, apples, and pumpkins mainly for consumption in the home and for sale in small quantities on the local markets. Sorgo is grown in small patches by many of the farmers for the manufacture of sirup for home use, and a small quantity of the sirup is sold on the local market. Some cabbage and potatoes are shipped by rail or transported by truck to outside markets.

There are several commercial apple orchards in the county. These are situated in the mountain coves, on protected slopes, or on the rolling intervalley areas where air drainage is good. Stayman Winesap, Delicious, Rome Beauty, York Imperial, Limbertwig, Grimes Golden, and Virginia Beauty are the principal late varieties. The earlier varieties are Red June, Yellow Transparent, Early Harvest, Horse, and Summer Pearmain. Most of the fruit is shipped either in bulk or in barrels as the crop matures, and only a small part is stored.

The raising of beef cattle is important in Henderson County. According to the United States census, there were 6,828 cattle over 3 months of age in the county on April 1, 1940, of which 4,255 were cows and heifers 2 years old or older. Shorthorn, Aberdeen Angus, Hereford, and Devon are the leading breeds. Many of the cattle are of mixed breed. On every well-established farm there are from one to three or more milk cows that supply milk and butter for home use and a small surplus for sale. In 1939, 3,918 cows and heifers were milked, producing 2,055,416 gallons of milk, a substantial increase over the production of 1,660,962 gallons in 1929. A few dairies, mainly in the vicinity of Hendersonville, supply milk for this town, for some of the other towns in the county, and for Asheville, which lies only a short distance to the north.

On April 1, 1940, there were 2,657 hogs and pigs over 4 months of age. There is an insufficient number to supply the towns with meat. Only a small number of sheep are kept, although the climate is favorable for them.

In 1939, 384,282 dozen eggs were produced and 124,679 chickens were raised. In 1929, 391,973 dozen eggs were produced and 109,387 chickens were raised.

The number of farms in Henderson County on April 1, 1940, was 2,323. Owners and part owners operated 77.7 percent of the farms, tenants 21.6 percent, and managers 0.7 percent. Most of the tenant farming is on the share basis. On most of the rented farms the landowner furnishes the land, work animals, and implements and receives one-half of the crops produced. On some of the rented farms that include the more productive soils of the bottom lands, the tenant supplies the work animals and the landowner receives one-half of the crop.

Many of the farmhouses, particularly in the intermountain areas and adjacent to the rich alluvial soils in the bottoms, are large and

substantial. Some have modern conveniences, and many of them have running water supplied by gravity from mountain springs. The tenant houses on these farms are of fair quality. In the remote mountain districts the tenant houses and many of the farmhouses are small, poorly constructed, and inexpensive. The barns on the best farms are good and large enough to give necessary room for the proper storage of crops and housing of livestock. There are generally a number of outbuildings for the storage of machinery. The fences are chiefly of barbed wire, although in some places rail fences are still in use.

Equipment on the average farm includes one-horse and two-horse turning plows; hillside plows; bull-tongue or single-tongue plows; double-shovel walking cultivators; other walking or riding cultivators; a grain drill; a disk, drag, or spike-tooth harrow; a mowing machine; and a hay rake. Some of the farms have corn harvesters, reapers, manure spreaders, and tractors. There are a few silos. Work animals include both mules and horses, mules predominating. Oxen are used to some extent in hauling logs or drawing sleds in the rough mountainous sections.

According to the Federal census, the average size of farms in 1940 was 50.3 acres. The greater number of the farms range in size from 15 to 250 acres. Land in farms aggregated 116,917 acres, or 47.8 percent of the area of the county. The farm land in 1939 was made up as follows: Cropland, 37,409 acres; plowable pasture, 13,217 acres; woodland, including woodland pasture, 53,212 acres; and all other land in farms, including other pasture, 13,079 acres.

Lumber companies own large tracts of land in the mountains, and the Federal Government owns 18,635 acres in the Pisgah National Forest. One or two farmers own a thousand or more acres of land and cultivate only a small acreage or only the part that has a favorable relief. In the intervalley area the landholdings are comparatively small, but the proportion of land under cultivation is relatively high. It is reported that about one-third of the farmers of the county hire labor for farm work. Most of the hired labor on the farm is white. It is also reported that a number of the farmers purchase hay and grain.

In 1940 the census reported 1,750 farms using commercial fertilizer at a total expenditure of \$77,784, or an average of \$44.45 a farm. The fertilizer mixtures in general use are 4-8-4,<sup>4</sup> 3-8-3, and 5-7-5 and superphosphates. An expenditure of \$8,872 for 3,690 tons of liming materials also was reported by 373 farms, an average of \$23.79 a farm. In addition to these, some farmers apply nitrate of soda or ammonium sulfate as top or side dressing. All barnyard manure is applied to the farm land, and some farmers increase the fertility of their soil by growing and turning under crimson clover and other leguminous crops.

#### SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road

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<sup>4</sup> Percentages, respectively, of nitrogen, phosphoric acid, and potash.

or railroad cuts, are studied. Each excavation exposes a series of distinct soil 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<sup>5</sup> and its content of lime and salts are determined by simple tests. 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, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics, soils are grouped into classification units, the three principal of which are (1) series, (2) type, and (3) phase. In 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 map but must be mapped as (4) a complex. Areas of land, such as rock outcrop or bare rocky mountainsides, that have no true soil are called (5) miscellaneous land types.

The most important of these groups is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics, the same natural drainage conditions, and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may differ within a series. The soil series are given names of places or geographic features near which they were first found. Porters, Hayesville, Balfour, Congaree, and Toxaway are names of important soil series in this county.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Balfour loam and Balfour fine sandy loam are soil types within the Balfour series. Except for the texture of the surface soil, these soil 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 soil unit to which agronomic data are definitely related.

A phase of the soil type is recognized for the separation, within a type, of soils differing in some minor soil characteristic that may, nevertheless, have an important practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type, some parts may be adapted to the use of

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<sup>5</sup> 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.

machinery and the growth of cultivated crops and other parts may not. Even though no important differences are 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 plants. In such an instance the more sloping parts of the soil type may be segregated on the map as a sloping or hilly phase. The following slope ranges are used to designate the different phases: 0 to 2½ percent, level land; 2½ to 7 percent, smooth land; 7½ to 15 percent, sloping land; 15 to 30 percent, hilly or hill land; 30 to 60 percent, steep land; and over 60 percent, very steep land. Similarly, 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 growth of native plants.

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 Henderson County are varied in color, texture, structure, and consistency in both the surface soil and the subsoil. There is also much variation in the relief, or lay of the land, and in the degree of erosion. The soil areas range from small, scattered, rather intricately mixed areas to large and continuous areas of several square miles. The more intricate soil pattern is in the intermountain valley area and in the stream valleys.

The large number of soil types, phases, and classifications of materials are due to the different rock formations from which the soils are developed and particularly to the wide variation in relief. Large areas of rough mountainous land are steep to very steep, and some are stony. In the western part of the county there are 18,635 acres of land in the Pisgah National Forest owned by the Government. In the same locality there is a gross area of 27,800 acres within the so-called forestry boundary in the county.

The large area of comparatively smooth country, or the so-called intermountain valley area, is an exception for this mountainous region. Much of this land lies favorably for general farming operations and the use of improved machinery. This particular locality, which also includes the areas of soil on the first and second bottoms, offers possibilities for agricultural development. Thousands of acres of good soils could be brought under cultivation when there is need for the production of more farm crops, cattle, fruit, and especially potatoes, cabbage, and truck crops.

There are three main classes of soils in the county as regards the general character of the soils and subsoils, relief, drainage, stoniness, and erosion conditions: (1) Soils of the mountains, (2) soils of the intermountain valley, and (3) soils of the first bottoms and second bottoms. The soils in the mountains have dominantly brown surface soils and have brown, yellowish-brown, or reddish-brown friable clay loam subsoils. Most of these soils are included in the Porters series. The several types and phases are due to the very wide ranges

in relief or in stoniness. These soils occupy a large area, particularly in the northwestern part of the county. They are developed mainly from Carolina gneiss and to less extent from Roan gneiss and granite.

Associated with the Porters soils are the Ashe, Burton, and Rabun soils. The Ashe soils are developed from granites and gneiss and occur on some of the higher mountains at elevations ranging from 3,000 to 5,000 feet, generally lying higher than the Porters soils. The Ashe soils have light-colored surface soils and yellow or brownish-yellow friable clay loam subsoils. Small areas having a black or dark-gray surface soil that contains a large quantity of organic matter are classed as Burton stony loam. This soil has developed from the same parent material as the Porters and Ashe soils, but it differs from them in the content of organic matter. It occurs on the smoother parts of some of the higher mountains and in the coves on the north slopes. Rabun stony clay loam, which occurs in small areas, is characterized by a brown or reddish-brown surface soil and a red fairly heavy clay subsoil. The pronounced red color of this soil readily distinguishes it from associated soils of the mountains. It is developed from dark-colored basic rock or from Roan gneiss. At the base of some of the steeper mountains small areas of soil consist of materials sloughed, washed, or rolled down from the steep mountainsides and accumulated at the base of the slope or spread out for a short distance over the valley floor. These areas have a brown surface soil and a brown or yellowish-brown friable clay loam or loam subsoil and are mapped as Tusquitee loam.

The greater part of the Porters, Ashe, Burton, and Rabun soils are marked by steep to very steep relief. Some of them have on the surface a sufficient quantity of angular fragments of either gneiss or granite and some dark-colored basic rock to exclude them from cultivation. In addition some areas are steep and contain numerous large boulders and outcrops of solid rock. Such areas are too stony and too void of soil even to be classed with the stony loams but are designated as rough stony land (Porters soil material). Steepness and stoniness preclude this classification of material from any agricultural use except forestry. Most of the area of the soils of the mountains is too steep in relief for general farming, but a considerable part may in time be used for pasture grasses or to a limited extent for apples or special crops.

The soils in the intermountain valley area that have a smooth relief and lie favorably for farming operations include the Edneyville and Balfour and the smoother areas of the Hayesville soils. They constitute the principal agricultural soils of the uplands for general farming. As a group, these soils are light-colored; that is, the color in the surface soil ranges from grayish yellow to light brown and in the subsoils from yellow to brown in the Edneyville and Balfour, respectively, and is red in the Hayesville. These soils do not contain so much organic matter as the soils in some parts of the mountains. In the forested areas, however, a thin layer of leaf-mold covers the surface and the upper 1 or 2 inches of soil contain enough organic matter to give a brownish-gray color. The subsoils and the underlying soft disintegrated rock material contain a large proportion of potash. They have developed from Henderson and Whiteside granites, which occupy a large area of the central and

eastern parts of the county. These rocks are composed of orthoclase feldspar, quartz, and muscovite and biotite mica.

In this group, the Edneyville soils have grayish-yellow surface soils and yellow to brownish-yellow friable fine sandy clay subsoils. Associated with the Edneyville soils are the Balfour soils, which have light-brown or brown surface soils and yellowish-brown, brown, or faintly reddish-brown friable clay loam subsoils. The Hayesville soils are readily distinguished from the other soils in the valley by their red moderately heavy clay subsoils. Scattered throughout this group of soils are small areas here and there with gray or yellowish-gray surface soils and mottled gray, yellow, and brown subsoils. These areas, classed as Worsham fine sandy loam, represent a condition rather than a definite soil type, as there is much variation in the color, texture, consistence, and drainage conditions.

The Fletcher soils are the only silt loams developed in the uplands. They are easily distinguished from the other soils by their floury feel and also by the underlying parent material. They occur in a narrow strip extending in a northeast-southwest direction near Boylston Creek Church and Fletcher. The surface soils are gray or light brown, and the subsoils are reddish-yellow or light-red silty clay. They have developed from Brevard schist, a fine-grained mica schist that is variable in color and contains some black shales. Near Fletcher and Boylston, this formation contains lentils of limestone or marble that is so pure that it has been burned and used for building purposes and for agricultural lime.

In the first bottoms along the French Broad and Mills Rivers and Mud, Clear, Cane, and Hooper Creeks are some fairly large areas of first-bottom soils. These consist of materials brought down from the hillsides and mountainsides and deposited by the streams at times of overflow. The brown surface soils and the brown subsoils contain a noticeable quantity of fine mica scales. These soils are classed in the Congaree series. Associated with the Congaree soils are areas of a soil having a black or dark-gray surface soil and a dark-gray or bluish-black subsoil. This soil is Toxaway silt loam. It has a high content of organic matter. In addition there are large areas of Congaree-Toxaway complex and areas of alluvial soils, undifferentiated. The latter classification consists of material so variable in color and texture that no separation into types could be made on the map of the scale used.

In some of the broader valleys, fair-sized areas of soils on the second bottoms or terraces comprise the Altavista and Roanoke soils. Altavista silt loam has a gray or light-brown surface soil and a yellow or brownish-yellow subsoil. It is sufficiently well drained for the production of crops. Roanoke silt loam represents the poorly drained areas, and both the surface soil and the subsoil indicate poor drainage and aeration. Artificial drainage is necessary in both the Roanoke and the Toxaway soils in order to reclaim them for use as cropland.

Chemical analyses of soils similar to those made by the North Carolina Department of Agriculture and the Division of Soil Chemistry and Physics of the Bureau of Plant Industry show that the soils are relatively low in phosphorus and nitrogen, but that they have a high percentage of potash. Congaree silt loam and Toxaway silt loam

are naturally fertile soils and produce good yields of corn and hay without the application of fertilizer.

The soils of the mountainous section contain dominantly more organic matter and are slightly less acid than the soils of the uplands in the intermountain valley. This is caused largely by climate, as less leaching of organic matter and mineral plant nutrients takes place in the soils of the mountains than in the soils of the intermountain valley. All the soils of the uplands, except the Burton and some of the Porters, are deficient in organic matter. In the forested areas on some of the high mountains, and particularly in the coves on the north side of the mountains, a considerable amount of organic matter has accumulated in the surface soil. All the forested areas have a shallow covering of leafmold on the surface and enough organic matter in the first 1 to 3 inches to give a brownish-gray color. This organic matter is soon lost under cultivation.

All the soils in Henderson County are strongly to extremely acid, except where lime has been applied. The pH value of several of the extensive and important soils ranges from 4 to 5.5.

Sheet erosion and gulying have been active on some of the steeper sloping or hilly areas devoting to clean-cultivated crops. It was a common practice in early days to abandon a field when it became unproductive and to clear new land. After the land was abandoned, it suffered severe erosion in some places before a grass or forest cover could get started. These soils have grown up in old-field pine or small oaks. Most of the erosion took place on the Hayesville and Fletcher soils. Owing to the loss of fertility in the surface soil through leaching and erosion, the farmer is constantly confronted with the problem of managing his land so as to achieve not only soil conservation but soil improvement.

In this county, relief is the important external factor that determines in a large measure the crops grown and land use. Agriculture is confined largely to the soils in the first and second bottoms and the smoother lands in the intermountain valley. Less than one-fourth of the land is devoted to the production of crops or is plowable pasture, fallow land, or idle or abandoned land.

Corn is an important crop. It is grown to greater or less extent on every arable soil in the county, but particularly on the productive soils on the first and second bottoms and on the smooth lands of the intermountain valley.

Most of the potatoes are grown on the Balfour soils and the smoother areas of the Porters loam. A good quality of sirup can be produced from sorgo grown on the Edneyville and Worsham soils. Most of the apple orchards are in the northeastern part of the county in the vicinity of Fruitland on the Balfour, Edneyville, Hayesville, and Porters soils, although some are in the southern part.

The soils of Henderson County are grouped into five classes according to such characteristics of the soil as relief, stoniness, drainage, degree of erosion, and crop yields, as follows: (1) First-class soils, (2) Second-class soils, (3) Third-class soils, (4) Fourth-class soils, and (5) Fifth-class soils. These groupings are made primarily for the sake of convenience in describing the agriculture as it relates to the characteristics of the soil and land use and not for the placing of an intrinsic value on any of the lands. In general, soils of the first three

classes are suitable for cultivated crops, the Fourth-class soils are best suited for forestry, and the Fifth class are suited only for forestry. Some of the Second-class soils may equal or even surpass those of the First class in crop yields; similarly, some of the Third-class soils equal or surpass those of the Second class, and so on, depending on present and past soil management.

In the following pages the soils are described in detail and their agricultural relationship is discussed; their distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in table 4.

TABLE 4.—*Acreage and proportionate extent of the soils mapped in Henderson County, N. C.*

Soil type	Acres	Per- cent	Soil type	Acres	Per- cent
Congaree silt loam.....	4, 608	2. 0	Porters loam.....	21, 632	9. 4
Congaree fine sandy loam.....	3, 136	1. 4	Porters stony loam, hill phase.....	6, 400	2. 8
Congaree-Toxaway silt loams.....	4, 160	1. 8	Rabun stony clay loam.....	1, 920	. 8
Toxaway silt loam.....	3, 136	1. 4	Burton stony loam.....	384	. 2
Tusquitee loam.....	3, 136	1. 4	Ashe fine sandy loam.....	1, 792	. 8
Hayesville fine sandy loam.....	640	. 3	Ashe stony fine sandy loam, slope phase.....	2, 368	1. 0
Hayesville loam, smooth phase.....	11, 328	4. 9	Fletcher silt loam, hilly phase.....	2, 368	1. 0
Balfour loam.....	5, 376	2. 3	Hayesville loam, steep phase.....	448	. 2
Balfour loam, smooth phase.....	7, 680	3. 4	Hayesville clay loam, eroded hilly phase.....	384	. 2
Balfour fine sandy loam, smooth phase.....	6, 272	2. 7	Wehadkee silt loam.....	448	. 2
Hayesville loam.....	2, 816	1. 2	Stony colluvium (Porters soil mate- rial).....	448	. 2
Hayesville clay loam.....	704	. 3	Porters loam, very steep phase.....	7, 296	3. 2
Edneyville fine sandy loam.....	3, 392	1. 5	Porters stony loam.....	46, 208	20. 2
Altavista silt loam.....	3, 904	1. 7	Ashe stony fine sandy loam.....	4, 608	2. 0
Balfour fine sandy loam.....	2, 624	1. 1	Rough gullied land (Hayesville soil material).....	64	( <sup>1</sup> )
Fletcher silt loam.....	3, 328	1. 5	Rough stony land (Porters soil ma- terial).....	11, 968	5. 2
Fletcher silt loam, smooth phase.....	1, 024	. 4	Rock outcrop.....	1, 280	. 6
Roanoke silt loam.....	1, 984	. 9			
Alluvial soils, undifferentiated.....	2, 240	1. 0	Total.....	229, 120	100. 0
Worsham fine sandy loam.....	4, 480	2. 0			
Balfour fine sandy loam, hilly phase.....	5, 504	2. 4			
Balfour loam, hilly phase.....	10, 112	4. 4			
Porters loam, hill phase.....	19, 004	8. 7			
Hayesville loam, hilly phase.....	7, 616	3. 3			

<sup>1</sup> Less than 0.1 percent.

#### FIRST-CLASS SOILS

First-class soils include Congaree silt loam; Congaree fine sandy loam; Congaree-Toxaway silt loams; Toxaway silt loam; Tusquitee loam; Hayesville fine sandy loam; Hayesville loam, smooth phase; Balfour loam; Balfour loam, smooth phase; and Balfour fine sandy loam, smooth phase.

These soil types and phases are considered the best soils in the county when such factors as inherent fertility and productivity of the soil, relief or lay of the land, proportion under cultivation, and the ease of cultivation, particularly with improved farm machinery, are taken into consideration. These soils are scattered widely throughout the intermountain valley and the valleys along the streams. They occupy 49,472 acres, or 21.6 percent of the area of the county.

The soils in this group dominate the agriculture of the county; that is, they produce the greater part of the corn and hay. Congaree silt loam and Toxaway silt loam are the best soils for corn and hay, not only in Henderson County but throughout western North Carolina. A large proportion of the soils in this group is under

cultivation, and the principal crops grown are corn, hay, small grains, potatoes, cabbage, some apples, garden vegetables, and sorgo.

These soils lie favorably for the use of all kinds of improved farm machinery. The land is almost level or gently sloping to undulating, comprising a large part of the smooth land of the county. All these soils are naturally well drained, with the exception of Toxaway silt loam and Congaree-Toxaway silt loams; and for the most part the latter soils have been drained artificially and reclaimed for agricultural use.

In addition to the favorable relief, these soils generally have surface soils and subsoils that are mellow and friable, and the surface soils contain a moderate quantity of organic matter. The Hayesville and Balfour soils contain the least organic matter of any soils in this class. Congaree silt loam is a well-balanced soil as regards content of organic matter and content of mineral plant nutrients. Some of these soils are already in a high state of productivity; the rest are capable of improvement. Most of these soils are benefited by a liberal application of lime, particularly when clovers and other leguminous crops are grown. Corn and wheat are also benefited by lime used in addition to a complete fertilizer. Some of the best farmers have increased the yields of crops to a marked degree by turning under green-manure crops. Even on these good agricultural soils, commercial fertilizer is used to a greater or less extent, especially for intensive crops. It is true that Congaree silt loam, Toxaway silt loam, and Tusquitee loam produce good yields without the use of fertilizer, but these soils respond readily to the addition of lime and to the addition of commercial fertilizer or the turning under of green-manure crops.

**Congaree silt loam.**—The surface soil of Congaree silt loam is brown or dark-brown mellow friable silt loam to a depth of 10 to 14 inches. It is underlain by light-brown or yellowish-brown silt loam or silty clay loam, which continues downward to a depth of 3 or more feet. Both the surface soil and the subsoil contain a large proportion of small mica flakes. As mapped, Congaree silt loam includes small areas of Toxaway silt loam, Congaree-Toxaway silt loams, Congaree fine sandy loam, and alluvial soils, undifferentiated. These inclusions are too small in extent to be separated on the map. Bordering areas of Toxaway silt loam, the subsoil of Congaree silt loam grades from brown silty clay at a depth of 15 to 20 inches into dark-gray silty clay.

Congaree silt loam is an important agricultural soil and has a total area of 4,608 acres. It occurs in the first bottoms along many of the streams, especially the Mills and French Broad Rivers and Cane, Clear, Mud, Crab, and Hooper Creeks. Isolated areas occur along the North Fork and South Fork of Mills River and along Sitton, Stone, and Rock Creeks.

The surface of this soil is level to very gently undulating. It is well drained for a soil in a first-bottom position. It is subject to overflow during ordinary freshets and heavy rains. The material giving rise to this soil consists of sediments washed from the uplands and brought down and deposited by the streams at times of overflow. In its natural condition this soil contains a larger quantity of mineral plant

nutrients and organic matter than any other soil in the county. As regards plant nutrients it is one of the best soils in the State.

Practically all of the land is cleared and under cultivation. Probably 90 percent is devoted to corn, and the rest is devoted to wheat, potatoes, and hay crops. This soil is especially adapted to the production of corn and is also well suited to the growing of hay. Although crops are sometimes injured by occasional overflow, they are never injured by drought. Locally some of the soil is damaged by the deposit of sandy gravel at times of extreme heavy overflows.

Yields of corn range from 40 to 60 bushels an acre. Some of the farmers apply from 200 to 300 pounds per acre of a 4-8-4 or 3-8-3 fertilizer. The mixture may contain less nitrogen where corn follows a leguminous crop that has been turned under. Some farmers report as high yields as 30 to 40 bushels of wheat to the acre where the soil has been fertilized with 300 pounds of a 4-8-4 mixture or a heavy application of 16-percent superphosphate. Wheat is grown on the slightly higher lying areas that are not subject to so frequent overflow as most of the soil. Yields of wheat on this soil range from 16 to 24 bushels. Rye returns about 18 bushels; hay, consisting of soybeans or timothy and redtop, from 1½ to 2 tons; and potatoes 100 to 160 bushels when the land receives from 400 to 600 pounds per acre of a 5-7-5 or 5-8-6 fertilizer.

Although corn has been grown year after year on Congaree silt loam for a long time, the yields remain about the same, particularly under good management. Growing soybeans and crimson clover as green-manure crops and turning these under have maintained the soil in a high state of productivity. Applications of lime, in addition to the complete fertilizer and the green-manure crops, have been given the soil by some of the farmers. The use of lime with the complete fertilizer usually increases yields of corn and wheat. Lime also is necessary for the successful growing of clover.

**Congaree fine sandy loam.**—In many places Congaree fine sandy loam is closely associated with Congaree silt loam. Narrow strips border the streams throughout the central, northwestern, and southern parts of the county. The largest areas lie along the French Broad, Mills, and Green Rivers and along Cane, Clear, Mud, Hooper, and Britton Creeks, and a few small strips occur along some of the smaller streams elsewhere in the county.

The surface soil is grayish-brown or light-brown mellow fine sandy loam, from 10 to 20 inches deep. Consisting of light-brown or yellowish-brown fine sandy loam or fine micaceous loamy sand, the subsoil reaches to a depth of 40 to 50 inches. The underlying substratum is generally sand and gravel. Both the surface soil and the subsoil contain some fine mica scales. Narrow bands of brown loamy fine sand or sand occur here and there bordering the streams. There are also a few small areas of very fine sandy loam. Locally, small spots of Toxaway silt loam or Congaree silt loam are included in the mapping. In some places only an arbitrary boundary could be drawn between Congaree fine sandy loam and Congaree silt loam.

Although inextensive, Congaree fine sandy loam is an important agricultural soil, as it occupies nearly level to slightly undulating areas and is well drained. It is subject to occasional overflow. Those

areas occurring nearest the streams occupy a slightly higher position than do areas of Congaree silt loam, and crops on them are seldom damaged by overflow. The materials giving rise to this soil consist of sediments washed from the uplands and brought down and deposited by the streams during times of overflow. Natural drainage is better than in any other soil in the first bottoms in this county.

Practically all of the land is cleared, and most of it is in cultivation. The principal crops grown are corn, rye, sorgo, and watermelons. In some places where this soil has been properly managed and crops of soybeans or clover have been turned under, the yields of corn are almost as good as those obtained on Congaree silt loam. Approximately 80 percent of this soil is used for the production of corn, and yields range from 25 to 45 bushels an acre. Some of the farmers use from 200 to 400 pounds to the acre of a 3-10-4 fertilizer for corn. Rye yields from 10 to 18 bushels, the land is usually given a light application of commercial fertilizer. Watermelons do well on this soil and are of excellent flavor; the land is fertilized with a 3-6-6 mixture at the rate of 400 to 600 pounds to the acre. Garden vegetables and truck crops, when fertilized, also do well on this soil. This soil is easily tilled and can be cultivated under a wide range of moisture conditions. Improved farm machinery can be used advantageously.

**Congaree-Toxaway silt loams.**—Congaree-Toxaway silt loams represent those areas of soil on the first bottoms that comprise Toxaway silt loam and Congaree silt loam so intricately associated that they could not be separated on a map of this scale. In some places this complex includes areas of brown silt loam to a depth of 8 to 12 inches, underlain by dark-gray to almost black silty clay loam. Many variations are mapped in this complex. In places the surface soil is fine sandy loam and the subsoil is yellow fine sandy clay; in other places the subsoil consists of layers of fine sand and silty clay. About 30 years ago when a soil survey of Henderson County was made, some of the soil now mapped as a Congaree-Toxaway complex was at that time typical Toxaway silt loam. Since then much erosion has taken place on the hillside and sediments have been brought down and deposited by the streams over this original first-bottom soil, and such areas have a Congaree surface soil and a Toxaway subsoil.

Congaree-Toxaway silt loams cover a total area of 4,160 acres. This soil complex occurs on the first bottoms along the streams and in widely scattered areas throughout the county. The largest areas border Mud, Cane, and Crab Creeks, Devils Fork, and French Broad River.

Areas of this soil complex are level to slightly undulating, and all are subject to overflow, although some lie at slightly higher elevations where overflows seldom occur. Drainage ranges from well drained to imperfectly drained. The complex has been formed in the same way as Congaree silt loam and Toxaway silt loam.

Probably 95 percent of this land is cultivated or in pasture. The principal crops are corn and hay, although some wheat, oats, and rye are grown. Corn occupies 90 percent of the land, and the yields range from 25 to 50 bushels an acre. Cornland usually receives from 200 to 300 pounds to the acre of a 3-10-4 or 4-8-4 fer-

tilizer. Hay (soybeans or timothy or redtop) yields from 1 to 2 tons. This soil is handled in about the same way as Toxaway silt loam and Congaree silt loam. Some of the areas of Toxaway silt loam within this complex, being imperfectly drained, require open ditches or tile drains in order to reclaim them for agricultural purposes. Some of the farmers dig narrow, shallow ditches, place poles in them or two boards nailed together in a V-shape over a board in the bottom of the ditch, and fill the ditches with soil. This complex, particularly the areas of Toxaway silt loam, responds readily to the application of lime and to the addition of complete fertilizer.

**Toxaway silt loam.**—Toxaway silt loam is the black soil of the first bottoms and is readily distinguished from the Congaree and associated soils. The surface soil is black or dark-gray mellow silt loam to a depth of 12 to 20 inches. In many places it contains a very large proportion of organic matter. The subsoil is light-gray or bluish-gray slightly sticky silty clay or silty clay loam, which extends to a depth of 30 to 36 inches. In places there is a light-gray very sticky silty clay layer. Below this is a layer, a few inches thick, of light-gray fine sandy loam, which passes into the substratum of gray, yellow, and almost white sand and some gravel. Here and there the soil is black or dark-gray silt loam to a depth of 3 feet or more, or the upper subsoil layer is dark-brown silt loam, which grades into brownish-yellow silt clay. Included in the mapping of Toxaway silt loam are small areas of Congaree silt loam, Congaree fine sandy loam, Congaree-Toxaway silt loams, and alluvial soils, undifferentiated.

Toxaway silt loam is an important agricultural soil, although it does not cover a large total area. It occurs in the first bottoms along many of the streams, especially the French Broad and Mills Rivers, Devils Fork, and Boylston, King, Mud, Clear, Cane, Grassy, and Crab Creeks.

Many areas of this soil are nearly level, and others are very gently sloping, particularly where the soil joins the uplands. Most of them lie some distance back from the streams, for instance, between areas of Congaree silt loam bordering the stream courses and the uplands. This soil is subject to overflow during times of extremely high water, and crops are damaged to considerable extent. Natural drainage of the greater part of this soil is imperfect, and in many places open ditches are used to carry off the excess rain water. Some of the farmers have constructed so-called blind ditches; that is, they have dug narrow, shallow ditches and placed poles or boards in them and covered these over with soil. Some areas of Toxaway silt loam would be improved by better drainage.

Toxaway silt loam apparently represents the original areas of first-bottom soils. The sediments consist of materials that were brought down from the surrounding mountains and hillsides before any land in the county was cleared. The material consists principally of silt, clay, very fine sand, and in some places a noticeable quantity of mica scales. After it was deposited by the streams, this material was in a swampy or semiswampy condition for a long time, and this favored the growth of water-loving grasses, shrubs, and trees. This accounts for the large quantity of organic matter in this soil and its black color, as contrasted with the lighter colored soils in the first bottoms.

At present practically all of this land is under cultivation or in pasture; the rest supports a growth chiefly of elms and maples. Toxaway silt loam is regarded as one of the best soils in the county for the production of corn, hay, and pasture grasses. Potatoes, cabbage, and celery do well on this soil. In many places the yields of corn and hay are comparable with those on Congaree silt loam. This soil is not so well drained as Congaree silt loam, and this condition limits its crop adaptation.

Probably 80 percent of this land is planted to corn, and most of the rest is sown to grasses for hay and pasturage. Corn yields from 30 to 60 bushels an acre, hay 1 to 2 tons, and rye 8 to 15 bushels. Celery was formerly grown and did well on this soil. Cabbage and potatoes give good yields when the land is fertilized with 400 to 600 pounds to the acre of a 5-7-5 or 5-8-6 mixture. From 200 to 300 pounds of a 3-8-3 or 4-8-4 mixture is used by some of the farmers for corn. Lime is also used.

Some areas of Toxaway silt loam would be improved considerably by better drainage. The North Carolina Agricultural Experiment Station<sup>6</sup> has found, through field experimentation, that the addition of lime, particularly when used with a complete fertilizer; gives increased yields of corn and hay crops, especially where clovers are grown. An application of 1 to 2 tons of agricultural lime or ground limestone every 4 or 5 years is recommended for this soil by the department of agronomy of the station.

**Tusquitee loam.**—Tusquitee loam is a brown friable soil that owes its origin to material sloughed or washed down from higher lying areas and accumulated at the base of the slopes or spread out a short distance on the valley floor. The 9- to 15-inch surface soil is brown to dark-brown mellow loam containing a comparatively large proportion of organic matter. The friable clay loam subsoil ranges in color from yellowish brown to reddish brown. In most places it extends to a depth of 25 to 40 inches or more. In places this material has accumulated to a depth of several feet and is fairly uniform in color, texture, and structure throughout. The wide range in the depth of the surface soil and subsoil is due to the lay of the land on which this material has been deposited. The shallower soil is on the upper side of the slope, where the soil grades into the typical soils of the uplands, and the deepest soil is at the base of the slope. It grades into the Porters, Balfour, and Hayesville soils on the one side and into the alluvial soils on the other. Here and there small fragments of gneiss and granite rock are present, but not in sufficient quantities to interfere with cultivation. One of the characteristic features of Tusquitee loam is the friable, mellow character of both the surface soil and the subsoil. Where the soil material is derived from the Hayesville soils, the subsoil is reddish-brown or pale-red friable clay loam. Included with Tusquitee loam as mapped are a few small areas in which the subsoil is mottled yellow, brown, and gray heavy silty clay. In a few places the surface soil is fine sandy loam.

Although not extensive, Tusquitee loam is an important agricultural soil. Areas occur in the vicinity of Blue Ridge School; south

<sup>6</sup> WILLIAMS, C. B., RANKIN, W. H., and CLAPP, S. C. THE VALUE OF LIMESTONE ON TOXAWAY LOAM AND PORTER'S LOAM SOILS. N. C. Agr. Expt. Sta. Bul. 285, 15 pp. 1938.

of Hendersonville; and near Edneyville, Pleasant Grove Church, Fanning Chapel, Mills River Church, Osceola Lake, and Naples. In the mountains the greater part of this soil is in the coves and at the base of the steep mountains, as in the vicinity of Patty Chapel, Fruitland, Mount Moriah Church, Mountain Home Church, Bear-wallow Mountain, Mount Zion Church, Mountain Valley Church, and Mount Olivet Church and near Gerton.

The surface is dominantly gently sloping, ranging in gradient from 3 to 7 percent. Most of it lies favorably for farming operations. Natural drainage is good but not so thorough as that of the closely associated Hayesville, Balfour, and Edneyville soils.

Practically all of the land is cleared and farmed. The principal crops are corn, hay, potatoes, cabbage, and garden vegetables. Most of it is used for the production of corn, which yields from 20 to 40 bushels an acre. Some farmers apply 200 to 300 pounds to the acre of a 4-8-4 fertilizer on cornland. Potatoes and cabbage give good yields where the land is fertilized with from 400 to 600 pounds of a 5-7-5 or 5-8-6 mixture. Applications of lime, together with a complete fertilizer, increase the yields of corn. Pasture grasses benefit from the use of lime and phosphatic fertilizer.

Tusquitee loam is considered one of the good, productive soils of the county. Inherently, it is a good soil, and by proper treatment fertility can be easily maintained. The friable structure of both the surface soil and the subsoil favors the absorption of a large quantity of rain water. Under ordinary good management, sheet erosion is practically negligible on this soil. Over much of the surface farm machinery can be used advantageously, but many areas are too small to justify the use of heavy machinery.

**Hayesville fine sandy loam.**—The surface soil of Hayesville fine sandy loam in cultivated fields is grayish-yellow or light-brown mellow fine sandy loam, from 6 to 10 inches deep. This is underlain by a 3- to 5-inch layer of light-red heavy fine sandy loam. The subsoil is red stiff to moderately brittle clay extending to a depth of 30 to 50 inches, where it grades into the soft disintegrated Henderson or White-side granite or Carolina gneiss. Sheet erosion is noticeable in some places on the more sloping areas that have been under clean cultivation for a long time.

Only a very small total area of Hayesville fine sandy loam is mapped, chiefly in the east and south-central parts of the county. The largest body is north of Upward; smaller bodies are near Flat Rock, St. James Church, Hillgirt, Flint Hill School, and Tracy Grove Church; north-east and south of Edneyville; north of Dana; and west of Liberty Church.

The surface ranges from undulating or gently sloping to rolling. On the more uniform slopes the gradient is from 3 to 8 percent. Owing to the sloping relief and the open structure of the surface soil, both surface and internal drainage are good. This soil lies favorably for farming operations with improved machinery. It was placed in the group of First-class soils because most of the areas are smooth, and the few steeply sloping or rolling areas are too small to warrant a phase separation on the map.

About 80 percent of the land is cleared and cultivated; the rest is covered with timber, mainly of hardwoods and some pine, particularly

white pine. The soil is easy to till, warms early in the spring, and responds readily to the application of fertilizer. Like many of the other soils in the county, this soil also responds to the turning under of leguminous crops. Unless the steeper slopes are protected by some cover crop during the greater part of the time, sheet erosion will impair this soil. Some terracing and strip cropping are essential in order to hold the soil.

Corn, wheat, and clover are the principal crops. Yields of corn range from 20 to 35 bushels where from 200 to 300 pounds to the acre of a 4-8-4 or 3-8-3 mixture has been applied. Wheat yields from 12 to 15 bushels an acre, and wheatland usually receives from 200 to 300 pounds of a 3-8-3 mixture or 200 pounds of 16-percent superphosphate in the fall at sowing time. Hay (timothy and redtop) yields 1 ton. Redtop does well on this soil, especially when lime and fertilizer are applied. Garden vegetables, truck crops, and apples are grown successfully. Because of the favorable relief, good drainage, and ease of cultivation, this soil can be used for a wide variety of crops.

**Hayesville loam, smooth phase.**—Hayesville loam, smooth phase, occurs on gentle slopes and in undulating areas that have a gradient of 3 to 8 percent. Most of it lies favorably for the use of improved farm machinery. This soil is separated from typical Hayesville loam because of its smooth surface, ease of handling, and less susceptibility to erosion under similar treatment.

The surface soil of Hayesville loam is light-brown or grayish-brown mellow loam to a depth of 8 to 12 inches. The subsoil is light-red or red stiff but moderately brittle clay, which extends to a depth of 30 to 40 inches. Beneath this is mottled light-red and yellow friable clay loam or heavy fine sandy loam, which grades into the soft disintegrated granite or gneiss rock from which this soil is developed. Minor variations include spots in the more sloping areas where sheet erosion has removed some of the original surface soil, and other spots, particularly in slight depressions, where fine material has accumulated over the original soil. The subsoil ranges in color from light red to red and in structure from very friable to heavy. This soil is closely associated with Hayesville loam, Edneyville fine sandy loam, and the Balfour soils. Small areas of these soils are included with the Hayesville loam, smooth phase.

Hayesville loam, smooth phase, is an important and fairly extensive agricultural soil. Most of the land has been cleared and is farmed or is in pasture grasses; the rest is forested with hardwoods and pines, especially white pine. All this soil is naturally well drained, and the more sloping areas are subject to sheet erosion under clean cultivation. The control of erosion on this soil is much less of a problem, however, than on typical Hayesville loam, which occupies much steeper relief. A few terraces and some strip farming in connection with contour cultivation, no doubt, will be beneficial in retaining this soil. This soil responds readily to fertilizing and to turning under green-manure crops, and its productivity can be maintained.

The principal crops are corn, wheat, and clover. Corn yields from 25 to 35 bushels an acre, and cornland usually is given an application of 200 to 300 pounds to the acre of a 3-8-3 or 4-8-4 fertilizer. If corn follows a leguminous crop that has been turned under, less nitrogen is

necessary in the fertilizer. Wheat does well on this soil and yields from 12 to 20 bushels. Hay yields 1 to 1½ tons. Most of the farmers apply 200 or 300 pounds of a complete fertilizer or 200 to 300 pounds of superphosphate at the time of sowing. Clover does well if the soil has been limed and a liberal application of fertilizer or barnyard manure has been made. Garden vegetables, potatoes, and cabbage grow successfully. Where potatoes and cabbage are grown for market, the land is fertilized with 400 to 600 pounds of a 5-7-5 or 5-8-6 mixture.

**Balfour loam.**—Balfour loam is an agriculturally important soil in this county. It occurs throughout the central and eastern intermountain valley, especially in the vicinity of Blue Ridge School, northeast of that school, and northeast of Uno. Smaller bodies lie west and southwest of Dana, near Fanning Chapel, and near Osceola Lake.

The surface soil of Balfour loam is grayish-brown or light-brown mellow loam to a depth of 8 to 10 inches. The subsoil is yellowish-brown or light reddish-brown friable fine sandy clay or clay loam extending to a depth of 24 to 40 inches. This is underlain by brown or brownish-yellow fine sandy clay mottled with brown and yellow. At a varying depth this grades into the soft, disintegrated, and partly weathered Henderson or Whiteside granite. This soft granite maintains the constructional form of the original rock. In forested areas a thin layer of leafmold covers the surface and the first 1 or 2 inches of the surface soil contains a noticeable quantity of organic matter. On the more sloping areas the subsoil in some places is shallow over the soft disintegrated light-gray or yellowish rock material. In a few places, part of the original surface soil has been removed through sheet erosion and the brown subsoil is exposed.

Balfour loam has a sloping relief ranging in gradient from 7 to 15 percent. Some areas are rolling to hilly. All areas have excellent surface and internal drainage, owing to the lay of the land and to the friable character of the soil and subsoil. The more sloping areas that have been under clean cultivation have lost part of the original surface soil, and in some places small gullies are beginning to form.

About 50 percent of the land has been cleared and is farmed or used for pasture. The principal tree growth on the rest consists of a variety of oaks, maple, sourwood, hickory, dogwood, and white pine. Practically all of the cleared land is used for the production of corn, wheat, oats, clover, and truck crops, including potatoes, cabbage, and sweetpotatoes. It is reported that this soil is not so well adapted to the growing of wheat as the Hayesville soil on the same relief and that the yields are slightly lower. Roots readily penetrate the friable surface soil and subsoil. This soil is readily accessible, lying at lower elevations than the Porters and Ashe soils in close association with the Edneyville soils. Modern farm machinery can be used successfully on the smoother areas. Most of the land now in forest could be cleared and used for crops and pasture grasses.

Corn yields from 20 to 35 bushels an acre, and cornland usually receives from 200 to 300 pounds of a 4-8-4 or 3-8-3 fertilizer. Some of the farmers apply a small quantity of lime. Wheat yields from 8 to 15 bushels, and wheatland usually receives the same fertilizer treatment as the associated soils. Potatoes return from 80 to 150

bushels and cabbage 4 to 8 tons. Land devoted to these crops is fertilized with 400 to 600 pounds of a 5-7-5 or 5-8-6 mixture. Oats and clover do fairly well. Garden vegetables and truck crops are grown for the local market. The higher yields of many of these crops are due to good management, heavy applications of fertilizer, the use of lime, and the turning under of green-manure crops.

Because of the more sloping relief, typical Balfour loam is more subject to sheet erosion than Balfour loam, smooth phase. It should be given a longer rotation of crops and more strip cropping than the soil of the smooth phase.

**Balfour loam, smooth phase.**—In color, texture, and structure, the surface soil and the subsoil of Balfour loam, smooth phase, are essentially the same as the corresponding layers in the typical soil, except that in some places the subsoil is slightly darker over the disintegrated rock. The principal difference between the two soils is in the gently sloping to undulating relief of this soil. All of it lies favorably for agricultural use, and improved machinery can be operated easily on it. This soil is less susceptible to sheet erosion under similar treatment than typical Balfour loam. Most of it occurs in close association with Balfour loam and the Edneyville soils.

Surface and internal drainage are good. The soil is responsive to improvement. By properly rotating crops and by turning under leguminous crops, farmers can easily maintain the productivity of this soil. Probably 50 to 60 percent of the land is cleared and farmed; the rest supports a growth of hardwoods, together with some white pine.

Yields of corn range from 20 to 40 bushels an acre when an application of 200 to 300 pounds of a 4-8-4 or 3-8-3 fertilizer has been made. Wheat does not do quite so well as on the corresponding Hayesville soils, yields ranging from 10 to 18 bushels to the acre. Wheatland usually receives a small application of a complete fertilizer or 200 to 300 pounds of 16 percent superphosphate. Hay (timothy and redtop) yields from 1 to 1½ tons, cabbage 4 to 10 tons, and potatoes 80 to 160 bushels. Land devoted to potatoes and cabbage is given 400 to 600 or more pounds of a 5-7-5 or higher rate mixture. Garden vegetables and truck crops do well. The higher yields obtained on Balfour loam, smooth phase, are due to good farm practices by some of the farmers, heavy fertilization, the judicious use of lime, and the turning under of green-manure crops. This treatment accounts for the wide range in yields of various crops on this soil.

**Balfour fine sandy loam, smooth phase.**—This soil differs essentially from typical Balfour fine sandy loam in that it occurs in smoother areas, that is, on slopes ranging from about 2 to 7 percent. The relief in places is undulating to gently rolling. In some places the surface soil is slightly deeper and the subsoil is thicker over the soft bedrock than the corresponding layers of typical Balfour fine sandy loam, which occupies more sloping areas. This soil is closely associated with the typical soil in the intermountain valley. It is an important agricultural soil, although not extensive. Natural drainage is good, and all areas lie favorably for agricultural operations. Because of the more favorable relief, this soil is less subject to sheet erosion under similar treatment than typical Balfour fine sandy loam.

Probably 60 percent of the land has been cleared and is used for farming purposes; the rest supports a growth dominantly of hardwoods, although some white pine grows here and there. The principal crops are corn, potatoes, sweetpotatoes, hay, and sorgo; and some apples are grown. Yields on this soil are slightly higher than those obtained on typical Balfour fine sandy loam, and, because of its smoother surface, this soil is easier to handle than that soil. It warms early in the spring and responds readily to the use of commercial fertilizer and lime and to the turning under of green-manure crops or barnyard manure.

Corn yields from 15 to 35 bushels an acre when from 200 to 300 pounds to the acre of a 4-8-4 or 4-10-4 fertilizer is applied. Potatoes yield from 80 to 120 bushels, and the land usually receives from 500 to 800 pounds of a 5-7-5 fertilizer. Hay, mainly timothy and clover, yields from 1 to 1¼ tons an acre. About 200 to 400 pounds of 16-percent superphosphate to the acre is applied. Sweetpotatoes do well when a high-analysis fertilizer is used. Some sorgo is grown, particularly in the lower positions, where the moisture conditions are most favorable. A few apple orchards are on this soil, and the trees are in a healthy condition. When the land is fertilized or given an application of barnyard manure, garden vegetables do especially well.

#### SECOND-CLASS SOILS

Second-class soils include the following soil types and phases: Hayesville loam; Hayesville clay loam; Edneyville fine sandy loam; Altavista silt loam; Balfour fine sandy loam; Fletcher silt loam; and Fletcher silt loam, smooth phase.

As a whole, the soils in this group are closely related to the soils in the First class as regards agricultural use and crop yields, and in some instances the line of division between the two classes is somewhat arbitrary. Some of these soils are inherently fertile, but their productivity is reduced by sloping relief, eroded condition, or susceptibility to serious erosion if kept in clean-cultivated crops. These soils, however, occupy a much smoother relief, are less eroded and better drained, are more easily cultivated with improved farm machinery, and are less expensive to handle than the soils in the Third class.

Some farmers who practice good management on these soils—that is, use a good rotation of crops, turn under green-manure crops, use lime and manure, or fertilize heavily—obtain yields equal to or greater than those on some of the soils in the First class. The proportion cultivated is smaller than in the First class but greater than in the Third class. Some terracing and strip cropping are essential on some of these soils in order to prevent sheet erosion on the sloping to strongly sloping areas that are under clean cultivation.

A wide variety of crops is grown; and, in addition, some commercial apple orchards and some good pastures are maintained. A large part of this land, or the part that is susceptible to sheet erosion, could be seeded to pasture grasses in conjunction with general or special farming on the smoother areas.

**Hayesville loam.**—Hayesville loam has a brownish-yellow, grayish-brown, or light-brown mellow loam surface layer from 8 to 12 inches deep. This grades into a 2- to 4-inch layer of reddish-yellow heavy

loam or clay loam. The subsoil is red or light-red stiff but moderately brittle clay that readily crumbles into a granular mass under ordinary pressure and under normal moisture conditions. At a depth of 30 to 40 inches a reddish-yellow or mottled red and yellow fine sandy clay or clay loam is reached. This layer ranges from 6 to 10 inches in thickness and grades into the soft disintegrated Henderson granite, Whiteside granite, or Carolina gneiss, from which the soil has developed. In some places this soft disintegrated rock shows the constructional form of the original rock. In wooded areas a thin covering of leafmold lies on the surface and the first 1 to 3 inches of the surface soil is darkened by the presence of organic matter. In cultivated fields where some sheet erosion has occurred the surface soil is yellowish-red loam. On some of the steeper slopes the subsoil is shallow over the soft disintegrated rock and the color ranges from brown to red. Hayesville loam occurs in small areas throughout the central intermountain valley and occurs along the lower slopes in other parts of the county. The largest areas are west of the Blue Ridge, near Upward, east of Flat Rock, and near Hendersonville, Osceola Lake, Pleasant Hill Church, Edneyville, Mountain Sanitarium, Fruitland, and Patty Chapel.

The relief of this soil is dominantly steeply sloping to hilly. On the main slopes the gradient ranges from 8 to 15 percent. Hayesville loam is placed in this class because of its relief. Otherwise, it is inherently a good soil; but it is more subject to erosion under clean cultivation than the soils in the First class. All areas of this soil have good surface and internal drainage. Where this soil has been under clean cultivation for several years, sheet and gully erosion are pronounced. Although very few terraces have been constructed on this soil, they are essential for adequate control of runoff.

Probably 40 to 50 percent of this soil is cleared and under cultivation. The rest is forested, principally to hardwoods, consisting of red, white, post, southern red, black, and chestnut oaks, and to a less extent to white pine, sourwood, dogwood, and hickory.

The principal crops grown on this soil are corn, wheat, clover, and lespedeza, as well as garden vegetables and a few apples. This soil is reported to be well suited to the growing of wheat and clover. Burley tobacco does well on this soil, and where air drainage is favorable commercial apple orchards also do well.

Probably 70 percent of the cleared land is devoted to corn, 20 percent to wheat, 5 percent to clover, and 5 percent to apples. Corn yields from 15 to 30 bushels an acre when from 200 to 300 pounds to the acre of a 4-8-4 or 3-8-3 commercial fertilizer has been applied. Wheat yields from 12 to 18 bushels where a light application of commercial fertilizer or 200 or 300 pounds of 16-percent superphosphate has been applied. Clovers, particularly red clover, yield well on this soil where some lime and a complete fertilizer have been used.

This soil requires more careful management in order to prevent erosion, and it is more difficult to till than the soils of smoother relief. Under clean cultivation, particularly on the steeper slopes, this soil is very susceptible to erosion. With proper terracing, strip cropping, cultivating on the contour, and the incorporation of organic matter, this soil can be held, improved, and maintained in a fair state

of productivity. On the smoother areas farm machinery can be operated, but most of the cultivation is done with light implements. Some of the areas now in forests could be cleared and used for farm crops; or, if fertilized, limed, and seeded with a proper mixture of grass seed, good pasture grasses could be grown. Most of this soil should be kept in close-growing crops; only occasionally in the rotation should clean-cultivated crops be grown, particularly on the more sloping areas.

**Hayesville clay loam.**—Hayesville clay loam, locally known as red clay land of Henderson County, differs from Hayesville loam in having a red color and a heavier texture. At one time part of this soil was Hayesville loam, but sheet erosion has removed all or part of the original surface soil. This soil occurs on the slopes in the intermountain valley and lies at a lower elevation than the Porters soils. In relief it is gently sloping, undulating, or gently rolling. The more uniform areas, or rather the longer slopes, have a gradient of 3 to 7 percent. All areas are naturally well drained. Because of the heavy character of the subsoil and, to a less extent, the heavy character of the surface soil, rainfall does not penetrate this soil so readily as it does the Porters and Balfour soils; and, as a result, sheet erosion on those areas under clean cultivation is pronounced. Although inextensive, this is a conspicuous soil because of its red color and its location in the county.

The surface soil of Hayesville clay loam is reddish-brown to light-red clay loam to a depth of 4 to 6 inches. The subsoil is stiff but brittle clay that is moderately friable under normal moisture conditions. It reaches to a depth of 30 to 40 inches. Beneath this is a lighter colored and more friable material, which grades into the parent material of a soft disintegrated granitic rock. Here and there the surface material is red clay, particularly where severe erosion has exposed the subsoil. In places the subsoil is 4 to 5 feet thick over the bedrock.

Small areas of this soil are in the vicinity of Boylston Creek Church, Edith Grove Church, and Etowah; east of Crab Creek Church; southwest of Calvary Church; and near Naples and Gypsy.

Probably 30 percent of this soil is cleared and used for the production of the staple crops and pasture grasses. Some of the formerly cultivated areas have been abandoned and have a growth of shortleaf pines. The original forest growth was dominantly hardwoods, together with some scattered white pines.

Hayesville clay loam is used mainly for growing wheat, rye, clover, and pasture grasses. On some of the smoother areas where the surface soil is deepest and contains the largest quantity of organic matter, some corn is grown. Yields of wheat range from 12 to 18 bushels and corn from 15 to 30 bushels an acre. Clover, mostly red clover, does well on this soil, especially if a liberal application of lime has been made in addition to commercial fertilizer. Most of the cornland and wheatland is given a liberal application of a complete fertilizer similar to that applied on Hayesville loam. Some of the farmers plant corn on clover sod and follow the corn with wheat. Care should be exercised in the management of this soil, especially under clean cultivation, as it is very susceptible to sheet erosion. The soil lies favorably for the use of improved machinery; in fact,

it requires heavy machinery and strong work animals for proper handling. Properly constructed terraces, strip cropping, incorporation of organic matter, and contour tillage are recommended on this soil. Runoff is rapid, even though the slope is gentle. Lime is very beneficial, especially when used in connection with a complete fertilizer for the growing of leguminous crops, particularly clover and soybeans. These crops not only supply the needed organic matter but also improve the physical condition of the soil.

**Edneyville fine sandy loam.**—Edneyville fine sandy loam is the lightest colored soil of the uplands in the intermountain valley, resembling the Durham soils in the Piedmont or the Norfolk soils in the Coastal Plain physical provinces of the State. It is one of the important agricultural soils of the county, although it is not extensive. It is named for the town of Edneyville, near which it is typically developed.

The surface soil in cultivated fields is light-gray or grayish-yellow mellow fine sandy loam, from 7 to 9 inches deep. This grades into a 3- or 4-inch subsurface layer of pale-yellow friable heavy fine sandy loam. The subsoil begins at a depth of 10 or 12 inches and consists of yellow friable fine sandy clay. At a depth of 32 to 36 inches it is underlain by yellow or brownish-yellow fine sandy loam, which grades within a few inches into the soft disintegrated granite. This material is variable in color in the upper part and reaches to a considerable depth before grading into the hard bedrock. Here and there a few small rock fragments are present throughout the surface soil and the subsoil. One of the outstanding characteristics of this soil is the friable character of the surface soil and the subsoil.

Bordering areas of the Balfour soils, the surface soil is grayish brown and the subsoil is brownish yellow or yellowish brown. In places the subsoil also ranges from yellow to reddish yellow and from friable fine sandy clay to rather heavy fine sandy clay or clay loam. Other inclusions are small spots of Hayesville fine sandy loam, which have a red moderately heavy clay subsoil.

Edneyville fine sandy loam occurs mainly in the eastern and north-eastern parts of the county. Some of the largest areas are found in the vicinity of Edneyville, Mount Moriah Church, Dana School, and Tracy Grove Church and southeast and east of Hendersonville. Smaller areas occur in the vicinity of East Flat Rock, Dana, Liberty Church, Fruitland, Yale, and Mountain Sanitarium.

The relief ranges from undulating to gently rolling; here and there are some fairly uniform gentle slopes. On the broad comparatively smooth areas the slope ranges from about 3 to 8 percent. This soil lies favorably for farming operations, and all kinds of improved farm machinery can be used successfully. Both surface and internal drainage are good, owing to the relief and to the friable character of both the surface soil and the subsoil. On some of the more sloping areas that are under clean cultivation, sheet erosion is noticeable. This can be checked by terraces, strip cropping, and proper rotation of crops.

Probably 70 percent of the land is cleared and used for corn, wheat, sweetpotatoes, oats, and truck crops. The rest supports a growth dominantly of hardwoods, together with some pine. Yields of corn

range from 15 to 30 bushels, wheat 10 to 15 bushels, and sweetpotatoes 100 to 150 bushels to the acre. Oats and clover return fair yields. From 200 to 300 pounds to the acre of a 4-8-4 or 4-10-4 fertilizer is applied for corn, and about the same or slightly less is applied for wheat. For sweetpotatoes the soil is fertilized with from 800 to 1,000 pounds of a 5-7-5 or 3-8-6 mixture. Land devoted to truck crops, such as snap beans and cabbage, is given an application of 600 to 800 pounds of a 5-7-5 mixture. A few apple orchards are kept, and the trees are in a healthy condition.

Edneyville fine sandy loam is easy to till, warms early in the spring, and can be cultivated under perhaps a wider range of moisture conditions than any other soil of the uplands in the county. This soil can be built up to a fair state of productivity, and this state can be easily maintained by growing and turning under leguminous crops. The addition of barnyard manure and the use of green-manure crops are recommended to provide needed organic matter. Applications of lime increase the yield of corn and are needed for clover and other leguminous crops.

**Altavista silt loam.**—Although not extensive, Altavista silt loam is an important soil agriculturally. It occupies almost level or slightly undulating areas on the second bottoms and low terraces along the French Broad and Mills Rivers and some of the other larger streams. In places this soil lies only a few feet higher than the Congaree or some of the other soils of the first bottoms. This soil has developed from material washed from the soils of the uplands and brought down and deposited by the streams when they flowed at higher levels. This old alluvial material has lain in a fairly well drained position for sufficient time to develop a normal soil profile.

To a depth of 7 to 10 inches the surface soil of the Altavista silt loam is gray or grayish-brown mellow silt loam. The subsoil is yellow to brownish-yellow moderately heavy fine sandy clay or clay loam, extending to a depth of 30 to 40 inches. In some places the lower part of the subsoil shows some mottles of light gray. Generally, below a 30- to 40-inch depth the underlying material is mottled yellow, brown, and gray heavy clay. In places the subsoil is reddish-yellow or brown heavy silty clay. There is considerable variation in the color and texture of some of the soil included with the Altavista silt loam. In places the color ranges from light gray to brown and the texture ranges from silt loam through fine sandy loam to loam. Where this soil borders Roanoke silt loam, the subsoil is mottled yellow-gray clay. In places the underlying substratum consists of small rounded quartz gravel. Here and there a few small pebbles are scattered over the surface, and in one or two spots the quantity of gravel is sufficient to interfere with cultivation. Near Cannon, Hendersonville, French Broad Church, and Holly Springs Church are small areas where the surface soil is gray fine sandy loam and the subsoil is a yellow fine sandy clay. Owing to their small extent, these areas are included with the Altavista silt loam.

The largest area of Altavista silt loam occurs on the second bottoms along the French Broad and Mills Rivers in the vicinity of Mills River School, Zion School, and northwest of Patty Chapel. Smaller areas are near Upward and Highland Lake, northeast of East Flat Rock, and near Etowah and Pleasant Grove Church.

For the most part, this soil has good surface and internal drainage. Some of the most nearly flat areas, however, particularly those bordering Roanoke silt loam, are imperfectly drained and would be benefited by artificial drainage. All areas of this soil lie favorably for agricultural operations and the use of improved machinery. Probably 75 percent of the land is cleared and cultivated; the rest is forested mainly with hardwoods, together with a few pines.

The principal crops are corn, wheat, rye, oats, and hay. Probably 60 percent of the cultivated land is devoted to the production of corn, 30 percent to wheat, and the rest to rye, oats, and hay crops. Yields of corn range from 15 to 35 bushels and of wheat 10 to 15 bushels to the acre. Cornland is given an application of about 200 pounds to the acre of a 3-8-3 or 4-10-4 fertilizer, and wheatland in some instances is given the same or even a heavier application. Hay yields range from 1 to 1½ tons. Lime is used by some of the farmers on this soil, and increased yields are obtained, especially in connection with complete fertilizer. The higher yields on this soil are due to good management, the use of a leguminous green-manure crop, or heavier applications of fertilizer. For the improvement of this soil, better drainage in a few areas, leguminous green-manure crops, and an application of lime are recommended. Because of the smooth surface, adaptation to the staple crops of the county, and absence of overflow except in times of extremely high floods, this soil is considered one of the good and potentially valuable agricultural soils.

**Balfour fine sandy loam.**—In cultivated fields the surface soil of Balfour fine sandy loam is light-gray or light-brown mellow fine sandy loam to a depth of 7 to 9 inches. The subsoil is brownish-yellow heavy fine sandy loam or fine sandy clay in the upper 3 to 5 inches and yellowish-brown to brown friable fine sandy clay below. At a depth of 30 to 40 inches this is underlain by friable partly weathered Henderson or Whiteside granite that is dominantly light gray but contains streaks or splotches of black and yellow. The soft underlying rock crumbles easily, but in many places it shows the structural form of the original rock. In the wooded areas a shallow covering of leafmold lies on the surface, and the organic matter darkens the first 1 to 3 inches of the surface soil. In some places the subsoil is shallow, that is, not more than 20 inches in thickness over the soft bedrock. There is some variation in the color of the surface soil, owing to sheet erosion, and where a part of the original surface soil has been washed off, the surface material is yellowish brown and in some places slightly reddish brown. At the base of some of the slopes the surface soil is deeper than elsewhere, because of the accumulation of materials sloughed or washed from the higher areas. Balfour fine sandy loam is closely associated with Edneyville fine sandy loam, and small areas of the latter type are included in the mapping. In a few spots the subsoil is yellowish-red heavy fine sandy clay mottled with yellow and gray. These spots are comparable with Appling fine sandy loam in the Piedmont plateau section of the State.

Balfour fine sandy loam covers a small total area, but it is a fairly important agricultural soil. It occurs mainly in the east-central part of the county in the intermountain valley. The largest areas are in the vicinity of Pleasant Hill Church, Flint Hill Church, Balfour,

and Edneyville and east of Hendersonville. Many smaller areas are scattered throughout the central valley.

This soil has a sloping to steeply sloping or hilly relief. It lies at a lower elevation than the Porters soil. It resembles the Porters in color and structure. Both surface and internal drainage are well established.

Probably 40 to 50 percent of the land has been cleared and is used for crops, pasture grasses, and apple orchards. The rest supports a growth dominantly of hardwoods with some white pine. The principal crops are corn, hay, apples, potatoes, sorgo, sweetpotatoes, and vegetables. Corn yields from 15 to 30 bushels an acre, and cornland usually receives an application of 200 to 300 pounds to the acre of a 4-8-4 or 4-10-4 fertilizer. Potatoes yield from 80 to 125 bushels where from 400 to 800 pounds of a 5-7-5 mixture is applied. For hay (mainly timothy and clover or soybeans) usually 200 to 400 pounds of 16-percent superphosphate is applied, and yields of 1 to 1¼ tons are obtained. Apples do well on this soil where the air drainage is good. When fertilized or manured, gardens return good yields of vegetables. Sorgo is grown in patches here and there, particularly on the lower slopes, where the moisture conditions are the most favorable. A few sweetpotatoes are grown for home use and for sale locally.

Although this soil has a decidedly sloping relief, improved farm machinery can be operated over a greater part of it. It is easy to till, warms early in the spring, and responds to the addition of fertilizer or green-manure crops and barnyard manure. It can be cultivated over a wide range of moisture conditions. The friable structure and consistence of the surface soil, the subsoil, and the soft underlying rock allow absorption of a large part of the rainfall. This soil is not so susceptible to sheet erosion as the Hayesville soils on the same relief and under the same cultural treatment. Under clean cultivation on the steeper slopes, however, there is evidence of damage by sheet erosion. Terracing, strip cropping, and the growing of cover crops are recommended in order to hold and improve this soil.

**Fletcher silt loam.**—The 6- to 8-inch surface soil of Fletcher silt loam is light-brown or brownish-yellow silt loam having a slightly greenish cast. The subsoil to a depth of 30 to 40 inches is yellowish-brown, reddish-brown, salmon-red, or light-red rather heavy smooth silty clay with a pinkish cast. Both the surface soil and the subsoil contain a considerable quantity of small platy schist fragments, especially in the lower part of the subsoil, which tend to give the material a friable, crumbly structure. The presence of these small schist fragments is beneficial, as they improve the consistence of the soil and help it to warm rather quickly. The underlying substratum consists of partly weathered or disintegrated Brevard schist. These schist rocks break up in convex and concave platy fragments that are brownish on the outside and have a metallic luster on the inside. The surface soil varies considerably in depth over the subsoil, depending mostly on the degree of erosion.

Even in its virgin condition Fletcher silt loam contains very little organic matter. In wooded areas there is on the surface a shallow covering of dark-gray partly decomposed leafmold derived from leaves and twigs. This material is lost rather quickly when the soil is cleared and cultivated.

The Brevard schist formation, from which this soil is developed, runs in a northeast-southwest direction across the northwest-central part of the county, beginning on the Buncombe-Henderson County line near Fletcher and running across Henderson and Transylvania Counties to the South Carolina State line.

The most important bodies of this soil are in the vicinity of Fletcher and Brickton; smaller areas are near Shehan and Patty Chapel and in the vicinity of Mills River Church. Altogether the total area is small. The surface ranges from 7 to 15 percent in gradient. Inherently, Fletcher silt loam is not so fertile a soil as some of the other soils in this class or in the Third class, but its favorable relief is such that it can be handled much more easily than the hilly types and phases. Surface drainage is good, and the large proportion of schist fragments mixed throughout the surface soil and the subsoil seems to aid internal drainage.

Probably 40 percent of this land has been cleared and is used for cultivated crops or for pasture. The rest is forested principally to white pine, southern red oak, post oak, white oak, red oak, sourwood, dogwood, and a few scattered shortleaf pines.

The principal crops are corn, wheat, oats, rye, and lespedeza. Corn yields from 10 to 25 bushels an acre when the land is treated with 200 to 300 pounds to the acre of a 3-8-3 or 4-8-4 fertilizer. Wheat yields 8 to 12 bushels when 200 to 300 pounds of a 4-8-4 mixture is used and 100 pounds of nitrate of soda is added in the spring as a top dressing. Rye yields from 10 to 14 bushels, and the land is usually fertilized with 200 pounds of 16-percent superphosphate. Oats yield rather poorly on this land. Clover and lespedeza yield fairly well, especially if lime and fertilizers are used.

The cleared areas of this soil under clean cultivation are susceptible to sheet erosion, and very careful management is required to prevent serious erosion. Deep plowing and turning under cover crops are very beneficial. Lespedeza is an excellent crop both to hold and to improve the soil. Under proper crop rotation and management this soil may be built up to a fair or even good state of productivity. On the more gently sloping areas heavy farm machinery can be used advantageously. Liming, fertilizing, and the growing of lespedeza and other leguminous crops are highly recommended.

**Fletcher silt loam, smooth phase.**—Fletcher silt loam, smooth phase, differs from the typical soil mainly in that it occupies smoother slopes ranging from 3 to 7 percent. The surface soil is from 2 to 4 inches thicker and organic matter and mineral plant nutrients are less scarce in the soil of the smooth phase than in the typical soil. The color, texture, and structure of the surface soil and the character of the subsoil, substratum, and underlying rocks of this smooth phase are identical with those features of the corresponding layers in Fletcher silt loam. In small depressions this soil has a tendency to puddle or run together after rains.

This phase of Fletcher silt loam is not extensive. Areas occur north of Fletcher and in the vicinity of Patty Chapel and North Mills River Church.

About 70 percent of the land is cleared and used for cultivated crops and pasture. Corn, wheat, oats, rye, clover, and lespedeza are the

chief crops. These crops yield about 5 to 10 percent higher than crops on Fletcher silt loam under the same fertilizer treatment. At least 60 percent or more of the cleared land is used for the growing of small grains, lespedeza, and clovers, and about 10 percent for corn. In the vicinity of Patty Chapel this soil has been built up to a rather high state of productivity and produces much higher yields than elsewhere. The same system of management is practiced on this soil as on typical Fletcher silt loam and on Hayesville loam, smooth phase.

Fletcher silt loam, smooth phase, is not quite so susceptible to erosion as the normal soil. Where clover and lespedeza are grown, it is necessary to use about 2 tons of lime to the acre, as the Fletcher soils are strongly acid in reaction.

#### THIRD-CLASS SOILS

Third-class soils include Roanoke silt loam; alluvial soils, undifferentiated; Worsham fine sandy loam; Balfour fine sandy loam, hilly phase; Balfour loam, hilly phase; Porters loam, hill phase; and Hayesville loam, hilly phase. Inherently some of these soils are as good as the soils in the First class or the Second class, previously described. Hilly relief and poor drainage are the main unfavorable factors that limit the soils in this group. These soils are more difficult and expensive to hold, cultivate, and drain than the soils in the other groups. Only a small proportion of them is devoted to general farm crops. Because of relief, the hilly phases are more subject to sheet and gully erosion under similar treatment than the soils previously described.

These soils may be termed marginal land, or land that has a potential value. When there is need for increased production of farm crops and a good price is offered, more of this land can be brought under cultivation. These soils will require careful management and should be used in a long rotation where hay crops dominate and where strip cropping is practiced. Some of them that have been under clean cultivation have already undergone considerable sheet erosion and some gulying. The steeper areas should remain in forest until more pasture land is needed, and then these areas should be seeded to a proper mixture of grass immediately after the clearing of the land.

**Roanoke silt loam.**—Roanoke silt loam is the poorly drained soil of the second bottoms and terraces closely associated with Altavista silt loam. It differs from Wehadkee silt loam mainly in that it occupies slightly higher positions on the low second bottoms and high first bottoms. It occurs along the rivers and larger creeks in the vicinity of Edneyville, near Highland Lake, near Etowah, northeast and southwest of Mills River School, south of Boiling Springs Church, and in the vicinity of Brickton and Fletcher.

Roanoke silt loam has a gray or steel-gray silt loam surface soil 7 to 10 inches deep. The subsoil is gray or yellowish-gray silty clay mottled with yellow and rust brown and extending to a depth of 40 to 50 inches. In some places the subsoil is brownish-yellow slightly plastic silty clay mottled with gray. The texture and consistence of the subsoil vary considerably, but the larger areas have a heavy stiff silty clay subsoil that is distinctly mottled with yellow and rust brown. On some of the slightly higher lying areas, particularly where the soil

borders Altavista loam, the subsoil is pale yellow or grayish yellow only slightly mottled with gray and rust brown. In some of the lower lying and more poorly drained areas both the surface soil and the subsoil are mottled and streaked with rust brown.

This soil occupies low flat areas or slight depressions on the second bottoms, generally lying between the areas of Altavista silt loam and the foot of the uplands. It has poor surface and internal drainage. All areas of this soil require artificial drainage in order to reclaim them for the production of crops. Open ditches are satisfactory on this soil, as the walls of the ditches stand up well in the heavy silty clay subsoil.

Roanoke silt loam is an inextensive and comparatively unimportant soil. Probably 85 percent of it has been cleared, and most of the cleared land is used for pasture. The rest is forested, mainly with oaks, together with some of the other hardwoods. The areas under cultivation are devoted mainly to the production of corn and hay crops, although a few of the well-drained areas are used for wheat and soybeans. This soil is not easy to till, as it has a tendency to pack, puddle, or run together when wet and is very hard when dried out. Corn yields from 15 to 30 bushels and hay 1 to 1½ tons to the acre. Cornland is usually given a liberal quantity of a complete fertilizer. Lime, together with stable manure, increases the yield of both corn and hay on this soil.

For the improvement of Roanoke silt loam, artificial draining, liming, and the turning under of leguminous crops are recommended. The best use for this soil is for the production of hay, corn, and pasture grasses. Inherently the soil is as good as Altavista silt loam, but poor drainage depreciates it and restricts its agricultural use.

**Alluvial soils, undifferentiated.**—This classification represents a soil condition rather than a definite soil type or phase. There is no uniformity in the color, texture, or depth of this soil material; and the areas are so intricately mixed that they cannot be classed with the Congaree or Toxaway soils. The surface soil ranges in color from gray through brown to black and in texture from fine sandy loam to silt loam. Many very small spots consist of sand and gravel, and many low spots are poorly drained. The subsoil is also very variable in color and texture and consists of brown to black silt loam, fine sandy loam, fine sand, or gravelly fine sand.

This soil is subject to change, as material is deposited or removed by each overflow of the streams. The varied color of the surface gives areas of this material a spotted appearance. Most of the bodies border Mud and Clear Creeks and Bat and Devils Forks, and smaller ones border other streams. The total area is small.

This soil occurs on the first bottoms, where it occupies level to undulating areas or slight depressions and is subject to frequent overflow. Like the other first-bottom soils, it consists of sediments washed from the higher lying soils and brought down and deposited by the streams. In places bordering the uplands this alluvial material from the hill-sides has spread out over some of this first-bottom soil. Alluvial soils, undifferentiated, are not so well drained as the Congaree soils. Open ditches are necessary to drain the soil, especially in the flatter areas. Some of the slight depressions would be difficult to drain.

The greater part of this land has been cleared and is used for pasture and to some extent for the growing of corn and hay. The rest is forested to maple, elm, and alder, or, in places, is covered with a heavy growth of coarse grasses. In dry seasons this soil, particularly the spots of silt loam and fine sandy loam, produces good yields of corn and hay crops. The damage to crops from overflow is greater on this soil than on the Congaree soil. Some of the soil supports native wild grasses that afford excellent summer pasture for cattle. Corn yields from 15 to 35 bushels and hay from 1 to 1½ tons or slightly more to the acre.

**Worsham fine sandy loam.**—Worsham fine sandy loam is not a uniform soil as regards texture, color, structure, or drainage conditions. The surface soil of the more uniform areas is grayish-yellow or grayish-brown fine sandy loam to a depth of 5 to 12 inches. The subsoil is yellow or brownish-yellow heavy fine sandy clay or clay reaching to a depth of 20 to 40 inches, where it is underlain by light-gray heavy fine sandy clay or heavy clay mottled with gray and rust brown. In places this very light gray or almost white clay, locally known as whitening or pipe clay, is used for whitewashing fireplaces. In some areas the texture is silt loam or loam and the depth and color vary considerably. A few small areas in the northwest-central part of the county have a silt loam surface soil and a subsoil of heavy gray clay mottled with yellow and rust brown, which grades within a few inches into steel-gray or bluish-gray plastic clay. These areas are locally known as pipe clay land. Such areas are in the vicinity of Patty Chapel, Etowah, Horse Shoe, Brickton, and Mountain Home.

Worsham fine sandy loam is a comparatively inextensive soil in this county. Small areas are scattered throughout the intermountain valley, especially northwest of Balfour, in the vicinity of Flint Hill Church, Mountain Home Church, Blue Ridge School, Dana, Boiling Springs Church, Upward, Gypsy, St. Johns Church, and Fanning Chapel and southwest of Holly Springs Church. Smaller areas join the bottom lands along Willow, Shaw, Boylston, and Ponds Creeks.

This soil occurs mainly around the heads of streams and on the gentle slopes bordering the alluvial and colluvial soils and in the low gaps between the drainageways. The slope of the land ranges from 3 to 7 percent for the greater part, but some of it is steeper. There are some short, steep breaks. In some places erosion has removed the surface soil, exposing the subsoil, and in a few places gullies have formed. The greater part of this soil occupies a bench-like position, resembling a terrace, yet most of it is developed from granites and gneisses, weathered in place. In some places natural surface drainage is so well established that runoff is excessive. Owing to the heavy texture of the lower part of the subsoil, internal drainage is imperfect. This soil receives excessive water in many places from the higher areas.

Because of the favorable relief, a considerable part of the land has been cleared and is used for pasture and for the growth of corn, sorgo, potatoes, and hay crops. The timber growth on the rest consists mainly of maple, sourwood, elm, dogwood, and white pine. Yields of corn range from 15 to 30 bushels an acre, depending on the amount of fertilizer applied and method of treatment. Small areas of this soil lie favorably for farming operations. Hay yields from 1 to 1¼

tons. By the use of lime, complete fertilizer, and organic matter, some of this soil can be built up to the point where it would produce excellent yields of corn, potatoes, and hay crops. Yields of crops are usually low without the addition of fertilizer or manure. The ordinary moisture condition of this soil is favorable for sorgo, and good yields can be obtained if the land is fertilized or manured. The greater part of this land, however, should be devoted to pasture and hay. Care must be exercised in handling the more sloping areas in order to prevent sheet erosion and gulying, unless a permanent sod is maintained.

**Balfour fine sandy loam, hilly phase.**—The hilly phase differs from typical Balfour fine sandy loam mainly in having a steep or hilly relief. Where the slopes are uniform the gradient ranges from 15 to 30 percent. Compared with the corresponding layers of the typical soil, the surface soil and subsoil are similar in color and texture, but in many places the subsoil layer over the soft disintegrated rock is much thicker. In other places the depth and color of the surface soil vary greatly. Included with this phase are small areas in the vicinity of Middle Fork, Mount Moriah, and Liberty Churches and Dana, where the surface soil and subsoil are much lighter than elsewhere and the disintegrated rock material comes within 24 to 30 inches of the surface. This inclusion resembles the Edneyville soils. None of it has been cleared or used for farming purposes.

Balfour fine sandy loam, hilly phase, occurs throughout the intermountain valley in close association with the typical soil. The largest areas are east of Crab Creek Church; in the vicinity of Holly Springs Church; southwest of Tuxedo; southeast of Zirconia; in the vicinity of Oak Grove Church, Dana, Hooper Creek Church; and southwest of Mud Creek Church. Several smaller areas occur scattered throughout the county. Together with Balfour loam, hilly phase, it occupies the steepest relief of any of the Balfour soils.

Probably 20 percent of the land has been cleared, and most of it is used for pasture. The rest is forested, chiefly to hardwoods, together with some white pine and shortleaf pine that has come in on abandoned areas. Scattered rhododendron and mountain-laurel make up the undergrowth in places. This land is too steep for clean cultivation, and the greater part of it should be in pasture. Small areas have been planted to corn, potatoes, and hay crops, but the yields are from 10 to 30 percent less than those on Balfour fine sandy loam. Lespedeza does well on this soil, and this crop, together with a permanent grass mixture, should be established. Some of the areas now in forest would produce good pasture grasses if they were limed, fertilized, and seeded to the proper pasture mixtures immediately after the land was cleared. Garden vegetables and potatoes do well on this soil. Where air drainage is good, apples also do well.

**Balfour loam, hilly phase.**—Balfour loam, hilly phase, a comparatively extensive soil, represents the steepest areas of the Balfour loam. It occurs throughout the central, north-central, western, and south-central parts of the county. The largest areas are in the vicinity of Uno, Balfour, Rugby, Yale, Osceola Lake, Pleasant Hill Church, Etawah, Pleasant Grove Church, Flat Rock, Ebenezzer Church, Crab Creek Church, Fruitland, Hooper Creek School, and Mountain Sanitarium.

The surface soil and the subsoil are not essentially different from those of Balfour loam, except that the subsoil is not so uniform in thickness. In many places on the steep slopes and hillsides the soft disintegrated rock lies near the surface and the subsoil layer is only a few inches thick. Some small angular fragments of Henderson or Whiteside granites are present here and there on the surface and throughout the soil. In the forested areas there is a thick covering of leafmold on the surface. On some of the slopes that have been under clean cultivation sheet erosion has removed part of the original surface soil, and such areas are more brown than elsewhere.

Owing to the hilly and sloping relief, the friable character of both the surface soil and the subsoil, and the character of the underlying disintegrated rock material, all these hilly areas are exceptionally well drained. The soil takes up a large part of the rainfall and is not so subject to serious erosion as are the Hayesville soils on the same relief and under the same cultural treatment.

About 20 percent of the land is cleared and is in pasture or in farm crops. The natural vegetation on the rest consists mainly of hardwoods, together with some white pine and an undergrowth of rhododendron and mountain-laurel. Corn, potatoes, and truck crops grow successfully on this soil. Corn yields from 15 to 25 bushels, potatoes 60 to 100 bushels, and rye 8 to 12 bushels an acre. For corn usually a small quantity of complete fertilizer is applied, whereas for potatoes 400 to 600 pounds to the acre of a 5-7-5 mixture is applied. Heavy applications of fertilizer are also made for cabbage which yields well. Garden vegetables and truck crops grow successfully. Apples do well on this soil where air drainage is good and bedrock does not lie too near the surface. Owing to the hilly relief, heavy farm machinery cannot be used advantageously; only light implements, such as one-horse cultivators and hillside plows, are used. This soil has a potential value for the growing of pasture grasses. If the land is limed, fertilized, and seeded immediately after the trees are removed, the grass will protect the soil from erosion.

**Porters loam, hill phase.**—Areas of Porters loam that have a slope ranging from 15 to 30 percent are separated as a hill phase; whereas areas of the typical soil have a slope of 30 to 60 percent. Because of the gentler relief, the surface soil and the subsoil of the hilly phase are more uniform in color, consistence, and texture over bedrock than the corresponding layers of the normal soil.

In cultivated fields the surface soil is brown or light-brown mellow loam to a depth of 8 to 12 inches. In wooded areas a shallow covering of leafmold lies on the surface and the first 2 to 4 inches of the surface soil contains enough organic matter to give it a dark brownish-gray color. The subsoil is yellowish-brown to reddish-brown friable permeable clay loam. At a depth of 25 to 35 inches or more this is underlain by brownish-yellow fine sandy loam or loam, which grades within a few inches into light-gray soft disintegrated and partly weathered granite or gneiss rock. A few small scales of mica are distributed throughout the soil, and mica is particularly noticeable in the underlying soft rock.

Included in the mapping are small areas that have a brown or reddish-brown surface soil and a rather heavy-textured subsoil. These inclusions belong to the Hayesville series, but the bodies are too small

to separate on a map of the scale used. Here and there a few small angular rocks are scattered over the surface and mixed with the soil, but not in sufficient quantities to interfere with cultivation. In some of the fields that have been in clean-cultivated crops, sheet erosion is noticeable, and in such places the surface soil is definitely brown to reddish-brown loam or, in a few places, clay loam.

Porters loam, hill phase, is one of the extensive and important soils in this county, having a total area of 19,904 acres. Large bodies are scattered throughout the mountainous districts, in most places on the lower gentler slopes, below steeper areas of Porters loam and Porters stony loam. The largest ones are in the vicinity of Mountain Home Church, Mount Zion Church, Hooper Creek Church, Patty Chapel, Holly Springs Church, Mountain Home, Laurel Park, Edneyville, Barnwell Church, Kanuga Lake, Sewell House, Pleasant Grove Church, Horse Shoe, Rugby, and Mills River Church.

Surface and internal drainage are everywhere good, owing both to the steeply sloping relief and to the friable character of the surface soil, subsoil, and soft broken underlying rock material.

Probably 20 percent of the land is cleared and is used for cultivated crops, apples, and pasture grasses. The forest growth on the rest consists mainly of a variety of oaks, some dogwood, tuliptree, and sourwood, together with white pine, pitch pine, and in many places a rather heavy undergrowth of rhododendron and mountain-laurel. The principal crops are corn, hay (mainly orchard grass), potatoes, cabbage, apples, and garden vegetables. Of the cleared land, about 40 percent is in apple orchards, 30 percent in corn, and 10 percent in potatoes.

Corn yields from 15 to 30 bushels an acre, and cornland usually receives an application of 200 to 300 pounds of a 4-8-4 or 3-8-3 fertilizer to the acre. The wide difference in yields is due to soil management; that is, if a crop of corn follows a clover crop, the yields are higher, and in some instances higher than 30 bushels, especially with a heavy application of fertilizer. Potatoes yield from 80 to 160 bushels an acre when the land receives about 600 pounds of a 5-7-5 mixture. Yields of hay range from 1 to 1½ tons and cabbage 8 to 15 tons. Garden vegetables do well, particularly where the land is heavily fertilized. Some lime is usually applied before the sowing of clover and lespedeza seed. Apple trees do well on this soil where air drainage is good, and there are several commercial orchards.

Porters loam, hill phase, is not so susceptible to sheet erosion as the Hayesville soils, even on gentler relief. This is due to the friable, open character throughout the subsoil and the soft rock beneath. This soil will erode, however, if devoted to clean-cultivated crops; and care should be taken to hold this soil. Strip cropping is recommended strongly. A long rotation in which cover crops play an important part should be given consideration. More of this land could be used advantageously for pasture and for apples. Pasture grasses usually do well where the soil has been limed and given a liberal application of phosphatic fertilizer. Inherently, Porters loam, hill phase, is a good soil, but the steepness of slope precludes its use generally for farming purposes. Improved farm machinery cannot be easily operated on these steep hillsides, and light farming implements are in use at present.

**Hayesville loam, hilly phase.**—Hayesville loam, hilly phase, differs from Hayesville loam and Hayesville loam, smooth phase, mainly in that it has a steeply sloping or hilly relief and the subsoil is shallower over bedrock in many places. On the smoother slopes the gradient ranges from 15 to 30 percent. Both the surface soil and the subsoil are variable from place to place on the steep slopes, and in some places the soft disintegrated rock comes near the surface. Most of the underlying material is Henderson and Whiteside granite, although Carolina and Roan gneiss may underlie some of this soil. In some places where this soil has been used for clean-cultivated crops, sheet erosion is pronounced; here the surface soil, instead of being light-brown loam, is brown or reddish-brown clay loam to clay. Some of the more prominent eroded spots are indicated on the map by symbols.

Hayesville loam, hilly phase, occurs in close association with the other Hayesville soils and the Balfour soils throughout the intermountain valley section. The largest areas are in the vicinity of Horse Shoe, Pleasant Grove Church, and Beulah Church; east of Barnwell Church; southeast of Blue Ridge Church; northwest of Cedar Springs Church; northeast of Patty Chapel; northeast of Hoopers Creek Church; and 2 miles west of Edneyville.

Because of the steeply sloping or hilly relief, surface drainage is good to excessive; internal drainage also is good. The comparatively heavy-textured subsoil does not allow this hilly phase to take up rain water rapidly; therefore clean-cultivated areas show much sheet erosion after a heavy rain.

A fairly large percentage of Hayesville loam, hilly phase, has been cleared, but some of this has been allowed to grow up to old-field pine, particularly in places where part or all of the original surface soil has been lost through erosion. The original forest growth consisted dominantly of hardwoods together with some white pine and shortleaf pine.

On the cultivated areas corn, wheat, clover, and lespedeza are grown. Corn yields from 15 to 30 bushels an acre, wheat 8 to 15 bushels, and clover 1 to 1½ tons. About the same fertilizer is used for these crops as on the smoother areas of the Hayesville soils. This soil is more difficult to handle than Hayesville loam or Hayesville loam, smooth phase. It is subject to erosion, and the moisture conditions are not so favorable for all seasons as in those soils. Only the smoother areas of this soil should be used for clean-cultivated crops. If the soil is cultivated, it should be terraced, and strip cropping should be a common practice on the hillsides. Cover crops should play an important part in the rotation. Much of the land now in forests would produce good pasture grasses if the land were limed, given a liberal application of phosphatic fertilizer, and seeded immediately after the trees were removed.

#### FOURTH-CLASS SOILS

Fourth-class soils include Porters loam; Porters stony loam, hill phase; Rabun stony clay loam; Burton stony loam; Ashe fine sandy loam; Ashe stony fine sandy loam, slope phase; Fletcher silt loam, hilly phase; Hayesville loam, steep phase; Hayesville clay loam, eroded hilly phase; Wehadkee silt loam; and stony colluvium (Porters soil material). Either relief, drainage conditions, stoniness, or erosion is an unfavorable factor in each member of this group and bars them from

use for general farming. It is true that small areas of these soils here and there are in cultivation, but the greater part of these soils should be devoted to pasture. Some areas produce apples of good quality. When more farm land is needed, some areas could be used if the stones were removed or if artificial drainage were provided, as in Wehadkee silt loam. On the other hand, certain small areas should remain in forests because of steep relief or extreme stoniness. Under present economic conditions the best use for the soils in this group is pasture.

**Porters loam.**—The surface soil of Porters loam consists of light-brown, brown, or dark-brown mellow friable loam to a depth of 7 to 15 inches. The subsoil is yellowish-brown to reddish-brown friable permeable clay loam or friable clay. At a depth of 18 to 38 inches it grades into soft disintegrated Carolina gneiss or Roan gneiss or rests directly on broken hard bedrock. In some places the surface soil directly overlies the soft rock material and the subsoil is lacking. Small scales of mica are scattered through the surface soil and the subsoil. Where this soil is associated with the Burton soil the surface soil is darker colored, and where it is associated with the Ashe soils the surface soil is much lighter colored than elsewhere. In the latter areas the subsoil is brownish yellow. Many small spots of Ashe fine sandy loam are included with this soil in mapping.

One of the main characteristics of Porters loam is its mellow, friable surface soil and permeable, friable subsoil, which allows free downward movement of soil water and easy penetration of roots. In most places this soil is well supplied with organic matter and plant nutrients. In wooded areas there is a thin layer of leafmold on the surface and the first 1 or 2 inches of the surface soil is darkened by organic matter. Here and there a few angular stones, mostly gneiss fragments, are on the surface and mixed with the soil.

This soil is scattered throughout the mountainous sections, especially on the north end of Forge Mountain, on Davie Mountain, north of Liberty Church, along the Henderson and Buncombe County lines in the northeastern part of the county, and north of Tuxedo.

Porters loam is an extensive soil, occupying a total area of 21,632 acres on steep mountainsides, knobs, and ridges. On the more uniform mountainsides the slope ranges from about 30 to 60 percent. The open, friable character of the surface soil, the subsoil, and the underlying soft disintegrated rock material, together with the steeply sloping relief, gives good surface and internal drainage to all areas.

Only a small proportion of the Porters loam has been cleared, and this is used mainly for pasture and for the growing of apples. The forest growth on this soil is important and consists of hardwoods—white, chestnut, red, post, scarlet, black, and shingle oaks, together with some hickory, chestnut, tuliptree, maple, linden, sourwood, dogwood, and ash. White pines grow in numbers in a few places, some shortleaf and Virginia pine grow here and there, and some hemlock grows along the streams. There is an undergrowth of mountain-laurel and azalea, and in the coves and along the streams rhododendron is abundant and reaches a large size. Medicinal herbs are gathered to a small extent, but these are not so important as in some of the more mountainous counties in the State.

Porters loam is naturally a good, strong soil and possesses excellent physical characteristics, but the steep slope precludes its use for general

farming. In a few places on the smoother land, corn, potatoes, cabbage, and garden vegetables are grown successfully and fair yields are obtained. A few apple orchards are kept. The trees are healthy and produce an excellent quality of apples. A considerable part of the Porters loam could be used for pasture. On the more gentle slopes this soil, if properly treated and seeded, would produce good pasture grasses for the grazing of cattle and sheep. This soil should be seeded immediately after the native vegetation has been removed, however, in order to prevent sheet erosion and gullying. The friable character of the surface soil and the subsoil allows the absorption of a large part of the rain water, and erosion on the Porters loam is less severe than on the soils in the Piedmont plateau, which are developed on much gentler relief. This soil responds readily to an application of fertilizer and lime for the establishment of excellent pasture grasses. In some places in western North Carolina, Porters loam is used to a considerable extent for pasture.

**Porters stony loam, hill phase.**—Porters stony loam, hill phase, differs essentially from Porters loam, previously described, in that it has a gentler relief and has a large quantity of angular fragments of rock, mainly gneiss, on the surface and mixed with the soil. It is this stony condition that bars the soil from general farm use. The surface soil, the subsoil, and also the underlying parent material are quite similar in their characteristics to those of Porters loam; in fact, in some places the subsoil is deeper over bedrock than in typical Porters loam.

The greater part of this hill phase occurs in the northern part of the county. Some of the largest areas are west and southwest of Mount Zion Church and on top of Bank Mountain; smaller ones are southeast of Crab Creek Church; near Fruitland, Mountain Home Church, Chestnut Hill, Fanning Chapel, Sewell House, Beulah Church, Mount Page School; and southeast of Zirconia.

Porters stony loam, hill phase, ranges in gradient from 15 to 40 percent, and generally occupies the lower slopes near the base of the higher mountains. Both surface and internal drainage are well established, owing to the friable character of the surface soil and the subsoil, as well as to the sloping relief.

Probably 60 percent of the land has been cleared, and of this land about 70 percent is used for pasture. Small areas are devoted to the production of corn, potatoes, cabbage, and apples. In a few places the stones have been removed from the surface, thereby allowing this soil to be farmed with improved machinery. Such areas produce fair to good yields of crops with a small quantity of fertilizer. The forest growth on this soil is similar to that on Porters loam. Because of the comparatively gentle relief, large quantity of stones on the surface, and friable character of the surface soil and the subsoil, which favors the absorption of a large quantity of rain water, this soil does not erode seriously under ordinary management. The stones, however, interfere with cultivation, and only light farming implements can be used in the preparation of the land for crops. Stoniness, therefore, is the dominant deterrent factor that places this soil in the group recommended for pasture. Removal of the stones, although possible, would be expensive. Therefore, considering this phase as a whole,

its best uses are for pasture or apples, and, in the more stony areas, forestry.

**Rabun stony clay loam.**—The surface soil of Rabun stony clay loam is reddish-brown or brownish-red rather friable granular clay loam, 4 to 8 inches deep. In some places the surface soil is a brown fluffy soil, locally called "push land." In wooded areas there is a thin covering of leafmold on the surface. The subsoil is deep-red moderately heavy clay, which extends downward to a depth of 20 to 40 inches. This is underlain by and derived from a dark-colored basic rock, mainly hornblende schist. A large quantity of flat fragments of this rock are scattered over the surface and mixed with the soil. Here and there on some of the less steep slopes the stones are fewer and do not interfere with farming operations for some crops. In some places the subsoil is thin over bedrock.

This soil occupies a small area. The largest bodies are southeast of Flat Rock, northwest and north of Mountain Valley Church, northeast of Green River Church, southwest of Cedar Springs Church, northwest of Zirconia, southeast of Stepps Mill, bordering Lake Summit, and south of Barnwell Church.

Rabun stony clay loam occurs on hilly to steep relief where the slopes range from about 15 to 60 percent. Surface drainage is good to excessive, and internal drainage is good.

Probably 10 percent of this land is cleared and is used for apple orchards or for farming. The forest growth on the rest consists mainly of white, post, southern red, red, and chestnut oaks and to a less extent of chestnut, tuliptree, dogwood, sourwood, and locust.

Inherently Rabun stony clay loam is a good soil, but the steep slope and stony character preclude, for the most part, its use for general farming purposes, although it is well suited to pasture grasses. A few small areas are devoted to the production of wheat, corn, potatoes, and cabbage. Apples are grown to a small extent and do well. The soil erodes easily on the steep slopes under clean cultivation, and good management is required to hold it. Because of its steep slope, some of this land should remain in forests, or, if cleared, should be seeded immediately to pasture grasses.

**Burton stony loam.**—Burton stony loam is the only black soil of the uplands in this county. It occupies a very small total area. It occurs on some of the highest mountains and in the coves on the north slopes, especially on top of Bearwallow and Sugarloaf Mountains and on top of the north slope of Little Pisgah Ridge. It lies between altitudes of 3,300 and 5,500 feet above sea level.

The surface soil to a depth of 8 to 12 inches is black friable loam that contains much organic matter and, in places, is slightly mucky. The subsoil is brownish-yellow friable permeable loam, clay loam, or heavy fine sandy loam, which extends to a depth of 15 to 24 inches. The upper part of the subsoil is slightly darkened by organic matter. The subsoil is underlain by disintegrated or soft Carolina gneiss, and fragments of these rocks are scattered over the surface and through the surface soil and the subsoil. In places the black surface soil rests directly on the hard or soft rock, particularly on top of Bearwallow Mountain, where the soil ranges in depth from 6 to 9 inches. In some places bedrock outcrops on the surface. Burton stony loam is closely associated with the Porters and Ashe soils. There are small areas

where the surface appears to be free of rocks, but generally rock fragments are present a few inches below the surface.

Burton stony loam occupies some of the smoother parts of the high mountains where the slope ranges from 7 to 15 percent. Natural surface drainage is well established except in some of the coves, where this soil receives the seepage water from the higher mountainsides. The forested areas have a growth of chestnut (dead or partly alive), chestnut oak, and some small oaks with a dense undergrowth of rhododendron, azalea, and, in most places, large beautiful ferns. There are a few open areas of grass and sedges.

Most of this soil is used for pasture. Owing to the high elevation, cool climate, short growing season, and inaccessibility, this soil is not used for farming. Inherently it is a fertile soil and would require very little or no fertilizer to produce good yields. The soil is strongly acid in reaction, being slightly more acid than the Porters soil, but the high content of organic matter makes it slightly more fertile than that soil. This soil is especially adapted to bluegrass, and, where a good subsoil has formed, it is well suited to the production of potatoes, cabbage, and apples.

Lime and phosphatic fertilizer are recommended for this soil where grass and corn are to be grown.

**Ashe fine sandy loam.**—The surface soil of Ashe fine sandy loam is grayish-yellow to light brownish-yellow fine sandy loam 7 to 9 inches deep. The subsoil is yellow or grayish-yellow friable fine sandy clay to a depth of 22 to 40 inches, where it passes into soft disintegrated rock or hard broken bedrock. In places there is no subsoil, the surface soil resting directly on the soft or hard bedrock. The thickness of the surface soil varies greatly from place to place. In virgin areas there is a shallow covering of dark-gray leafmold on the surface.

This soil is neither extensive nor important. Areas are west of Tuxedo, northeast of Upward, east of Dana, northwest of Flint Hill Church, east of Dana School, near Stepps Mill, and east of Blue Ridge Church.

The slope ranges from 30 to 60 percent. Ashe fine sandy loam is developed from granitic rocks, such as the Henderson and Whiteside granites, which are light-colored. Because of the sandy, mellow surface, very friable fine sandy clay subsoil, and steep relief, this soil has excellent drainage, both internally and externally. Sheet erosion would be severe on clean-cultivated areas.

Only a very small proportion of the land has been cleared, and this is used mainly for pasture and orchards. The tree growth on the uncleared areas consists mainly of chestnut (dead); chestnut, white, post, red, southern red, and black oaks; and dogwood, sourwood, maple, locust, tuliptree, and cucumbertree. There is a scattering of white pines and an undergrowth of mountain-laurel and rhododendron. If cleared, this soil should be seeded to pasture grasses, because the land is so steep and so subject to severe erosion under clean cultivation that it would soon become of little value for any crop.

**Ashe stony fine sandy loam, slope phase.**—This slope phase of Ashe stony fine sandy loam occupies slopes of 7- to 15-percent gradient in close association with Ashe fine sandy loam.

Ashe stony fine sandy loam, slope phase, has a grayish-brown or grayish-yellow fine sandy loam surface soil, 7 to 9 inches deep. The

subsoil is grayish-yellow or brownish-yellow friable fine sandy clay or clay loam, which generally extends to a depth of 20 to 30 inches. It is underlain by Henderson and Whiteside granite or Carolina gneiss. In wooded areas it has a thin covering of leafmold on the surface and the first 1 to 3 inches is dark-gray to nearly black fine sandy loam. This dark color is due to the presence of organic matter, particularly in areas that have had an undercover of grass for a long time. In some places the subsoil is shallow over bedrock, and in a few places bedrock outcrops on the surface. Scattered over the surface are an abundance of angular granite rocks, ranging in diameter from 6 inches to several feet. Included with this slope phase in the northern part of the county are small areas of Ashe stony loam and Ashe loam. In the southwestern part of the county small areas of this phase are practically free from stone and the texture is fine sandy loam. Areas free from stone, however, are too small to be separated on the map of the scale used.

Both surface and internal drainage are good because of the steep slope and the friable character of the soil. Sheet erosion is noticeable on the areas that have been used for clean-cultivated crops. Only about 10 percent of the land has been cleared, and this is used for pasture and for farm crops. The native vegetation on the rest consists mainly of post, chestnut, red, black, and southern red oaks and a few table mountain pine. Mountain-laurel, rhododendron, huckleberry, and chinquapin bushes form a dense undergrowth. In a few areas where some or all of the stones have been removed from the surface, corn, potatoes, and oats are grown. The yields of these crops are generally low. Probably 90 percent of the cleared land is used for pasture or for apple orchards. The largest areas are in the southwestern part of the county, northeast, south, and southeast of Grassy Mountain, south of Holly Springs Church, near Mount Olivet Church, southeast of Crab Creek Church, east of Seahole Lodge, and northwest of Barnwell Church. Other areas are south of Mountain Home Church and east of Bat Cave School.

This soil is difficult to handle because of the large quantity of stones scattered over the surface and mixed with the soil. Apples, grapes, and garden vegetables should do well when the land is properly fertilized. This soil is too stony for profitable cultivation, as it would require much labor and expense to remove the stones from the surface in order to use the ordinary farm implements successfully. In its present condition the best use for this soil is pasture or forestry.

**Fletcher silt loam, hilly phase.**—Fletcher silt loam, hilly phase, differs from Fletcher silt loam mainly in that it occupies steeper slopes or more hilly relief. The slope ranges from 15 to 30 percent, but the gradient is not uniform everywhere. In some places the surface soil and the subsoil are similar in characteristics to the corresponding layers of Fletcher silt loam, but in other places the surface soil and the subsoil, especially on the steeper slopes, are thinner over the schist rock. A few small platy fragments of schist are on the surface mixed with the surface soil and the subsoil, and here and there the soft disintegrated schist lies near the surface. This soil contains only a small quantity of organic matter, and when the land is cleared and cultivated this organic material soon disappears.

Fletcher silt loam, hilly phase, occurs north and southwest of Holly Springs and southwest of Butler Bridge. Surface drainage is good to excessive, and internal drainage is fairly good. This is one of the inextensive and unimportant soils. It is placed in this class because of the dominantly shallow surface soil and subsoil over the schist and its susceptibility to erosion.

Probably less than 5 percent of this hilly land is cleared, and this is used mainly for pasture. A few areas have been under clean cultivation, and low yields are ordinarily obtained. A few areas that have been under clean cultivation have lost a large part of the original surface soil through sheet erosion, and in some places shallow gullies have formed. The forest growth is mainly white, post, red, chestnut, and black oaks, together with some dogwood, sourwood, tuliptree, white pine, maple, Virginia pine, and an undergrowth of mountain-laurel.

This soil is not well adapted to the general farm crops. It is very susceptible to erosion, particularly on the steeper slopes under the present farm practices for row crops. It is best suited for pasture or forestry.

**Hayesville loam, steep phase.**—Hayesville loam, steep phase, differs from other members of the Hayesville series in that it occupies steep slopes and hillsides ranging from 30 to 60 percent in gradient. Because of the steep slope, the surface soil and the subsoil are not so uniform in depth and consistence as those of typical Hayesville loam. In many places the subsoil is shallow over the granite and schist that underlie this soil. The virgin soil has a shallow covering of leafmold, consisting of partly decomposed leaves and twigs.

This is an inextensive soil. The largest areas occur southeast of Barnwell Church, northwest of Horse Shoe, south of Patty Chapel, and southeast of Dana. Other small areas are scattered throughout the intermountain area. Surface drainage is good.

Only a few small areas of the steep phase of Hayesville loam have been cleared, and these are used for pasture. The tree growth on the rest is mainly southern red, scarlet, white, and post oaks, together with some white pine. Because of the steep slope and the consequent susceptibility to sheet and gully erosion under clean cultivation, none of this phase should be farmed. Its best uses are pasture and forestry. When the native vegetation has been removed, this soil should be limed, fertilized, and seeded immediately to pasture grasses in order to prevent loss of the soil through erosion. Lime and phosphatic fertilizer should be applied to the areas already in grass.

**Hayesville clay loam, eroded hilly phase.**—The surface soil of Hayesville clay loam, eroded hilly phase, is not so uniform in color or depth as the surface soil of typical Hayesville clay loam. In the areas where clean cultivation has been practiced, sheet erosion has removed a large part of the original surface soil and in some places exposed the subsoil. The subsoil of this phase is red moderately stiff brittle clay, which extends to a depth of 30 to 38 inches. Below this is the disintegrated soft granite or gneiss from which this soil has developed. Many shallow gullies and in some instances fairly deep gullies have formed in once cleared areas. Such areas in their present condition are unsuitable for general farming purposes. In

places the subsoil ranges from light red to dark red and from friable to heavy clay.

This inextensive soil occurs mainly in the north-central part of the county on sloping to hilly relief. The slope in the smoother areas ranges from 15 to 30 percent. Most of this soil occupies the foothills between the intermountain plateau and the higher mountains. The larger areas are near Berea Church, Flint Hill Church, Horse Shoe, Lower Shaw Creek Church, Rugby, Fanning Chapel, Naples, Boiling Springs Church, Edneyville, Hooper Creek Church, and Edith Grove Church. Surface drainage is good to excessive, and internal drainage is well established.

Practically all of Hayesville clay loam, eroded hilly phase, has been cleared and farmed at one time or another, but now the greater part of it is grown up to shortleaf pine or is used for pasture. Small areas are used for the production of corn, wheat, and cowpeas, but the yields are low. The eroded condition of this soil is due largely to the fact that it has been used for clean-cultivated crops. It would have been better to have seeded this soil to pasture grasses when the native vegetation was removed. Most of this soil can be reclaimed for pasture, however, by filling the gullies, terracing the hillsides, and growing cover crops, such as lespedeza. After the soil has been thus reclaimed for pasture and has been in grass for several years, it could be devoted to close-growing crops for a year or two, but it should be reseeded thereafter to pasture. Grasses respond readily to the application of lime and phosphatic fertilizers.

**Wehadkee silt loam.**—Wehadkee silt loam is the low-lying, poorly drained soil of the first bottoms. The surface is dominantly flat, and both surface and internal drainage are poor. This soil lies only slightly above the normal water level of the streams, and it is therefore subject to frequent overflow. Its low position relative to the water table makes artificial drainage somewhat difficult. On some of the flattest areas or in slight depressions water stands on the surface part of the time.

To a depth of 10 to 20 inches, the surface soil of the Wehadkee silt loam is gray or bluish-drab fairly heavy silt loam, mottled with rust brown. It is underlain by dark-gray or light-gray silt loam or silty clay loam containing some rust-brown mottles. Generally below this depth the color is dominantly a light gray but the texture remains the same. In places the surface soil is silty clay loam, and in a few places the subsoil is black silt loam or silty clay loam resembling the corresponding layer of the Toxaway soil. The substratum, which generally lies 4 to 5 feet below the surface, consists of gray sand and small to large water-worn gravel. Included with this soil are small areas of Toxaway silt loam. All areas of the Wehadkee silt loam consist of sediments washed from the soils of the uplands and brought down and deposited by the streams in the low positions in the first bottoms.

The largest areas border Mud Creek near Hendersonville. Smaller areas occur west of Fletcher, south and west of Naples, west of Etowah, and northeast of Brickton Church. A few smaller areas occur elsewhere in the county in the first bottoms.

The native vegetation consists of willow, swamp maple, elm, and an undergrowth of bulrush and coarse water-loving grasses. Some

of this land has been cleared and used for pasture. In its present undrained condition this soil is not used for agricultural purposes except grazing. If it were drained, limed, and given frequent applications of phosphatic fertilizers, it would produce good pasture grasses, and some areas could be used for corn and hay crops. As the native coarse grasses are of low quality, the soil should be limed, fertilized, and seeded to a suitable mixture of grass seed.

**Stony colluvium (Porters soil material).**—Stony colluvium (Porters soil material) represents a condition rather than a soil type. It consists of a mixture of fine sand, silt, clay, gravel, small stones, and large stones that have sloughed, rolled down, or washed down by strong currents from the steep mountainsides. These materials have accumulated at the base of the mountains or have been carried out by streams a short distance and spread on the valley floor. Most of the stones are rounded or subangular, although some of them have not rolled far enough to become rounded.

This material is dominantly brown or grayish brown and friable throughout, ranging in depth from 1 or 2 feet to several feet. Where it has been spread out along the streams it resembles riverwash. The largest areas occur along the Green River, in the vicinity of Chestnut Hill and Shoal Creek Falls, along Hickory Nut and Bradley Creeks, along the South Fork of Mills River, and northwest of Boyleston Creek Church. These areas are gently sloping to sloping and with few exceptions are naturally well drained.

Most of this stony colluvium (Porters soil material) is in forests, and the main trees are oaks, chestnut (partly dead), hickory, and tuliptree. As a large quantity of stones are scattered over the surface and mixed throughout the soil, only a small proportion of this land is farmed. Farm machinery cannot be used. Small areas are used for the production of corn, potatoes, garden vegetables, apples, and pasture; but this use represents subsistence or patch farming. On some of the less stony areas the yields of crops are fairly good. Most of the stony colluvium should be used for pasture or remain in forest.

#### FIFTH-CLASS SOILS

Porters loam, very steep phase; Porters stony loam; Ashe stony fine sandy loam; rough gullied land (Hayesville soil material); rough stony land (Porters soil material); and rock outcrop are classed as Fifth-class soils. These types, phases, and land types represent those areas of soil that are so steep or so stony in character as to preclude their use for agricultural purposes other than possibly scant pasturage in small spots and for forestry. These soils and land types are placed in this group not because they are suited for trees but because forestry is practically the only feasible use for them under present conditions.

It is possible to reclaim some areas of rough gullied land (Hayesville soil material) and Ashe stony fine sandy loam for pasture grasses.

**Porters loam, very steep phase.**—Porters loam, very steep phase, differs from Porters loam mainly in that it occurs on very steep relief. The slope ranges from 60 to 90 percent or more. The color, texture, and structure of the surface soil, subsoil, and underlying rock material are identical with those characteristics of the corresponding layers of Porters loam. In some places the surface soil and subsoil are

shallow over rock and a few stones are scattered over the surface and mixed with the soil.

Porters loam, very steep phase, occurs throughout the rougher, mountainous parts of the county. The largest areas are on the steep slopes bordering the Hungry and Little Hungry Rivers, along the Henderson-Transylvania County line in the vicinity of Buttermilk Mountain, east of Middle Fork Church, and south of Bat Cave School. Owing to the friable character of the surface soil and subsoil and the steep slope, all areas of this phase are exceptionally well drained.

Practically all of this soil is in forest, and the growth is similar to that on Porters loam. Small areas here and there occurring in close association with areas of Porters loam have been cleared and used for pasture. Because of the very steep relief, this soil is not suited even to pasture, and forestry is its best use.

**Porters stony loam.**—Porters stony loam is the most extensive soil in Henderson County, occupying 46,208 acres. It occurs throughout the steepest and roughest mountainous parts of the county. The largest areas are in the Pisgah National Forest, on the mountainsides along Sugarloaf Creek, along the Hungry River, near Mountain Valley Church, north of Gerton, east and northwest of Cedar Springs Church, on the slopes bordering the Green River, and on Butler and Smoky Mountains. This soil is quite similar in color, texture, and structure to Porters loam except that the surface soil and the subsoil in many places, especially on the higher mountain parts, are shallow over bedrock. A large quantity of small to large angular rocks, mainly of Carolina gneiss or Roan gneiss, are scattered over the surface and mixed throughout the soil. The slope ranges from 60 to 90 percent or more. All this soil is especially well drained.

Porters stony loam is suited only to forestry. The tree growth is practically the same as on Porters loam. A few of the less steep and stony spots might possibly be used for pasture, but none of the land has been cleared. Some revenue is derived from the sale of timber, cross ties, locust poles, pulpwood, acid wood, and barrel staves. In some of the mountainous counties of North Carolina, this soil supports good pasture grasses.

**Ashe stony fine sandy loam.**—Ashe stony fine sandy loam is the typical light-colored soil developed in comparatively high positions, ranging from 2,500 to 5,000 feet above sea level. The soil occupies steep slopes where the gradient ranges from 30 to 60 percent. Drainage is good to excessive. The greater part of this soil occurs in the southern and southeastern parts of the county and in close association with Ashe fine sandy loam and Porters stony loam.

In forested areas there is a shallow covering of leafmold on the surface, and below this is gray to dark-gray fine sandy loam to a depth of 3 to 5 inches. This is underlain by pale-yellow fine sandy loam to a depth of 5 to 8 inches. The subsoil is yellow friable heavy fine sandy loam or fine sandy clay extending to a depth of 24 to 30 inches. It grades into the soft disintegrated Henderson or Whiteside granite. In a few places in the northern part of the county the soil is more loamy and deeper than in the southern part. Angular fragments of variable-sized stones, mainly of granite, occur on the surface and throughout the soil, and bedrock outcrops in a few places. In

some places the soft light-colored rock is very near the surface, and here the soil is young from the viewpoint of soil development.

Ashe stony fine sandy loam is not used for any agricultural purpose in this county except for scant pasturage and forestry. The principal trees are red, black, white, post, southern red, and chestnut oaks; chestnut (partly alive); hickory; and a few scattered pines, dogwood, sourwood, and tuliptree. Most of this soil should remain in forest. When the demand for pasture land is greater, however, the less stony and smoother areas, if limed, fertilized, and properly seeded, immediately after clearing, would produce fairly good pasture grasses.

**Rough gullied land (Hayesville soil material).**—This classification includes very small areas scattered here and there in the intermountain part of the county in which accelerated erosion has removed all or part of the surface soil and deep gullies have cut into the subsoil and in some places have penetrated into the friable underlying material. This severely gullied and dissected condition of the land presents a problem for reclamation. A few of these areas have gone beyond a condition for economically feasible reclamation by the owner for agricultural purposes. Most of these areas can be reclaimed, however, by constructing earth or brush dams, adding coarse manures, and seeding the land to grasses or kudzu, or planting it to trees. This severely eroded condition is the result of improper management of the soil after it was cleared of its natural vegetation. The soil absorbs very little rainfall, and, as the water rushes off the surface, it carries with it a considerable quantity of silt and clay, which is a contributing factor to the silting of reservoirs.

**Rough stony land (Porters soil material).**—This classification of material differs essentially from Porters stony loam in that it includes a much larger proportion of larger stones, boulders, and outcrops of solid rock. In general, the relief is very steep and broken, and in places the walls are almost precipitous, the slope ranging from 40 to 100 percent. Because of the steepness of slope, surface runoff of water is rapid. The soil material between the rocks is dominantly shallow, but in some places it is rather deep, resembling the soil of the Porters series.

Approximately 19 square miles of rough stony land (Porters soil material) is mapped in Henderson County. The largest areas are developed on the mountain slopes north of the Green River, Grassy Mountain, Stone Mountain, Rocky Ridge, and The Pinnacle. Smaller areas are scattered throughout the rougher parts of the mountainous sections of the county.

Owing to the numerous outcrops of bedrock and large, loose boulders, the forest growth is sparse and inferior to that on the Porters soils. Dead chestnut, chestnut oak, and some pitch pine are on the higher ridges, and hemlock and pitch pine are the principal trees on the lower slopes and in the coves. In many places there is an undergrowth of rhododendron, azalea, and ferns in the more shaded areas and where the soil is deep. On some of the higher ridges where the soil material over bedrock is very shallow the tree growth is dominantly pine. At present very little merchantable timber is found on this land. The land is at present nonagricultural except for forestry.

**Rock outcrop.**—The areas indicated on the soil map as rock outcrop consist of bare rock exposed on the sides and precipitous parts

of the mountains and also on the tops of some of the high mountains. The more prominent areas are the bare cliffs on The Pinnacle, on Grassy Mountain, on the northwest side of Sugarloaf Mountain, and near Bat Cave. Areas of rock outcrop are valueless except for building stone, material for road construction, and for scenery. Many bare rock areas within bodies of soils are too small in extent to delineate on the soil map but are indicated by symbol. The rocks are granite or gneiss.

#### PRODUCTIVITY RATINGS AND PHYSICAL LAND CLASSIFICATION

Table 5 lists the soils of Henderson County in the approximate order of their general productivity for the common crops under the better soil-management practices. The most productive soils are at the head of the table and the least productive at the foot. The order is modified to some extent to show the comparative desirability of the soils as influenced by their workability and erodibility.

The rating compares the productivity of each soil for each crop to a standard of 100. This standard index represents the approximate average acre yield obtained without treatment on the more extensive and better soil types of the regions in which the crop is most commonly grown. An index of 50 indicates that the soil is about half as productive for the specified crop as are those with the standard index. Soils given treatment, such as lime and commercial fertilizers, and unusually productive soils of small extent may have productivity indexes of more than 100 for some crops.

The rating in column A under each crop indicates yields obtained under the less careful and intensive soil-management practices, which, on most of the soils, include the use of small amounts of commercial fertilizers. On more fertile soils, such as Congaree silt loam and Toxaway silt loam, little or no fertilizer is used. In the columns headed B, yields under more careful and intensive recommended practices are given. These practices consist of regular crop rotation including the growing of legumes, the use of barnyard and green manures, the application of adequate quantities of complete commercial fertilizers, the use of improved varieties and high quality seed, and, where necessary, the use of mechanical measures, such as contour tillage, strip cropping, and terracing, for the control of erosion.

The principal factors affecting the productivity of land are climate, soil (including the many physical, chemical, and biological characteristics), slope, drainage, and management (including the use of fertilizers and lime). 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 the associated factors and therefore are used where available. In Henderson County many of the indexes are based on estimated yields rather than on reported yields, as definite information is scarce. Interviews with farmers, together with the observations of members of the soil survey party, furnished the bases for estimates of yields.

Because of limited information, no indexes are given for vegetables or pasture. Only general statements are used to indicate the productivity of the soils for these crops.

TABLE 5.—Productivity ratings of the soils of Henderson County, N. C.

Soil (soil types, phases, complexes, and land types) <sup>1</sup>	Crop productivity index <sup>2</sup> for—													Vegetables <sup>3</sup>	Pasture <sup>3</sup>	General productivity grade <sup>4</sup>		Soil group or physical land classification
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Rye (100=25 bu.)		Mixed timothy and clover (100=2 tons)		Red clover (100=2 tons)		Les-pe-deza (100=1.5 tons)	Soy-beans (100=25 bu.)	Pota-toes (100=200 bu.)			A	B	
	A	B	A	B	A	B	A	B	A	B	B	B						
Congaree silt loam.....	70	100	50	80	60	90	80	100	70	90	110	80	80	Very good...	Very good...	3	1	First-class soils. (These are the best soils in the county for farming. As a group they are inherently the most fertile and are the most easily tilled, and their productivity is the most easily maintained of all the soils in the county. Relief is favorable for the use of farm machinery. Except for the Toxaway soils, they are all naturally well drained; the Toxaway soils are drained artificially.)
Toxaway silt loam <sup>5</sup> .....	60	90	30	70	30	70	50	100	40	80	110	80	80	do.....	Good.....	6	2	
Congaree-Toxaway silt loams <sup>6</sup> .....	60	85	30	70	30	70	50	100	40	80	110	80	70	Good.....	do.....	6	2	
Congaree fine sandy loam.....	50	80	40	60	50	70	60	90	40	80	100	75	80	Very good...	do.....	5	3	
Tusquitee loam.....	50	70	50	70	50	70	50	90	45	100	100	70	90	Good.....	do.....	5	3	
Balfour loam, smooth phase.....	40	70	40	70	45	75	55	90	55	100	100	75	70	do.....	do.....	6	3	
Hayesville loam, smooth phase.....	40	70	50	80	50	80	55	100	55	100	100	75	60	do.....	do.....	5	3	
Balfour fine sandy loam, smooth phase.....	35	70	30	60	40	70	50	90	50	100	100	70	65	do.....	do.....	6	4	
Hayesville fine sandy loam <sup>6</sup> .....	35	65	40	70	45	75	45	95	45	95	95	75	60	do.....	do.....	6	3	
Balfour loam.....	35	65	30	60	40	70	50	100	50	100	100	75	60	do.....	do.....	6	4	
Altavista silt loam.....	30	70	40	60	40	60	40	70	30	70	90	70	60	Good.....	Good.....	7	4	Second-class soils. (These soils have one or more characteristics that make them individually less desirable for cropland than the First-class soils. Generally, they are more rolling and require more careful management to prevent losses by erosion and to maintain productivity.)
Hayesville loam <sup>7</sup> .....	30	60	45	70	45	70	50	80	50	80	95	75	50	do.....	do.....	6	4	
Hayesville clay loam.....	30	55	40	70	40	70	40	80	40	80	95	75	40	Fair.....	do.....	7	4	
Balfour fine sandy loam.....	25	60	25	55	35	65	35	90	40	90	90	70	60	Good.....	Fair.....	8	5	
Edneyville fine sandy loam.....	25	60	25	55	35	65	30	90	35	90	90	70	60	do.....	do.....	8	5	
Fletcher silt loam, smooth phase.....	20	40	20	40	30	50	30	55	10	40	70	60	50	Fair.....	do.....	8	6	
Fletcher silt loam.....	10	35	10	35	25	40	25	50	10	30	65	50	40	Poor.....	do.....	9	7	

Porters loam, hill phase	40	60	30	60	30	60	40	95	30	95	70	80	80	Good	Good	7	4	Third-class soils. (These soils, as a group, are less desirable for cropland than the Second-class soils. Steepness of slope in some and poor drainage in others are the principal limitations. Difficulty of tillage, erodibility, and need for careful management make these soils marginal for cropping under present farming conditions.)
Hayesville loam, hilly phase	20	40	20	40	20	40	15	80	10	80	80	70	40	Fair	Fair	9	6	
Balfour loam, hilly phase	20	40	15	40	15	40	15	80	10	80	80	60	45	Good	do	9	6	
Balfour fine sandy loam, hilly phase	20	40					15	80	10	80	80	55	45	Fair	do	9	7	
Roanoke silt loam <sup>1</sup>				50		50	40	90		70				Good	Good	10	3	
Worsham fine sandy loam	20	50					40	65	30	60				Fair	do	9	5	
Alluvial soils, undifferentiated <sup>2</sup>		70					30	80		80	85	70	50	Good	Very good	9	3	
Porters loam <sup>3</sup>														Good		9		Fourth-class soils. (These soils are considered to be better suited for pasture than for cropland, although many small fields or patches are used for corn, potatoes, cabbage, tobacco, hay, etc. Some areas likewise will produce apples of good quality. Other small areas probably should remain in forest. In general, however, these soils are reasonably well suited for pasture.)
Porters stony loam, hill phase <sup>3</sup>														do		9		
Rabun stony clay loam														do		9		
Burton stony loam														do		9		
Ashe fine sandy loam														Fair		10		
Ashe stony fine sandy loam, slope phase														do		10		
Fletcher silt loam, hilly phase														do		10		
Hayesville loam, steep phase														do		10		
Stony colluvium (Porters soil material)														do		10		
Hayesville clay loam, eroded hilly phase														Poor		10		
Wehadkee silt loam														do		10		
Porters loam, very steep phase																10		Fifth-class soils. (Steep slope and stoniness are the two principal characteristics of these areas and limit their use almost wholly to forestry.)
Porters stony loam																10		
Ashe stony fine sandy loam																10		
Rough gullied land (Hayesville soil material)																10		
Rough stony land (Porters soil material)																10		
Rock outcrop																10		

<sup>1</sup> The soils are listed in the approximate order of their general productivity of the common crops under the better management practices and their general suitability for cultivated crops. Where no index is given the crop is not commonly grown.

<sup>2</sup> The soils of Henderson County are given indexes that indicate the estimated average production of each crop to the nearest 5 percent of the standard of reference. The standard represents the approximate average yield obtained without treatments with fertilizers and lime on the more extensive and better soil types of the regions of the United States in which the crop is most widely grown. The indexes in the column headed A under each crop refer to yields obtained under the less careful management practices, which include the use of only small quantities of fertilizer and lime and under which little regard is given to the control of erosion and to the maintenance of soil productivity. The indexes in column B refer to yields obtained by the better farmers, or those that may be expected under careful management, including crop rotation, fertilization, liming, control of erosion, and maintenance of organic matter.

<sup>3</sup> Only general comparative terms are given for vegetables and pasture, because of insufficient yield data.

<sup>4</sup> This classification includes the comparative general productivity of the soils for the common crops under: A, Less careful and intensive management practices; and B, the more careful and intensive practices of the better farmers. Actually, of course, more variations in management practices exist than have been indicated in columns A and B.

<sup>5</sup> Because of better drainage and larger area, these soils are more productive and desirable for farming than similar areas in Clay County, N. C., in the soil survey report of which they are grouped as Second-class soils.

<sup>6</sup> Hayesville fine sandy loam in Henderson County has a comparatively smooth surface and is therefore grouped as a First-class soil.

<sup>7</sup> Hayesville loam in Henderson County is more rolling than the fine sandy loam and has been grouped as a Second-class soil. In Madison and Clay Counties, Hayesville loam as mapped included also areas of Hayesville loam, smooth phase, and so was grouped as a First-class soil.

<sup>8</sup> The indexes apply to those areas in which drainage has been improved by ditching.

<sup>9</sup> The yields from the small patches of corn, hay, potatoes, and alfalfa on these soils are almost as high as those obtained on Porters loam, hill phase.

The soils are listed in the order of their general productivity under the more careful practices, and productivity grade numbers are assigned in the column headed "General productivity grade." The general productivity grade is based on a weighted average of the indexes for the various crops, the weighting depending upon their relative acreage and value. If the weighted average is between 90 and 100, the soil type is given a grade of 1; if it is between 80 and 90, a grade of 2 is given; and so on. As it is difficult to measure or express mathematically either the exact significance of a crop in local agriculture or the importance and suitability of given soils for particular crops, the weightings are used only as guides, and in Henderson County the general productivity grades were determined by inspection of the indexes rather than by mathematical calculations.

In the column headed "Soil group or physical land classification" the soils are grouped according to their comparative desirability or physical suitability for crops, for grazing, or for forestry.

The best soils of the area, grouped as First-class soils, are considered to be good cropland. That is, they are, in general, capable of moderate to rather high production of the common crops of the area under good soil management practices; they are rather easily worked; and it is not difficult to maintain their productivity. In short, it is possible to farm these soils rather intensively and at the same time to conserve them without great difficulty. The land is so desirable for crops that comparatively little of it is devoted to pasture or woodland, in spite of the fact that it will support a good growth of pasture grasses or trees.

Second-class soils are considered somewhat less desirable and are designated as good to fair cropland. They are generally somewhat less productive than the First-class soils and as a rule are somewhat harder to till or harder to conserve if tilled. They are capable of supporting fair to good pasture, and some areas are in timber.

Third-class soils are considered as poor cropland or fair to good pasture land. They are medium to low in productivity and are generally rather hard to till or to protect from erosion.

Fourth-class soils are characterized by hilly and steep topography that makes them unsuited for cropping by common farm machinery. Their susceptibility to accelerated erosion when cropped also limits their use for corn, tobacco, truck, and other crops requiring rather intensive tillage. The Porters and Ashe soils are especially productive of grasses, and this fact, together with the fact that a large part of the county is still rougher and more stony, has led to the designation of these soils as pasture land.

Fifth-class soils have a still more rugged relief than the Fourth-class soils, and as a result they are not well suited for pasture. Their best use over a long period appears to be growing trees, although small patches are worked by hand for corn, tobacco, truck, and other subsistence crops because of a shortage of better land. This use of such land emphasizes the influence of the distribution of soil types (soil pattern) upon land use and the need for adjustment of land resources to demands.

The productivity rating and the physical land classification do not present the relative roles that soil types, because of their extent and

the pattern of their distribution, play in the agriculture of the county. They give a characterization to the productivity and use capabilities of the individual soil types, but they do not picture the total production of crops by soil types, as this depends also on the acreage of each type devoted to each crop.

Economic considerations play no part in determining the crop indexes and little part in determining the physical land classification; therefore neither indexes nor soil classes can be interpreted 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. The association or the pattern of distribution of soil types in any particular locality or individual farm may have a very important influence upon the use and value of the land. Such conditions are not adequately covered in this classification.

#### LAND USES AND AGRICULTURAL METHODS<sup>7</sup>

Land uses, agricultural methods, and prevailing types of agriculture in Henderson County are similar to those being used throughout the mountainous parts of western North Carolina. The agriculture consists mainly of the production of subsistence crops (chiefly corn, hay, wheat, oats, and potatoes), the raising of cattle and hogs, and the growing of apples. The average acre yields of corn and wheat have been fairly steady for the last 60 years. There has been no large increase in acreage of any crops, except hay crops, market vegetables, and potatoes. The increase in yields in recent years is due to better farm practices, the judicious use of commercial fertilizer and lime, and the growing and turning under of leguminous crops on the soils of the uplands, in spite of the fact that some of these lands have deteriorated through loss of soil by sheet erosion.

Most of the agriculture of the county is on the soils in the first bottoms and second bottoms along the rivers and larger creeks and on the soils of the intermountain valley where the relief is favorable for agricultural operations. A large part of the corn and hay crops are produced on the fertile soils, such as Congaree silt loam, Toxaway silt loam, and Altavista silt loam. Some of these soils have been in continuous cultivation for a long time and are devoted primarily to corn and hay crops. General farming is practiced on the Edneyville, Balfour, and Hayesville soils in the intermountain valley. Most of the wheat and potatoes and a considerable part of the hay crops, truck crops, and apples are grown on the soils of these series that have a gently sloping or moderately hilly relief. The more sloping soils in the valley and the less sloping soils in the mountainous country produce apples, some corn, truck crops, and a large part of the pasturage.

According to the 1940 census, 50,626 acres, or less than one-fourth of the total land area of the county, was available for cropland in 1939, as follows: 29,397 acres in cultivated crops, including hay and fruit trees; 13,217 acres in plowable pasture; 635 acres on which crops were a failure; and 7,377 acres in idle or fallow cropland or

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<sup>7</sup> Much of the information in this section was obtained from the county agricultural agent.

grown up to shortleaf pine and small oaks. More than one-half of the land in the county is not classed as farming land because of its steep and very steep relief and stoniness. A large area in the northwestern part is owned by the Government and is included in the Pisgah National Forest. A fairly large area of woodland could be cleared and, if seeded, would produce good pasture grasses.

Because of steep relief or stoniness, all areas of Porters loam, very steep phase; Porters stony loam; Ashe stony fine sandy loam; rough gullied land (Hayesville soil material); and rough stony land (Porters soil material) should remain in forests. Considerable areas of the Fourth-class soils, as described under Soils and Crops, could be used for pasture grasses and to a less extent for commercial apple orchards and for the growing of potatoes, cabbage, and truck crops. The production of the staple farm crops, which form the basis of the agriculture of Henderson County, will probably for a long time be confined to the soils on the first and second bottoms and in the intermountain valley, which are members of the First, Second, and Third classes.

The greater part of the soils in the mountains and much of the soil in the foothills and intermountain valley are naturally adapted to pasture grasses. The climate is favorable, as it is dominantly cool and fog is common in early morning. When the soils are limed and treated with phosphatic fertilizers excellent pasture grasses may be produced.

It is apparent that not all the land in the county that is now growing crops is best adapted to clean-cultivated crops. On the other hand, considerable areas in forests or in pasture could be used for farm crops. Some of the intermountain valley soils that have been under clean cultivation for a long time are severely eroded, and in some places gullies have formed. These areas have become unprofitable for crop use and have been abandoned or are used for what scant pasturage they afford. This is a striking example of destroying the value of good soil for pasturage or for forestry by a few years of mismanagement. Erosion, both sheet and gully, is responsible for the areas of rough gullied land (Hayesville soil material) and the Hayesville clay loam, eroded hilly phase. Similar conditions are seen throughout all the mountainous parts of North Carolina, in the Piedmont plateau, and in other parts of the Tennessee Valley. In early years land was plentiful and cheap, and practically no regard was given to its conservation. The soils of the Hayesville series are the most erodible on the same relief and under the same cultural treatment of any soils in the county. This condition is probably due to the fact that the subsoil of the Hayesville soils is a heavy clay and does not allow so rapid percolation of the rainfall as the more open and permeable subsoils like those of the Porters, Balfour, and Edneyville soils.

Proper use of the land is the basic problem that confronts the farmers of Henderson County and western North Carolina. Land use inevitably changes, at least in detail, along with changes in transient social and economic conditions, but the problems remain inherent in any feasible plan to perpetuate a profitable type of agriculture and to conserve the soil. The permanent productive use to which land is suited must be determined largely and fundamentally on the

basis of soil characteristics. The soil and land characteristics are more or less permanent, and the work of assigning land to productive and profitable use can be easily adjusted to meet these changing conditions, especially where scientific data of the permanent soil and land characteristics are furnished.

In carrying out proper land use it is to be expected that a number of restraining factors will be encountered. Each farm has its individual problem, not only as regards the soil and lay of the land, the location of the farm, and market conditions, but also as regards the ability of the farmer himself to adjust his farming operations to meet changing economic conditions. These restraining factors have affected the use of farms throughout a long period of time; therefore an immediate perfect readjustment of all land use is not to be expected.

Improper land use along with bad management, such as the production of clean-cultivated crops on steep slopes, has been the principal cause of soil deterioration and erosion in Henderson County. As a rule, the intermountain valley soils are low in organic matter and have undergone considerable leaching of the original mineral plant elements. Practically all of the soils in the county are strongly acid to extremely acid, except where lime has been applied.

Very little terracing has been done, and this has been done during the last few years. It is believed that more of the sloping land should be terraced, but the steep lands cannot be terraced. Terraces do not prevent sheet erosion, but properly constructed terraces will prevent gullyng. Strip cropping and contour cultivation should be practiced in connection with the terraces. Strip cropping on the steeply sloping lands has proved very satisfactory. More of the steep hillsides now in cultivation should be seeded to lespedeza and clover or some other legume for the purpose of improving the soil and preventing sheet erosion.

Planting and plowing under winter cover crops protects the soil from much leaching and erosion during the winter, and the organic matter thus added enables the soil to absorb and retain more moisture. Many of the soils in this county can be built up to a rather high state of productivity, which can be maintained easily by the use of lime, complete fertilizers, and good crop rotations that include grasses and leguminous crops.

Pastures constitute the best source of minerals for livestock.<sup>8</sup> Immature grasses contain about twice as much phosphoric acid as does freshly cured hay from mature grasses. Grass produced on fertile and well-fertilized soils also contains more nutrients than that produced on a poor soil. Pasture grasses will be deficient in those mineral elements that are not present in sufficient quantities in the soil on which the grasses are grown. Animals can be better supplied with vitamins when grazed on immature grasses. The fertilizer recommended for establishing new pastures is from 300 to 400 pounds of 4-12-4 and 1,000 to 2,000 pounds of ground limestone to the acre; on established pastures 400 to 600 pounds of superphosphate should be substituted for the 4-12-4.

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<sup>8</sup> BLAIR, E. C., and KIMREY, A. C. PASTURES IN NORTH CAROLINA. N. C. AGT. COL. EXT. CIR. 202, 12 pp., illus. 1934.

Marked increase in the yield of corn follows the use of lime and a complete fertilizer on Porters loam and Toxaway silt loam.<sup>9</sup> Wheat also shows an increase in yield when lime is used in conjunction with a complete fertilizer. Yields of red clover and soybeans are greatly increased by a complete fertilizer, and they are frequently doubled by the application of lime in connection with fertilizer. On soils used for hay, lime should be applied every 3 to 5 years, depending on the rate of liming and the length of the rotation.

In the growing of corn on the soils of the uplands, moisture is an important factor. Lack of organic matter, shallow soil, and rapid runoff of rain water are deterrent factors for the corn plants during dry periods on some of the mountain soils. Therefore, plenty of moisture and organic matter are essential factors in the production of corn. Adding organic matter not only provides some or all of the necessary nitrogen but improves the moisture-holding capacity of all the soils of the uplands. Summer cover crops help to maintain the organic-matter content of the soils.

Some of the farmers have practiced a rotation of crops for a long time, but in recent years many more of them have worked out fairly good rotations with the aid of the county agricultural agent and the North Carolina Extension Service. It is true that some of the farmers have grown corn in the same field on some of the soils of the bottom lands for many years in succession. Today the farmers recognize that the practice of crop rotation is an essential part of good farming and that the plan of rotation adopted will depend on the kind of soils and the crops to be grown. More legumes are being grown now than ever before, and these play an important part in the rotations that are being used.

The crop rotations recommended by the North Carolina Agricultural Experiment Station and also practiced by some of the best farmers on the soils of the upland valley are as follows: First year—corn with soybeans, and wheat or other small grain in the fall; second year—wheat or other small grain with clover and grass mixture, including lespedeza, drilled in the grainfields in March or April; third year—clover and grass mixture, including lespedeza, for hay; fourth year—clover and grass mixture, including lespedeza, for grazing and turning under. If enough land is available the clover and grasses may be left on the farm for 2 to 3 years.

Much of the choice corn produced in the bottom lands is grown year after year on the same land where crimson clover is seeded in the cornfields in July or August and is turned under in the spring. A rotation recommended for these bottom lands is as follows: First year—corn with crimson clover in summer to be turned under; second year—corn, clover, and grass mixture; third year—clover and hay; fourth year—clover and grass mixture for grazing and to be turned under. Another good rotation recommended for use on the bottom lands is: First year—corn with soybeans for seed or for turning under and wheat or other small grain in the fall; second year—wheat or other small grains, followed by lespedeza for turning under. A mixture of grasses for permanent pasture includes: Redtop 5 pounds, Kentucky bluegrass 5 pounds, orchard grass 8 pounds, timothy 5 pounds, white

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<sup>9</sup> See footnote 6, p. 21.

clover 2 pounds, and lespedeza 5 pounds. Rotations such as are described above will provide leguminous crops to be plowed under, which, in turn, will increase the organic-matter content of the soil, improve the physical characteristics of the soil, increase the yields of the corn and small grains, and effectively maintain the productivity of the soil.

The selection of good seed for planting or sowing and the use of enough seed in order to get a good stand are important. The following is a list of varieties of crops recommended for the predominant soils in Henderson County: Corn—Holcombe Prolific, Southern Beauty, Biggs (Mountain Branch Station strain), and Jarvis Golden Prolific; wheat—Fulcaster, Nittany, and V. P. I. 131; oats—(spring sowing) Fulghum, Appler, and Burt; grasses—orchard grass, redbud, Kentucky bluegrass, timothy, and meadow fescue; clovers—red, crimson, white, and sweetclover; soybeans for soil improvement—Herman, Southern Prolific, Virginia, and Laredo; soybeans for hay—Herman, Laredo, and Virginia; cowpeas for hay—Monetta, Iron, and Brabham; cowpeas for seed—Groit, Early Red, and New Era; rye—Abruzzi and common or winter rye for soils on higher mountains; sweetpotatoes—Porto Rico and Nancy Hall.

In table 6 recommendations made by the North Carolina Agricultural Experiment Station for the use of fertilizers for the major crops grown on the important soils of Henderson County are given. The quantities are acre applications.

The fertilizer recommended for wheat on the Porters, Hayesville, Balfour, and Edneyville soils<sup>10</sup> are as follows: 300 pounds of 2-12-6 on the improved lands, 300 pounds of 4-12-4 or 4-10-6 on the medium or poor soils. Applications of lime, in addition to the complete fertilizer, increase the yields of wheat and oats. Lime should be applied to the land just before sowing the small grain after the field has been plowed or disked, and the lime should be harrowed in. Lime should be used especially on the soils where clover and lespedeza are sown with clean-cultivated crops. In order to obtain satisfactory yields, wheat and oats should be sown on good soil, but rye will do fairly well, even on the poor soils of the region.

Since much of the cost of fertilizers is included in freight and handling, it is usually more economical to use smaller quantities of the more concentrated forms; that is, the same amount of plant nutrients is contained in 150 pounds of 0-20-8 as in 300 pounds of 0-10-4, and usually the cost is significantly less.

The following list of publications is recommended to persons interested in detailed information on these special crops in addition to those already mentioned. The publications may be obtained from the North Carolina Agricultural Experiment Station and the North Carolina State College of Agriculture and Engineering, Raleigh, N. C., as indicated.

North Carolina Agricultural Experiment Station Bulletins 293, Agricultural Classification and Evaluation of North Carolina Soils; 315, Influence of Crop Rotation and Soil Treatments upon the Yield of Crops on Porters Loam.

North Carolina State College of Agriculture and Engineering Extension Circular 178, Winter Legumes for Soil Improvement.

<sup>10</sup> BLAIR, E. C. SMALL GRAINS FOR THE PIEDMONT AND MOUNTAINS. N. C. Agr. Col. Ext. Cir. 243, 11 pp., illus. 1940.

TABLE 6.—*Recommendations for the use of fertilizer for the principal crops on major soil types in Henderson County, N. C.*

Soil	Fertilizers recommended for—					
	Corn	Small grains	Legumes	Potatoes	Sweetpotatoes	Adaptable vegetables
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Porters loam.....	300 to 400 of 4-10-4 <sup>1</sup> or 4-12-4 and 10 to 12 of soluble nitrogen as side dressing when needed.	300 to 400 of 4-10-4 or 4-12-4 and 10 to 12 of soluble nitrogen as top dressing when needed.	300 to 400 of 2-10-4 or 2-12-4.	700 to 800 of 3-8-6 or 5-7-5.	600 to 800 of 3-8-6 or 4-8-6.	600 to 800 of 5-8-6 or 5-7-5.
Balfour loam.....						
Hayesville loam.....						
Balfour fine sandy loam.....	300 to 400 of 4-10-4 or 4-12-4 and 16 of soluble nitrogen as side dressing when needed.	300 to 400 of 4-10-4 or 4-12-4 and 16 of soluble nitrogen as top dressing when needed.	300 to 400 of 2-10-4 or 2-12-4.	600 to 800 of 3-8-6 or 5-7-5.	600 to 800 of 3-8-6.	600 to 800 of 5-8-6 or 5-7-5.
Edneyville fine sandy loam.....						
Hayesville fine sandy loam.....						
Worsham fine sandy loam.....	200 to 300 of 2-10-4, 2-12-4, 4-10-4, or 4-12-4.	200 to 300 of 2-10-4, 2-12-4, 4-10-4, or 4-12-4.	200 to 300 of 0-14-4, 2-12-4, or 0-10-6.	500 to 600 of 3-8-6 or 5-7-5.	-----	500 to 600 of 3-8-6 or 5-7-5.
Altavista silt loam.....						
Roanoke silt loam.....						
Congaree silt loam.....	200 to 300 of 0-12-4, 2-10-4, or 2-12-4.	200 to 300 of 0-12-4, 2-10-4, or 2-12-4.	200 to 300 of 0-14-4, 0-12-6, or 0-10-6.	400 to 500 of 3-8-6 or 5-7-5.	-----	500 to 600 of 3-8-6 or 5-7-5.
Toxaway silt loam.....						
Tusquitee loam.....						
Congaree fine sandy loam.....						

<sup>1</sup> Where available, it is usually more economical to apply proportionally smaller quantities of the more concentrated fertilizers, as 200 pounds an acre of 6-20-8 instead of 400 pounds of 4-10-4.

North Carolina Agricultural Experiment Station Agronomy Information Circulars 69, Soil Fertility—A Most Important Factor in Making Richer Farm Homes and Community Life; 93, Some Facts About Legumes as Soil Improvers; 116, Adapted Fertilizers for Different Crops Grown in North Carolina; 124, Corn Varieties for North Carolina, 1940; and 126, I—Factors in Soybean Production, and II—Variety Recommendations and Characteristics.

### MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of forces of weathering and development acting on the materials 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 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 is less important in its effects on soil development than is internal soil climate, which depends not only on temperature, rainfall, and humidity, but on the physical characteristics of the soil or soil material and the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

Henderson County is in the Gray-Brown Podzolic soil region of the United States, and all the soils in the mountainous part of the county belong in this region. The soils in the large intermountain valley have characteristics similar to those of the soils of the Red and Yellow Podzolic soil region in the Piedmont plateau, which lies a short distance to the east. The surface soils in the mountainous part are predominantly brown, whereas the surface soils in the valley are much lighter in color, ranging from gray to reddish brown. Such conditions are to be expected and are due to the effects of climate, which, in turn, is due to the wide differences in elevation. The elevation in the intermountain valley ranges from about 2,200 to 2,400 feet above sea level, whereas on some of the higher mountains the elevation ranges from 4,000 to more than 5,000 feet. The high elevations in parts of Henderson County give climatic conditions somewhat similar to those in some of the New England States. The soils, therefore, in color, texture, and consistence have the characteristics of the Brown soils of southern New England.

The soils have been formed under a forest cover dominantly of deciduous trees, although there are some conifers—mainly white pine and hemlock—with an undergrowth of rhododendron, mountain-laurel, and ferns. In this cool climate the soils on the more elevated areas are frozen for a considerable time during the winter, and there has been less leaching of the soluble mineral elements and less decomposition and leaching of the organic matter than in the soils in the intermountain valley. In the latter section leaching of the more soluble compounds of the alkali and alkaline earth elements is practically continuous throughout the year. This leaching has removed a considerable part of the finer materials, as well as the organic matter, from many of the soils in the intermountain valley, and this may account for the large areas of fine sandy loams that are light-colored. The soils in the intermountain valley are dominantly low in organic matter as contrasted with the soils in the mountainous parts of the county. In many of the coves, particularly

on the north side of the mountain and locally on some of the smoother parts of the higher mountains, a large quantity of organic matter has accumulated. This is particularly true of the Burton soils. All the wooded areas have a thin covering of leafmold, consisting of decayed or partly decayed leaves and twigs on the surface and a noticeable quantity of organic matter in the topmost 2 or 3 inches of the soil. The Toxaway soils occurring on the first bottoms contain an abundance of organic matter. This is due to the swampy condition that prevailed for a long time during the development of these soils.

The Porters and Ashe soils have a high content of potash. Although no chemical data are available for the Balfour and Edneyville soils, it is reasonable to expect that the subsoils and the underlying material of these soils contain also a large percentage of potash.

One important characteristic of the soils in the mountainous parts is youthfulness. The profiles, therefore, are immature. In general, the solum is shallow; that is, it ranges from 2 to 4 feet in thickness except in a few places. This shallowness may be due to the fact that erosion has kept close pace with the disintegration and decomposition of the underlying rocks. Another feature in connection with the solum is the absence of a definite line of demarcation between the A and B horizons or between the B and C horizons. The A horizon grades into the B horizon, and the B horizon gradually passes into the soft, disintegrated rocks. There has been comparatively little eluviation in the A horizon and only slight illuviation in the B horizon. Many of the soils in the intermountain valley, however, show a marked difference between the A horizon, which has a distinctive color, and the B horizon, which has a distinctive texture and consistence.

With the exception of those on the first bottoms and on the second bottoms or terraces, all the soils of Henderson County are residual in origin and bear direct relationship to the rocks that underlie them. The soils have developed through the soil-forming processes from the weathered products of the underlying rocks. The principal rock formations in this county are Carolina gneiss, Brevard schist, Henderson and Whiteside granites, and small areas of Roan gneiss or dark basic rock.<sup>11</sup> The Carolina gneiss covers the northwestern part and all of that part of the county lying west of Sutton. Brevard schist occurs within a comparatively narrow belt running in a northeast-southwest direction through Boylston, Creek Church, Mills River, and Fletcher. Whiteside and Henderson granites cover the central and eastern parts of the county, but small bodies of Roan gneiss and dikes of basic rock lie within these areas.

Carolina gneiss, a metamorphic rock, consists of an immense series of interbedded mica schist, granite schist, mica gneiss, and granite gneiss. In their fresh condition these rocks are light to dark gray and in places contain layers of white granitic material and lenses or veins of pegmatite. Quartz and feldspar, together with some muscovite and biotite, are the principal minerals in this rock. Carolina gneiss disintegrates slowly, offers a greater resistance to weathering than do the rocks of any formation in the county, and hence under-

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<sup>11</sup> The classification of the rocks in this county is taken from the following publication: KEITH, ARTHUR. PISGAH, N. C.—S. C. U. S. Geol. Survey Atlas of the United States, fol. 147, 8 pp., illus. 1907.

lies the highest mountains. This is the principal formation that gives rise to the Porters soils.

Brevard schist, named for its occurrence near Brevard in the adjoining county of Transylvania, is the only sedimentary rock in the county. This formation consists mainly of schists and shales. Most of it is dark bluish-black or dark-gray schist, and some of it has a pearly lustrous hue. These rocks are composed of very fine quartz, muscovite, and small grains of iron oxide producing the dark color. The most unusual part of this formation in Henderson County is the series of limestone lentils and finely crystalline limestone or marble. In the quarries at Fletcher the total thickness of the marble lentils is 250 feet and the length over a mile. Other areas are near the head of Boylston Creek. At Fletcher the rock is so pure that it has been burned for building lime, and it can also be made a source of agricultural lime. From this fine-grained Brevard schist the Fletcher soils have developed. These are the only silt loam soils of the uplands that are residual in origin.

Henderson and Whiteside granites are igneous rocks and occur throughout a large part of the county. These are composed mainly of orthoclase, plagioclase, quartz, muscovite, and biotite, enumerated in the order of their importance. One of the main differences between Whiteside granite and Henderson granite is that the Whiteside contains some porphyritic feldspar crystals. Most of the Balfour and Edneyville soils are developed from Whiteside granite; some areas apparently are from Henderson granite. The Hayesville soils are formed mainly from Henderson granite and in places from Roan gneiss. The small areas of Rabun stony clay loam have developed from dark basic rock or Roan gneiss.

All the soils in Henderson County are strongly acid to extremely acid except where lime has been applied. Table 7 gives the pH determinations for several of the extensive and important soils in the county.

TABLE 7.—pH determinations of samples of profiles of several soils in Henderson County, N. C.<sup>1</sup>

Soil type and sample No.	Depth	pH	Soil type and sample No.	Depth	pH
<b>Edneyville fine sandy loam:</b>	<i>Inches</i>		<b>Fletcher silt loam:</b>	<i>Inches</i>	
239705	1 - 8	3.7	239726	0- 4	4.5
239706	8 -16	4.3	239727	4-12	4.3
239707	16 -28	4.3	239728	12-35	4.6
239708	28 -34	4.7	239729	35-45	4.6
239709	34 -45	4.4	<b>Hayesville loam:</b>		
<b>Toxaway silt loam:</b>			239731	1- 6	4.4
239710	0 -18	4.2	239732	6-12	4.5
239711	18 -30	4.2	239733	12-38	4.5
239712	30 -37	4.8	239734	38-45	4.5
<b>Balfour loam:</b>			239735	45-60	4.4
239715	1½- 7	4.0	<b>Porters loam:</b>		
239716	7 -13	4.1	239745	0- 2	5.6
239717	13 -28	4.3	239746	2- 8	4.9
239718	28 -34	4.5	239747	8-31	4.4
<b>Altavista silt loam:</b>			239748	31-45	5.0
239720	0 - 8	4.1	239749	45-60	5.1
239721	8 -28	4.1	<b>Rabun stony clay loam:</b>		
239722	28 -40	3.9	239767	0- 8	4.9
<b>Congaree silt loam:</b>			239768	8-38	5.0
239723	0 -12	4.8	239769	38-50	5.4
239724	12 -28	4.9			
239725	28 -48	4.9			

<sup>1</sup> Determinations made by E. H. Bailey, assistant soil technologist, Division of Soil Survey, by the hydrogen-electrode method.

Large areas of soils do not have a normal soil profile development, particularly in the mountainous section, because of the very steep slope. Here, erosion has kept close pace with the disintegration and decomposition of the underlying formations. In many places some of the soils are Lithosols, viz. rough stony land (Porters soil material); Porters loam, very steep phase; Porters stony loam; and some of the Ashe soils. Other areas that do not have a normal mature profile are the Toxaway soils and alluvial soils, undifferentiated, in the first bottoms, and the Roanoke soils on the terraces. In these soils the lack of a normal profile is due to poor drainage, and the high water table has prevented the action of the soil-forming processes. Areas of rough gullied land (Hayesville soil material) once had a normal soil profile, but these in places have been changed through sheet and gully erosion. On some of the types and phases, particularly Hayesville clay loam, eroded hilly phase, and in places, Hayesville clay loam, sheet erosion has removed part or all of the original surface soil.

Fairly wide areas of the first bottoms and the second bottoms or terraces border the streams. Fairly large areas of recent alluvium on the first bottoms consist of material brought down by the streams from the uplands and deposited in comparatively recent years. These materials give rise to the Congaree and Toxaway soils and alluvial soils, undifferentiated. From the old alluvium, which now lies above ordinary overflow, have developed the Altavista and Roanoke soils. Within the last 30 years considerable erosion has taken place on the soils of the foothills where clean cultivation has been practiced, and as a result areas of originally black first-bottom soils have been covered to a depth of from 12 to 15 inches by brown materials brought down and deposited by the streams.

The Edneyville, Balfour, and some of the Hayesville soils in the intermountain valley constitute the normally mature soils of the county. These may be considered the soils that express the normal effects of the climate acting on the weathered rock formations.

A description of the profile of Hayesville loam, as observed in a road cut  $1\frac{1}{4}$  miles southwest of Mores Grove Church in the valley section of the county, is as follows:

- A. 0 to 2 inches, thin covering of leafmold on the surface over brownish-gray loam containing considerable organic matter.
- A<sub>2</sub>. 2 to 7 inches, light-brown friable loam.
- B. 7 to 12 inches, reddish-yellow friable and crumbly heavy loam or clay loam. This is the gradational layer between the typical A horizon and the B horizon.
- B<sub>2</sub>. 12 to 38 inches, red heavy but brittle and moderately friable clay. This breaks down under normal moisture conditions into a granular or blocky structure.
- C. 38 to 45 inches, light-red friable material faintly mottled with red and brown. It consists of some clay and fairly well decomposed rock fragments and overlies light-colored soft disintegrated Henderson or Whiteside granite.

The other members of the Hayesville series differ from the above description in the texture and color of the surface soil, as a result mainly of sheet erosion. In many places the hilly and steep phases do not have so uniform a solum as the typical soil.

The Balfour and Edneyville soils, which are closely associated with the Hayesville soils, differ from them mainly in texture and color of both the A and B horizons. The Balfour soils have dominantly brown or light-brown A horizons and yellowish-brown to brown B horizons. The Edneyville soils are the lightest colored soils in the county. These soils resemble the Durham soils in the Piedmont plateau. They have light-gray or grayish-yellow A horizons and yellow to faintly brownish yellow friable fine sandy clay B horizons.

Porters loam is the representative soil of the mountainous parts of the county. A description of a profile of Porters loam observed 1¼ miles east of Mount Moriah Church is as follows:

- A<sub>1</sub>. 0 to 2 inches, thin layer of leafmold, consisting of partly decomposed leaves and small twigs, over brownish-gray friable loam containing considerable organic matter.
- A<sub>2</sub>. 2 to 8 inches, brown mellow loam containing many small plant roots and a small quantity of organic matter.
- B. 8 to 32 inches, faintly reddish brown friable clay loam that readily breaks down under normal moisture conditions into a granular or finely blocky mass.
- C. 32 to 45 inches, brownish-yellow friable crumbly fine sandy loam with no definite structure but containing some of the weathered rock material. Below a depth of 45 inches the material is light gray or grayish yellow and consists of soft disintegrated Carolina gneiss having some brown or black streaks.

The Ashe soils differ from the Porters soils in that they are much lighter colored in both the A and B horizons. The structure and consistence of the material in the B horizon are somewhat similar to those features of the Porters. The Ashe soils occur at higher elevations than the Porters soils—generally from 3,500 to more than 5,000 feet above sea level. In many places the solum over the soft rock is much shallower than that of the Porters. Burton stony loam is the black soil of the mountains and contains a large quantity of organic matter. The B horizon is similar in structure and consistence to that of Porters. It is developed on some of the higher mountains and in the coves. Rabun stony clay loam is the reddest soil in the mountains. It is developed from a dark basic rock or Roan gneiss. It occurs in close association with the Porters and Ashe soils.

Table 8 gives the chemical analyses of a profile of Porters loam near Chimney Rock in Rutherford County, which adjoins Henderson County.

TABLE 8.—*Chemical analyses of samples of a profile of Porters loam near Chimney Rock, Rutherford County, N. C.<sup>1</sup>*

Sample No.	Depth	SiO <sub>2</sub>		TiO <sub>2</sub>		Fe <sub>2</sub> O <sub>3</sub>		Al <sub>2</sub> O <sub>3</sub>		MnO		CaO		MgO		K <sub>2</sub> O		Na <sub>2</sub> O		P <sub>2</sub> O <sub>5</sub>		SO <sub>3</sub>		Ignition loss	N	
		In.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.				
236524.....	0-2	71.59	0.39	1.79	11.57	0.02	0.20	0.09	3.32	0.84	0.04	0.06	9.20	0.18												
236525.....	2-10	72.17	.45	2.61	14.68	.02	.16	.13	3.94	.74	.03	.04	4.81	.04												
236526.....	10-36	60.83	.56	4.48	22.25	.05	(?)	.78	2.54	.85	.06	.03	7.69	.01												
236527.....	36-54	65.46	.52	3.97	19.37	.06	(?)	.53	4.26	.44	.01	.05	5.42	.01												
236528.....	54+	68.57	.46	3.21	17.35	.08	.09	.59	4.93	.62	(?)	.01	3.92	.60												

<sup>1</sup> Samples collected by R. C. Jurney, associate soil scientist, Division of Soil Survey, and analyzed by G. Edgington, assistant chemist, Division of Soil Chemistry and Physics.

<sup>2</sup> Trace.

## SUMMARY

Henderson County, in the mountainous southwestern part of North Carolina bordering the North Carolina-South Carolina State line, covers a total area of 358 square miles, or 229,120 acres. For the most part the relief is steep, broken, and mountainous, and there are some very steep slopes. The county also includes a large intermountain valley that has a gently rolling to strongly rolling and hilly relief cut in places by comparatively wide nearly flat areas of first and second bottoms following the main drainageways. The elevation of the intermountain valley ranges from 2,100 to 2,400 feet above sea level, whereas the elevation for the greater part of the county ranges from 2,400 to 5,200 feet. Drainage is effected through the French Broad, Green, Hungry, and Broad Rivers and their tributaries, which ramify throughout all parts of the county.

The climate is continental; that is, there is considerable difference between the temperatures of winter and summer. It is mild and pleasant from late spring to late fall, and the nights during the summer are cool. This climate, together with many beautiful waterfalls and mountain peaks and roadsides lined with white pine, attracts thousands of summer tourists. Cool, refreshing waters from the springs in the mountains add comfort to many rural dwellers. The climate and soils favor the growth of pasture grasses, apples, potatoes, cabbage, and late truck crops, as well as the general farm crops common to this region.

General farming has been carried on in this county for more than 100 years. It has been supplemented with lumbering, which has furnished a substantial income to many landowners and farmers from the sale of forest products. Most of the settlement was in the intermountain valley and on the fertile soils in the bottoms. Corn, hay, rye, wheat, and potatoes are the principal crops for this subsistence type of agriculture. Cash income is derived mainly from the sale of cabbage, tomatoes, apples, beef cattle, and, to a less extent, dairy products and poultry products. From the hardwood forests, lumber, cross ties, staves for making barrels and tubs, acid-wood, and tanbark from hemlock and chestnut bring in a considerable income and furnish the means of livelihood for many people. The raising of beef cattle is of considerable importance, and the commercial growing of apples is worthy of attention. Most of the soils of the county are inherently good, and some are quite fertile. The large number of soil types and particularly of phases is due to the wide differences in relief. Relief is the controlling factor as regards the land use over most of the county.

The soils are classified into soil series, types, and phases on the basis of the internal characteristics of the surface soil and subsoil, such as color, texture, and consistence; but in actual mapping, such characteristics as relief, stoniness, drainage, and degree of erosion are given due consideration. These soils are grouped into five classes based on such characteristics of the soil as relief, drainage, land use, crop yields, and ease of management, as follows: (1) First-class soils, (2) Second-class soils, (3) Third-class soils, (4) Fourth-class soils, and (5) Fifth-class soils.

The First-class soils are Congaree silt loam; Congaree fine sandy loam; Congaree-Toxaway silt loams; Toxaway silt loam; Tusquitee loam; Hayesville fine sandy loam; Hayesville loam, smooth phase; Balfour loam; Balfour loam, smooth phase; and Balfour fine sandy loam, smooth phase. These soil types and phases are considered the best soils in the county when all factors are taken into consideration as regards the inherent fertility of the soil, its productivity, lay of the land, proportion under cultivation, and crop yields. These soils dominate the agriculture of the county; that is, they produce the greater part of the corn and hay.

The Second-class soils comprise Hayesville loam, Hayesville clay loam, Edneyville fine sandy loam, Altavista silt loam, Balfour fine sandy loam, Fletcher silt loam, and Fletcher silt loam, smooth phase. The soils in this group are closely related as regards agricultural use and crop yields to the soils in the First class, and in some instances it was difficult to know just where to place some of them. Considered as a whole, these soils occupy dominantly more sloping relief, are more subject to sheet erosion if kept in clean-cultivated crops, are slightly more difficult to handle, and the yields are slightly less than on the soils of the previously described class. Under good farming practices some of these soils may produce yields as good as or better than those obtained on some of the First-class soils that may not be properly handled.

Third-class soils include Roanoke silt loam; alluvial soils, undifferentiated; Worsham fine sandy loam; Balfour fine sandy loam, hilly phase; Balfour loam, hilly phase; Porters loam, hill phase; and Hayesville loam, hilly phase. Because of poor drainage or hilly relief, these soils are less desirable for general farming purposes than the soils in the two classes previously described. These may be termed the marginal lands or those lands that have a potential value. When there is need for increased production of farm crops, a considerably larger acreage of these soils could be used for crop purposes in a long rotation in which grasses are the important crops. Some of these soils that have been under clean cultivation have undergone sheet erosion and some gullying.

In the Fourth-class soils are Porters loam; Porters stony loam, hill phase; Rabun stony clay loam; Burton stony loam; Ashe fine sandy loam; Ashe stony fine sandy loam, slope phase; Fletcher silt loam, hilly phase; Hayesville loam, steep phase; Hayesville clay loam, eroded hilly phase; Wehadkee silt loam; and stony colluvium (Porters soil material). Unfavorable conditions of relief, drainage, stoniness, or erosion do not allow feasible use of these soils for general farm crops. Most of them can be used advantageously for pasturage, and some of them can be used for the production of apples. Small areas of these soils here and there are in cultivation, and fair yields are obtained.

The Fifth-class soils include Porters loam, very steep phase; Porters stony loam; Ashe stony fine sandy loam; rough gullied land (Hayesville soil material); rough stony land (Porters soil material); and rock outcrop. These types and phases and miscellaneous classifications of material represent those areas that are so steep or

so stony as to preclude their use for agricultural purposes other than forestry or, in some places, for scant pasturage.

Perhaps one-third of the land in this county will remain for a long time in forest, as it is unsuitable for agricultural purposes, owing to the very steep relief or stony condition of the soils. Thousands of acres of good soil in the intermountain valley and in the smoother parts of the mountains could be brought under cultivation for general farm crops or truck crops, devoted to pasture grasses, or used for the growing of apples. The intermountain valley offers great possibilities for agricultural development.

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