

SOIL SURVEY OF HANOVER COUNTY, VIRGINIA.

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LOCATION AND BOUNDARIES OF THE AREA.

Hanover County, situated just east of the center of Virginia, is included within parallels 38° and $37^{\circ} 30'$ north latitude and meridians $77^{\circ} 50'$ and 77° west longitude. Its extreme length from east to west is about 37 miles, 12 miles of which lie within the Piedmont Plateau. In width it measures approximately $11\frac{1}{2}$ miles along the eastern boundary, 7 miles across the center, and 20 miles along the western boundary. The area of the county is 475 square miles or 304,000

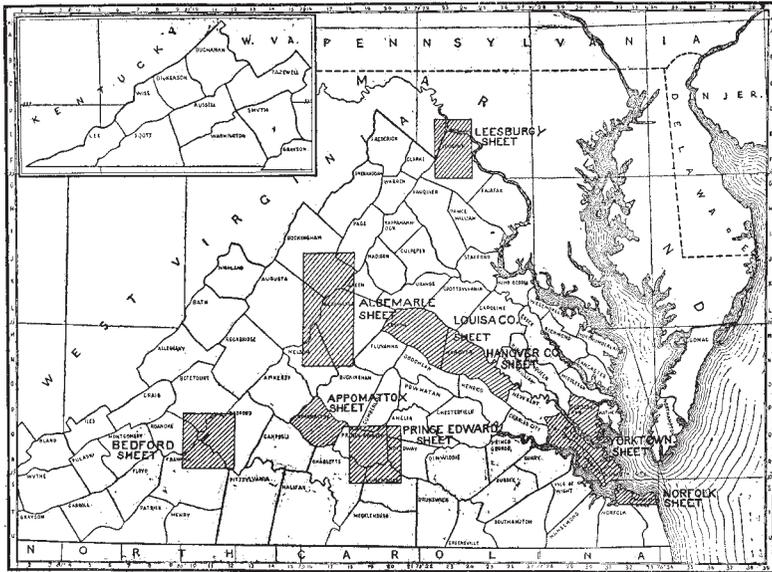


FIG. 7.—Sketch map showing location of the Hanover County area, Virginia.

acres. The northern boundary is formed by the North Anna and Pamunkey rivers, the latter being a continuation of the former, which flow in a general southeasterly direction. Owing to the numerous bends in these streams, the northern boundary is irregular. The Chickahominy River, rising about 10 miles east of the southwestern corner of the county, flows in a southeasterly direction along the southern boundary roughly parallel with the streams forming the northern boundary. Included between these rivers the county forms

a long, narrow strip running from northwest to southeast. It is bounded on the north by Spottsylvania, Caroline, and King William counties, on the east by King William and New Kent counties, on the south by Henrico and Goochland counties, and on the west by Louisa County. Ashland, the largest town, is situated very near the center of the county and is about 99 miles south of Washington, D. C., and 16 miles north of Richmond, Va. Hanover is the county seat.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Hanover County was formed from a part of New Kent County by an act of the colonial legislature passed in 1720. In 1742 a large part of the western portion of the county was cut off and organized as Louisa County. The early settlers came either from the early English colonies or direct from England. The population for the most part is of almost pure English descent.

The early agricultural practices were very crude. Little manure was used and no definite crop rotation practiced until about the middle of the nineteenth century. Prior to the Revolutionary war the land was cultivated continuously to tobacco, and when the yields ceased to be profitable new land was cleared and devoted to this crop. The growing of tobacco generally proved profitable to the farmers and its cultivation so engrossed their attention that all other crops were subordinated to it. To lessen the evils of this one-crop system the colonial legislature enacted laws from time to time restricting the tobacco acreage of the farms and requiring the cultivation of a stipulated acreage of other crops. Standards of quality were fixed for tobacco intended for exportation, and public warehouses were designated through which the crop was sold after being inspected by public officials.

At the close of the Revolutionary war there came a period of agricultural depression, brought on largely by decreased productiveness of the cleared fields and low prices for tobacco. The prices of cereals advanced and their production increased, while the tobacco acreage diminished, particularly in the Coastal Plain region. Later, however, the demand for cereals decreased and the profitableness of tobacco increased. Because of the declining yields of the soils of the Coastal Plain region, its production was confined almost entirely to the Piedmont Plateau and brought an exceptional degree of prosperity to the farmers of that region. The early plan adopted for handling those fields that had become too poor for profitable crops of tobacco was to cultivate them in corn for about three years in succession, then every second year so long as yields of about 5 bushels per acre were obtained, and after this to abandon the land and clear new fields. The soil was "rested" between corn crops, either under a crop of small grain or allowed to lie fallow.

About 1850 the farmers began treating the soils of the Pamunkey bottoms with greensand marl obtained from deposits along the river. Applications of this material, made sometimes at the rate of 250 or more bushels per acre, proved quite beneficial and were said to be very lasting in their good effects. The greensand marl was applied in some instances in conjunction with organic manures, it being recognized that the best results were obtained in this way. About this time cowpeas and clover were introduced in some localities as regular crops, along with wheat and corn, in a six-year rotation, and were plowed under, grazed, or cut for hay. The practice of "marling" has not been attempted on an extensive scale since the civil war.

Prior to the civil war each plantation was entirely self-sustaining and had its own distinct round of occupations, which were so much alike from year to year that the details of farm management could be intrusted to overseers. Following the war changed conditions forced the abandonment of a large acreage of farm land, much of which is now covered by a heavy growth of old field pine. After an adjustment to the new conditions more intensive cultural methods became the rule, and a great deal more attention was paid to the manurial requirements of the soil.

CLIMATE.

The following tables show the normal monthly and annual temperature and precipitation, and the dates of first and last killing frosts, as given by the Weather Bureau records at Ashland.

Normal monthly and annual temperature and precipitation.

Month.	Ashland.		Month.	Ashland.	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	° F.	Inches.		° F.	Inches.
January.....	36.0	2.85	August.....	76.0	3.92
February.....	36.5	3.48	September.....	69.5	5.15
March.....	48.2	3.41	October.....	57.8	3.84
April.....	56.0	3.67	November.....	48.0	2.49
May.....	66.1	4.78	December.....	38.9	2.97
June.....	73.0	3.53	Year.....	57.0	44.81
July.....	78.0	4.72			

Dates of first and last killing frosts.

Year.	Ashland.		Year.	Ashland.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1897.....	Apr. 21	Oct. 31	1902.....	Apr. 14	Oct. 15
1898.....	Apr. 7	Oct. 24	1903.....	Apr. 6	Oct. 19
1899.....	May 17	Oct. 6	1904.....	Apr. 22	Oct. 16
1900.....	Apr. 10	Nov. 10	Average.....	Apr. 16	Oct. 22
1901.....	Mar. 29	Oct. 26			

These records are believed to represent quite accurately the average climatic conditions for the county. On account of a difference in altitude of something like 200 feet the climate of the region near the western boundary is slightly cooler than that of the district near the eastern boundary, but there is no apparent difference in the precipitation. The climate of the North Anna-Pamunkey Valley is more unfavorable for early crops than that of the adjacent uplands, because of the tendency of the heavier cold atmosphere to settle in the valley.

The range of temperature between normals for January, the coldest month, and July, the hottest month, is about 42° F., while the absolute maximum range is probably not much greater than 110° F. On the whole, the climate is equable and healthful and is quite favorable to agriculture. Injurious hail storms and winds are infrequent. With good drainage and proper seeding, little damage is done to grain by heaving of the soils, due to alternate freezing and thawing. Red clover is frequently more or less winter killed where the seeding has been done late. Peaches are subject to serious damage by the alternate warm and cold spells of early spring. There are some wild fruits, such as the blackberry and dewberry, that rarely bloom until after the danger of frost is past. Although the rainfall is heaviest during the growing season, the longer continued rains of spring, together with less evaporation and less absorption by the more thoroughly saturated soils, cause more freshets in the spring than occur at any other season. The characteristic dry falls are favorable for harvesting crops and curing tobacco, but are often unfavorable for fall-seeded grain. The heavy dews appearing during the latter part of August are quite beneficial in thickening up filler plug leaf tobacco. Cold nights without dews about the time of maturing are said to prevent to some extent a perfect development of the leaf.

PHYSIOGRAPHY AND GEOLOGY.

Hanover County comprises two main physiographic divisions—the Piedmont Plateau, which lies west of a curved line crossing the area in a north and south direction about 3 miles west of Ashland, and the Coastal Plain, which lies east of this line. There are two distinct subordinate physiographic divisions—the North Anna-Pamunkey Valley and the zone marking the coalescence of the Piedmont with the Coastal Plain regions.

The general surface configuration of the Piedmont Plateau, represented in Hanover County by the eastern border of that great physiographic division, is that of a plain much dissected by a highly diversified stream system. In Hanover County the slope from east to west is barely perceptible, although there is a drop of from 50 to 100 feet in a distance of a little over 12 miles. The Piedmont division of the county is well drained by the North Anna, Little, New Found, and

South Anna rivers. For a distance of 9 or 10 miles from the western boundary these streams flow almost parallel to one another, but draw closer together as they approach the point of confluence with the Pamunkey River. By the cutting of deep valleys these streams have formed a series of roughly parallel ridges, growing narrower toward the east, with crests approximately 100 feet above the stream beds. These major ridges, constituting true drainage divides, are flanked by irregularly developed secondary ridges formed by the smaller streams that rise near the crests of the divides and flow nearly at right angles into the main water courses. With the settlement of the region and the subsequent deforestation of the land a larger proportion of the rainfall was carried off with the surface drainage. For this reason many former perennial streams have become dry except during seasons of rainfall and have formed numerous shallow V-shaped ravines and gullies. There are no table-land divides, the valley sides rising with diminishing slope toward the ridges. In the immediate vicinity of the streams the slopes are more abrupt and marked by greater surface inequalities. The greater part of the area is gently rolling, owing to the comparatively shallow valleys of the streams in their upper courses. Generally the altitude at any one point is proportionate to the distance from large streams.

The Coastal Plain division of Hanover County has an altitude of about 250 feet on the west and 175 feet on the east, and represents the more elevated portion of that physiographic province. Excepting the deeply cut drainage system, which resembles closely that of the eastern Piedmont, the general upland topography of this section is quite similar to that of the typical Coastal Plain farther east. This division, included between the lowlands of the Pamunkey River on the north and the Chickahominy River on the south, constitutes a nearly level plateau cut by deep valleys of winding streams which rise in the irregularly developed drainage divide following, and very near, the Chickahominy River. These streams flow in a northeasterly direction and empty into the Pamunkey River. A narrow strip, constituting the southern slope of the drainage divide, is drained by numerous small, short streams that empty into the Chickahominy River. The valleys are deep and generally narrow, their steep walls reaching the level of the uplands within a comparatively short distance of the streams. In the neighborhood of the larger waterways the gullylike escarpments of the short laterals give the country a rolling topography. The interstream country, corresponding to the main ridges of the Piedmont division of the county, consists of flat to gently rolling expanses frequently poorly drained near their centers. The section north of Ashland is cut by the rivers that converge in that vicinity to form the Pamunkey, and is quite rolling and well drained.

The Piedmont grades into the Coastal Plain so gradually that the boundary was established with considerable difficulty. South of the South Anna River this boundary passes through a kind of gradational zone or province having a distinctly level to gently undulating surface cut only by shallow streams. This grades insensibly into the more definite Coastal Plain province a few miles east of Ashland. The center of this zone is somewhere near the town of Ashland, where there is a faintly developed table-land, slightly depressed, and very poorly drained.

Commencing about where the Richmond, Fredericksburg, and Potomac Railroad crosses the North Anna River, running down that stream to its junction with the Pamunkey River, and thence down the Pamunkey, is a well-developed terrace formation. This comprises first and second terraces, interrupted by numerous secondary terraces, and lies approximately between 30 and 55 feet above the level of the river. There is little or no slope riverward, but a gradual steplike descent of the numerous secondary terraces. Excepting some of the narrow, low-lying areas adjacent to the river, this terrace formation is never overflowed. The outer limit of the river plain is marked by a distinct bluff line which rises abruptly to the level of the upland. The Pamunkey River is deep and flows rather sluggishly. The water table frequently lies within 7 or 8 feet of the surface of those areas along the river that are underlain by a coarse gravel substratum.

The soils of the Piedmont section of the county have been derived mainly from the granite and gneiss formations, belts of which cross this part of the county in a northeast and southwest direction. The distinctly banded and greatly tilted character of the gneiss near the western boundary becomes less conspicuous toward the east. The granite and gneiss are so similar in composition and so intimately associated near the Coastal Plain boundary, where there are few rock exposures, that it is often hard to determine whether the parent rock of a given soil formation is granite or gneiss. A few rock variations have given rise to small, unimportant nonconformations in the soils. Weathering has taken place very uniformly to a depth of 30 feet or more, and with the exception of quartz fragments—the remnants of quartz veins that intersect this entire region—rock fragments are very scarce. The deeply weathered rocks have exerted little influence upon the topography. Streams cross the region without reference to the rock formations and have cut deep steep-sided channels without exposing the underlying rocks. Northwest and north of Ashland, however, occurs an area of very resistant Newark conglomerate, which, while it has had no appreciable influence upon the overlying soils, has determined the character of the topography in the neighborhood of the streams. Here the streams are frequently flanked by pre-

cliff-like rock walls 50 feet or more in height, the valleys are narrow, and bottom land is practically absent.

The Coastal Plain division of the county, exclusive of the terraces of the North Anna-Pamunkey Valley, belongs to the Lafayette formation. It consists principally of loose sandy loams underlain by yellow sandy clays, and represents materials washed from the Piedmont and laid down near shore during the period of submergence of the area. These materials, subjected to the action of tides and waves during the shallow-water stages of the subsequent uplift of the ocean floor, were greatly modified, assorted, and distributed over the Coastal Plain area. Since the final uplift they have not been changed materially, except along slopes, where the finer particles have been carried away by rains and streams, leaving the coarse sands and gravels. The soils differ from those of the Piedmont in their loose structure, lack of loaminess, the predominance of sand—generally more or less rounded—and the frequent occurrence of waterworn gravel throughout the soil profile.

The western boundary of the Coastal Plain province is much farther east than formerly, as is evidenced by the beach-worn pebbles scattered over the eastern margin of the Piedmont, showing the existence there of a former mantle of these unconsolidated materials. There are included in this province several isolated outliers of the Piedmont, a mile or more removed from the boundary.

In its lower depths the Lafayette consists of a coarse sandy or gravelly loam, often showing stratification and cross-bedding. The Lafayette rests unconformably upon the Chesapeake formation, indistinct outcrops of which are probably seen in the gray or olive clays along the slope bordering the Pamunkey River bottom and the small stiff clay spots west of Polegreen. The materials of the Chesapeake formation have little direct influence upon the soils. They may, however, have entered into the formation of the heavy soils of the Columbia terraces.

The river terraces represent the fluvial phase of the Columbia formation, and to a depth of 15 feet or more consist of coarse sands, sandy loams—becoming coarser below about 3 feet—and clays. These constitute materials of the original Coastal Plain, and, to a less extent, of the Piedmont, reworked and intimately mixed by water currents of recent Pleistocene time.

The Columbia terraces overlie the Pamunkey formation of the Eocene. This formation is exposed along the Pamunkey River, and consists mainly of glauconitic sands and marls of a dark-green or grayish-green color. It contains many calcareous shells and shell fragments. These greensand marls have little influence on the soils of Hanover County, but have been used extensively as fertilizers. They contain small quantities of phosphoric acid, lime, and potash.

Nearly every stream in the county is bordered along the greater part of its length by a narrow strip of Meadow or alluvium, the result of overflow depositions and the accumulation of material washed down from the adjacent slopes. The area of this soil formation is being gradually increased at the expense of other soils which are being worn away by erosion. A considerable percentage of this is marshy, but is susceptible of reclamation by artificial drainage.

SOILS.

Twelve distinct soil types were encountered in Hanover County. The classification of these was based largely upon their texture, that is, the relative proportion of the various sizes of the constituent soil particles—sand, clay, and silt—as determined by mechanical analyses. Here, as with most soils, texture determines in a large measure the relative productiveness of soils, since it practically controls moisture conditions and the circulation of air in the soil. This is more nearly true for soils under relatively similar conditions and depends considerably upon soil structure, that is, the arrangement of the soil particles with relation to each other—whether compact or granular—and upon the position of the soil, whether in low-lying, poorly-drained situations or the reverse. This last influence can be altered by cultural methods and artificial drainage. The texture of the soil can be modified by the incorporation of vegetable matter. Thus, an open sandy soil from which water drains away rapidly can be made spongy and capable of maintaining a favorable moisture supply in dry seasons by plowing under well-rotted organic matter.

Some of the types in Hanover County owe their distinguishing characteristics and even their origin to accident of position. The Leonardtown loam owes its peculiarities largely to the fact that its flat surface is not conducive to good natural drainage. The Norfolk gravelly loam and the Cecil clay owe their origin, respectively, to the washing out of the fine particles from the Norfolk sandy loam and the Norfolk fine sandy loam occupying slopes and the washing off of the soil from Cecil sandy loam areas.

The boundaries of the different types were easily determined except in the case of the Cecil sand and the Norfolk sandy loam, which grade into each other so as to make the line of separation very indistinct.

The following table shows the actual and relative extent of the different soils:

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Per cent.
Cecil sandy loam.....	97,856	32.2	Swamp.....	6,208	2.1
Norfolk sandy loam.....	88,256	29.0	Wickham sandy loam.....	5,120	1.7
Norfolk fine sandy loam.....	39,232	12.9	Wickham sand.....	4,416	1.4
Cecil sand.....	29,696	9.8	Wickham clay loam.....	2,176	.7
Meadow.....	15,552	5.1	Norfolk gravelly loam.....	1,344	.5
Cecil clay.....	7,360	2.4			
Leonardtown loam.....	6,784	2.2	Total.....	304,000	.....

CECIL SANDY LOAM.

The soil of the Cecil sandy loam to a depth of from 6 to 16 inches consists of a gray to light-brown medium sandy loam, generally of a more open and coarser texture in the surface 6 inches. The subsoil is a red sandy clay which becomes heavier, stiffer, and more intensely red with increase in depth. The subsoil is inclined to be friable where the drainage is good. Sharp, angular quartz fragments, varying in size from small particles to pebbles about one-half inch in diameter, usually occur throughout the soil profile, but seldom in quantities sufficient to impart a distinctly gravelly nature to the soil. The sand is sharper and more angular than that of adjacent Coastal Plain soils. Near the Coastal Plain boundary the type is decidedly more loamy, more nearly uniform in texture, depth, and topography, and is almost entirely free from rock fragments.

The Cecil sandy loam occupies nearly 75 per cent of the Piedmont section of the county. With the exception of a few small, detached areas it occurs in one general body broken throughout by erratic areas of Cecil sand and, in the southwestern corner of the county, by irregular bodies of Cecil clay. Its surface features consist of a series of irregularly developed ridges with crests approximately 100 feet above the beds of the main water courses. These major ridges are flanked by a series of secondary ridges, included between escarpments of small streams rising near the crests of the main ridges and flowing almost at right angles into the larger streams. These stream escarpments are comparatively shallow, except in a small part of their lower course, and for this reason the greater part of the surface varies from undulating in the higher positions to gently rolling near the major stream valleys, the walls of which are quite steep and rolling. Frequently the soil of the steep valley sides has been made shallower or has been entirely removed by erosion. Small areas where the subsoil has been exposed in this manner are locally called "galls." Usually the slopes are so gentle and the soil so absorbent of rainfall that surface wash has

done but little harm. Natural drainage for the most part is very good, practically no ditching being done.

There are many small irregular areas which, because of poor drainage, differ somewhat from the general description of the type, particularly in the neighborhood of Beaverdam. These areas are locally known as "crawfish lands" and usually occur near the sources of small streams. They consist of a gray sandy loam about 5 inches deep, underlain by a very clammy, plastic, mottled white and blue sandy clay. Water is held in the soil almost immovably, as if it were a part of the soil itself. This characteristic may be due in part to a too even distribution of the soil particles that divide the interstitial space into a great number of minute pores, through which water is distributed and held by capillary attraction so as to overcome gravitational flow. Frequently the unmanageable nature of the clay is erroneously ascribed to the action of crawfish, great numbers of which make their homes here. The extensive ditching necessary to reclaim these "crawfish land" areas practically precludes their use for agricultural purposes.

The Cecil sandy loam is a residual soil, derived from the weathering of granite and gneiss rocks carrying little mica but considerable feldspathic material. Weathering has taken place very uniformly to an average depth of about 30 feet. The sandy material constituting the soil portion of the type probably represents accumulations of the coarser constituents—the residuum left upon removal of the finer particles by erosion—of a section of soil material many feet thick and perhaps not greatly unlike the subsoil. Few rocks, with the exception of quartz fragments—the remnants of quartz veins that intersect this region—are met with. Occasionally waterworn gravel has been left on the surface along the eastern boundary of the soil type by the removal of the finer particles of a Coastal Plain material that formerly overlapped the present margin of the Piedmont.

At one time about three-fourths of the type was cleared, nearly one-half of which has since been allowed to grow up in old field pine. The original forest growth consisted principally of oak, hickory, and pine.

The Cecil sandy loam, while not so productive as the Cecil clay, is the most important of the Piedmont soils because of its great extent. It is easily cultivated and is quite susceptible of improvement. The soil needs organic matter, which can be supplied by growing cowpeas and clover. Applications of lime also prove beneficial. The plowing under of cowpeas and crimson clover is fast becoming a general practice. Instead of plowing under the pea vines while green, the crop is allowed to stand until matured, and is then either plowed under in the fall or else allowed to remain as a cover crop through the winter. The latter practice is said to preserve loaminess and moisture quite as well as when the crop is turned under while green. Con-

siderable commercial fertilizer is used in the form of acid phosphate or "complete fertilizers," carrying generally about 8 per cent of phosphoric acid and 1 per cent each of potash and nitrogen. The average application for tobacco is from 300 to 500 pounds per acre sown in the row, for corn 100 to 200 pounds in the row, and for wheat about 350 pounds sown in the drill with the grain. More lime should be used on this soil type. While the plowing as a rule is deep, it should be much deeper in some localities.

The Cecil sandy loam is devoted to general farming. Tobacco has been the staple crop for a long time. The yields range from 600 to 1,000 or more pounds per acre. It makes an excellent plug or chewing tobacco and commands good prices. The curing is done in well-ventilated barns. Some of the farmers "scaffold" the leaf in the sun for several days, or until it is thoroughly wilted, before it is put in the barn to be air cured. The tobacco grown in this region is placed upon the market as "Virginia sun-cured." Corn yields from 15 to 40 bushels, wheat from 7 to 25 bushels, oats about 30 bushels, and hay about 1 ton per acre. The hay generally consists of a mixture of clover, herd's-grass, and timothy or pea vines.

The following table gives the average results of mechanical analyses of samples of the fine earth of Cecil sandy loam:

Mechanical analyses of Cecil sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14145, 14147.....	Soil.....	3.6	12.7	8.1	25.9	12.2	24.9	12.4
14146, 14148.....	Subsoil.....	2.2	7.3	4.9	14.3	9.3	16.9	44.8

CECIL CLAY.

The soil of the Cecil clay to a depth of from 4 to 10 inches consists of a red clay or clay loam, usually containing appreciable quantities of medium and coarse sand near the surface. The subsoil is a brittle heavy red clay, becoming heavier and stiffer with depth. Frequently below a depth of 28 inches it has a distinctly greasy feel, due to the presence of minute particles of mica, and contains soft concretions of hydrated oxides of iron and coarse angular sand or fragments of quartz. A slight variation is found in the higher situations representing heavily timbered areas. Here the type is a dark-red mellow clay loam, 16 inches deep, underlain by a brittle chocolate-colored clay containing but few quartz fragments.

The Cecil clay occurs in irregular-shaped areas in the southwestern part of the county, occupying mainly the slopes of the South Anna River, Taylors Creek, and their tributaries. Small areas occur along the undulating ridge crests. The rolling topography is conducive to

excellent surface drainage, and the general absence of severe erosion indicates a good water-holding capacity and better underdrainage than the textural character of the subsoil would suggest. If plowed when too wet, very resistant clods are formed or the soil runs back into the furrow, puddles, and becomes very hard when dry. On the other hand, if allowed to remain too long without plowing after a heavy rainfall the soil bakes and when plowed large, unmanageable clods are turned up.

The Cecil clay is a residual soil, derived from the weathering of granite and gneiss in a manner similar to that giving rise to the Cecil sandy loam. That part of the type occupying the steeper slopes seems to have had a former sandy covering which has been removed by erosion, while the higher lying, dark-red phase of the type probably never had this sandy mantle. This last phase is timbered with a heavy growth of oak, pine, and hickory.

A large percentage of the type is under cultivation. It is very productive and is well adapted to general farm crops, particularly corn, small grain, grass, and tobacco. When thoroughly prepared and cultivated under favorable moisture conditions it produces from 30 to 50 bushels of corn, from 12 to 25 bushels of wheat, 1 ton or more of hay, and from 800 to 1,200 pounds of tobacco per acre. The tobacco, while not as fine textured as that produced on the Cecil sandy loam, is quite as profitable, since the lower price is offset by the heavier yield. If thoroughly prepared before seeding, this soil is especially suited to red and crimson clover, timothy, and orchard grass.

In dealing with this soil the chief problem is to maintain a loamy condition so as to preserve a favorable moisture supply, without which the crop yields can not be expected to approximate the soil's maximum productive power. The compactness of the soil particles needs to be disturbed by deep, thorough, and seasonable plowing and a spongy, open structure brought about by the incorporation of vegetable matter, particularly pea vines and clovers. Turning under green manures is at present disapproved by the majority of farmers, who claim better results are had by turning under dried vegetable matter. As to pea vines, it is claimed that the land is much benefited by allowing the vines to remain through the winter as a cover crop. The use of lime with green manuring would greatly increase the beneficial results to be had from this practice. A regular rotation of crops is also important. The prevailing practice is to follow wheat by grass and clover, the clover being cut for two or three years and then succeeded by corn or tobacco. Cowpeas are generally sown between the corn rows with the last plowing. Considerable commercial fertilizers are used.

The following table gives the average results of mechanical analyses of samples of the Cecil clay:

Mechanical analyses of Cecil clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14151, 14153.....	Soil.....	1.9	9.0	7.9	19.9	9.4	26.4	25.6
14152, 14154.....	Subsoil.....	2.3	8.7	6.4	13.6	5.2	20.3	43.3

CECIL SAND.

The Cecil sand to a depth of from 6 to 10 inches consists of a light-colored medium sandy loam, underlain by a loose, incoherent, pale yellow material of about the same texture extending to an average depth of 18 inches. This rests upon a yellow sandy loam, which in depressed and poorly drained areas grades into heavy sandy loam or sandy clay, frequently mottled and clammy. In the vicinity of the Coastal Plain boundary the soil becomes more loamy and the subsoil is a heavier sandy loam, quickly passing into a sandy clay. Here there is little variation in the type. Its close resemblance to the contiguous Norfolk sandy loam, from which it seems to differ merely in origin, made it somewhat difficult to draw a distinct boundary between the two. The absence of waterworn gravel from the profile of the latter type, however, helped to establish a fairly accurate boundary between these gradational soils.

The Cecil sand occurs throughout the Piedmont section of the county in numerous widely separated areas which range in size from a few acres to approximately 1 square mile. A large percentage of the type is included in the irregular bodies occupying the drainage divide to the south of the North Anna River and the large body in the southeast corner of the Piedmont. The smaller areas generally occupy undulating ridge crests near the sources of small streams, while the larger areas cross the ridges and follow the slopes down about half the distance between the stream and the crest of the ridge. The extensive area in the southeastern corner of the Piedmont has been cut through by streams, the valleys of which give the area a gently rolling surface. The drainage varies with the elevation. On the higher situations the soil is well drained and inclined to be droughty. The subsoil is always more retentive of moisture than its texture would indicate, while along the lower slopes it is clammy and frequently quite impervious to water. In the immediate vicinity of the Coastal Plain boundary the drainage is very good and a favorable moisture supply is maintained throughout the year. As a whole, however, the type is improved by artificial drainage.

The Cecil sand owes its origin to the weathering of granite and gneiss. The granite, a gray, medium-grained variety, contained considerable quartz. The close resemblance of the parent gneiss to that giving rise to the Cecil sandy loam suggests that the difference in these types, which is here chiefly in depth of soil and color and texture of subsoil, is largely accounted for by a peculiar retardation of drainage, aeration, and subsequent weathering in the subsoil of the Cecil sand. The soil in most cases is deeper where the underdrainage is good.

On account of the open nature of the surface soil and the consequent rapid leaching of fertilizers, together with the generally unfavorable condition of the subsoil, the Cecil sand is not naturally a productive soil and is not susceptible of rapid improvement. It is used, however, for general farming. Tobacco yields from 500 to 800 pounds per acre. Crimson clover and cowpeas afford yields of a ton or more of good hay per acre. Very little vegetable matter is turned under, and until more organic matter is incorporated in the soil by plowing under green or matured leguminous crops or by the addition of barnyard manure, little improvement in the type can be expected. While not especially well adapted to grass, sufficiently good stands can be secured to maintain a very beneficial crop rotation, similar to that practiced on the Cecil clay and the Cecil sandy loam. It would seem advisable to plow under pea vines in the fall, rather than to allow them to remain through the winter as a cover crop. Near the Coastal Plain boundary very fair crops of grain, corn, and grass are produced.

The following table gives the average results of mechanical analyses of samples of the Cecil sand:

Mechanical analyses of Cecil sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14141, 14143.....	Soil.....	2.3	11.5	8.7	31.4	18.6	21.7	5.4
14142, 14144.....	Subsoil.....	3.3	10.3	7.4	30.3	17.8	17.6	13.2

NORFOLK SANDY LOAM.

The soil of the Norfolk sandy loam to a depth of about 8 inches consists of a gray, loose, and incoherent medium sandy loam, underlain to an average depth of 18 inches by a pale-yellow, more compact material containing more fine sand. The subsoil is a yellow sandy clay which is inclined to be friable where the drainage is good, and clammy and sticky in the poorly drained areas. The constituent sand is more rounded than that of the Cecil soils, but owing to lack of fine material it is more distinctly harsh. A small percentage of rounded gravel occurs throughout the soil profile. At a depth of from 20 to 30 feet

there usually occurs a stratum of material containing considerable coarse sand and gravel.

The Norfolk sandy loam occupies about one-half of the total area of the Coastal Plain region of Hanover County. It adjoins the Cecil sandy loam and the Cecil sand areas along the Piedmont-Coastal Plain boundary in a continuous body, except for the interruptions of small areas of Meadow and of Norfolk gravelly loam. The largest bodies of the type occur in the eastern part of the county. It occupies the most rolling areas of the Coastal Plain, including practically all of the steep valley slopes, some of which rise 100 feet or more within a half mile of the stream. In the eastern and southern parts of the county the surface is very rolling. There are some interstream plateau areas that have an undulating to gently rolling surface. Areas of the type are also found in narrow marginal strips along the flat bottom lands of the Pamunkey and Chickahominy rivers. On account of its sandy texture, open structure, and rolling surface nearly all of the Norfolk sandy loam is well drained, and a considerable proportion of it is so low in organic matter content and so open textured that crops suffer seriously from drought. The soil in some of the plateau areas could be improved by better drainage. The spongy nature of the soil prevents washing, the rain water being absorbed as rapidly as it falls.

The Norfolk sandy loam owes its origin to the deposition of material washed from the Piedmont during the submergence of the Coastal Plain. The heavier subsoil represents that part of the material laid down in comparatively deep water, while the soil owes its sandy nature in part to tidal and wave action during shallow-water stages of the uplift. There seems to have been but little modification of the material since the final uplift, except the removal of the finer particles along the slopes.

There are some local variations in the type. In a marginal strip west of Ashland the soil is shallow and contains enough fine material to impart a loamy character closely resembling that of the contiguous Cecil sand. This phase of the type is better adapted to grain and grass than is the typical light soil. As a result of erosion the soil of the steeper valley sides is more open textured and coarser grained and is often gravelly. Here the excellent drainage and the better circulation of soil atmosphere have brought about oxidation and dehydration of the underlying material, resulting in a red-colored and friable subsoil. This phase of the type, particularly those slopes receiving the most sunshine, seems to be especially well adapted to early vegetables, apples, peaches, and small fruits. Between Polegreen and Old Cold Harbor occurs a very light phase, occupying a position somewhat higher than the surrounding country. Here the soil to a depth of from 8 to 15 inches closely resembles the Norfolk sand. Below this is a pale yellow to reddish, slightly compact material con-

taining more fine sand, which is underlain by a reddish-brown sticky sand or very light sandy loam, which may be 40 feet or more deep. The subsoil is so open that wells frequently run dry during droughts. The soil, however, maintains moisture remarkably well, considering its texture, and is the best early truck soil of the county. It is well adapted to cabbage, mustard, turnips, watermelons, cantaloupes, tomatoes, sweet corn, squash, sweet potatoes, lettuce, etc. The melons and sweet potatoes have a wide reputation for their fine quality and are shipped in large quantities. The potatoes are especially prized for their peculiar, dry, mealy characteristics and sweet taste. This phase of the Norfolk sandy loam is not sufficiently retentive of moisture for general farming, although sorghum, cowpeas, and oats and timothy give fair yields of hay. The native crab grass flourishes on this phase.

The Norfolk sandy loam has been cultivated for many years with but little attention to crop rotation. Large quantities of commercial fertilizers are used, particularly on the light trucking phase. They are applied in conjunction with stable manure at the rate of from 400 to 800 pounds per acre for cabbage, and about 400 pounds for sweet potatoes, melons, and a few other truck crops.^a That the soil is naturally deficient in organic matter is generally recognized, yet there has been little effort made to improve it in this respect. Cowpeas and crimson clover plowed under green would prove very beneficial to this soil, increasing both its productiveness and its moisture-retaining capacity. As a rule the soil should be plowed deep and the depth of furrow varied from year to year so as to avoid the formation of a plow sole.

Corn, the leading crop, yields on an average 10 to 15 bushels per acre, although yields of 30 or more bushels are secured under good cultural methods. Wheat, oats, and mixed grasses give from poor to fair yields. Cowpeas, crimson clover, and sorghum with cowpeas can be grown with profit.

^a A study of the manurial requirements of a sample of this type of soil was made in the Bureau laboratories. The field from which the sample was taken has been under cultivation for a century or more with but little fertilization, and yet the yields are at present fair. The results of the tests indicate that the soil shows greatest improvement where applications of barnyard manure or a complete mineral fertilizer was used. Nitrate of soda alone gave results indicating some improvement in the soil conditions, but the other ingredients, sulphate of potash and acid phosphate, produced little or no effect, either when used singly or together. The tests with lime showed a small beneficial effect when it was used alone, but when added with the complete fertilizer lime seemed to have little or no effect. These results, which were secured with wheat plants as an indicator, are held to be strictly applicable only to that and allied crops, and then only on areas of the Wickham sandy loam in a condition similar to that of the field from which the sample was taken. They may, however, prove suggestive to farmers desiring to make field experiments along this line.

The following table gives the average results of mechanical analyses of fine-earth samples of the Norfolk sandy loam:

Mechanical analyses of Norfolk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14167, 14169.....	Soil.....	1.0	14.7	14.1	35.5	13.0	14.1	6.6
14168, 14170.....	Subsoil.....	.7	8.3	10.9	34.0	12.7	14.7	18.5

NORFOLK FINE SANDY LOAM.

The soil of the Norfolk fine sandy loam to a depth of about 6 inches consists of a gray fine sandy loam, passing into a yellowish compact but friable material of approximately the same texture, extending to a depth of about 18 inches. The subsoil is a yellow or bright yellow friable or slightly clammy fine sandy clay, sometimes underlain at from 20 to 30 inches by a coarse sandy material, frequently quite gravelly. It is very retentive of moisture. The soil in Hanover County is somewhat heavier than the type as found in other areas, containing more fine and very fine sand.

The Norfolk fine sandy loam occurs in irregular-shaped areas of varying extent throughout the Coastal Plain section of the county. The largest single area extends from Ashland southeast to a little beyond Newmans and Studley. This soil body is interrupted by areas of Leonardtown loam and is ramified by arms of Norfolk sandy loam wherever important streams pass out of it. The type mainly occupies level or gently rolling interstream uplands. It is always quite retentive of moisture. In the more nearly level areas farthest removed from streams the soil is shallow and of a heavier texture and is underlain by a bright yellow or mottled, poorly drained subsoil. In the vicinity of Studley and Ruel are extensive areas of a very flat, compact, pale yellow soil, which blends at a depth of about 10 inches with the subsoil without any distinct line of demarcation. Here the prevention of aeration, through inadequate drainage, has contributed to the unyielding nature of the subsoil and indirectly to the unproductiveness of the soil. The bad results of this poor drainage are in striking contrast to the productiveness of the soil in the more rolling, well-drained areas near streams or contiguous to areas of the Norfolk sandy loam. Occasional small areas of this phase, having a quite impervious nature, have washed and gullied, giving rise to unmanageable, unproductive spots having the characteristics of "galls."

The Norfolk fine sandy loam owes its origin to marine deposition of materials washed down from the Piedmont. There has been probably very little modification in the type since its uplift above the ocean.

This soil type, while only moderately productive in its natural state, is so susceptible of improvement where well drained as to

warrant its recognition as the best general farming soil of the Coastal Plain uplands. In the neighborhood of Hanover the recent inauguration by several farmers of a system of more thorough soil preparation, in connection with rotation of grains with legumes and grasses and the turning under of leguminous crops, has demonstrated the worth of this soil type. Here yields of more than 40 bushels of corn, 25 bushels of wheat, 50 bushels of oats, and 1 ton of hay per acre are obtained. There is reason to believe that the type as a whole, with good artificial drainage where needed, can be made to produce similar yields. As has been demonstrated here, plowing for corn should be from 9 to 14 inches deep, and for wheat at least 8 inches, with subsequent thorough pulverization by repeated harrowing, disking, and rolling if necessary. While rolling is of value in securing good soil condition, it should not generally follow the drilling of grain or grass, since it destroys the ridges which tend to lessen the evil effects of heaving, which is a source of considerable damage to these crops, particularly on the heavier phases of the type. Commercial fertilizers are generally used by the best farmers. These are applied at the rate of about 200 to 400 pounds per acre.

While the Norfolk fine sandy loam is not so well drained and therefore not so warm or early a soil as the lighter Norfolk sandy loam, the larger yields of both trucking and general farming crops on the better drained areas, coupled with the more lasting effects of manures, more than offset the advantages of the latter type. The deep, very fine sandy loam in the vicinity of Atlee is especially well adapted to medium and late truck. Cabbage, tomatoes, melons, sweet potatoes, cucumbers, and squash constitute the principal crops. Good yields of wheat, corn, and hay are secured, and these should be grown as a regular part of the crop rotation.

The poor yields produced on the farms in the flat, poorly drained areas can not be increased until a good system of artificial drainage is established. Open ditches 6 to 10 feet deep were seen to have a beneficial effect upon a considerable width of contiguous soil. The distance between the ditches must be determined by field tests. Tiling would greatly benefit these areas, but its cost, in view of the abundance of cheap, well-drained land, practically forbids its use.

The following table gives the average results of mechanical analyses of samples of the Norfolk fine sandy loam:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14173, 14175.....	Soil.....	0.4	3.6	5.5	28.4	26.2	27.9	7.8
14174, 14176.....	Subsoil.....	.4	3.0	4.5	24.0	20.2	24.8	23.0

WICKHAM CLAY LOAM.

The soil of the Wickham clay loam to a depth of about 6 inches consists of a pale yellow clay loam or gray very fine sandy loam, passing into a yellow clay loam which extends to a depth of 12 inches. The subsoil varies from a slightly friable to a stiff yellow, olive, or mottled silty clay containing considerable fine sand and numerous very minute flakes of mica in its lower depths. If undisturbed for a few months the soil assumes a compact structure which, however, readily changes to a good tilth when cultivated under favorable moisture conditions. The structure and color of the subsoil vary with the drainage conditions. Near Wickham, where the drainage is fairly good, the subsoil is yellow and uniformly compact, though fairly friable, while in the areas north of Oldchurch, where the drainage is not so good, the subsoil is distinctly mottled, compact, and somewhat brittle. The soil of those areas northeast of Oldchurch is deeper and contains more fine sand, while the subsoil has a dull olive color. There are a few irregular strips of a dark heavy clay, representing former swampy conditions, occurring in local depressions. Numerous small areas have such a shallow soil that the yellow subsoil is turned up when the fields are plowed, thus giving them a spotted appearance.

The Wickham clay loam occurs in small areas along the Pamunkey River, where it occupies level or gently undulating first and second terraces. The type owes its origin to the deposition of erosion material in comparatively quiet water during late Pleistocene time. While it is obvious that the type is composed in part of materials of the Norfolk soils intermingled with those washed down from the Piedmont, the clay content probably has been derived largely from outcrops of the Chesapeake formation. The drainage is exceptionally good for so heavy a soil, but open ditches are beneficial and even necessary in some of the flat or slightly depressed areas.

The soil is plowed generally to a depth of from 8 to 10 inches. If the depth is varied from year to year the formation of a hardpan that sometimes results from the smoothing of the plow and the trampling of the horses is avoided. After grazing, very hard clods are turned up when the land is plowed.

The Wickham clay loam is a very productive soil. It yields in good seasons from 40 to 60 bushels of corn, from 15 to 30 bushels of wheat, 50 or more bushels of oats, and from 1 to 2 tons of hay per acre. Very little grass is grown, however, except for pasturage. Many farmers follow wheat or oats with corn for one or more years and then sow the land in grass for grazing. Commercial fertilizers are coming into general use on this type. With more careful management this soil can be made to produce larger yields. To increase its productiveness more seasonable cultivation, the plowing under of leguminous crops, and avoiding grazing in wet weather are recommended.

The following table gives the average results of mechanical analyses of samples of the Wickham clay loam:

Mechanical analyses of Wickham clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14191, 14193.....	Soil.....	0.8	3.4	4.5	27.3	24.7	22.2	16.4
14192, 14194.....	Subsoil.....	.3	1.4	2.6	15.9	21.8	24.3	33.7

WICKHAM SANDY LOAM.^a

The soil of the Wickham sandy loam, to a depth of from 10 to 26 inches, consists of a brown or reddish-brown loamy sand to friable mellow sandy loam. The surface appearance of much of the type is that of a sand, but closer examination reveals a very intimate mixture of about equal parts of clay, silt, and the various grades of sand, imparting to the soil decided loamy characteristics despite a high total sand content. The subsoil is a reddish or reddish-brown sandy loam, or sometimes sandy clay, containing minute scales of mica. At a depth of from 30 to 50 inches the subsoil passes into a stratum of very coarse sand and medium gravel or into a quite porous coarse sandy to medium gravelly loam. Like the other light soils of the terrace formation, the Wickham sandy loam maintains an inherent loaminess, even under continuous cropping, without the addition of manure. About one-half the area mapped may be described as a slightly heavier phase, and this is considered a rather better soil for general farming.

It occurs in many small areas occupying terraces generally adjacent to the North Anna and Pamunkey rivers or the overflow land. The surface is level or nearly so, a fact accounted for in part by the sudden drop from one terrace to another. The soil is open, well-drained, and easily tilled under a wide range of moisture conditions. While crops are apt to suffer to some extent during protracted droughts, damage from this source is never serious.

The type represents materials of the original Coastal Plain, for the most part the Norfolk sandy loam reworked and intermingled with small quantities of wash from the Piedmont and deposited in recent Pleistocene time. The prevailing red color is the result of the inti-

^a Wire-basket tests on a sample of this type of soil taken from a "wornout" field showed that it responded best where applications of barnyard manure or of a complete mineral fertilizer with lime was used; that nitrate of soda, alone or in combination with another salt, gave a fair increase in productiveness; and that sulphate of potash alone produced some improvement in the soil conditions. On the other hand, lime alone and acid phosphate, alone or in combination, seemed to be without effect. These results were secured with wheat as an indicator and are held to be strictly applicable only to this and related crops, and only on areas on this soil that are in a condition similar to the field from which the tested sample was secured.

mate mixing with red Cecil soils and thorough oxidation of the iron components.

The Wickham sandy loam is a very desirable soil for general farm crops. Because of its good circulation of soil atmosphere and its excellent drainage it is adapted to the production of early truck, but its suitability for this purpose is somewhat impaired because of the chilling effects of the colder atmosphere that settles in the river valleys during the night. The principal crops grown are corn, wheat, oats, grass, and sweet potatoes. Upon the more loamy or heavy phase of the type the yields of corn range from 30 to 60 bushels, wheat from 15 to 25 bushels, and oats 30 to 50 bushels per acre. Grass and forage crops are grown for grazing and for fattening cattle. A mixture of sorghum and cowpeas makes yields of from 1 to 3 tons or more per acre of very good hay. General farming should give way, at least in part, to a more specialized system, including the cultivation of potatoes and certain medium and late truck crops, as cabbage, beans, tomatoes, etc.

Walnut and locust form a part of the characteristic timber growth of this terrace soil. In its higher situations the type is well adapted to the production of apples.

The following table gives the average results of mechanical analyses of this type of soil:

Mechanical analyses of Wickham sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
13697, 14181, 14183, 14185.....	Soil.....	<i>Per cent.</i> 2.2	<i>Per cent.</i> 16.1	<i>Per cent.</i> 15.5	<i>Per cent.</i> 23.5	<i>Per cent.</i> 13.6	<i>Per cent.</i> 16.8	<i>Per cent.</i> 12.0
13698, 14182, 14184, 14186.....	Subsoil.....	1.5	13.0	14.3	21.2	10.9	15.7	23.2

WICKHAM SAND.

The soil of the Wickham sand is a dark-brown to yellowish-brown coarse sand, from 16 to 26 inches deep, generally coarser in texture and lighter in color below 14 inches. The subsoil, a reddish-brown or yellowish, loose, incoherent sandy loam, becomes lighter in color with depth and is underlain at from 28 to 40 inches by a decidedly coarse gravelly material similar to that underlying the Wickham sandy loam. While the type carries a high percentage of coarse sand and medium and fine gravel, the soil, owing to peculiar structural arrangement of the component particles, tends to preserve its original loamy characteristics. The surface 5 or 6 inches, when undisturbed by cultivation, assumes a compactness which apparently is due both to the settling and packing effects of rains and to a tendency of the finer particles to adhere or cling to the coarser ones. Some areas were observed where there was more fine material in the surface soil than was contained in the soil a few inches beneath. However, with continued

cultivation a large proportion of the finer particles have been washed out of the soil of a considerable percentage of the type, leaving a very unproductive coarse sand. Along the lower course of the Pamunkey River the type is underlain at from about 15 to 20 feet by greensand marl.

The Wickham sand is found along the lower course of the North Anna River and along the Pamunkey River in small, widely separated areas, where it occupies first terraces which are level or have an almost imperceptible slope toward the river. It has no definite occurrence with relation to other types, but it occurs in areas more or less semi-circular in shape and generally occupies the concaves of bends abutting the river or overflow land. The drainage is good, and the coarser phase is inclined to be droughty. The water table lies at about 5 feet below the surface. Wells with a depth of 10 feet give a plentiful supply of water, even in dry seasons.

The soil was laid down in Pleistocene time by rapidly moving water, and represents reworked Coastal Plain and Piedmont materials.

Nearly all of the Wickham sand is cleared and has been under cultivation at one time or another for probably more than seventy-five years. Considerably more than one-half the type is very desirable for farming purposes, particularly for the production of cowpeas, forage crops, and hay, in connection with stock raising or the fattening of cattle. The better areas are capable of producing from 30 to 40 bushels of corn, 10 bushels of wheat, 10 bushels of peas, and from 1 to 1½ tons of hay per acre. The hay consists of pea vines or grass mixtures, generally including crimson clover, timothy, orchard grass, and tall meadow oat grass. Cowpeas furnish excellent grazing. For the growing of corn and wheat commercial fertilizers are sometimes used at the rate of about 300 pounds per acre. Crimson clover sown with rye is sometimes plowed under after spring grazing.

Cowpeas constitute the chief crop grown on the less productive phase. A yield of 5 to 8 bushels per acre is considered good. The little expense attached to the cultivation of peas, coupled with recent good prices, makes this a fairly profitable crop. They are sown broadcast or on ridges. Large yields of hay are occasionally produced on land that makes less than 10 bushels of corn per acre. Mixtures of orchard grass, timothy, tall meadow oat grass, and crimson clover afford good grazing. Wire grass flourishes on this soil. This last phase is considered poor land, and applications of manure have but temporary effect on it.

The following table gives the average results of mechanical analyses of samples of the fine earth of the Wickham sand:

Mechanical analyses of Wickham sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14157, 14159, 14163, 14165.....	Soil.....	7.1	30.8	12.4	16.7	13.0	10.6	9.2
14158, 14160, 14164, 14166.....	Subsoil.....	6.3	27.8	13.4	18.9	13.0	10.2	10.2

NORFOLK GRAVELLY LOAM.

The soil of the Norfolk gravelly loam as typically developed consists of a dark-gray medium gravelly loam, grading at about 8 inches into a yellowish material containing more sand and less gravel. This is underlain, generally at a depth of 20 inches, by a yellowish coarse sandy loam containing comparatively little gravel, or by a reddish coarse sandy clay carrying considerable coarse and medium gravel. The gravel represents rounded quartz pebbles rarely exceeding three-fourths of an inch in diameter, while the sand, for the most part of medium grade in the surface soil, becomes coarser with depth.

The type is confined mainly to stream slopes near the Piedmont-Coastal Plain boundary and consists largely of materials remaining after severe erosion of sloping areas of the Norfolk sandy loam. The soil depth varies with position and angle of the slope. Along the base of the slopes it may consist of a heterogeneous mass of gravel and sand, while near the summit it may consist almost entirely of gravel.

Most of the type has been cleared and under cultivation at one time or another. Its occurrence in small sloping areas, together with its extreme droughtiness and unproductiveness, renders it practically a nonagricultural type of soil. Several areas in the neighborhood of Doswell and one near Farrington which occupy gentle slopes produce small yields of corn. Here the soil to a depth of 24 inches is a uniform gravelly loam with considerable fine interstitial material.

The following table gives the average results of mechanical analyses of the fine earth of this type of soil:

Mechanical analyses of Norfolk gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14187, 14189.....	Soil.....	6.9	19.4	18.8	21.1	6.8	19.0	7.7
14188, 14190.....	Subsoil.....	8.7	27.5	13.4	17.4	4.6	8.0	20.2

LEONARDTOWN LOAM.

The soil of the Leonardtown loam to a depth of from 3 to 8 inches consists of a grayish to dark-colored, rather heavy, very fine sandy loam. The average depth is about 4 inches. The subsoil is a deep yellow to mottled brown and bluish fine sandy clay, passing at about 2 feet into a clammy mottled clay. The soil of the poorly drained flat areas is frequently black or dark colored and is very similar in texture to a clay loam, while the subsoil is very clammy and is mottled with yellow and steel-blue colors. Below 30 inches the subsoil not infrequently has a puttylike consistency, even in very dry spells. Notwithstanding the variation in color and structure, the textural differences are not pronounced. In the neighborhood of the North Anna-Pamunkey River escarpment the soil consists of a grayish very fine sandy loam 5 to 9 inches deep, underlain by a heavy, massive, mottled yellow and brown clay extending to a depth of 20 feet or more. Where this heavy clay is exposed in the deep gorges indenting the type along the rim of the escarpment it cracks in a manner resembling jointed clay.

The Leonardtown loam is confined almost entirely to a narrow belt lying between the Piedmont-Coastal Plain boundary and a north and south line drawn about 6 miles east of Ashland. While the areas are irregular shaped and widely separated, they conform rather closely to a definite topographic position, namely, the interstream plateaus corresponding to the poorly drained areas described under the Norfolk fine sandy loam. The largest area is in the vicinity of Ashland. Small patches of the Norfolk fine sandy loam, too limited in extent to be shown upon the map, have been included with this type.

The surface of the Leonardtown loam is gently undulating, flat, or slightly depressed. Continued wet weather brings about a marshy condition in the poorly drained locations, and the higher lying areas, though apparently firm, become very miry. The subsoil remains cold and wet until late spring, even after crops on other soils are suffering for lack of moisture, and because of the shallowness of the soil plowing is delayed until late in the season. However, when the soil once gets into a cultivable condition very little trouble is experienced during the growing season, provided the rainfall is not above normal. In those areas north of Ashland where the heavy subsoil comes near enough the surface to be turned up with ordinary plowing very intractable clods are formed.

The type owes its origin to depositions in comparatively deep water. Since its uplift above the sea very little modification has taken place. It is very deficient in both surface and underdrainage; hence weathering has been restricted to a very few inches of the surface soil. There is practically no erosion, except in areas bordering the bluffs.

About three-fourths of the type supports a thick growth of stunted pine, hickory, and oak. This soil is recognized as being naturally the most unproductive, as well as the most difficult to improve, of all the upland soils. The effects of manures are not lasting. Poor drainage and the cold, stubborn nature of the subsoil tends to retard the development of root systems and check the growth of the plants. Yields of from 5 to 15 bushels of corn per acre are made occasionally, and on the better drained areas fair yields of oats, wheat, and moderate stands of orchard grass, herd's-grass, and crimson clover are sometimes secured. Drainage by deep open ditches, placed at intervals best determined by field tests, would put this soil in a condition to produce at least moderate yields of a great variety of crops. On the dark phases drained by open ditches good crops of wheat and grass were seen growing. Much of the type should not be cultivated until better drainage is secured.

The following table gives the average results of mechanical analyses of this type:

Mechanical analyses of Leonardtown loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14197, 14199.....	Soil.....	1.4	6.8	5.2	21.3	19.4	27.2	18.6
14198, 14200.....	Subsoil.....	.9	6.2	4.9	17.9	17.9	22.7	28.9

SWAMP.

In Hanover County Swamp comprises the low-lying areas along the lower North Anna and Pamunkey rivers, which are subject to annual inundations, and nearly all the overflow land of the Chickahominy bottoms included in the Coastal Plain.

The Swamp areas of the North Anna and Pamunkey are repeatedly covered in the spring and summer by deep floods carrying in suspension material brought down from the Piedmont. The soil consists largely of a deep chocolate-colored silty clay, which is generally wet the year around. The surface is inclined to be ridgy or hummocky. The small intervening depressions are merely ponds of water during wet seasons, which dry up during the summer and support a luxuriant growth of water-loving plants, the remains of which form thick deposits resembling muck. These Swamp lands support a thick growth of heavy timber, consisting principally of gum, tulip or poplar, pine, and beech. Not infrequently the ridges support a growth of holly.

The Swamp areas of the Chickahominy River represent an almost continuous strip, varying in width from a few rods to one-half mile. On account of the small extent and sandy character of the drainage

basin the overflow water is never as muddy as that of the North Anna and Pamunkey rivers. The soil varies from sandy loam to clay loam. It is generally wet and is entirely covered by a dense growth of small size gum, tulip, birch, and beech.

None of the Swamp is under cultivation. Because of its low-lying position and the annual overflows crops would be very uncertain.

MEADOW.

The Meadow of the Piedmont region consists usually of 2 or more feet of dark-colored soil varying from sandy loam to silt loam. It occurs in narrow strips of level bottom lands or terraces along nearly all the streams. The texture of the soil along the lesser streams depends upon the character of the soils of the respective drainage basins. Much of the Meadow in the upper courses of these small streams simply represents soil, frequently of residual origin, which, through seepage, is kept too wet for cultivation. The Meadow contiguous to large streams is usually a clay or silt loam composed largely of materials transported a considerable distance and laid down in time of overflow. The most extensive areas occur in the concaves of bends, the convex sides of which are generally more or less precipitous.

Probably 50 per cent of the Meadow areas west of Ashland have been drained and put under cultivation. The type is especially adapted to corn, producing about 50 bushels per acre year after year without the use of fertilizers. Oats or grass, particularly wild or native species, do well. The uncultivated part of the type is covered by a dense growth of water-loving plants and trees.

The Meadow of the Coastal Plain consists of narrow bands of sandy material generally too wet for agricultural purposes. It is not being built up nearly so rapidly as in the Piedmont for the reason that the surface flow-off is much less rapid and the soil constituents are too coarse for ready transportation. The open soil absorbs a considerable proportion of rainfall and liberates it gradually. On the deep-stream valleys the water of the numerous perennial springs in the base of the exposed gravelly substratum underlying the soil keeps the bottom land nearly saturated the year round.

In the neighborhood of the Piedmont Coastal Plain boundary the Meadow land becomes quite narrow, until it disappears along the streams flowing through gorgelike channels.

Meadow is a very uncertain type for crops on account of the danger of overflow. However, crops planted after the usual spring inundations are not often destroyed. By straightening channels and removing obstructions a large part of this productive bottom land could be brought under cultivation.

AGRICULTURAL METHODS.

Hanover County comprises practically three agricultural provinces, having essentially different agricultural methods to fit the differences in soil texture, crop adaptation, and physiographic features. The Piedmont division is characterized by general farming and tobacco growing, the Coastal Plain highlands by general farming and trucking, and the North Anna-Pamunkey River escarpment by general farming and the fattening of stock.

In the Piedmont a general adherence to some form of crop rotation, as well as the improving of methods and the systematizing of farm operations, has done much to maintain the productiveness of the soil. In the general scheme of crop rotation wheat is followed by a crop of cowpeas or a grass-clover sod for two or three years, then either by a crop of tobacco or corn, or by corn succeeding tobacco. Farmers generally are averse to cultivation of corn before tobacco, but with fall plowing and heavy manuring instances have shown the practice to be commendable, since the clean cultivation is very destructive to insect pests. Cowpeas and crimson clover should have a place in the rotation whenever possible. The former are often sown broadcast between corn rows at the last plowing, while crimson clover is frequently sown with rye in the fall, grazed in the spring, and turned under preceding a crop of corn. The latter practice finds favor throughout the area. While diversity of opinion has led to minor alterations in the above plan, its adaptability to prevailing conditions can not be well questioned. Considerable injury, however, arises from too close grazing of grass lands, not only here but throughout the county. It is claimed that the best results from cowpeas are to be had either by plowing them under after maturity or allowing them to remain through the winter as a cover crop, serving as a mulch. This last practice as a means of maintaining a good water supply and soil structure has displaced to a marked extent fall plowing. The prejudice against turning under green manures undoubtedly would be overcome on the Cecil and some of the heavier Norfolk soils if the practice were supplemented by judicious applications of lime and by growing winter crops of grain. Barnyard manure is generally carefully saved, but so little is produced that it is necessary to supply other kinds of manure or fertilizers. Considerable commercial fertilizers are used for general farming purposes, usually in the form of acid phosphate or special brands analyzing approximately 8 per cent phosphoric acid and from 1 to 2 per cent each of potash and nitrogen. Applications are made at the rate of about 150 pounds and from 300 to 500 pounds per acre sown in the rows for corn and tobacco, respectively, and 300 pounds per acre sown broadcast or in drills for grain. The grades of fertilizers are better and the applications per acre

much heavier in the trucking districts. It is generally conceded that mineral fertilizers are far more beneficial when used in conjunction with organic manures. The cheaper practice of home mixing of concentrated fertilizer ingredients is earnestly recommended.

Corn and tobacco are cultivated on ridges pretty much on the same plan. When the plants are large enough, shallow furrows are run close up on both sides of the bed with a turning plow or small shovel, which throws a part of the bed toward the middle of the row, leaving the plants on sharp ridges. For later cultivations larger, deep-set plows are used to run several furrows between the rows, until finally the entire middle is thrown out and the plants are left on high ridges separated by deep, gutterlike furrows. Grass and weeds are removed from between the stalks by repeated hoeings, during which soil is frequently heaped around the stalks so as to form a small hill. The ridges bring the root system nearer the baking effects of the sun and at the same time increase the surface area exposed to evaporation, while the deep inter-ridge cultivation not only breaks up the surface root system, but also leaves a furrow that serves the purposes of a ditch in collecting and carrying off a large proportion of the rainfall. This disadvantageous system should be replaced by a more nearly level cultivation, with the use at frequent intervals of harrows, shallow-toothed cultivators, and lighter plows, following deep initial preparation of the soil.

Tobacco is cut and placed directly in well-ventilated barns for air curing or is scaffolded in the sun for several days if the weather permits, and is then placed in the barn.

Truck farmers buy large quantities of stable manure at Richmond, hauling it not infrequently 20 or more miles. Heavy applications of this manure are made on the light truck soils.

While the Coastal Plain upland soils generally should be plowed deeper, their primary need is increased organic matter content. Green manuring seems much more appreciated here than in the Piedmont, yet far too few crops are turned under. The poorly drained areas of the Norfolk fine sandy loam and the Leonardtown loam are not well managed, but there is no particular need of improved methods in the cultivation of these soils until better drainage systems are installed.

The large quantities of truck of inferior quality produced on the numerous rudely cultivated patches tend to weaken prices in the local market, thereby discouraging the efforts of the better truck farmers in the southwestern part of the area. In the trucking section between Atlee and Old Cold Harbor, where the cultural methods are well adapted to the local conditions, improvements are needed in the plan of marketing. Trucking is carried on more nearly on the market-gardening plan. Most of the truckers grow 1 or more acres of very early cabbage. The cabbage plants are set out in the fall, often

as late as Christmas, and are wintered over so as to have an early start in the spring. The only protection offered them is the ridges between which the plants are set, yet they are rarely damaged by cold weather.

Tomato plants grown under glass, when transplanted without detaching the soil enveloping their roots, make a rapid growth on the light phases of the Norfolk sandy loam and Norfolk fine sandy loam. By topping and suckering, a heavy fruitage of large tomatoes of excellent quality is secured. Sweet potatoes are often "hilled up" in the field, being piled up and covered with straw and soil, one or more small openings being provided for ventilation. It frequently happens that the potatoes rot in large quantities if not well dried before hilling.

Owing to favorable texture and structure of the soils, the level surface and good natural drainage without danger of washing, thorough methods are practiced in preparing the bottom lands along the North Anna and Pamunkey rivers. Here the preparation of the land includes plowing to a depth of from 8 to 14 inches and frequent harrowing and rolling. Grain and grass are nearly always drilled in, and in some instances rolled to prevent heaving. Spring rolling to firm the grain land puffed by the action of frost would prove beneficial not only on these lowland soils, but probably on all soils of the area.

Corn is either cut in the stalk and shocked or else allowed to remain on the stalk until late in the fall, when it is pulled off and hauled to the barn. Large quantities of fodder are ruined by the weather when planting is done so late that the grain can not mature until after frost, because of the scarcity of labor and the consequent impossibility of "pulling the fodder." The remedy seems to be in early planting, so that the corn can ripen enough to be cut before the fodder is ruined by frost and rain. Corn is generally followed by wheat and occasionally by grass. It is the plan of the best farmers to turn under cowpeas and crimson clover before planting wheat and corn. Recently the raising of hogs for market and fattening cattle driven from Richmond has become an industry of some importance. Instead of fattening cattle driven in from Richmond, it would seem that raising the stock at home would prove more profitable. In this connection large quantities of cowpeas and mixed grasses are grown for grazing purposes. The land does not seem to be injured seriously by close grazing.

Thrashing, husking, and shredding of corn, and the manufacture of sorghum sirup are done largely by traveling outfits, the owners of which are paid generally by toll.

Because of a recent scarcity of labor, modern agricultural methods and labor-saving machinery are being forced upon the farmers in this region, their adoption being much more rapid than would have been the case with an abundance of cheap labor at hand.

As a rule, the soils are tilled with little difficulty, although in the areas of the Cecil clay and Wickham clay loam many intractable spots are found that can be managed and properly cultivated only under favorable conditions of soil moisture. The chief problems of soil management are those relating to better drainage in certain of the types—as the Norfolk fine sandy loam and the Leonardtown loam—more thorough soil preparation, and the incorporation of more organic matter in the soil. While the larger proportion of grain is drilled in, there still prevails the faulty practice of seeding by hand, whereby poor stands are secured and more damage is done by heaving, especially on heavy soils.

AGRICULTURAL CONDITIONS.

Hanover is strictly an agricultural county. There are no large towns, and aside from sawmills and gristmills there are no manufacturing industries. The area affords an interesting example of conditions resulting from a close adherence to conservative methods over a long period of time. While farming operations have been carried on since early colonial days, on a variety of soils ranging from poor to very productive, and embracing a wide crop adaptation, the farmers, as a rule, have done little more than make a comfortable living. The scarcity of money and disorganization of labor during the period immediately following the civil war necessitated the abandonment of a large acreage of cultivated land, much of which now supports a heavy growth of old field pine. Plantations left to the care of tenants have deteriorated, while those operated by the owners have been kept in good condition in the majority of cases. The dwellings, many of which were built before the war, generally are quite substantial and some are handsome and commodious. Occasionally a silo is seen in the section adjacent to the North Anna-Pamunkey lowlands, where considerable attention is paid to stock raising. Barbed wire fences have been substituted for the old rail fences in many cases.

Notwithstanding the scarcity of labor, there are distinct evidences of progress and increased prosperity on many of the farms. Up-to-date farm machinery and the better methods of soil management have combined to increase the acreage yields, to stimulate diversification, and to make farms more generally self-sustaining. Tobacco growers, finding it impracticable to cultivate a large acreage of that crop, have extended the acreage of other crops. In the neighborhood of Rockville there are many instances where, in addition to the tobacco crop, a surplus of wheat, corn, and hay is produced. Indications are that this may be at an early date the rule rather than the exception throughout the tobacco district. A growing spirit of cooperation is evidenced in a recent organization of the tobacco growers for the purpose of securing better methods for handling and marketing the

tobacco crop. The cultivation of the soils of the North Anna-Pamunkey Valley has generally proved quite profitable, yet some fine farms with excellent dwellings, intrusted to the care of overseers or tenants, have deteriorated greatly in value. The bottom lands are valued at from \$15 to \$40 an acre.

In the trucking district between Atlee and Coldharbor the farmers make a comfortable living, and some have accumulated considerable money. The dwellings and outhouses, though small, are comfortable and sufficient for general needs. Much of this trucking land is valued at more than \$40 an acre.

The least degree of prosperity is shown on the farms situated on the Leonardtown loam and the poorly-drained areas of the Norfolk fine sandy loam. Here the land is cultivated in patches and the dwellings are very small.

The expenditures for commercial fertilizers in Hanover County have more than doubled in the past twenty years. While the acreage yield of wheat has not materially changed during this period, that of tobacco and corn has increased considerably. These increased yields are attributed to the general better plan of farming.

About 60 per cent of the farms are operated by the owners. This percentage is being increased through the purchase of farms by immigrants attracted by the equable climate and cheap land. Under ownership management expenses are light, purchases are paid for in cash, and very little land is encumbered.

Farm tenancy comprises two general systems; under the one the landlord furnishes land, stock, tools, and feed, and receives as his share one-half of the crops; under the other he furnishes the land and pays one-fourth of the fertilizer bill, and receives one-fourth of the crops. The tenant rarely pays any house rent or for fuel. The liberal opportunities thus afforded do not seem to have been appreciated generally, judging from the migratory disposition of tenants.

Farms range in size from about 25 to 500 acres, the average being about 105 acres. Though most of the large antebellum plantations have been divided among heirs, several holdings of 1,000 or more acres have remained intact. Quite a number of small farms are owned by colored people, particularly in the section about 6 miles southeast of Hanover. In the tobacco-growing district the average farmer generally cultivates 5 or 6 acres of tobacco, from 20 to 40 acres of corn, and about the same area in grain, grass, and other crops combined. Truck growers do their own work largely and cultivate from 10 to 30 acres, including general farm crops. The largest cultivated farms are those of the North Anna-Pamunkey bottoms, where, sometimes, 200 acres or more, including grass lands for grazing purposes, are tilled under one management.

As crop adaptation has been pretty well worked out the greatest developments must necessarily follow along the line of more intensive methods of cultivating crops now grown. It frequently happens, however, that a certain acreage of land is put in corn and grain year after year from force of habit, with but little attention paid to the suitability of soils.

Hanover County and the neighboring counties of Caroline, Spottsylvania, Louisa, and Fluvanna produce the bulk of the Virginia sun-cured tobacco. The leaf produced in Hanover County is probably a little darker and coarser textured than the average. It is moderately oily and gummy, and as a popular chewing variety commands good prices. While some of the crop is cured partially in the sun, the greater part is cured from the beginning in well ventilated barns. There is but little difference in the color of the cured product. Most of the crop is sold unprized. The leaf grown on the newly cleared land has a finer texture and some of it makes excellent wrappers. The Cecil soils, including even the heavy Cecil clay, are admirably adapted to tobacco. The better quality is produced on the light soils, but the largest yields per acre are secured on the heavy types. Some very good crops are grown on the Norfolk sandy loam and Norfolk fine sandy loam in the neighborhood of the Coastal Plain-Piedmont boundary, but the bulk of the crop is produced on Cecil sandy loam and Cecil clay. The quality of the cured product depends largely upon the ability of the grower properly to manage the leaf after cutting.

Corn, wheat, and hay are grown on every soil type of the county, and outside of the tobacco and truck districts constitute the staple crops and everywhere enter the best rotations. Though every farm, with the possible exception of those situated on the light Norfolk sandy loam and the Wickham sand, could be made at least self-sustaining in respect to hay and grain for the farm stock, actual production too frequently falls short of this, notably on those upland soils growing other crops as specialties. The especial adaptation of the Cecil clay, Wickham clay loam, and Wickham sandy loam to corn, wheat, oats, and a variety of grass and forage crops is evidenced by the yields generally produced on these types. Almost as good yields can be secured from a large part of the Cecil sandy loam and Norfolk fine sandy loam by careful handling of the soil. The excellent yields of forage crops, particularly cowpeas and crimson clover, and the good winter and spring grazing afforded by rye and crimson clover, would make stock raising or dairying on a small scale profitable on some of the lighter soils not especially adapted to general farming.

The light Norfolk sandy loam and Norfolk fine sandy loam in the southeastern part of the county are well suited to market gardening and general trucking. Owing to limited market facilities, sharp local

competition, and to a large quantity of inferior vegetables produced on poorly drained soils, sales of these crops are often made at unprofitable prices. The Norfolk sandy loam produces good nursery stock. Some of the heavy poorly drained soils could be profitably used for growing grasses, millet, or sorghum. Fruit receives too little attention. The Winesap and other varieties of apples flourish on the Cecil soils, although there has been considerable trouble in late years on account of the apples rotting and falling from the trees. Better success could be obtained by more careful cultivation and by the use of sprays and washes. Peaches and small fruits could be grown more extensively on the well drained sandy soils of the Coastal Plain.

The Chesapeake and Ohio and the Richmond, Fredericksburg and Potomac railroads afford good transportation facilities to the central and most of the western part of the county. Considerable quantities of forest products are shipped by boats that ascend the Pamunkey River to a point several miles northwest of Oldechurch. In the southeastern part of the county shipping is done over the Southern Railway to Westpoint and thence by boat to Baltimore. Richmond is the general market of the area. Some sweet potatoes and melons are shipped to other markets. An extension of the shipping of products to more or less distant markets, which is far short of what it should be in view of the good transportation facilities, affords about the only means for stimulating general trucking, but apparently little effort has been made toward widening the outside markets. The county roads in the Piedmont region become so miry in places during the winter and spring months as to be well-nigh impassable, while those on the light Norfolk sandy loam are very difficult to travel in dry weather. Road-making machines owned by the county are making considerable improvements.

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