Issued June 16, 1914.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief,

IN COOPERATION WITH THE PENNSYLVANIA STATE COLLEGE SCHOOL OF AGRICULTURE AND EXPERIMENT STATION, THOMAS F. HUNT, DEAN AND DIRECTOR.

# SOIL SURVEY OF YORK COUNTY, PENNSYLVANIA.

BY

J. O. VEATCH, LEWIS A. HURST,

AND

GUSTAVUS B. MAYNADIER.

HUGH H. BENNETT, INSPECTOR, SOUTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1912.]


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1914.

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# LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
*Washington, D. C., November 29, 1913.*

SIR: In the extension of soil survey work in the State of Pennsylvania work was undertaken in York County during the field season of 1912. This work was done in cooperation with the Pennsylvania State College School of Agriculture and Experiment Station, and the selection of this area was made after conference with State officials.

I have the honor to transmit herewith the manuscript report and map covering this area, and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1912, as provided by law.

Respectfully,

MILTON WHITNEY,
*Chief of Bureau.*

Hon. D. F. HOUSTON,
*Secretary of Agriculture.*

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MAP.

# SOIL SURVEY OF YORK COUNTY, PENNSYLVANIA.

By J. O. VEATCH, LEWIS A. HURST, and GUSTAVUS B. MAYNADIER.

## DESCRIPTION OF THE AREA.

York County is located in the southeastern part of Pennsylvania. The city of York, situated near the center of the county, is 93 miles west of Philadelphia and 58 miles north of Baltimore. The Susquehanna River forms the entire eastern boundary, separating the county from Lancaster and Dauphin Counties. It is bordered on the north by Cumberland County and on the west by Adams

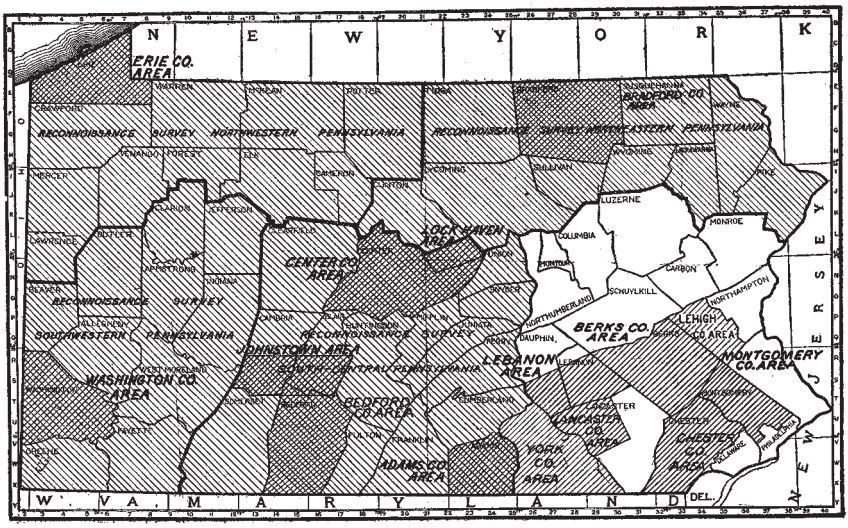


FIG. 1.—Sketch map showing areas surveyed in Pennsylvania.

County. The southern boundary is Mason and Dixon's line, a part of the State line between Pennsylvania and Maryland. Harford, Baltimore, and Carroll are the adjoining Maryland counties. York County has an area of 577,920 acres, or 903 square miles.

Two of the major physiographic provinces of the eastern United States are partly included in the county—the Piedmont Plateau and the Appalachian Mountains. The county lies almost entirely within the Piedmont Plateau province. South Mountain is regarded as the northward extension of the Blue Ridge of Virginia and Maryland and is the physiographic feature separating the Plateau from the

Great Appalachian Valley. South Mountain extends into York County near Dillsburg, from Cumberland County, a distance of only about 2 miles, and there terminates, so that northeastward from Dillsburg, for a distance of about 40 miles, there is no conspicuous feature separating the Piedmont Plateau from the Great Appalachian Valley. The narrow strip of limestone valley land lying along Yellow Breeches Creek, west of New Cumberland, represents the southern limit of the Cumberland Valley, the northward extension of the Shenandoah Valley of Virginia. The trend or direction of the physiographic provinces is northeastward-southwestward, this being also the general trend of the major geologic divisions and the minor topographic features.

To the casual traveler, and likewise to the greater part of the inhabitants of the county, the term "plateau," as the word is usually construed to mean an elevated, level, or plainlike country, with a comparatively abrupt descent on one or more sides, does not seem very appropriate, since in passing across the county, for example from northwest to southeast, the topography appears to be a succession or maze of hills, ridges, and valleys of varying altitudes. The original surface, however, was a comparatively level southeastward sloping plain, formed by general stream erosion. This ancient land surface, known to physiographers as the Schooley peneplain, was elevated by earth movements and became a plateau; later plains were cut within the old land surface and such subsequent modifications by erosion took place that only remnants of the former plain now exists. The country is still a plateau, in that it lies considerably above the Atlantic Coastal Plain to the east, but the levels of the higher ridges and stream divides are the only remnants of the former plainlike surface.

The topography in general may be described as rolling to hilly and mountainous; there are no large areas of level or flat land, and, on the other hand, while some of the elevations reach the dignity of mountains, there is scarcely any of the country too rugged for agricultural occupation. The extremes of elevation above sea level vary from about 100 feet on the Susquehanna River bottom land in the southeastern corner of the county to a maximum of 1,460 feet on the crest of South Mountain in the northwestern corner.

The principal minor topographic divisions and features of the county will be briefly mentioned, since they have had an important bearing on the character of the soils and on the agricultural development of the county.

Perhaps the most easily recognized and sharply defined minor unit of the topography is the narrow valley which occupies the central part of the county, extending in a southwesterly direction from Wrightsville, on the Susquehanna River, into Adams County. The

city of York is located in this valley, and the name York Valley is probably the most appropriate for this topographic division. The valley itself has a gently rolling topography, there being small minor valleys and low, rounded hills and ridges. It has an elevation above sea level of 350 to 400 feet in the eastern part and 500 to 550 feet near Hanover and the Adams County line, and lies from 300 to 500 feet below the higher land to the southeast and northwest. The width varies from 3 to 5 miles. It is underlain by limestones and shales which have been less resistant to weathering agencies and erosion than the adjacent quartzites, schists, and phyllites. In the valley itself the limestone occupies the lower land, while the low, rounded hills and ridges are underlain by shale. From York westward the valley is split by a conspicuous shale ridge, a spur of the Pigeon Hills, so that there is a narrow secondary limestone valley, parallel to the main valley, extending from near Emigsville to Farmers. The soils are fertile, the land easily cultivated, and communication between different points within the valley is comparatively easy. This valley was chosen for settlement by the first German immigrants, and is to-day the most prosperous agricultural and industrial portion of the county.

That part of the county to the southeast of York Valley may be considered as a unit and will be called for convenience of description the Southeastern Plateau. The elevation of the escarpment facing York Valley is 700 to 800 feet above sea level, and increases gradually to over 1,000 feet on a broad inconspicuous drainage divide, extending roughly from Red Lion, through Winterstown and Shrewsbury, entering Maryland near Black Rock, and forming a part of the drainage divide of the Maryland Piedmont Plateau known as Parrs Ridge. The drainage of the north slope is effected by Codorus Creek and its tributaries; to the south the land gradually slopes to an elevation of 500 to 600 feet in the vicinity of Delta, the drainage being southward and eastward into the Susquehanna River and Chesapeake Bay. The southeastern part of the county is rather minutely dissected by streams, so that the only level areas remaining are narrow tops of ridges and stream divides. Most of the valleys are narrow and V-shaped and some are gorgelike. The Susquehanna River has cut a gorge nearly 500 feet deep and the smaller creeks and branches have cut valleys 200 to 400 feet deep. This section is underlain by hard schists and gneisses, and as a result of this and the deep dissection much of the agricultural land is stony, steep, and subject to serious erosion.

On the northwest of the York Valley are the high quartzite ridges and hills known as Hellam Hills and Pigeon Hills. Hellam Hills [1]

[1] The name Hellam Hills does not appear on maps of the county. The ridge country to the northwest of York, however, is locally designated by this geographic name and the name also appears in old historical descriptions of the county.

extend from near the city of York northeastward to the Susquehanna River. This topographic division is a rough, hilly belt of country, from 1 to 5 miles in width, which rises 400 to 500 feet above the eastern end of York Valley. Pigeon Hills, located in the western part of the county, to the northeast of Hanover, have about the same or a slightly higher elevation than the Hellam Hills and an equally rough topography. These hills form the abrupt escarpment or ascent which flanks the York Valley on the northwest. Hellam Hills and Pigeon Hills are similar in their physiographic history. The two are parts of an ancient anticlinal ridge of Cambrian quartzite, which is parallel to the York Valley. The ridge, however, is not continuous, being broken in the central part of the county by a gateway or depression about 8 miles wide.

The next topographic division to the northwest of the Hellam Hills and Pigeon Hills is a broad basin or lowland plain, having a northeast-southwest trend, extending entirely across the county. This belt has a width of 4 to 10 miles. It is bounded on the northwest by the prominent ridge or line of hills known as Conewago Mountains. It includes the towns and villages of Manchester, Mount Wolf, Weiglestown, Dover, Davidsburgh, and Bigmount. This area might be appropriately named the Dover Plain. This plain is underlain by soft red shales and sandstones of Triassic age. The topography is gently undulating or rolling and ideal for general farming. The soil is fairly fertile and the area is thickly settled and occupied by a large number of prosperous farms.

The Conewago Mountains comprise a northeast-southwest belt of hills, having an elevation roughly of 600 to 1,000 feet above sea level, reaching a maximum of 1,040 feet and rising very prominently 150 to 500 feet above the Dover Plain on the south. The hills attain their maximum height in the central part of the county north of Dover, and decrease in elevation above sea level both to the northeast and southwest. This hilly section extends roughly from Goldsboro southwest to the old village of Mulberry, thence becoming less prominent, being represented near the Adams County line by a few low, inconspicuous ridges. The hills are underlain by Triassic sandstone and owe their elevation to the fact that the rocks are much thicker bedded and slightly harder than the Triassic formations to the south. Much of the land is rough and stony and of low agricultural value. The roughness of the topography has been an obstacle preventing the construction of railroads and good wagon roads, and the agricultural development of the area has been retarded on this account.

The area to the northwest of the Conewago Mountains has a more varied topography than any other part of the county. The complexity of the topography is due in a large measure to intrusions of diabase and other igneous rocks in the soft shales and sandstones of

the Triassic which underlie most of the northern part of the county. This is an area of low, parallel ridges and valleys and of irregular-shaped basins and high, rounded hills or knobs. Many of the ridges do not have the normal northeast-southwest trend, but conform to the diabase intrusions, which in several places have cut the bedding planes of the sediments and have produced local structural disturbances. The diabase in general has offered greater resistance to weathering and erosion than the surrounding shales and sandstones and has produced such conspicuous knobs or hills as Roundtop and Nells Hill, which have elevations, respectively, of 1,380 and 1,240 feet above sea level. Heat from the intrusions has metamorphosed adjacent sedimentary formations, converting them into hard rock, which has also produced ridges. The unaltered shales and sandstones have been less resistant to erosion and underlie irregular, basin-like areas surrounded by the higher diabase and metamorphosed sandstone and shale hills and ridges. The largest of these red-land basins are the Lewisberry and Yocumtown basins, named from the towns which are located in them, while other large lowland areas occur in the vicinity of Mount Top and Dillsburg. The elevation of the basins and valley land is generally 400 to 600 feet above sea level, while the surrounding ridges or higher land varies from 700 to 900 feet. The variations in the character of the topography and the rocks have produced corresponding wide differences in the soils. The land of the valleys is generally fairly fertile and easily cultivated, while there is a great deal of hill and ridge land, which is stony, rough, and of low agricultural value. This complex area of hills and valleys is bounded on the northwest and north by South Mountain and Cumberland Valley.

South Mountain is composed of two roughly parallel northeast-southwest ridges and a complementary narrow valley, which is occupied by Dogwood Run. It is underlain principally by hard quartzite and sandstone and rises rather abruptly 600 to 700 feet above the adjacent lowland to the east. On account of the roughness of the topography and stony character of the soil, the land has a comparatively small agricultural value.

The Cumberland Valley is represented in this county by the low, rolling limestone valley land which lies along Yellow Breeches Creek, the northern boundary of the county. This lowland area has an elevation of 300 to 400 feet above sea level. The soil is fertile and the valley is occupied by prosperous farms. The valley is bounded on the south by hills of Triassic conglomerate and sandstone, which rise 100 to 200 feet higher.

The county lies entirely within the drainage basin of the Susquehanna River. There is a network of tributary streams, and the land throughout is generally well drained. Practically all of the streams,

even the small branches and creeks, are perennial and afford abundant water for farm use and power for a large number of gristmills. The valleys are universally narrow, and none of the streams have yet developed broad areas of bottom land. Even along the Susquehanna River the maximum width of the alluvial bottom is not more than a mile and the average width is less than one-fourth mile. The smaller streams conform to the topography and geologic structure, flowing either eastward or westward, but the Susquehanna River and the main branch of Codorus Creek are quite independent in their courses of ridges and rock character, whence it is inferred that they must have assumed their courses before the development of the present topography. Alluvial terraces or benches occur along Susquehanna River, Codorus Creek, and Conewago Creek, although they do not occupy large areas and are not continuous, but exist merely as erosion remnants.

Springs are widely distributed throughout the county, although all are of small size, affording healthful drinking water and being especially valuable where dairying is carried on.

The early settlers of York County were German immigrants, mainly from the Rhenish Palatinate; Scotch-Irish, originally from Province of Ulster, Ireland; and Quakers, from Chester County, Pa., and from Delaware. The Germans settled in the central part of the county, the Scotch-Irish in the southeastern part, and the Quakers, or Friends, in the northwestern part. The first authorized settlement was made in 1729.[1] The first settlers were English, but the English were rapidly succeeded by Germans. In 1760 a small colony of Huguenots and Dutch settled on the Conewago. The present population is predominantly German, many of the people being direct descendants of the original German settlers. People of Scotch-Irish ancestry, however, still occupy to a large extent the southeastern part of the county.

At the time of the first settlements this county formed a part of Lancaster. In 1749, York County was laid off and included what is now Adams County, while the present boundaries were established in 1800.

From about 6,000 in 1749 the population has increased to 136,405 (1910). York has become one of the wealthiest and most prosperous counties in the State, ranking sixth in the value of all farm property and, in addition, being one of the largest manufacturing counties. York is the county seat and the largest city, having a population in 1910 of 44,750. It is one of the important manufacturing cities of Pennsylvania, ranking thirteenth in the value of its products and being especially notable for the diversity of its industries. Hanover,

[1] Histories of York County, by John Gibson and by George Prowell, are the principal sources of historical data for the report.

Mount Wolf, Spring Grove, Red Lion, Dallastown, and Glen Rock are other important manufacturing towns, and afford good local markets for farm produce.

There are five railroads in the county and the greater part of the area is within short distances of shipping points. In addition to the steam railroads, electric lines radiate from York to Hanover, Wrightsville, Red Lion, Windsor, and Dover. These are a great convenience to farmers living along the lines, as express and freight service are furnished in addition to the passenger service.

The public wagon roads on the whole are kept in fair condition. Toll roads or pikes have been built out from York and Hanover and afford excellent highways for wagon and automobile transportation of farm necessaries for the section they penetrate; the State has also constructed a model macadamized road with easy grades, passing through Dillsburg, Mount Top, Wellsville, and Rossville to Yorkhaven, and plans have been made for the further extension of State roads. Notwithstanding the excellent roads mentioned, better roads than now exist in the more remote and rougher parts of the county are necessary. The chief objection to many of the present roads is the high grades, which necessitate four or even six horses for loads which on the pikes and State road can be drawn by two. Such poor roads increase the cost and greatly limit the use of lime and commercial fertilizers.

Every part of the county is reached by rural free delivery mail routes, and the telephone is in common use in the country districts. The county is well supplied with schools, and there are a very large number of country churches notable for the substantial character of the buildings.

York and Harrisburg are excellent local markets for all farm products, while the county is also only a comparatively short distance from Philadelphia, Baltimore, and other eastern cities. The Northern Central (a part of the Pennsylvania system), Western Maryland, and Maryland & Pennsylvania Railroads afford good transportation facilities to large city markets. Baltimore is the chief market for the southern part of the county for milk, potatoes, cabbage, and other products.

## CLIMATE.

York County has a healthful, temperate climate, suffering neither from prolonged hot or sultry weather in the summer nor extreme cold in the winter. The annual average temperature is 52° F. The average growing season, or the period between late frosts in the spring and early frosts in the fall, is 158 days. Crops generally are matured before early frosts, although tobacco may be occasionally damaged.

The average annual rainfall is 41.9 inches, which is well distributed throughout the year, so that ordinarily crops nowhere suffer from

excessive moisture, and it is only on the sandier and more porous, open soils that they are injured by the occasional short periods of summer drought.

The following table of climatological data has been compiled from the records of the Weather Bureau station at York:

*Normal monthly, seasonal, and annual temperature and precipitation at York, Pa.*

| Month. | Temperature. | | | Precipitation. | | |
|---|---|---|---|---|---|---|
| | Mean. | Absolute maximum. | Absolute minimum. | Mean. | Total amount for the driest year. | Total amount for the wettest year. |
| | °F. | °F. | °F. | Inches. | Inches. | Inches. |
| December | 33 | 68 | −1 | 3.1 | 3.3 | 6.2 |
| January | 30 | 66 | −14 | 2.9 | 4.0 | 2.7 |
| February | 29 | 70 | −17 | 3.4 | 1.0 | 6.7 |
| Winter | 31 | | | 9.4 | 8.3 | 15.6 |
| March | 39 | 80 | −5 | 3.8 | 2.5 | 4.8 |
| April | 50 | 94 | 16 | 2.6 | 3.7 | 3.4 |
| May | 62 | 95 | 31 | 4.3 | 2.7 | 1.2 |
| Spring | 50 | | | 10.7 | 8.9 | 9.4 |
| June | 70 | 103 | 38 | 3.3 | 3.1 | 5.2 |
| July | 75 | 107 | 43 | 4.1 | 1.4 | 5.7 |
| August | 73 | 102 | 42 | 4.1 | 2.4 | 4.2 |
| Summer | 73 | | | 11.5 | 6.9 | 15.1 |
| September | 66 | 95 | 20 | 3.8 | 4.0 | 4.1 |
| October | 53 | 88 | 20 | 3.1 | 2.4 | 6.4 |
| November | 43 | 77 | 10 | 3.4 | 1.8 | 2.4 |
| Fall | 54 | | | 10.3 | 8.2 | 12.9 |
| Year | 52 | 107 | −17 | 41.9 | 32.3 | 53.0 |

Average date of first killing frost in autumn, Oct. 1; of last in spring, Apr. 25. Earliest date of killing frost in autumn, Sept. 19; of latest in spring, May 10.

## AGRICULTURE.

York County from its earliest settlement has been primarily an agricultural region. The original German settlers were principally farmers in their native land and came to America with the intention of tilling the soil for a livelihood, bringing, in some instances, their agricultural implements with them. Agriculture is now the most important industry and will doubtless continue to be the chief source of wealth as long, at least, as the present German element remains dominant in the population, notwithstanding the immense growth of manufacturing industries.

A system of general farming is carried on; crops are diversified and rather intensive cultivation is practiced. Dairying, trucking, and

fruit growing, while in the aggregate of considerable importance, are in the main subsidiary to general farming. Stock raising is comparatively unimportant; there was probably proportionally more stock raised in the earlier periods than at present. On the whole the farm practice is excellent; definite systems of crop rotation are practiced, the use of stable manure, lime, and fertilizers is general, the value of leguminous crops is appreciated, and thorough plowing and preparation of the land is the rule.

Corn, wheat, oats, hay, and tobacco are the principal staple crops grown at present. Potatoes, rye, buckwheat, fruit, and truck crops are a considerable source of income, but are less important than the foregoing. The following table, taken from the census of 1910, shows the acreage and average yields of the various crops:

*Production of the principal crops in York County, Pa., for the year 1909.*

| | Acreage. | Yield. | Average per acre. | Average for State. |
|---|---|---|---|---|
| | | *Bushels.* | *Bushels.* | *Bushels.* |
| Corn | 78,597 | 2,402,419 | 30.5 | 30.01 |
| Wheat | *83,920 | 1,818,050 | 21.5 | 17.6 |
| Oats | 26,528 | 799,354 | 30.1 | 24.6 |
| Rye | 12,342 | 191,199 | 15.4 | 12.8 |
| Buckwheat | 741 | 10,802 | 13.2 | 16.4 |
| Potatoes | 10,841 | 732,112 | 66.6 | 83.0 |
| | | *Pounds.* | *Pounds.* | *Pounds.* |
| Tobacco | 6,341 | 6,281,294 | 1,024.00 | 1,106.0 |
| | | *Tons.* | *Tons.* | *Tons.* |
| Hay and forage | 92,463 | 101,047 | 1.09 | 1.19 |

Wheat has been grown since the first settlements were made and still remains, over the greater part of the county, the principal staple money crop, although it has been supplanted to some extent by tobacco and Irish potatoes. Spelt was grown in the early period of settlement and was not replaced by the common varieties of bread wheat until 1820–1830. Fultz, Fulcaster, and Poole are the principal varieties. Wheat is grown on all of the different soil types of the county as a matter of necessity in the present system of farming, irrespective of the adaptation of the soils to this grain. The yields range from 15 to 30 bushels per acre. The Hagerstown loam, Penn loam, Berks loam, Chester loam, and Montalto clay loam types are naturally best adapted to wheat. The use of commercial fertilizers is general; commonly a 2–8–2 fertilizer is applied at the rate of 200 to 400 pounds per acre.

The acreage of corn is at present very near, perhaps slightly less than, that of wheat. Like wheat, it is grown throughout the county on all the soils. Yields range from 25 bushels or even less on certain

of the poorer types of soil to 60 or 70 bushels per acre on the Hagerstown and Chester loams. Commercial fertilizers are commonly used, but in smaller quantities than for wheat. Very little corn is sold from the farms. Yellow Dent is the principal variety grown. It is a common practice to plant pumpkins in the corn fields, these being utilized chiefly for stock feed.

The acreage planted to oats is much less than that of wheat and corn. Oats will do fairly well on almost all the soil types, and yields of 30 to 40 bushels per acre are commonly obtained. Preparation of the land, seed selection, and the fertilizer needs of the crop are given less attention than in the case of other crops. Oat smut is prevalent, yet this could be largely eliminated by a comparatively inexpensive washing of the seed oats in a solution of formalin. Oats are grown principally for feed for the work animals of the farm, very little being sold.

Rye is grown throughout the county on practically all of the soils, but probably the larger part of the acreage is on thin, stony, or sandy lands, which are not so well adapted to wheat and oats. It affords a good winter cover crop, in addition to pasturage, and should be more extensively grown on steep hillsides subject to serious erosion. In the rotation plan it generally follows corn. The grain is utilized principally as a part of the ration for work animals and dairy cattle, although some is sold to near-by distilleries and breweries.

Buckwheat is a catch crop and the total production is very small. It is grown only in the southern part of the county on soils of the Chester and Manor series. The fields generally range from one-half acre to 8 or 10 acres. Yields of 25 to 30 bushels per acre are obtained on the better lands and with proper fertilization, but on the whole the average yield is about 12 to 15 bushels. This grain is grown chiefly for chicken feed and for flour for home use.

The hay grown is almost entirely mixed timothy and clover. These grasses have been the principal source of hay since the early settlement of the county. Clover was introduced about 1800. It is practically the only leguminous crop grown. Some of the soils are not very suitable for it, and it might in such cases be profitably supplanted by some other legume. The Hagerstown loam, Berks loam, and Chester loam are probably the soils naturally best adapted to clover and the crop does fairly well on the Penn loam, but there is scarcely any land that does not need an application of lime in preparation for it. Difficulty is often experienced in obtaining a good stand of clover on such soils as the thin hillside lands of the Berks shale loam and Manor slate loam types and it also frequently freezes out. Timothy does better than clover on the Penn stony sandy loam, the Lehigh stony loam, and the Dekalb stony loam and in many hay fields it is

grown exclusively. Wild carrot is the principal weed pest. Practically all of the hay is fed on the farms.

Small patches of millet are frequently sown after oats, but this forage crop is not by any means common or extensively grown. The millet is utilized principally for feeding dairy cows.

Alfalfa has thus far been grown only in an experimental way and with but little success. The poor results have been due in several instances to the fact that the thinner and poorer lands have been selected in the hope of enriching them and in other instances to failure to prepare the seed bed properly by liming and inoculating the soil. Alfalfa can without much doubt be successfully grown on the Hagerstown, Berks, and Chester loams, and on the Penn and Edgemont loams where the deeper and better soils are selected. It can also be grown on the bottom lands where these have been well drained and otherwise properly prepared.

Irish potatoes are grown on practically every farm for home use, and in some sections of the county potatoes are one of the principal money crops, and hold a definite place in the crop rotation. The Chester loam and, to a less extent, the Chester stony loam and Cecil clay loam in the vicinity of Stewartstown, Fawn Grove, Shrewsbury, and New Freedom, are the soils most utilized in potato growing The fields embrace generally from 2 to 20 acres, and yields during favorable years range from 125 to 200 bushels per acre. The average yield in this section of the State, taking the product of all kinds of soil into consideration, is probably near 100 bushels. The American Giant variety is planted most extensively, but many other varieties are also grown.

Tobacco was first introduced soon after 1800 and was grown along the Susquehanna River. The first tobacco was a hybrid from Kentucky seed and was known as "Shoestring" tobacco, a heavy, gummy, and black leaf of low value. Cuban seed was introduced in 1837, but after several years of cultivation the small-leaf Cuban tobacco developed, as the result of soil and climatic differences, into what is commonly known as "Pennsylvania seed leaf," or "broad leaf." Connecticut seed leaf was introduced about 1853; like other varieties, it lost its original character after a few years of cultivation. Seed has also been imported from Virginia. Practically all of the varieties at present grown are known to the trade simply as Pennsylvania seed leaf. The tobacco is used almost entirely for cigar filler and binder, but has been in the past used to some extent for wrapper. Burley was grown a few years ago, good yields being obtained, but scarcely any at all is grown at present, on account of unfavorable market conditions. The size of the tobacco fields ranges generally from 1 acre to 10 acres, but there are a few farms where as much as 15 to 20 acres are cultivated. The tobacco transplanter is in common use where the fields exceed 2 or 3 acres in extent.

The principal soils on which tobacco is grown are the Hagerstown loam, Conestoga loam, Chester loam and stony loam, Cecil clay loam, Berks shale loam and loam, the Dekalb soils, and the Penn loam. Much the greater acreage is on the first four soils, while comparatively little is planted on the Penn loam and Berks shale loam. Tobacco growing is almost entirely confined to the eastern and southeastern parts of the county, scarcely any being grown west of York or north of Yorkhaven. This restriction of the crop, however, is not due to soil or climatic differences, and without doubt it can be successfully grown on these same and certain other soil types in the western and northern parts of the county. The Hagerstown loam, Chester loam, and Conestoga loam seem to produce the heaviest yields; the leaf produced on the Dekalb soils and the Berks shale loam seems to be lighter in color and thinner, but under present market conditions there is little or no difference in price, provided the tobaccos are equally well cured. In the rotation plan tobacco generally follows corn, but it is also planted to some extent on sod land. The fields are heavily manured in the fall or spring and in addition 500 to 1,000 pounds of commercial fertilizer, generally a 2–8–10 formula, is applied.[1] Yields range from 1,000 to 1,800 pounds per acre, the difference in yields in most cases being determined by the natural fertility and suitability of soils for this crop. On the same soil type, however, the amount of stable manure and commercial fertilizer used is generally the controlling factor in the yields obtained.

With the judicious use of fertilizers, careful cultivation, and with facilities for properly curing the product, tobacco is without much question the most profitable crop grown in the county. The lack of labor deters farmers from growing it on a larger scale.

Fruit growing as a special industry has only recently begun to assume importance in the county. A number of small and a few large commercial apple and peach orchards have been established. These have been fairly successful and a moderate expansion of the fruit-growing industry may be expected. Practically every farm has its small orchard to supply fruit for home use and generally a small surplus for local markets. Apples, peaches, and pears are the most common fruits. Cherries are plentiful in the central part of the county, the trees commonly lining the roadsides. Apple trees are also very frequently planted along the fences, in order that greater space may be devoted to field crops.

The largest orchards are located on the Montalto soils southeast of Dillsburg and near Siddonsburg, in the northern part of the county. Other orchards have been set out on the Dekalb stony loam in the Pigeon Hills and Hellam Hills, and there are a few

[1] In the formulas of grades of commercial fertilizers in this part of the country the first figure refers to the percentage of nitrogen, the second to phosphorus, and the third to potash.

small orchards on the Berks shale loam, Manor slate loam, Chester loam and stony loam, and Cecil clay loam. Well-drained slopes in these areas with good air drainage and fairly deep and fertile soils have a selling price at the present time of $20 to $40 an acre. In considering cheap rough lands for orchard purposes, however, it must be borne in mind that there is a limit to roughness, since the cost of clearing, subsequent cultivation, and spraying may be such that in the end higher priced lands would be cheaper.

The varieties of apples seemingly well adapted to the soil and climatic conditions are: York Imperial, Smokehouse, Fallawater, Stayman Winesap, and Grimes Golden. Many other varieties are planted, among them the Baldwin, Jonathan, Rambo, Ben Davis, Rhode Island Greening, Northern Spy, Hubbardston, Mammoth Black Twig, Gano, and Smith Cider.

Peaches will grow and do fairly well on all the soils of the county excepting poorly drained bottom land, but the crop is generally more uncertain than apples. There are several commercial peach orchards distributed throughout the county, the largest being located on the Montalto soils east of Dillsburg. This fruit seems to do fairly well on the Lehigh stony and gravelly loams. There are also a number of small orchards on the Berks shale loam and Manor slate loam, but, excepting on the steeper hillsides, it is considered doubtful whether they are as profitable as general farming. Peach trees are commonly set as fillers in apple orchards. Elberta, Belle of Georgia, Smock, and Carmen are the varieties principally and most successfully grown.

Pear trees are commonly planted in the small home orchards, but there are only a very few commercial orchards. The Kieffer variety is commonly grown. Cherries can be grown on practically all of the soils.

Many farmers in certain localities now depend largely upon small fruit and truck for their money crops, growing only sufficient grain and hay for the needs of their few farm animals. Raspberries, blackberries, and strawberries are the principal fruits grown. These can be cultivated on very rough stony land and will give a larger return per acre than any other crops for which the land could be utilized. Strawberries thrive on the Lehigh stony and gravelly loams, types of small value for general farming, and it is reported that the plants will bear for a longer period of time than on other soils. The extension of the production of small fruits is retarded at the present time by the fact that much of the land most suitable for the purpose is distant from the principal local markets. Poor wagon roads and lack of railway facilities are further handicaps.

Trucking is not an extensive specialized industry, but is carried on principally as an adjunct to general farming and in connection with

small-fruit growing. There are few soils naturally well adapted to trucking and there is little opportunity for the development of a special trucking industry dependent upon distant city markets. The canning industry should be encouraged, as this will create a market for vegetables and small fruit that can be grown on certain rough or steep and stony lands not suitable for general farming or orcharding on a large scale. Such, for example, are the Dekalb stony soils of the Hellam Hills and Pigeon Hills. There are already a number of small canning factories in the county. These use principally tomatoes and sweet corn. Tomatoes are now grown extensively in patches of 1 to 10 acres on the Chester and Manor soils, chiefly for the supply of the local canneries. Cabbage is also being cultivated in large patches in the southern part of the county on the Chester soils, the product being shipped in carload lots, principally to Baltimore. Where the land is properly fertilized and the crop carefully cultivated yields of about 12 tons per acre are obtained.

Crop rotation is practiced throughout the county on all soils, and without question has been one of the chief means of maintaining the fertility of the land. Crop rotation began in the county about 1837 with the first extensive use of lime. Prior to this time fields were cultivated continuously in one crop until their productiveness greatly decreased; they were then abandoned, were soon covered with a scrubby growth of trees, and were commonly known as "barrens." Generally, a 4-year or 5-year rotation is practiced, with but little variation to suit differences in soil conditions. The grass land is plowed for corn, this grain being only rarely grown for more than one year; corn is followed by oats, or by rye where the latter crop is grown; then wheat, with which timothy is sown in the fall and red clover in the spring, the grasses being cut for hay the year following the wheat harvest. Wheat is frequently grown two years in succession on the stronger soils. Where tobacco and potatoes are special crops these follow corn, the corn plot being divided into fields for oats, tobacco, potatoes, tomatoes, and cabbage where these latter are grown. Wheat then generally follows tobacco and the truck crops, in such cases giving excellent yields, owing partly to the residual effect of the fertilizers applied to the preceding crop. It is the practice of some of the farmers to plow sod or grass land for tobacco.

The use of lime and commercial fertilizers in addition to stable manure is general throughout the county. Lime is applied at the rate of 30 to 75 or even 100 bushels per acre every four or five years, while some lands receive large applications only once in 10 years. The quantity of lime used is usually determined by the character of the soil, but in many cases the cost of freight and haulage is the limiting factor. It has been determined from experience that on

some of the lighter textured and more porous soils more than 30 bushels per acre is likely to injure plants and deaden the soil, while on such types as the Hagerstown loam and Montalto clay loam 50 to 75 bushels can be applied without serious injury. It is, however, probable that in general excessive amounts of lime are used and that much smaller applications would give equally good results. Generally the lime is distributed in small heaps over the fields and after slaking is spread by hand. Pulverized lime and automatic lime spreaders are coming into more common use and are more economical and efficient than the old system. From 700 to 1,000 pounds per acre of pulverized lime is used. Finely ground limestone has not yet been employed to any considerable extent, although it would perhaps have some advantages over lime on certain soils. There are lime kilns at York, Wrightsville, Hellam, Thomasville, and Hanover, and farmers living within hauling distance of the kilns are able to procure lime at a cost of 8 to 10 cents a bushel. Lime kilns are also located at New Holland and Dillsburg. In the southeastern and north-central parts of the county, however, where there are no limestones, lime may cost as much as 13 to 15 cents a bushel delivered on the farms.

The use of commercial fertilizers to supplement stable manure and lime is general. The amount spent for fertilizers, according to the census of 1910, was $561,061. Corn is heavily manured with stable manure and generally only 150 to 200 pounds of fertilizer is used, but as much as 300 to 400 pounds is applied by farmers in the area occupied by the Chester loam. A phosphatic fertilizer, generally 2–8–2 in composition, is applied to wheat land at the rate of 200 to 400 pounds per acre, and smaller quantities, 150 to 200 pounds, are used for oats and rye. Potash fertilizers, generally analyzing 2–8–5 or 2–8–10, are used for tobacco and potatoes at the rate of 500 to 1,000 pounds per acre. The cost of the fertilizer, determined by the condition of the roads and the distance of the farm from railway shipping points, is on many farms the limiting factor in the quantity used rather than the character of the soil or the manurial requirements of the crop. Scarcely any nitrate of soda is sold by fertilizer dealers. Small amounts of bone meal are used for grains. Stable manure is obtained principally as a by-product of dairying, but in the more remote parts, where dairying is not profitable, the practice is to feed the forage and grain to beef cattle during the winter, the resulting manure being the principal object, as only a very small profit is realized from the marketing of the cattle. Poultry and sheep manures are also utilized.

Dairying is an important industry in the county, but is carried on almost entirely as an adjunct of general farming. Dairying can be made to yield a small profit within itself and is the most economical

means of producing the stable manure which is so essential in the present system of farming for the production of large yields of the staple crops. The success of dairying is largely dependent upon good transportation facilities and city markets, and it is not therefore feasible at the present time to carry on this industry over the whole county. The city of York is a good local market for dairy products, while along the lines of the Western Maryland and Northern Central Railroads in the southern part of the county large quantities of milk are daily shipped to Baltimore. In parts of the county more remote from the steam and electric railways small local creameries have been established which buy milk according to the butterfat content, the separated milk usually being carried back by the farmer for hog feed.

There are only a few purebred dairy herds, most of the cows being grade animals, with Holstein and Jersey blood predominating. Very little attention is given to maintaining a good breed of beef cattle; the cattle are kept principally for the manure they produce, little profit being realized from the sale of the animals. Hog raising is not a special industry in any part of the county, each farmer usually keeping a small number merely for his home meat supply, and little attention is therefore given to maintaining purebred stock. There are only a few flocks of sheep, these being principally in the York Valley. The flocks number 10 to 20, their small size being due to the lack of pasture land in the ordinary York County farm.

The total area of the county is 577,920 acres. According to the census of 1910, 92.1 per cent of this is in farms, with 81.5 per cent of the farm land improved. Small tracts of wooded land, most of them, however, poorly suited for agricultural purposes, are being cleared annually and the number of farms shows a slight yearly increase both from new land brought into cultivation and from the division of the larger farms. As a rule the larger farms of improved land are located on the best general farming types, such as the Hagerstown loam, Chester loam, and Penn loam, while the smallest farms are on less arable types, such as the Edgemont stony loam, Dekalb stony loam, Penn stony sandy loam, and Montalto stony loam.

According to the census of 1910, 28.5 per cent of the farmers are tenants. The share system of renting is generally followed, the percentage of cash tenants being very small. The landowner furnishes half of the seed and all or two-thirds of the fertilizer and pays the county and State taxes, while the renter furnishes the stock and labor and pays the road and school taxes; the proceeds of the farm are then divided equally.

Farm laborers are paid $1 to $1.50 a day and board during harvest, and $15 to $18 per month where the laborer is hired for 8 or 9 months of the year. There is a general scarcity of farm labor, this scarcity being most keenly felt during the harvest periods. Neighbors,

however, assist one another in harvesting and thrashing, and among the German farmers the women and children of the family generally assist in the work in the fields.

The selling price of farming lands shows considerable range, and depends upon improvements and location, as well as upon natural productiveness of the soil. The present price of the better farming land is from $40 to $150 an acre. There is much land adapted for orchards and small fruit and truck farms that may be bought for $20 to $40 an acre, while there is a considerable area of very rough and stony land of very little agricultural value which is sold at $5 to $20 an acre.

The crop yields at present are high compared with those obtained throughout the United States in general, and higher than the average in the State of Pennsylvania as a whole, and the agricultural practices are in many ways admirable. Yet the necessity of increased yields and of improvements in present methods are appreciated by the more intelligent farmers. Crop yields and farm income must keep pace with increasing land values, and the increasing cost of farm machinery, work animals, labor, and of the necessities of life other than those produced on the farm. Greater income can be obtained only by increased crop yields and greater economy in farm management. The present agricultural eminence of the county after all should perhaps be ascribed to the indefatigable industry and frugality of the farming population, rather than to conscious application of the principles of scientific agriculture. It is becoming more and more evident, however, that the old order is changing, and the farmer to be successful must have a knowledge of scientific agriculture and must understand the reasons for agricultural practices in order to meet new and varying conditions and compete with other lines of business.

One of the greatest needs at present is a more intelligent study of commercial fertilizers. Admitting the necessity of the use of commercial fertilizers as a supplement to stable manure, the manurial requirements of the different soils and different crops must be carefully investigated if the best results are to be obtained. At present complete fertilizers are often used rather indiscriminately; the same amounts for the same crops are in too many cases applied on entirely different soils, while a fertilizer of the same composition is applied to different crops, regardless of the manurial requirements of different plants. It is quite probable that many of the soils are in need of only one essential element and not in need of complete fertilizers, and the application of these is therefore an economic waste. The particular fertilizer and the quantities to use must to a large extent be determined from field trials by the individual farmer, since general rules can not always be applied, because of the many different kinds of soils and other purely local conditions.

There is a need for growing more leguminous crops in order to supply more nitrogen and organic matter to the soil, constituents that are most lacking in practically all the soils of the county. Under present conditions very few farmers are able to obtain sufficient stable manure for the needs of their land. Clover, practically the only legume at present grown, is not well adapted to some of the soils, while on other soils only a thin stand is obtained, and in addition the grass is in general pastured too close to be of greatest benefit to the land. Such crops as alfalfa, soy beans, and cowpeas might on certain soils be profitably grown and substituted to a certain extent for clover. As a means of obtaining more green manure, clover might be more extensively sown with oats to be turned under for the succeeding wheat crop.

In general too little attention is given to careful seed selection, yet this is one of the simplest means of increasing the yield and improving the quality of crops. Scarcely any attention has been given to the question of special adaptation of varieties of plants to the different soils. A more careful study of this question should be made. The yield or quality of the crops now grown could doubtless be improved by the careful adjustment of crop variety to soil conditions.

Dairying should be extended wherever facilities for the transportation of milk to markets are adequate, as this is the most economical means of producing stable manure. More care should be taken in the preservation of stable and barnyard manure. In many cases the manure is allowed to collect in the barn lots and is not properly protected from rain and the drip from the barn roof; thus a considerable percentage of the valuable constituents is lost by leaching.

With the increase of population and the pressing necessity for new land, many very steep hillsides have been cleared and placed in cultivation, while little or no effort has been made to prevent erosion of the surface soil. The result has been serious deterioration in productiveness and in several instances the abandonment of fields. This is true especially in portions of the Chester stony loam, Manor slate loam, and Berks shale loam areas in the southern part of the county. Steps should be taken to prevent erosion by terracing the land. Much of the steeper hillside land may more profitably be placed in permanent pasture or, where conditions are suitable, in orchards.

## SOILS.

York County possesses an unusually large number of soils of markedly different characters. In the system of classification developed by the Bureau of Soils the soils are separated into provinces, series, and types, primarily on the basis of geology, physiography, and character of the soil material. Soils of the same series are similar in color, structure, and origin; the soil type, the unit of soil mapping, is

determined mainly by the texture or relative proportions of silt, clay, and various grades of sand of which it is composed. On this basis of mapping 25 soil series, with a total of 46 soil types, exclusive of Meadow, Muck, and Rough stony land, were recognized in the county. Large as this number is, more detailed mapping than that undertaken in the present survey would doubtless reveal a number of other types or phases of types.

Residual, alluvial, and colluvial soils, the general classes made on the basis of geologic origin or manner of formation, are all developed within the area of the county. The residual soils are most widely distributed, and most of the soil types described in succeeding pages belong to this general class. These soils have been formed by processes of weathering, are in their place of origin or have not been moved appreciable distances, and have inherited their characters mainly from the rock which immediately underlies them. The thickness of the mantle of rock waste or regolith in this area is surprisingly small considering the fact that the region is south of the limit of ice invasion during the Glacial Period and has been a land surface for an enormous period of time. The depth of rock decomposition and disintegration, exclusive of local hillside accumulations, is generally from 2 to 10 feet, a thickness much less on the average than is found in the Piedmont Plateau in the southern part of the United States. The most plausible explanation of the difference is that climatic conditions have been less favorable in the north for the accumulation of great thicknesses of residual material.

Alluvial soils represent detritus, or the residual material of rock weathering, which has been carried into streams, transported by them, and redeposited along their courses. The materials of such soils in this county are mainly of local derivation. The alluvial deposits are of comparatively small thickness and none of the streams have yet developed broad flood plains or "bottoms," so that the area of this class of soils, although occurring along all of the main creeks and rivers, is relatively small and of little agricultural importance.

The material of colluvial soils is the detritus of residual decay which has moved down slopes under the action of gravity, aided by rainfall run-off, frost, and other agencies. Such deposits have been transported from their place of origin, but the rock material has been only crudely assorted and does not possess a definite structure. The rock débris which has been carried down by rivulets and spread out at the bases of slopes without definite assortment or stratification is also included. This latter material is properly "wash." Colluvial deposits are thus intermediate between residual and alluvial; there are gradations into the other two classes and sharp lines of division can not be drawn. Colluvial soils by virtue of their origin

possess characters different from the other two classes. Soils of such origin are found at the base of nearly every hill and in shallow drainage sags, but their extent, except in a few places, has not been sufficient to justify separate mapping. In the present survey such soils have been included with types mainly residual in origin, altnough in the detailed descriptions in the following pages they are referred to specifically.

Local classifications of the soils have been made by the inhabitants of the county, which have been based upon the most noticeable or obvious characteristics, whether these may be due to topography, color, vegetation, underlying rock, or texture. The local classification happens in some instances to conform more or less closely to the soil types which have been established on a more scientific basis. A comparison of local soil names and those used in this report will aid the person familiar with the local names more readily to locate and perceive the general character of several of the different soil types. The "limestone lands" have been mapped principally as the Hagerstown and Conestoga loam types. The "slate lands" are included principally in the Berks shale loam, Manor slate loam, and to a less extent in the Edgemont loam. The "red lands," as this descriptive term is generally used in the central part of the county, are included in the Penn series. "Ironstone soils" refer pretty definitely to soils in the northern part of the county, derived from diabase and containing fragments or rounded bowlders of this rock. These soils are described in this report under the name Montalto. "Bluestone land" refers to soils lying mainly north of the Conewago Mountains, having a slaty gray color, and containing fragments of peculiar bluish-black rocks; the "bluestone" land is included in the Lehigh series. The term "mountain gravel" is locally applied to soils in Hellam Hills, Pigeon Hills, and South Mountain, which are mapped in this report as the Edgemont, Dekalb, and Hanceville series. The term "bottom land," referring to alluvial soils, is in common use; the various alluvial soils have been mapped as types of the Huntington, Bermudian, Codorus, and Wehadkee series.

The varied character of the soils and the relations of the different soils to one another can be properly understood and explained only when these are studied in their relations to an equally varied lithology and topography. The soil series, which are the broader divisions in soil mapping, bear a close relation to the broader geologic divisions, while still further the soil type bears a close relation to lithologic phases and to minor topographic forms. The descriptions of the geology and topography of the county which are given in the present brief report have been written in recognition of the fact that soil character is involved with geologic and physiographic history.

No recent geologic map of the county has been made and no accounts of the geology have been published in which the rocks have been subdivided in the light of recent stratigraphic knowledge and their lithologic character described in detail. However, the ages of the broader divisions of the rocks are known with some degree of certainty, mainly from the map made by Persifor Frazer for the Second Pennsylvania Geological Survey and from paleontologic studies by Walcott,[1] while legitimate inferences as to correlation of the rocks may be drawn on the basis of geographic position and by lithologic comparison with rocks in near-by areas where more thorough geologic studies have been prosecuted.

The oldset rocks are schists and gneisses (presumably pre-Cambrian in age), located in the southeastern part of the county. A belt of sedimentary schists, phyllites, and shale or slate of probable Ordovician age lies to the northward of the pre-Cambrian area. The York Valley, which extends entirely across the central part of the county, is underlain principally by limestones, with some interbedded shale, which are Cambrian in age and probably belong to the Shenandoah group. The quartzites and coarse siliceous slates which border the York Valley on the north and underlie the Hellam Hills and Pigeon Hills are also Cambrian,[2] but seem to lie beneath the limestones and to be older. The northern part of the county is underlain mainly by Triassic formations (Newark group), while throughout the Triassic area there are extensive dikes and rather large intrusive masses of diabase which are Triassic or post-Triassic in age. Diabase dikes probably of the same age as those cutting the Triassic rocks also cut all of the older formations, but are of comparatively small width. The rocks of South Mountain can with some degree of certainty be referred to the Cambrian, since a few miles to the southward in Franklin County they have been so classed in recent detailed mapping.[3] Small areas of volcanic rocks are associated with the Cambrian quartzites in the northwestern and central parts of the county; these are probably pre-Cambrian. Recent alluvium and Pleistocene terrace deposits occur along the streams, but are of comparatively small areal extent.

The broader geologic divisions occur in roughly parallel belts having a northeast-southwest or nearly east-west trend. The rocks have been compressed into folds and the beds or layers are generally steeply inclined.

The soils are briefly described in their relations to the various rock divisions in the following paragraphs.

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[1] Walcott, C. D., Cambrian Rocks of Pennsylvania, Bul. 134, U. S. Geological Survey.
[2] Walcott, C. D., op. cit.
[3] Stose, G. W., Chambersburg-Mercersburg Folio, U. S. Geological Survey.

The southeastern part of the county is principally underlain by a complex of mica schists and mica gneisses, presumably the oldest rocks of the area. The rocks are possibly in part of sedimentary origin, but if so the sediments have been highly metamorphosed and rendered schistose and crystalline, so that little trace of their original character remains. There is a suggestion that much of the rock represents highly metamorphosed granite, while in an area south of Glen Rock much of the rock is a massive chloritic schist or gneiss derived from a more basic rock than granite, possibly a diorite. The mica schists and gneisses, through processes of weathering, have given rise to the soils of the Chester and Cecil series. The Chester series is characterized by its yellowish to orange subsoil, while the Cecil series has a red subsoil; the color is the chief distinction, as the soils of the two are quite similar in structure and topography. The cause of the difference in color is believed to be due primarily to local differences in the mineralogical composition of the rocks, in the proportions of readily oxidizable iron-bearing minerals. The rocks contain a high percentage of micaceous minerals, which are present also in the soils and determine to some extent their peculiar structure.

The Peach Bottom slate formation occurs in the extreme southeastern part of the county, being infolded in the older pre-Cambrian schists and appearing as a narrow synclinal ridge. The rock is a hard blue-black slate of sedimentary origin. The Cardiff slate loam soil type is residual from the weathering of this slate and the soil and rock boundaries closely coincide. This soil is distinguished from the Berks shale loam, a similar but much more widely distributed type, by the darker color of the surface soil, a dull brownish to chocolate, while the subsoil is a dull yellow brown or chrome yellow. The high percentage of small, black, flaky rock particles has doubtless been instrumental in imparting the dark color.

Northwest of the area largely occupied by the Chester and Cecil series are the soils of the Manor series, which occur as a northeast-southwest belt from 4 to 7 miles wide, extending entirely across the county. This belt is underlain by grayish-green or green, finely laminated chloritic schist. The rock has been highly metamorphosed and subjected to intense mashing or shearing, so that little trace of the original bedding remains, and the layers are highly inclined to vertical. The rocks are more thinly laminated, have a more highly developed rock cleavage, and are finer grained and less crystalline than the schists underlying the Chester and Cecil soils. The rocks are of sedimentary origin, are of probable Ordovician age, and may be the equivalent of the Octoraro schist.[1] Chlorite and quartz in very fine grains are the predominant mineral constituents,

[1] This formation has been mapped and described in the vicinity of Philadelphia by Florence Bascom, Philadelphia Folio, U. S. Geological Survey.

with scattered cubes of pyrite and in places considerable magnetite as accessory minerals. The soils of the Manor series are characterized by the distinctly grêasy or smooth feel of both the surface soil and subsoil, and the reddish-yellow or yellowish-red color of the subsoil.

The Berks series of soils lie to the northwest of and roughly parallel to the belt of Manor soils. These soils have yellowish-brown, brown, or yellowish colors. The rock from which they are derived is a highly argillaceous shale and slate, drab, or olive green, locally black in color, weathering to various shades of yellow, brown, or even red. The residual soils generally contain a high percentage of small, flat fragments of the parent rock. Complete decomposition of the rock has extended to depths of only 4 or 5 feet. The rocks have not been as highly metamorphosed or altered from their original condition as the schists to the southward, so that there has been a smaller development of chlorite and other micaceous minerals and the rocks are less thinly laminated and less schistose. However, in passing southward from the York Valley, the shales or slates become gradually more micaceous and fissile, seemingly merging imperceptibly into the chloritic schists and phyllites, so that no sharp line of division can be drawn between the two belts of rocks; this intergradation of rocks is reflected in the soils, and the line between the Berks and Manor soils is consequently somewhat arbitrary. The shales and slates underlying the Berks series are probably in the main of Ordovician age and possibly occupy the same horizon as the Martinsburg shale. They have been considered in the older discussions of the geology of the county as the equivalent of the Hudson River slates.

The Hagerstown soils have brownish or yellowish-brown surface soils and generally yellowish, in places yellowish-red, clay subsoils. The soils are residual, being derived principally from massive bedded, bluish-gray to black limestones. The rocks in the vicinity of York have been classed as Cambrian, on the basis of fossil evidence, by Walcott.[1] It is not improbable that they belong in the Shenandoah group of formations, Cambro-Ordovician in age. In the York Valley thin bands of shale alternate in places with limestone and the soils consequently can not everywhere be considered as residual entirely from limestone, although this is the prevailing class of rock. In the processes of weathering solution has been dominant rather than decomposition and disintegration; that is, the inorganic constituents of the soil represent mainly the impurities of the original limestone, the calcium and magnesium carbonates having been removed in solution. In such a process of weathering there is a distinct plane of separation between the subsoil and the underlying rock. The rock floor has a billowy or uneven surface due to inequality of solution, and the thick-

[1] The Cambrian Rocks of Pennsylvania, Bul. U. S. Geological Survey No. 134.

ness of the soil layer varies accordingly The limestones being less resistant to weathering than the surrounding rocks have been worn away to a greater extent and generally occupy valleys.

The Decatur clay loam differs from the Hagerstown soils chiefly in color, having a reddish-brown surface soil and intense red or blood-red subsoil. The Decatur clay loam is derived from a white to bluish-gray crystalline limestone belonging to the same geologic group as that underlying the Hagerstown. The rock, however, is freer from carbonaceous impurities than that under the Hagerstown, and the difference in the color of the soils is attributed mainly to this lithologic difference in the rocks.

The Conestoga loam has been derived from a limestone formation, probably belonging to the Shenandoah group, which occupies a basin around East Prospect and along the Susquehanna River, about 5 miles below Wrightsville. The rock here has been subjected to intense dynamic forces and has undergone mashing and shearing, which has developed a finely laminated or schistose structure, while the original carbonaceous matter is now in the nature of graphite or in one of the stages of conversion to graphite. The soil derived from this rock is darker colored, lighter in texture, and more friable than the Hagerstown, and has other peculiar characters. This is a notable instance of soil character due primarily to the structure of the parent rock.

The Dekalb and Edgemont series are characterized by pale-yellowish or grayish-brown surface soils and yellowish subsoils. The soils are mainly residual, but include considerable colluvial material on slopes. They are derived from arkosic quartzites, quartz schist, siliceous slate or phyllite, and sandstones of Cambrian age. These rocks have been generally more resistant to weathering than adjacent strata and have formed such conspicuous topographic features as Hellam Hills, Pigeon Hills, and South Mountain. In the last-named section the Dekalb has been recognized, while to the east, in the Piedmont section, the grayish and yellowish soils derived from the rocks named have been mapped as Edgemont.

The northern part of the county, a belt 15 to 18 miles in width, is underlain mainly by Triassic formations (Newark group). The rocks are principally dark-red or reddish-brown shale or mudstone, sandstones, and both siliceous and calcareous conglomerates. While the rocks are commonly red in color, drab or grayish shales and arkosic sandstones are present in narrow belts, being closely interbedded with the red rocks. The Triassic, north of Conewago Creek, has been extensively intruded by igneous rocks, principally diabase, and the sediments have in many places been profoundly altered by heat. The Triassic formations have the prevailing northeast-southwest trend of the rocks of the older geologic divisions;

the beds are inclined, generally dipping at angles of 20 to 45 degrees to the northwest. However, the rocks retain to a large extent their original texture and have not been complexly folded and highly metamorphosed as have those of the Paleozoic and pre-Cambrian formations. The thickness of the residual material from the weathering of the Triassic rocks is on the whole less than for the older rocks, generally not exceeding 4 or 5 feet, while in many places, even where the land is comparatively level, unaltered rock is encountered at a depth of 18 inches.

The great number of lithologic phases and the complex rock character effected by igneous intrusions have given rise to a large number of soil types. The Penn series is derived from the red sandstones and shales, and is characterized by a peculiar dark-red, commonly described as Indian-red, subsoil, while this is also generally, but not universally, the color of the surface soil. The red color of the rocks is generally believed to be original and the soils have inherited this color, with perhaps some slight intensification by oxidation in the weathering processes. The sandstones are commonly arkosic or contain considerable kaolin, to which is attributed the clayey nature of the subsoils of the sandy soil types. The Lansdale soils are characterized by a grayish or brownish color, being otherwise similar in structure, topography, and manner of formation to the Penn soils. They are derived from the drab or grayish shales and sandstones, which do not differ essentially from those underlying the Penn, except in color. The Lehigh series of soils is characterized by the gray, slaty-gray, or drab surface colors and by grayish to yellowish subsoils; there are without doubt obscure physical and chemical differences between the soils of this series and those of the Penn and Lansdale series, which are reflected in the crop growth and in the character of the native vegetation. The Lehigh soils are derived from metamorphosed Triassic rocks. They occur principally in the area lying north of Conewago Creek. In this area the original red, drab, and grayish rocks were penetrated by dikes and intrusive masses of igneous rocks and were profoundly altered by heat, being changed in color, texture, and structure.

The Athol clay is residual from a coarse limestone conglomerate and breccia, so-called Potomac marble, which occurs along the northern border of the Triassic basin, in the vicinity of Dillsburg. This soil is similar in color to the Penn soils, but the large quantity of Paleozoic limestones and other foreign material in the parent rock have imparted a peculiar character to it.

The Herndon stony loam has a grayish-brown or pale-yellowish surface soil and red or dull reddish brown subsoil, color characteristics not possessed by any of the soil types of the other series mentioned. The underlying rocks are Triassic calcareous and siliceous

conglomerates and arkosic sandstones, which have been altered from their original condition by contact metamorphism. Physical and chemical changes, effected by the surrounding intrusions of diabase, have resulted in the hardening of the original rock and in the formation of new minerals, such as garnet, magnetite, and serpentine, and certain peculiarities of the soil can perhaps be traced to these and other metamorphic minerals.

The soils of the Montalto series are residual in origin. They have typically brownish surface soils, with yellowish-brown to yellowish-red or dull-red stiff clay subsoils which generally contain a high percentage of partially decomposed minerals of the parent rock. The soils are derived principally from igneous rocks of Mesozoic age. These are principally the dikes of coarse-grained diabase which are intruded in the Triassic rocks in the northern part of the county, but in a few places syenite and a rock tentatively classified as diorite were found. The soils in two small areas of basic volcanic rocks associated with Cambrian quartzites, in the western part of the county, have been included in the Montalto series, although perhaps not precisely similar to the soils derived from the Mesozoic diabase.

The Ashe series is represented by a single type, the Ashe silty clay loam, which has a brownish surface soil and a yellowish-brown subsoil. The soil is derived from a felsitic and slaty rock, probably a metamorphosed acidic volcanic closely associated with Cambrian quartzites of South Mountain, Pigeon Hills, and Hellam Hills.

The alluvial soils of the county are largely of local derivation. All of the streams except the Susquehanna River originate in the county or in near-by counties which are similar geologically. The Bermudian silt loam represents material which has been washed from areas mainly occupied by the Penn series, and in the color of the surface soil is similar to the parent residual soils. The soils of the Huntington series are brown soils largely derived from Paleozoic shale, limestone, and sandstone materials, which give rise principally to the Berks, Dekalb, Edgemont, and Hagerstown series. The Codorus silt loam is derived mainly from the soils coming from the micaceous schists and gneisses of the southern part of the county and differs from the Huntington chiefly in having a higher content of micaceous minerals, which have produced a slightly different structure in the soil. The Wehadkee silty clay loam represents detrital materials resulting from the decay of the igneous and metamorphic rocks which produce the Montalto and Lehigh soils. The Birdsboro silt loam is similar in origin to the above-mentioned alluvial soils, but differs from them in occupying terraces which are above present stream overflow. The Holston silt loam type along the Susquehanna River, while derived mainly from the weathering of the Paleozoic shales, sandstones, and

limestones of the Appalachian Valley and Allegheny Plateau regions to the northward, doubtless contains some glacial material. The terrace deposits along Codorus Creek are of local origin.

Soils resulting from colluvial accumulations are present and widely distributed, as is true in practically every hilly or mountainous country. However, because of the small extent of separate areas of soils of this class, only two types, largely or entirely of colluvial origin, were found which seemed to justify separate mapping, the Lickdale silty clay loam and the Hanceville gravelly loam. The materials composing these two types is wash or colluvium derived principally from the mantle of rock waste which covers South Mountain.

Areas of Rough stony land, Meadow, and Muck were encountered. The names are in a measure self-explanatory. Descriptions of the character of the land so classed are given in succeeding pages.

The table below shows the actual and relative extent of the various soil types. The loam class of soil predominates, while there is comparatively little heavy clay, and, on the other hand, very little extremely sandy soil. Detailed descriptions of the types are given in the following pages.

*Areas of different soils.*

| Soil. | Acres. | Per cent. | Soil | Acres. | Per cent. |
|---|---|---|---|---|---|
| Chester stony loam | 99,008 | 17.1 | Meadow | 2,688 | .5 |
| Manor slate loam | 78,272 | 13.5 | Codorus silt loam | 2,688 | 0.5 |
| Penn loam | 65,344 | 11.3 | Dekalb stony loam | 2,560 | .4 |
| Chester loam | 47,552 | 8.2 | Lehigh silt loam | 2,432 | .4 |
| Berks shale loam | 34,304 | 6.0 | Huntington loam | 2,368 | .4 |
| Cecil clay loam | 28,736 | 5.0 | Huntington silt loam | 2,368 | .4 |
| Penn stony sandy loam | 20,416 | 3.5 | Lehigh gravelly loam | 2,368 | .4 |
| Berks loam | 20,032 | 3.4 | Penn silt loam | 2,112 | .4 |
| Edgemont stony loam | 19,328 | 3.4 | Wehadkee silty clay loam | 2,112 | .4 |
| Hagerstown loam | 18,176 | 3.1 | Lansdale loam | 1,920 | .3 |
| Montalto stony clay loam | 14,336 | 2.5 | Holston silt loam | 1,664 | .3 |
| Penn sandy loam | 12,416 | 2.1 | Conestoga loam | 1,600 | .2 |
| Lansdale sandy loam | 11,520 | 2.0 | Birdsboro silt loam | 1,408 | .2 |
| Rough stony land | 10,624 | 1.8 | Cardiff slate loam | 1,280 | .2 |
| Montalto stony loam | 9,664 | 1.7 | Lickdale silty clay loam | 1,216 | .2 |
| Edgemont loam | 8,320 | 1.4 | Ashe silty clay loam | 1,088 | .2 |
| Lehigh stony loam | 7,552 | 1.4 | Herndon stony loam | 960 | .2 |
| Penn gravelly sandy loam | 5,760 | 1.0 | Penn clay loam | 576 | .1 |
| Decatur clay loam | 4,800 | 0.8 | Penn gravelly loam | 512 | .1 |
| Cecil stony loam | 4,672 | .8 | Hanceville gravelly loam | 448 | .1 |
| Bermudian silt loam | 4,032 | .7 | Hagerstown clay loam | 320 | .1 |
| Penn shale loam | 3,968 | .7 | Muck | 256 | .1 |
| Manor silt loam | 3,968 | .7 | Athol clay | 128 | .1 |
| Chester slate loam | 3,776 | .7 | | | |
| Montalto clay loam | 3,136 | .5 | Total | 577,920 | ..... |
| Lehigh fine sandy loam | 3,136 | .5 | | | |

PENN LOAM.

The soil of the Penn loam is typically a friable or mellow loam, having an Indian-red or brownish-red color. The thickness of the surface soil ranges from 10 to 18 inches, although there is no very marked line of separation between the surface soil and the subsoil. The subsoil is an Indian-red—a brighter or more intense shade in the lower part than in the top soil—clay, which in places is decidedly compact and in others friable and noticeably sandy. A small percentage of chips and blocklike fragments of shale or sandstone are generally present in both soil and subsoil. Weathering throughout the whole Penn loam area has extended to only shallow depths, the disintegrated or unaltered rock being encountered at 2 to 4 or 5 feet below the surface.

Local variations in the texture and color of the surface soil are found throughout the area. Small bodies of silt loam, sandy loam, and clay loam too small for separate mapping occur and are due to local topography and changes in the character of the underlying rock. In some areas, particularly in the vicinity of Dover, grayish or brownish soils are closely associated with the red soils, giving the fields a spotted appearance. Where these grayish soils occupy any considerable area they have been separated and mapped as Lansdale loam and sandy loam.

The Penn loam occupies a comparatively large area in the county and is extensively used for general farming. The principal area lies to the south of the Conewago Mountains, extending in a southwesterly direction from the Susquehanna River near Yorkhaven through Dover to the Adams County line. Two important basinlike areas were found near Lewisberry and Yocumtown, while considerable areas occur southeast and southwest of Dillsburg, respectively, in the vicinity of Mount Top and Clear Spring. Three are also smaller and isolated areas distributed throughout the northern portion of the county. The soil belts generally have a northeast-southwest trend, conforming in this respect to the strike of the underlying geologic formations.

The topography of the area occupied by the Penn loam is comparatively level to gently rolling, and in only a few localities is it at all rough or hilly. The natural drainage on the whole is good. There is no land in a continuously wet or swampy condition, although there are a few small bodies of land in the more nearly level tracts that could doubtless be improved by tile drainage. Soil erosion is serious only on a few areas of steep hillside or creek-bluff land. The Penn loam area has a lower elevation than the soil areas with which it is closely associated—the Montalto, Lehigh, and stony and sandy loam types of the Penn. The principal area is a rolling lowland plain having an elevation of about 400 feet above sea level, lying between the Conewago Mountains and the Hellam Hills and Pigeon

Hills. The Lewisberry and Yocumtown areas are basins topographically.

The soil is residual from the weathering of red sandstones and shales Triassic in age. The shales and argillaceous sandstones alternate in narrow belts, the sandstone being the predominant rock. The soil bears a close relation to the local character of the parent rock, divergences in texture and color from the typical soil being accounted for by changes in the underlying rock. The sandstones are medium to fine grained and in many places are arkosic. Mica is a common constituent of both the shale and sandstone, although not in particularly large amounts, and the slightly greasy feel of the subsoil is due to the finely divided flakes of this mineral. The color of the rock is some dark shade of red, brownish red, Indian red, or brick red, these colors with but little change being also the characteristic colors of the soil. The red colors of the rock is believed to be original and due to finely disseminated iron oxide in the form of hematite. Microscopic examination of the soil reveals hematite as a coating over the sand grains.

The area occupied by the Penn loam is practically all in cultivation and very little of the original forest remains. The tree growth was probably mainly white oak and hickory. Old inhabitants report that there was considerable red oak and black oak in the original forest. Cedar, scrub pine, and hemlock are found in a few places on the thin soil of steep hillsides and creek bluffs. Elm, walnut, and beech grow sparingly along the streams.

The soil is easily cultivated and a good tilth can be maintained where reasonable care is taken to keep up a moderate supply of organic matter. There are few places where poor drainage or roughness of topography are obstacles and rock fragments are in no place of sufficient size to interfere with tillage. The soil and subsoil are fairly retentive of moisture and crops do not often suffer from dry weather.

Probably 95 per cent of the area is in farms and under cultivation. There is scarcely any waste land, and this fact, together with ease of tillage makes the Penn loam a very desirable soil for general farming, although naturally it is probably less fertile and less durable than a number of other types in the county. Corn, wheat, oats, and hay are the staple crops grown. Some rye is produced, but the acreage is much less than that of the other grains. Yields of 50 to 75 bushels of corn per acre are not uncommon, but the general average is perhaps nearer 30 to 40 bushels. The yields of wheat are on the average 15 to 20 bushels; oats 30 to 40 bushels; rye, 15 to 20 bushels; and hay, timothy, and clover, 1 to 1½ tons per acre. Tobacco is grown to a small extent, the quality being excellent, but the yields not as large as on some other types which seem to be a little better adapted to this crop;

for example, the adjacent Hagerstown loam. There are a few small commercial peach orchards which have given fair yields and quality of fruit, but this type is hardly as suitable for fruit growing as the Penn stony sandy loam and a number of other types which have a lower selling price. Special crops are not grown to any considerable extent.

Crop rotation is practiced, the system being that which is generally employed throughout the county. Corn is followed by oats or rye and by tobacco where this latter crop is grown; then wheat, which is followed by the hay crop and the grass land, is again turned under for corn. The use of animal manure, lime, and commercial fertilizers is general. Slaked lump lime is applied at the rate of 35 to 50 bushels per acre and seems to give decidedly beneficial results. Commercial fertilizer, generally a 2–8–2 grade, is applied at the rate of about 100 to 150 pounds per acre for corn, 200 to 350 pounds for wheat, and 100 or 150 pounds for oats.

The Penn loam type seems to be better adapted for general farming than for special crops. Dairying is extensively carried on in connection with general farming and is especially recommended for this type, as it affords the most efficient means of supplying in the form of barnyard manure organic matter in which the soil is most deficient. The soil responds readily to fertilizers and is capable of producing higher average yields than are at present obtained.

The selling price of land of this type is determined largely by the farm improvements and proximity to shipping points and markets. The better improved farms of 50 acres or more are valued at $75 to $90 an acre, but the average selling price throughout the whole area is near $40 to $50 an acre.

### PENN GRAVELLY LOAM.

The soil of the Penn gravelly loam to a depth of 10 to 18 inches is a yellowish-brown friable loam which contains a considerable percentage of very coarse, angular sand and small rock fragments the size of fine gravel. This coarse sand imparts a deceptive feel, and one might readily mistake the soil for a sandy loam. The surface soil shows a departure in color from that characteristic of the Penn series, but the subsoil, beginning at a depth of 10 to 18 inches assumes a light Indian-red color. The subsoil is a moderately friable gravelly or gritty clay. Angular fragments of grayish and pinkish quartzite and red sandstone are present in sufficient quantity in both the soil and subsoil to give the type a gravelly character. Cultivated fields, especially the lower slopes, have more of a brownish color in the surface material. The soil portion of this type is more like that of the Lehigh soils, but the subsoil is fairly typical of the Penn. The type really represents a light-colored phase of the Penn gravelly loam, as it has been found in other areas.

The Penn gravelly loam is confined to a hilly area of about 1 square mile, located 6 miles southwest of Dillsburg, near the Adams County line.

The soil is residual from strata which are without much doubt Triassic in age, although there is little opportunity for observing the lithologic character of the rock, on account of the soil covering and scarcity of outcrops. The quartzite gravel is similar to and was doubtless originally derived from the Cambrian quartzites of South Mountain, but here seems to be directly residual from the weathering of Triassic breccia.

The tree growth is principally chestnut, with white oak, chestnut oak, and a few scrub pine.

The soil is loose and friable and little difficulty is experienced in tilling it, except from the steepness of some of the hillsides. The type, however, is of comparatively little agricultural importance in York County. General farm crops can be grown, but the soil is probably best adapted to the production of peaches, apples, and berries.

### PENN SANDY LOAM.

The surface soil of the Penn sandy loam is generally a brownish-red or pale Indian-red medium to fine sandy loam, 8 to 15 inches in thickness. The subsoil is typically an Indian-red friable sandy clay loam to sandy clay, everywhere a deeper or more intense red than the surface soil. The subsoil in most localities becomes more granular or friable at about 30 inches and gradates into the unaltered or but little altered parent rock at depths of about 3 feet. Small, blocklike fragments of sandstone are in many places rather abundant throughout the soil section, but are not of such size as seriously to interfere with cultivation.

Textural variations occur and the area shown on the soil map as Penn sandy loam includes some loam and silty loam areas too small for separate mapping. There are also a few areas where the soil and the subsoil exhibit a very dark purplish red color, this variation being due apparently to the slight baking which the underlying rock has undergone from heat from near-by igneous intrusions. In such instances the soil is associated with the Lehigh soils and shows a gradation into the types of that series.

The Penn sandy loam type is not as widely distributed nor the total area as large as that of the Penn loam and Penn stony sandy loam. The principal area is a narrow belt lying on the south side of the Conewago Mountains, extending from Strinestown southwestward to the western boundary of the county. A second important area extends westward from Lewisberry through Andersontown to Yellow Breeches Creek. Smaller bodies are found throughout the area occupied by the Penn series.

The topography of the type is gently rolling to moderately hilly, being similar in character to that of the Penn gravelly sandy loam,

but perhaps a little more varied than that of the Penn loam areas. The topography is ideal for general farming, since there are very few areas where the drainage is deficient or erosion excessive, while scarcely any of the land is so rough that tillage is difficult.

The soil is residual in origin, such parts as are colluvial forming only a very small percentage of the total. The parent rock is a brownish-red or Indian-red fine to medium grained sandstone, which belongs to the Triassic group. The rock is soft, friable, and generally argillaceous or arkosic. It is thinner bedded and less resistant to erosion than the rock underlying the Penn stony sandy loam; hence the topography is less hilly and the land generally at a lower elevation above sea level.

The native tree growth was probably not very different from that which prevailed on the Penn loam. Practically all of the type is now under cultivation and there is very little opportunity for making comparative observations on the native vegetation. On the few areas of woodland remaining white oak, hickory, red oak, and chestnut are the principal trees. As on the Penn loam, a growth of cedar and scrub pine appears in places where the soil is thin or where the bedrock lies very near the surface.

The Penn sandy loam type is utilized principally for general farming, with dairying, small-fruit growing, and trucking as adjuncts. The soil is easily tilled and the work can be done with light draft animals. Rolling of the land is considered necessary over most of the area to obtain a sufficiently compact seed bed for wheat and grass.

Corn, wheat, oats, and hay are the staple crops. The soil responds readily to fertilizers and naturally produces earlier crops than the heavier general-farming types, although the yields are on the average somewhat smaller and growing crops are more likely to suffer from summer droughts. The system of crop rotation does not differ materially from that employed throughout the county in general. The use of lime and commercial fertilizer is common, but the amount of lime used per acre is slightly less than for heavier soil types, such as the Hagerstown and Montalto loams. The yields of corn are on the average about 30 to 40 bushels per acre, wheat 15 to 20 bushels, and oats about 30 bushels. The hay yields are likely to be small unless the rainfall happens to be well distributed. It does not seem advisable to keep the fields in grass more than one year, and the fields can not be pastured very closely.

Berries, melons, and garden truck can be successfully grown. Dairying may be extended where proximity to railways and markets justifies it. Dairying affords the most profitable means of producing barnyard manure, so essential in the present system of farming.

The selling price of land of this type is on the average about $40 an acre.

### PENN STONY SANDY LOAM.

The soil of the Penn stony sandy loam type is characteristically a pale Indian-red sandy loam to fine sandy loam, 8 to 10 inches in depth. The subsoil is a moderately friable and pervious sandy clay or sandy loam, light Indian red, wine red, and hematite red in color, the color being generally brighter or more intense than that of the surface soil. Angular fragments or blocks of red sandstone varying from 3 or 4 inches up to 3 or 4 feet in diameter are strewn over the surface, large scattered blocks rather than a great abundance of small fragments being characteristic. The stone content is the principal basis of differentiation from the Penn sandy loam and Penn gravelly sandy loam, the finer material being very similar to that of the two types mentioned.

The soil is pretty uniformly a pale Indian red in color, but in a number of places assumes a brownish-red, brownish, or even slightly grayish color. The subsoil, however, in these instances of variation has the characteristic red color of the Penn series. The soil adjacent to diabase intrusions is notably light in color, owing to changes in the underlying rock effected by heat. However, where there is any considerable area of these light-colored soils they have been included in the Lehigh series. While the stone content for the most part consists of angular fragments of Triassic sandstone, there are a few places where the stones came originally from older formations and are waterworn or rounded, the underlying rock in such places being a coarse conglomerate or breccia interbedded with massive red sandstone. In the small area of this soil which lies on the north slopes of Pigeon Hills not a few large fragments of gray or yellowish Cambrian quartzite appear over the surface, while in parts of the area northeast of Lewisberry bowlders or large cobbles of quartzite are not uncommon near the contacts with the Penn gravelly sandy loam type.

In its distribution the type is confined chiefly to the area included by the Conewago Mountains, which extend from near Goldsboro southwestwardly about three-fourths of the distance across the county, forming a belt from 1 to 4 miles in width. A spur extends northward from Newberrytown, a second area is located west of Lewisberry, and a third small area lies roughly parallel to the Susquehanna River, north of Goldsboro. The trend of these three latter areas is roughly northwest-southeast, the deflection from the normal direction of strike of the Triassic formations being effected by large intrusions of diabase. A fourth very narrow belt of this type is situated on the northern slopes of Pigeon Hills.

The topography of the Penn stony sandy loam is rougher than that of any of the other types of the Penn series. In several places the land is of little or no agricultural value, on account of the steepness of slopes and ruggedness due to large blocks of sandstone. Conewago

Mountains, which include the principal area of the type, are a conspicuous topographic feature, varying in elevation from 500 to 1,000 feet above sea level and rising from 200 to 500 feet above the adjacent comparatively level areas of Penn loam and Penn sandy loam.

The type is derived from thick-bedded red sandstone belonging to the Triassic group of rocks. The stony character of the soil as compared with other types of the Penn series is doubtless due to the slightly greater hardness of the rock and the greater thickness of individual sandstone beds. The sandstone is generally a brownish red in color, flecked white with kaolin and containing megascopic flakes of mica. The rock is composed essentially of fine to medium, angular grains of quartz cemented by iron oxide and, to a less extent, by silica. The clayey nature of much of the subsoil, which may seem anomalous in that the soil is derived from a sandstone, bears a relation to the kaolinic or arkosic character of the rock.

The native tree growth of the type is principally chestnut and white oak; in addition chestnut oak, tulip, hickory, red oak, black oak, mountain maple, dogwood, scrub pine, and cedar are fairly common. Mountain laurel is the common undergrowth. There is a much greater percentage of chestnut, and on the whole the plant growth is more varied than on other types of the Penn series. Native grasses attain only a sparse growth and consequently the uncleared areas have but little value for pasturage.

The steepness of the slopes or rough character of the topography and large stone content greatly interfere with plowing and the cultivation of crops and have been the principal factors which have determined the small size of the farms. The soil is mellow, friable, and a good tilth can be easily maintained, while the drainage is good and the land dries rapidly after rains.

It is estimated that not more than 50 per cent of this type is in cultivation, a proportion smaller than that for any of the other soil types of the county. The size of the farms is small—from 10 or 15 to 40 or 50 acres. The type is probably best suited to small-fruit and truck farms, although some general farming is also attempted. The soil responds readily to fertilizers and on a small acreage the yields and quality of corn, wheat, and oats are perhaps as good as those obtained on the other soils of the Penn series, although the labor and expense of tillage and harvesting is greater. The yields of rye are good—17 to 20 bushels per acre. Hay yields are small; timothy seems to give better results than clover. General farming is not likely to be profitable, and a combination of fruit and truck farming is believed to be the best way of utilizing the land if it is to be cleared for agricultural purposes. Apples, peaches, plums, and pears of good quality are grown, while raspberries, blackberries, and strawberries, particularly, seem to be adapted to the soil condi-

tions. Much of the area is 12 to 18 miles from York and Harrisburg, the best local markets, and this, together with poor roads, has retarded the development of farms.

The present selling price of much of the unimproved land is as low as $5 to $15 an acre, exclusive of valuable timber; the tracts which contain improved land or small farms have a value of $20 to $40 an acre.

### PENN GRAVELLY SANDY LOAM.

The Penn gravelly sandy loam type is closely associated with the Penn sandy loam and differs from the latter type only in the presence of a large amount of gravel in the soil and subsoil. The surface soil is a dull-red or light Indian-red, friable fine sandy loam to sandy loam, generally 8 to 15 inches in depth. The subsoil is an Indian-red or light Indian-red sandy loam or gritty sandy clay, which in places passes below into rather heavy, somewhat plastic clay of the same color. Gravel—rounded or waterworn pebbles of quartzite and quartz up to 4 inches in diameter—forms 10 to 20 per cent of the soil mass. Angular fragments of sandstone also form a small part of the gravel content. The type as mapped is not entirely uniform, since small areas occur where the gravel content is very small, the soil in these places not differing materially from the Penn sandy loam. In places the surface soil is grayish, owing to the leaching out of the red iron oxide which seems to exist as a coating over the sand grains. The divergence in texture from the typical soil is toward the loam class rather than the sand.

The total area of the type is comparatively small, amounting to about 9 square miles. The principal occurrences are in Fairview Township, in the northern part of the county. Small lens-shaped or oval bodies, many too small for separate mapping, were found along the southern border of the Penn loam belt, extending southwestwardly from Mount Wolf to the Adams County line.

The topography is gently rolling to moderately hilly, none of the land being too rough for tillage, while, on the other hand, there is scarcely any land that is deficient in drainage or swampy.

The soil is residual in origin. The underlying rocks are sandstone and conglomerate, belonging to the Triassic group and having the red color characteristic of this series of formations. Sandstone and conglomerate are interbedded, the sandstone predominating and the conglomerate being sufficient merely to give a gravelly character to the soil. The sandstone does not differ materially from that underlying other types of the Penn series, except that it is possibly a little coarser grained. The pebbles of the conglomerate are principally quartzite, derived from older Paleozoic formations to the northward, rather loosely interbedded in a matrix of red sand and clay. In places there are pebbles or fragments of limestone and shale in the

rock, but these constituents do not appear to any extent as gravel in the soil, having been decomposed in the weathering processes.

White oak seems to be the predominant tree growth in the few tracts of woodland remaining. Other common trees are hickory, chestnut, sweet gum, red oak, cedar, scrub pine, and wild cherry. Sumac was observed at several places. There seems to be a greater variety of trees than on either the Penn sandy loam or Penn loam, but the growth is probably less sturdy.

The soil is loose, is easily tilled, and the gravel content is not high enough, except in a very few localities, to make plowing difficult. Rolling of the land is practiced and is necessary in order to obtain a sufficiently compact seed bed for wheat.

The greater part of the type is utilized for general farming, corn, wheat, oats, and hay being the staple crops. Rye is grown to a small extent. On account of the loose, porous nature of the soil, crops are likely to suffer during periods of dry weather. Hay yields are on the average rather small, probably about 1 ton per acre. The soil on the whole has about the same agricultural rank as the Penn sandy loam, but is more difficult to till, owing to the presence of gravel. Lime is generally used, but the nature of the soil is such that only small applications are found advantageous. The soil responds readily to commercial fertilizers.

Apples and peaches are fair in quality and the yields are also fair, although as yet none but small orchards for home use have been set out. Raspberries, blackberries, and strawberries do well, and small-fruit growing in connection with trucking is an industry which might be gradually extended.

The average selling price of land is $30 to $40 an acre.

### PENN SHALE LOAM.

The surface soil of the Penn shale loam is a light Indian-red to brownish-red mellow silty loam or silt loam, 8 to 15 inches deep. The subsoil is characteristically an Indian-red, friable silty clay loam, usually underlain within the 3-foot section by partially decomposed rock fragments or solid bedrock. In places there is scarcely any subsoil, the underlying shale rock being encountered at depths of 12 to 15 inches. The soil is characterized by the presence of 10 to 20 per cent of chips and blocklike or flat fragments of shale or mudstone, one-fourth inch to 3 or 4 inches in length or thickness. These fragments are abundant either in the soil or subsoil or throughout the soil section. The fragments are too small for the type to be called a stony loam, and too thick and blocky for a typical shale loam. They do not have the flat shape or the highly developed cleavage and laminated structure of shales proper, such as those

underlying the Berks shale loam. The term nevertheless seems to be a little more appropriate than the alternative "gravelly loam."

There are areas where the shale fragments are not conspicuously abundant and where the surface soil is similar to that of the silt loam, loam, or clay loam types of the Penn, but such areas were too small and irregular to be mapped. Even in these areas the underlying rock, but little disintegrated or even hard and impervious, lies within 15 to 24 inches of the surface, imparting a peculiar character to the soil type and influencing plant growth. The soil layer is particularly thin on the crests of the low ridges and on the steeper hillsides.

The total area of the type is comparatively small, amounting to 6.2 square miles. The principal areas occur near Kralltown, in Washington Township, while there is also a considerable development between Conewago and Bermudian Creeks in the western part of the county.

The type is characterized by a nearly level to gently undulating topography. Much of the land occupies the crests and steeper slopes of low ridges or stream divides. The trend of the separate soil areas is northeast-southwest, conforming to the strike of the underlying rock.

The soil is residual, being derived from red, fine-grained, argillaceous, imperfectly laminated shale, or, perhaps more properly, mudstone, belonging to the Triassic group of rocks. Thin layers of olive-drab or olive-green shale, weathering yellowish or brownish, are in a few places interbedded with the red shale and produce variations in the color of the soil.

The tree growth on this type is about the same as on the Penn loam. White oak and hickory predominate; cedar occurs in areas of very thin soils.

The soil is nearly everywhere mellow or friable and easily tilled. The rock fragments are not large enough to interfere with plowing and being soft exert but little wear on farm implements.

The land is utilized almost entirely for general farming, wheat, corn, oats, and hay being the staple crops. Wheat is the money crop, the other crops being largely fed on the farm, as is the general practice throughout the county. Rye is grown to a less extent than oats and wheat. With well-distributed rainfall crop yields are good even on the very thin soils, but plants very frequently suffer from summer droughts, since neither soil nor subsoil are favorable texturally or structurally for retaining moisture. The soil responds readily to commercial fertilizers and lime, but fertility is perhaps more difficult to maintain than on the Penn loam, Hagerstown loam, and other general-farming types. Applications of stable manure are of most value in building up and maintaining the productivity of the land. The following are yields obtained on well-improved farms during

favorable years; the average yields are considerably below the figures given: The yield of corn, with about 150 pounds of commercial fertilizer, is 40 bushels per acre; wheat, with 200 to 250 pounds of commercial fertilizer, 20 to 25 bushels; oats, with 100 to 150 pounds of fertilizer, 30 to 40 bushels; rye, 18 to 20 bushels; hay, timothy and red clover, during favorable years, 1 to 1½ tons per acre. The average yields, however, are less than on the Penn loam type and perhaps about the same or a little less than those obtained from the Penn sandy loam type. The soil is probably better suited to general farming than to any other type of farming.

The selling price of most of the land is near $30 to $40 an acre, the price depending upon the improvements, size of the farm, and location.

### PENN SILT LOAM.

The surface soil of the Penn silt loam is a pale Indian-red to brownish, compact or moderately friable silt loam to silty clay loam about 12 inches in depth. The average depth of the soil is slightly greater than that of the other types of the Penn series, and it also differs in being almost entirely free from coarse rock fragments. The subsoil is a brownish or at best pale Indian-red silty clay, plastic and rather compact in structure. The depth to underlying rock in places varies from 30 inches to 3 or 4 feet, this being determined by local topography. The subsoil in the lower part of the section is nearly everywhere brownish, yellowish, or even mottled yellowish and gray, and, in respect to color especially, exhibits a departure from the Penn series. The differences in color from typical Penn are in the main most probably due to local drainage conditions, but at some localities the material has been to some extent derived from the light-colored or grayish and drab rocks of the Triassic. The soil is partly colluvial in origin and in places contains some material washed from the Lansdale loam and sandy loam, and also in a few areas contains some material washed from the Lehigh soils. The type as mapped is thus rather variable, having somewhat the aspect of the Lansdale and Lehigh as well as of the Penn, but on account of the small size of the areas, their relative unimportance agriculturally, and the impossibility of making satisfactory divisions on the scale of mapping employed, separation into two or more types was not undertaken. In more detailed mapping on a large scale the type might be divided into typical Penn silt loam, a light-colored phase of this type, and the Lehigh silt loam.

In its distribution it is confined mainly to the portions of the county occupied by the Penn loam and Penn shale loam divisions, occurring in small, separate areas rather than in a few large, uniform bodies. The separate areas are really very numerous, but in most cases are so small that they have been included on the map with other types of the Penn series.

Topographically this soil occupies swales or very shallow drainage depressions, and where there is any considerable tract the surface is level or but very gently undulating. On the whole, natural drainage is deficient.

In origin a part of the type is purely residual from fine-grained red shales or mudstone belonging to the Triassic group, but in places is largely colluvial, the material being washed mainly from adjacent Penn loam and Penn shale loam slopes. Where entirely colluvial it merges into the Bermudian silt loam, the alluvial type derived from the Penn series, and no sharp line or division between the two can be drawn.

White oak, swamp white oak, pin oak, tupelo, and shagbark hickory are characteristic trees, the nature of the growth being expressive of drainage conditions. Where the land is clear of trees, especially on the colluvial phases, native grasses attain a good growth and are valuable for hay.

The greater part of the area of this type is in cultivation, fair yields of corn, oats, wheat, and hay being obtained. The soil is frequently too moist for successful cultivation and tends to clod and compact. With tile drainage and a moderate use of lime doubtless a good tilth can be obtained, and with its naturally deeper soil and better supply of humus the land should produce as good or better crops of corn, wheat, and hay than other types of the Penn series, and might also be utilized successfully for such vegetables as onions, asparagus, lettuce, celery, and cabbage.

Since the areas are small and most of the land is farmed in connection with other types, it is difficult to arrive at any accurate estimate of the yields of the different crops per acre and the comparative selling price of the land. As at present cultivated the type has on the whole perhaps a slightly lower agricultural rank than the Penn loam or Penn shale loam.

### PENN CLAY LOAM.

The surface soil of the Penn clay loam type is a pale Indian red, moderately friable clay loam, having a thickness of 8 to 10 inches. The subsoil is a moderately friable Indian-red clay to clay loam, which at a depth of about 20 to 30 inches grades into disintegrated red shale. A small percentage of shale fragments occurs both in the soil and subsoil, but the particles are not in sufficient amount to impart a gravelly or shaly character. The type is locally called "red-gravel land."

The only considerable tract of the Penn clay loam mapped is located near Wellsville, in Warrington Township. However, there are a number of scattered small areas, not shown on the soil map, associated with the Penn loam and Penn shale loam types, which are due to

local erosion of the loam surface soil on hillsides, and very small bodies of clay loam are found which are colluvial in origin, representing the accumulation of the silt and clay particles, from the other types, at the bases of slopes.

The area near Wellsville is a low-lying, level to gently undulating tract. The smaller areas have no distinctive topography.

The soil near Wellsville is residual from a fine-grained red shale or mudstone very similar to that underlying the Penn shale loam.

Very little of the type is at present in forest, but it is probable that the native vegetation was very similar to that on the Penn loam, consisting mainly of white oak and hickory.

The soil has about the same agricultural value as the Penn loam. It contains a higher percentage of clay, and for this reason is a little more difficult to till. The crops grown, methods of cultivation, and crop yields are, however, about the same as for the loam type of the series.

### LANSDALE SANDY LOAM.

The soils of the Lansdale series are closely associated with the Penn series and are similar in origin, but are distinguished from the Penn mainly on the basis of color, the Lansdale soils being grayish or brownish in contrast to the red of the Penn.

The surface soil of the Lansdale sandy loam is a brownish or grayish, rather heavy though friable sandy loam, 8 to 12 inches deep. The subsoil is a yellowish-brown friable heavy sandy loam which generally grades into a yellowish sandy clay loam, which in turn at about 30 inches becomes more sandy and grades into soft, disintegrated arkosic sandstone. A small percentage of angular sandstone fragments occurs in both the soil and subsoil. A few areas, like the one near Mount Wolf, carry considerable rounded and subangular quartz pebbles ranging in size up to 3 or 4 inches in diameter.

In places small areas of the grayish or brownish soils of this type are so mixed with the red soils of the Penn loam that they can hardly be separated on the scale employed in the accompanying soil map. As a result of this close association some of the bodies of Penn loam are spotted or streaked with gray or brown, and vice versa the Lansdale soils are spotted with red Penn loam. In these mixed areas the soil has been mapped according to the predominating color.

The Lansdale sandy loam is confined principally to a narrow northeast-southwest belt, 1 to 3 miles wide, extending from the Susquehanna River below Yorkhaven to Manchester and thence with some interruption to Weiglestown, passing a short distance south of Dover to the village of Admire and thence through Paradise Township nearly to the Adams County line. The type does not occur to any considerable extent north of the Conewago Hills. There is a conspicuous ridge of gravelly soil lying a short distance east of Mount

Wolf and extending about 1½ miles southwestward from the Susquehanna River, which has been included with this type.

The topography is level to gently rolling and of about the same character as that of the Penn loam areas. There is very little excessive drainage or serious soil erosion and, on the other hand, very little land where there is any need for artificial drainage.

The soil is residual from the weathering of grayish or yellowish Triassic sandstone, with a small amount of interbedded drab shale. The sandstone is soft, friable, medium, and coarse grained, and arkosic, being composed essentially of angular to subangular particles of quartz, with some disseminated white kaolin and particles of decomposed feldspar and flakes of mica. The finer material of the rock is yellowish clay, which, together with silica, is the cementing material. The area near Mount Wolf is derived from yellowish quartz conglomerate and coarse sandstone. The light color of the Lansdale soils and the red of the Penn soils are traceable to the colors of the parent rocks.

Practically all of the type is under cultivation, very little of the original forest growth remaining. White oak and hickory seem to have been the principal tree growth.

The soil is loose and friable, and a good tilth is easily maintained, many farmers preferring it to adjacent soils for this reason. The type is utilized principally for general farming. Agricultural practices are the same as over the Penn loam and sandy loam areas. Tobacco is grown on a few farms near Manchester and Yorkhaven; the quality of the leaf is good, but the yields per acre are not as high as is desirable. There are a few small peach orchards, and trucking is carried on in a small way as an adjunct of general farming. The yields of corn are probably on the average as good or possibly better than those on the Penn loam, while on the other hand the yields of timothy and clover are perhaps slightly less.

The agricultural value of the small areas of gravelly soils which have been included in this type is lower than that of the typical sandy loam.

Most of the land is valued at $40 to $50 an acre, but the price varies considerably, depending upon improvements and location.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of the Lansdale sandy loam:

*Mechanical analyses of Lansdale 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.* | *Per cent.* |
| 181761 | Soil | 9.1 | 16.5 | 7.3 | 17.6 | 13.1 | 27.0 | 9.5 |
| 181762 | Subsoil | 4.4 | 14.1 | 11.5 | 21.2 | 7.7 | 27.8 | 13.1 |

LANSDALE LOAM.

The soil of the Lansdale loam type is a light-brown or grayish-brown mellow loam, 8 to 10 inches deep. Texturally the soil varies from a rather light loam to a heavy silty loam, the textural differences being determined by local topography and variations in the character of the underlying rock. The subsoil is a yellow to yellowish-brown, friable silty clay loam, which generally becomes more sandy and more friable at about 30 inches. The soil is for the most part entirely free from coarse rock fragments; however, one narrow strip lying on the north side of Bermudian Creek includes a small amount of gravel which is probably remnantal from an alluvial terrace deposit.

In its distribution the soil is confined almost entirely to the Triassic area lying south of Conewago Creek. The soil is closely associated with the Lansdale sandy loam type, and bears about the same relations to the Penn soils. It is not everywhere sharply separated from the Penn, and faint reddish shades of color may be found in places in the areas mapped as this type. It occurs in smaller and more scattered bodies, and the total acreage is less than that of the Lansdale sandy loam.

The topography is nearly level to gently undulating. Natural drainage in several places is deficient, and tile should be installed in order to obtain the best results from cultivation.

The soil is mainly residual from brownish or olive-drab shale and grayish or yellow sandstone of Triassic age, the more argillaceous rock predominating. The color of the rock has not been produced by heat metamorphism from igneous intrusions, as in the case of the rock underlying the Lehigh series, the soils of which also have grayish colors in contrast to the red of the Penn, but is a color traceable to the character of original sedimentary material which has undergone no greater metamorphism than the sediments underlying the Penn series.

The forest growth was originally white oak and hickory, with a small admixture of other hardwoods.

The greater part of the type is in cultivation—corn, wheat, oats, and hay being the principal crops. The agricultural practices are about the same as on the Penn loam type. The soil is more retentive of moisture, has a closer structure, and is probably better adapted for the production of hay than the sandy loam type of this series. It is easily tilled and the surface soil can be kept in a loose, friable condition with ordinary care, except in some of the very level or more poorly drained areas.

The land is in most places cultivated in connection with other soils, there being very few farms lying wholly within the loam areas. It is

therefore rather difficult to obtain accurate data as to crop yields and the comparative selling price of the land. The soil is about equal in natural fertility to the Penn loam.

### LEHIGH STONY LOAM.

The Lehigh stony loam is a gray, dull slaty gray or drab to olive-drab silty clay loam to silt loam having a depth of 8 to 10 inches. The subsoil is a bluish-gray, olive-drab to yellowish plastic clay or silty clay, mottled in places with gray. This generally becomes more friable at about 30 inches, on account of the increase in the percentage of small rock fragments. The lower part of the 3-foot profile is in places composed mainly of partially decomposed rock. Bedrock is encountered at depths of 3 to 5 feet. Angular rock fragments, averaging 6 to 10 inches in diameter, but in many places in blocks up to 2 to 3 feet in diameter, are commonly scattered over the surface and are sufficiently abundant to interfere with cultivation and to lessen the agricultural value of the land. The greater part of the type is locally known as "bluestone land," the name having been suggested by the dark bluish color of much of the rock from which the soil has been derived. The distinguishing characters of typical Lehigh stony loam are the bluish or slaty-gray color and the compact structure of the soil and subsoil.

Variations from the typical soil in texture, color, and structure obtain, accordingly as the underlying rock is sandy or argillaceous or was originally red, drab, or olive green in color. A phase of the type contains a high amount of sand rather than silt, and the rock fragments are sandstone or quartzite rather than claystone. The stony loam type differs from the silt loam and gravelly loam types of the Lehigh chiefly in the percentage and size of the stones, the finer material in all three types being similar.

In its distribution the soil is confined mainly to Washington, Warrington, Newberry, and Fairview Townships. It is closely associated with the soils of the Montalto series and occurs as narrow bands conforming to the trend of or encircling diabase intrusions. As a result of this conformity some of the areas are shown on the map in roughly parallel belts.

The type occupies narrow ridges and moderately steep slopes. The ridges generally rise well above the areas occupied by the loam, silt loam, and sandy loam of the Lehigh and Penn series. The rainfall run-off is in places rather rapid, but the large stone content prevents gullying.

The soil is residual from Triassic shales and sandstones which have been metamorphosed by intrusions of diabase. In some places the beds have been so changed by heat that little trace of the original character of the rock remains and it might easily be mistaken for

material of igneous origin. The rock underlying the typical Lehigh stony loam is blue-black or slate colored, hard, brittle, breaks with a ringing sound under the hammer, is very fine grained in texture, and minutely jointed. There are, however, varieties of the metamorphosed rock corresponding to the texture and color of the original. The original beds were, without much doubt, similar to the soft red and yellowish shales and sandstones which underlie the Penn and Lansdale series. Heat has effected profound changes and the character of the rock has in turn been the chief factor in producing important differences in color, structure, and agricultural value of the soil.

There is at present about 40 per cent of the type in forest. The principal trees in order of their abundance are: White oak, hickory, chestnut, chestnut oak, red oak, tulip, gum, and scrub pine. Cedar is a conspicuous and rather characteristic growth on the thinner and stonier phases. There is a thick tree growth on the type, but as a rule individual trees do not attain a sturdy growth.

The soil has a low agricultural rank, due to difficulties in tillage on account of the stones, while it is naturally of low fertility. The soil of the more silty and clayey phases retains a large amount of water and in the winter and spring the land frequently becomes soggy or even mobile on slopes, being described locally as "running land." Upon drying, the soil has a tendency to become rather hard and compact. The land is also in many places cold or clammy and the plant growth is rather slow and the crops late in maturing. The above description is not entirely applicable to certain sandy phases, the sand in this latter case tending to effect a more friable and porous structure.

The land is utilized principally for general farming, but on the average the crop yields are small. Corn averages about 25 bushels per acre; wheat 15 bushels; oats 20 to 30 bushels; rye 12 to 15 bushels. Clover seems to be poorly adapted to the soil and the hay yields are consequently small. There are individual instances of better yields than those given above, especially on the sandy phases, but on the whole, general farming, at the present prices of farm products, can hardly be expected to be profitable on this type. The land should be allowed to remain in forest, or if cleared for agricultural purposes utilized for orchards and small-fruit farms. Raspberries, blackberries, and strawberries in particular yield well.

### LEHIGH GRAVELLY LOAM.

The fine earth of the surface soil of the Lehigh gravelly loam, which is locally known as "bluestone land," is a dull-gray to bluish-gray silty loam, 8 to 10 inches deep. The subsoil is a bluish-gray or drab silty rather compact clay which at 24 to 36 inches grades into loose

rock and becomes more friable. Small, angular rock fragments are abundant both in the soil and subsoil.

The principal variation from the typical soil is a light-brown or yellowish-brown silt loam, overlying yellowish friable silty clay loam, which at 15 to 20 inches passes into rather compact, plastic silty clay, usually of a mottled yellow and gray color. On drying the surface soil of such areas has a pronounced grayish color.

The type differs from the Lehigh stony loam chiefly in the smaller size of the rock fragments. Small, angular, blocky and slaty fragments of light-colored, pinkish, metamorphosed shale and sandstone are present in sufficient quantities to give the soil a marked gravelly character. The proportion of such material is less in the soil than in the subsoil, which is often so filled with gravel that boring is difficult or impossible. Most of these fragments range in size from small particles to pieces 5 inches in length and 2 or 3 inches thick. The type is generally associated with areas of its sandy phase and of the Lehigh stony loam.

The soil is residual from metamorphosed Triassic shales, together with a small amount of interbedded sandstone. It seems that where the original rock was red the metamorphosed rock is a hard, bluish-black or dull-purplish mudstone, which produces characteristic Lehigh, "bluestone" land; where the original rock was a light-colored shale, the metamorpbosed rock is hard, brittle, greenish or yellowish, and produces a soil with a yellowish or brownish clay subsoil.

This soil is largely under cultivation, being utilized for general farm crops, but has a comparatively low agricultural rank. The soil is very thin in places and the subsoil becomes soggy in wet weather and dries to a hard mass, much as in the case of the Lehigh stony loam. With large applications of manure, a judicious use of lime, and especial care in tillage, the land can be brought into a fair state of fertility, but the net income from general farm crops can hardly be expected to equal that from the naturally more fertile soils of the county. Small fruit farming, the growing of raspberries, blackberries, and strawberries, might be carried on with some profit; practically all of the area, however, is at present rather distant from markets.

A sandy phase of the Lehigh gravelly loam was encountered. This consists of a grayish to light brownish loam with a rather high content of sand, closely approaching a sandy loam in texture, and overlain at 8 to 10 inches by a pale-yellowish or light-brownish fine sandy clay loam to gravelly sandy clay, faintly mottled in places with shades of yellow and gray. Hard rock is usually encountered at depths of 3 to 5 feet. The soil and subsoil contain a high percentage of angular fragments of sandstone and clay stone for the most part from

2 to 5 inches in length or thickness. The fragments are so abundant that in many places it is very difficult to bore 3 feet with the soil auger, but their size is such that they do not seriously interfere with plowing and the cultivation of crops.

This phase is confined to the northern part of the county and is closely associated with the igneous rocks which give rise to the soils of the Montalto series. It occurs as small, separate areas rather than in large, uniform bodies. The principal areas occur in Newberry, Fairview, Warrington, and Carroll Townships, occupying ridges and moderately steep slopes. The natural drainage of the land is good and the topography is in no place so rough as to prevent cultivation.

The soil is residual from Triassic formations which have been metamorphosed by igneous intrusions, as is true of the Lehigh series as a whole. In this case the original Triassic rock was largely or predominantly an argillaceous sandstone. The result has been a soil containing a high percentage of sand and one which is more friable and porous or open in structure compared with the phases of the Lehigh which have been derived largely from metamorphosed shale or mudstone.

The tree growth does not seem to differ markedly from that of the other soils of the Lehigh series. White oak, hickory, and chestnut are the principal trees.

This phase is more easily cultivated than the "bluestone" or stony loam type and the typical gravelly loam and has a higher agricultural rank. The sand content and the large percentage of gravel have produced a rather friable, moderately pervious soil, and no great difficulty is experienced in maintaining a good tilth. On the better improved farms the yields of corn are 30 to 40 bushels per acre; wheat 18 to 20 bushels; oats 30 to 40 bushels; rye 18 to 20 bushels; hay, timothy, and clover, about 1 ton per acre. The quality of the grain produced is generally good. Crop rotation is practiced, and lime, stable manure, and commercial fertilizers are used. The land is suitable for small fruit farms and under favorable market conditions it could be so utilized with profit. Peaches and apples are good in quality and the trees produce fairly well, but commercial fertilizers are generally necessary in order to insure a vigorous tree growth. No large commercial orchards, however, have as yet been developed exclusively on this phase.

There are few farms located entirely on this phase and it is somewhat difficult to obtain information as to the selling price in comparison with other types. Land of this character would probably bring about $40 an acre.

### LEHIGH SILT LOAM.

The Lehigh silt loam differs from the Lehigh stony loam chiefly in being free from large rock fragments. The soil is a drab, gray, or slaty-gray to grayish brown heavy silt loam, 8 to 10 inches in thickness. The color of the soil is everywhere characteristically some shade of gray, the particular shade varying with the moisture content of the soil and the nature of the rock from which the soil is derived; the fields during dry weather are almost white in contrast with the red color of the Penn soils, with which the Lehigh is closely associated. The silt content is always high; the soil is pulverulent when dry and has a soft, flourlike feel. The subsoil is a gray, drab, or yellowish-olive friable silty clay loam, which passes abruptly into compact, plastic silty clay of lighter color. This becomes generally somewhat more friable in the lower part of the subsoil and grades into disintegrated rock at about 3 feet.

In its distribution the soil is closely associated with the Montalto and other types of the Lehigh series. It occurs as small, separate bodies, mainly in Warrington and Washington Townships. The total acreage is small, being 3.8 square miles.

The type occupies level or flat areas on the tops of ridges and gently undulating lower slopes, the topography being such that the accumulation of soil material has not been as rapidly removed by erosion as in the Lehigh stony loam areas. There are many fields which would be greatly benefited by tile drainage.

The soil is mainly residual in origin, being derived from metamorphosed Triassic rocks similar to those underlying the Lehigh stony loam. Where the soil appears on the lower slopes of ridges it is to some extent colluvial, having received considerable wash of fine material from the higher lying Lehigh soils. That portion of the type which has a brownish cast in the soil and a greenish color in the subsoil is derived from the grayish and greenish rocks, while the gray to drab areas come from the slate-colored "bluestone."

The soil is fine grained, compact, and very retentive of moisture. During rainy seasons the plant growth is slow and crops are rather late in maturing. When plowed wet, the soil is somewhat sticky and hard clods are likely to be formed which are not easily pulverized. However, where the land is carefully prepared and judicious applications of lime and manure are made the crop yields are good. In agricultural rank it is considered about the equal of the Penn loam, and if properly handled is more durable and capable of being built up to a higher state of fertility.

The crops grown are corn, wheat, oats, and hay, together with a small amount of rye. Light applications of commercial fertilizers are employed, the largest amounts, about 200 or 250 pounds per acre, being used for wheat. The soil is probably best adapted to general farming.

### LEHIGH FINE SANDY LOAM.

The surface soil of the Lehigh fine sandy loam is a grayish to light-brown or yellowish-brown fine sandy loam or light loam, about 10 inches deep. The soil is mellow and pulverulent and free from any tendency to crust or clod. The subsoil is a grayish to drab or olive-drab friable fine sandy clay loam to fine sandy clay, generally mottled to some extent with shades of gray and yellow. Disintegrated argillaceous sandstone is encountered at about 30 inches. In places small, angular fragments of sandstone are fairly abundant, but rarely sufficient to impart a pronounced gravelly character. Near Pinetown the soil is a sandy loam, and at other places it merges into a very fine sandy or silty loam. The texture in places varies to a loam or silt loam on lower slopes and to gravelly loam on the upper slopes. The chief difference between this type and the Lehigh silt loam is in the higher sand content of the fine sandy loam, especially in the subsoil, which produces a more mellow soil and more friable and pervious structure in the subsoil.

The total acreage of the type is relatively small. There are several separate occurrences, the principal areas being in Carroll Township, east and south of Dillsburg, in association with the soils of the Montalto and Penn series. The topography is gently rolling to level.

The Lehigh fine sandy loam is derived from a Triassic rock, a fine-grained argillaceous sandstone which has been metamorphosed by heat from diabase intrusions. The altered rock is grayish pink with yellowish-green splotches, dull purplish or brownish in color. In a few places the original sandstone has been changed to a hard, bluish, vitreous quartzite. The difference in texture and structure in comparison with the Lehigh silt loam is traceable to the lithologic character of the underlying rock, in the one case a fine-grained sandstone and in the other a metamorphosed mudstone or shale.

The soil is mellow, free from large stones, is easily cultivated, and responds readily to fertilizers. It has a higher agricultural rank than any of the other soils of the Lehigh series in this county. Practically all of the land is under cultivation for general farm crops. The crop yields are about the same or a little higher than on the Penn loam. The soil should also prove to be fairly well adapted to truck crops. Irish potatoes would probably do well.

### MONTALTO STONY CLAY LOAM.

The Montalto stony clay loam is typically a yellowish-brown heavy silty clay loam to clay loam, underlain at about 8 to 15 inches by somewhat gritty clay having a yellowish-brown or ocherous-yellow to reddish-yellow color. This passes at about 20 inches into buff or dull-red, heavy, rather plastic clay. The subsoil characteristically contains a high percentage of partly decomposed coarse mineral

grains, which impart a crumbly structure to the clay; at many places soft disintegrated rock appears at 30 inches to 3 feet. The depth of weathering or the depth to the hard, unaltered parent rock is generally 3 to 10 feet. Small angular and rounded fragments of diabase, commonly known as ironstone, are strewn over the surface, and, in addition, many huge, rounded bowlders, having a diameter of 3 to 10 feet, are scattered over fields. Most of the large bowlders are residual from weathering and are free, but not a few of the projecting rocks are attached to the underlying mass and are properly rock outcrop.

The principal variation from the type as described above is in color. In places, such as the area 1½ miles east of Mount Zion Church, the soil consists of a reddish-brown to reddish-yellow clay resting at a depth of 6 or 8 inches on a yellowish-red crumbly clay, which below becomes quite heavy, stiff, and red.

This soil type occupies a comparatively large area in the northern part of the county and is coextensive with the larger dikes of diabase which have been intruded in the Triassic sediments. The principal areas are in Washington, Carroll, Monaghan, Newberry, and Fairview Townships.

The Montalto stony clay loam is generally found on hills and moderately steep slopes, but there are many comparatively level or but gently rolling areas. Natural drainage is generally adequate, but the erosion of fields to the extent of gullying is not often observed, the stones being the chief agency in preventing destructive wash.

The soil is residual, being derived mainly from intrusive dikes of diabase commonly called trap rock. In texture the diabasic rocks vary from black, very fine-grained, typical diabase to coarsely crystalline doleritic rock, granitoid in texture and weathering much in the manner of a normal granite. Some of the rock possibly should be classed as gabbro, while at one locality about 1½ miles southeast of Kralltown the parent rock appears to be a diorite, although the field classification has not been confirmed by microscopic study. Most of the rock is a coarse-grained diabase. Slight differences in the soil were observed corresponding to variations in the underlying rock. The type is locally known as "iron-stone lands."

About 30 to 40 per cent of the total area still remains in forest. There is a greater variety of tree growth on this soil and on the Montalto stony loam than on any other types in the county, with the possible exception of the Chester stony loam. White oak, red oak, black oak, hickory, chestnut, chestnut oak, tulip (commonly called poplar), dogwood, ash, beech, cedar, and scrub pine are common. The oaks predominate and are followed by hickory and chestnut. In addition to the above varieties, elm, walnut, sycamore, persimmon, cherry birch, gum, papaw, locust, and a few white pine were observed.

The principal obstacle in the cultivation of this type is the large size and abundance of the stones. Many of the rocks are too large for removal from the fields without first being broken. Dynamite could possibly be used at some localities to advantage, although the rocks are peculiarly tough and difficult to break. A common practice of ridding fields of projecting bowlders is to remove the earth from beneath them, thus burying them in the fields without removal. The bowlders render plowing difficult and laborious and in the aggregate take up considerable space in the fields, thus lessening the crop yields per acre. The soil, however, retains moisture well, naturally possesses a good supply of humus, and where reasonable care is exercised a good tilth can be maintained; it is strong, durable, and produces excellent yields. On account of the labor and expense of clearing fields, the amount of cultivated land per farm is much smaller than on many of the other more arable types of the county. The average yields on the better improved farms are: Corn, 40 to 50 bushels per acre; wheat, 20 to 25 bushels; oats, 40 bushels; hay, 1½ to 2 tons. Only very light applications of commercial fertilizers are used. The distance from limekilns and the poor condition of wagon roads prevent extended use of lime over much of the area. As much as 75 to 100 bushels of lump lime have been applied to the acre without apparent injury to plants, although such large amounts are probably unnecessary.

Apples and peaches can be grown successfully, and the land is also suitable for such small fruit as plums, cherries, raspberries, blackberries, and strawberries.

Farm land of this type has a selling price of $20 to $40 an acre, depending upon improvements.

### MONTALTO STONY LOAM.

The Montalto stony loam is a brown to reddish-brown, moderately friable, rather heavy loam, underlain at about 8 to 14 inches by reddish-yellow clay, which becomes heavier, stiffer, and redder in color with increase of depth. The subsoil at intermediate depths is a light-red or buff clay, while in the lower portion of the 3-foot section partially decomposed rock material of a predominant greenish-yellow color gives the clay a crumbly or friable structure. In places the subsoil does not show much red, being more of a yellow or yellowish-brown color. At about 30 inches the clay content usually is so low that the material consists simply of soft, friable, disintegrated rock. The subsoil, although appearing stiff and compact, crumbles rather easily. The surface is strewn with small, angular rock fragments and large spheroidal bowlders; in places the stones reach such size and are in such quantities that the land is nonarable and is so

shown on the soil map as Rough stony land. The soil of this type is classed as "ironstone land," according to the local popular classification.

The soil is residual from igneous rocks, principally diabase, but there are three small areas where the underlying rock is syenite. Where the diabase is the black, hard, tough, very fine grained rock, the soil generally has a reddish shade of color, but where the rock is a coarse-grained, grayish, highly feldspathic diabase approaching a gabbro in character, as most of it is, the soils are brownish or yellowish brown, with very stiff clay subsoils. The rock which appears to be syenite [1] is a holocrystalline, coarse-grained, grayish rock, which gives rise to a dark-brown to reddish-brown, friable loam, with a reddish-brown to light-red, gritty clay subsoil, more friable and less stiff and compact than the more typical Montalto subsoil. The principal areas of the syenitic phase of the type are located near Monaghan and Siddonsburg, about 5 miles northeast of Dillsburg; there is a high hilly area about 2 miles northeast of Stevenstown and a third small area near Mount Pleasant Schoolhouse, northwest of Wellsville.

The total area of the Montalto stony loam is less than that of the stony clay loam type with which it is closely associated. The soil occurs in irregularly shaped areas rather than in belts or bodies, which have uniform outlines or definite trends. In many places the Montalto stony loam occupies the tops of hills or ridges where soil erosion is not active, while the stony clay loam type is developed on the slopes.

The topography is throughout hilly and the land rough. The drainage is good, and the abundance of stones prevents serious soil erosion.

The soil is somewhat more friable and mellow and easier to till than that of the clay loam type. The stones, however, in many places interfere with plowing and greatly add to the expense of clearing the land for farm or orchard purposes. The soil naturally contains a fair supply of humus, is strong and durable, and produces excellent yields, but the amount of waste land on the individual farm is large and the labor or expense of producing good yields are greater than on the more arable types of the county. It is estimated that about 60 per cent of the type is under cultivation.

The suitability of the soil for fruit has been recognized for several years and some of the largest apple and peach orchards in the county are located within the areas of this type.

The selling price of the land, exclusive of that in orchards, is $20 to $40 an acre.

[1] The rock has not been studied microscopically, but there is little doubt that it is a granite.

MONTALTO CLAY LOAM.

The soil of the Montalto clay loam type to a depth of 10 to 12 inches is a yellowish-brown, friable silty clay loam to clay loam. The subsoil is an ocherous or bright yellowish brown, crumbly, gritty clay, which quickly grades into heavier clay of a rather plastic structure and of a light-buff, reddish-yellow, or ocherous-brown color. Generally the lower subsoil, beginning at about 24 to 30 inches, contains enough partially decomposed material of the parent rock, while in some places the lower subsoil is composed entirely of incompletely decomposed rock. The chief variation from the typical soil is a phase which apparently represents more completely weathered or oxidized material. In this development the subsoil begins with a light-buff or reddish-yellow color and quickly passes into material of a yellowish-red to dull-red color. In places the lower subsoil is much like the red clay of the Cecil series, but there is always a suggestion of brown or an ocherous cast to the material. The partially decomposed rock is not in evidence so near the surface as in case of the typical portion of the type. On the eroded slopes the texture of the soil is frequently a good clay loam. These variations did not seem to be of sufficient importance to warrant their being mapped separately. This soil is relatively free from fragments and bowlders of diabase and is distinguished from the Montalto stony clay loam chiefly on this basis. The soil is residual from igneous rocks similar to those underlying the stony type, excepting two localities in the western part of the county near the Adams County line, where the underlying rock is a bluish-black to greenish, massive to schistose rock, probably a metamorphosed basic volcanic.

The principal occurrence of the Montalto clay loam is located near Dillsburg; a rather large area was also mapped in the northern part of the county, about 3 miles southwest of New Cumberland. Two small areas occur in association with the Ashe silty clay loam in the Pigeon Hills and near South Mountain.

The topography is hilly to rolling. Some of the hillsides are moderately steep, but the land is in no place so rough as seriously to hinder cultivation. Erosion gullies tend to form on the steeper hillsides and precautionary measures should be adopted.

The Montalto clay loam is a strong, durable soil and is well suited for general farming. The soil is heavy and has a tendency to stick to the moldboard, so that plowing at times is rather laborious. The soil is fine grained and very retentive of moisture, so that during wet seasons corn and other crops are apt to be backward in growth. The durability of the soil and good yields, where careful cultivation is practiced, offset the disadvantage it may have. The average yields on the better improved farms are: Corn, 40 to 50 bushels per acre; wheat, 20 to 30 bushels; oats, 40 bushels; hay, 1½ to 2 tons. Very

light applications of commercial fertilizers are employed. Lime may be used at the rate of 50 to 75 bushels per acre without apparent injury, although such large applications are probably unnecessary.

The better improved farm land of this type has a selling price of $50 to $75 an acre.

### HERNDON STONY LOAM.

The surface soil of the Herndon stony loam to a depth of about 12 inches is a yellow to yellowish brown friable gritty loam, which contains a fair supply of humus. The subsoil grades from light-buff or reddish-yellow friable gritty silty clay loam in the upper part into bright-red or dull-red friable gritty clay. In a good many places the color of the lower subsoil is practically the same as that of the Cecil. Locally the subsoil assumes a very dark red color or consists of red material along with brown to almost black material, the black color being due to dark-colored mineral matter and not to organic matter. The thickness of the soil section or depth of rock decay is generally 4 to 8 feet, although there are a few rock outcrops in the fields. There are present on the surface and throughout the soil section numerous fragments of quartzite, conglomerate, and light-colored sandstone.

Only two small areas of this type were found, the total area being 1.5 square miles. The topography is rough and hilly, and the cultivation of the land for general farm crops is rendered somewhat difficult on this account. The natural drainage of the land is good.

The soil is residual from Triassic rocks which have been altered from their original condition by contact metamorphism through the agency of diabase intrusions. The rocks are gray arkosic, quartzite, quartz conglomerate, and siliceous limestone breccia. A number of minerals have been developed in the metamorphic processes, such as serpentine, epidote, specular hematite, magnetite, and garnet. Dendrites of manganese dioxide are rather common. The rocks underlying this type seem to grade into the unaltered sandstone and conglomerate which produces the Penn gravelly sandy loam.

The tree growth is principally chestnut and chestnut oak, with some white oak, red oak, and other hardwoods, the growth not differing materially from that on adjacent soil types.

About half of the total area is under cultivation. General farm crops are grown, the yields per acre being about the same as on the Penn loam, although the soil is somewhat more troublesome and expensive to cultivate on account of the stones and the roughness of the topography. It is rather difficult to obtain a good seed bed for wheat, owing to the loose, stony character of the soil. Timothy seems to be better adapted to the soil than clover. There are several small-fruit and truck farms.

The present selling price of the land is $20 to $35 an acre.

### DEKALB STONY LOAM.

The fine material of the surface soil of the Dekalb stony loam is a pale-yellow or yellowish-brown friable silt loam having an average depth of about 8 inches; while that of the subsoil consists of pale-yellow silty clay loam, which frequently passes into yellow, friable silty clay loam below. The soil in many places contains a high percentage of coarse sand particles, and in addition is mainly covered with small and large fragments of quartzite, which fragments are also disseminated throughout the soil section. The depth to hard bedrock varies with the topography, ranging generally from about 3 to 5 feet on the smoother portions and to about 6 to 15 feet or more where there have been colluvial accumulations at the base of slopes.

The type is confined to South Mountain, along the western edge of the area. The material is derived mainly from quartzite. Drainage is well established, and the soil is not subject to serious erosion. The principal tree growth consists of chestnut and chestnut oak. There is present some white oak, hickory, tulip, red oak, maple, dogwood, pine, and mountain laurel.

The type, on the whole, is not very well suited to general farming, on account of the steepness of slope and the stone content. A portion of it, however, is under cultivation, and rather good yields are frequently obtained. The general farm crops are grown, such as corn, wheat, oats, and rye, and these constitute the principal products.

### EDGEMONT LOAM.

The soil of the Edgemont loam type to a depth of 10 to 12 inches is a pale-yellowish to grayish loam, which contains a rather high percentage of silt or very fine sand. The immediate subsoil is a yellow to pale-yellow silty loam, which at most places grades into silty clay loam in the lower part of the 3-foot section. In places the subsoil is a yellow fine sandy clay loam to fine sandy clay, the lower subsoil having here and there a buff color. The soil generally contains a small percentage of flat, slaty rock fragments, but it is only on a few of the steeper hillsides that the proportion of slate fragments is high enough to give the soil the character of a slate loam. Small angular fragments of vein quartz are conspicuous in places, notably near Starview. The depth to bedrock, excepting hillsides where erosion has been more active, is generally 3 to 6 feet. The soil is more fine grained, more compact, and more retentive of moisture, on the whole, than the stony loam of this series and that of the Dekalb.

The Edgemont loam is somewhat similar in appearance in the fields to the Berks loam and shale loam, but has a lighter color, has a smaller clay content, and is more friable and mellow than the Berks loam. The slate fragments in the soil are, on the whole,

coarser and thicker than those in the Berks shale loam. However, the Edgemont loam and the Berks types are so similar in places, especially north of Spring Grove and Menges Mill, that the line of division between them has been more or less arbitrarily established.

The type occurs on the lower slopes of Pigeon Hills and Hellam Hills, and also occupies valley areas within the hills. A large body occurs in the vicinity of Starview, about 6 miles north of York. The land generally has a lower elevation than the Edgemont stony loam type. The topography is, on the whole, undulating to hilly, but the upland area near Starview is comparatively level. Drainage is good, and, excepting a few of the steeper and stonier hillsides, none of the land is so rough as to interfere seriously with plowing and the harvesting of crops with machinery.

The soil is residual, being derived from dark-gray, minutely jointed slate or phyllite, together with thin-bedded shaly sandstone and coarse-grained argillaceous schists. The rock is probably of the same geologic age, Lower Cambrian, as the quartzite underlying the Dekalb and Edgemont stony loams. The phyllites are more siliceous and more coarsely laminated than the shale or slate underlying the Berks series, and the residual rock fragments are consequently coarser and thicker.

Very few forest tracts remain, probably 85 per cent of the land being in cultivation. There is notably a thicker and sturdier growth of oak and hickory as compared with the stony loam type.

The land is much more arable than the Edgemont stony loam, and a large number of well-improved farms have been developed upon it. The soil is easily tilled, holds moisture fairly well, and responds readily to fertilizers, excepting some of the more slaty land.

The land is utilized principally for general farming. On small farms, as near Starview, where very intensive farming is carried on, 50 to 75 bushels of corn, 20 to 30 bushels of wheat, 40 to 50 bushels of oats, 2 to 2½ tons of hay, and 1,200 to 1,500 pounds of tobacco are not uncommon yields. The average yields for the type, as a whole, are less. It has about the same agricultural rank as the Berks shale loam.

Apples, peaches, pears, and cherries do well, although no large orchards have yet been planted. Trucking is carried on in a small way in connection with general farming. Irish potatoes could probably be grown successfully as a special crop on selected areas.

### EDGEMONT STONY LOAM.

The Edgemont stony loam consists of a yellow or pale-yellow gritty loam which grades beneath into yellow, friable, gritty silty clay loam. There are present in much of this soil enough sharp angular particles or coarse sand from the parent quartzite and quartz conglomerate to

give the material an apparent sandy character, but more than 50 per cent of the soil body is composed of silt and clay. There are present on the surface and throughout the soil section sufficient rock fragments to give the land a predominantly stony character and to interfere with cultivation. The depth to bedrock varies with topography, being greatest on the lower slopes, where there has been accumulation of soil through colluvial action, the depth ranging all the way from about 3 to 8 feet or more. Some of the type, such as that on the ridge slope at Emigsville, consists of a light-brown mellow loam overlying yellow friable fine sandy clay loam to fine sandy clay. In this fragments of slabby quartzite having a banded or schistose structure and fragments of siliceous shale are present on the surface and throughout the soil body in sufficient quantity to interfere somewhat with cultivation.

Both soil and subsoil contain a high percentage of angular rock fragments, principally quartzite and quartz schist, ranging from small angular gravel up to stones 4 to 6 feet in length. Rounded quartz gravel from conglomerate are present in a few places. Rock outcrops are rather abundant.

Within the areas of this type there are a few patches of cold-natured clammy silty soil of a gray color which is comparatively free from stone. These occupy minor depressions.

The soil occurs on ridges and slopes in the Hellam Hills and Pigeon Hills in the central part of the county and on the ridge which extends from near Emigsville eastward to Codorus Creek. The ridges have an elevation of about 600 to 1,000 feet above sea level, and rise 200 to 400 feet above the general level of the York Valley to the southeast. The topography is irregular in places and many slopes are so steep and rough that cultivation is extremely difficult or impossible. Although the run-off of rainfall is rapid, the porous character of the soil prevents serious erosion. The thinner and more porous soil, such as that on the higher slopes, does not retain moisture well, and crops frequently suffer during periods of dry weather, but on the smoother situations and those places where colluvial accumulations have formed the soil retains moisture better and is more productive.

The material is derived principally from quartzite or quartz schist of Cambrian age, the formation representing the westward extension of the Chickies quartzite of Lancaster County. The rocks are highly siliceous, consisting of gray arkosic quartzite, quartz schist, in which considerable greenish chlorite has been developed, and light-colored sandstone, together with a small amount of argillaceous schist. Thin beds of limestone occur in association with iron-ore deposits along the lower southern slopes of Hellam Hills and Pigeon Hills, but this rock has been obscured by débris from the quartziferous rocks of the higher slopes.

The ridges occupied by this type are mostly thickly forested, chestnut being the principal growth in the higher situations. Other trees grow on the type, such as white oak, chestnut oak, hickory, tulip, maple, dogwood, and pine. Mountain laurel is the principal undergrowth.

The type as a whole is not very well suited for general farming on account of the steep slope and stony character of the land. Portions of it are cultivated with fair to surprisingly good results. The content of organic matter in the newly cleared soil is sufficiently high for good crop yields to be secured the first few years of cultivation, but this is rather rapidly diminished under cultivation and must be replenished in order to maintain the productivity of the land. Many of the farmers of small means in the Pigeon Hills supplement their farm income by day labor in near-by factories or in sawing lumber and cutting wood for fuel. The amount of improved land of individual farms is small on this type, ranging for the most part from about 10 to 60 acres. In the neighborhood of 30 to 40 per cent of the total area of the type probably is in cultivation.

The staple farm crops of the county—corn, wheat, oats, hay, rye, and tobacco—are grown. Corn and rye, on the whole, appear to do better than wheat and oats, and timothy better than clover. Tobacco is grown in the eastern part of the county, but the average yields are smaller than on the Hagerstown and Chester soils, although the texture of the leaf is finer and the color lighter. At the present time, however, there seems to be little difference in the price paid for the tobacco from the different soils. Much of this land is favorable for growing apples and peaches, and it is believed that well-managed orchards could be made profitable, possibly more so than general farming. The production of small fruit and certain vegetables also could be carried on successfully on the more accessible areas situated near markets or shipping points. The roughness and steepness of wagon roads at present is an obstacle in the development of farming operations on the Edgemont stony loam.

The selling price of the land ranges from about $10 to $60 an acre, depending mainly upon improvements, distance from markets, character of roads, and the steepness of the land.

### HANCEVILLE GRAVELLY LOAM.

The soil of the Hanceville gravelly loam is a brown, friable, gritty loam, 12 to 14 inches in thickness. The subsoil is typically a brick-red to reddish-brown stiff clay. The land is locally named "mountain gravel land." Angular fragments of quartzite and quartz having dimensions for the most part of not over 4 or 5 inches are strewn over the surface in sufficient amounts to give the soil the character of a gravelly loam, but do not seriously interfere with cultivation. The

greater part of the type is underlain by Triassic rocks, which give rise to Indian-red material in the substratum. In places the red clay is reached within the 3-foot section.

A few small, separate occurrences of this type were mapped on the lower slopes of South Mountain, northwest and southwest of Dillsburg. There are possibly other areas in close association with the Dekalb and Edgemont soils in other parts of the county which have been overlooked, but certainly no considerable areas are to be expected.

The material composing the soil is mainly colluvial in origin. It is the residual material from the weathering of quartzites and sandstones of South Mountain which has been washed down the slopes and mingled with other soils and rock débris. Triassic sandstones and shales, similar to those producing the Penn soils, underlie a part of this type, and in places the lower subsoil or substratum has the characteristic red color of the Penn series. The Hanceville differs from the Dekalb soils in having a brick-red subsoil.

The Hanceville series has been mapped at localities in Alabama and Georgia and at these localities is also closely associated with the Dekalb soils, but is mainly, though not entirely, residual in origin. The soil in York County is considered as a colluvial phase of the Hanceville. This type is similar to the Lickdale silty clay loam in that both are colluvial in origin and are derived from the same residual material. The Hanceville, however, differs from the Lickdale in occupying a higher topographic position and in having better drainage.

The soil is easily cultivated, fairly well drained, and practically all of it is utilized for field crops. The crop yields and the methods of farming are about the same as for the Dekalb stony loam. Wheat is reported to be excellent in quality. Clover does not do as well as on the Penn loam or on the Montalto soils.

The soil is more easily cultivated, on account of the smaller size of the rock fragments and the more subdued topography, and thus possesses a slightly higher agricultural value than the Dekalb stony loam.

### LICKDALE SILTY CLAY LOAM.

The Lickdale silty clay loam is a grayish-brown to dark-gray or drab silty clay loam, 8 to 12 inches thick, overlying mottled gray and yellow, rather friable fine sandy clay to stiff plastic clay. In places coarse sandy clay and gravel are reached at less than 3 feet below the surface. This description fits the greater part of the soil area shown on the soil map. There are, however, considerable variations in texture and to a less extent minor variations in structure, color, and topography, although the soils have throughout a common origin. On account of the small total area and the relatively small agricultural

importance of the soils, the labor of making several divisions was not believed to be justifiable.

The Lickdale silty clay loam occupies very gentle slopes on South Mountain. The soil is colluvial in origin or is wash derived from the mantle of rock decay over the quartzites and sandstones of the mountains. It represents colluvial Dekalb material that has been subjected to poor drainage conditions. On the higher slopes near where the arbitrary line between the Lickdale and the Dekalb has been drawn the soil has a coarser texture, being more sandy and gravelly, and the color is more uniformly brownish or yellowish. As the distance from the mountain increases the material becomes finer and the clay content of both the soil and subsoil increases. Along the larger branches narrow strips of soil were included with this type which are alluvial in origin and represent areas of Holly silt loam too small to map.

The difference between this soil and the Hanceville is due to natural drainage conditions. The Lickdale type characteristically has poor drainage, and the grayish or yellowish color of the subsoil in contrast to the reddish color of the Hanceville is a result of conditions unfavorable to aeration and to oxidation of iron-bearing minerals.

Only two localities were discovered where there was any considerable or typical development of this type, namely, along Dogwood Run and its branches near Dillsburg and along the small tributary streams north and northwest of Clear Spring. On the flat bottom land along Dogwood Run much of the soil is coarse grained and sandy, with a porous gravel and sand substratum at 2½ to 3 feet. Some of the soil in the flat, poorly drained areas near Clear Spring contains a high percentage of organic matter, which has produced a very dark gray to almost black color.

The trees observed were shagbark hickory, white oak, pin oak, gum, alder, and a few ash and elm.

The land, excepting in a very few places, is deficient in drainage, and in its natural condition is too wet for successful cultivation. No attempt is made to cultivate a large part of it, the land being valued chiefly for pasture and for its meadow hay. Where artificial drainage has been resorted to and in places where the land is naturally driest excellent yields of corn, wheat, and oats are obtained, while the hay yields are larger than those obtained from adjacent higher land.

### ASHE SILTY CLAY LOAM.

The surface soil of the Ashe silty clay loam is a grayish-brown to yellowish-brown to very dark brown silty clay loam or heavy loam, about 12 inches in thickness. The subsoil is a yellowish-brown or yellow friable silty clay carrying locally a high percentage of small,

flat rock fragments which impart an open porous structure. This type includes some patches, too small to map, which have a reddish color. Such areas really are the Porters clay loam. In addition to the small slate fragments, large angular blocks of white-vein quartz and long slabs of rock are scattered over the surface. A part of the area is so rocky as to be of scarcely any agricultural value, although such areas represent only a small proportion of the total. The dark color which the soil assumes in places, as in the Pigeon Hills area, seems to be due in part to small particles of black rock, although the soil naturally has a fair supply of humus. Weathering has extended to depths of 4 to 10 feet.

The type is not widely distributed and the total acreage is small, being 1.7 square miles. It is associated with the Dekalb and Edgemont soils and occupies rolling to hilly areas on the slopes of South Mountain southwest of Dillsburg and on the north slopes of Pigeon Hills near Rogersville, while a third area occupies a basin in the Hellam Hills about 2 miles northwest of Wrightsville. The topography is hilly but hardly mountainous, the land generally being at a lower elevation than the adjacent quartz ridges, which are covered with Dekalb soils. The land is well drained, excepting a few flat areas along small branches.

The soil is residual in origin. The underlying rock is hard, fine grained, and felsitic in texture, in places porphyritic; it is a bluish-gray, bluish-black, or even dull purple in color. An accurate classification of the rock has not been made through microscopic study, but it is very probable that it represents a pre-Cambrian volcanic rock, equivalent to the acid volcanic (metamorphosed rhyolite) described [1] from other localities in the South Mountain region of Pennsylvania and Maryland. Through shearing or dynamic metamorphism the rock has assumed a slaty structure such that the weathered rock in many places might be easily mistaken for a slate of sedimentary origin. Chlorite has been developed extensively in the rock on the slopes of South Mountain, producing a soft, greenish-gray slate, the soil from which is locally termed "soapstone land." Greenish stains of a copper mineral are common in the Pigeon Hills and also in the locality northwest of Wrightsville. The rock is commonly intersected by quartz veins.

Tillage is somewhat difficult on account of the stone content, but excepting small areas of the rougher land the greater part of the type is under cultivation for general farm crops. It has about the same agricultural rank, or possibly slightly higher, as the Dekalb and Edgemont stony loams, which are adjacent to it. Apples and peaches

[1] G. H. Williams, the Volcanic Rocks of South Mountain, Pennsylvania and Maryland, American Jour. Sci., Vol. XLIV, pp. 482–496, 1892; Florence Bascom, Ancient Volcanic Rocks of South Mountain, Pennsylvania, U. S. Geological Survey, Bul. 136.

have been grown successfully on similar soil in Adams County, and orcharding in York County would probably be more profitable than general farming.

### BERKS SHALE LOAM.

The surface soil of the Berks shale loam type is a brownish or light yellowish brown to pale-buff silty loam, 8 to 10 inches deep. The subsoil is a yellowish-brown to pale-buff, friable silty clay loam. A high percentage of small, flat shale or slate fragments is a characteristic of the type, forming on the average probably 40 to 50 per cent of the bulk of the soil mass through the 3-foot soil section. The thickness of the soil and the percentage of rock fragments vary with the topography; in places on steep hillsides the subsoil is largely a loose mass of shale fragments. Such a mass is reached at depths varying from 12 to 36 inches. The depth to hard, impervious rock over most of the area is 3 to 5 feet. The high proportion of shale fragments in the soil and substratum tends to produce a very open structure and allows free aeration and root penetration, but also permits of a somewhat too free underdrainage; crops therefore frequently suffer during dry periods. In a few places the subsoil of the type was observed to be of a reddish color, but the areas are hardly extensive enough to warrant separate mapping. The red color seems to be due to iron oxide, formed by the alteration of pyrite by weathering agencies. Scattered crystals of pyrite in the unaltered shale were observed at several localities.

The Berks shale loam grades into the Manor slate loam type on the south, and in places a line of division between the two soils is arbitrary. In color, however, the typical Berks shale loam has a lighter surface soil, while the subsoil is brownish-yellow or pale-buff in contrast to the characteristic yellowish-red or reddish-yellow of the Manor series. The Berks shale loam is also closely related to the Edgemont loam to the north, which is also derived in part from shales and slates similar to those underlying the Berks series. The rock fragments in the Berks shale loam, however, are on the whole smaller and flatter and the soil and subsoil are slightly darker in color and have a higher content of silt and clay than in the Edgemont soils.

The principal area of this type occurs in a belt of hills bounding the York Valley on the southeast, which extends entirely across the county in a northeast-southwest direction. This belt varies from 2 miles in width in the eastern part of the county to a maximum of 5 miles south of Hanover. There are in addition several small areas to the north of this belt occurring as rounded hills and ridges rising above the Hagerstown loam. Two small, isolated areas occur along Yellow Breeches Creek, the northern boundary of the county.

The topography in general is undulating to hilly. The soil is everywhere well drained and some of the steeper hillside land suffers

from soil erosion and excessive leaching out of fertilizers. In some places the steepness of slopes adds materially to the labor and expense of tillage and harvesting of crops.

The soils are residual from shales and slates of probable Ordovician or Cambro-Ordovician age. The beds have not yet been accurately classified and mapped in this county; they were designated in the older geological surveys of Pennsylvania as "Cambrian phyllites" and "Hudson River slates." Some of the beds are probably the equivalent of the Martinsburg shale. The shale or slate is fine-grained, drab, olive-green to almost black, weathering to various shades of yellow, brown, and even red. The rock has been dynamically metamorphosed with the development of hydrous micas or chlorite, and there seems to be a transition into the chloritic schists underlying the Manor soils. The slates are intersected by narrow veins of quartz, locally termed flint, and fragments are rather abundantly strewn over the fields.

In the few tracts of timber remaining white oak and hickory are the principal trees, with a smaller amount of chestnut, chestnut oak, and red oak. A thick undergrowth of bushes is found on the moist soils at the bases of hill slopes.

The soil is utilized principally for general farming, about 80 per cent or more of the type being in cultivation. Corn, wheat, and hay are the principal crops, with oats and rye grown to a less extent. Several small commercial apple and peach orchards have been established, and where proper care is taken of the trees good results may be expected. Irish potatoes are grown in small patches of one-half acre to 2 or 3 acres in connection with general farming. The yields are fair, the quality excellent, and this special industry might be extended with profit. Pennsylvania seed-leaf or broad-leaf tobacco is grown in the eastern part of the county, but the yields per acre are less than on adjacent limestone soils. The type is more productive than the Dekalb shale loam mapped in other areas in Pennsylvania.

Crop rotation is practiced, and the use of stable manure, lime, and commercial fertilizers is general. The soil responds readily to commercial fertilizers, and frequently the crop yields are as large as on the adjacent Hagerstown, although the average yields are considerably less and the expense and labor of producing crops somewhat greater. Yields of corn on the better improved farms are 40 to 50 bushels per acre, but on much of the thinner land the average is hardly above 25 bushels; wheat yields, with about 200 pounds of fertilizer per acre, are 18 to 20 bushels; oats, with 100 to 150 pounds of fertilizer, 30 to 40 bushels. Rye is grown principally on the thinner, poorer land, but gives fairly good yields, 15 to 20 bushels per acre. About 1 ton per acre of hay—timothy and clover—is obtained. Small

patches of millet are often sown after oats have been cut. Wheat occasionally freezes out during severe winters.

In cultivating this type for general farm purposes it is essential that a good supply of organic matter be maintained, and especial care should be taken to prevent loss of fertility from soil erosion. The plow furrows should as far as possible follow the contours of the hills, and the farm plats on hillside land should be so arranged that hay and small grainfields lie above or below cornfields, thus checking to some extent the wash of surface soil, which is greatest in fields cultivated for corn.

The selling price of the average farm of 50 to 100 acres is $40 to $75 an acre; there is considerable variation in price, depending upon improvements and distance from markets or railway lines.

### BERKS LOAM.

The surface soil of the Berks loam type is a brownish, mellow loam 8 to 10 inches in thickness. The soil characteristically contains a high percentage of silt, and not a few flat, poorly drained areas closely approach the silt loam or silty clay loam classes. The subsoil is a moderately friable, brownish-yellow or yellowish silty clay to a depth of 24 to 32 inches, thence it is generally more friable and contains a considerable percentage of fragments of decomposed shale or slate. The soil is freer from shale fragments, has a closer structure than the Berks shale loam, and is more retentive of moisture. Small angular blocks of white vein quartz, largely derived from the breaking down of veins in the underlying shale itself, are present in considerable quantities in some localities, notably near Hanover and southwest of York near Bairs Station.

The main body of this soil lies in the York Valley, extending from Wrightsville to Hanover, and is closely associated with the Hagerstown loam. Small, isolated areas of soils, comparatively free from shale fragments, occupying more nearly level tracts in the Berks shale loam area to the south of the Valley, were also mapped as this type. The loam also commonly occurs on the lower gentle slopes of the shale loam hills. The topography is nearly level to gently undulating in contrast to the hilly topography of the Berks shale loam. Natural drainage is deficient on many of the more level areas and the land could be materially improved by the installation of tile drains.

The soil is mainly residual in origin. The parent or underlying rock is a thinly laminated, minutely jointed argillaceous shale or slate of the same geologic age as that underlying the Berks shale loam. A few thin layers or lenses of limestone are interbedded in places with the shale, but the shale has been the dominant source of the soil

material. Not a little of the soil occurring in shallow drainage sags and at the bases of hillsides consists in part of colluvial material or wash from the shale loam. In the area lying north of Hanover adjacent to Pigeon Hills, near the line of contact with the Edgemont stony loam, there is considerable admixture of detritus from quartzite.

The tree growth is predominantly white oak and hickory on the few small woodlots remaining on the type, and these trees probably predominated in the original forest.

The type is devoted principally to general farming, with dairying as an important adjunct. The soil is mellow and easily tilled, and the subsoil retains sufficient moisture to carry crops through ordinary periods of dry weather. Corn, oats, wheat, and hay are the principal crops. Tobacco is grown in the valley east of York. Crop yields in general are about the same as those obtained from the Hagerstown loam, and the two types have about the same agricultural rank. Lime is applied at the rate of 50 to 75 bushels per acre every four or five years, and a commercial fertilizer high in phosphorus is generally used for the grain crops.

The present selling price of the land varies from $75 to $125 an acre, while small tracts near the city of York are valued at $150 an acre.

### MANOR SLATE LOAM.

The soil of the Manor slate loam type is characteristically a brownish, cinnamon-brown, or faint reddish silty loam to silty clay loam, underlain at a depth of 8 to 10 inches by terra cotta, reddish-yellow or yellowish-red, moderately friable silty clay. Both the soil and subsoil contain a high percentage of small rock fragments; these fragments are thin or flat and similar in shape to those in shale or slate soils, and the term "slate" is therefore used, although the parent rock is properly a schist. This land is locally called "slate land." In places the subsoil at a depth of about 30 inches passes into what is merely a loose mass of rock fragments, with insufficient fine material to fill the interstices. The fragments, however, are on the whole less abundant than in the Berks shale loam and are thinner and flatter than those of either the Berks shale loam or Chester stony loam types, which lie adjacent to the Manor, respectively, on the north and south. The stones are not large enough to interfere seriously with tillage and, being for the most part soft, do not exert much wear upon the implements. Both the soil and the subsoil contain a high percentage of micaceous minerals, mainly chlorite, in very minute particles, which impart a peculiar greasy feel. The greasy feel is one of the distinguishing characters in the field classification.

The surface soil of the type exhibits in places a decidedly dull reddish cast, this being especially pronounced after a rain, and the type has on

the whole more of a reddish shade of color than the adjacent Berks shale loam, from which it is not always easily distinguished. Locally, a considerable quantity of vein-quartz fragments is strewn over the fields, and where the underlying schist is highly quartzose and coarsely laminated the land is apt to be rough and stony. The stony areas, however, were not considered to be of sufficient extent to warrant separate mapping. The material of colluvial origin at the bases of steep hills in most places has a brownish or even grayish-brown color, rather than the typical reddish yellow, the lighter shade of the color being due to the rather continuously moist condition of the colluvial deposits and the consequent conditions unfavorable for oxidation and rather favorable to deoxidation.

The Manor slate loam occurs as a northeast-southwest belt, conforming to the general strike of the major geologic divisions, from 4 to 8 miles wide, which extends entirely across the southern part of the county. It includes the towns of Red Lion, Dallastown, Loganville, and Jefferson; it is parallel to the belt of Berks shale loam on the northwest and to the extensive belt of Chester and Cecil soils which occupy the southeastern part of the county. It is the middle belt of the three important soil series which occupy the plateau area to the south of the York Valley.

The topography is rolling to hilly; the type occupies alike rolling upland and very steep hillsides and valley slopes. The elevation of the upland or plateau level is for the most part 800 to 900 feet above sea level, while Codorus Creek and its tributaries have cut narrow valleys 150 to 250 feet deep. The natural drainage is good; in fact, there is an entire absence of swampy or ill-drained land. Erosion is excessive on steep hillsides and some of the hill land along the larger streams is too steep for successful cultivation for general farm crops, but many or most of the slopes are sufficiently gentle and regular for safe cultivation. On many of the steep hillsides in the vicinity of Glen Rock, and southeast of Hanover, erosion in cultivated fields has greatly lessened the natural fertility of the land; the soil covering in a number of places is not more than 12 to 18 inches, and rock outcrops are not uncommon.

The soil is residual in origin, excepting certain small areas of colluvial soils at the bases of hillsides, which are really not typical nor representative. The parent rock is an extensive schist formation of probable Ordovician age.

The rock is fine-grained, highly schistose or thinly laminated and greenish or greenish gray in color. The beds are highly inclined to vertical. Chlorite is the principal mineral constituent, while quartz is the next most abundant megascopic mineral. Pyrite is also a common constituent. The weathered schist has a variety of colors, due to various stages of oxidation of pyrite and other iron-

bearing minerals, ranging from yellowish brown and terra cotta to deep vermilion. The rock was very probably originally a sediment in the nature of shale and has assumed its present structure amd mineral composition through intense regional metamorphism. The argillaceous shale or slate underlying the Berks shale loam seems in passing southward to become gradually more foliated and more chloritic, changing into the greenish chlorite schist underlying the Manor, so that no line of division can be accurately drawn, and this same difficulty is experienced in separating the soils. In contrast to the mica schists underlying the Chester and Cecil soils, that underlying the Manor is more thinly laminated or less massive in structure, less crystalline, and contains smaller amounts of mica and feldspar. The micaceous mineral is predominantly chlorite, while in the schists and gneisses underlying the Chester it is biotite or muscovite or some closely allied mica. A few narrow belts of quartzite and several narrow, lenslike bodies of limestone are found in association with the chloritic schist. The quartzite or quartz-chlorite schist produces the rough and stony ridges which are present throughout the Manor slate loam area. The limestone, on account of its very small areal distribution, has been a negligible factor in determining the character of the soil.

The tree growth on this type is predominantly chestnut, especially on the thinner and stonier land. On the deeper and moister soil, those of colluvial origin, on the lower slopes of hills, a greater variety of growth exists; in addition to chestnut, white oak, red oak, hickory, tulip, mountain maple, dogwood, chinquapin, and elm were observed.

It is estimated that 85 to 90 per cent of this type is under cultivation, being utilized principally for general farming. The soil on the whole is loose, friable, and easily plowed, and does not seriously clod or crust even when worked moderately wet. Much of the hillside land is troublesome to cultivate, on account of the steepness of the slopes; in addition such land is somewhat droughty.

Corn, wheat, oats, and hay are the principal crops; rye, tobacco, Irish potatoes, and buckwheat are less important products. Dairying, especially along the lines of the Northern Central and Western Maryland Railroads, is an important adjunct of general farming. Truck crops are also grown in a small way for the supply of local markets. Crop rotation is practiced, the plan being that which generally prevails throughout the county, and the use of stable manure, lime, and commercial fertilizers is general. Excellent crop yields are obtained on the more level upland, being equal to those obtained on the naturally more fertile Hagerstown, Berks, and Chester loams, and a large number of well-improved and prosperous farms can be found on this type; the yields on the steeper hillsides,

however, are low and considerably reduce the average for the type. Peaches seem to do fairly well, and there are a number of small commercial orchards south and southeast of York. Tobacco is grown only in the eastern part of the county. Where the land is heavily manured and fertilized yields of 1,200 to 1,600 pounds per acre are obtained. Buckwheat is a catch crop only, the fields ranging from one-half to 8 or 10 acres in size; yields of 25 or 30 bushels are obtained by a few farmers, but the average is certainly much lower. Irish potatoes yield well, and a greater acreage might be profitably devoted to this crop. The following crop yields are probably near an average for this type: Corn, 40 bushels; wheat, 15 to 20 bushels; oats, 30 to 40 bushels; hay, 1 ton per acre.

On the more arable upland fruit growing is not likely to be as profitable as general farming. Much of the hillside land is too steep for successful cultivation of general farm crops and might be placed in orchards or in permanent pasture. Erosion of the surface soil is serious in many places, but the effect is not at once very evident to the average farmer, because the erosion is principally in the nature of blanket removal of the soil without the formation of deep gullies. The land on this type on the whole is in need of larger amounts of organic matter.

The better land of the Manor slate loam type near railway lines or good local markets is valued at $50 to $90 an acre. The selling price of the more inaccessible and rougher land is $20 to $40 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Manor slate 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.* | *Per cent.* |
| 181701 | Soil | 4.5 | 4.7 | 2.2 | 6.4 | 6.0 | 54.3 | 21.7 |
| 181702 | Subsoil | 2.4 | 2.8 | 1.5 | 5.8 | 6.6 | 63.1 | 17.2 |

### MANOR SILT LOAM.

The soil of the Manor silt loam type is a yellowish-brown to faint reddish-brown, mellow silt loam to a depth of 8 to 10 inches; the subsoil is a yellowish-red silty clay loam. At a depth of about 3 feet the partially decomposed parent rock is present in sufficient quantities to give a pronounced friable structure. The soil and subsoil contain a high percentage of minute flakes of micaceous minerals and have the same distinctive smooth or greasy feel that the slate loam type possesses. The soil differs from that of the slate loam in being comparatively free from rock fragments, in having a higher silt content, a heavier surface soil, and a closer, more compact struc-

ture favoring greater retention of moisture; the soil also on the whole contains a slightly higher amount of organic matter.

This type occurs as small areas having irregular boundary lines, scattered throughout the Manor slate loam belt. It occupies nearly level to gently rolling country, the smooth portions of drainage divides or ridges, and also appears on very gentle slopes and in the bottoms of shallow drainage depressions. Much of it in the latter topographic position is partly colluvial in origin, representing fine material washed from hillsides occupied by the slate loam type. On account of the small size of the areas, no attempt was made to map this somewhat heavier colluvial soil. Many small bodies of the silt loam from 1 to 4 or 5 acres in extent will be found included in the slate loam type.

The rock underlying the type is essentially the same as that from which the Manor slate loam is derived, and it is therefore concluded that topography has been the principal factor in determining the soil differences.

The soil tends to clod when plowed wet, but otherwise no especial tillage difficulties are encountered. Many of the low-lying areas in drainage depressions might be tile-drained to advantage.

The land is utilized chiefly for general farm crops, producing perhaps slightly higher yields, especially of hay, than are obtained from the Manor slate loam. The soil, if properly drained, should be excellent for Irish potatoes; it is also suitable for celery and asparagus.

### CHESTER SLATE LOAM.

The surface soil of the Chester slate loam is a pale-yellowish to grayish-brown, friable, silty loam, 10 to 12 inches deep. The soil is grayish in color when very dry; it contains a small percentage of flattish to blocklike rock fragments—sufficient to impart an open, porous structure, but not large enough to seriously interfere with cultivation. The subsoil is a yellowish or pale yellowish brown, friable silty clay loam. Loose, disintegrated rock is generally encountered at 30 inches to 3 feet. The subsoil has a smooth, greasy feel, but is, perhaps, on the whole less distinctly greasy than the typical Manor slate loam. This soil is similar in texture, structure, and origin to the Manor slate loam, but shows a considerable departure in the matter of colors in that the subsoil rarely has a reddish cast. Except for its micaceous character it might with equal propriety be considered a phase of the Berks shale loam.

The principal areas lie in the East Prospect basin, closely associated with the Conestoga loam; a second narrow belt lies on the south side of Kreutz Creek, extending from near Yorkana to about a mile west of Ore Valley. The light-colored schist soils are also conspicuously developed along Codorus Creek near Reynolds Mill. The broad east-

west valley extending from Seven Valleys westward to near Jefferson is also occupied by light-colored soils referable to this type. Other small areas occur throughout the belt occupied by the Manor series, but have not been mapped separately on account of their small size.

The topography is rolling to moderately hilly and the land is naturally well drained.

The soil is residual from the weathering of grayish phyllite and chlorite schist. In the vicinity of East Prospect the rock is a slaty and schistose quartzite or a highly siliceous phyllite. It is gray or greenish gray in color; it is composed principally of silvery-gray chlorite and fine quartz and is speckled with black and brown mica. Scattered cubes of pyrite are common. The rock weathers to a pale-yellow or brownish color. It is less thinly laminated than that underlying the typical Manor slate loam and the rock fragments in the soil are consequently thicker or more blocklike. It is very probable that the rock represents a metamorphic sediment, originally in the nature of a fine sandy shale. It is less crystalline than the schists and gneisses underlying the Chester stony loam and loam and very probably belongs to a younger series of rocks. Along Kreutz Creek and near Ore Valley the schist differs from the typical greenish schist of the Manor series belt in having a higher percentage of gray or silvery chlorite or micaceous minerals and a slightly higher percentage of fine quartz and a lighter color, but is similar in structure.

This soil is utilized principally for general farm crops, practically all of it being under cultivation. Tobacco is grown to a small extent and Irish potatoes seem to do well and might be more extensively grown. In agricultural rank the soil is equal or perhaps slightly superior to the Chester stony loam and Manor slate loam.

### CHESTER LOAM.

The soil of the Chester loam to a depth of 12 to 15 inches is a brownish to yellowish-brown, mellow, friable loam. The subsoil is a yellowish or brown to yellow, friable clay loam, which in many places assumes an orange color in the lower subsoil. The surface soil is a light grayish brown when very dry; it is generally a light loam in texture; the subsoil is characteristically granular, rarely very compact or plastic, and contains a considerable percentage of micaceous minerals, yet on the whole is not distinctly micaceous and does not possess the distinctively greasy feel of the Manor soils. The depth of the soil mantle is for the most part 4 to 8 feet, but in some places it is 12 to 15 feet to hard, unaltered rock. The soil generally contains small, rather flat chips of schist and also a less amount of small, blocklike fragments of vein quartz, but these are nowhere sufficient to interfere with tillage. Sections of the typical soil near Stewartstown and Newpark reveal, first, brownish, light, friable loam about 12

inches; yellowish or yellowish-brown friable clay loam 20 inches to 2½ feet in thickness; soft, rather fluffy, highly micaceous material, with a lower clay content than the stratum above, 2 to 3 feet; thence soft decomposed or disintegrated schists, with hard rock at 8 to 15 feet from the surface.

The principal departures from the more typical Chester loam are certain small areas of soils lying southwest of Red Lion which have a darker colored soil and a yellowish to drab, rather greasy clay subsoil full of small, black schist fragments. Some of the areas near Delta have a reddish-yellow or yellowish-red color in the lower part of the subsoil. These either represent the Manor silt loam or a close approach to that type.

The Chester loam occupies a large area in the southeastern part of the county. The northern limit of this area is approximately marked by a line extending northeastward from Blackrock, near the Maryland line, to Glen Rock and Red Lion, thence eastward to Susquehanna River. Small outliers occur in the vicinity of East Prospect, Seven Valleys, and Loganville. The principal area is a dissected plain or plateau having an elevation of 700 to 900 feet on the northwest, decreasing to 500 to 600 feet above sea level on the southeast. The Chester loam occurs on the level tops of narrow ridges and in larger bodies on certain more level, plainlike areas which have not yet been subjected to minute stream dissection. There are also small bodies on the gentle slopes of the shallow drainage depressions which are found at the heads of small branches and creeks. The natural drainage of the land is adequate for the staple farm crops at present grown. There are no swamps. Erosion is nowhere excessive, nor is the land too rough or too steep for easy tillage.

The soil is residual in origin from dark-gray to greenish-gray mica schists and mica gneisses, probably pre-Cambrian in age, and belonging to the Wissahickon gneiss and schist formation. The rocks have been highly altered by regional metamorphism and are generally foliated, highly micaceous or chloritic, but in places are rather massive, coarse grained, crystalline, and in their mineral composition suggest that the original rock was a granite. Rocks of sedimentary origin are very probably represented in the complex, but have been so highly metamorphosed that little trace of their original character remains. The soil of those areas in the vicinity of East Prospect and between Seven Valleys and Jefferson is residual from a bluish-gray or gray siliceous phyllite, less schistose than the typical greenish chlorite schist of this part of the county.

It is estimated that 90 per cent or more of the land is under cultivation and of the original forest only a few woodlots have been left. The tree growth was principally chestnut and chestnut oak, but oak

and hickory formed a greater proportion of the timber than on some of the Cecil, Manor, and Chester types which are adjacent to it.

The land is easily plowed, rarely clods or crusts, and a good tilth can be easily maintained where a reasonable amount of care in cultivation is exercised. The soil holds fertilizers well; the subsoil is fairly retentive of moisture, but is not so close and compact as to hold excessive amounts during rainy periods, and the soil therefore warms up fairly early.

The Chester loam is utilized more extensively and for a greater variety of crops than any other soil type in the county. It is utilized principally, however, for general farming and is excellently adapted for this purpose. Many of the best farms of the county are located within the area of this type. Corn, wheat, oats, hay, potatoes, and tobacco are the staple crops grown. Conservative estimates of the average yields on the better farms are: Corn, 40 to 60 bushels; wheat, 20 to 25 bushels; oats, 40 to 50 bushels; hay, timothy, and red clover, 1½ to 2 tons per acre; potatoes, 150 bushels; tobacco, 1,500 pounds. Rye and buckwheat are grown, but the acreage is much smaller than for the other grain crops. Crop rotation is practiced, and the use of stable manure and commercial fertilizers is general. Lime is used by the better farmers where the cost of transportation is not excessive, and applications of 35 to 50 bushels of burnt lime or 700 to 800 pounds of pulverized lime every four or five years seem to be very beneficial. Manure at present is produced principally by the feeding of stock during the winter. Dairying is carried on to some extent and might be profitably extended in connection with general farming, especially on areas within easy reach of transportation lines, so that milk can be shipped to near-by cities.

Tobacco and potatoes are, over most of the area, the principal money crops. Very little hay or grain, excepting wheat, is sold from the farms. Pennsylvania seed leaf is the principal variety of tobacco. Burley has been grown to some extent and fair yields obtained, but there is little market demand for it in this section. Irish potatoes are planted on this and the similar Chester stony loam type to a greater extent than on any other soil types. They have a definite place in the crop rotation plan, generally following corn, and there are no exclusive potato farms. Fields average from 2 or 3 to 20 acres in size. There are a very large number of varieties, but the American Giant seems to predominate. Tomatoes and sweet corn are extensively grown, especially in the vicinity of Stewartstown, Fawn Grove, and Red Lion, for the supply of local canneries. Cabbage is grown along the Stewartstown Railroad, and with proper fertilization and cultivation gives yields of about 15 tons per acre. Apple trees have a vigorous growth, and the quality of the fruit is good. Nearly every farm has a small orchard for home use, and there are a few commercial

orchards. It is believed, however, that in the end general farming will be more profitable than orcharding. The Chester stony loam type affords much cheaper land equally or better adapted to fruit growing.

Much of the better land of this type lying near railways is valued at $75 to $100 an acre, while farm land less accessible to markets is valued at $40 to $60 an acre.

### CHESTER STONY LOAM.

The soil of the Chester stony loam is a friable, slightly micaceous brownish loam to a depth of 12 to 14 inches. The subsoil is a brownish-yellow or yellow slightly micaceous clay loam which grades into yellow clay in the lower part of the soil section. The subsoil on the whole, even where the clay content is highest, is not distinctly plastic or compact. A high percentage of rock fragments, varying from gravel size up to fragments for the most part 18 inches to 2 feet in length, are strewn over the surface, but in many places along the bluffs of the Susquehanna River and Muddy Creek the fragments are even much larger and in addition the land is so steep that it is of little agricultural value. The subsoil of the type is also stony and in many places at a depth of 2½ or 3 feet is merely a loose aggregation of rock fragments, with not enough fine material to fill up the spaces between, so that the lower subsoil and substratum is on the whole very open and porous. Colluvial accumulations at the bases of hills or valley slopes, representing wash from the higher land, reach a thickness of 12 to 15 feet. The soil of colluvial deposits is thicker, retains moisture better, is slightly darker in color, and is naturally more fertile than the higher lying land.

This type and the Chester loam are closely associated and are coextensive, being confined to the southeastern part of the county, roughly to the area lying southward from Red Lion and Glen Rock. This area is rather deeply dissected by streams and the topography may be described as hilly. The bottom of the Susquehanna River gorge lies about 500 feet below the general upland level and even the small streams have narrow, V-shaped valleys 150 to 300 feet deep. The Chester stony loam occupies the hillsides or valley slopes, while the loam type is confined mainly to the more level upland. The steepness of much of the land interferes with easy cultivation and makes much of it undesirable for general farming. Unless precautions are taken, much of the land on the steeper hillsides is subject to serious blanket erosion of the surface soil and many abandoned fields may also be observed where destructive gullying has begun.

The rock from which the Chester stony loam is derived is a mica schist and mica gneiss, the same formation that underlies the Chester loam type. Topography has been the primary factor in producing

the differences between the two types. Near the line of division between this type and the Manor slate loam the rock is highly schistose, chloritic, and similar to that underlying the Manor, and the soils are likewise similar in their outward physical appearance. In passing from one area to the other after a few miles one realizes that a soil change has taken place, but it is in many places rather difficult to determine just where a line of division should be established.

The native tree growth on the type is predominantly chestnut and chestnut oak, but there is in addition a large variety of other trees; on the lower lying, moister colluvial soils white oak, red oak, hickory, tulip, dogwood, beech, and cherry birch are rather common. Papaw, cucumber tree, sycamore, and walnut are less frequently observed. Scrub pine and cedar appear in many places, while hemlock is rather common on steep, rocky hillsides along Susquehanna River and Muddy Creek.

Notwithstanding the hilly character of the land and objectionable stone content, probably 75 per cent of this type is in cultivation. Practically the same crops are grown as on the Chester loam type. Crop yields are on many farms equal to those produced on the loam type, but the expense of producing the same yields is greater on account of difficulties of tillage, while commercial fertilizers are not retained as well and the percentage of waste land on the average farm of 50 to 100 acres is much larger. On the whole the average crop yields are less and the net income per acre less than from the loam type. The largest yields of tobacco are obtained on the lower lying colluvial soils, where the natural humus supply is largest.

In the cultivation of the greater part of the land of this type care should be taken to prevent erosion if soil fertility is to be maintained. By following the contours of the hills in plowing, erosion will be checked to some extent, yet even this obvious and simple precaution is not always observed. It is possible on practically all of the farms so to divide the land into plots that an entire hillside will not be in corn at any one time and that grass and some other crop of the rotation lies above or below the corn. This plan will be helpful, since the most serious erosion takes place when the land is in corn.

The better farms on this type have a selling price of $40 to $80 an acre, but the greater part of the land is valued at $20 to $40.

### CECIL CLAY LOAM.

The Cecil clay loam, as it is typically developed in the vicinity of Shrewsbury and New Freedom, is a dark-brown to reddish-brown friable heavy loam to clay loam about 12 inches deep. The immediate subsoil is a light reddish friable clay loam; the color increases in intensity with depth, and the material of the lower subsoil is a red granular clay. Decomposed and disintegrated rock is generally encountered

at a depth of 2½ or 3 feet. The surface is strewn with small, flattish fragments of schist, more latitude perhaps having been allowed in the percentage and size of stones in the mapping of this type than in the Chester loam. In many places, especially in the vicinity of Stewartstown and eastward from this place, the surface soil in color, texture, and structure does not differ materially from that of the Chester. The subsoil, however, especially in the lower part of the 3-foot section, is distinctly red, and this color difference is the principal basis for a separation of the two soils. The subsoil is granular and moderately friable, as is that of the Chester, and is also slightly micaceous, but not decidedly so.

The Cecil clay loam is closely associated with the Chester loam, and has a similar topography. The difference in the color of the subsoils is believed to be primarily due in most localities to slight differences in the mineralogical composition of the underlying rock. The schists and gneisses underlying the Cecil clay loam seem to contain larger proportions of one or all of the minerals (chlorite, pyrite, magnetite, and garnet) than the schists underlying the Chester. The topography and drainage conditions of the two are for the most part very similar and consequently difference in the degree of oxidation of iron-bearing minerals is not an adequate explanation, except, perhaps, in a very few instances. The rock from which the Cecil is derived is prevailingly a dark greenish or gray schist and gneiss belonging to the pre-Cambrian complex which occupies the southeastern part of the county. The origin of the rock is not clear, but it is believed in the main to represent highly metamorphosed igneous rocks.

The Cecil clay loam is somewhat similar to the Manor slate loam in that both have reddish subsoils and in places where the two are adjacent show intergradation, so that the line of division shown on the soil map is somewhat arbitrary. The principal differences between the typical soils are: The subsoil of the Cecil clay loam has a more intense red color, is more granular, has a coarser structure, and although slightly micaceous does not possess the smooth, greasy feel which is so characteristic of the Manor.

The tree growth on the Cecil clay loam was probably very similar to that on the Chester loam. It is stated, however, that there was probably a somewhat greater proportion of chestnut on the Cecil, and this is borne out by observations on the few remaining tracts of woodland.

The land is well drained, and no especial tillage difficulties are encountered. The same crops are grown as on the Chester loam and the two seem to have about the same agricultural rank, with possibly slight differences in crop yields in favor of the Chester loam.

### CECIL STONY LOAM.

The surface soil of the Cecil stony loam is a brownish mellow loam 10 to 12 inches deep. The subsoil is a friable clay containing a high percentage of coarse rock fragments; the color is generally a somewhat lighter shade of red than prevails in the subsoil of the Cecil clay loam. The surface is strewn with rock fragments in such size or in such abundance as to interfere seriously with tillage. The virgin soil contains a good supply of humus, but this is lost after a few years of cultivation where the land has been cleared of stones, partly by oxidation and to a considerable extent by erosion. Some colluvial accumulations at the bases of steep slopes which are in a continuously moist condition have a brownish subsoil not materially different in aspect from the Chester stony loam, although a red color is nearly everywhere present at a depth of 3 feet or more.

This type is not widely distributed and the total acreage is small in comparison with the analogous Chester stony loam. The principal areas occupy the rough hilly country lying south and southeast of Glen Rock and north of New Freedom. Fields which have been cleared of stones suffer from erosion unless preventive measures are taken.

The land has a much lower agricultural value than the clay loam type, on account of the roughness of the topography and the large size of the stones. Orcharding is feasible on some of the more favorably situated and gentler slopes. The greater part of the type is at present in forest, chestnut and chestnut oak, together with some white oak, red oak, and hickory, being the predominant trees. Scrub pine and cedar are conspicuous in places, especially on cut-over land and in abandoned fields.

### CARDIFF SLATE LOAM.

The soil of the Cardiff slate loam type is a dull-brownish friable loam, 8 to 10 inches in thickness. The immediate subsoil is a dull brownish yellow, friable clay loam, which, within a few inches, passes into a lighter colored yellowish clay. The soil and subsoil are characterized by a high percentage of black slate particles and fragments from one-half inch to 3 or 4 inches in length. The slate fragments produce the open, friable structure, the fine interstitial material itself being a heavy silty loam to clay loam, while the finer material of the subsoil is a plastic clay or clay loam. The depth of weathering or decomposition of the rock is generally 3 to 6 feet. Beneath 3 feet the slate fragments increase in size and percentage, there being very little clay.

The type is confined to one locality, a narrow ridge one-half mile to 2 miles wide, extending from Delta, on the Maryland line, northeastward to the Susquehanna River, a distance of about 6 miles.

The ridge has a uniform elevation of 500 feet above sea level and rises rather prominently above the adjacent Chester loam and stony loam areas to the north and south. The natural drainage of the soil is good.

The soil is residual from the Peach Bottom slate formation, which is extensively quarried for roofing slate in Maryland and Pennsylvania. The rock is pretty uniformly a black or bluish-black, fine-grained, jointed slate. The beds are intersected in places by veins of quartz, and there is a narrow band of quartz conglomerate near the Maryland line; but these rocks have not had much influence in determining the character of the soil.

The tree growth is predominantly chestnut, with a less proportion of chestnut oak, red oak, white oak, black oak, hickory, and honey locust. Cedar is conspicuous on a few tracts of thin land.

About 75 or 80 per cent of the Cardiff slate loam is in cultivation. A considerable part of the area near Delta is occupied by slate quarries. The crop yields are reported as being about as good as on the adjacent Chester soils, except during dry years. The yields on the better farms are, during favorable years: Corn, with 200 to 300 pounds of commercial fertilizer, 50 bushels per acre; wheat, with 300 to 400 pounds of fertilizer, 18 bushels; oats, with 200 pounds of fertilizer, average about 30 bushels per acre; hay (timothy and clover), about 1 ton per acre. Crop rotation is practiced, as in general throughout the county.

The present selling price of farming land is about $35 an acre.

### HAGERSTOWN LOAM.

The Hagerstown loam is a brown mellow silty loam to silt loam, underlain at about 10 to 12 inches by yellowish-brown or dull-red clay of moderately friable structure. The surface soil contains a rather high percentage of silt and in several places approaches a silt loam and silty clay loam rather closely, but these slight textural variations are not believed to be sufficient to effect important differences in crop adaptation and agricultural value, and hence a refined division of the Hagerstown soils on the basis of texture was not attempted in the present survey. Soil having a decidedly sandy nature occurs in two small areas—one in the western part of the city of Hanover and a second about a mile east of Hanover. Since these sandy soils are in very small bodies and of little agricultural importance, they are included with the loam type on the soil map.

The subsoil is a compact or moderately stiff, brownish-yellow to reddish-yellow or dull-red clay and clay loam, which in most places becomes more granular and friable in the lower part of the 3-foot section. The clay subsoil or substratum changes rather abruptly to rock, so that there is a distinct plane of separation between the hard lime-

stone rock and the overlying residual material. The depth to rock varies from 3 to 15 feet in thickness, and there are comparatively few rock outcrops.

The soil is generally free from stones, except where it is adjacent to stony soil types of other series where there has been a mingling of soil materials due to wash or creep from higher to lower levels. Water-worn or rounded quartz and quartzite pebbles were found in places in the York Valley, but not in sufficient quantity to impart a gravelly character to the soil. Gravelly areas also occur in the northern part of the county along Yellow Breeches Creek, west of New Cumberland. In this latter instance the gravel probably represents erosion remnants of a Pleistocene terrace deposit. Fragments of vein quartz strewn over the surface are especially abundant near Hanover, but these were probably derived from veins in the shale underlying the closely associated Berks loam rather than from veins in the limestone.

The principal areas of the type are located in the York Valley, extending from Wrightsville to Hanover. A second important area occurs along Yellow Breeches Creek, extending for a distance of about 5 miles westward from New Cumberland. A small separate basin occurs at New Holland, on the Susquehanna River.

The Hagerstown loam occupies low lying or valley land. The surface is level to gently rolling. The natural drainage is for the most part adequate, but some of the more nearly level flat areas in the York Valley could be greatly improved by tile drainage.

The soil is residual in origin, principally from limestones probably belonging to the Shenandoah group of Cambro-Ordovician age. The limestone is generally bluish gray to blue-black, massive to slightly schistose, and minutely jointed. Thin layers of shale are intimately interbedded with the limestone, but the latter rock rather than the shale has been dominant in determining the character of the soil. The interbedded shales in several places were observed to be highly calcareous.

The land was originally timbered with a sturdy growth of oak, hickory, ash, elm, walnut, sycamore, and other hardwoods.

Little difficulty is experienced in plowing and in maintaining a good tilth. The soil structure and topography are favorable for the retention of moisture.

The land is practically all under cultivation and the Hagerstown loam is regarded as one of the most valuable types for general farm purposes. Corn, tobacco, wheat, oats, and hay are the staple crops, while dairying is carried on extensively in connection with general farming. Rye is grown to a much smaller extent than oats and wheat. The average crop yields on well-improved farms are: Corn, 50 to 60 bushels; wheat, 20 to 25 bushels; oats, 40 to 50 bushels;

hay (timothy and clover), 1½ to 2 tons per acre. Tobacco, cigar filler and binder class, is grown in the valley east of York and in the New Holland area. The yields obtained vary from 1,200 to 1,800 pounds per acre. Wheat and tobacco are the principal sources of ready money; oats and forage crops are largely fed on the farm. Crop rotation is generally practiced, the fields being kept in wheat and grass either one or two years and in other crops only one year. Stable manure, lime, and commercial fertilizers are generally used. Slaked lime is applied at the rate of 50 to 75 bushels per acre. Such an application should be sufficient for a period of 8 or 10 years.

Farming land of this type is valued at $75 to $150 an acre, and even higher prices have been obtained for small tracts near the city of York. Location, however, in instances of very high prices, rather than especially superior productivity, has controlled the price.

### HAGERSTOWN CLAY LOAM.

The Hagerstown clay loam is very similar to the Hagerstown loam, differing chiefly in texture. The surface soil is a brown friable clay loam to silty clay loam having an average depth of about 12 inches. Probably not all of the soil in the area mapped as this type is a clay loam in texture, but this is the prevailing texture, and the soil, on the whole, is heavier than that in the Hagerstown loam. The land is more difficult to plow and keep in good, mellow tilth than the Hagerstown loam. The subsoil is a yellowish-brown to reddish, rather stiff clay, which becomes a little more friable at a depth of 32 to 36 inches.

Only one area of this type was mapped, an elliptical body of less than a square mile lying north of Dillsburg. The topography of this area is a little rougher or hillier than that of the typical Hagerstown loam, although there is no serious soil erosion.

The soil is residual from a limestone formation, which is probably of the same geologic age as that underlying the Hagerstown series at other localities in the county.

Practically all of the land is in cultivation and is devoted to general farming, corn wheat, oats, and hay being the staple crops. The crop yields are little if any lower than on the Hagerstown loam, but the selling price of the land is somewhat less, on account of its less favorable location with reference to railways and markets.

### CONESTOGA LOAM.

The soil of the Conestoga loam to a depth of 10 or 12 inches is a medium-brown to dark-brown, mellow, silty loam. The soil is comparatively free from rock fragments of such size as to give a gravelly character or interfere with cultivation, but contains a small proportion of dark-colored, thin, flaky particles, which impart a rather porous,

friable structure. The subsoil to a depth of about 30 inches is a yellowish-brown, friable clay loam to clay, containing a rather high percentage of micaceous rock particles which impart a smooth or greasy feel. Beneath 30 inches the subsoil becomes more friable, the clay content decreases, and the increased percentage of flaky rock particles gives the material an even more graphitic or greasy feel than the upper subsoil and soil. The lower subsoil also has a peculiar greenish-yellow color. Hard rock is encountered generally at a depth of 4 or 5 feet, but rock outcrops on steep hillsides are not uncommon. The Conestoga loam differs from the Hagerstown chiefly in having a darker colored and more friable surface soil and in having a coarser and more open subsoil.

The type is not widely distributed. The only area mapped occurs in the basin in which East Prospect is located, about 5 miles south of Wrightsville. This body is the westward extension of a very large area across the Susquehanna River in Lancaster County.

The area occupied by the type is rolling to hilly and the topography on the whole is more varied than that of the Hagerstown. The natural drainage is adequate for the general farm crops grown, and, excepting a few steep hillsides near the Susquehanna River, the land is nowhere too rough or precipitous for easy tillage.

The soil is residual from a thin-bedded, bluish-gray to black, highly schistose limestone, together with a smaller amount of black, calcareous shale or slate. The limestone was doubtless originally massive and the schistose or thinly laminated character is due to intense mashing or shearing of the rock from regional metamorphism. The dark color seems to be due to carbonaceous matter, which is in a later stage of conversion to graphite.

Practically all of the land is under cultivation and none of the original forest remains. Oak and hickory were probably the principal tree growth. The honey locust seems to have a sturdier growth on the limestone soil than on the adjacent shale or slate soils.

A good tilth is easily maintained and the soil retains moisture and fertilizers fairly well. The principal crops grown are corn, wheat, oats, hay, and tobacco. Yields of 50 to 75 bushels of corn are obtained on the better improved farms. The corn land is heavily manured with stable manure and in addition 100 to 150 pounds of some fertilizer high in phosphorus is used. The wheat yields are 20 to 25 bushels per acre, with 300 to 400 pounds of fertilizer, generally 2–8–2 in composition. Very little commercial fertilizer is used for oats, of which the yield per acre varies from 30 to 50 bushels. The yield of hay, almost exclusively timothy and clover, varies from 1½ to 2½ tons per acre. Tobacco, the Pennsylvania seed-leaf variety, is a staple money crop; 1,200 to 1,500 pounds per acre are considered

good yields. The tobacco land is heavily manured, and in addition 500 to 700 pounds of a commercial fertilizer high in potash is applied.

The land is at present valued at $60 to $100 an acre. The natural fertility of the land is nearly equal to that of the Hagerstown loam. The somewhat lower selling price is due to location rather than to a corresponding lower productivity.

### DECATUR CLAY LOAM.

The Decatur clay loam, so far as can be determined by field observations, differs from the Hagerstown loam and clay loam chiefly in having a red color. The surface soil is a reddish brown to red friable clay loam or heavy loam to a depth of 8 to 10 inches. The subsoil is a stiff clay, a blood-red or more intense red than the surface soil. In a few places fragments of chert, which appear over the surface, and coarsely disintegrated rock in the lower subsoil tend to produce a friable structure, but the cherty character is not typical of the soil as a whole. The thickness of the soil mantle is pretty uniformly 2½ to 6 feet, and there are but very few areas of rock outcrop in the fields.

The total area of this type is small in comparison with the Hagerstown soils. The principal development extends from the limits of the city of York westward, mainly north of the Western Maryland Railroad, to a distance of about 6 miles. Two small separate bodies occur near Menges Mill and a third occurrence is located a short distance north of the village of East Prospect.

The type occupies nearly level to gently rolling valley land. Natural drainage is adequate, while none of the land is so steep that it suffers from erosion. Practically the whole area can be cultivated and there is scarcely any waste land in individual farms.

The soil is residual from limestones belonging to the same geologic group as that underlying the Hagerstown. The rock is a bluish-gray to white, minutely jointed crystalline limestone, much of it in the nature of marble. It is freer from carbonaceous and other impurities than the limestone underlying the Hagerstown, and the red color of the soil is attributed to this lithologic difference.

Notwithstanding its heavy texture, the soil is mellow and friable, the natural humus content is good, and a good tilth can be easily maintained.

The same crops are grown and the agricultural practices are about the same as on the Hagerstown soils, and as at present utilized the type has about the same agricultural value. The color differences of the two series are, however, certainly indicative of obscure chemical or physical differences which, as adaptation of soils to varieties of plants becomes recognized by farmers, will be revealed in the character of plant, of growth, or in the quality of the products.

### ATHOL CLAY.

The surface soil of the Athol clay type is an Indian-red to dark blood red, stiff, plastic clay having a depth of about 8 inches. The subsoil is a very stiff, plastic clay, not materially different in texture and structure from the surface soil, but of a slightly lighter shade of red. The underlying rock, a limestone conglomerate, is encountered at depths of 15 to 24 inches. There are a few fragments of limestone and other rocks scattered over the surface. The soil contains small, calcareous particles in many places in sufficient amount to show effervescence with acids.

The total area of the type is very small and as mapped it is confined to four small, lens-shaped and roughly circular areas in the northwestern part of the county. One of the areas, about 2 miles west of Dillsburg, occurs on the lower slopes of South Mountain, where it has received creep or colluvial material from the quartzite soils of the mountain. The soil here is not quite as heavy as in the other localities, but the small size of the area hardly warrants its being mapped separately, and for convenience it is included in the clay type.

The soil is similar to the Penn series in color and is derived from rocks belonging to the same geologic group, but the admixture of foreign material, especially Paleozoic limestone, has imparted a different character to it. The parent rock is a Triassic conglomerate or breccia, which carries a large percentage of limestone pebbles and angular fragments varying from small size up to 12 to 18 inches in diameter, together with sufficient detritus from the older Triassic formations to impart a red color. This is the variety of rock commonly known as "Potomac marble." The calcareous conglomerate probably underlies a considerable area in the vicinity of Dillsburg, but only in the few localities mapped has it had any influence in determining the character of the soil.

The Athol clay is very intractable or difficult to till on account of its clayey nature and stiff structure, but gives excellent yields of wheat, hay, and corn.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Athol 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.* | *Per cent.* |
| 181729 | Soil | 1.2 | 2.4 | 1.6 | 6.0 | 12.9 | 51.8 | 23.9 |
| 181730 | Subsoil | 2.6 | 4.2 | 2.0 | 6.2 | 13.6 | 48.3 | 22.8 |

The following sample contained more than one-half of 1 per cent Calcium carbonate ($CaCO_3$): No. 181,729, 1.44 per cent.

ROUGH STONY LAND.

Rough stony land includes land which, on account of roughness of surface due to rock fragments and rock outcrop or to steepness of slopes, can not be cultivated and is, therefore, of little or no value for agricultural purposes. The land represents extreme stoniness or roughness of several different stony soil types and is regarded simply as the nonarable portions of these types, not differing to any extent in the character of the soil material. Such land is produced under several different topographic and geologic conditions. The areas occupy mountainous ridges and steep slopes where disintegration and decomposition of the rock have not kept pace with erosion, precipitous river and creek bluffs, and a few areas which, although occupying gentle slopes, are strewn with such large bowlders that the land can not be plowed. Practically all of the Rough stony land of York County is forested and brings in a small income from timber, fuel, and pasturage, although the grazing is on the whole scant.

Several large areas of rough land occur on the diabase knobs or mountains in the northern part of the county, such as Flat Mountain, Roundtop, Nells Hill, and Johns Knob. The land here represents extremely rough and stony phases of the Montalto stony loam and stony clay loam. The soil supports a thick growth and large variety of hardwoods, which under proper management can be made a continuous source of income from the timber and fuel which they yield. Even on this very rough land small patches of one-half to 1 acre have been cleared and placed in strawberries and raspberries.

There is a considerable area of nonarable land on South Mountain, in the northwestern corner of the county. The land here is covered with very large angular blocks of quartzite and there are also precipitous slopes almost bare of soil covering. The mountain is forested mainly with chestnut.

Several areas of Rough stony land were mapped in the Conewago Mountains, being associated with the Penn stony sandy loam.

The river bluffs and very steep hillsides along the Susquehanna River also form in the aggregate a large area of nonarable land. The upper slopes of bluffs are nonarable on account of their steepness, while in addition the soil covering is very thin, and the lower or colluvial slopes, on account of the presence of huge rock fragments which have rolled down from higher levels, are also too rough to be successfully cultivated.

Rough stony land is at present valued at $3 to $10 an acre, depending mainly upon the character of the timber growth.

BERMUDIAN SILT LOAM.

The Bermudian silt loam is an alluvial type, the material composing it having been derived mainly from the Penn soils. The name

is taken from Bermudian Creek, along which the soil is typically developed.

The surface soil is a dark Indian-red mellow silt loam, underlain at variable depths, generally 12 to 15 inches, by Indian-red friable silty clay loam to clay. The soil is generally free from stones or gravel.

The surface layer shows considerable variation in texture, and in several places passes into a loam or fine sandy loam, owing to the derivation of a large part of the alluvium from adjacent residual sandy loam. Fine sandy loam and loam were observed, particularly along Yellow Breeches Creek, in the vicinity of Lisburn. On the whole the silt loam class predominates and the loam and fine sandy loam spots do not seem to be of sufficient importance or extent in this area to warrant the establishment of new types. The lower subsoil in places—the more poorly drained spots—is mottled reddish, brownish, yellowish, or even grayish, depending upon drainage conditions.

The type is confined to stream courses in the northern part of the county. These bottoms are generally narrow, the maximum width being not more than one-half mile. Excepting along Conewago Creek, where some second-bottom material has been included, the bottoms are not more than 4 to 6 feet above their respective streams and are subject to frequent overflows. Drainage on the whole is poorly established, and where the land is to be placed under cultivation tile drainage or open ditches would be advantageous.

The type is only sparsely wooded; the greater part of it is in the condition of meadow, supporting a good growth of native grasses. Pin oak, shagbark hickory, elm, sycamore, ash, willow, and alder were observed.

Small areas of this type are under cultivation and the crop yields are good, but rather uncertain, on account of overflows, especially along the smaller streams. Unless the land can be drained and protected from overflows, which often remove the surface soil bodily, it should be utilized for pasture. There is, however, considerable land along Conewago Creek which is not often flooded, and on such yields of corn, wheat, oats, and hay are superior to those obtained on the Penn loam and other upland types of the Penn series.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Bermudian silt 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.* | *Per cent.* |
| 1817130 | Soil | 0.0 | 0.2 | 0.3 | 4.4 | 16.1 | 64.1 | 15.2 |
| 1817131 | Subsoil | .0 | .3 | .5 | 4.3 | 19.0 | 59.3 | 16.4 |

### CODORUS SILT LOAM.

The surface soil of the Codorus silt loam is typically a brownish to grayish-yellow floury silt loam 12 to 15 inches in depth. The subsoil is a yellow silty clay loam faintly mottled in places with grayish and brownish colors. The soil varies considerably in texture, ranging from a loam to silty clay loam, but the silt-loam class predominates. This soil is characterized particularly by a large percentage of finely divided chlorite or mica, both in the soil and subsoil, which imparts a greasy feel and peculiar structure. The soil is somewhat fluffy when dry, and on the other hand compact when moist, but possesses only a low degree of plasticity.

In its distribution it is confined mainly to Codorus Creek and its tributaries to the south of the city of York. It is first-bottom soil, lying generally not more than 4 or 5 feet above the creek levels. The bottoms are very narrow and in but few places reach a width of more than one-fourth mile. The material composing the soil is washed from soils derived principally from chloritic and mica schists, that is, the Manor and Chester soils. Some of the material comes from the Berks soils. Along the small tributaries in the extreme southern part of the county the alluvium possesses very little uniformity in texture, is subject to frequent overflows, and receives constant accessions of wash from hillsides. Most of the soil of this character has been mapped as Meadow.

There is only a sparse tree growth on the bottoms and none of the land can be aptly described as swampy. White oak, swamp white oak, pin oak, hickory, and willow were observed at several places. There are several different varieties of native grasses which attain a luxuriant growth and afford a nutritious hay.

The drainage of the land is poor and most of it is subject to rather frequent overflows. There is very little of the type in cultivation, but where it is farmed crop yields during favorable years are equal to those obtained on adjacent upland soils. The yields of native hay are good, as much as 2 tons per acre being cut during favorable seasons. Excepting a few of the naturally better drained areas, the land included in this type will probably give better returns if utilized for hay and pasturage instead of cultivated crops.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Codorus silt 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.* | *Per cent.* |
| 1817144 | Soil | 0.1 | 0.5 | 0.4 | 3.7 | 13.3 | 67.1 | 14.8 |
| 1817145 | Subsoil | .1 | .4 | 1.3 | 4.0 | 18.2 | 61.0 | 15.1 |

### WEHADKEE SILTY CLAY LOAM.

The Wehadkee silty clay loam consists of a pale yellowish brown to grayish-brown or drab plastic silty clay loam, underlain at 10 to 18 inches by gray, drab, or bluish plastic silty clay, mottled with reddish and brownish oxide of iron material. In a few poorly drained areas the soil contains a high percentage of organic matter and is a very dark gray to nearly black in color. Coarse grayish and yellowish clayey sand in places underlies the heavier subsoil and rarely there is a gravelly layer at about 3 feet.

This type occupies level or flat strips along the branches and creeks which drain the areas of Montalto and Lansdale soils. The soil is typically developed in Warrington Township along Beaver Creek and its branches. The soil is mainly alluvial in origin. The material composing it has been derived principally from the Montalto soils. Some of the soil occurs in very shallow drainage depressions at the heads of branches and is purely colluvial, resulting simply from the wash of fine soil material from immediate slopes. These colluvial flats are in places strewn with rounded bowlders of diabase, rendering the land almost valueless for any other purpose than for pasturage. Bowlders are also numerous, even on some of the broader flats along the larger streams, as, for example, along Stony Run near Pinetown.

Part of the land supports a tree growth, but much of it is in the condition of meadow. Cedar, shagbark hickory, white oak, and pin oak are characteristic trees.

The land is all deficient in drainage, and much of it is continuously in a wet condition. Tillage is consequently difficult, and the soil, if plowed wet, tends to aggregate into hard clods. A few small fields have been placed in cultivation, and good yields of corn, wheat, oats, and hay have been obtained.

With proper tile drainage as good or better crop yields may be expected than from adjacent upland soils. The greater part of the land, however, is too rough and too wet to be of any value except for pasture.

### HUNTINGTON LOAM.

The soil of the Huntington loam is characteristically a brown mellow loam underlain at 12 to 15 inches in depth by yellowish-brown friable silt loam to silty clay loam and loam. As is generally true of alluvial soils, there are rather wide variations in texture. The surface soil is in places light and rather sandy, while the subsoil is in places a loam, sandy loam, or sandy clay. The soil also has a pronounced reddish-brown color in a few places. There are pebbles or gravel in the soil, but nowhere in sufficient amount to constitute a gravelly loam. On the island south of Yorkhaven a gravel and coarse sand substratum is present, varying from 2 to 6 or 8 feet

beneath the surface, the depth depending upon the original irregular deposition and subsequent unequal erosion by floods. At some localities very little change can be observed in the texture or color of the material of the 3-foot section.

The total area of this type is small. It is confined almost entirely to first-bottom land along the Susquehanna River. The bottom land lies 15 to 25 feet above normal water level and occurs as narrow strips a few hundred feet to a maximum of three-fourths mile in width. Much of the bottom land is in such narrow belts that it can not be shown on the soil map without exaggeration. The land is subject to destructive overflows; the ice flood of 1904, in particular, left many barren areas on the islands.

The material composing the soil has been largely derived from Paleozoic limestones, shales, and sandstones underlying the Dekalb and Hagerstown soils, but in York County there has been considerable detritus washed from the Triassic rocks or from the Penn soil series, and in the extreme southern part of the county there is a very noticeable amount of micaceous minerals in the soil, indicating that some of the material has been derived from the mica and chloritic schists underlying the Manor and Chester soils.

The soil contains a good supply of humus, is mellow or friable, and easily tilled. The largest area in cultivation is located on the narrow island lying south of Yorkhaven. Corn, wheat, oats, and hay, and a small amount of tobacco are grown; the crop yields are fair, but in the average no larger than on the adjacent upland soil types. The very narrow strips of alluvium at the bases of steep bluffs can be utilized most profitably for truck rather than for field crops. Some of the islands have been so completely denuded of soil that the land is worthless for anything except the meager pasturage that it affords for horses and cattle.

The more arable part of the land has a selling price of $30 to $50 an acre.

### HUNTINGTON SILT LOAM.

The surface soil of the Huntington silt loam is a brown, mellow silt loam to silty clay loam, about 10 inches in thickness. The subsoil is a yellowish-brown compact friable silty clay or silty clay loam, which at a depth of 30 to 36 inches frequently grades into sand and gravel. In the more poorly drained tracts the immediate subsoil is a bluish gray or grayish, mottled with rusty-brown spots of iron oxide.

This type embraces only a small total acreage and is not widely distributed, being confined largely to the York Valley. It occurs as narrow strips of first-bottom land, the surface of which is generally not more than 3 or 4 feet above the creek levels. Most of the land is subject to frequent overflows.

The soil is recent alluvium, derived largely from upland soils of limestone shales and sandstone origin, such as the Hagerstown, Berks, and Dekalb soils. Most of the bottom land was probably originally forested, and the few lots of timber remaining indicate that white oak, shagbark hickory, ash, and elm were the principal trees.

About half of the area of the type is under cultivation; the remainder is utilized for pasture, while the native grass is cut for hay. The land is often too wet for successful cultivation, and practically all of it, if cultivated at all, should be tile drained. Corn, wheat, and hay are grown, and during favorable years—that is, when rainfall is light—the yields are equal to those obtained on the adjacent Berks and Hagerstown loams; but on account of poor drainage and frequent overflows the agricultural rank of the soil is lower than that of the residual soils.

### BIRDSBORO SILT LOAM.

The soil of the Birdsboro silt loam is a light-brown or yellowish-brown silt loam to rather heavy loam, about 12 inches deep. The subsoil is generally a yellowish or yellowish-red gritty clay. Small, rounded and subangular quartz gravel are scattered over the surface, but are not at any place in sufficient quantity to give the soil the character of a gravelly loam. A thin gravelly substratum is generally present.

The total acreage is small and the type is relatively of very little agricultural importance. The soil occurs as small separate areas along Codorus Creek, near the city of York. It occupies a poorly developed narrow terrace plain lying 20 to 30 feet above the creek, is well above overflow, and fairly well drained. The detritus composing the alluvium is of local origin, being washed mainly from soils derived from argillaceous shales, chlorite, and mica schists lying within the drainage basin of Codorus Creek. There is also some influence from limestone soils. A considerable proportion of colluvial material, wash from adjacent hillsides, is mingled with the original terrace alluvium.

The greater part of the type is under cultivation, being used chiefly for general farm purposes. Good yields of corn, wheat, oats, and hay are obtained.

### HOLSTON SILT LOAM.

The surface soil of the Holston silt loam is a mellow light-brown or yellowish-brown silt loam, 12 to 14 inches in thickness. The subsoil is a yellow or yellowish-brown silt loam to silty clay loam, containing sufficient fine sand to make it friable. The lower subsoil is often variable, ranging from moderately friable silty clay to very friable, heavy fine sandy loam. The substratum is composed of stratified silty and sandy material and in places waterworn or

rounded gravel. A few pebbles were observed in the surface soil, and scattered bowlders 12 to 15 inches in diameter are occasionally found, but these do not materially influence the character of the soil. The principal textural variation in the surface soil is toward a very fine sandy loam.

The type occurs along the Susquehanna River in the vicinity of Newmarket, embracing an area of 2.6 square miles.

The Holston silt loam occupies alluvial terraces or second-bottom land. The terrace along the Susquehanna is a level to undulating plain 30 to 60 feet above river level. The alluvium is mainly silt and fine sand, with a gravel layer at the base, and varies in thickness from 4 to 15 feet or more. It is doubtless Pleistocene in age. The material composing the alluvium was derived mainly from the Paleozoic limestones, sandstones, and shales which lie within the drainage basin of the Susquehanna, but it is also quite probable that some Glacial material is included.

Practically all of this type is under cultivation, being utilized for general farming. The drainage is good. The land is easily cultivated and retains fertilizers without excessive leaching. There is very little or no waste land on individual farms. The yields of corn are on the average about 50 bushels per acre; wheat, 20 bushels; oats, 40 bushels; hay, 1½ to 2 tons. Very little commercial fertilizer is used for corn and oats, 100 or 150 pounds of 2–8–2 grade, while about 200 pounds are used on wheat. Lime can be applied at the rate of 50 or 75 bushels per acre without injury to the land. Irish potatoes and truck should do well on this type.

The Holston silt loam type is valued at $60 to $75 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Holston silt 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.* | *Per cent.* |
| 1817146 | Soil | 1.8 | 3.4 | 3.8 | 10.1 | 10.6 | 55.6 | 14.6 |
| 1817147 | Subsoil | 2.0 | 3.5 | 4.2 | 13.0 | 13.7 | 43.8 | 19.7 |

MUCK.

Muck in the soil classification is soil that contains a high percentage of organic matter which is in a more advanced stage of decomposition than that composing peat. The soil is formed under conditions of poor natural drainage. A narrow strip of Muck, a belt about 2¼ miles in length, occurs in the northern part of the county, a short distance south of New Cumberland. The material at the surface

is a black silty clay loam, 5 to 10 inches in thickness; this passes into a jet-black muck consisting of highly decomposed vegetable matter mixed with silt and clay. In places the subsoil approximates peat in character, containing little mineral matter and fine organic matter showing traces of its original structure. The Muck assumes a dark brownish color when dry. The vegetable matter seems to be derived from grasses. Water is encountered at 18 to 30 inches. Some of the less mucky parts include areas that consist of a dark-gray to black silty clay loam, 5 to 15 inches deep, overlying a dark bluish gray plastic clay. The soil occurs in a narrow low-lying area known as Marsh Run, which probably represents the site of an abandoned channel of Yellow Breeches Creek.

The land when drained should prove very suitable for such truck crops as celery, onions, and cabbage. Corn also should do well. It is at present used principally for pasture, although an attempt is made to cultivate the less mucky parts of the bottom.

### MEADOW.

Low-lying, poorly drained alluvium occurring in narrow strips along the smaller creeks and in small areas of wet bottom land at the junction of branches has been mapped as Meadow. The material of this classification is extremely variable in texture and does not admit of any separation into definite soil types. The color also varies widely within small areas both on the surface and through the vertical section. The land is subject to frequent overflows and fresh accessions to the alluvium are being continually made.

The principal areas mapped occur in the extreme southern part of the county, the material composing the soil coming mainly from the Chester and Manor soils. The soil varies from silt loam to sandy loam, with generally a coarse gravelly or sandy substratum. Some of the soil contains a high percentage of organic matter and is very dark in color. The land yields a good growth of native grasses; there is only a scattered or sparse tree growth, an occasional swamp white oak and pin oak, with alder and willows fringing the banks of the streams.

The land is of little or no value for cultivated crops, on account of poor drainage and frequency of overflows. The native grasses afford a nutritious hay and the land is also utilized for pasture.

### SUMMARY.

York County is situated in the southeastern part of Pennsylvania and comprises an area of 903 square miles, or 577,920 acres. It lies principally within the Piedmont Plateau, although a small area in the northern part of the county is included within the two other physiographic divisions of eastern United States—the Blue Ridge

and the Great Valley, the southern part of the latter division being known in Pennsylvania as the Cumberland Valley. The topography is rolling to hilly and mountainous. The extremes of elevation range from about 100 feet to 1,460 feet above sea level, but the greater part of the county has an elevation of 400 to 800 feet.

The county is thickly settled, having a population of 136,405, more than half of which is rural. It was estimated in the census of 1910 that 92.1 per cent of the area was in farms; the farms are small, the average size being about 60 acres.

A rather intensive system of general farming prevails. Crop rotation is practiced, and the use of stable manure and lime is general, while commercial fertilizers are extensively used to supplement the stable manure. Wheat, corn, oats, and hay are the staple crops grown; tobacco, Irish potatoes, tomatoes, and cabbage are the most important special crops. Some attention is being given to the establishment of commercial apple and peach orchards, and an extension of the fruit industry may be expected in the near future.

There is a great diversity of soils in the county; 25 soil series, with 46 soil types, were mapped, exclusive of Rough stony land, Meadow, and Muck. The loam class of soil predominates, there being very little extremely sandy or heavy clay land.

The Penn soils occupy a large area in the northern part of the county. They are red soils derived from Triassic shales and sandstone. The soils of this series are generally well drained and well adapted for general farming, except the stony sandy loam, which is best suited for orchards and small fruit farms.

The grayish or brownish soils derived from unaltered Triassic sediments are classed as the Lansdale series. These soils have about the same agricultural value as those of the Penn series.

The Lehigh soils are closely associated with the Penn and are characterized by drab or slaty-gray soil and subsoil. They are derived from Triassic sediments metamorphosed by diabase intrusions. The soils, on the whole, are inferior in agricultural value to those of the Penn series.

The soils of the Hagerstown series are derived from limestones. The Hagerstown loam is naturally one of the most fertile and durable soils and is excellently adapted for hay and grain crops, and in addition produces heavy yields of tobacco.

The Chester soils are brownish or yellowish-brown soils derived from ancient gneisses and schists. They occupy a large area in the southeastern part of the county. The loam type is an excellent general farming type, and in addition the special crops—tobacco, Irish potatoes, tomatoes, and cabbage—are extensively grown.

The Cecil soils are closely associated with the Chester series, but are distinguished by their red subsoil.

The Berks series includes yellowish or brownish soils derived from slaty shales. The soils are utilized principally for general farm crops.

The soils of the Manor series are characterized by their yellowish-red or reddish-yellow subsoils and contain high percentages of minute flakes of chlorite or other micaceous minerals. The soils produce fair yields of the general farm crops of the county. Probably 85 per cent of the total area is under cultivation.

The Dekalb and Edgemont soils are pale yellowish or yellowish-brown soils derived from quartzites, sandstones, and siliceous slates or phyllites. The soils, excepting the Edgemont loam type, have a lower agricultural rank than adjacent Penn, Hagerstown, and Berks soils, on account of the roughness of the topography and stony character of the land.

The Montalto soils are typically brownish soils, with bright yellowish-brown or golden-brown stiff clay subsoils, derived principally from diabase. The soils are strong and durable, but much of the land is strewn with large bowlders of diabase, which interfere seriously with cultivation.

The soils of the above 11 series occupy about four-fifths of the area of the county and are relatively of the greatest agricultural importance on account of their area, and because the agricultural prosperity of the county will depend upon their proper utilization and management.

The alluvial or bottom-land soils are of small areal extent, are subject to frequent overflow, and are not extensively cultivated.

It is recommended that legumes be planted more extensively and plowed under, or that larger quantities of organic matter be supplied to the soils. The use of lime is to be encouraged, although in many instances excessive quantities are probably used. The average farmer possesses too little knowledge regarding commercial fertilizers and the fertilizer needs of his soil, and there is undoubtedly at present a large economic waste in the use of fertilizers.

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[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

*Resolved by the Senate and House of Representatives of the United States of America in Congress assembled*, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on the field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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