Issued July 18, 1907.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

COOPERATING WITH THE WEST VIRGINIA GEOLOGICAL SURVEY, I. C. WHITE, STATE GEOLOGIST.

SOIL SURVEY OF THE WHEELING AREA, WEST VIRGINIA.

BY

THOMAS A. CAINE AND G. W. TAILBY, JR.

[Advance Sheets—Field Operations of the Bureau of Soils, 1906.]

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1907.

[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 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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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., December 11, 1906.

SIR: At the request of the West Virginia Geological Survey a soil survey of Ohio, Brooke, and Hancock counties, and a part of Marshall County, West Virginia, was made during the summer of 1906, to ascertain the characteristics of the soils and to learn their adaptations to different crops. The State geological survey desired to embody this information in their report to the State legislature upon the geological conditions and resources of the area. I herewith transmit a report and map covering the work, with the recommendation that they be published as advance sheets of the Field Operations of the Bureau of Soils for 1906.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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SOIL SURVEY OF THE WHEELING AREA, WEST VIRGINIA.

By THOMAS A. CAINE and G. W. TAILBY, Jr.

DESCRIPTION OF THE AREA.

The Wheeling area comprises the northern part of that section of West Virginia known as the Panhandle, and includes the whole of Hancock, Brooke, and Ohio counties and the northern part of Marshall County. It is bounded on the north and west by the Ohio River, on the east by Pennsylvania, and on the south by parallel 40° north

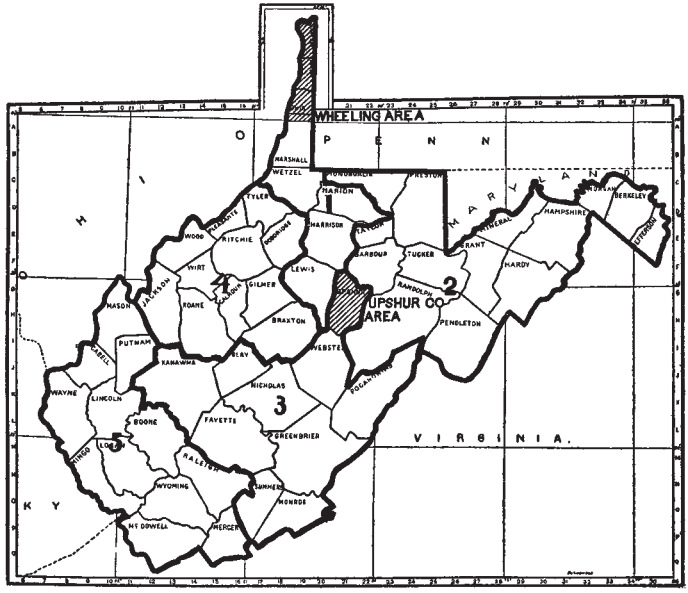

FIG. 1.—Sketch map showing location of the Wheeling area, West Virginia.

latitude. In a north and south direction it has a length of 45 miles, while its width varies from about 4½ to 12 miles. The area is included within meridians 80° 30′ and 80° 45′ west longitude and parallels 40° and 40° 40″ north latitude.

When viewed from the Ohio River the area presents a hilly and rugged appearance. The river valley is gorgelike, the bottom land along the river being very narrow and in many places entirely lacking, and the stream is often bordered by steep, angular hills varying in

elevation from 300 to 600 feet. The altitude of the Ohio River is about 615 feet above sea level. Proceeding back from the river a mile or so it is seen that the region is better adapted for agriculture than at first appeared. The Ohio Valley is scarcely noticeable at that distance, and the tops of the hills in all directions as far as can be seen are of the same general level. These are the remnants of an ancient upland plain which has been dissected by ages of erosion. The general altitude of these uplands varies from 1,100 to 1,300 feet. The surface, however, sometimes rises 100 feet or more above the general level, and viewed from one of these high points the whole region resembles a mountainous country in miniature. The highest point in the area is in Marshall County, and has an altitude of 1,476 feet, so that there is a total range in elevation within the area of 850 feet.

The drainage of the area is all toward the Ohio River, and the channels of the larger streams lie deeply intrenched in narrow, steep-sided valleys from 300 to 500 feet below the level of the upland plain. The valleys of the smaller tributary streams are also steep-sided and vary in depth from 50 to 300 feet. The floors of these valleys are seldom wide enough to permit the accumulation of sediments along the streams, for which reason there is little bottom land in the area. In some places the valley floors are so narrow that the stream bed is utilized as a road. The many ravines dissecting the area have made much of the region unfit for general farming, but this is partly compensated for by the fact that the deep erosion has exposed beds of coal and fire clay, which are being mined with profit.

The first permanent settlers in the area came from Virginia, Maryland, and North Carolina, and located in the vicinity of West Liberty in 1772. Soon afterwards more colonists came and located near Wellsburg and Wheeling. When the original thirteen States were organized the Panhandle fell within the territory of Virginia and remained a part of that State until the formation of West Virginia in 1863.

Ohio County was organized in 1785 and at that time included not only all of the Panhandle, but extended indefinitely westward. In 1797 Brooke County was separated from Ohio County. At that time it included all of what is now Brooke and Hancock counties, and also extended westward over an indefinite territory. After the formation of the State of Ohio the westward extension of these counties became fixed by the Ohio River. In 1848 the northern end of the Panhandle became more thickly settled and Hancock County was separated from Brooke County.

The additions to the population were considerable during the first fifty years following 1772. Among those who came were a few Germans and many Scotch and Irish. The majority of the settlers, many

of them men of education and refinement, came from eastern Virginia and brought with them the customs and manners of that locality.

Until about twenty years ago little had been done to develop the natural resources of the area. Coal, natural gas, and fire clay are now being utilized, and numerous potteries, glassware factories, brick works, tin mills, and blast furnaces are in operation. There has been a great increase in population, and the old towns have increased in size and many new ones have sprung up. At present only about 30 per cent of the population of the area are engaged in agricultural pursuits. The original forest growth has practically all been removed, and all of the region not too steep for general agricultural purposes is cleared and in cultivation or pasture.

The chief towns of the area are Wheeling, Wellsburg, New Cumberland, and Chester, all located on the banks of the Ohio. Across the river in Ohio, East Liverpool, Wellsville, Steubenville, Martins Ferry, and Bellaire are important cities, and are connected with the West Virginia side by railroads, trolleys, and ferries. There are numerous other smaller towns within the area that are important from a manufacturing standpoint. These cities and towns furnish a greater demand for general farm and dairy products and truck crops than is at present being supplied by the agricultural population of the area.

The superior shipping facilities afforded by the Ohio River have always been an important factor in the development of the region, and at present there are numerous landings along the western side of the area where products can be loaded on the steamers. The area is now also well supplied with steam railroads and electric lines. The "Panhandle" line, a part of the Pennsylvania system, extends along the banks of the Ohio from Wheeling to Chester. Another line extends the full length of the area on the other side of the river. The main line of the Pennsylvania Railroad crosses about the middle of the area through Harmon Creek Valley, and the Wabash crosses a little south of this. A branch of the Baltimore and Ohio crosses the southern part of Ohio County and connects Pittsburg with Wheeling, which now has considerable importance as a railway center. A trolley line connects Wheeling with Steubenville, Ohio, passing through Wellsburg, W. Va., and another one passes through Wheeling Creek Valley from Wheeling to the State line at West Alexander, Pa. These all carry passengers, baggage, freight, and dairy products.

CLIMATE.

The climate of the Wheeling area is healthful and well suited to the carrying on of general farming. The winter weather is cold, and often there is considerable snow, but it can not be said that the winters are very severe. It is seldom that the mercury goes below

zero, and the average for the three coldest months—December, January, and February—is about 28° F. The summers are warm and pleasant, and the mercury seldom goes as high as 100° F. The average for the three hottest months—June, July, and August—is about 72° F.

The average annual rainfall for the area is about 40 inches. The least precipitation occurs in October, after the close of the growing season, while the greatest precipitation occurs in June and July, when the growing crops need it most. The average length of the growing season is six and one-half months, and stock can be pastured for about seven months.

The following tables give the normal monthly and annual temperature and precipitation for the area, as shown by the Weather Bureau records at Demos, Ohio, and at New Martinsville, W. Va., and the dates of the earliest and latest killing frosts, as shown by records at Wheeling, W. Va.:

Normal monthly and annual temperature and precipitation.

Month.	Demos, Ohio.		New Martinsville, W. Va.		Month.	Demos, Ohio.		New Martinsville, W. Va.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	°F.	*Inches.*		°F.	*Inches.*	°F.	*Inches.*
January	27.5	2.66	32.0	3.12	August	72.4	3.40	74.1	2.93
February	26.0	3.16	30.6	2.96	September	66.3	2.55	68.0	2.42
March	39.6	3.61	42.7	3.32	October	53.9	1.97	56.0	2.09
April	49.5	3.14	52.9	3.44	November	41.8	2.37	44.1	3.35
May	62.4	3.23	63.6	3.54	December	30.3	2.88	34.8	3.19
June	69.9	4.21	72.1	3.85					
July	73.6	4.88	72.8	5.42	Year	51.1	38.06	53.6	39.63

Dates of first and last killing frosts.

Year.	Wheeling.		Year.	Wheeling.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1897	Apr. 20	Oct. 30	1902	Apr. 8	Oct. 22
1898	Apr. 8	Oct. 28	1903	Apr 5	Oct. 25
1899	Apr. 5	Oct. 1	1904	Apr. 21	Oct. 28
1900	Apr. 10	Nov. 14	Average	Apr. 11	Oct. 26

AGRICULTURE.

The early settlers found the virgin soils well adapted to grain, particularly wheat, corn, and rye, and the growing of these crops constituted the main type of farming for the first fifty years following 1772. The production of these crops was far in excess of the local demands, and upon the establishment of river transportation with

the older colonies on the lower Mississippi a large flour trade was developed. Distilleries were built in connection with the flour mills and the corn and rye were marketed at the mills and converted into whisky.

By 1840 grain growing is said to have become unprofitable because of the constant cropping of the soils under careless methods. The wheat yields, it is stated, had fallen off year after year from 35 bushels to about 10 bushels per acre, and other grain crops had decreased in like proportion. Considerable land was abandoned as "worn-out" and allowed to grow up to weeds and brush, and for a time grain growing was so far abandoned as scarcely to supply the local demands. Another, and perhaps the most influential, cause of the decrease in grain production was the fact that the hill farmers of the area were not able to compete with the farmers on the level virgin soils of the West.

About this time it was thought that sheep raising could be carried on with profit, and in 1835 a number of Merino and Saxony sheep were imported from Europe. The industry was so profitable that it spread in all directions and became very important in Virginia, Ohio, and Pennsylvania. Nearly every farmer kept some sheep, and a number of those who had large flocks became quite wealthy. The wool answered the commercial requirements of the time, since it was not exceedingly bulky, could be handled easily, was nonperishable, easily shipped, and brought ready cash. The wool or the manufactured woolen products were readily exchanged in the Southern markets for sugar, molasses, and cotton.

For a number of years sheep raising was the most important industry in the area and little attention was paid to other lines of agriculture. It was found that after being pastured to sheep for a number of years the "worn-out" soils were greatly benefited and some claim that they became more productive than ever. By this time the whole country had made marked progress in settlement and with the increase of population there arose a great demand for all kinds of farm produce, especially dairy products and fruit and truck crops. A reduction in the price of wool caused sheep raising to become somewhat unpopular and the wool industry no longer constitutes the principal pursuit. However, it is still an important auxiliary to general farming, especially among the most progressive and prosperous farmers, who use this means of maintaining the productivity of their soils.

There has been an increase in the acreage of wheat, corn, and oats, and in parts of the area the production of apples has assumed considerable importance. Some of the farmers are striving to supply the increasing local demands for milk and butter, fruit of all kinds, and truck crops. Many of the orchards in close proximity to the brick

and tile works along the river have been greatly damaged by gas and smoke, and the influence of this is noticeable for a mile or so back from the river. In places the native vegetation has all been killed and the steep, rough hills above the manufacturing plants present a barren aspect.

It is recognized that the upland areas are well adapted to the dairy business, but owing largely to the confining nature of the occupation and the lack of intelligent labor to handle the stock, as well as the steep, rough roads to market, this industry is limited mostly to farms convenient to towns. It is also recognized that the upland areas, especially those having soils of sandstone origin, are well adapted to truck crops and fruit, but owing largely to inaccessibility to markets the trucking industry is mainly confined to the level sedimentary soils along the Ohio River and its larger tributaries. The fact that the important local markets are along the river and the roads are good makes this class of soils very profitable for trucking purposes. These sedimentary soils are also well adapted to general farm crops, but they are more profitable for trucking. Owing to the demand for factory, manufacturing, and town sites in recent years, the extent of the sedimentary soils used for trucking is becoming more and more limited.

On the upland farms the steep hillsides are usually fenced off from the tillable part of the farm and kept in permanent pastures, some of which have been standing for over forty years. The customary system of rotation upon the tillable upland farms is one year each of corn, oats, and winter wheat. What few potatoes are grown on these farms are planted in small patches in the cornfields. Timothy is sown in the fall with the wheat, and clover is sown the following spring. The first year the meadow consists largely of clover, but the next year the timothy predominates. The field is permitted to stand in timothy as long as it will yield a profitable crop, usually from three to five years. On the limestone soils as the timothy thins out Kentucky bluegrass comes in. The latter is never cut for hay, but makes fine pasturage. The length of time a field remains in pasture depends upon the size of the farm, the amount of stock kept, and somewhat upon the character of the soil. The most successful farmers try to keep land seeded down as long as possible and keep enough stock to consume the greater part of the hay, straw, and grain. Some grow corn for two successive years and then follow the usual rotation. There are only three custom flour mills in the area, and practically all of the farmers sell their wheat and buy flour imported from other States. This has led some to abandon wheat growing and to substitute a yearly rotation of corn and oats. Timothy and clover are sown in front of the drill with the oats, and usually two excellent crops of clover are secured the following year. There are a few farmers who do not keep

stock, but depend upon the renovating effect of the clover to keep the soil in good condition. Again, there are a few farmers who follow the usual system of rotation, but instead of keeping an abundance of stock and turning the sod as seldom as possible they shorten rotation to four or five years and sell off all available grain, straw, and hay, and depend upon the use of commercial fertilizers to keep up the crop yields. In the trucking areas no rotation is practiced. These level areas are not subject to erosion, and their productivity is maintained by occasional overflows and the application of manure obtained from the livery stables.

The great demand for truck in the Wheeling markets has led some to engage in trucking on the hilltops 600 or 700 feet above the town. Usually the truckers haul manure from town and do not follow any rotation, except in cases where it is impossible to get sufficient manure. Then they put in a crop of wheat and seed the ground to grass for a few years.

The adaptation of the methods to the present conditions on the rolling uplands is well illustrated in the case of the corn crop, practically the only clean-cultivated general farm crop in the area. The soil is plowed to a depth of about 7 inches, and the corn is either drilled or dropped in rows running with the contour of the hills so as to keep erosion in check.

The low prices paid for wool, the rapid industrial development of the region, and the increased demands for agricultural products have completely changed the agricultural conditions during the last quarter of a century. On the whole the farmers south of Kings Creek are quite prosperous, as is shown by the low percentage of mortgaged farms. Their dwellings and barns are usually quite substantial, they are well supplied with good draft horses, and there is an abundance of up-to-date farm machinery in use. In recent years the sale of coal, oil, and gas rights has brought much wealth to the farming class.

The great demand for laborers in the factories, mills, potteries, blast furnaces, and mines has attracted many people from adjoining States, and many of the young men have left the farms for the towns, where they have shorter hours of work and better pay. The scarcity of good farm labor is one of the most serious drawbacks to farming. The wages paid farm hands range from $20 to $30 a month with board, lodging, and washing, and feed for a driving horse. The most progressive farmers feel the necessity of arranging their farm practice in such a way as to get along with as little labor as possible. About 60 per cent of the farms are operated by the owners, the remainder being rented for cash or on shares. The average size of the farms is about 100 acres. The size of the holdings, however, ranges from a few acres to 500 acres.

There has been a great increase in the selling price of farm lands within the last twenty years. Farm lands without the coal rights are now bringing as much as they did twenty years ago with the coal rights. The average price of land throughout the area is about $50 an acre without the coal rights. The price varies considerably, depending upon the kind of soil and the nearness of the farm to town. Many of the wage-earning population of the area have built houses along the little runs and branches back from the Ohio River, where building sites can be obtained cheaply, and the problem of getting to and from their work has been solved by the trolley systems.

At present the live-stock interests of the area are not as important as at times in the past. Some cattle, sheep, and hogs are kept by the farmers, but on most farms the number of animals could be profitably increased. The animals are of good quality, including the farm horses, which are well bred and well cared for.

Until about twenty-five years ago the production of wool and mutton was one of the most important pursuits of the farmer. Since then the drop in the price of wool, together with losses from dogs, has caused so many farmers to cease sheep raising that now the number of sheep is reduced at least two-thirds. The most sheep were kept in Ohio and Brooke counties, where the Brooke clay loam gives permanent bluegrass pastures, which favor the profitable production of wool and mutton.

Only fine-wooled sheep, the Delaines and Merinos, are raised. These give a good yield of wool, besides the lambs, which are marketed in the fall and bring from $2 to $3 a head when six months old. It is believed that the number of sheep could be profitably increased on the Brooke clay loam, where protection from dogs can be had.

The dairy interests are confined almost exclusively to the territory immediately surrounding the cities and villages. Within a radius of 3 miles of Wheeling nearly every farm maintains a dairy of from 10 to 50 cows, the average being about 20. Little fine-bred stock is kept. A few farmers within 5 miles of the city retail their milk daily. Others along the trolley lines send their milk to wholesale dealers in the city. Milk retails at 8 cents a quart winter and summer, and at wholesale prices brings from 15 to 18 cents a gallon. In Wheeling the legal standard for milk is 3 per cent of fat, a standard which is easily maintained by the farmers. At present the local supply of milk does not meet the demand and milk is shipped in from a distance.

Some farmers have found the production of beef profitable, and send into the city annually half a dozen or more fat steers. For farms too remote from towns for profitable milk production, and not well adapted to sheep raising, the production of beef is especially to be recommended. By this means the roughage produced on the farm may

be turned into money and the productivity of the soil maintained. Only a few hogs are raised, but wherever corn is grown it is believed they can be raised at a profit.

SOILS.

The soils of the area fall naturally into three general divisions, each of which is represented by one or more different soil types. The first and most important are the residual upland soils, which occupy about 90 per cent of the area and are found in all locations from the gently rolling hilltops to the steepest hillsides. Geologically the upland portion of the area belongs to the Coal Measures of the Carboniferous age, and that portion of the Coal Measures here represented belongs to the Allegheny, the Conemaugh, the Monongahela, and the Dunkard series (Permian). Seven upland soil types were found, each differing from the others in texture, topography, and agricultural value.

The Conemaugh series is composed largely of fine-grained sandstone and sandy shale and where the topography is gently rolling or moderately hilly it weathers into the Dekalb silt loam, while where the surface is hilly and steep the soil has been mapped as Steep broken land. The Monongahela is composed of limestone, calcareous shale with some sandstone, and where the topography is rolling or moderately hilly it weathers into the Brooke clay loam. The Dunkard is composed of both sandstones and limestones, and weathers into the Dekalb silt loam, the Dekalb loam, and the Brooke clay loam, according to the character of the underlying rock.

The soils of limestone origin are recognized as the best and most durable for wheat, corn, oats, hay, and pasture, and are especially adapted to supporting a permanent bluegrass pasture. The soils of sandstone origin are not as durable and productive for general farming as those derived from limestone. Both kinds are used for the same crops, however, though the yields are greater upon the limestone than upon the sandstone soils. Where the two classes of soil occur together and somewhat mixed the difference is not so noticeable, but where found typically developed in widely separated parts of the area the difference is marked. This is indicated by the fact that in Hancock County, where the soils of sandstone origin predominate, about 20 per cent of the farms are mortgaged, while in Ohio County, where the limestone soils are well developed, not more than 5 per cent of the farms are mortgaged.

The second of the three general divisions of soils is found in the valley of the Ohio River, and occurs in the form of terraces. The material forming these terraces is reworked débris brought from the north during the Glacial epoch. The material is composed largely of sand and gravel, with considerable quantities of well-rounded

stones, varying from 2 to 10 inches in diameter. This gives rise to two soil types, the Wheeling gravelly loam and the Wheeling sandy loam, depending upon the original assortment of the sand and gravel.

The third of the three general divisions of soils found in the area comprises the recent alluvial deposits in the valleys of the Ohio River and its larger tributary streams. The resulting soil types are the Huntington fine sandy loam and the Huntington loam. The former type occurs in narrow strips bordering the river and represents areas where the coarser materials, such as sand and vegetable matter, were dropped in flood time. The Huntington loam is usually found farther away from the stream, in areas where the finer materials, like clay, silt, and fine sand, were deposited from quieter currents. In the Ohio Valley these two soil types occur as a veneer over the sandy and gravelly terrace materials discussed above. This is shown by excavations at Chester, New Cumberland, Wellsburg, and Wheeling.

The bottoms of all the smaller tributary streams are narrow and the streams are rapidly cutting their channels to the level of the Ohio River, very little energy being spent in widening them. Only in places are there patches of soil, and these are usually too small to be shown upon a map of the scale used. Along the bottoms of the larger tributary streams, such as Short, Cross, and Wheeling creeks, there is a considerable area of bottom land. The channels of these streams are nearly down to the level of the Ohio River and the valleys in places are a half mile or more in width. The bottoms are all subject to overflow, and the soil found there, though rather variable in texture, is a loam having the characteristics of the Huntington loam.

The following table gives the names and the actual and relative extent of the different soil types:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Steep broken land	56,448	28.0	Huntington fine sandy loam	1,536	0.8
Rough stony land	41,856	20.8	Wheeling gravelly loam	1,472	.7
Brooke clay loam	38,080	18.9	Upshur clay	704	.3
Dekalb loam	27,008	13.4	Wheeling sandy loam	576	.3
Dekalb silt loam	23,424	11.6	Total	201,600	
Huntington loam	8,576	4.2			
Dekalb sandy loam	1,920	1.0			

STEEP BROKEN LAND.

The soil of the Steep broken land, which is often a silty or heavy loam, varies in depth from a few to about 10 inches. The color ranges from brown to light brown. The subsoil usually contains considerable clay, enough to make it a clay loam, and in some instances almost a clay. Scattered upon the surface and throughout both

soil and subsoil are found fragments of shale and sandstone, and often the solid rock is reached at a depth of a few feet. Where the sandstone formations are prominent the fragments become quite numerous, those upon the surface being plentiful enough to interfere with cultivation. This type is not often cultivated, and, where it is, it requires very careful attention, and the crops have to be sown and gathered by hand.

This is one of the most widely distributed soils encountered and is especially well developed in the northern part of the area in connection with the Conemaugh series of rocks, which consist largely of soft marly and sandy shales. These shales weather rapidly and produce long and rather steep slopes. The type is also well developed in the southern part of the area in connection with the upper part of the Dunkard series of rocks, where some of the conditions of rock texture and structure are similar to those of the Conemaugh series. It is less well developed in the middle part of the area, where the Monongahela series and the base of the Dunkard occur. In these, either limestones or shales predominate, which weather into gentler slopes and form another type of soil.

The Steep broken land is made up wholly of slopes which are too steep for convenient tillage, and on which the drainage is excessive. The soil is residual and derived from the weathering of soft marly and sandy shales, which are the most extensive of any of the rocks in the area. The fine-grained sandstones which occur interbedded with the shales also enter into its formation.

These areas were originally covered with a growth of hardwoods, practically all of which has long been removed. As they are too steep for convenient tillage about 80 per cent is used for grazing. Very often the steepest and roughest parts of the pasture fields are permitted to grow up to locust thickets, which furnish very durable posts. Near the towns, where the dogs have become very troublesome to sheep, some of the farmers are cultivating even the steeper slopes of the type. The general farm crops of the area are grown, but the yields are not large. Corn yields from 20 to 40 bushels per acre, wheat from 7 to 15 bushels, oats from 20 to 45 bushels, and potatoes from 50 to 150 bushels. Apples do very well when the orchards are properly cared for.

The type is cultivated usually only where sheep are not kept to any extent. After a few years of cropping and exposure to rains the humus content of the soil becomes exhausted and then erosion becomes more rapid. Some have attempted to restore the loss of productivity by means of commercial fertilizers, with the result that a temporary increase in yields is noticeable, but the fields become washed and eroded more and more and finally have to be abandoned. It is believed that this type should not be used for general agricultural

purposes, but should be used exclusively for grazing and orcharding. It is thought that vineyards would do well. A farm composed entirely of the type would not be esteemed very highly, because there would not be an opportunity to grow general farm crops, but a considerable proportion of a farm may be composed of land of this character without being considered detrimental, since it furnishes permanent pasture and may be used for orcharding in some instances.

ROUGH STONY LAND.

The areas of Rough stony land occur principally in the hills bordering the Ohio River and its larger tributaries. The larger streams as they approach the river have worn their valleys so deeply that the hills adjoining them, like those along the Ohio, are often abrupt and precipitous. These steep, clifflike hills are the ones which make up the type, Rough stony land, and they are nearly always associated with hard, massive sandstone strata, which have been more resistant to the agencies of weathering and erosion than the more numerous strata of softer sandstones, shales, limestones, and coal lying above and below them.

In the northern part of the area the Lower Freeport sandstone is the one which gives rise to the type, while farther to the south the Buffalo, Saltzburg, and Connellsville sandstones have the greatest influence in its formation. These sandstones vary in thickness from 20 to 100 feet and are sometimes found high up in the hills and sometimes, owing to a uniform dip to the southeast, much lower down. At the higher elevations they sometimes form bare rock walls, below which are strewn large angular bowlders of sandstone. Usually, however, the surface is very steep and strewn with sandstone fragments and covered with a thin layer of soil. The fine earth on these steep slopes is usually the product of the weathering of softer layers of sandstone and shale which underlie the massive sandstone; hence considerable clay is occasionally found. The original forest growth consisted largely of oak, maple, and hickory. This has all been removed and replaced by a small second growth. Immediately adjoining the stream courses small hemlocks are quite characteristic. Landslides which strip everything down to the underlying rocks are not uncommon in these steep slopes.

Rough stony land is really more of a condition than a soil type. It never has been and never will be of any great agricultural value, not being desirable even as grazing land. It is recommended that these slopes be allowed to stand in timber, which when it becomes large enough should be removed by systematic forestry. The percentage of the area occupied by this type is so small that it has very little influence upon the agricultural conditions and value of lands in the region.

DEKALB SANDY LOAM.

The soil of the Dekalb sandy loam is a medium-textured sandy loam of light-brown color and with an average depth of about 10 inches. The subsoil, to a depth of 3 feet or more, is practically the same as the soil, except that it is somewhat lighter colored and sometimes has a slightly greater clay content. When the soil is dry it is rather incoherent. Very often there are considerable quantities of micaceous sandstone fragments varying from one-eighth of an inch to 2 inches in diameter scattered upon the surface and disseminated through both soil and subsoil. This is a residual soil derived principally from the weathering of the Pittsburg and Connellsville sandstones.

The Dekalb sandy loam is a very easy soil to handle. In the spring it can be plowed the earliest of any type in the area. It is, however, inclined to be quite droughty during the dry spells of summer, as the type occurs principally upon the hilltops and narrow winding ridges, and its natural drainage is apt to be excessive.

The native vegetation, which was largely chestnut, has been removed and all the type has at sometime been in cultivation. At present about one-half of it is in pasture and the remainder used for general farm crops. Corn yields from 20 to 40 bushels per acre, oats from 20 to 45 bushels, and wheat from 8 to 18 bushels. When seeded down to timothy and clover the results are not satisfactory. The clover stand is poor and the timothy comes up thin and after the second year is crowded out by plantain and sorrel. Kentucky bluegrass, the natural grass of the region, does not replace the timothy and clover. Owing to the rather loose, open nature of the subsoil the type has a tendency to leach and the effects of manure and other fertilizers are not lasting. A few farmers have used commercial fertilizers upon the type, but they report that the effects are not permanent enough to pay for the outlay.

The cultural methods at present used upon the Dekalb sandy loam are the same as upon the Dekalb silt loam and the Brooke clay loam. The type is so limited that not much of it is ever found upon any one farm, and the value of the lands and the general agricultural conditions in the area are not much influenced by the type. It is believed that the usual location of this type upon hilltops and ridges and the texture of its soil and subsoil make it the best type in the area for peaches and that orcharding would be more profitable upon it than general farming. On one farm a short distance north of Hollidays Cove alfalfa was growing, but the result was not very encouraging.

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

Mechanical analyses of Dekalb sandy loam.

Number.	Description.	Fine gravel	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
15225, 15227	Soil	1.1	10.3	19.9	16.1	10.3	25.4	15.9
15226	Subsoil	1.5	11.9	18.7	17.6	4.2	34.9	10.8

BROOKE CLAY LOAM.

The soil of the Brooke clay loam is a brown or dark-brown heavy loam or clay loam ranging in depth from 6 to 10 inches, with an average of about 8 inches. The subsoil is a light-brown clay and changes gradually to a slightly yellowish heavier clay at a depth of about 20 inches. Below this to a depth of 3 feet or more the texture remains a heavy clay, but the color continues to get lighter and sometimes at a depth of 3 or 4 feet it becomes a gray or drab. Scattered over the fields and disseminated through both soil and subsoil are small fragments of gray or bluish-colored limestone and limy shale, and these rocks can often be seen outcropping in the road cuts. On narrow ridges, where the surface soil has been removed by erosion, the rock fragments are more noticeable and the surface material is apt to be a clay. This type requires very careful and intelligent treatment. If plowed when either too wet or too dry serious results follow. When plowed in just the right condition of moisture it turns easily and pulverizes readily, and is usually cultivated without difficulty. It is believed that less trouble is experienced in handling it when plowing is done in the fall, so as to give the soil the beneficial pulverizing action of the frost during the winter months.

The type first appears near the southern boundary of Hancock County, on the hilltops southeast of Hollidays Cove, and is found from there to the southern boundary of the area. In its first appearance it occurs merely as caps for the highest hills, while farther south, where the formation from which it is derived becomes thicker, it occupies both the highest hilltops and ridges and extends down the hill slopes for a considerable distance. It reaches its best development upon the McCullocks Ridge northeast of Wheeling. Farther south, as for example, along Wheeling Creek, the formation from which it is derived passes under heavy cover and the type occurs as far down as the lower slopes of the hills bordering the creek.

The Brooke clay loam is derived from the disintegration of the limestone rocks and calcareous shales. Where the limestone areas are well developed and the stream courses have not cut down through the Monongahela series into the sandstones and sandy shales of the

underlying Conemaugh series the topography is gently rolling to moderately hilly, with very little or no waste land along the stream slopes. The drainage of the type is very good, though not excessive. The soil absorbs moisture readily and retains it well during the dry spells in summer. The ability of the type to absorb and retain moisture causes the bluegrass pastures to be much more permanent than upon the soils of sandstone origin, and this fact accounts for the greater profitableness of sheep raising.

The earliest settlements were made upon this type and the original growth of hardwood has all been removed. Fully 70 per cent of the type is at present under cultivation. It is recognized as the strongest and best soil in the area for general farm crops, and is easily kept in a good state of productiveness. Corn, oats, wheat, timothy and clover, and bluegrass are the principal crops. Apples, cherries, plums, raspberries, strawberries, and garden vegetables are grown for home use and to some extent for market. Corn yields from 40 to 70 bushels per acre, oats from 30 to 60 bushels, and wheat from 15 to 35 bushels. Clover usually makes an excellent stand and is followed by timothy, which is cut for two or three years and yields about 1 or 1½ tons per acre. Bluegrass comes in as the timothy thins out and is very valuable for grazing purposes. Very few potatoes are grown upon this type, as it is considered too heavy.

Among the best farmers the type is handled very intelligently and with profit, and not many suggestions for improvements can be made. All of the farmers keep stock enough to maintain the productivity of the soil. Near the towns, however, there are a few farmers on this type who sell off all the available hay and straw and keep very little or no stock. Their farms have become "worn out," and it is recommended that stock be kept for dairy purposes and all of the hay and straw converted into manure and used on the farm.

The farmers have not felt the necessity of using commercial fertilizers upon this type.[a] A few have used them, but without permanent beneficial results. The farmers as a rule feel that there is no fertilizer equal to barnyard manure, and when applied the beneficial effects are noticeable for years afterwards. A very few farmers have used a light application of lime, which seems to improve the clover crop and also seems to make it easier to put the soil in proper tilth.

[a] For the purpose of determining the manurial requirements of this soil type a study was made by the wire-basket method of large samples collected at points within the area from fields that were representative of the type as it is found in this section. The results of the test, as indicated by increase in plant growth over that observed in the untreated soil, while held to apply strictly to the fields from which the samples were taken, are doubtless reliable for this type throughout the area.

Lime, nitrate of soda, sulphate of potash, and acid phosphate applied singly produced but slight increase, and combinations of the above fertilizers, with one exception, were no more effective than the elements added singly. Nitrate of soda, when

The general agricultural conditions are influenced more by this type than any other in the area, and it is this type that has contributed most to the reputation of the region for producing a fine wool of long staple.

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

Mechanical analyses of Brooke clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
15245, 15247	Soil	0.2	1.0	0.8	2.7	4.6	56.4	34.0
15246, 15248	Subsoil	.3	1.1	.7	2.5	3.8	48.0	42.8

DEKALB SILT LOAM.

The soil of the Dekalb silt loam consists of a rather light brown mellow silt loam which varies in depth from 7 to 10 inches, with an average of about 8 inches. The subsoil to a depth of 3 feet or more is either a very light brown or a pale yellowish material varying in texture from a silty loam to a silty clay loam. The type is quite similar in texture to the soil of the Steep broken land found lower down the slopes, but owing to its position and the smaller percentage of rock fragments found in both soil and subsoil and upon the surface it is a much easier soil to plow and cultivate than the latter, and therefore much better adapted to general agricultural purposes. Disseminated through both soil and subsoil and scattered upon the surface are sometimes found small fragments of sandstone and sandy shale, but these are never numerous enough to interfere with cultivation.

The type is well developed in Hancock County and in the northern part of Brooke County in connection with the sandstones and sandy shales of the Allegheny and Conemaugh series. It is also found less well developed southward over the remainder of the area in connection with the sandstone and sandy shale strata of the Monongahela and Dunkard series. This is a residual soil derived from the

used in combination with sulphate of potash, did, however, give a much greater increase than any other combination, being about as effective as the application of manure or cowpea vines with lime. At the present time there seems to be no indication of the need of chemical fertilizers upon these soils, the application of manure and the plowing under of the sod serving to maintain the necessary amount of humus in them, as well as to render available by their decomposition sufficient potash and phosphoric acid. The use of a legume at the time of renewing the grass is a point that should not be overlooked if their fertility is to be maintained, and while the present practice is commendable the plowing under of a crop of clover or cowpeas at that time would doubtless greatly benefit the succeeding crops of hay.

weathering of the sandstones and sandy shales of the rock series just mentioned.

The type occurs principally as flat or gently rolling tops of hills and ridges. The size and shape of the areas are variable, depending upon the extent to which erosion has eaten back into the old plateau. Occasionally erosion has reduced the ridges to a "hog-back," and in that case the Steep broken land extends over the ridge.

The Dekalb silt loam is sometimes found 100 feet or more below the tops of the hills, in a shelflike position. This is due to the outcropping and weathering of resistant massive sandstone strata which extend around the contour of the hills, usually approximately parallel to one another. In a few cases the type is also found in the sandstone valleys, where it occupies the gentle lower slopes of the hills. Owing to the topography of the type and the texture of both soil and subsoil the drainage is good. Though not subject to severe washing or erosion, it is more apt to suffer from a lack than from an excess of moisture.

The original forest growth of chestnut and oak has long since been removed and it is estimated that fully 80 per cent of the type is under cultivation. It is not especially well adapted to any one crop, but where carefully handled is a fair soil for the general farm crops of the area. Corn yields from 25 to 60 bushels per acre, oats from 20 to 50 bushels, wheat from 10 to 25 bushels, and potatoes from 50 to 150 bushels. Apples, cherries, plums, berries, and garden vegetables do well and are grown for home use. Strawberries and raspberries also do well and are grown on a small scale for market.

In the early settlement of the region the type was not so rapidly taken up and cleared as was the limestone soil near by. This was due in part to the isolation of the areas and in part to the general recognition of the fact that soil of sandstone origin is usually less productive than one of limestone origin. Sheep raising never became very popular upon the Dekalb silt loam, for the reason that bluegrass did not thrive on this soil.

This is not naturally a strong soil type and can not be expected to stand the same methods of cropping as the Brooke clay loam, though this is what the farmers have been doing.[a] The use of lime is recommended and the incorporation of more organic matter would prove beneficial. For this reason less hay or straw should be sold and enough stock should be kept to convert these into manure. In this way the type should be brought to a satisfactory state of productivity. Nearly one-half of the tillable farm lands of the area is composed of

[a] Two large samples of this soil were used in a study, by the wire-basket method, for the purpose of determining the manurial requirements of this soil. In the last few years some little commercial fertilizer has been used upon the fields from which samples were taken—usually about 200 pounds per acre—but the analysis and source could not be ascertained. With such treatment as they have received the average

this type, so that it has a great influence upon the general agricultural conditions and value of farm property.

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

Mechanical analyses of Dekalb silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
15229	Soil	0.0	0.7	0.5	1.6	17.9	63.0	15.9
15230	Subsoil	.1	1.3	.4	1.6	30.2	46.1	20.2

UPSHUR CLAY.

The Upshur clay consists of about 7 inches of red or dark-red stiff, tenacious clay, underlain to a depth of 3 feet by a red clay of a slightly heavier texture.

This is a very difficult type to till because of its stiff, tenacious character. It is spoken of locally as "cold, wet, late land," owing to the difficulty of plowing it in time for planting. In dry weather it has a tendency to bake and is very difficult to handle. In wet weather it forms a deep, sticky mud in the roads, through which wagons pass with the greatest difficulty, and in dry weather these roads become very hard and rutty if not smoothed over with a road machine.

The Upshur clay is found in small unimportant areas in the northern end of the survey. It usually occupies the tops and slopes of small hills, and sometimes occurs as a band of soil extending around

yields are about 15 to 20 bushels of wheat, 40 bushels of corn, and from 20 to 30 bushels of oats per acre. Clover and timothy are usually sown together, producing from 1 ton to 1½ tons of mixed hay per acre.

These fields are rolling and well drained. Owing to the silty nature of the surface there is a great tendency to pack, and considerable care is required to keep it in good physical condition.

The results observed, as indicated by increase of plant growth over that obtained in the untreated soil, while held to apply strictly to the fields from which the samples were taken, are no doubt reliable for this type of soil throughout the area.

The addition of fertilizers, both singly and in combination, gave an increase in plant growth, the largest being that obtained from the use of a complete fertilizer, both with and without the addition of lime. The increase derived, however, from the use of manure exceeded that from any fertilizer or combination of fertilizers, and was itself inferior to that obtained from the use of cowpea vines and lime.

The beneficial results obtained by the use of both manure and cowpea vines are strongly indicative of the need of organic matter in these soils, and there can be no doubt that green manuring would improve their physical structure and greatly retard the packing that soils of this character are so liable to—a feature that is noticeable in this type in this locality.

the hill, the rocks from which it is derived apparently extending through the hill horizontally. Occasionally it occupies narrow ridges.

The surface of the Upshur clay is usually steep and hilly, and where the soil occurs on the hillsides it has a tendency to gully and wash badly, the impervious nature of the soil preventing the absorption of the rain. It is a residual type derived principally from the weathering of the soft, marly red shales of the Pittsburg formation. In the region where the Upshur clay is mapped these shales occur well up toward the tops of the highest hills, where they have a chance to weather into soil. The same shales were seen in many places along road cuts and stream courses farther south, but owing to the steepness of the slopes they have no soil covering. The red color of this type is not due to recent oxidation, but to the deposit of red sediment derived from the erosion of old land areas when the Conemaugh series was being deposited. The soil usually contains fragments of limestone and iron ore.

The native vegetation consisted of hardwoods, principally oak, hickory, beech, and maple. Practically all the type has been cleared and put under cultivation, but, owing to the great difficulty of handling, it is not a satisfactory soil for general farming and is used mostly for hay and pasture. It is well adapted to these purposes, and when carefully handled is a fairly good soil for wheat and corn. Wheat yields from 10 to 20 bushels and corn from 20 to 50 bushels per acre. Oats are not much grown upon the type and it is not well adapted to potatoes or fruits.

When wet this soil is not porous enough to allow water to pass downward readily, so that it becomes water-logged and lacking in aeration. In times of drought it bakes and becomes difficult to till. The type needs a treatment which will overcome these tendencies. A heavy application of lime is recommended, and the plowing under of clover or other coarse organic substances would also be very beneficial.

Owing to the small percentage of the area occupied by this type it has but little influence upon the general agricultural conditions and value of lands in the region. The red clay has considerable value for making earthenware and is used for this purpose in a number of potteries.

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

Mechanical analyses of Upshur clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
15217	Soil	0.1	0.9	0.8	2.7	8.4	33.0	54.4
15218	Subsoil	.8	3.1	2.0	6.2	10.1	29.3	48.9

HUNTINGTON FINE SANDY LOAM.

The soil of the Huntington fine sandy loam is a fine sandy loam varying in color from light brown to dark brown or nearly black. The subsoil to a depth of 36 inches or more is about the same in texture as the soil, but is lighter in color, though in places it seems to contain considerable organic matter. The presence of a considerable portion of the organic matter in both soil and subsoil is accounted for by the fact that small fragments of limbs, bark, leaves, and other debris were deposited with the fine sand. The soil is an easy one to plow and cultivate, being mellow and having little tendency to pack or bake. The elevation of the type above the normal level of the river is only from 20 to 40 feet, and consequently a large proportion of it is under water every spring, and sometimes later in the year. It occurs as long, narrow strips bordering the banks of the Ohio River, and is sedimentary in origin, being still in the process of formation. Often the long, narrow strips are somewhat higher than the area back of them, presenting the appearance of a natural levee. This is accounted for by the fact that when the river overflows its banks the heaviest and greater part of the material is deposited as soon as the current slackens in overflowing the banks.

None of the hardwood timber which originally covered this type is now standing, the land being in great demand both for general farming and for trucking. Of the general farm crops, corn does well, the average yield per acre being about 45 or 50 bushels. Only fair yields of wheat and oats are obtained. Hay will yield on an average from three-fourths to 1 ton per acre. It is an excellent type for Irish potatoes, the average yield being about 150 bushels of salable potatoes per acre. Cabbage will yield about 300 barrels per acre. Besides these general and special crops, asparagus, tomatoes, onions, radishes, lettuce, and grapes are also produced. Some small fruits and berries are grown for the near-by markets.

Although of limited extent, the Huntington fine sandy loam has considerable influence upon the agricultural conditions and value of land within the area, because of its especial adaptability to commercial trucking and its convenience to markets. The fertilizer problem is simplified by the nearness of the type to numerous livery stables, where manure can be obtained cheaply, and by the level roads over which to haul it.

It is recognized that this type is well adapted to general farm crops, but because of its especial adaptability to truck, convenience to market, and the inability of the area to satisfy the demand for the latter products, it is believed that it would be more profitable to grow truck crops exclusively.

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

Mechanical analyses of Huntington fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
15239	Soil	0.5	1.6	1.0	13.3	38.7	32.2	12.4
15240	Subsoil	.0	.2	.4	14.0	45.8	27.5	12.8

DEKALB LOAM.

The soil of the Dekalb loam is a light-brown loam from 7 to 12 inches deep, with an average depth of about 8 inches. The subsoil, to a depth of about 24 inches, is a pale-yellow clay loam, which frequently has a slightly greasy feel when rubbed between the fingers. Below 24 inches the material is heavier in texture, and is often mottled with gray or drab. At a depth of 5 or 6 feet, as shown in the road cuts, the subsoil rests upon a mass of disintegrated sandstone, beneath which occurs the bed rock. Scattered upon the surface and disseminated through the soil and subsoil are often found small fragments of sandstone, but these are not numerous enough to interfere with cultivation. On the tops of some of the narrow ridges where the bed rock comes closer to the surface and the small sandstone fragments are more numerous, the soil is somewhat sandier than the average.

The Dekalb loam is not as difficult to farm as the Brooke clay loam, but is heavy enough to demand care and attention in plowing and cultivating. When properly handled, there is no trouble from puddling or baking.

The Dekalb loam is confined to the uplands of the southern part of the area, and is especially well developed in the region south and southeast of West Liberty, extending to the southern boundary of the area. In the vicinity of West Liberty it occurs as a capping for the highest hills, but the areas become larger and better developed to the south, as the formation from which it is derived becomes thicker.

The topography varies from broad and gently rolling to hilly and sometimes deeply eroded areas. The drainage, as a whole, is excellent, but in places where the surface is nearly level artificial drainage would be beneficial. In such places iron concretions are often present in the subsoil. In dry weather the crops are not apt to suffer from drought, except upon the narrow ridges and hilltops, where the underlying bed rock comes close to the surface.

The Dekalb loam is a residual soil derived from the weathering of fine-grained sandstone and sandy shales. The native vegetation was

largely chestnut, with considerable oak, beech, and maple. The type is not especially well adapted to any one crop, but is a fair soil for the general farm crops of the region. Corn yields from 25 to 60 bushels per acre, with an average of about 40 bushels; oats from 25 to 50 bushels, with an average of about 35; wheat from 8 to 25 bushels, with an average of about 15, and hay from three-fourths of a ton to 1½ tons, with an average of about 1 ton. Potatoes, vegetables, and small fruits do remarkably well, but are usually grown only in small patches for home use. During the last decade considerable difficulty has been experienced with the clover crop. It seems to die out in spots the first year after sowing, and is replaced by plantain and sorrel. The trouble seems to be greatest where commercial fertilizers have been used to the exclusion of barnyard manure. Very few farmers have used lime on the fields thus affected, but those who have done so are satisfied that the results more than justify the expense. At present but little commercial fertilizer is purchased, but the value of barnyard manure is well understood by the farmers, many of whom haul it from the city. Few sheep are kept, but near Wheeling and along the trolley lines leading to that city dairies are numerous. These dairy farms are the most productive found on this type, due solely to better management and the use of stable manure.

On the hills near Wheeling, where stable manure can be hauled from the city, some truck crops and fruit are grown successfully, but the area used in this way is very limited. Heavy annual applications of manure are necessary where truck crops are grown year after year without regard to rotation. When manure can not be secured the land is seeded down to grass and allowed to recuperate for a few years. [a]

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[a] A study was made of a large sample of this soil, by the wire-basket method, to determine the manurial requirements of this soil type.

The field from which this sample was obtained lies near the top of a high hill. The soil is somewhat stony and is not susceptible to much erosion. About 30 bushels of corn, 12 bushels of wheat, and 1 ton of hay are the average yields per acre. No fertilizers or manure have been used upon this field.

Of all treatments tried the largest increase in plant growth was observed when applications were made of stable manure. Lime applied singly had no effect, and seemingly interfered with the good results which might have resulted from the use of the cowpea vines, and actually reduced the effect of the complete fertilizer, the increase obtained from the use of the fertilizer without lime being greater than that produced by the fertilizer and lime.

Nitrate of soda and sulphate of potash used singly gave increases, while applications of acid phosphate were negative. When used in combinations of two these fertilizers all gave increases, but considerably inferior to that derived from the use of manure.

These results, while held to be strictly applicable only to the field from which the sample was taken and with wheat, the indicator used in the test, will doubtless apply to all of this soil type within the area.

The Dekalb loam is a somewhat stronger soil than the Dekalb silt loam, and is considered the more valuable by the farmers. The reported yields are slightly in excess of those on the Dekalb silt loam. About 13 per cent of the upland portion of the area is occupied by this type of soil.

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

Mechanical analyses of Dekalb loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct*
15221, 15223	Soil	0.9	2.5	1.3	2.5	9.2	58.8	24.5
15222, 15224	Subsoil	.9	3.3	1.3	2.1	3.2	51.9	37.3

WHEELING GRAVELLY LOAM.

The soil of the Wheeling gravelly loam has an average depth of about 8 inches and consists of a brown loam usually containing considerable coarse sand and fine gravel. Local variations occur, in which the soil may contain considerable more than the average quantity of silt, or again the sand content may be rather high, so that we find the interstitial material in phases ranging from a silty loam to a heavy sandy loam. The subsoil to a depth of 3 feet or more is a light-brown or yellowish gravelly loam. The particles of gravel vary from one-fourth inch to 2 or more inches in diameter and consist largely of waterworn shale and rounded fragments of the harder rocks. Occasionally the surface is strewn with rounded stones and gravel, but they are seldom numerous enough to interfere with cultivation. On the whole, the type is a loose, porous soil, easily handled, and never too steep for cultivation.

The Wheeling gravelly loam is confined principally to the terraces of the Ohio River and occurs as long, narrow strips whose elevation above the normal level of the river ranges from 40 to 100 feet. Its topography varies from nearly level to rolling and hilly. The loose, open nature of the subsoil insures good natural drainage, and where the surface is hilly the drainage may be excessive, so that crops are apt to suffer severely during dry weather.

The Wheeling gravelly loam consists of reworked material brought from the glacial region to the north when the volume of the river was greater than now. The sand, gravel, and stones found beneath the surface represent approximately the original condition of deposition. The surface of the type, however, has been more or less modified by weathering and an accumulation of organic matter since deposition, producing a fairly good soil for agricultural purposes. It was origi-

nally forested with the hardwood trees common to the region, but none of these are now standing and the type is used either for orcharding or general farm crops.

The type is better adapted to corn than to any of the other general crops, the yields averaging about 45 bushels per acre. The wheat yields average about 15 bushels, but range from 10 to 25 bushels. Oats range from 25 to 50 bushels, with an average of about 35 bushels. The yield of hay is usually not more than 1 ton per acre on an average. Truck crops are grown to some extent, and judging from what was seen in this area and what has been done upon the same type of soil in other areas it is evident that the trucking industry should be extended. Potatoes can easily be made to yield on an average 125 bushels per acre. Some very good apple orchards are growing upon this type and it is believed that an extension of this industry would prove profitable. Plums, cherries, and pears also do well. The same type in other areas produces good tobacco. Barnyard manure is practically the only fertilizer used.

The Wheeling gravelly loam is not an extensive type of soil in the Wheeling area, but its convenience to the markets and the possibilities of extending the trucking and fruit industry makes it a much more important type than is at present thought, and it might be made to affect the agricultural conditions and value of lands within the area more than it does at present.

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

Mechanical analyses of Wheeling gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
15241, 15243	Soil	0.2	5.1	12.8	15.7	19.6	30.3	15.7
15242, 15244	Subsoil	4.8	11.7	6.3	15.6	25.0	18.9	18.0

WHEELING SANDY LOAM.

The Wheeling sandy loam consists of about 8 inches of light-brown sandy loam, resting upon a rather incoherent yellowish sandy loam or sand, which extends to a depth of 3 feet or more. Scattered upon the surface and disseminated through soil and subsoil are sometimes found numerous quartz pebbles. Owing to the loose, loamy nature of the soil and its good underdrainage the type is an easy one to cultivate.

The Wheeling sandy loam is confined to the terraces of the Ohio River, where it usually occurs only in small patches. The only place where the areas were large enough to map was at Arroyo, in the north-

ern part of the survey. Here it occurs as a gently rolling terrace and has excellent surface and underdrainage. The elevation of the terrace above the river is about 40 feet.

This type is composed of reworked material brought from the glacial region to the north when the volume of the river was much greater than now, and the sand of the subsoil represents approximately the original condition of the material at deposition. Since it was laid down the surface material has been somewhat modified by the accumulation of organic matter. The type was originally forested with the hardwoods of the region, but is at present cleared, the areas being in great demand for the production of apples. The growing of apples upon a commercial scale began upon this type and from these orchards as a nucleus it has spread out over the tops and sides of the hills round about. The character of the type and the climatic conditions in the Ohio Valley make the Wheeling sandy loam especially well fitted to the production of the Willow Twig, the Northern Spy, and the Rome Beauty varieties of apples, and a few skilled orchardists have become wealthy in the business. The greatest enemy to the orchards is the codling moth, and spraying is a necessity. The common practice is not to have the ground in sod for more than a year or so at a time, and when the orchards are pastured hogs and sheep are preferred to cattle because the last are more likely to injure the trees. Cowpeas and rye are used extensively as cover crops, the peas being sown in June and the rye in September. Practically the whole of the type is in orchards, hence little can be said as to its adaptability for other purposes.

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

Mechanical analyses of Wheeling sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
15237	Soil	0.2	10.4	22.9	31.3	7.8	16.8	10.6
15238	Subsoil	.3	5.8	26.7	30.7	10.3	17.3	9.5

HUNTINGTON LOAM.

The Huntington loam is a light-brown or brown loam with an average depth of about 10 inches, resting on a subsoil of light-brown or yellowish loam usually somewhat heavier than the soil and extending to a depth of 30 inches or more. The color of the soil and subsoil is somewhat variable. Along Wheeling Creek, where the limestone material has entered into the formation of the type, the soil is dark brown and in places almost black. In locations where the drainage conditions are poor the subsoil is apt to be drab-colored. The texture

of the type also varies, often within short distances. Sometimes the soil in patches contains decidedly more fine sand and occasionally some gravel, and in the lower depth of the subsoil it is not uncommon to encounter considerable gravel.

The Huntington loam occurs as first bottoms along the Ohio River and its larger tributaries. Its usual topography is level or slightly rolling. It is each year subject to several overflows during the spring months, but there is little danger from these after planting time and during the growing season. The surface drainage and underdrainage are usually fair, owing to the slight fall toward the near-by streams and the presence of gravel in the lower depths of the subsoil. Only a few depressions were seen where artificial underdrainage would be beneficial.

The Huntington loam consists of a mantle of recent alluvial material spread out over the gravel deposits of the Glacial period. In places the wash from the adjoining hills is contributing to its formation, and in general it is still in the process of building, as each overflow leaves a thin deposit of loam and organic matter washed from the upland soils.

None of the original hardwood timber is now standing. In the early days the type was in great demand as a general farming soil, being regarded as especially well adapted to corn. The present average yield of corn, when well cared for, is about 60 bushels per acre. Other general farm crops are grown to some extent and with fair yields. Of late years the trucking industry has assumed considerable importance upon the type, owing largely to its especial adaptability to that purpose and also to the convenience to market and the increasing demand for trucking products. All of the ordinary truck crops of the region are grown with profit.

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

Mechanical analyses of Huntington loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
15219	Soil	0.0	0.4	0.2	2.6	25.7	44.4	25.9
15220	Subsoil	.1	.1	.1	2.2	24.2	44.9	27.6

SUMMARY.

The Wheeling area is located in the northern end of the Panhandle of West Virginia and includes all of Hancock, Brooke, and Ohio counties and part of Marshall County. In a north-and-south direction it is 45 miles long, while in an east-and-west direction it varies in width

from 4½ to 12 miles. It contains 201,600 acres, or 315 square miles. The Ohio River borders the area on the western side and for a mile or so back from the river the region is very hilly and dissected, but farther back it becomes less abrupt and broken and is better suited to general farming. The floors of the valleys are seldom wide enough to permit the accumulation of sediment along the streams, for which reason there is little bottom land in the area. The steep vertical erosion adjacent to the Ohio River and the absence of bottom lands over a large part of the area have rendered much of it unfit for general farming, but this is partly compensated for by the fact that beds of coal and fire clay are exposed.

The present farming population, which is about 30 per cent of the total population of the area, are mostly the descendents of the settlers who came from Virginia, Maryland, and North Carolina. The remaining 70 per cent of the population live in the towns and represent people from various States and foreign countries. The town people are largely a laboring class employed in various industries, and they furnish a greater demand for all kinds of products than is at present being supplied by the agricultural population of the area.

The farms are not being worked to their full capacity, largely because of the scarcity and high wages of skilled farm labor. The output of the farms is mostly limited by what the owner can do himself. An abundance of modern farm machinery and good work stock are used, and the farmers as a class are wideawake and are making a good living. Since the sale of their coal, oil, and gas rights, however, some of them are neglecting their farms.

The Brooke clay loam is the most important soil of the area for general farm crops and is the type which has made the region famous for sheep yielding a fine wool of long staple. The Dekalb loam is an important soil for the same products. Both of these soil types are also well adapted to fruit and truck crops. The Dekalb silt loam, though not so well adapted to general farming and stock raising as the types first named, is somewnat better adapted to fruit and truck crops. The Dekalb sandy loam, though limited in extent, should be an important type for fruit and trucking purposes, and judging from the experience of one farmer it seems that alfalfa would be profitable. The Upshur clay had better be used exclusively for meadow and pasture. The remaining upland types, which are too steep for convenient tillage, are very important for pasture, and, as has been demonstrated in Hancock County, are also very important for commercial orcharding. The level sedimentary and alluvial types found along the Ohio River and Short, Cross, and Wheeling creeks are very well adapted to all kinds of trucking purposes, and where general farming is pursued upon them it is recommended that it be discontinued, as they are too valuable for trucking purposes to be used for general farm crops.

The question of maintaining the productiveness of the sedimentary and alluvial types is easily solved, both by reason of the frequent overflows and because of the nearness to cities, where stable manure may be obtained cheaply, but upon the upland types the problem is considerably more serious. Any system of general farming upon the uplands, which excludes stock raising, must ultimately prove a failure and it is recommended that more stock be kept to supply the increasing demands for dairy products and mutton, and indirectly to furnish the needed organic manures.

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