

Issued May 13, 1915.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—MILTON WHITNEY, Chief.
IN COOPERATION WITH THE STATE OF INDIANA DEPARTMENT OF GEOLOGY,
EDWARD BARRETT, STATE GEOLOGIST.

SOIL SURVEY OF HENDRICKS COUNTY, INDIANA.

BY

W. E. THARP, OF THE U. S. DEPARTMENT OF AGRICULTURE,
AND E. J. QUINN, OF THE INDIANA DEPARTMENT
OF GEOLOGY.

W. E. McLENDON, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1913.]



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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., September 25, 1914.

SIR: Under the cooperative agreement with the State of Indiana Department of Geology, Edward Barrett, State Geologist, a soil survey of Hendricks County was carried to completion during the field season of 1913.

I have the honor to transmit herewith the manuscript and map covering this work and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1913 as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

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

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SOIL SURVEY OF HENDRICKS COUNTY, INDIANA.

By W. E. THARP, of the U. S. Department of Agriculture, and E. J. QUINN, of the Indiana Department of Geology.

DESCRIPTION OF THE AREA.

Hendricks County is situated in the central part of Indiana. It is bounded on the north by Boone, on the east by Marion, on the south by Morgan, and on the west by Putnam and Montgomery Counties. It embraces about 408 square miles, or 261,120 acres. Indianapolis is about 10 miles east, in Marion County.

The county as a whole is a somewhat uneven plain with a general slope toward the south. The elevation above sea level ranges from 800 to 900 feet for most of the county, with a few points rising to about 1,000 feet. Throughout the northeastern part of the county and in the west-central section the characteristic topography, except in the immediate vicinity of the creeks, is a succession of slight swells and low, broad divides, usually without very definite trend and more or less uneven with regard to relative elevation. The depressions vary from mere swales a few rods across to very irregularly extended flats embracing several hundred acres. A few of the largest are several miles in length and in places more than a mile in width. In the northern part of the county such large bodies of low land are exceptional. Instead there are frequent slight variations in elevation, the differences being accentuated by the strong contrast between the light-gray shades of the higher ground and the black color of the soils in the depressions.

In the southern part of the county the relief is much more pronounced. The National Road between Plainfield and Stilesville crosses several high divides that decline in long undulating slopes to the wide valleys of Mill and Mud Creeks. To the south of this highway the country slopes to the south, and the local differences in elevation are generally greater than farther north along the Pennsylvania and Big Four Railroads. Except in the immediate vicinity of the



FIG. 1.—Sketch map showing location of the Hendricks County area, Indiana.

drainage lines, there is very little land on which the heaviest farm machinery can not be used with ease. In many places the comparatively mild contours of the uplands prevail to the very crest of the bluffs overlooking the valleys of the White Lick Creeks. Occasionally hilly land extends some distance back, or the tributaries are bordered by very short, steep slopes.

Between New Winchester and Coatesville much of the surface has very slight relief, and there are frequent flats or slightly depressed areas, but these seldom include more than 10 or 20 acres. The largest body of level land in the county is that embraced by the several branches of Ramp Run. This tract is somewhat lower than the uplands to the west and south and much inferior in elevation to the high morainic ridge to the northeast. The latter extends from below Danville nearly to North Salem, rising about 100 feet above most of the country to the east. Its western slopes are very moderate, but it becomes more rolling on the eastern side. Near Danville the lower parts of the divide are cut by many short ravines, and hilly to broken land occurs in many places.

Throughout the northern part of the county there are numerous local elevations rising from 10 to 40 feet above the general level of the surrounding country. These vary from small mounds of less than 1 acre to ridges a fraction of a mile in length. From Danville southwest to the county line there are many of these isolated elevations. Some of those along East Fork Mill Creek are essentially gravel mounds with a veneer of loam, but those near Stilesville are broad ridges not very distinct from the other elevations in that section.

The northern and northeastern part of the county, which has poor natural drainage, is the southern extension of that great area of central Indiana which is characterized by similarly immature development of its minor drainage systems. In this county artificial mains and the installation of hundreds of miles of tile drains have remedied the natural deficiencies so far as agricultural interests are concerned.

In the southern half of the county the drainage is much better developed. This is due mainly to the greater differences in elevation as compared with the surface of the northern townships and to the longer periods the streams have been actively eroding their valleys. The White Lick Creeks and Aber Creek have trough-shaped valleys from one-eighth to one-half mile in width. Their floors are comparatively flat, while the sides in most instances are nearly vertical bluffs from 20 to 50 feet in height. The abrupt declivities are most striking features of the landscape along the above-mentioned streams, and also on the lower Eel River, where there are bluffs upwards of 100 feet

in height. The small tributaries of these creeks usually have V-shaped valleys along their lower courses, while the upper parts have relatively wider strips of alluvium bounded by low banks. In most cases the extreme heads of all these drainage lines have their origin in the structural depression of the uplands where there has been little or no erosion. This, of course, is most noticeable in those branches that rise in the northern part of the county, but is also true of the majority of the small drainage lines in other sections.

Mud Creek Valley is a broad depression which had poor natural drainage until the present channel was artificially opened. Since this was done the moderately high gradient has resulted in the widening and deepening of the main channel so that it affords a good outlet for the numerous laterals that have been constructed.

The Mill Creek valleys are comparatively wide, but consist in part of low terraces. The recent alluvium is limited to narrow strips seldom more than one-fourth mile in width. These valleys and that of Mud Creek have no such bluffs or abrupt slopes on either side as occur along the other streams. The long upland slopes merge so gradually into the lowlands that no definite boundary can be drawn between them.

The terraces along the White Lick Creeks and lower Eel River are nearly level benches 20 to 50 feet above the bottom lands. Their outer margins are sharp, stony declivities, but on the upland sides the transition to the latter, both with respect to topography and character of soil, is very gradual.

The larger creeks maintain their flow throughout the year. Many of the smaller streams are perennial, being fed by tile drains and numerous artificial ditches. Along all the bluffs, particularly those facing the south, springs are of very common occurrence, and the quality of water is excellent. Near New Winchester, Amo, and Clayton there are a number of flowing wells. In the valleys and in most of the larger areas of Clyde soils potable water is usually obtained at less than 15 feet. On the uplands the depth of dug wells ranges from 20 to 50 feet, and the supply is generally sufficient for all farm purposes. In recent years many driven wells have been sunk from 90 to 150 feet and an apparently inexhaustible supply is thus obtained.

All of this area, with the exception of a few small tracts in the larger bodies of black land in the north-central townships, was at one time heavily forested. These so-called "prairies" consisted of marshy land not yet sufficiently free from water to permit cottonwood, willow, elm, or other moisture-enduring species to establish themselves. The timber now remaining consists mainly of scattered trees in pastures, along the highways, and forming the groves around farm buildings.

It is probable that less than 10 per cent of the area of the county has not been cultivated. Practically all is included in well-improved farms, the untillable areas being utilized for pasture to such an extent that there is very little undergrowth or young timber.

The Government survey of the lands in this county was made in 1819, and the first group of settlers located on lower White Lick Creek in 1820. Owing to the better natural drainage of the lands in the southern part of the county, and to the completion of the National Road through this section in 1830, its development was much more rapid than that of the northern part. As late as 1830, it is stated, there were not more than 50 persons within the present limits of Union, Middle, Brown, and Lincoln Townships. The artificial drainage of the larger areas of Clyde soils in these townships was not generally effected until about 1880, and at a somewhat later date the flat lands along Mud Creek and lower Mill Creek were reclaimed. These drainage systems have been so extended that practically all the land is suitable for agriculture.

The population of Hendricks County is reported in the 1910 census as 20,840. Danville, the county seat, is the largest town in the county. It has a population, according to the census of 1910, of 1,640. Plainfield is the next largest town, with a population of 1,303. The population of Brownsburg is given as 876. Other towns of local importance are Coatesville, North Salem, Clayton, and Pittsboro, each having a population of about 500. A number of smaller towns are located in various parts of the county.

The county is crossed from east to west by four steam railroads and two electric lines, all radiating from Indianapolis. Danville is connected with Indianapolis by a third electric railway.

The public roads are good, and rural delivery of mail is made daily to practically every farm house.

CLIMATE.

The data in the following table giving the normal monthly, seasonal, and annual temperature and precipitation at Indianapolis, Marion County, are fairly representative of the climatic conditions in Hendricks County.

Normal monthly, seasonal, and annual temperature and precipitation at Indianapolis, Marion County.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December.....	32.5	68	-15	2.98	4.09	0.90	5.0
January.....	28.4	70	-25	2.96	1.59	5.94	6.5
February.....	30.4	72	-18	3.09	1.63	4.58	5.0
Winter.....	30.4			9.03	7.31	11.42	16.5
March.....	40.1	82	0	4.04	4.11	7.44	4.3
April.....	52.4	87	19	3.39	3.19	2.27	1.0
May.....	63.3	96	31	4.00	2.45	5.11	0.1
Spring.....	51.9			11.43	9.75	14.82	5.4
June.....	72.3	100	39	4.23	3.52	7.54	0.0
July.....	76.1	106	48	4.06	0.83	.48	0.0
August.....	73.9	101	46	3.21	3.57	5.86	0.0
Summer.....	74.1			11.50	7.92	20.88	0.0
September.....	66.9	98	30	2.99	0.66	3.85	0.0
October.....	55.51	89	22	2.66	3.52	4.42	Trace.
November.....	41.4	76	-5	3.48	1.17	2.26	1.4
Fall.....	54.5			9.13	5.35	10.53	1.4
Year.....	52.7	106	-25	41.09	30.33	57.65	23.3

The average rainfall for each of the spring and summer months is sufficient to produce good yields of grain and grass, but the precipitation for these months during seasons of marked deficiency is not great enough to meet the requirements of most crops. There are comparatively few years in which at some period of the growing season there is not a shortage of rainfall and consequent decrease in yields of one or more crops. For this reason the necessity and means of conserving moisture are discussed at some length in connection with the type descriptions in subsequent chapters. In this respect, however, the conditions in Hendricks County do not differ materially from those in adjoining counties.

The average date of the last killing frost in the spring, as recorded at the Indianapolis station, is April 16, and of the first in the fall, October 19. The date of the earliest killing frost in the fall recorded is September 21, and of the latest in the spring May 21.

AGRICULTURE.

Corn, wheat, oats, clover, and timothy are the principal crops of Hendricks County, and no other products have ever received very much attention. The general trend of agriculture is indicated by the figures in the following table, taken from the census reports:

Acreage and yields of principal crops of Hendricks County as given in the census reports of 1880, 1890, 1900, and 1910.

Year.	Corn.		Wheat.		Oats.		Clover	
	Acres.	Yield.	Acres.	Yield.	Acres.	Yield.	Acres.	Yield.
		<i>Bushels.</i>		<i>Bushels.</i>		<i>Bushels.</i>		<i>Tons.</i>
1879.....	54,114	2,016,351	31,523	553,506	4,699	138,917
1889.....	50,637	1,642,054	32,956	376,831	10,178	259,872	5,676
1899.....	63,282	2,770,000	44,115	507,180	3,499	105,160	14,981	20,519
1909.....	76,085	3,125,343	26,614	363,548	17,522	467,480	2,935	3,452

Corn is by far the most important crop of the county. Interest is taken in every possible means of increasing the yields of this crop, especially on the lighter colored soils. Few farmers consider wheat in itself a profitable crop, and while the average returns from oats are somewhat better, both of these grains are grown mainly because of the opportunity thus afforded of seeding the fields to clover and timothy. On all types except the Genesee soils and the darkest colored phases of the Clyde soils a frequent change to clover is recognized as indispensable to the maintenance of the productiveness of the soil, or from the more common viewpoint, as essential to the profitable production of corn.

Not only are the crop rotations planned chiefly to meet the requirements of corn, but commercial fertilizers are used extensively on both this crop and wheat. The use of manufactured fertilizers has increased very rapidly during recent years. According to the census reports, \$1,217 was expended for commercial fertilizers in 1879, \$680 in 1889, \$14,710 in 1899, and \$21,160 in 1909.

The grades of fertilizers most commonly used have about the following proportions of the three essential elements: Nitrogen, 1 to 2 per cent, potash 4 to 8 per cent (usually 4 per cent), and phosphoric acid 8 to 10 per cent. The fertilizer is generally applied at the rate of 100 to 200 pounds per acre. Such applications result in materially increased yields of corn and wheat and in an improvement in the quality of the latter. On the so-called "chaffy" lands potash is generally used with corn, and invariably improves both the yield and quality of grain.

A promising rotation consists of corn, followed by wheat or oats, after which the field is seeded to clover, which is left for two years. The supply of manure on the average farm is entirely inadequate for proper applications to the grain lands. The nitrogen supply is maintained by returning a part of the two-years' growth of clover to the soil. On the light-colored soils a good practice is to turn under one crop of clover. In view of the resulting increase in the yields of corn, the practice of so utilizing a part of the clover growth is profitable. Under present methods, however, the greater part of the clover crop is removed. The lime requirements of the various soils of the county are discussed in connection with the detailed type descriptions in the following pages.

Hendricks County ranks high among the counties of Indiana in the number of cattle fattened annually. It is claimed that more cattle are fattened in Eel River Township than in any other township in the State. According to the Indiana Department of Statistics, there were 8,635 horses and colts, 1,412 mules, 14,197 cattle of all kinds, 40,407 hogs, and 11,745 sheep in Hendricks County in 1912. The value of domestic animals in this county is given in the 1910 census as \$2,518,444. Through the use of manure, the keeping of live stock has a direct bearing on the productiveness of the soils. On many farms the method of handling manure is very wasteful. In the villages the accumulations from livery barns are sold at nominal prices.

Dairying has become an important industry in this county since the shipment of dairy products to Indianapolis has been facilitated by the construction of the electric lines serving the county.

The permanent pastures consist of bluegrass and white clover. The land devoted to pasturage is mainly the Miami loam and rolling areas of the Miami silt loam, but flatter areas of the silt loam type are also used for woodland pasture. The application of ground limestone is highly beneficial to such pastures, for both the bluegrass and clover do best where the soil is well supplied with lime. Very little attention is given the fertilization of pasture land or the mowing of weeds. The upland pastures and mowing lands are infested with ragweed and some of the bottom lands are hardly less free in the fall from various kinds of large weeds.

In the last few years alfalfa growing has received considerable attention and small fields, experimental in many instances, are quite numerous throughout the county. In relative adaptability of the several types to alfalfa, as indicated by these fields, the Miami loam ranks first, the Clyde soils second, and the Miami silt loam third. The heaviest yield observed was on well-drained Clyde silty clay loam. Ideal conditions are found in those phases where lime nodules

occur in the subsoil and the water table is within 6 to 8 feet of the surface. Good stands have been established on the best drained Genesee types. In the Miami loam a calcareous substratum is usually encountered at less depth than under either of the other upland types, and this is a factor of much significance in alfalfa culture.

Any soil type well adapted to corn is usually suitable for alfalfa, with the addition of lime and inoculation. Since sweet clover has so generally spread along the roads and railway lines, the soil in places requires no artificial introduction of bacteria, but it is a good practice to scatter dirt from sweet clover patches over the ground at about the time the seed is sown. Lime at the rate of 4 to 6 tons per acre is generally necessary, particularly on the Miami silt loam. Seeding during July and August is safer than spring sowing. It is necessary to plow early and harrow frequently to destroy all weeds.

Very little attention is given to truck crops of any kind, except tomatoes for canning. The acreage and yield of this crop vary widely from year to year. The Miami silt loam and Miami loam are said to produce firmer tomatoes than the Clyde soils.

Strawberries are grown in a few instances, in patches of 1 or 2 acres, to supply the local market. In areas near the electric lines, which afford almost hourly service to Indianapolis, the production of strawberries offers excellent opportunities.

Soil and climatic conditions favor the production of apples on a commercial scale. The Miami loam, especially, comprises excellent sites for orchards, and all of the soils, except possibly the Miami clay loam, are well suited to this fruit. The present orchards in many cases include old trees which have received but little attention. There is little present demand for the summer and fall varieties of apples produced, but this is partly due to lack of a sufficient quantity to assure commission men of a dependable supply. This is also true to some extent of winter varieties, such as the Ben Davis, Genet, Jonathan, and others, while the quality of much of the fruit through failure to spray is usually inferior.

The price of farm land has advanced very rapidly during the last 10 years. The best lands range in price from \$125 to \$150 an acre, even higher prices being readily obtained for small tracts along the electric lines or near the towns. According to the census of 1910 the land of this county has an average value of \$85.52 an acre. The average value of land an acre is reported in the 1900 census as \$39.73.

The value of all farm land, according to the census, increased from \$10,324,880 in 1900, to \$21,735,044 in 1910, and of buildings from \$2,130,490 in 1900 to \$3,852,155 in 1910.

The average size of the farms is about 91 acres. There are a few individual holdings of more than 500 acres, but large estates are not common. The majority of farms include from 80 to 160 acres, with a good many of 40 acres, and even smaller ones near the towns. About 30 per cent of the farms are operated by tenants. The rates of rent vary considerably, but are generally being advanced. Some farms rent for one-half of all the grain and hay produced, others for two-fifths of the grain crop and cash payments for grass land. The cash rent for farms consisting chiefly of Clyde soils is about \$8 an acre. For land less desirable for corn \$6 to \$8 an acre is the usual rent.

SOILS.

Throughout the county the prevailing surface material is a silt or silty clay, having an average depth of about 3 feet. In the extreme western and northwestern parts of the county it is somewhat deeper, while in the southern section it is frequently less than 2 feet in thickness.

This superficial stratum overlies glacial material known geologically as the early Wisconsin Drift. This till, at least in the southern part of the county, rests upon the Knobstone shales, which are exposed in a number of places along White Lick Creek. In only a few places in the uplands is the depth to rock less than 50 feet. As a rule it is far more than this, so that neither the shales nor the glacial material older than the Wisconsin has influenced the soils to any appreciable extent.

For a few feet below its contact with the overlying silty clay the till, especially on the hillsides, is usually a reddish-brown, granular clay, with more or less sand and stony material. The brown coloration is due to a higher degree of oxidation of the iron content in this upper portion than in that below. The lower part of the till is a very light brown or pale yellowish brown mixture of silt and clay with enough sand to render it rather porous and friable. Weathered exposures are usually very crumbly, and in fresh excavations it may be very fine or compact, but the material never approaches an impervious condition. Its physical structure generally admits of relatively free circulation of air and water throughout the mass. This is also favored by the presence of coarse material varying from gravel to small stones. Large boulders are not of common occurrence in the drift. Most of this rock consists of well-rounded fragments of quartz, fine-grained granites, and other hard, resistant species. Pieces of shales, sandstone, and other soft rock seldom occur in any considerable quantity, but at a depth of 6 or 8 feet from the surface limestone fragments are relatively numerous and at lower depths the till is so calcareous as to effervesce freely with hydrochloric acid.

In the valley of Mud Creek stratified sand and gravel are encountered a few feet below the surface and evidently extend to a great depth. Similar conditions prevail on Mill Creek above Stilesville, indicating in these places preglacial valleys, deeply filled with outwash material. In some of the flat areas of black lands in the northern part of the county water-laid gravel occurs at a depth of a few feet, but such deposits are not so common as in Boone County.

While glacial material has entered to some extent into the composition of all the types, the dominant types owe their origin to the silty clay. This thin but almost unbroken deposit is found everywhere except in the creek valleys and in the larger depressions of the uplands where local erosion and redeposition have modified its original condition to a greater or less extent. On the steeper slopes it has suffered partial removal in places or has lost its identity by admixture with the underlying till. Elsewhere the contact between this silty layer and the boulder clay is well defined, and the two deposits have distinct physical characteristics.

To a depth of about a foot a representative section of the silty clay consists chiefly of silt, or the grade of soil particles between clay and very fine sand. The latter is the next highest component, but there is not usually enough of the coarser sand to affect materially the physical properties. The percentage of clay is usually too low to impart a marked degree of plasticity or to render the material sticky when wet or very hard if dry. In general, this silty surface is characterized by extreme friability and a degree of porosity favoring the retention of moisture and ease of tillage.

Between the depths of 12 and 30 inches, although these limits are subject to more or less variation due to topographic position, the silty clay has a higher content of clay. Its structure is more compact than that of the upper layer and internal drainage and aeration are less effective. This is indicated by the mottled coloration usually observable in this stratum. The glacial material immediately below is favorable to more thorough underdrainage and to deeper and freer circulation of air than would be the case if the dense silty clay had a greater depth, but nevertheless the latter has a more or less marked influence on the moisture conditions and so on weathering processes. The average conditions in this respect are expressed by the normal phases of the Miami silt loam, which is the dominant upland type in this region.

Where the silty clay layer has a somewhat greater depth a soil of the Miami series characterized by comparatively poor drainage and deficient aeration is developed. This soil is mapped as the Miami clay loam. Extreme conditions of this kind are locally termed "clay spots." On the other hand, where the silty clay is shallow and there

has been more or less admixture of coarse material from the underlying till, relatively free underdrainage and aeration have resulted. Consequently there has been a more complete oxidation of the iron content and brown and yellow are the characteristic colors throughout the soil section. Such modifications of the silty material give a soil with the texture of a loam, and areas where these conditions generally prevail are mapped as the Miami loam. This type occupies comparatively steep erosional slopes near drainage lines and the moundlike morainic elevations which are so conspicuous in some sections of the county.

The surface soil of these Miami types is generally very light colored. There is but little organic matter in any form and practically no tendency toward the black color and abundant organic matter that characterize the Clyde soils. All the Miami types were originally forested, and such a covering on well-drained soils never results in as great accumulation of organic matter in the surface soil as a long-continued growth of herbaceous vegetation or prairie grasses.

It is also probable that the light color of the surface soils, where no organic matter is present, indicates a degree of leaching considerably greater than has occurred in the material at a little greater depth. This suggests a larger proportion of siliceous material and a proportionately lower content of the mineral elements of fertility in the surface soil. With respect to lime this is known to be true, and doubtless is applicable in some degree to the other less soluble but equally important constituents. Under favorable physical conditions all of these types respond readily to tillage and the addition of organic matter, indicating that the silty clay or loess as a whole is comparatively rich in mineral plant food.

In the depressions of the uplands conditions originally were favorable for the preservation of organic remains, and in practically all such situations the Clyde soils are developed. While most of the black lands were heavily forested when the first settlers entered the county, it is probable that most of the dark carbonaceous material that renders them so valuable agriculturally accumulated during that comparatively recent period when all these tracts were marshy prairies. Most of the humus is vegetable matter in the form it assumes when decomposition takes place under water or when air is partially excluded.

The mineral constituents of the black soils consist chiefly of the silty clay, in nearly its original position, as in the case of small local depressions, or such material derived by surface wash from the adjoining higher areas. In the assorting process that resulted the very fine silt and clay were generally first deposited in these shallow lakes and ponds, which were finally filled largely by the accumulation of plant remains. Therefore the subsoils of the larger areas are usually

composed of stiff, somewhat impervious silty clay. The condition in many instances is relieved by the occurrence of gravel immediately beneath the clay, or more frequently of the relatively open till at a depth of a few feet from the present surface.

In some instances the proportion of organic matter at the surface is so high that the soil is mucky or "chaffy." Such places, as well as the few small areas of true Muck, are less common in this county than in the counties to the north. In the course of time all of these areas will be changed to soils of normal structure.

The development of these types has been so largely dependent upon the topography that a relief map would show the approximate location and extent of the individual areas of each type. On the uplands the Miami silt loam and Clyde silty clay loam are so closely associated that an actual representation by this means would require a map with about 1-foot contour intervals. In this section very slight differences in elevation, if associated with obstructed drainage, have given rise to pronounced modifications in the organic-matter content and in many instances in the texture of the soil and subsoil.

The alluvial lands consist of reworked material of local origin. In the White Lick drainage area a silty or fine sandy loam is the prevailing surface soil, while coarse sand enters largely into the composition of the lower subsoil. There has been a slight development of terraces along the smaller streams, but they are of such comparatively recent origin that the materials have not been greatly modified by weathering, drainage, or the addition of organic matter.

The high terraces on the larger streams are entirely distinct from those just mentioned. They are much older and are covered by a layer of silty clay, except where removed by recent erosion, of essentially the same character as that lying on the upland.

Along Mill Creek and its several branches a silty loam is the prevailing type, owing perhaps to the wider valleys of that stream or to a more nearly level topography than prevails along the White Lick Creeks. The source of material along the former stream is chiefly the surface silt of the uplands, while the alluvium of the White Lick Creeks, owing to the deeper valleys of the main streams and their principal tributaries through the drift, contains large quantities of glacial débris.

In all instances the alluvial soils of the larger streams are characterized by a lighter color than prevails in a soil with a high content of humus. The color is a pronounced brown, suggestive of exceptionally uniform oxidation and distribution of ferruginous material. Owing to their structure and to the elevation above the stream channel the drainage throughout is generally good.

The following table gives the names and the actual and relative extent of the several soils mapped in Hendricks County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami silt loam.....	146,880	69.6	Clyde loam.....	2,240	0.9
Flat phase.....	34,816		Genesee silt loam.....	1,472	.6
Clyde silty clay loam.....	31,680	12.1	Fox sandy loam.....	1,408	.5
Miami loam.....	13,440	5.1	Genesee sandy loam.....	640	.2
Genesee fine sandy loam.....	12,288	4.7	Muck.....	64	.1
Fox silt loam.....	8,256	3.2			
Meadow.....	5,056	1.9	Total.....	261,120
Miami clay loam.....	2,880	1.1			

MIAMI SERIES.

The Miami series is one of the most important of the Glacial and Loessial Province. The soils are brown, light brown, or grayish, and are underlain by yellowish and brown, heavier textured subsoils. Mottlings of brown and light gray are present in the subsoils in many places, particularly in the case of the clay loam member, which for the glacial region as a whole is by far the most extensive type of the series. The surface drainage is usually good, but artificial drainage is necessary in some of the heavier types. The soils are in the main derived, through weathering, from glacial till of a generally calcareous nature.

Three types of this series are found in Hendricks County—the silt loam, loam, and clay loam, named in order of their area—the first-named being by far the most extensive soil in the county.

MIAMI SILT LOAM.

The surface soil of the Miami silt loam to a depth of 8 to 10 inches is a light brownish gray silt loam. The percentage of silt in the soil is very high, but there is considerable fine sand and a little medium sand present, and scattering pebbles and small stones are found on the surface of most areas.

Cultivated land, when dry, has an ashy-gray color, but under normal moisture conditions very light brownish gray is the characteristic color. The friable, porous clods crush easily to a fine earth in which there is but slight tendency to granulation, or the "crumb structure," observable in the black soils. This is due to the low content of organic matter. Even in virgin soils there is very little humus below 4 or 5 inches.

The subsurface soil is usually a yellowish or mottled gray and yellowish-brown silt loam which at 10 to 15 inches changes to a brown, stiff, compact silty clay loam. To a depth of 25 or 30 inches it offers considerable resistance to penetration by any implement and is not usually so permeable to air and moisture as is desirable. While

somewhat crumbly on drying, it has a rather close structure with but slight granulation. This condition is modified in some measure by the occurrence of coarse sand grains and occasional small pebbles, which may be considered as characteristic of the more rolling areas. Here the subsoil has a distinct brownish color without any mottling, but in the flatter areas, where the close silty clay loam or clay extends to a depth of $2\frac{1}{2}$ feet or more, the color grades to a light brown or yellowish brown and may be slightly mottled with gray.

Below 30 inches the proportion of sand and gravel rapidly increases, this stratum varying from a coarse loam to sandy clay. The material is much more open and permeable than the silty clay overlying it. The moisture content is usually much higher, often sufficiently high to render the material sticky or plastic when the surface soil is quite dry. The color is generally brown, with a slight reddish tinge.

The depth at which the coarser material occurs and the relative thickness of the soil and middle subsoil sections are somewhat variable, but not to such an extent as materially to modify the general physical properties of the type. These variations usually have a rather definite relationship to local topography. The soil and subsoil are shallowest on the slopes and deepest where the surface is nearly level or but gently inclined. In the latter areas the gravelly substratum is sometimes encountered at a greater depth than 40 inches, while on convex slopes of moderately high gradient it may occur within 12 to 18 inches of the surface. In the latter case the soil is generally somewhat more sandy and has a brown color. As the surface flattens out the soil becomes more distinctly gray. Such areas are described in later pages as the flat phase of the type. In depressions the soil contains more than the average amount of humus, and where the natural drainage is poor the type passes into the Clyde silty clay loam. There are many variations of this character which can not be shown satisfactorily on the soil map.

There are certain regional variations in the average thickness of the silt-clay layer. It is of greater depth in the western than in the central townships and is considerably thinner in the southern part of the county than in the northern part. South of Plainfield and Cartersburg most of the Miami silt loam contains sandy or gravelly material at less than 25 inches. Heavy phases and "clay spots" are of rare occurrence in this section of the county.

The Miami silt loam with its flat phase is the dominant soil throughout the county. It is locally known as "clay land" and "white land." All of this type was formerly forested with a mixed growth of deciduous trees. On the heavier phases beech, ash, hickory, white oak, and elm were more common than on the lighter textured phases, where sugar maple, poplar, walnut, and red oak formed a

large part of the forest growth. There seems to have been less tendency on this type toward the dominance of certain species than on the Clyde soils.

With the exception of a small acreage in woods pasture, all of this type is cultivated. Large bowlders are of rather common occurrence in some sections, but neither they nor small stones are sufficiently numerous to interfere with cultivation.

The usual yields of corn on this type are below rather than above 40 bushels per acre. Land that has been sown to clover and fields in which there are numerous swales where the soil has more than the average content of humus often produce 50 to 60 bushels. The latter estimates indicate the possibilities of the type as a corn soil. The deficiency in organic matter is the chief cause of the comparatively low average yields, but the close structure of the subsoil renders the type susceptible to injury from irregularities of rainfall, a factor of great importance in most seasons.

The yields of oats are more generally affected by seasonal extremes than if the soil were somewhat richer in organic matter. In 1912, when the precipitation was ample, the average returns were about 50 bushels, but in 1913 dry weather prevailed during May and June and most of the oat crop was hardly worth harvesting. Wheat sometimes produces 25 to 30 bushels per acre, but the usual returns range from 10 to 20 bushels.

After a stand is secured timothy and clover do well on even the heaviest areas of the type. The yield of hay is less than on the Clyde soils, but the quality is considered somewhat better. In view of the fact that all the surface soil is in need of lime, it is somewhat remarkable that clover does so well. The free lime in the substratum at 4 to 5 feet below the surface doubtless compensates for the deficiency in the soil and subsoil. All the Miami silt loam is in need of humus and better internal drainage.

Tile drains greatly improve the physical condition of the type. They are most effective where laid in, rather than below, the heavy subsoil and at intervals of 6 or 8 rods, and even less in many instances. Tiles not only remove excess water but induce a freer circulation of air than usually takes place in such dense subsoils. This material is particularly in need of better aeration, especially where mottling is conspicuous or where bluish-gray clay is present in the lower subsoil. Where drains are installed the cost is soon returned in increased yields of grain.

The value of farms consisting largely of this type ranges from \$125 to \$150 an acre. Such farms rent for usually one-half the grain produced, or, where cash is paid, for \$5 to \$7 an acre.

Miami silt loam, flat phase.—The flat phase of the Miami silt loam is found principally in the northeastern corner of the county. It

occurs along the northern border and in quite a wide strip along the eastern border, extending south of the Cleveland, Cincinnati, Chicago & St. Louis Railway. There are also several small areas in Mud Creek Valley. The topography varies from almost perfectly level to gently undulating. While the difference between this phase and the normal developments of the type is chiefly in the topography, the resulting conditions of drainage have in most instances modified the soil material and affected its agricultural value in this way as well.

The soil is a silt loam, similar to that of the uplands, but it usually has a very light color and in many instances a peculiar lifeless, ashy-gray appearance suggestive of low productiveness. There is an absence of granulation, and even where some medium sand is present, as is often the case, the soil is more inclined to pack after rains than in the more rolling and better drained areas. The organic-matter content is low and the sharp contrast in this respect with the adjoining black lands is often marked. Below the soil is a light-gray or ashy-gray mottled silty clay loam extending to a depth of about 16 inches.

The subsoil is a light-brown or yellowish-brown silty clay loam mottled to some extent with gray. The aeration and drainage are usually poor, or at least not effective to as great a depth as in the higher lying areas. The lower subsoil generally consists of sandy material, but instead of being distinctly brown, as in the typical Miami silt loam, it is commonly light yellow or bluish gray.

Most areas of this phase are especially in need of more complete drainage. Wherever the surface soil has an ashy-gray color a compact subsoil is found, and in such places the installation of tiles gives better results than the construction of open ditches. With improved drainage it is highly probable that the soil would assume a better physical condition, but liberal applications of lime and the incorporation of vegetable matter result in most effective and permanent improvement in this respect. Under natural conditions, or where but little artificial drainage is provided, the yields of grain are very dependent upon weather conditions.

The greater part of this phase is cleared and farmed in the same way as the typical soil. However, the average yields are not quite as good as on the more rolling lands, where the soil is naturally better drained.

MIAMI CLAY LOAM.

The surface soil of the Miami clay loam, to a depth of 6 to 8 inches, is a light-gray or brownish-gray, compact silt loam to silty clay loam. Immediately below the soil is a light-gray and yellow or brown mottled heavy silt loam to silty clay loam, which within 2 or

3 inches grades into a brown and gray mottled tough silty clay. The surface soil is generally very light colored when dry and sticky and inclined to puddle when wet. It clods more readily than the Miami silt loam if stirred when wet or trampled by stock during rainy periods. The deficiency in organic matter and lack of granular structure are very apparent in the soil. The upper subsoil is generally characterized by extensive mottling, and the lower part is so compact that it is sometimes designated locally as "hardpan." It is not impervious, however, although at about 40 inches a layer of bluish-gray tenacious clay is sometimes encountered, and this is even less permeable than the silty clay above it.

This type is not very extensive. One large area occurs in the western part of the county. Smaller areas are mapped elsewhere, and throughout the Miami silt loam are numerous spots comprising an acre or two. The "clay spot" condition obtains chiefly in local flats where both surface drainage and underdrainage are poor. In many instances much of the adjoining upland is but little better in this respect, so that the heavy phase generally prevails. The areas indicated on the map as Miami clay loam are but approximate representations of the type, because no sharp line can be drawn between it and the Miami silt loam. A slight slope toward a drainage line or local elevation suffices in most instances to prevent the sluggish drainage, which is the chief factor in the development of the "beech tree" land, as this is locally termed.

Some of the smaller areas are not farmed, but the larger areas are under cultivation and in normal seasons produce about as good crops as the Miami silt loam, flat phase. The drainage requirements of this soil are similar to those of the Miami silt loam.

MIAMI LOAM.

The soil of the Miami loam to a depth of 7 to 10 inches is usually light brown or grayish brown in color. It varies from a silty loam to fine sandy loam. Coarser material in the form of pebbles and small stones is usually present, but not to such an extent as to interfere with cultivation.

The upper subsoil is generally a silty loam, moderately compact but possessing good capillarity. Brown or yellowish-brown tints are the characteristic colors, but in the heavier phases the material is mottled in places with gray. The lower subsoil is a brown or dull reddish brown loam with more or less coarse sand and small gravel. This lower part of the subsoil, as well as the material below, is usually boulder clay with the relatively high degree of oxidation of the iron content that characterizes the upper part. In many places the material is a silty clay with a coarse, blocky structure. The color in such

instances is a dull chocolate brown, or the material may be obscurely mottled with very dark reddish brown iron stains.

In practically all areas the type has good internal drainage and good aeration to a depth of several feet. The structure induces good capillarity, and as the substratum has a high moisture content the soil seldom becomes very dry. This condition, combined with good drainage, enables this type to endure seasonal extremes. Crops seldom suffer from excessive rainfall, and they are not affected by dry weather as soon as on the Miami silt loam.

The Miami loam has a larger proportion of calcareous material than the Miami silt loam. Limestone fragments are sometimes found within the 3-foot section, and calcareous material occurs at slightly greater depths.

The Miami loam is a rather extensive type, embracing the soils found in the rougher parts of the uplands. The topography varies from local elevations with usually moderate slopes to more hilly lands along the streams, where shallow ravines and blufflike escarpments are very common features. Under such conditions uniformity in the texture and structure of the soils is not to be expected. There is considerable variation in this respect, most apparent in the majority of cases where there are local differences in surface configuration. The soil and subsoil material found on steep slopes is usually coarser textured and more open than that on the crests of ridges or where the land is but slightly rolling. In a broad way, however, the agricultural value of the land in any one section near the larger streams does not differ greatly from that in another area of corresponding size similarly located. This is also true with regard to those developments of the type on the elevations, or morainic hills, in the upland. Locally there may be considerable difference in the character of the soil in a 10-acre field, but in comparing areas of much larger size one with another the average value is about the same.

The surface soil on the slopes along the drainage lines is usually coarser textured and presents more variable subsoil conditions than that on the ridges and morainic mounds. In the latter situations the soil is more silty and the subsoil heavier, and the type as a rule is less stony.

The largest area of this type is found on the morainic divide and steep slopes between Cartersburg and North Salem. There are many smaller areas in the southern and western parts of the county.

The very small areas shown on the map are mounds from 10 to 50 feet above the general level of the country. In the northern part of the county most of these elevations have a moderately heavy loam soil which on the lower flanks grades into the Miami silt loam. The areas between Amo and Stilesville are prominent ridges with sandy

loam surface soils underlain at a few feet by gravel. Some of these areas are inclined to be droughty.

All of this is locally called "sugar-tree land." This name, which is also applied to the lighter and better drained phase of the Miami silt loam, indicates the prevailing timber growth. The few remaining "sugar camps" are generally open groves on ground too rough to be easily farmed.

The high agricultural value of this type is due to its excellent drainage and aeration. As previously stated, the glacial material, excepting the gravel beds, generally maintains a high content of available moisture. In most of this type the upper limit of the soil water supply is generally within 2 feet of the surface. The texture of the overlying material is usually very favorable to capillarity and to easy penetration by the roots of the growing crops.

The low content of organic matter is doubtless the limiting element in the production of corn, and to a less marked degree of other crops. The average yield of corn is above 40 bushels per acre. Wheat does well, compared with returns on other types, and oats are not so likely to be affected by unfavorable seasonal conditions as on either the Clyde soils or the Miami silt loam. Some excellent stands of alfalfa have been established on this type, while clover is ordinarily grown with little trouble.

CLYDE SERIES.

The Clyde series is characterized by dark-brown to black surface soils and gray, drab, or mottled gray and yellowish subsoils. The series has been derived through the deposition and reworking of the soil material in glacial lakes or ponds, the dark color of the surface soils being due to the high percentage of organic matter resulting from the decay of plants in the presence of water under swampy conditions. The soils of the Clyde series grade into Muck and Peat on the one hand and such glacial-lake soils as the Dunkirk series on the other without very sharp boundary lines. They are distinguished from the Poygan soils by the gray instead of reddish subsoils, and from the Fargo in the lower content of calcium carbonate. The topography is level and the soils are naturally poorly drained.

CLYDE SILTY CLAY LOAM.

The soil of the Clyde silty clay loam is a black silty clay loam. The content of organic matter is high, imparting a rather open, friable structure which is very apparent in well-tilled ground. Below the plow line the proportion of clay is usually higher and the material is more compact. Occasionally it is so dense that it is termed "gumbo," but as a rule it is a very firm black silty clay which has

a tendency to break into coarsely cubical granules. There are not usually so many coarse sand grains or as many small pebbles in this sublayer as in the surface soil.

Below 15 inches the color is much lighter. It is dull brown or drab, often with some brownish iron stains, but the mottling is not usually very pronounced. This material, generally a silty clay, has a somewhat granular structure, but at a little greater depth it changes to light gray and is very sticky and tenacious when wet. The lower subsoil is not impervious, for as a rule silt particles form a large proportion of the material, and even if no sand is present dried samples show a considerable degree of porosity.

Areas of this type surrounded by the Miami soil usually have a substratum of glacial material. In many instances this is encountered at 40 inches, and the lower part of the 3-foot soil section consists of yellow or grayish mottled material with more or less sand. Many of the areas along small streams are underlain by gravel. In such instances the soil contains more sand and scattering pebbles are found on the surface. Practically all of the Clyde soils in Mud Creek Valley have a substratum of loose gravel at 5 to 10 feet below the surface.

In this type as a whole there is much variation in the percentage of organic matter present. As a rule it is highest in the soil of the large tracts and lowest in that of the smaller, ill-defined areas surrounded by the Miami silt loam, but local differences are often quite pronounced. In many instances the lowest part of an area has a soil containing so much organic matter that it is loose, or almost "chaffy," as the semimucky spots are called, while the marginal portions of the area have a firm, silty soil containing no more humus than necessary to insure good physical conditions. In general, the organic content is highest in the soils of the northern half of the county and lowest, or at least more variable, in the southern part.

Practically all of the Clyde soils east of White Lick Creek and south of the Cincinnati, Hamilton & Dayton Railway contain but a moderate amount of organic matter. A large part of each area consists of silty loam which is smooth and friable rather than granular. "Chaffy" conditions never occur in these phases. The subsoils generally consist of silty clay loam with good aeration and internal drainage to considerable depths, as indicated by the prevalence of brown and yellow coloration.

The areas on the west side of Mud Creek Valley comprise soils which are high in silt. In places the humus content is rather low and the surface appearance of the soil suggests a long period of effective drainage.

The smaller areas are local depressions in the uplands and the larger ones valleys of present streams or sites of former lakes. In all cases

obstructed drainage and conditions arising therefrom have been the chief factors in the development of the type.

The organic matter consists almost entirely of black, carbonaceous material resulting from the decomposition of vegetable débris under water. It imparts excellent physical properties to what would otherwise be heavy clayey soils, and to its presence must be attributed their high agricultural value.

The Clyde silty clay loam is the most important corn soil of this county. The yields are from 50 bushels per acre to 80 or 90 bushels. The highest average returns are secured from those areas where a water-bearing substratum occurs at 3 or 4 feet. If the surface is well drained these phases are but little affected by extremes of precipitation. In the small areas surrounded by the Miami silt loam and including more or less transitional phases between the types seasonal variations have a more marked effect, but the average returns of all crops are exceptionally good.

The occasional spots in which an excessive amount of humus in the surface soil gives rise to "chaffy" conditions are improving, the washing from higher land having a tendency to correct this trouble. Deep plowing has the same effect. In areas in which the upper subsoil is a very stiff clay deep fall plowing is beneficial. The exposure of this clay to the atmosphere gives rise to a finely granular condition, and through subsequent tillage admits of more or less admixture with the coarser organic remains of the surface soil.

Wheat sometimes yields 30 bushels per acre, but this is much above the average. In seasons of heavy rainfall oats are liable to grow so rank as to lodge badly. In 1913, when but little rain fell in May and June, much better yields were obtained on this type than in 1912, when there was abundant precipitation in these months.

Clover and timothy make exceptionally heavy yields on this soil. There is usually but little difficulty in securing a stand or maintaining it as long as desired. According to the litmus paper test, the soil as a rule is not in need of lime. In some instances the lower subsoil effervesces with hydrochloric acid, but lime concretions and limestone fragments are numerous in the substratum at less than 5 or 6 feet, where the material is not exceptionally gravelly. In the latter case the subsoil evidently contains enough lime to meet the requirements of all ordinary crops.

Well-drained locations are suitable for alfalfa. Where a very smooth, light-colored clay is found at less than 30 inches the average level at which the ground water stands should be ascertained, because in such places the drainage may be insufficient for alfalfa. Most of the silty phases that have tile drains or even an open ditch near-by are suitable with respect to moisture conditions. Fields that

produce good corn and clover and which have water-bearing gravel at about 6 feet are admirably adapted to alfalfa. The soil is benefited by the application of lime, and inoculation is sometimes necessary.

Commercial fertilizers are not generally used on this soil, and as a rule are not needed. It is probable that no profitable increase in yields could be secured above those obtainable by means of better tillage and the use of legumes. This statement does not apply to the "chaffy" spots where the liberal use of potassium in some form is beneficial to corn.

Under continued cultivation there is a noticeable tendency toward reduction of the original organic-matter content. Farmers state that some land that has long been in cultivation now requires more labor to keep it in good tilth. The most practicable means of improving such land is by turning under clover or applying manure. This is practiced to a considerable extent on the black soils, but in no such measure as to compensate for the steady drain occasioned by almost continuous cropping to corn.

The value of this land, where unimproved except by artificial drainage, is generally above \$100 an acre. Well-improved and desirably located farms consisting chiefly of this type are valued at \$150 to \$200 an acre. Farms of this type rent for \$7 or \$8 an acre.

CLYDE LOAM.

The soil of the Clyde loam to a depth of about 6 inches varies from a moderately heavy black loam to sandy loam. There is a rather high percentage of clay present, so that the material when wet is slightly sticky, and the tendency to form friable clods is very observable in cultivated fields. They crush easily, and the fine earth is "crumbly" or granular. This desirable structure is due in large measure to the high content of humus, practically all of which is in the form of finely divided carbonaceous material.

Between the depths of 6 and 15 inches the subsoil is usually a bluish-drab or black stiff clay loam. It contains some sand and gravel, and while the property of granulation is not lacking, this part of the subsoil is much more compact than the surface soil. In a few places it is difficult to turn with the plow, and is locally termed "gumbo."

The lower subsoil is usually a clay or clay loam, but contains considerable coarse sand and gravel. A light-bluish color, indicative of rather poor aeration, prevails in some places, but most of the material is dull brown or some shade of yellow, with numerous dark-brown iron stains.

The material between 30 and 40 inches below the surface consists largely of sand and gravel, and at a depth of 5 or 6 feet in most

places the upper limit of what is evidently a deep water-bearing gravel bed is reached.

This description applies to most of the large area on the lower part of Mud Creek Valley. The areas farther up the stream and those adjoining the Clyde silty clay loam are not so sandy.

Practically all of this type has been reclaimed within the last 30 years, or since the channel of Mud Creek was deepened. The original forest growth consisted chiefly of elm, ash, hickory, and white oak.

The average yields of corn are high, 75 to 90 bushels per acre sometimes being secured on well-tilled ground. The yields of wheat, clover, and timothy are comparable with those of corn. The friable, easily tilled soil and excellent moisture conditions of the subsoil and underlying stratum render the type very drought resistant.

A heavier phase of the Clyde loam occurs on the low Mill Creek terraces in association with the Fox silt loam. The soil is a loam or silty loam to a depth of 8 or 10 inches. The proportion of sand is not so high as in the development of this type along Mud Creek, but there are usually more pebbles and very small stones on the surface. The organic-matter content is sufficiently high to impart a black color and crumbly structure to the surface soil.

The subsurface layer is a rather heavy clay loam, which in the lower part contains considerable sharp, coarse sand and more or less gravel. Its color ranges from bluish drab to various shades of brown or yellow. The drainage is good, since the main streams in this section have channels much below the level of this soil and the substratum consists of loose sand and gravel. This substratum is encountered at varying depths, but in many places it is not more than 5 feet below the surface.

All of this heavier phase is very desirable farm land. It may not have quite so high a degree of available fertility as the areas along Mud Creek, but the crop yields are nearly as high in normal seasons.

The value of land of this type is about \$125 an acre. Farms consisting wholly or in part of this type and with good buildings command a higher price.

FOX SERIES.

The Fox soils are gray to brown in color. The topography is generally level. Where the surface is not level its variation is due to the occurrence of potholes or to the existence of valleys eroded since the formation of the plain or the deposition of the material. The material was laid down either as outwash plains or as terraces along streams within the glacial area or flowing out of it. The soils occur in regions where the bedrock is limestone or other calcareous rock.

FOX SANDY LOAM.

The surface soil of the Fox sandy loam throughout most of the larger areas is rather coarse sandy loam, about 8 inches deep, with enough interstitial material to cause friable clods to form where plowed when wet. The color is dull gray to brown, due to weathering, but the mineral particles almost invariably have a coating of iron oxide that gives the fresh soil a pronounced brown color. The soil usually contains only a small proportion of organic matter, except in local depressions.

The subsoil to a depth of about 30 inches, although this depth varies widely, contains much more silt and clay than the surface soil. It is usually a reddish-brown loam or clay loam with more or less sand and gravel and frequently many small stones. The lower subsoil is a gravelly clay which with slight increase in depth generally grades into gravel or sand.

On slight elevations and along the marginal slopes the soil is usually a rather light sandy loam and the subsoil is very gravelly or frequently a loose brown sand. Such spots are droughty, and crops soon show the effect of dry weather. As the uplands are approached the surface soil becomes heavier, and the subsoil has no gravelly stratum immediately below it. In sags and in spots which were formerly somewhat marshy, at the foot of the slopes, the soil is usually a black silty loam, but such areas are small and not very numerous. In many instances there is an exceptionally large percentage of yellow iron oxide at various depths in the subsoil, suggestive of deposits of bog iron.

This type occupies the low terraces of the larger valleys. Most of these second bottoms lie well above overflow, and the drainage is good. In most instances the outer margin is a gentle slope or a slight acclivity rising a few feet above the average level of the more recent alluvial deposits between it and the stream. The surface of the larger areas is nearly level or has a very moderate gradient from the foot of the adjoining uplands and toward the down-stream side. The small areas have more uneven surfaces and also greater variation in texture of the soils.

These low terraces consist mainly of reworked glacial material deposited by the stream when it flowed at a higher level than at present. Along the foot of the uplands, in many instances, the material is derived largely from adjoining slopes or was laid down by floods from the small tributaries.

With some exceptions, there is a sufficient depth of fine-textured material to hold enough moisture to meet the requirements of crops except during prolonged droughts. This type is somewhat less retentive of moisture than the Genesee fine sandy loam or most of the upland types. The water table, as indicated by wells, is from 10 to

15 feet below the surface, but the presence of a gravelly substratum may, and undoubtedly does in many places, prevent capillary action between this source of supply and the surface soil.

Some successful stands of alfalfa have been established on this soil. Clover also does well. In both cases it is probable that the roots reach water. The soil is not in need of lime, and on the heavier phases near the hills there is more or less direct deposition from slopes where the calcareous till is exposed.

In normal seasons corn yields from 40 to 60 bushels per acre. The yields are increased by the frequent growing of clover. This type is usually treated as an alluvial soil, but most of it receives no additions of silt from floods. The deficiency in humus is not such a serious matter as in the upland types, but the productiveness of the soil is increased by plowing under vegetable matter.

Several of the areas on White Lick Creek near Avon are terraces much older than those just described, being at a greater elevation. The soils are heavier than those on the low terraces of the same stream. In most instances the surface soil is a brown silty loam with considerable sand and gravel, and the subsoil is a yellowish silt loam. The drainage is good and the general agricultural value is similar to that of the Miami loam. The slopes are very similar to the rougher areas of the latter type, but the level surface suggests a terrace structure and these areas are included with the Fox soils.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Fox sandy loam:

Mechanical analyses of Fox sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
281522.....	Soil.....	2.4	9.5	13.4	25.9	11.9	26.0	10.8
281523.....	Subsoil.....	3.6	8.2	13.2	26.4	11.3	22.9	14.5
281524.....	Lower subsoil...	3.6	11.8	13.6	21.8	9.2	22.1	18.1

FOX SILT LOAM.

The Fox silt loam to a depth of about 6 inches is a moderately dark brownish gray silt loam to loam, which usually contains enough medium and fine sand to impart a decidedly gritty feel and materially increase its friability. Some gravel and small stones are usually present, but large bowlders are of rare occurrence. The organic-matter content is generally low and in most instances does not affect the color below the plow line, but in local depressions it is sometimes more abundant, and in such cases the soil to a depth of a foot or more is quite dark and slightly granular, approaching the

condition of the Clyde soils. The latter property is almost entirely lacking in the normal phases of the type.

The subsoil to a depth of about 15 inches is a crumbly silt loam or silty clay loam which is rather compact, but contains some coarse sand and well-rounded gravel. The lower subsoil is usually a reddish or yellowish-brown clay loam containing so much gravel that it is difficult to penetrate with a soil auger below 25 or 30 inches. In places the material is a sticky sandy clay. Where stratified gravel occurs at a depth of a few feet the lower part of the 3-foot soil section is usually a reddish-brown clay of pronounced granular structure, but unconsolidated sand and gravel are not found at such shallow depths in many places. Near the uplands the substratum consists of glacial material which evidently does not contain a great deal more coarse débris than the till underlying the upland soils, but it is sufficiently open to admit of comparatively free underdrainage and there is seldom any indication of poor aeration. Farmers state that this land is in condition for tillage after heavy rains much sooner than the Miami soils.

This description applies to the area along White Lick Creek a few miles east of Joppa. The surface is nearly level except for occasional ravines extending back some distance from the bluff margins overlooking the valleys. These slopes are too steep for cultivation, but the soil is gravelly loam which is by no means droughty or unproductive.

The small areas of this type along the middle course of White Lick Creek have not so great an elevation as the larger area. This is also true of some terrace soils on Eel River near North Salem, which are included with this type. In all such instances the surface is more or less uneven, and a relatively larger part of the entire area consists of marginal slopes. The soil is more sandy than that of the higher terraces and the subsoil is quite variable in texture. The agricultural value of such developments is about the same as that of the Miami loam.

The areas of Fox silt loam north of North Salem are not more than 15 or 20 feet above the stream levels. Those south of this town lie 50 feet or more above the valleys and the general difference in elevation rapidly increases toward the southeast. None of these areas are very sharply differentiated from the adjoining Miami silt loam. The long, easy slopes of the latter merge almost imperceptibly into the level surface of the terraces, and there is hardly a greater difference in the general character of the underlying glacial deposits. The Fox soils usually contain more sand and are a little darker colored than the Miami silt loam, and the subsoil is seldom so heavy as, or has the mottling characteristic of, that of the Miami silt loam.

The methods of handling the Miami silt loam are applicable to these heavy phases of the Fox soils. They are deficient in humus and in some places need artificial drainage to carry off excess rain-water. As previously stated, however, most of the type has good underdrainage.

The low terraces are extensively developed along Mill Creek. The valley of the East Fork below Pecksburg is more than a mile wide, and all except the narrow flood plain, seldom exceeding one-fourth mile across, consists of level bench lands from 5 to 20 feet above the first bottom. Above Stilesville terraces of greater or less extent occur on each of the branches of Mill Creek. The surface is very slightly undulating, or has only a slight inclination from the foot of the upland slope toward the stream and also down the valley. The surface drainage is good and is supplemented by the generally coarse structure of the underlying material, which throughout most of the valley of the East Fork consists of gravel or very gravelly till. The low, isolated hills in this locality have gravelly centers, and on the level land adjoining them similar material is usually encountered at 5 to 10 feet. The gravel beds which occur in places at the head of this valley seem to be deeper, the general structure of the soils being more like that of the upland types. The areas above Pecksburg are separated from the Miami silt loam chiefly on account of the level topography.

In general the soil on these low terraces is somewhat darker colored than that of the high terraces. It contains more sand, and usually some pebbles and stones are present, often in large quantities along the margin near the stream. In places there is enough organic matter to darken the surface, but as a rule the quantity is small. A slightly ashy-gray color often prevails and the soil in such instances is not crumbly. These ashy-colored areas, as well as very light-colored silty soils near the upland slopes, are in need of artificial drainage. The subsoil is often a mottled gray and yellow silty clay, quite close and heavy to a depth of several feet. As a rule the soil on these low terraces is in need of lime, lime fragments not being present except in deeper exposures of the heavier phase of the till.

Wheat does well on the Fox silt loam and the ordinary yields, according to the farmers, are somewhat higher than on other upland types. In adaptation to clover, timothy, corn, and oats this soil compares closely with the Miami loam, but the level surface renders tillage easier and there are not such great local differences in the surface soil.

GENESEE SERIES.

The Genesee series consists of dark-brown to grayish-brown alluvial sediments deposited along the major streams and their tributaries throughout the northeastern glaciated region, particu-

larly where the Dunkirk, Volusia, Miami, and Ontario series constitute the principal upland soils. The soils of this series also occur for a short distance south of the glaciated area, where main streams have their headwaters in areas covered by these soil series. The sandy members of the series are prevailingly light brown to gray and the loam and silt loam members darker brown. The soils of this series are subject either to annual or frequent overflow. Where they can be protected from destructive overflow they are recognized as strong soils for grass and pasture, corn, oats, and in some instances sugar beets, cabbage, potatoes, and similar crops.

GENESEE SANDY LOAM.

In each of the larger valleys there has been some development of coarse-textured soils on the first bottoms. As a rule the individual areas are limited to the immediate vicinity of the channels, or to the debouchure of a tributary valley. In the latter case the soil materials include more silt, clay, and stones than in the former. In all instances there has been considerable assortment of materials, so that uniformity in texture and structure is not found over any considerable development of the type.

On White Lick Creek between Brownsburg and Plainfield most of the alluvium indicated as Genesee sandy loam ranges from a brown loamy sand to moderately heavy sandy loam. In depressions there is enough fine material to give the soil a silty loam texture, but heavy phases constitute much of the area. The subsoil is usually a sand or very open material of some kind. Much of the surface is overflowed each spring, but parts of these areas are not inundated except by unusually high water, and in no case are the lands covered for any length of time. The high gradient of the streams and the strip of lower ground that immediately borders them in so many places prevent any prolonged occurrence of a flood stage. This is true of practically all the larger creeks in the county.

South of Plainfield the sandy loam near the Meadow is generally a coarse brown sand with enough interstitial material to give most of it some agricultural value. Farther from the stream where the line between the sandy loam and the fine sandy loam is drawn the soil is a sandy loam of variable depth and texture. All this part is cultivated, but is somewhat susceptible to drought. Small areas near the foot of the bluffs are generally a loam with a brownish sandy clay subsoil of sufficient depth to retain moisture fairly well. Most of these areas lie above overflow from the main stream and are not usually injured by water from the tributaries.

Most of the sandy soil is regularly cultivated to corn and the yields are satisfactory. Wheat does not do well except on the heaviest

phases. Clover and bluegrass usually show the effects of dry weather on the light sandy knolls and in other places where the subsoil fails to afford capillary moisture during protracted dry periods.

GENESEE FINE SANDY LOAM.

The surface soil of the Genesee fine sandy loam ranges from a light fine sandy loam to a silt loam. Silt and fine sand are the chief constituents, with a rather variable quantity of coarser particles. Gravel and small stones occur in most places, but are never abundant. The color is a pronounced shade of brown. The soil is uniformly colored with brown oxide of iron, and there is seldom sufficient vegetable matter present materially to modify this dull-ocherous tint.

There is no definite line between the soil and subsoil. The latter consists of the same kind of material, although at a depth of 6 or 8 inches a little heavier and more compact layer is usually encountered, and this sometimes continues to a depth of 20 or 30 inches below the surface. The lower subsoil is much coarser textured, consisting in most instances of a fine sand which with increasing depth rapidly changes to coarser sand with but little interstitial material. Five or 6 feet below the surface gravel is usually encountered.

In general the depth of the soil body, that is, the stratum of material having a sufficiently close structure to retain moisture well, is about 30 inches. It is thinnest and also more sandy as a rule near the stream channel and becomes thicker and heavier in texture toward the foot of the bluffs. In the latter locations in the widest parts of the valleys the depth to the substratum of coarse sand or gravel may be several feet.

Practically all this superficial stratum consists of reworked material of local origin. It is probable that the silty surface covering of the hills has contributed the greater part. The deposit is comparatively recent, although general overflows are not now of frequent occurrence except in the narrower parts of the valleys. In the spring of 1913, however, nearly all of this type was inundated, and in 1875, when exceptional floods covered all the alluvial soils.

Near the channels of the main streams, and more especially below the entrance of tributaries into the valleys, the surface is often overflowed for a few hours at a time, but with these exceptions the type is not frequently or extensively flooded. In nearly all the larger areas the surface elevation above the channel, or above the Meadow, where the latter is developed, ranges from 3 or 4 feet to as much as 10 or 15 feet near the outer margin of the valley.

In all of the widest sections of the White Lick Valleys this fine sandy loam is the prevailing material. On the Mill Creek branches and also on Eel River the texture of the alluvium is more variable,

ranging from a moderately heavy silt loam to a sandy loam, but much of it corresponds fairly well to the typical. Along the small branches the type is quite variable.

Notwithstanding its deficiency in humus, practically all this soil is highly productive. This is due chiefly to its physical structure. The soil is easily tilled, and with but little labor may be kept in excellent tilth. The subsoil is sufficiently open to permit the deep penetration of water, while it also has good capillarity and is seldom lacking in moisture. Much of this supply doubtless comes from the permanent water table, which is seldom more than a few feet below the surface. In some places a thin stratum of coarse sand at 30 or 40 inches may interfere with capillary action between the subsoil and the permanent supply of ground water below, but such a layer is not of common occurrence except on slight local elevations or near the stream channel.

The ordinary yield of corn on this type is about 40 bushels per acre. On the heavier phases, especially in the depressions along the foot of the bluffs, much higher yields are generally secured. This is also true of fields where corn follows clover, but there is less clover grown on this bottom land than is desirable for the maintenance of as high a degree of fertility as the type is capable of attaining.

Oats usually do well, and excellent yields of wheat are secured, but owing to possible injury by winter or early spring floods wheat is not generally sown. The higher areas of this land are suitable for alfalfa, and some good stands have been established. Liming and the addition of organic matter in some form are advantageous.

The narrow strips of this type along the small branches are more frequently used for pasture than for cultivated crops. Bluegrass usually makes a more continuous growth than on the upland soils, especially where the moisture content is above the average, as is frequently the case at the foot of the stony slopes.

GENESEE SILT LOAM.

The Genesee silt loam to a depth of 8 or 10 inches is a light-brown or dark grayish brown silt loam. It contains but little coarse material of any kind, with the exception of a few pebbles scattered over the surface. The percentage of organic matter is low, but owing to the predominance of silt and very fine sand, the soil is friable and is not inclined to become cloddy or compact.

The subsoil is a moderately heavy silt loam to a depth of about 30 inches, where it usually grades into a fine sandy loam. This with increasing depth passes into sand or other light-textured material. In the lower part of the subsoil mottled rusty-brown and reddish-brown spots occur, but in the upper part the color is uniformly a pronounced brown, indicating favorable moisture conditions.

This is the dominant type on the first bottoms of Mill Creek and its principal branches. The surface is generally level, with fewer local inequalities than occur in the fine sandy loam. The average elevation of the area north of Stilesville above the stream channel is from 5 to 10 feet, so that overflows are not frequent. The general surface drainage is good, and is supplemented by open ditches. Lighter variations of this type occur along Mill Creek near the channel and occasionally in the wider parts of the valleys, but practically all the phases have a high content of silt and are valuable agricultural lands.

The small areas in the West Fork of White Lick Creek Valley are silty loams corresponding in the main to the larger developments on Mill Creek. The small areas below Plainfield consist of a rather heavy silt loam with enough organic matter to give the soil a dark color. They owe their differentiation from the adjoining fine sandy loam to depositions of silty material from back waters of high floods. The natural drainage in most instances is poor, owing to their low position and to the more or less seepage from the bluffs.

Corn in the principal crop grown on this type. Other crops do well and excellent stands of clover are easily established. As in the case of the Genesee fine sandy loam, the productiveness of this soil is due largely to its good structure and unfailing moisture supply.

MISCELLANEOUS MATERIAL.

MUCK.

In only a few places in this county are there such accumulations of vegetable débris that true Muck has formed. In sec. 15, T. 17 N., R. 1 W., several small areas of shallow Muck occur. The depth seldom exceeds 12 inches, and there is considerable earthy matter mixed with the vegetable remains. Muck consists of a black, spongy soil, grading into a very black, waxy clay which extends to a depth of 15 or 20 inches. The lower part of the subsoil in many instances is a rather soft silty clay, containing so much carbonate of lime that it effervesces when tested with hydrochloric acid. Where the Muck is not so deep, or is little more than a very light "chaffy" soil, the lower subsoil is a yellow clay without an unusually high content of lime.

The areas of Muck indicated on the map, as well as other areas too small to be shown separately, are associated with the Clyde soils and produce nearly as much corn and clover per acre as the latter. In most cases potash is profitably used with the former crop.

Occasional small accumulations of Muck which owe their origin to seepage from the hillsides occur at the foot of the bluffs on the lower course of White Lick Creek. Most of these are included with the adjoining soil on the map on account of their small extent and the comparative shallowness of the mucky material.

MEADOW.

The very recent alluvial deposits along the larger streams and the narrow strips of low land along the small branches are mapped as Meadow. The character of these soils and their drainage and agricultural value are widely variable.

On the comparatively level uplands of the western part of the county many of the minor drainage lines have throughout most of their courses flat bottoms varying from a few rods to 100 yards or more in width. The soil of these small valleys—which in many cases are bounded on each side by a low bank or sharp acclivity of several feet—is usually a brown silty loam which toward the head of the branch merges with the Clyde soils. While subject to frequent overflow, the drainage at other times is sufficient to permit cultivation or a good growth of bluegrass. Occasional patches are so wet that only coarse wild grasses thrive, but these are exceptional.

In the northern part of the county the small branches, after leaving the areas of black land, have cut rather deep, narrow courses without much land subject to overflow until the valleys of the creeks are reached. There is little of this low land which can not be classed with either the Clyde or Genesee soils. There is but little Meadow along the streams in the southern part of the county.

Along the middle course of White Lick Creek and to a less extent along the West Fork of that stream the channel is bordered by a strip of sand lying from 5 to 10 feet below the adjoining bottom land. This supports a growth of willow, sycamore, and other water-loving trees and bushes. Below Plainfield the areas indicated as Meadow include many sand and gravel bars, for the stream is rapidly deepening and widening its channel.

In nearly all instances the actual width of the strips of low land is necessarily somewhat exaggerated on the map. Where such strips are not indicated along the creeks the tillable ground usually extends well up to the banks of the streams.

SUMMARY.

Hendricks County is located in the central part of Indiana, and has an area of 408 square miles, or 261,120 acres. In general the topography of the northern and western townships is undulating to very gently rolling. In the central and southern part of the county the relief is stronger, but, with the exception of low bluffs along White Lick Creek, practically all the land is suitable for cultivation. The valleys of this creek and its tributaries are comparatively narrow and bounded by short, abrupt slopes. This is also true of the lower course of the Eel River. The valleys of the Mill Creek branches and of Mud Creek are much wider.

In the northern and northeastern part of the county the natural drainage is poor, although this condition is largely relieved by the establishment of artificial drainage. In the southern part of the county, owing to the more pronounced topographic variation, the drainage is good.

Hendricks County was first settled about 1820. The population is reported in the 1910 census as 20,840. Danville, the county seat, is the largest town in the county, with a population of 1,640. The county is crossed by four steam and two electric lines. The public roads are generally good.

The mean annual temperature in Hendricks County is about 53° F. The annual precipitation averages about 41 inches. There is frequently a shortage of rainfall at some time during the growing season. From the last killing frost in the spring to the first in the fall there is a normal growing season of about six months.

Corn, wheat, oats, clover, and timothy are the principal crops grown in this county, corn being by far the most important. The live-stock industry, consisting mainly of hog raising and the fattening of cattle for market, is important, and dairying is receiving increasing attention. Alfalfa is grown to some extent. Truck crops are not produced extensively, but the production of fruit, mainly apples, offers excellent opportunities.

The average size of the farms is about 91 acres. The value of farm land has increased rapidly during recent years, the best land now being valued at \$125 to \$150 an acre.

Throughout the county the principal soil-forming material is a surface layer of silty clay, ranging from 2 to 3 feet in thickness. This overlies a deep deposit of bowlder clay which has an important influence upon the soils.

Where the silty clay stratum has about the average depth and the natural drainage is good the Miami silt loam is developed. This type is characterized by the light color of the surface soil and its rather heavy subsoil. Wheat, oats, and timothy do well on this soil, but its deficiency in lime and humus renders it somewhat less suitable for clover and corn than the Miami loam.

The Miami loam, on account of its coarser texture and more rolling surface, has somewhat better internal drainage and is not quite so susceptible to seasonal extremes as the silt loam. Both the Miami silt loam and Miami loam are subject to some variations, resulting mainly from differences in topography, drainage, and depth to the underlying till.

The Miami clay loam is of small extent, covering about 4.5 square miles. It produces about the same yields as the Miami silt loam, flat phase.

The Clyde soils comprise the black lands found in all the depressions of the uplands and in valleys wherever the natural drainage is poor. They have a high content of organic matter and where artificially drained are very productive. Associated with these soils are small areas of mucky, or, as locally termed, "chaffy" lands.

The strictly alluvial soils are mainly brown silty loams or fine sandy loams. They consist of material derived locally from loessial and glacial deposits. Owing to the depth of the present stream channels and to the generally sandy nature of the substratum, the drainage of these soils is good. Practically all are under cultivation and are highly esteemed for general farming. These soils are included with the Genesee series.

The soil of the second bottoms, which are of small extent, is very similar to the Genesee sandy loam, but since these bottoms lie above overflow the soil is mapped as the Fox sandy loam. The high terraces found along the large creeks give rise to the Fox silt loam, a highly desirable soil for all crops commonly grown in the county.

Strips of Meadow—in part agricultural—are mapped along many of the smaller streams. Muck, an organic soil, is of small extent.



[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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