Issued April 12, 1916.

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 WARREN COUNTY, INDIANA.

BY

E. J. GRIMES, OF THE INDIANA DEPARTMENT OF GEOLOGY, AND
E. H. STEVENS, OF THE U. S. DEPARTMENT OF AGRICULTURE.

W. E. McLENDON, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1914.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1916.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., August 27, 1915.

SIR: Under the cooperative agreement with the State of Indiana Department of Geology, Edward Barrett, State geologist, a soil survey of Warren County was carried to completion during the field season of 1914.

I have the honor to transmit herewith the manuscript report and map covering this work and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1914, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

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

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SOIL SURVEY OF WARREN COUNTY, INDIANA.

By E. J. GRIMES, of the Indiana Department of Geology, and E. H. STEVENS, of the U. S. Department of Agriculture.

DESCRIPTION OF THE AREA.

Warren County adjoins the western boundary of Indiana, a little north of the center of the State. It is bounded on the north by Benton County, on the east by Tippecanoe and Fountain Counties, on the south by Fountain and Vermilion Counties, and on the west by the Illinois state line. It has an area of 368 square miles, or 235,520 acres.

Physiographically, Warren County is a plain of low relief. Topographically, it consists of two areas of smooth to undulating prairie and a belt of low, hilly relief. The main smooth area lies along the western side of the county, broadening northward, and the other lies in the northeastern part. The width of the western area at the north line of the county is about 8 miles. It retains this width southward for about 12 miles and then tapers to a point near the village of State Line. The smooth area in the northeastern part of the county is separated into two parts by the upper part of Big Pine Creek, the western and smaller part being less well preserved and less typical than the eastern. This feature of the topography is a constructional plain, faintly modified by the erosion of widely separated, shallow valleys with few tributaries. Its dissection has hardly begun, and the drainage ways are shallow. The unmodified surface is that of a gently undulating ground moraine of glacial origin. It is at present covered with a silt layer, which, however, lies as a mantle and does not obliterate the original topography of the ice-laid material.

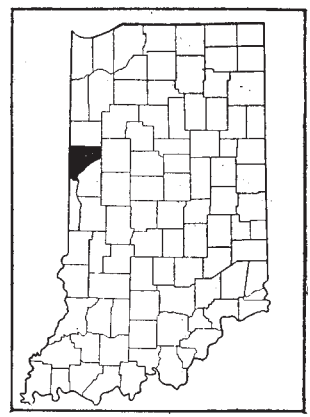

FIG. 1.—Sketch map showing location of the Warren County area, Indiana.

The hilly belt, including the valley of the Wabash River, lies along the southeastern boundary of the county, adjoining the river valley and extending up the main tributary streams. It ranges in width from about 3 to 5 miles, except where it includes a broad northward embayment on both sides of Big Pine Creek extending northward nearly to the county line. This belt is merely a portion of the original

smooth upland plain that has been dissected by streams. It consists of small, shallow valleys and intervening low watershed ridges with a widely branching arrangement. The depth of the dissection or the height of the hills reaches a maximum of less than 150 feet.

The Wabash Valley consists of a narrow belt of low, flat bottom land subject to overflow and a broader belt of practically flat terrace land lying high above the level of overflow.

The principal drainage outlets on the north and east are Little Pine and Kickapoo Creeks. The lower courses of these creeks are flanked with bluffs of sandstone and gravel. Big Pine Creek Valley is deep and tortuous, being 75 to 150 feet below the average surface level. From Rainesville to the junction Big Pine Creek has carved a channel in sandstone. The generally broad bottoms and terraces, together with the high bluff lines, suggest that at one time this stream was an important drainage way. Possum Run, Redwood and Rock Creeks, and Fall Branch drain the central and southeastern sections. Possum Run at its headwaters is a superficial stream, but farther south it is skirted by till bluffs. The hilly or rolling uplands adjoining these streams include but very little untillable land. The steep slopes break directly into the level plain, which is cultivated frequently to the very edge. Prairie and Jordan Townships are drained by Jordans Creek, a tributary of the Vermilion River in Illinois. The upper branches of this stream are surface streams with artificial channels that usually represent the formerly ill-defined and obstructed natural channels enlarged and straightened by dredging.

At the time of the first settlement of the county much of the prairie was too wet for cultivation, and a number of marshes which had not reached the state of "wet prairie" were scattered throughout its area. To drain these water-logged areas properly was for years the chief problem of the farmers. Reclamation has been effected by the construction of a system of surface ditches and tile drains covering all parts of the prairie.

The elevations above sea level, as determined by various railroad surveys, are as follows: Williamsport, 668 feet; West Lebanon, 700 feet; Marshfield, 706 feet; State Line, 730 feet; Pence, 700 feet; Judyville, 771 feet; Hedrick, 709 feet; Pine Village, 702 feet; and Winthrop, 677 feet.

Independence, the oldest town in the county, was an Indian trading point as early as 1811. The development of the region was retarded at first by the lack of means of transportation and by the presence of unfriendly Indians. The only markets were to the south. They were reached by the lengthy and perilous journey to New Orleans. By 1824 a great many settlers had located in this region, largely in Warren Township. They were attracted by the fertile valleys and the excellent pasture land on the adjoining slopes. The

county was organized January 19, 1827, and Williamsport was made the county seat the same year. Many of the early immigrants came up the Wabash River from southern Indiana, Kentucky, and Ohio. The advent of the Wabash Railroad in 1856 gave an outlet for the county's produce and stimulated development.

According to the census reports, the population has changed but little during the last 40 years. In the 1910 census it is reported as 10,899. The county is sparsely settled as compared with other sections of central Indiana.

Williamsport, the county seat, is a modern town of about 1,200 inhabitants, located on the west bank of the Wabash River. West Lebanon and Pine Village are the only other incorporated towns, with populations of 642 and 352, respectively. State Line and Independence are the next largest towns. Pence, Tab, Hedrick, Marshfield, Foster, and Judyville are small villages and shipping points. There are many sidings and grain elevators within the county.

The transportation facilities of the county are good. Two north-and-south lines—the Chicago & Eastern Illinois and the Chicago, Indiana & Southern—give direct connection with Chicago, lying about 100 miles to the north. The Wabash Railroad and the Peoria division of the Big Four Railroad cross the southern part of the county east and west. A branch of the Illinois Central enters the county from the west and connects with the Wabash at West Lebanon. A branch of the main line of the Chicago & Eastern Illinois has its eastern terminus at Judyville.

The county has a total of 366 miles of improved roads. These are mainly surfaced with gravel. Substantial progress is being made in the effort to have a permanent system of good roads, but there are certain sections of the prairie not yet open to travel.

The county is in a very prosperous condition. The improvements are of the best type. Well-built farmhouses, large barns, good outbuildings, and labor-saving machinery are the rule. Telephones are in general use, and rural mail routes reach all parts of the county.

CLIMATE.

The climate of Warren County is characterized by wide variations in temperature and rainfall. Sudden changes in temperature are frequent. Periods of drought and years of too little rainfall for the requirements of corn and grass are common.

The natural physiographic regions of the county have somewhat distinct climatic features. The prairie belt is marked by wider variations in temperature and a smaller annual rainfall than the forested sections. The Wabash Valley apparently has a tempering influence on the climate of the eastern section.

The following table gives the mean and extreme monthly, seasonal, and annual temperatures and precipitation as recorded at the Weather Bureau station at La Fayette, Ind., and the mean monthly, seasonal, and annual temperature and precipitation as recorded at Danville, Vermilion County, Ill. The records of the La Fayette station are representative of the Wabash Valley portion of Warren County, while those of the Danville station, immediately west of Warren County, are applicable to the prairie belt..

Monthly, seasonal, and annual temperature and precipitation at La Fayette, Tippecanoe County, Ind., and Danville, Vermilion County, Ill.

Month.	La Fayette, Ind.							Danville, Ill.	
	Temperature.			Precipitation.					
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snowfall, average unmelted.	Mean temperature.	Mean precipitation.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	°F.	*Inches.*
December	29.7	69	−17	2.59	1.95	5.84	3.5	30.5	1.99
January	25.3	70	−33	2.47	1.18	.40	7.0	26.5	2.92
February	26.9	69	−26	2.75	2.94	5.78	6.3	27.1	1.75
Winter	27.3	70	−33	7.81	6.07	12.02	16.8	28.0	6.66
March	37.6	83	−5	3.20	1.41	3.30	4.4	39.6	3.54
April	50.5	89	10	3.27	2.94	2.25	.4	52.0	2.78
May	61.5	97	25	4.40	2.11	3.82	T.	64.8	3.35
Spring	49.9	97	−5	10.87	6.46	9.37	4.8	52.1	9.67
June	70.7	100	33	4.43	1.97	7.16	.....	72.5	2.82
July	74.6	105	42	3.77	.88	2.05	.....	76.6	2.96
August	72.6	102	39	3.23	3.08	.47	.....	74.0	2.91
Summer	72.6	105	33	11.43	5.93	9.68	.....	74.4	8.69
September	66.1	101	29	2.77	3.02	4.20	.....	67.8	3.35
October	53.3	92	16	2.35	1.62	4.42	T.	55.1	2.55
November	39.5	95	−1	3.06	3.72	6.49	1.2	40.6	3.25
Fall	53.0	101	−1	8.18	8.36	15.11	1.2	54.5	9.15
Year	50.7	105	−33	38.29	26.82	46.18	[1] 22.8	52.3	34.17

[1] Included in mean precipitation.

The annual precipitation averages about 36 inches, and the rainfall, even in the driest years, is sufficient for all crops grown if proper cultural methods are employed to conserve the moisture. The snowfall is quite variable from year to year, but the average is about 23 inches. Snow is generally sufficient to protect the winter wheat, rye, and clover seedings.

The average date of the last killing frost in spring at La Fayette is April 26 and of the first in the fall October 5, giving an average

growing season of 162 days. The latest date of killing frost in the spring is May 27 and the earliest in fall September 14.

AGRICULTURE.

Warren County comprises large areas of productive, well-drained soils which are susceptible of easy cultivation, and which, notwithstanding the continuous cropping to which they have been subjected in the past, remain comparatively productive.

Farming operations were begun in what is now Warren Township about 1824. The rich soils of the bottoms, the good pasture lands on the adjoining slopes, and the means of transportation afforded by the river encouraged the early settlement of this part of the county in preference to the wet prairie soils. As settlement extended westward the prairie areas were gradually taken up. The first prairie section to be reclaimed was the better drained land around West Lebanon and Marshfield. The prairie lands were early utilized for grazing, and cattle feeding became an important industry with the prairie farmer. The native prairie grasses were cut for hay, while corn was brought in from distant points. Until about 30 years ago the original prairie sod remained unbroken. In 1882 tile drainage was undertaken, and extensive systems of open and underground drains have since been completed. Nearly all the black prairie land has been freed from surface water and the area so reclaimed forms the most productive land in the county. The value of these areas is indicated by the assessed valuation of the land of the county, which in 1914 is reported as $13,300,000, that of Prairie Township alone being given as $1,951,510.

The crops grown in Warren County at present are those characteristic of the corn belt—chiefly corn, oats, hay, and wheat, ranking in acreage in the order named. Corn and oats are grown almost exclusively on the prairie farms. Little wheat is grown on the Carrington or Clyde soils. The clover acreage, always small, has rapidly declined in recent years. The general trend of agriculture since 1879 may be seen from the following table compiled from data gathered in the census:

Year.	Corn.		Oats.		Wheat.		Hay.	
	Acreage.	Production.	Acreage.	Production.	Acreage.	Production.	Acreage.	Production.
1879	62,952	2,134,441	10,587	355,666	15,862	363,651	13,043	14,527
1889	54,613	1,740,244	25,285	886,023	12,695	177,851	19,323	23,689
1899	78,667	3,792,210	36,195	1,495,400	8,189	70,430	14,529	16,509
1909	75,789	3,250,565	48,071	1,664,179	7,973	153,023	12,226	14,218

Of the 191,711 acres of improved land in farms reported in the county in 1909 a little less than two-fifths was devoted to corn,

about one-fourth was sowed to oats, only a small part—less than a twentieth—was used for wheat, and a relatively small acreage was in hay crops, mainly timothy alone. Since only a small area is devoted to hay crops, it is evident that the grain crops are grown for sale as such or for stock feeding.

The oat crop is grown principally for sale. Approximately one-third of the total production is used for feeding work stock. Wheat is grown as a cash crop, while the hay produced is barely sufficient to supply feed for the work stock. The total yield of hay amounts to about 10 tons per farm. The crop consists mainly of timothy alone, timothy and clover mixed making up less than a fifth, and clover alone about one-ninth, of the total acreage.

Potatoes, vegetables, and fruits are grown for home use only or to supply local markets.

Corn is the chief crop. This cereal receives the greatest attention of the farmers because it is a profitable grain crop on most of the soils. The largest yields are obtained on the Clyde and Genesee soils—nearly twice as large as ordinarily obtained from the Miami soils. Corn frequently yields less than 40 bushels per acre, but yields of 70 bushels are not uncommon.

Corn and oats are grown on all the soils of the county. The highest yields are obtained on the black, moist, recently drained prairie soils. Wheat is confined to the lighter colored and better drained soils. Hay, being a farm-maintenance crop, is grown on all the soils, and the same may be said of vegetables. Apple trees do best on the light-colored, well-drained soils, but small fruits are grown in all sections for home use. Topography exercises no essential control over the crops grown. The fact that corn and oats are grown almost exclusively on the black prairie soils and wheat on light-colored soils shows a degree of recognition of the adaptation of the soils to particular crops.

Of the live-stock interests the most important consists of hog raising and feeding, a total of 32,006 head of hogs sold or slaughtered, an average of nearly 24 head per farm, being reported in the 1910 census. The same authority reports 10,232 head of cattle in the county. The quantity of cream, milk, and butter sold is insignificant, and dairy cattle are kept almost exclusively to supply dairy products for home use. The sale of cattle is also relatively unimportant. There is a small industry in buying stockers and feeding them for the fat-cattle market. This industry is said to be declining. The total receipts from the sale of animals in 1909 amounted to $895,825. Probably about half this amount was received for the hogs sold, the remainder representing receipts from the sale of 4,571 head of cattle, 1,073 calves, 1,700 horses and mules, and 3,617 sheep and goats.

While there are no statistics of the income derived from the sale of stock and grain, it is probable that the amount received for the grain is considerably in excess of that received for the live stock.

The prevailing methods in the cultivation of corn conform closely to those generally used throughout the prairie section of the corn belt. The land is fall-plowed and the following spring the bed is stirred, leveled, and pulverized with harrows. The crop is planted mainly with the check rower and cultivated both ways. The land is usually harrowed when the corn is just above the ground. The roller then finishes the pulverization. Three to five shallow cultivations are given as a rule, and the crop is "laid by" about the first or middle of July. On harvesting most of the corn is husked by hand, shelled, and hauled to the elevators. In late years an increasing percentage of the crop has been cut for ensilage, especially on the Miami soils. The number of silos is increasing rapidly. The planting of cowpeas or soy beans in the corn at the last cultivation, to be cut with the corn for ensilage, is practiced.

The barnyard manure available is applied to land intended for corn. Some commercial fertilizer is used for corn on the gray soils. The corn produced on the Miami soils grades better than that grown on the dark types. The prairie corn often fails to mature properly, and the cobs are large.

Strains of Reids Yellow Dent and Leaming are the leading varieties. Seed selection is not generally practiced, and seed is mainly brought from Illinois. Good seed corn is available from growers in the same latitude in Indiana.

Oats are generally sowed broadcast over the corn or oat stubble land and harrowed under in the early spring. The acreage of this crop has steadily increased until on some of the prairie farms it is almost equal to that of corn. The average yield over a period of years is about 30 bushels per acre. Oats are cut and left shocked in the fields until the thrashing outfit reaches them, and are frequently damaged by exposure. Most of the grain is shipped out of the county. The straw is baled and sold. The seed oats are grown locally. Smut reduces the yield of oats at least 3 to 10 per cent.

The production of winter wheat has gradually declined, and the crop is grown mainly for its value as a cover and nurse crop for clover and timothy. Little wheat is grown on the prairie soils, on account of loss through winterkilling by heaving. Some of the farmers drill the wheat in the standing corn. Wheat responds better to commercial fertilizers than either corn or oats.

There has been considerable difficulty during the last five years in securing a stand of clover. On the average it fails about three years in five. The summers are frequently so dry and hot that

when the nurse crop is removed the young clover burns out. The failure is usually due to an attempt to get a full crop of a grain that draws too heavily on the available moisture supply. Some failures are due to the acid condition of the soil, low germinating vitality of the clover or neglect to get the seed properly covered. When clover yields begin to decline the land is considered as becoming less productive of other crops as well. At present when the clover fails the farmers plow it up and follow with a cereal. Doubtless a high percentage of the poor stands is due to acidity of the surface soil. This is especially true on the Miami and lighter phases of the Carrington soils. The application of 1 ton to 4 tons of ground limestone per acre will correct this condition, and after the soil has been neutralized one-half ton to 2 tons applied once in the rotation should prove ample to prevent it from becoming acid.

There are a number of small patches of alfalfa in the county. The crop gives good yields and the acreage is increasing. Applications of lime are found necessary on most soils for success with this legume, but barnyard manure is said frequently to be the determining factor. The average upland soils and some of the terrace soils lack proper physical as well as chemical condition. They need the addition of some substance that will increase the moisture-holding capacity and will promote drainage by loosening the upper subsoil layers. Barnyard manure is used for this purpose. Top dressings in late fall or early spring where good stands have been obtained are very beneficial. Alfalfa can be produced on all the upland soils that are properly drained, limed, and inoculated.

There is only a small total acreage of cowpeas and soy beans. Both of these legumes are well suited to local soil and climatic conditions. They are resistant to heat and drought, and this feature alone recommends them for the Fox soils. They improve the soils on which they are grown, and may be grown on a soil too acid for clover or alfalfa. They rank with linseed and cottonseed meal as a concentrated feed for cattle and hogs. They may be substituted as a catch crop for clover when the latter kills out. The cowpeas may be cut for hay or used for pasture, while the soy beans can be thrashed and the vines either returned to the land directly or fed to stock, the manure being applied to the land.

Only a single field of sweet clover was seen during the survey, but it grows as a volunteer throughout the county, and can doubtless be used to advantage on a number of soils, including the Fox types, Steep broken land, and, when clover fails, prairie types. It should be drilled in the oats at the time of seeding at the rate of about 12 pounds of hulled seed per acre, in which case the nurse crop does not shade it out, nor does the sun kill it when the oats are removed. The extensive root system is beneficial in many ways.

According to the 1910 census, 41.6 per cent of the farms in Warren County are operated by tenants. In the prairie sections no less than 75 per cent of the farmers are tenants, who rent on a share basis, the landlord receiving one-half of the grain delivered at the elevators, and the tenant furnishing everything needed in producing the crop. In most cases additional rent is paid for pasture privileges, and some landlords exact a cash rent for the use of houses and outbuildings On this basis land is rented for $5 to $9 an acre.

The average size of farms has increased from 135 acres reported in 1880 to 161.4 acres reported in 1910. The prairie farms are all large. A farm of less than 100 acres is considered comparatively unprofitable. There are several estates of 1,000 acres or more.

The census reports an expenditure of $245,124 for labor in the county in 1909, and $2,401 for fertilizer.

But little land has changed hands in the last five years. The better prairie land is held for $200 to $225 an acre. In other sections land is valued at $125 to $200.

SOILS.

The soils of Warren County are derived mainly from the unconsolidated material deposited during, or soon after the close of, the glacial period. When the ice covered this portion of Indiana it carried a heterogeneous load of clay, silt, sand, gravel, and bowlders, in varying proportions. The material was influenced by the character of the rock over which it passed, and foreign and local rocks were ground up and mixed. Upon the melting and retreat of the glacier this load, known as glacial drift, was dropped, leaving an uneven and undrained surface consisting of numerous knolls, ridges, ponds, marshes, and small lakes. Many of the latter have been filled and converted into swamps or even dry land, while others have remained as lakes to the present time. Artificial drainage has been employed during recent years to convert the swampy areas into dry, tillable land.

The glacial deposit is variable in thickness, ranging from only a few feet to more than 250 feet. The average is probably less than 100 feet. The deeper deposits are in the western and northern parts of the county, becoming thinner as the Wabash River is approached. The glacial material at the surface in the prairie region is a light or grayish-colored, friable, sandy or gravelly clay. In the forested section it is prevailingly a yellowish-brown clay, containing, as a rule, less coarse material.

The rocks underlying the layer of glacial material belong, according to the Geological Survey of Indiana, to the Carboniferous age, consisting of the Knobstone at the base, and the Mansfield sandstone and the sandstones and shales of the Coal Measures above. The Knobstone occurs beneath the drift in the northeastern corner of this county and is exposed in a narrow strip along the north side of the

Wabash from where the river enters the county to Williamsport. The Mansfield sandstone underlies a large proportion of the eastern half of the county and outcrops along the Wabash and its tributaries from the eastern county line to the mouth of Redwood Creek. The Coal Measures rocks lie just beneath the deep drift of the western half of the county.

Generally these rocks have no direct influence upon the soils, but where the drift is thin they have weathered to a sufficient degree to modify the composition of the soil material, especially in the subsoil and substratum. The occurrence of purely residual material is local.

The bowlder till is covered with a layer of fine-grained, loesslike material to a depth of 2 feet or more. Flats, hills, and valleys alike are covered with it. The thickness varies somewhat with the surface irregularities, the steeper sloping areas having the thinnest mantle and the level and low-lying areas the thickest. This material, modified by differences in topography and drainage conditions, with the consequent variations in the effectiveness of the different formative agencies, such as weathering, erosion, and vegetation, has given rise to the different soil types of the uplands.

The upland types are divided into timbered soils and prairie soils, according to the character of the original vegetation. The large content of organic matter and the resulting dark color are striking characteristics of the prairie soils.

The prairie types are grouped on the basis of color and character of subsoil. The Carrington silt loam covers the nearly level to gently rolling prairie areas that originally had fairly good surface drainage. The soil color is dark brown. The Clyde silty clay loam occupies the lower lying flat areas that were originally poorly drained, and the soil is black.

The timbered soils are readily distinguished from the prairie types by their generally light or gray color and lower percentage of organic matter. They occur also in regions of rolling topography where the surface drainage has been good. The predominant soil is the Miami silt loam, which forms in gently undulating to rolling areas. Relatively small areas having a nearly level surface are mapped as the flat phase of that type. Strips of eroded and very hilly land along the stream courses, having a low agricultural value, are classed as Steep broken land.

The Wabash River is bordered by terraces of gravel and sand, with a covering of $1\frac{1}{2}$ to 3 feet of sandy loam, coarse sandy loam, and silt loam. Similar but smaller areas occur in the valley of Big Pine Creek. These terraces, or benches, were built when the streams flowed at a much higher level than at present. They comprise soils of the Fox and Allis series. The Fox series includes the brown or grayish-brown, originally timbered soils, in which the substratum of gravel

is largely calcareous. The coarse sandy loam type is a brown to black, coarse sandy loam, formed under prairie conditions. In a few areas along the Wabash River and Big Pine Creek the soil-forming material of the terraces is derived from the underlying sand rocks. This land is correlated as the Allis stony loam.

The alluvium of the flood plains or overflow land is of local origin, being derived mainly from the uplands, and has many of the characteristics of the upland material. The first bottom of the Wabash River is relatively narrow. The soils are of a grayish-brown color, and are classed as the Genesee. Other typically developed areas of this series are found along the lower courses of the larger tributaries. Most of the course of Big Pine Creek is bordered by some well-defined areas of black sandy loam and loam soils which are classed with the Wabash series.

Meadow is a brown, mixed loam type found along the minor drainage ways. Muck is an organic soil formed by the accumulation of the remains of various plants, chiefly sphagnum moss. It is of inextensive occurrence.

The following table gives the name and the actual and relative extent of each soil type mapped in Warren County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Carrington silt loam	88,192	37.4	Genesee fine sandy loam	2,496	1.1
Miami silt loam	65,984	29.7	Fox sandy loam	1,856	.8
Flat phase	3,968		Fox coarse sandy loam	1,088	.5
Clyde silty clay loam	44,224	18.8	Wabash loam	1,024	.4
Fox silt loam	8,256	3.5	Muck	896	.4
Steep broken land	5,696	2.4	Allis stony loam	448	.2
Meadow	4,480	1.9	Gravel pits	192	.1
Genesee silt loam	4,096	1.7			
Wabash sandy loam	2,624	1.1	Total	235,520	

Carrington Series.

The soils of the Carrington series are dark brown, and occasionally black. The subsoils are lighter colored, and generally light brown or yellowish. The series consists principally of loams, silt loams, and clay loams, and is chiefly made up of what was formerly called Marshall loam, silt loam. and clay loam. The Carrington series is developed in the central and western prairie region of the United States, and consists mainly of prairie soils. The topography is gently undulating to rolling, though in some areas the surface is nearly flat. These soils are derived through weathering from glacial till, with little or no modification from loessial deposits. One member of the Carrington series, the silt loam, is encountered in Warren County.

CARRINGTON SILT LOAM.

The surface soil of the Carrington silt loam consists of a grayish-brown to almost black, friable silt loam ranging from 12 to 22 inches in depth. The subsoil is a dull-yellow, compact silty clay loam or clayey silt, passing at about 30 inches into a more friable, yellow clay which contains an appreciable quantity of gravel, especially in the lower part. The type is uniform throughout most of its extent, but many variations occur where it grades into the Clyde and Miami soils. In a few small areas in the western part of the county the top soil is somewhat sandy or loamy, but such areas are too small to be shown separately on the soil map. In secs. 23 and 26, T. 23, R. 10, the SW. ¼ sec. 3, T. 22, R. 9, and in other, smaller spots, the soil is a brown, fine sandy loam or loam resting on a compact but friable, yellowish sandy clay. The sand content increases with depth until at about 40 inches the material is a loamy sand. This phase is found on the crests of sharp ridges or in elevated spots in level areas.

The Carrington silt loam type is common to the rolling prairie land of Illinois and Indiana and is the predominating type in Warren County. The topography varies from almost level to undulating or gently rolling, becoming irregular as the timber line is approached. Large areas are characterized by a flat or depressed surface, in many places so flat that the establishing of adequate drainage is quite a problem. Where this type is developed as islandlike bodies in areas of the Clyde silty clay loam it is slightly elevated above that soil, and such areas have mainly fair to good natural drainage.

On approaching the drainage lines the organic-matter content decreases and the color of the soil becomes lighter until it finally coincides with that of the Miami soils. This gradational area varies in width from 1 mile to 2 miles and originally supported a light forest growth. It was doubtless at one time a part of the prairie, the present light color of the soil being due to a later invasion of the forests. This transitional condition is in places so extensive that the area covered might possibly be considered as another type. In the present survey, however, it is included with the Carrington silt loam because the content of organic matter is higher than the average for the Miami soils and because of the presence of the characteristic yellowish or buff subsoil of the Carrington.

The Carrington silt loam is extensively developed in the western and northern parts of the county. The boundary of the type, approximately representing the former timber line, averages about 5 miles from the river front. The soil is most typically developed in ranges 9 and 10. In Mound Township it extends to within 2 miles of the river. It extends up to the creek valley on the west and south sides, while the corresponding area on the north and east is forested.

Most of the area lying north of Big Pine Creek and east of Mud Pine is broken by morainic ridges and a lighter colored surface soil is developed. A few areas were separated as Miami soil. The soil of these Carrington areas consists of 12 to 30 inches of a grayish-brown silty loam grading into a brownish-yellow, friable sandy loam. Below 2 feet there is considerable sand and gravel. The surface also carries varying quantities of cherty gravel.

Granite bowlders are common on this type in Prairie Township, in sections 35 and 27. A bowlder train is said to have existed in a belt about a mile wide passing from the northwest to the southeast, but this could not be traced. Most of the bowlders have been removed, so that they do not now interfere with cultivation.

In general the soil and subsoil are retentive of moisture. The rainfall is readily absorbed, and the compact silty clay layer between the depths of 18 and 36 inches serves as a reservoir to hold the percolating waters. The structure of the material insures good capillarity. This, combined with the good internal drainage induced by the friable sandy clay substratum, enables the soil to withstand drought to a marked degree, and crops do not suffer from excessive rainfall.

Originally the Carrington silt loam was one of the most desirable and productive soils of the corn belt, but much of this type, like the Clyde silty clay loam, has been subjected to continuous grain farming for about 30 years, and it is now considered less productive than formerly. In addition, its former good physical condition has been impaired by improper cultural operations. The cornstalks are pastured in late winter and spring, when the trampling of the stock puddles the soil. In many cases the fields are plowed too early, before they are dry enough to handle safely. The organic matter is sometimes depleted by burning the crop residues, such as stalk, straw, and weeds. The lighter phases of this type, particularly the undulating areas, are low in lime, as shown by the litmus tests.

Corn, oats, grass, and wheat are the main crops grown on this type. For a period of several years the average yield of corn is about 40 bushels, of oats 30 bushels, wheat about 20 bushels, and clover 1 ton to 2 tons per acre. No attempt has been made to grow special crops, except a small acreage of potatoes, which yielded about 200 to 300 bushels per acre. Sugar corn is grown extensively on this soil around Hoopeston, Ill. It is an excellent grass soil, and a considerable acreage is in bluegrass, especially in the rolling areas and near the timber line. Fruit is grown successfully, but only for home use.

Wheat is not generally grown. It is subject to winterkilling, either by the accumulation of water in low places or by being smothered out by the ice in winter. The plants are also killed by being heaved out of the ground by the alternate freezing and thawing in the fall and spring. Winterkilling is usually due to inadequate

drainage. With the improvement of the drainage and the use of hardy strains of Turkey Red wheat, the crop could be profitably grown on this type. Alfalfa, soy beans, cowpeas, and sweet clover do well on this soil.

The Carrington silt loam is valued at $150 to $225 an acre.

Clyde Series.

The soils of the Clyde series are dark brown to black in color, and overlie gray, drab, or mottled gray and yellowish subsoils. They have been formed in lakes, ponds, or low, poorly drained areas within glaciated regions through the influence of poor drainage and the accumulation of organic matter acting on the original glacial till of the basins or on accumulations of water-laid material washed into and deposited on the floor of the basins. They are distinguished from the Poygan soils by the gray instead of reddish subsoils, and from the Fargo by the generally moderate to low content of lime. The topography is level and the soils are naturally poorly drained, but when reclaimed they are highly productive and valuable for corn, grass, sugar beets, cabbage, and onions. The series is represented in Warren County by a single type, the Clyde silty clay loam.

Clyde silty clay loam.

The surface soil of the Clyde silty clay loam to an average depth of about 12 inches is a dark brownish gray or black heavy silt loam to silty clay loam. The content of organic matter is relatively high. It is black and finely divided, and is one of the elements which gives the soil its granular and mellow structure. As the content of organic matter is reduced by cultivation the soil becomes heavier and more difficult to handle. The intensity of color is proportionate to the amount of organic matter and moisture present in the soil. When dry the surface is dark brown, but it changes to black when moistened. The subsoil is a dark-gray to drab or bluish-black clay loam which grades at 18 to 24 inches into a gray, plastic, silty clay mottled with yellow and brown iron stains. The mottlings become more pronounced with depth, and the silty clay is more plastic and tenacious in the lower part of the 3-foot section. Occasionally below 30 inches a gravelly or coarse sandy clay is encountered. The subsoil has no constant characteristics and is subject to wide variation, especially in color, within short distances. The plastic and mottled condition is the result of poor drainage and consequently poor aeration and oxidation.

The type as a whole probably averages a heavy silt loam in Warren County. It is easily distinguished from the brown prairie soils. It is locally styled "black prairie," and the heavier development is known as "gumbo." In most instances the boundary between this

type and the associated Carrington silt loam is fairly distinct, although there is frequently a zone or strip between the two soils comprising a lighter phase which contains less clay and organic matter than the typical Clyde soil.

In local areas this soil is a black, heavy clay loam to a depth of 12 inches. This passes into a bluish-black, granular clay loam, which at about 18 inches gives way to a drab, heavy silty clay mottled with yellow. This phase is found only in the lowest depressions. It is generally so wet and intractable that it is not cultivated. A few such areas are found in sec. 35, T. 22, R. 9; another occurs in sec. 4, T. 22, R. 9, and a large body is developed in sec. 29, T. 20, R. 10.

A large percentage of the type borders the minor drainage ways of the prairie and the larger creeks and lower courses of the streams where they begin to form a channel. The material resembles alluvium and is underlain at about 3 feet by highly stained sand and gravel. Such an area is found in secs. 16, 17, 8, and 9, T. 22, R. 9, also in sec. 12, T. 22, R. 10.

The soil along Jordans Creek is a black silty clay loam from 6 to 10 inches deep, underlain by a bluish-black, friable or sometimes gummy silty clay loam or clay. This grades into a mottled drab or dark-colored, very sticky, plastic silty clay. Some gravel is mixed with the soil and subsoil. These bottoms are subject to overflow in times of heavy rainfall, but on account of the similarity in texture and structure, as well as in agricultural adaptation, they are included with this series, which is typically developed in the depressions of the uplands proper.

The type was formed under "wet prairie" conditions. The low-lying portions received the fine materials and organic matter washed in from the slightly higher uplands. The rank-growing sedges and grasses added much vegetable matter to the soil. More or less of the clay and finer silt has accumulated in the lower soil and subsoil sections. Surface wash is very active at the present time, and its influence can readily be observed on this type where it adjoins rolling areas.

The Clyde silty clay loam as mapped in Warren County differs from the same type as mapped in central Indiana, mainly in the greater depth of the surface soil. The dark color usually extends to a greater depth.

The Clyde silty clay loam occupies low-lying, flat areas which were originally swampy or inadequately drained. The type occurs also as depressions through the Miami silt loam, with which it is intricately associated. It has its best development in the western part of the county. Typical areas occur north of Tab, about 6 miles south of Pence, and in the southwestern corner of the county. The timbered

phase is not extensive. The largest bodies occur within a strip about 2 miles in width along the south edge of the Carrington soils in Warren Township. The soil of the greater part of the timbered phase is not essentially different from the prairie soil.

The early settlers found this type in a water-logged condition. It then comprised the sloughs or wet prairie. Most of the type has been under cultivation less than 30 years. Tile drainage was introduced about 1882 and was gradually extended until now the surface of most of the type is well drained. Most of the large ditches remaining open could be supplanted by underground drains.

The greatest problem in managing the Clyde silty clay loam has always been to secure good drainage, and there is yet urgent need for more tile drainage, especially in those parts of the type having a gummy subsoil.

As a rule this soil does not seem to be very acid, but traces of acidity are indicated by litmus-paper tests. The subsoil is well supplied with lime. The phosphorus and potassium content is known to be sufficient. The type requires careful treatment, and a constant supply of organic matter should be maintained to improve its physical condition. Applications of limestone and phosphorus may eventually prove profitable.

The Clyde silty clay loam has endured continuous grain farming unusually well, although some fields show signs of decreasing productiveness. It is the leading corn soil of the corn belt. The ordinary yields on this type are about 55 to 60 bushels per acre, while yields of 70 to 80 bushels are common. Oats average about 40 bushels, with an occasional maximum yield of 80 bushels. These two crops have occupied the greater part of the type, either continuously or alternately, for over 20 years. Farms located mainly on this type are held for $150 to $225 an acre.

Miami Series.

The soils of the Miami series 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. 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, though neither soil nor subsoil effervesces, as a rule, in acid Only one member of this series, the Miami silt loam, is mapped in Warren County.

MIAMI SILT LOAM.

The surface soil of the Miami silt loam to an average depth of 8 to 12 inches is a gray to brownish-gray silt loam, incoherent and mealy but not granular, and deficient in humus. The soil rests upon a gray or

yellow silt loam which extends to a depth of 18 to 24 inches. This material also is mealy, but becomes more granular with depth as the clay content increases. This layer resembles the soil very closely in texture, but is readily distinguished by its lighter color. The soil is composed chiefly of silt and very fine sand, with only a small percentage of sand of a coarser grade than fine sand. Small quantities of cherty gravel and stone fragments occur on the surface and throughout the soil section, mainly on the steeper slopes and on the crests of sharp ridges or mounds. The organic-matter content is low, perhaps averaging less than 2 per cent. This deficiency of humus is indicated by the characteristic color of the soil, which is grayish or whitish when dry, but changes to a dull gray or light brown when slightly moistened. Iron concretions occur on the surface and disseminated throughout the soil and subsoil in small local areas. The soil is very compact, but friable and porous when in good tilth.

The subsoil is a yellowish-brown, compact silty clay loam, grading at a depth of about 3 feet into a more friable clay loam. The content of gravel and sand usually increases at a depth of 4 to 5 feet, so that the substratum is often a sandy clay. The average thickness of the compact, dense layer is about 18 inches. Sometimes at a depth of 20 inches a gravelly clay is encountered. In such situations more of the coarse stony material is present, and the subsoil is quite open and permeable. This condition obtains along the largest stream courses, where glacial materials have been assorted and rearranged in stratified deposits. The subsoil is prevailingly well oxidized, as is evidenced by the characteristic brownish color, but gray streaks or mottlings are common. These mottlings are closely associated with the denser and poorly aerated plastic subsoil, which when dry may become so hard as to offer considerable resistance to the soil auger or tillage implements. It is seldom so compact as to prevent the downward movement of water, and the material is retentive of moisture.

The material composing the Miami silt loam is derived from the weathering of calcareous till, the surface material to an average depth of 30 inches being quite silty. The gray color of the soil is the result of leaching and the small accumulation of humus. All the type originally was forested with white, red, scarlet, and shingle oak, hickory, sugar maple, and poplar. The predominant species are white oak and hickory. With the exception of a small acreage of woods pasture, all the type is cultivated.

The topography for the most part is undulating or billowy. It is so rolling in places that considerable washing occurs where the fields are not properly managed. Near West Lebanon the relief is quite pronounced, owing to the occurrence of high morainic hills and ridges. North of Independence the type occupies broad elevations and gentle

slopes. The surface in other places is interrupted only by pothole or kettlehole depressions. In some places, as above Independence to the eastern county line and along Kickapoo Creek, the type appears to occupy a high terrace, but a study of the soil section shows that it is not of alluvial origin.

In secs. 8, 9, and 4, T. 22, R. 6, the soil is a pale ashy gray silt loam to a depth of 10 to 12 inches, passing abruptly into a gray, heavy silty clay loam, mottled with yellow and showing iron stains. At about 30 inches the material grades into a grayish or drab silty clay containing shale fragments, and at about 2 feet bedrock is encountered. The subsoil seems to be largely residual. This phase is not very productive and is in need of liming, drainage, and the addition of organic matter.

In general, the surface features of the type give it good natural drainage. However, the extension of the tile drainage, even in the gently rolling areas, improves the physical condition of the type.

One continuous body of the Miami silt loam occurs along the Wabash River, extending back from the river an average distance of 5 miles. The type extends up Big Pine Creek in a broad belt. A few isolated bodies occur in association with the prairie types. The zone which represents the gradation of this type into the prairie renders the establishment of definite boundary lines difficult in places. The topography usually becomes more nearly level on approaching the prairie, and in some places the change is abrupt, being marked by a low, sharp descent to the darker soils. The gray, gravelly till of the prairie may extend under this type for some distance, gradually giving way to the brownish-yellow till of the timbered section.

In normal seasons corn yields from 30 to 40 bushels per acre. Oats usually produce less than 40 bushels. Wheat is generally recognized as the best crop for this soil, and where good cultural methods are practiced average yields of 20 to 35 bushels are obtained. Yields of 1 ton to 2 tons of hay per acre are obtained. The yields as a whole are lower than on the prairie types, but the products are of a superior quality.

There is a larger percentage of farms operated by the owners on this soil than on any other type. The farms are smaller, systematic rotations are practiced, and more live stock is kept than in other sections.

The type is mainly in need of organic matter. This will improve its physical condition and increase its moisture-holding capacity. The soil is subject to drought. The drought of 1914 materially reduced corn yields. Applications of 1 ton to 2 tons per acre of finely ground limestone are beneficial, and the addition of acid or rock phosphate is needed to increase the phosphorus supply. Land values on this type range from $125 to $200 an acre.

Miami silt loam, flat phase.—The flat phase of the Miami silt loam is not extensively or typically developed in Warren County. The largest areas occur in Mound Township and near Greenhill in the eastern part of the county. The phase has a nearly level to gently undulating topography and is less perfectly drained than the typical soil.

The soil is a gray to brown silt loam, underlain at a depth of 8 to 10 inches by a light-gray and mottled, heavy silt loam to silty clay loam. This grades at about 20 inches into a grayish-yellow and mottled silty clay, containing gravel and sand. The subsoil is somewhat plastic and sticky, but is more friable in the lower depths. Iron concretions are common in both soil and subsoil. The surface soil of the phase is nearly identical with that of the main type, although it usually has a whitish or leached appearance, especially in the more elevated areas. Frequently where this soil grades into the Clyde silty clay loam the subsoil is a heavy, drab silty clay, highly mottled with iron stains. The soil in such places contains a higher percentage of organic matter than the main type.

The topography is so nearly level locally that drainage is poor. However, the greater part of the phase has sufficient slope for tile drainage. Both soil and subsoil are generally acid, and the deficiency in lime, coupled with a lack of organic matter, has so impaired the physical condition of the soil that it has a tendency to run together and clod badly. Deep-rooted crops, such as red, big English, or sweet clover, assist in loosening and aerating the dense subsoil. All crop residues and if possible an occasional crop of rye should be turned under to restore and maintain a good tilth. The application of one-half to 1 ton of ground limestone per acre, in connection with the addition of organic matter, is beneficial.

The flat phase is used for the same crops as the typical Miami silt loam, but the yields are somewhat heavier. The improvements on this soil are good, and the land commands about the same price as the Carrington silt loam.

Fox Series.

The types in the Fox series have brown surface soils and brown to yellowish-brown subsoils. The series has typically a level topography, drained here and there by potholes or by valleys eroded since the deposition of the material as outwash plains or as terraces along streams within the glacial area or flowing out of it. The soils, therefore, consist largely or wholly of glacially derived material, but an essential characteristic is the presence of at least 25 per cent of limestone. Three members of the Fox series, the coarse sandy loam, sandy loam, and silt loam, are encountered in Warren County.

FOX COARSE SANDY LOAM.

The surface soil of the Fox coarse sandy loam is a dark-brown or black, rather heavy, coarse sandy loam to an average depth of 13 inches. The content of organic matter is relatively high. The subsoil, extending to a depth of about 20 inches, is a yellowish-brown, compact coarse sandy loam or light loam, carrying a high percentage of coarse sand and fine gravel. The gravel is encountered at about 20 inches, and increases in quantity with depth. Below 2½ feet there is a substratum of sand and gravel which extends to great depths. This substratum as exposed in the gravel pits is a mass of gravel and sand some 40 to 60 feet thick, resting upon a shelf of shale. The gravel is of good quality for road surfacing and railroad ballast. It is largely of igneous origin, but perhaps as much as 30 per cent is limestone. Extensive gravel pits are worked in this type.

The terrace on which this type is developed rises about 50 feet above the Wabash River and its surface is level to very gently undulating. Its average width is about one-half mile. Its total length is about 3¾ miles, extending southward into Vermilion County about 2 miles. This terrace is known locally as Mound Prairie. It is similar in origin to the other, higher terraces along the Wabash River. It is a remnant of a former flood plain which was formed at the time of the melting of the glacier, below which the river cuts its channel.

The western boundary of this terrace is marked by a distinct bluff line of the rolling uplands. The terrace is separated from the upland types by a strip of the Fox silt loam. This strip consists largely of material washed from the adjoining slopes either by sheet erosion or the intermittent streams from the uplands.

The surface soil is remarkably uniform. Apparently it is a coarse loam, but carries a high percentage of coarse and medium sand and gravel. These particles seem to be in an advanced stage of disintegration, as they can be readily pulverized between the fingers. On examining the soil in a moist condition, numerous small, white particles are seen, which are probably limestone or chert in a state of partial decay. While the quantity of coarse material is large, there is sufficient fine interstitial material, such as clay and silt, to produce a structure favorable to the retention of moisture, the droughty nature of the type being due to the character of the subsoil. The soil materials are coherent. Areas allowed to remain uncultivated become so compact as to be almost impenetrable with a soil auger and offer considerable resistance to the plow, although often when cultivated under proper moisture conditions they are quite friable and easily brought into good tilth.

Corn, oats, wheat, and clover are grown on this soil. Corn probably occupies the greatest acreage, and in years of sufficient rainfall yields about 40 to 70 bushels per acre. Yields may be as low as

10 to 20 bushels per acre in years of drought. Oats produce 30 to 50 bushels, and wheat 12 to 25 bushels per acre. Clover is subject to winterkilling.

The moisture conditions in early summer are generally good. Corn makes an early start and does well until tasseling time, when it is likely to be injured by drought. Of the principal farm crops, wheat seems to be the most satisfactory for this soil. With proper management sweet clover and possibly alfalfa should prove successful.

The Fox coarse sandy loam just across the river is devoted to strawberries, raspberries, peaches, and market-garden crops. These find a ready market at Danville. Truck farming might be profitably undertaken in Warren County.

Owing to its location, the Fox coarse sandy loam is held at $150 or more an acre.

The results of mechanical analyses of samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Fox coarse sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
281701	Soil	4.7	31.8	7.8	2.7	1.8	31.0	20.1
281702	Subsoil	6.6	33.9	9.5	4.4	3.0	22.5	20.1

FOX SANDY LOAM.

The surface soil of the Fox sandy loam is a gray to light-brown medium sandy loam to a depth of 18 to 24 inches, the greater depth prevailing. The subsoil is a yellowish-brown coarse sandy loam to gravelly sandy loam or loam. The substratum consists of stratified beds of gravel and sand.

The type occupies terraces that are fairly well defined. The largest unbroken area is found southwest of Williamsport, adjoining the upland slope. It is somewhat higher than the associated Fox silt loam, and its surface is less regular. It rises from the Fox silt loam in a billowy ridge, resembling an accumulation of wind-blown material. The areas along Big Pine Creek mapped as the Fox sandy loam occupy less clearly defined terrace positions. The plain is well above overflow, but the texture and structure of the soil are suggestive of a flood plain. Most of the surface is 8 to 20 feet above the level of the creek. The largest body along Big Pine Creek is near Kramer. In this area the soil is quite mixed in texture and structure, and consists for the most part of a brown, friable sandy loam or fine sandy loam to a depth of 12 to 15 inches, grading into a brown, heavy loam or gravelly loam. The content of gravel varies widely

in the 3-foot section. Near the uplands the material may be a silt loam or loam, passing at 8 to 12 inches into a compact gravelly loam or gravel. Nearer the stream channel the soil is a gray to brown, medium, incoherent sandy loam or sand, with little change in the 3-foot section, except in the color of the subsoil, which is a shade lighter. This phase is open and loose and may become droughty.

The area in sec. 33, T. 23, R. 8, is underlain by the Mansfield sandstone. The soil is a gray sandy loam, and at about 12 inches a bright-yellow or cottonseed-meal colored sand or loamy sand, which appears to be residual from the underlying formation, is encountered. In this area the type is droughty, owing to the character of the substratum.

The Fox sandy loam as a whole is fairly well supplied with organic matter, as is indicated by the characteristic brown color of the soil. The color is more pronounced away from the creek. The drainage is good and often excessive, so that in dry seasons crops suffer from lack of moisture. The areas along the Wabash River are particularly subject to drought, but the Big Pine Creek bodies have a greater moisture-holding capacity.

Most of the type is regularly farmed to the staple farm crops. The soil contains sufficient coarse material to render it open, loose, and easily tilled with a light equipment. Corn averages about 25 to 40 bushels, oats 10 to 30 bushels, and wheat less than 15 bushels per acre. Melons of an excellent flavor are produced on the fine sandy loam phase. Alfalfa does well. Portions of this type having a loamy subsoil are well adapted to truck crops, and with judicious fertilization and management could be profitably used for trucking. The type stands in need primarily of organic matter, which can best be supplied by growing such crops as rye, soy beans, clover, or other legumes. Potassium fertilizers could be applied with profit on some fields.

In a few small areas the type consists of a brown medium sandy loam, containing a large quantity of calcareous gravel and coarse sand. The subsoil is a yellowish-brown, very gravelly sandy loam, and this in turn gives way at a depth of 2 feet or more to stratified beds of gravel and sand extending to great depths. The gravel is often so abundant as literally to cover the surface. It is especially noticeable after heavy rains and in cultivated fields where the water has washed away the finer materials. Most of the gravel particles have diameters of less than 1 inch. The interstitial material is fine sand and silt. These areas are indicated on the soil map by the gravel symbol. They occupy terraces along Big Pine Creek and the Wabash River. The most typical body is in sec. 4, T. 22, R. 8, along Big Pine Creek. Other areas are distributed throughout the Fox sandy loam along the Wabash.

The drainage of these gravelly areas is good to excessive. The soil may be worked under a wide range of moisture conditions and a good

seed bed can be worked up. The gravel to a certain extent prevents packing and baking of the soil, and insures better tilth through the growing season with a minimum of cultivation. The soil is droughty in years of low rainfall, however, so that crops are uncertain, but in seasons of normal rainfall good yields are obtained. Only early maturing crops should be grown. Of these, wheat seems to be the most profitable. In the management of the soil care should be taken to increase the organic-matter content. This, together with shallow cultivation, would assist the growing crops to resist droughty conditions.

FOX SILT LOAM.

The Fox silt loam consists of a brown or grayish-brown, friable, silt loam to a depth of 12 to 24 inches, underlain by a brown gravelly loam, coarse sandy loam, or gravel. The depth of the gravel is quite variable. The average depth is about 18 inches, but it is sometimes encountered at 12 to 15 inches. On low mounds or swells the gravel appears at the surface. In a number of small areas rounded cobblestones, about 4 to 8 inches in diameter, are scattered over the surface. Some of these stones have been removed and the fields put under cultivation. The surface is ordinarily strewn with whitish and cherty gravel.

The surface soil, while predominantly a silty loam, varies locally to a gravelly loam or gravelly sandy loam. These variations are of such small extent and are so badly mixed that it is impracticable to separate them. The color is likewise variable; the best defined areas are much darker than the small bodies that resemble the uplands. However, in all places there is enough organic matter to darken the surface and make the soil granular.

The Fox silt loam embraces the greater part of the Warren County terraces. It occurs as a broad, level plain along the Wabash River, about 40 to 80 feet above low-water level. It begins just above Independence and widens out westward until a maximum width of about 1½ miles is attained. It ends abruptly at the valley of Kickapoo Creek. From Williamsport it continues southwestward to about 2 miles below the mouth of Redwood Creek. The average width of this terrace, known as the "barrens," is about 1¼ miles. Below the Wabash Railroad the border line between this soil and the adjoining upland is marked by a high bluff. The boundary between the terraces above Big Pine Creek and the adjoining Miami silt loam is not very clearly defined. The long, gentle slopes of the uplands merge almost imperceptibly into the terraces, giving the land along the boundary the character of the underlying deposits, similar to the bowlder till.

The massive beds of gravel and sand composing these terraces are of great depth. They range in thickness from 75 to 100 feet or more.

The supply of gravel is practically inexhaustible. The gravel consists largely of different kinds of granite, although a high percentage is limestone. The particles range up to 6 inches in diameter, with occasional large bowlders.

The high gravel terraces were formed when the river flowed at a much higher level than at present. As the Wisconsin ice sheet melted great floods resulted, which were heavily loaded with glacial débris, and the deposition of this built up the high and broad flood plains. When the ice withdrew and the excessive supply of débris was exhausted the velocity of the stream was diminished and finer material was deposited over the gravel, forming the veneer of soil.

The surface configuration varies from level to gently undulating. The level areas mainly border the uplands, while the central and outer portions are more irregular. The most conspicuous inequalities are formed by the streams flowing from the uplands.

The lower 4 to 6 inches of the soil section is somewhat lighter and perceptibly heavier than the upper 12 to 14 inches in the typical development. There is a small area just south of Williamsport that has a dark-brown soil to a depth of 12 inches, underlain by a light-brown silt loam. The subsoil, extending from about 24 to 42 inches, is a compact, brown and gray mottled silty clay loam. The moisture conditions of this variation are good, and yields are heavier than on the typical soil.

While the prevailing substratum of the type consists of the unconsolidated deposits of gravel, in a few areas rock is encountered at a shallow depth. The terraces above Independence are underlain with the Knobstone shale, which has influenced the texture and productiveness of the soil. The soil is a light-gray, heavy silt loam to a depth of 8 to 12 inches, underlain by a mottled gray, compact silty clay loam subsoil, which gives way at shallow depths to a shaly substratum. Large bowlders occur on the surface. The soil is poor and is used largely for pasture.

In the portion of the "barrens" or terrace extending from Rock Creek southwest to Redwood Creek the soil of this type is generally more gravelly and shallow than the typical. Such areas are indicated on the soil map by the gravel symbol. They comprise two or more well-drained terraces or benches, and the surface is uneven. In these areas the surface soil ranges from a grayish-brown sandy or gravelly silt loam to loam. This grades at an average depth of 8 to 10 inches into a brownish gravelly loam or gravel, which continues to unknown depths. The gravel in the surface soil is quite noticeable. The soil is so shallow that it is very susceptible to drought, and crop yields are somewhat lower than those obtained on the higher areas of this type. The improvements are good, and the land of these gravelly areas has about the same value as the typical Fox silt loam.

There are a few small areas of this type on the terraces near Independence in which the surface is so thickly covered with granite bowlders, averaging somewhat less than 3 feet in diameter, as to be unfit for cultivation. These areas are indicated on the map by the bowlder symbol. The bowlders were doubtless transported by the glacier to their present position. They are so numerous that the expense of removing them would probably be prohibitive. The bowlder areas afford fair pasture land.

The Fox silt loam is friable and easily reduced to a fine seed bed, but compacts readily after rains or when allowed to remain unstirred for some time. The greatest problem in the management of this type is the conservation of moisture. The soil naturally is fertile, but the character of the subsoil is such that drainage is excessive. Where the gravel is near the surface it is impossible to store sufficient moisture in such a shallow soil to carry crops through a long period of dry weather.

The raising of live stock and the marketing of the crops in the form of beef and pork rather than by direct sale is good practice on this type.

The soil is devoted to the crops common to the region. The yields, particularly of corn, oats, and hay, depend entirely upon the rainfall. In normal years oats yield from 30 to 50 bushels, and corn yields 40 to 60 bushels per acre. The latter crop is most uncertain. In the season of 1914 large areas yielded only 5 to 20 bushels per acre. Wheat is the most certain and profitable cereal grown. Yields of 10 to 40 bushels of wheat per acre are obtained. The type is well adapted to bluegrass, and a larger acreage could well be used for permanent pasture.

Ground limestone is used, and phosphatic fertilizers are being tried on wheat with varying degrees of success. The greatest need of this soil is humus. The value of the Fox silt loam ranges from $75 to $150 an acre.

Genesee Series.

The Genesee series includes soils formed from dark-brown to grayish-brown alluvial sediments deposited along the major streams and their tributaries throughout the northeastern glaciated region, particularly 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 to frequent overflows. The series is represented in Warren County by two types, the Genesee fine sandy loam and silt loam.

GENESEE FINE SANDY LOAM.

The Genesee fine sandy loam to a depth of 12 to 20 inches consists of a grayish to light-brown fine sandy loam containing but little clay and silt and large quantities of medium and coarse sand. This is underlain by a brownish-yellow or brownish-gray fine sandy loam or loamy fine sand. The loamy material gradually decreases with depth, and at about 24 to 30 inches a clean, gray or brown sand is often encountered. There is no definite line between the soil and subsoil. The material is essentially the same, but the color usually becomes lighter with depth.

The principal occurrence of the type is along Possum Run and Redwood and Little Pine Creeks. It occupies strips of overflow, or first-bottom, land. It also occupies small, isolated areas along the Wabash River, where it occurs as low alluvial ridges or natural levees on the banks of the river. Such areas are formed in times of flood when the river overspreads its plain, depositing the soil material as the velocity of the flood waters is checked. They are usually narrow and rise a few feet above the associated Genesee silt loam. Where the type is developed as a natural levee, the sand is generally of medium texture and there is little change in color in the 3-foot section.

The surface of the type is quite uneven, especially along Possum Run and Redwood Creek, consisting of low knolls and ridges and shallow depressions. A few level fields occur, but they are not extensive. A large part of the type is subject to frequent overflows. A few areas are so dissected by creeks and so thickly strewn with gravel and stones that they are unfit for cultivation.

Most of the soil is well drained. It is deficient in humus, but is naturally productive, and is easily cultivated, on account of its light, open structure. At lower depths it is always moist, the permanent water table being near the surface. In a few of the sandier areas crops suffer in times of drought.

This soil is largely farmed to corn, producing an average yield of about 40 bushels per acre. Melons and sweet potatoes do well. The type also furnishes good bluegrass pasturage.

GENESEE SILT LOAM.

The Genesee silt loam consists of a dark-gray or grayish-brown to rather dark brown, mellow silt loam to depths of 12 to 42 inches. The soil grades into the slightly heavier and lighter colored subsoil at an average depth of 18 inches. There is very little change in color with depth, but the texture becomes perceptibly heavier as the clay content increases. The lower section is frequently a heavy silt loam, grading in places into a brown and gray mottled, heavy

silty clay loam. The immediate substratum is variable, ranging from pure sand to gravel. In some areas gravel is encountered at a depth of 20 inches. In color the Genesee silt loam is very uniform. It does not contain a very high percentage of organic matter. At the mouths of some of the larger creeks the soil is darker in color and more loamy. The soil varies from a loam along the streams to a silty clay loam near the uplands or in local depressions. The texture is most variable near the streams.

The Genesee silt loam is the principal bottom-land soil along the Wabash River. It occurs in a strip averaging less than one-half mile in width, its maximum width being only three-fourths mile. There is a slope toward the river. The surface is mainly level, but is uneven in places, owing to the presence of overflow channels and sloughs. The type includes some ridges of sandy material. It is encountered also in swales bordering the upland along some of the larger tributaries of the river. Areas at the foot of the upland are frequently gravelly. Other areas at the mouth of the small ravines are covered with shale fragments from the uplands. These areas of colluvial wash or alluvial soil, wherever of sufficient extent, are sowed in oats or alfalfa.

This type is subject to periodic inundation. It is most frequently overflowed in the early spring, and the water sometimes remains on the surface until the last of April. Fields are often overflowed after the crops are planted, and crops are sometimes, though rarely, lost by floods in August or September. The bottoms are so late in drying out in the spring that by the time the ground is plowed the danger of floods is past. Otherwise the natural drainage is fair. There are a few depressions that are permanently wet, and these are mapped as Meadow. The long sloughs which cut through the land interfere with cultivation. The fields are plowed from the stream toward the upland.

Corn is the only crop grown and produces large yields of good quality. Seventy bushels is considered a good average yield, although yields of 80 bushels per acre are not uncommon. During unfavorable seasons yields average less than 50 bushels. This type is easily tilled, and a good seed bed is effected without difficulty. The soil is mellow and friable, but is sticky when wet, and has a tendency to clod when plowed too wet. Clean cultivation is made difficult by the frequent flooding that causes noxious weeds, such as wild sweet potato, morning-glory, and cocklebur, to spread.

Crops are made uncertain by the annual overflows. These bottoms are not of sufficient extent to warrant the establishing of a system of levees or dikes.

Wabash Series.

The Wabash soils are prevailingly black, ranging to dark brown, and contain a high percentage of organic matter. The subsoils are drab or gray. These soils are developed in the first bottoms of streams in the central prairie States. They extend for long distances along the Mississippi River. The material is derived mainly from the calcareous drift material and loessial deposits of the Mississippi basin. Two types of this series, the Wabash sandy loam and the Wabash loam, are mapped in Warren County.

WABASH SANDY LOAM.

The Wabash sandy loam to a depth of 12 to 20 inches is a very dark brown or black, friable sandy loam or a loamy sand. The content of organic matter is relatively high and gives the soil a mellow or loamy structure. The subsoil is quite variable, but consists mainly of a brown or grayish-brown sandy loam or loam. In places it is a brown, heavy loam to silty clay loam, becoming plastic and gummy in the lower part, but the latter condition is confined to a few small, depressed areas. The 3-foot section usually contains coarse sand and gravel, and the immediate substratum is in places a bed of gravel.

The Wabash sandy loam occurs as long strips bordering Big Pine Creek. The topography is essentially that of a flood plain, but the greater part of the type is no longer flooded, except during periods of extremely high water.

The soil is very productive, and its position insures reasonable protection from flood waters. The short overflows do not do much damage, except in scattering weed seed. Owing to its good drainage and its high organic-matter content, this soil is desirable for a large number of crops. It is easily cultivated, and retentive of moisture.

The type is well suited to the production of muskmelons and watermelons. It produces a large muskmelon of good flavor, and a large acreage is devoted to the production of melons, which find a ready market. Alfalfa does unusually well in the better drained areas. Corn, oats, and wheat yield well.

WABASH LOAM.

The surface soil of the Wabash loam ranges from a light fine sandy loam to a silt loam. The color is prevailingly black to a depth of 8 to 18 inches. The percentage of very fine sand is high. The soil rarely contains much coarser material. Owing to the large quantities of organic matter present, the surface is inclined to be loose and sometimes fluffy. The depth and character of the subsoil are quite variable. It usually consists of a loam, silt loam,

or clay loam. The loam is dark colored or drab and mottled with yellow and brown stains to depths of 24 to 40 inches, and is mixed with a grayish-brown or dark plastic clay or a grayish or bluish and yellow mottled sandy loam or sand. The subsoil may be quite plastic below 20 inches, but the content of sand increases rapidly with depth, and the heavier material gives way to a mixture of sand, clay, and gravel. The gray sand resembles quicksand. The water table is encountered at about 3 feet.

The Wabash loam is developed in a few scattered areas along the larger creeks. The largest bodies occur along Big Pine Creek, in secs. 6 and 7, T. 23, R. 8, and along Kickapoo Creek. The type occasionally occupies depressions at the base of the valley slope, or the sides of overflow channels or old bayous, now silted up.

The greatest need of this type is drainage. With the dredging and widening of the stream channels now in progress the areas having poorest drainage will soon be brought under cultivation. Numerous laterals are needed to lower the water table.

The area at Hygenia Springs occupies a craterlike basin about one-half mile wide adjoining Big Pine Creek. This area was originally a swamp which was inundated during the greater part of the year, but has been reclaimed by drainage. It is now under cultivation, and produces large yields of corn. A few areas of this type furnish good pasture. It is well suited to timothy and alsike.

Allis Series.

The soils of the Allis series range from brownish to drab or gray and are about 8 inches deep. The subsoil is usually light gray, but sometimes mottled red and gray. These soils occupy steep slopes or elevated positions. The topography is rolling and the surface drainage good. On account of the heavy character of the subsoil, however, artificial drainage is frequently necessary. The soils are derived through the weathering of light-colored soft shales, the structure of which is often preserved in the deep subsoil. The series is represented in Warren County by a single type, the Allis stony loam.

Allis stony loam.

The Allis stony loam includes a mixture of soils of local origin developed on the terraces of the Wabash River and Big Pine Creek. Mansfield sandstone forms the substratum, and has contributed largely to the soil material. The surface soil ranges from a gray to black fine sandy loam to loam. The color is usually brownish gray or light brown in the drained areas. In the swales the color is light brown or dark brown, which may extend to a depth of 20 inches or more. The content of organic matter is typically low, and below 6 or 8

inches the soil is a light-yellow or bright-gray sand. In the poorly drained spots the subsoil is a drab or dark-colored silty clay, highly mottled with red and yellow blotches. In these places the bedrock is encountered at greater depths, or below the 3-foot section.

This soil is typically developed in an area extending from Williamsport southwestward for about 2½ miles. Three small bodies are mapped along Big Pine Creek.

The surface soil of this type carries a high percentage of angular fragments of a yellowish-brown, medium-grained sandstone, known geologically as the Mansfield. It belongs to the Pennsylvanian system of rocks that forms the base of the Coal Measures. A massive outcrop of this formation may be seen at Williamsport, where Fall Branch has cut a ravine over 100 feet in depth in this rock. The bits of sandstone strewn over the surface are highly ferruginous and have resisted decay. The areas along Big Pine Creek are not very stony at the surface, but are underlain at no great depth by bedrock. The area below Williamsport appears to be the remnant of a former terrace. It lies about 8 to 10 feet above the flood plain and 15 to 20 feet below the adjoining terrace. The soil material, however, is mainly residual. A former covering of alluvium has doubtless been removed by stream action or erosion.

The surface of the Allis stony loam is uneven, and it is intermittently wet and dry. The depressions through the type support a growth of buttonwood and willow. The drained areas are forested with white oak. The type has no value other than for the pasturage it affords.

Miscellaneous Material.

MEADOW.

The first-bottom or overflow land occurring along the minor streams and in a few areas through the wider bottoms in the county is classed as Meadow, on account of the mixed character of the soil and the poor drainage conditions. Meadow consists of a variety of soils so intricately associated that their separation is impracticable. In addition, the material is constantly being changed by floods. It is predominantly a loam of dark-brown or black color, but varies from a silt loam or silty clay loam to a sandy loam. The heavier or darker material occurs in the flat areas, while the wavy or gently undulating areas are lighter in color and loamier.

The soil is mainly a mottled drab or brown and grayish loam to silty clay loam, somewhat heavier than the subsoil. Usually there is no line of separation between the soil and subsoil, the only difference being a perceptibly lighter color in the subsoil. Frequently the lower subsoil and the underlying substratum are a gray sand or reddish gravel. The gravel is found mainly along the prairie streams.

Most of the alluvial material is of recent origin. Many of the valleys are shallow, narrow, flat, and poorly defined. The blufflike bank that is usually present on either side of the stream gradually gives way up the stream, and the boundary between Meadow and the Clyde silty clay loam is largely arbitrary. In the central part of the county and in the areas near the Wabash River the streams have cut deep and tortuous courses and formed narrow flood plains. Sometimes at the base of the declivities there is a large accumulation of material that resembles the uplands in color and texture. This material is composed of sediments washed from higher areas. Some of the valleys are walled in by perpendicular bluffs of sandstone and shale, and these have influenced the soils somewhat either by disintegration or by contributing fragments which occur on the surface.

The greater part of the land classed as Meadow is not suitable for cultivation, on account of poor drainage and frequent overflows. Some areas are under cultivation, but these are largely sandy spots. Corn is the chief crop on such areas and good yields are obtained. The tracts of Meadow bordered by the Steep broken land are usually of low agricultural value.

A few irregular areas in the Wabash bottoms that are covered with water for several weeks in the spring or are permanently wet are mapped as Meadow. These areas have a heavy silt loam soil with a grayish silt loam or silty clay loam subsoil. They are covered with a dense growth of silver maple and elm.

The actual width of the strips of Meadow is in most places necessarily exaggerated on the map. The position of the stream in many cases is only closely approximate.

MUCK.

Muck is composed very largely of organic matter. It has been formed by the accumulation and decay of the remains of various plants, principally sphagnum moss, under wet conditions. The first stage in the formation is usually Peat, in which the vegetable remains are still noticeable. Advancing decomposition gives a very black, powdery organic material, with a characteristic greasy feel when moist, the mass of organic material, being mixed with varying quantities of mineral matter washed in from the surrounding higher lands. It varies in depth from only a few inches along the margin of the areas to more than 3 feet near the center. There is but little change in color with depth, but in the lower sections the vegetable fibers are more noticeable. The Muck is underlain by bluish-black, stiff, plastic clay, which grades into a lighter colored or grayish mottled clay. The subsoil is streaked with iron stains. Some areas are underlain by coarse sand and, less frequently, by impure marl. The water table is encountered at less than 3 feet.

The smaller areas of Muck indicated on the map are usually but a few inches deep, and generally carry enough mineral matter to give rise to a loam type. In other spots where the muck is in an advanced stage of decomposition the surface material is loose and chaffy. A small area of Peat in sec. 2, Tps. 22 and 23, R. 7, is included with the Muck.

The Muck occurs in shallow basins or depressions which formerly were lakes and ponds, gradually being filled with the remains of aquatic vegetation. The largest area is located in the northeastern part of the county and covers about one section of land. A small part of this area is cultivated. Drainage is poor. A few small patches occur in the prairie and most of these are under cultivation.

Large yields of corn, oats, timothy, and alsike are obtained in dry years. The greatest problem in handling Muck is establishing good drainage. Another troublesome factor is the early and late frosts. The use of a heavy roller to make the seed bed firm is very effective in preventing injury by late frosts.

Muck soils show marked improvement from the use of potassium fertilizers. Coarse barnyard manure and lime are also beneficial.

STEEP BROKEN LAND.

Steep broken land includes very hilly and badly eroded areas in the uplands which can not be used satisfactorily for ordinary cropping. The separation of these areas from the Miami silt loam is based almost entirely on the topography. The surface varies from rolling to broken. On approaching the Wabash River the region is deeply dissected by the larger streams and their tributaries. The slopes are often steep or precipitous, and the streams are sometimes walled in by perpendicular bluffs of sandstone. These bluffs, as well as the Wabash Valley escarpment, are frequently 80 to 150 feet high. The most extensive areas of Steep broken land occur along Possum Run and Redwood, Big Pine, and Little Pine creeks and their tributaries. They are shown on the map as narrow bands paralleling the valleys or as fingerlike projections in the Miami soils.

The surface soil to a depth of about 12 inches ranges from a brown sandy loam to a yellowish-gray silt loam. The subsoil is a yellowish-brown to reddish-brown, compact silt loam to clay. The soil and subsoil contain varying quantities of gravel, depending upon the extent of erosion. Running water has been very active in modifying the soil materials since their deposition, particularly since the land has been cleared and put under cultivation. The original silty mantle has been removed from the steeper areas, exposing the underlying yellow silty clay or bowlder till.

Included with this type are narrow patches of arable land. The steep slopes break abruptly from the level plain. In a few instances the slopes can not be represented on a map of the scale used in the survey. In most cases the width of the strips of Steep broken land is exaggerated in preference to their being omitted, mainly for the purpose of emphasizing their influence on land value.

In the northeastern part of the county along the river the Knobstone shales have influenced the topography and to a less extent the soils. The surface has eroded into the characteristic knoblike topography. The bowlder till is often grayish or bluish, like the shale. In the same region the shale has greatly affected the surface configuration. Besides the exposures in the valleys, it is found capping the hills and narrow divides in a few places. A bold outcrop occurs at Black Rock that rises about 140 feet above the river.

Under ordinary methods of cultivation this type is subject to serious loss from surface washing, and even where untilled there is more or less erosion. Some of the areas should never have been cleared of their forest cover. Only a small percentage now has a protective covering of trees. The methods of handling this land should include contour cultivation and deep plowing, better rotation to lessen the number of tilled crops and make larger use of fine-rooted grasses, tile drainage of the slopes and the laying of tile drains in gullies, laying out the hillsides in narrow plow lands at right angles to the slope and cleaning out the dead furrows and leading them into sodded swales, and terracing and making sidehill ditches where necessary and practicable. The soil is in need of organic matter.

The soil is suitable for fruit growing. The general experience with fruit in the county, together with the presence of old, healthy, and productive trees on this and similar types, indicates that an extension of fruit production on this soil would prove profitable. This land ranges in value from $20 to $125 an acre.

SUMMARY.

Warren County is situated on the western boundary of Indiana just north of its center. It has an area of 368 square miles, or 235,520 acres.

The topography varies from level to undulating, being broken along the Wabash River, and in a belt extending along Big Pine Creek. The timbered or gray lands reach back from the river an average distance of 5 miles. The average elevation above sea level is about 700 feet.

The drainage flows southeastward into the Wabash. All the formerly water-logged areas of the prairie have been reclaimed by artificial drainage.

The first important settlement in the county was made about 1824. The county was organized in 1827. It has a population of about 11,000. Williamsport is the chief town and county seat, and has a population of about 1,200.

The transportation facilities are good. Six railroads cross or enter the county, and it has a total of 366 miles of improved public roads.

The interests of Warren County are entirely agricultural. The improvements are of the best and a general condition of prosperity prevails throughout the county.

The climate is similar to that of the general region, and is characterized by wide variations. The annual temperature averages about 51° F. and the annual precipitation about 36 inches. There is a normal growing season of about 160 days.

The agriculture consists mainly of grain farming. Corn and oats are grown almost exclusively on the prairie soils, with a greater proportion of wheat and clover on the gray or "clay" soils. Corn averages about 40 bushels per acre, oats 30 bushels, and wheat 15 bushels. Hog raising is the principal live-stock industry. No attention is given to dairying, and few cattle are fed.

Land is held in large tracts. The average size of the farms is reported as 161.4 acres.

The soils of Warren County are derived largely from the unconsolidated deposits of the early Wisconsin glaciation. The main soil-forming material is this till or drift, which in the uplands has weathered to a smooth, silty texture to a depth of 2 or 3 feet, becoming coarser and stonier at greater depth. The alluvial soils are quite extensive. Fourteen types, including Meadow, Muck, and Steep broken land, are mapped.

The Carrington silt loam is the most extensive and important soil. It includes undulating prairie areas that are naturally well drained. This soil is dark brown in color. It is used for the production of corn, oats, grass, and wheat.

The Clyde silty clay loam represents the low-lying, heavier soil of the flat prairie. The type was formed under swampy conditions. With artificial drainage it is a good corn and oat soil.

The Miami silt loam occupies the timbered or gray lands. The surface ranges from undulating to rolling. This type is best suited to wheat and grass. A small area of this soil has a level or flat topography and is separated as a flat phase.

The Fox coarse sandy loam is a black terrace soil which was developed under prairie conditions. Corn, oats, and wheat are grown with varying degrees of success. The Fox sandy loam is of small extent. It is inclined to be droughty and is relatively unimportant. A few gravel areas are shown on the map by the gravel symbol. The Fox silt loam includes most of the soil on the high

terraces along the Wabash River. It consists of about 18 inches of a brown, silty loam, overlying massive beds of gravel. Only early maturing crops should be grown on this type and more live stock should be kept. The gravelly areas of this type have a shallower soil. The type includes a few small areas of stony land, indicated on the soil map by the stone symbol.

The Genesee silt loam embraces most of the alluvium or first-bottom land. Corn is the only crop grown and yields are good. The fine sandy loam member of this series is an associated type of small extent.

The Wabash sandy loam and loam occur as first bottoms along Big Pine and Kickapoo Creeks, respectively. The soils are dark brown or black in color, and are very productive where well drained. Corn does well on the loam type, while the sandy loam produces a superior quality of muskmelon and watermelon.

The Allis stony loam is a residual sandstone soil of the terraces. It has a low agricultural value.

Meadow is developed as narrow strips of alluvial land along the minor drainage ways, and in a few areas through the wider bottoms. The soil is a brown loam of variable texture, and is generally poorly drained.

Muck consists mainly of organic matter. Owing to poor drainage conditions, only a few patches are cultivated.

Bordering the streams there is a belt of badly eroded or hilly land, mapped as Steep broken land. This land has a low agricultural value and can not be used satisfactorily for ordinary farming.

[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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