Soil Survey of Cass County, Indiana.

Colonzo C. Beals, Indiana University.

Description of the Area.—Cass County lies in the north central part of Indiana. It is bounded on the north by Pulaski and Fulton, on the east by Miami, on the south by Howard and Carroll, and on the west by Carroll and White counties. The greatest length north and south is twenty-four miles, while the maximum width is twenty-two miles. On the west boundary line it follows an irregular course. Commencing with the northwest corner of the county, it runs twelve miles south, three miles east, three miles south and eleven miles east to the southeast corner of the county. Cass County has a total area of 420 square miles and is divided into fourteen civil townships: Boone, Harrison, Bethlehem, Adams, Miami, Clay, Eel, Noble and Jefferson on the north side of the Wabash River, and Clinton, Washington, Tipton, Jackson and Deer Creek on the south side.

The county is roughly divided into a north and south portion by the Wabash River, which flows in a general east and west direction through the county. In the immediate vicinity of the Wabash and Eel rivers the country is undulating and broken. After leaving the rivers, to the south the surface is level. All the southern portion, in its natural state, was heavily timbered with hardwood, bottom and table land; the central portion is mostly bottom with high bluffs; the northern part is largely prairie.

The drainage of the county depends upon the large valley of the Wabash and Eel rivers, which extends in an east and west direction through the center of the county; the highland in Tipton and Washington townships south of the Wabash River; the highland in Jackson and Deer Creek townships, and the highland of Harrison and Boone townships. Deer Creek flows west near the central part of Jackson and Deer Creek townships, emptying in the Wabash River near Delphi. Rock Creek rises in the southwest part of Tipton Township, and flowing west through the southern part of Washington Township, empties into the Wabash River north of Rockfield in Carroll County. Pipe Creek rises in the southeast portion of Miami County near Xenia, and flowing

* The soil survey was done under the direction of Edward Barrett, State Geologist, in a similar way to the surveys of the past eight years. Mr. James Mathes assisted in making the survey which was done in the field season of 1917. Thanks are extended to those persons who assisted in making the survey a success.

in a south of northwest direction, enters Cass County about two miles below where the Wabash River enters, keeping the general direction until it is south of Lewisburg, when it turns sharply to the north, emptying into the Wabash River just below that town. Pipe Creek derives its name from the fact that for the greater part of its course in Cass County, the channel is carved in the limestone which comes to the surface at that place. Twelve Mile Creek drains the southern portion of Adams Township and a part of Bethlehem Township, emptying into Eel River. Indian Creek flows northwest, and Little Indian Creek drains west, both emptying into the Tippecanoe River. Crooked Creek rises in the southwest portion of Bethlehem Township and, after making many turns in flowing to the west, bends to the south and enters the Wabash River near Georgetown.

Lake Cicott is nine miles west of Logansport, a little to the southwest of the center of Jefferson Township. It is one mile long east and west and has an average width of one-fourth of a mile north and south, and its greatest depth is sixty-four feet. Bluffs twenty-five feet high surround it on all sides except the east, where during high water it drains by means of an old outlet through a former lake bed into Crooked Creek.

Abandoned Valleys.—A few well-marked abandoned valleys occur near the present Wabash Valley. The first one is around Waverly—in fact the town is in the valley. The channel enters the county in Sections 22 and 27, just east of Waverly, where it forms a valley almost a mile wide, narrowing to one-half of a mile near the Miami–Cass County line. Nearly a mile west of Waverly the valley turns to the south, entering the present Wabash Valley a short distance west of Lewisburg. The boundaries of the channel are rather uniform, except for a few gullies that enter on either side. Dr. M. N. Elrod and Mr. A. C. Benedict, in discussing the geology of Cass County in the nineteenth annual report of the Indiana Department of Geology and Natural Resources for 1894, say:

"This stream occupies a preglacial channel that starts west from the mouth of the Mississinewa, above Peru, and runs in a western direction until it reaches a point about one mile west of Waverly, where it turns south and intersects the Wabash one-half mile west of Lewisburg. At the time of our visit a diminutive streamlet was trickling over the rocks where once a volume of water poured."

We have shown that stream as an intermittent stream on the accompanying map.

Another interesting valley occurs west of Logansport in Clinton Township, where it roughly parallels the present channel of the Wabash River. This channel leaves the county one-fourth mile north of Clinton

Township, where it is about one-fourth of a mile wide. In places it has a width of about one-half of a mile. Near the east end as it approaches the river a large area of muck occurs. This channel seems to enter the Wabash Valley in the western edge of Section 36. Another deep valley enters the Wabash Channel in the eastern half of Section 31, heading toward the southeast. It starts just north of the present State insane institution at Long Cliff. Near the western end this valley has almost perpendicular walls and a width of over one-fourth mile. The southern escarpment of the two channels in Clinton Township, taken as a whole, show a very irregular outline with numerous gullies and V-shaped valleys, indicating very extensive erosion, while on the opposite side no indication of stream erosion exists. At present it is occupied by a few small streams, but no large ones.

Early History.—Until 1824 Cass County was included in Tippecanoe County. The organization of the county was completed April 13, 1829, under acts of the State legislature, passed December 18, 1828, and January 19, 1829. At that time it contained all that portion of the State now included in the counties of Miami, Wabash, Fulton, Marshall, Kosciusko and St. Joseph and parts of Laporte, Starke and Pulaski. The county seat was located at Logansport, August 10, 1829.

The first owners of the soil of Cass County were the Pottawottomie and Miami Indians. The former owned the land north of the Wabash, and the latter that upon the south. The first cessions of lands was made by the Miamis in the treaty of 1818, in which they gave up the land west of the mouth of Eel River. The Pottawottomies surrendered the land north of the Wabash in 1876 at the Mississinewa treaty and at subsequent times and by various other treaties.

Logansport was named in honor of Captain Logan, a Shawnee chief, who lost his life in November, 1812, because of his fidelity to the whites, and not for Logan the Mingo, as many suppose. The original plot of the town contained 111 lots, with streets 66 feet wide, except Broadway, which is 82½ feet wide.

Roads.—December 31, 1918, Cass County had 452½ miles of free gravel roads and 340 miles of unimproved roads. Rural free delivery extends to all parts of the county, which stimulates the extension of good roads.

Population.—The following table is based on the returns of the Federal Census, including estimated population for 1920:

	1910.	1900.	1890.	Estimated.
Cass County	36,368	34,535	31,152	38,200
Adams Township	984	974	962	.....
Bethlehem Township	999	1,047	1,113	.....
Boone Township, including Royal Center	1,802	1,807	1,680	.....
Royal Center, town	909	657	527	1,010
Clay Township	745	765	838	.....
Clinton Township	970	1,568	1,415	.....
Deer Creek Township	1,376	1,557	1,672	.....
Eel Township, including Logansport	20,239	17,237	14,052	.....
Logansport city	19,050	16,204	13,328	21,900
Harrison Township	1,231	1,258	1,189	.....
Jackson Township, including Galveston	1,748	1,725	1,655	.....
Galveston, town, incorporated in 1904	658	.....	.....	675
Jefferson Township	1,029	1,096	1,127	.....
Miami Township	854	926	938	.....
Noble Township	1,221	1,141	916	.....
Tipton Township, including Walton	1,975	2,038	2,015	.....
Walton, town	579	498	469	625
Washington Township	1,195	1,406	1,580	.....
Logansport, estimated in 1917....20,754	.....	.....	.....	.....
Hoover, estimated in 1910	100	.....	.....	.....
Lucerne, estimated in 1910	500	.....	.....	.....
Young America, estimated in 1910	600	.....	.....	.....
Lincoln, estimated in 1910	250	.....	.....	.....
Waverly, estimated in 1910	90	.....	.....	.....
Onward, estimated in 1910	250	.....	.....	.....
Lake Cicott, estimated in 1910	50	.....	.....	.....
Adamsboro, estimated in 1910	150	.....	.....	.....
Kennith, estimated in 1910	250	.....	.....	.....
Clymers, estimated in 1910	125	.....	.....	.....

The above table shows that the movement of population has been to build up the cities and larger towns at the expense of the rural districts. This is due to the fact that the younger generation, who replenish the working class, flock to the factories in town. The present (or just past) war conditions will cause the "from the farm to the city" exodus to continue.

Agriculture.—Cass County had 2,656 farms in 1900, while by 1910 the number had decreased to 2,443. In 1916 the number of farms containing over five acres amounted to 2,261, containing 256,229 acres.

The number of farms, classified according to size, were as follows in 1910:

Under 3 acres	4
3 to 9 acres	87
10 to 19 acres	113
20 to 49 acres	300
50 to 99 acres	765
100 to 174 acres	786
175 to 259 acres	212
260 to 499 acres	79
500 to 999 acres	6
1,000 acres and over	1

In 1910, the average farm contained 102.3 acres; 93.8 per cent of the total land area was in farms, and 82.7 per cent of this was improved; 35,392 acres were classed as wood land. In 1916 the waste land amounted to 4,067 acres.

Sixty-four and three-tenths per cent of all farms were operated by owners in 1910, which was a decrease of 1.4 per cent in ten years; twenty-three farms were operated by managers, a decrease of four in ten years. Eight hundred eighty-four of the farms operated by the owners were free from mortgage debt, while 669 had mortgages.

A crop that is on the increase is that of the soy bean—797 acres were devoted to it alone and 271 acres in combination with other crops. It can be used in the silo, thrashed for seed, or hogged down in the fall. Cow peas showed an acreage of seventy acres where grown alone and thirty-three acres where they were mixed with another crop or crops.

The crops cut for ensilage during 1917 amounted to 4,591 acres, which, we will suppose, were put in the 456 silos found in the county that fall. The greater percent of those crops consisted of corn, with some using part soy beans or cow peas.

The county had 934 acres devoted to white potatoes in 1917.

Most of the small fruit and truck crops occur in small farm gardens, but one acre was devoted to onions, two acres to tomatoes, five acres to cabbages, nine acres to watermelons, and fifteen acres to muskmelons (cantaloupes). Strawberries, blackberries and raspberries occupied sixty-four acres, while we find 43,849 bearing apple trees, 18,203 peach trees, and 11,455 pear trees.

Cass County is a grain-producing county, with a great deal of stock to consume the grain on the farm. Fifty-eight thousand six hundred three acres of corn were harvested in 1917, which did not give a normal yield that year because of the early frost.

During 1917 Cass County harvested 28,293 acres of wheat, but planted a larger acreage that year, amounting to 37,826 acres. The farmers

planted 31,754 acres in oats, or a little more than the amount devoted to wheat.

A great deal of the rye planted was devoted to pasturage or plowed under in the spring as a green manure. Some may be used as a winter cover crop where land tends to erode. The crop for 1917 amounted to 5,493 acres, while almost double that area was sown in the fall, or 9,032 acres.

Some barley is grown in this region, eighty-four acres in 1917, and considerable land is devoted to buckwheat, for the seed principally, and secondarily to be used as a source for honey; and, last but not least, buckwheat is used as a restorer of fertility and friability of the soil; fifty-four acres were devoted to this crop alone.

The hay produced in Cass County is an important factor in the agricultural economy, the largest item of which was 10,298 acres of land growing timothy hay during 1917. Some of it is sold and leaves the county; the greater part of it is fed nearby and returned to the farms in the form of manure. Twenty acres of land were devoted to millet and Hungarian grasses.

A crop that has a great beneficial effect on the soil and should have a greater acreage is clover, of which 8,787 acres were used for hay, while 3,317 acres were cut and thrashed for seed. The combined acreage could easily be one-fourth of the combined acreage of the oats and wheat grown, and the farming interests would profit by the change.

In 1917 there were ten pure-bred horses and colts, fifteen milk cows, and 200 hogs in Cass County (reported to the township assessor). At that time there were 10,604 horses, 1,686 mules, 8,066 milk cows, 56,630 hogs and 5,923 sheep. There were 4,417 sheep sheared, yielding an average fleece of 7.2 pounds.

In 1917 Cass County had only 173 colonies of bees, which yielded 2,550 pounds of honey. It would be safe to say that more than that amount of honey was "wasted on the desert air" in the county because no bees were present to save it.

The farmers of Cass County bought 862 tons of fertilizers in 1917 and used a great deal of it on their wheat land.

The farmers had forty-two tractors on their farms the same year to aid in increasing the amount of their farm crops. They also had 1,491 cream separators in use on their farms.

Climatology.—In a general way Cass County has the same kind of climate that north central Indiana experiences. The following data is based on a record of twenty-eight years in the city of Logansport about two squares north of Eel River at an elevation of 620 feet. (The country is slightly rolling.) The average date of the last killing frost in the spring is April 27th, and the last killing frost in the fall is October

13th. The latest killing frost in the spring occurred May 16th, and the earliest killing frost in the fall was September 21st. The average growing season is 169 days, ranging from 144 days in 1895 and 1904 to 210 in 1902.

The prevailing direction of the wind is from the west throughout the year.

The only available data on average hourly wind movement (miles), mean relative humidity (percentage), and sunshine (percentage) is from Fort Wayne from a five-year record. (See table below.)

The precipitation of Cass County is adequate for all crop requirements of that region, and it is uniformly distributed over the growing season. The greatest amount of the year falls during the summer months. Dry and wet spells are not unknown, but they do not normally destroy the crops. The dry spells usually occur during the middle or late summer, while the wet season normally comes in the winter or spring, as the spring high water.

Months.	Snowfall.	Precipitation.	Average No. of Days with 0.01 or more of Prec.	Mean Temperature.	Mean Maximum Temperature.	Mean Minimum Temperature.	Highest Temperature.	Lowest Temperature.	Wind Movement.	Relative Humidity, 8 a. m.	Relative Humidity, 8 p. m.	Sunshine.
January	6.1	2.32	9.6	25.4	31.6	18.2	69	25	9.6	82	82	30
February	6.7	2.64	7.7	26.4	35.1	17.1	69	24	11.3	81	77	44
March	4.7	2.91	9.0	37.6	47.8	28.6	87	3	10.8	80	74	52
April	0.1	3.31	10.6	51.1	61.4	40.3	91	15	11.1	78	70	56
May	trace	4.31	11.5	62.3	74.1	50.2	101	28	9.3	78	68	59
June	0	3.73	9.3	71.5	83.7	58.7	103	37	8.1	76	62	70
July	0	3.25	8.3	75.5	87.7	62.4	106	43	7.2	78	64	67
August	0	3.11	6.9	72.5	85.4	60.2	103	41	7.5	85	68	61
September	0	3.22	7.2	66.3	78.9	53.6	102	30	7.7	85	73	62
October	trace	2.56	7.2	53.9	65.7	41.5	91	18	8.4	87	72	51
November	1.0	3.15	8.4	40.5	49.6	30.9	80	3	11.8	81	73	42
December	4.2	2.54	8.2	29.6	37.4	22.7	70	15	10.5	83	80	30
Season	23.1	37.5	10.4	51.0	61.8	40.4	106	25	9.6	82	72	52

Soils.

Definition.—Soils consist of the broken and decomposed portions of rocks mixed with more or less organic matter in various stages of decomposition. To the agriculturist it is that portion of the earth's surface into which the roots of plants may penetrate and obtain nourishment.

Physical Properties.—In former years it was thought that the chemical analysis of a soil was of the most importance; but since the subject has been better understood, the physical side has gained in emphasis. A factor of prime importance to the agriculturist is the absorbing capacity of a soil and its ability to retain and furnish moisture to the growing plant as needed. In fact the ability of a soil to furnish an adequate amount of water to the growing crop is of far more importance than its chemical ingredients. Pure sand holds water poorly, so that sand is ordinarily a dry soil. At the other extreme, clay holds moisture very tenaciously, so that a pure clay soil is soggy and apt to be very wet. A mixture of the two, forming a loam, is not subject to either objections and is an ideal soil.

Liberation of Plant Food.—Ground limestone and decaying organic matter are the principal materials which the farmer can utilize most profitably to bring about the liberation of plant food. The ground limestone corrects the acidity of the soil and thus encourages not only the nitrogen-gathering bacteria which live in the nodules found on the growing roots of the growing plants of clovers, cow peas, alfalfa and other leguminous plants, but also the nitrifying bacteria in the soil, which have the power to make into plant food the insoluble and unavailable organic products. At the same time the products of this decomposition also make available the insoluble minerals found in the soil, such as the potassium and magnesium, as well as the insoluble limestones and phosphates, which can be applied by the agriculturist in a very low-priced form.

One of the chief sources of loss of organic matter in the corn belt is the burning of the corn stalks. If the farmers would only realize the loss they incur they certainly would discontinue the practice. Probably no form of organic matter acts to form good tilth better than the plowing under of corn stalks. It is true they decay slowly, but that only prolongs the desired conditions of the soil. The nitrogen in a ton of stalks is one and a half times that of a ton of manure, while a ton of dry stalks when ultimately incorporated with the soil is equal to four times that amount of average farm manure, but when they are burned the humus-making element and nitrogen are both gone and lost to the soil.

Upland Soils.—The upland soils of Cass County are mapped in three series, namely: Clyde, Miami and Dunkirk types, and, in addition, the miscellaneous type known as Muck. These types are all due to a difference in soil content and color and to surface conditions resulting from erosion. The Miami and Clyde series occur side by side, perhaps coming from a similar glacial till, but those areas having a better natural drainage and smaller amount of organic remains for humus become the

light-colored clay land or the Miami series, while the depressed areas with poor drainage, or no drainage, in swamp or marsh conditions, become the black or brown areas known as the Clyde series; or, where there was a great abundance of partly decomposed organic matter, they become Muck. The Dunkirk comprises the sand ridges and the loamy sand of a light yellowish brown color.

Alluvial Soils.—The alluvial soils of Cass County are the sediments deposited in the stream valleys by flood waters. A loam in the humid region always has a very luxuriant growth of vegetation where it has an adequate supply of water.

One of the effects of the presence of humus is to produce granules, forming a mellow, easily worked soil. Where a soil is cultivated without adding to the supply of humus, the soil becomes more compact and runs together, producing decreasing crops and reducing the moisture-retaining capacity. Cultivation loosens the soil, promoting aeration, and increases the amount of available plant food.

Chemical Properties.—A chemical analysis of a soil will show the amounts of the different plant foods, such as nitrogen, phosphorus, potassium, calcium, etc.; but the difficulty is that it does not even give a hint as to the form in which the elements occur in the soil. The analysis shows correctly the total organic carbon, but as a rule this represents about one-half the organic matter, so that 20,000 pounds of organic carbon in the upper six inches of an acre represent but twenty tons of organic matter. But this twenty tons is largely in the form of old organic residues that have accumulated during the centuries because they were so resistant to decay; so two tons of clover plowed under as a green manure would have greater power to liberate plant food for a growing crop than all the twenty tons of old residue of organic remains.

The sediments came from the uplands adjacent to the valleys of the different streams, and a certain kind of upland gave rise to a different type of alluvial soil. The overflow land is placed in the Genesee series. The Fox series consists of terrace soils, deposited perhaps by the glacial waters, which were a great deal more abundant than the waters of the present time. The meadow land has not been mapped, but much of the land along the smaller streams, classed as Genesee, belongs to this type.

Miami Silt Loam.

Characteristics.—The Miami silt loam consists of a dark gray or a light brown friable silt loam having an average depth of ten inches. It is usually deeper in depressed or level areas and somewhat shallower on the crest of ridges and on steep slopes. When moist the surface becomes almost uniformly grayish or yellowish brown, but when dry it becomes a light ashy gray.

The immediate subsoil consists of a yellow or yellowish brown silty clay loam having a depth of from twenty to thirty inches. This is immediately underlain by a yellowish clay or yellowish gritty or sandy loam with usually more or less amount of coarse sand, gravel and boulders. As a rule the material consists chiefly of fragments of limestone, a mixture of crystallines of various kinds.

The silt loam has a more brownish color near the streams, where the ground is more or less broken, and on the well-drained ridges. This is due to greater oxidation because of better drainage. The white clay knolls will take on a darker color when better drained and aerated.

The different soil areas mapped as the Miami silt loam will vary from the above description in one or more particulars, but will agree in the main. The Miami silt loam has a level to undulating or rolling surface and occurs throughout the country, with the Clyde series occuring in the depressions.

Origin.—The Miami silt loam, in common with other members of the Miami series, is due to the glaciation of the region in which it occurs. The retreating ice left the till with a very uneven surface, composed of numerous ridges and valleys or depressions. During the process of erosion and weathering since that time, the ridges have tended to become lower, thus filling the depressions with the organic remains and the finer sediments from the higher lands. The better natural drainage and lack of a large amount of humus would produce a light-colored soil with a high clay and silt content. This condition is well shown along the larger watercourses, where the surplus water rapidly drains away, producing a wide strip of the Miami series on either side without any or with very few areas of the Clyde series even in the largest depressions.

Drainage.—The fine texture and uniform structure causes ground water to move slowly and makes natural drainage inadequate in the Miami silt loam. This condition can be remedied by the use of tile drainage, but care should be taken by not using too small tile as lateral lines. The drains not only remove the surplus water in wet weather, thus lowering the ground water table, but also help to aerate the soil in dry weather. In most cultivated soils the pore space is from 25% to 50% of the volume, and this is the maximum water capacity or saturation capacity. The amount of this space occupied by water for the maximum development of most plants is from 40% to 50% of the pore space, which leaves one-half or more to be occupied by air. The presence of a large amount of oxygen in the soil is essential to the best growth of the plant crops as well as the liberation of the necessary plant food.

Tilth.—It is well to have in mind that, aside from fertility, drainage and tillage, one of the main factors of a good soil is good physical condition, or tilth. The Miami silt loam is in good tilth, but since it has a small percent of sand is very fine grained and easily injured by the tramping of live stock in the spring and fall on the stalk or stubble ground and by plowing or working the ground when too wet. Clods will result from these practices, and it usually requires considerable time and work to put the soil in good tilth again. An occasional application of ground limestone, followed with a crop of clover or some soiling crop, will produce good tilth. In fact good physical conditions depend to a large extent upon the amount of humus present in the soil.

Crops.—Corn, wheat, oats, clover and timothy do well on the Miami silt loam. It is not as good corn land as the Clyde, but it produces good crops where the soil is well cared for. To do the best a field should not be in corn two years in succession. Wheat and oats do well; in fact the Miami silt loam is better for wheat and oats than any member of the Clyde series, as it is apt to grow too rank and fall down when grown on the latter soils. Clover and timothy do well, but it is better not to grow the timothy alone, as it has a strong tendency to deplete the fertility of the soil. Some potatoes are grown on the Miami silt loam, but it does not give a high yield. Some orchards are grown on this type and seem to give good results.

Improvement.—As has been stated before, the Miami silt loam should be kept in good tilth by proper drainage, cultivation and the growing of crops for soiling purposes. All the manure produced on a farm should be carefully taken care of and spread over the land where it is most needed. It is well to follow a rotation where the corn is planted on clover sod. The number of crops and kinds used in rotation will depend on the size of the farm and the type of farming practiced, but should include one (two would be better) year of clover. Where the ground seems to be "clover sick" only an application of ground limestone is needed to insure a change. Commercial fertilizers may be resorted to under some conditions, but we believe that they should not be constantly used with all crops.

Miami Loam.

Properties.—The Miami loam is a transition between the silt loam and the sandy loam, and the boundary between them is usually arbitrary. It has a higher percent of sand and has perhaps a little darker color than the silt loam.

The subsoil of the Miami loam has a higher percent of sand and fine gravel than the silt loam and is variable in color and texture. On

the one hand it grades into the silt to loam type, while on the other it may be sandy, grading into the sandy loam.

The difference in the character of the till as left by the glacier and the removal of the silt by the weathering and eroding agents are probably responsible for the present structure of the Miami loam. The topography is similar to that of the Miami silt loam.

Drainage.—The drainage of the Miami loam is usually good on account of the open, porous structure of the soil and the large amount of sand and gravel in the subsoil. In some cases, however, the subsoil is hard and compact, producing a poor natural drainage. In such cases artificial drainage would be beneficial and greatly increase the producing capacity of the soil.

Crops Grown.—The crops grown on this type are similar to those of the Miami silt loam and they yield as good crops. Owing to the presence of sand it can be more readily kept in a state of good tilth, but it quickly responds to good farming methods. The same farming methods will apply equally well in the Miami loam as in the silt loam types.

Location.—The Miami loam is about as extensive as the silt loam and is largely south of the Wabash and Eel rivers. It is valued about the same as the silt loam types.

Miami Sandy Loam.

Characteristics.—The upper six inches consist of a grayish to dark brown fine sandy loam or fine loamy sand. The subsoil is a yellowish brown heavy loam grading at about eighteen inches into a sticky fine sandy loam or clay loam. In some places it changes to a yellowish sand mixed with some clay.

Location.—It occurs in Cass County north of the Wabash River, becoming less sandy towards the river. A great deal of gravel occurs around Adamsboro and Georgetown. The sandy phase is associated with the sand ridges where the sand has been blown over the nearby land. The ridges are usually more sandy or gravelly, while the valleys contain a greater percent of clay. The topography ranges from level to undulating or rolling. Part has a morainic surface with more or less boulders.

Drainage.—The drainage of the Miami sandy loam is more abundant and is apt to be somewhat droughty in more sandy areas. The depressions usually develop swamps which have little or no drainage. A number of open ditches have been made, heading in the Muck and Clyde areas. Numerous wet quicksand areas occur on the hillside, where the water-bearing sands and gravel are exposed. These places are difficult to drain because of the continuous water supply.

Crops Grown.—This type produces good yields of corn, oats, wheat, clover and potatoes. Apples, pears, peaches, grapes and small fruits should do well on this type of soil. A few orchards have been planted and seem to do well.

Where sand ridges occur in the sandy loam, care should be taken to keep the sand from blowing in the spring of the year. The sand not only uncovers the young crops on the ridges but it covers up the plants in drifting. Blowing sand does great damage by lacerating the leaves. The more sandy ridges should have cover crops during the spring of the year, such as rye.

The fine sandy loam is easily cultivated and requires less labor to secure a good seedbed than the other upland soils. The yields are slightly below those of the heavier types.

Care should be taken not to cultivate sandy land when too wet. The water soon sinks down and the surface soon dries off, but below the first inch the soil is too wet. If stirred too wet, the soil loses too much water by evaporation.

The application of barnyard and green manures is very important. Clover and other leguminous crops should be grown for green manure. It is well to remember that sandy land loses fertility easier than clay soil from leaching.

Clyde Silty Clay Loam.

Characteristics.—The surface of the Clyde silty clay loam is a silty loam to a depth of from ten to sixteen inches. It then grades into a sandier brown clay loam having an average depth of sixteen inches. The subsoil consists of a drab or a dark blue, mottled with a yellowish to a rusty brown plastic clay loam. When wet its surface is dark brown or black, but when dry its surface becomes a grayish brown to brown. When dry the soil crumbles, forming cubical blocks. The surface forms deep cracks.

The Clyde silty clay loam grades on one side into the Peat and Muck series, while on the other side it merges into the surrounding Miami soils.

The topography is naturally level, with perhaps an occasional slight elevation on the surface.

Origin.—The Clyde silty clay loam, in common with the Clyde series, is due to depressions in the surface after the retreat of the glacier. The depressions had a very poor natural drainage and became marshes and swamps in the case of the glaciated regions. The areas are connected in most cases by long, narrow, usually parallel lines, where the water slowly drained from the higher swamps to the lower ones and finally reached the smaller tributaries of the streams. The swamps

slowly filled with organic remains from the surrounding higher land in addition to the rank vegetation that flourished in the swamps themselves. The organic matter settled to the bottom, where it decayed and became mixed with the fine clay sediments that were washed into the depressions. The poor drainage produced the heavy phase, while the better and more free drainage gave rise to the silt loam with a bright yellow to reddish subsoil at a depth of two feet.

Drainage.—The Clyde series of soil types requires artificial drainage to lower the water level below the surface of the soil. In fact, when the country was first settled, the black land was all under water, but after thorough drainage it was considered the best soil type.

The Clyde silt clay loam contains a very high percent of humus, which, united with the clay, forms a porous, friable soil which absorbs moisture readily and is easily cultivated.

Crops Grown.—The Clyde soil is the leading corn land of the country. It yields fifty to seventy-five and sometimes eighty to ninety bushels per acre. Timothy is a good crop to grow on the more chaffy phases, where other crops have a tendency to dry up. Oats yields well and wheat does good, but both crops tend to produce too rank a growth of straw and consequently to lodge. Wet, open winters are bad for wheat. The open, loose texture admits water freely, and freezing heaves the soil, pulling the wheat out of the ground. A relatively dry winter season, with a few inches of snow for protection, is followed by good results.

The Clyde silty clay loam, or silty loam as it is sometimes called, occurs typically south of the Wabash River. The Muck is always associated with or surrounded by this soil type.

Clyde Loam.

Properties.—The Clyde loam is a grayish brown to a brownish black soil with an average depth of about ten inches. The subsoil is a grayish brown in color, increasing in clay content as it descends, and at about eighteen inches to two feet grading into a mottled bright yellow material. It is sometimes streaked with a reddish color and with the steel gray. This type occurs in shallower depressions, and the color of the surface soil is sometimes almost midway between the surrounding Miami soil and the darker Clyde silty clay loam.

Crops Grown.—The Clyde loam is well adapted to the growing of corn, clover, wheat, oats and timothy. It is first and last a corn soil; in fact, in some parts of the county that crop seems to be the only one grown.

A crop rotation should be practiced, including a crop of clover or some leguminous crop, every four or five years to enrich the soil. The

farmers are planting the soy bean in the corn rows and also as separate crops. This will help to improve the soil.

Location.—The Clyde loam is developed throughout the county, but principally south of the Wabash.

Clyde Sandy Loam.

Properties.—The Clyde sandy loam consists of a variable black to a brownish black loam about sixteen inches deep. The subsoil is a light drab or sticky fine sandy or loam mottled with brown or drab and grading at about thirty inches into a gravelly yellowish clay.

Below this and along the border of the lake plain the subsoil and the substratum is often of heavier glacier till. In places the top soil is Muck but has the typical Clyde subsoil. In other cases the subsoil grades into a fine water-bearing sand.

Location.—This type occurs in the lake plain region and to the east north of the Wabash, where it occupies the low depressed areas between the more sandy ridges. It is intermingled with higher, island-like areas, usually of Miami sandy loam.

The surface is level or very slightly undulating. The Clyde sandy loam is due to an accumulation of an abundant growth of marsh grass mixed in with the sand and clay and washed in from the higher bordering ridges.

Formerly it was covered with water and marsh grass, but at present a system of dredge ditches and lateral drain tile form fairly adequate drainage. Care must be taken in the spring of the year, as numerous marshy or boggy places occur, due to the excess of water and probably the presence of quicksand near the surface. This is a great hindrance to farming operations. Perhaps one of the greatest factors is a lack of sufficient drainage, but this will be remedied in time.

The Clyde sandy loam is the most extensive and most important soil type of the lake region, in fact of northwestern Cass County. Between 80% and 90% of this is in cultivation.

Crops Grown.—Corn and oats are the principal grain crops grown, yielding as much as eighty bushels per acre. Some wheat is also grown.

Before the Clyde sandy loam was drained most of it was used for marsh hay and pasture.

Perhaps potash is the best fertilizer to use, as experiments have shown an increase of from ten to twenty bushels per acre of corn from its use.

This type is used for trading purposes more than any other type.

Fox Loam.

Properties.—The Fox loam has a surface of a gray to a brownish color with a friable loamy texture to an average depth of ten inches. The surface becomes lighter in color as the amount of sand increases. The subsoil becomes sandy, while in some cases, as near Hoover, it changes to gravel. The surface is level to slightly undulating.

The natural drainage of this type of soil is usually good, although during dry seasons it has a tendency to drought.

Crops Grown.—The crops grown and yield per acre are similar to those of the Miami series.

Fox Sandy Loam.

Properties.—The surface soil of the Fox sandy loam is a gray to brownish sandy loam. The subsoil is lighter in color and in the upper part has the same composition as the top soil, but becoming heavier with depth. At a depth of twenty-four inches it is a fine sandy clay, becoming lighter in color, often changing to a layer of sand in the three-foot section. Coarse gravel also may occur. This type occurs as a river terrace along the stream valleys. The surface is level or pitted and sometimes rolling, due to erosion.

The Fox sandy loam with the clay subsoil around Hoover holds the moisture during the dry, growing season, as the clay prevents evaporation. It yields from forty to fifty bushels of corn, fifteen to thirty bushels of wheat and about fifty bushels of oats per acre.

Genesee Loam.

Properties.—This soil consists of a light brown loam to a sandy or silty loam. The subsoil is very similar in texture to the soil, but is usually lighter brown in color. Below eighteen to twenty inches the substratum is frequently made up of horizontal beds of sand and clay.

The Genesee loam is an alluvial soil and its variation in structure is due to the same causes as in the case of the sandy loam. It has a level to somewhat broken topography and occurs along the sources of streams.

Agricultural Conditions.—The Genesee loam is used for the growing of grain crops, particularly corn. It is productive, easily cultivated, and readily kept in good condition. A great deal of the land is used for pasture purposes.

The drainage is usually good, but it does not stand dry weather as well as soils with a very high clay content.

Genesee Fine Sandy Loam.

Characteristics.—The Genesee fine sandy loam consists of a variable light brown to dark brown medium heavy fine sandy loam ranging from ten to twenty inches deep.

The subsoil has about the same texture, but usually of a lighter color. There are in places local variations from the typical Genesee, due to the variations of the flow of the depositing water. Sand and silt areas are due to erosion and depositing by the overflow waters. It is subject to frequent or annual overflow.

The Genesee forms the flood plains of all the streams. Some of the areas mapped as Genesee are the same as those usually called meadow land. The two were not separated. The boundary between the Clyde series and the Genesee series is not distinct. Since the Genesee fine sandy loam is an alluvial soil, it varies in short distances, owing to the changes in the current of the streams at various flood stages. Near the streams and across the sharper bends, where the currents were sharp, the coarser particles were deposited, and in many cases the soil has a large proportion of coarse sand. Near the larger bends, or where the water found settling basins, where the water was less turbulent, the finer material was deposited, giving rise to the heavier and more silty type, usually of a darker color. Mixture of the fine clay or silty material with the right proportion of sand is the basis of the Genesee fine sandy loam.

Agricultural Conditions.—The bottoms are flooded annually, or oftener, and in places are cut by smaller streams and branches tributary to the main stream. The drainage is usually good and the land dries rapidly after a rain. It is a soil that is friable, easy to till, and, where protected from overflow, is admirably adapted to corn, oats, clover or timothy. A great deal of the rougher land is in pasture.

The fertility of the Genesee fine sandy loam is renewed each time it is flooded by high water, making the growing of leguminous crops of less importance. Thorough cultivation is necessary to keep down the large number of weeds springing up from the seed brought in by high water.

The flood of 1913 took off all the top layer of soil of a field along the Wabash River. It was planted in corn that year and yielded ten bushels to the acre. Oats made ten bushels per acre the next year, but a good stand of clover was obtained. Two years later the field yielded eighty bushels of corn per acre. This goes to show the vital importance of clover on river-bottom land.

Dunkirk Loamy Fine Sand.

Characteristics.—The surface of this type is a yellowish gray to brown fine sandy loam. At six to ten inches it gradually changes to a fine yellowish sand, with perhaps a small amount of clay. The subsoil is variable, ranging from almost pure sand to a very sandy loam.

The topography of the Dunkirk fine loamy sand ranges from almost level to a rolling surface comprised of a series of sand ridges, the valleys holding the Clyde fine sandy loam. The Dunkirk loamy fine sand usually borders the muck patches, forming sand ridges.

Drainage.—The drainage is good, except in the narrow, depressed valleys, which are poorly drained.

Crops Grown.—Corn and oats do well on this type where the organic content is well supplied. Wheat does well when it has a favorable winter. Cow peas seem to be the best crop to supply plant food, as it can be grown more easily than clover. Most of the crop, however, should be plowed under. The agricultural practices given for the Miami series apply here.

Dunkirk Fine Sand.

Characteristics.—The Dunkirk fine sand occurs as a fine yellowish sand in ridges on the border of the lake plane region. These ridges are resting on a clay bottom. In some instances the clay seems to form the core of the ridge, the sand forming a sort of veneer. The loose drift sand was formed in unequal ridges by the wind blowing it in one direction, forming a gentle slope on the windward side and a sharp, abrupt slope on the leeward side.

The sand blows on the surrounding land, smothering the vegetation and beating the tender leaves to strings in the early spring. Care must be taken to keep a cover crop on all ridges and sandy areas that have a tendency to be moved by the wind. Rye is a good crop for this purpose.

Crops Grown.—Corn and oats do moderately well on this type. Wheat does very well, while navy beans are grown to some extent. A sand ridge is always damp just under the surface during the dryest weather. The crop yield is usually limited by the amount of available plant food. This is difficult to retain because of the bleaching power of the soil water. Clover is a good crop for green manure, or perhaps a better crop is cow peas.

Muck.

Characteristics.—Muck is a dark brown to black mixture composed of the organic remains of swamp vegetation in various stages of oxidation, mixed with varying quantities of sand, clay and silt. It ranges from two or three feet to many feet in depth. On the outer margins the muck merges into the Clyde series.

Most of the muck occurs north of the Wabash and in many areas is bordered by sand ridges. The surface is level, and before it is drained it is covered with water, forming a marsh. Many of the areas were known as prairie by the early settlers. They were covered with a growth of sedges, marsh grass, etc. At the present time it is usually drained by dredge ditches. When it is properly drained and sown in grass it forms fine meadow or pasture land, in fact that seems to be the most satisfactory farm crop to use.

Crops Grown.—It produces good crops of corn where the frost does not get it in the late spring or early fall, but this land is affected most of all. Most muck is deficient in potash, which can be supplied by manure and potash salts. Grains grow too rank and lodge badly. Muck is well adapted to the growth of onions, celery, cabbage, lettuce, beets, turnips, cauliflower and Irish potatoes. It is especially used for gardening when close to town.

Meadow.

Meadow represents the variable soil conditions encountered in the narrow, trough-like valleys of the streams. It consists of alluvial material, varying from almost pure sand to silt or clay, and is usually subject to overflow with very high water. Part of it is in cultivation, but most of it is in pasture, trees, underbrush and weeds. This type is not shown separately on the map, but is included with the Genesee series.