SOIL SURVEY OF LEE COUNTY, IOWA.

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DESCRIPTION OF THE AREA.

Lee County lies in the extreme southeastern corner of the State of Iowa. It is bounded on the north by Henry County; on the northeast by Skunk River, which separates it from Des Moines County; on the east by the Mississippi River, dividing it from the State of Illinois; on the southwest by the Des Moines River, between it and the State of Missouri; and on the west by Van Buren County. The county is very irregular in shape. Its greatest dimension from north to south is 30 miles, and from east to west 31 miles. It has an area of 511 square miles, or 327,040 acres.

The upland of the county was formerly a plain, but as the result of erosion it ranges at present from smooth where uneroded through undulating and rolling to hilly, depending upon the depth to which the valleys have been cut. The rivers which border the county on the northeast, southeast, and southwest have cut valleys to a depth of about 250 feet below the upland plain surface. Those parts of the county lying adjacent to these valleys in belts varying considerably in width have been thoroughly dissected by the streams and ravines opening into the valleys. The rise from the valley floors is abrupt, and the bluff line may be interrupted by a valley or ravine many times within a mile. Along Skunk River the hilly belt is narrowest, averaging a little less than 3 miles. Along the Mississippi River it is nearly 10 miles in width, and along the Des Moines it is about 8 miles. Along the larger streams flowing into the three main rivers the dissected belts extend beyond these limits from the rivers, while between the minor valleys upland projections extend toward and within a few miles of the main rivers. The greater part of the county consists of the old upland plain, smooth of surface except where crossed by creek valleys, shallow near their headwaters, but much deeper downstream. The smoothest part of the county, aside from the alluvial lands, is the northwestern section. A long, smooth ridge extends eastward from this large plain along the south side of the Skunk River hill belt nearly to the Mississippi bluffs east of Denmark, with a branch run-

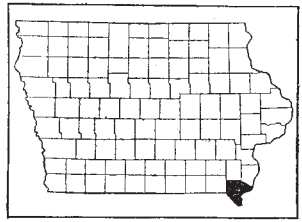


FIG. 48.—Sketch map showing location of the Lee County area, Iowa.

ning south of Lost Creek Valley nearly to Fort Madison. Another very prominent, smooth, ridgelike tongue of the upland extends southeastward along the north side of the Des Moines River hill belt to the Mississippi bluffs near Montrose.

The Mississippi alluvial plain is not continuous across the county, but consists of two flat areas. The northerly one forms the extreme eastern corner of the county, lying in a triangle formed by the Mississippi River, Skunk River, and the bluffs running nearly north from Fort Madison. It comprises about 25 square miles. The other area is a rather crescent shaped belt about 10 miles long and 1 to 3 miles wide extending from Fort Madison to Montrose. Elsewhere the bluffs extend practically to the river bank.

The Des Moines Valley is narrow, rarely being more than one-fourth mile wide on the Lee County side. There are two places, however, where it is much broader. One is about 4 miles west of Keokuk, the other at Vincennes. The former comprises about 3 square miles, the latter about 5 square miles.

The Skunk River Valley is also narrow, rarely reaching a width of more than one-fourth mile on the Lee County side.

The elevation of the Mississippi flood plain at Fort Madison is a little more than 500 feet above sea level, and that of West Point on the upland plain is 758 feet.

The alluvial plains of the Mississippi and the Des Moines Rivers may be divided into two parts, namely, first-bottoms and terraces. The former are low and subject to overflow. The terraces rise to as much as 50 feet above the first bottoms and are largely composed of sandy material. Remnants of three or four terraces 5 to 15 feet in height exist. However, these minor terrace differences have been destroyed to a large extent through erosion by wind or water.

The fall of the Mississippi River between Montrose and Keokuk is 23 feet, or a little over 2½ feet per mile. Its course is over the chert beds at the top of the Burlington limestone. In 1867 the United States Government completed a canal between the two points named, in order that boats might pass up and down. In 1913 the Mississippi River Power Co. completed a dam and locks at Keokuk. The difference in water level on the upper and lower sides of the dam is now 32 feet, and is expected ultimately to be 35 feet. This improvement has obviated the need of a canal.

The three main streams of the county are boundary streams. The drainage flows into these through widely branching small streams of dendritic arrangement. The width of the belt drained into each of the main streams corresponds roughly to the size of the streams. In addition to these boundary rivers, the most important streams are Sugar Creek, Big Sugar Creek, and Lost Creek, in the order named.

These creeks develop very narrow strips of bottom (flood plain) 4 or 5 miles below their source which widen out to an eighth or a half mile near their mouths.

The first white settlers in Lee County located at the site of the present town of Montrose in 1796, and there established a trading post. The Indians relinquished possession of this territory in 1833. Prior to that time few settlers had come in, but thenceforward immigration proceeded steadily. The early settlers were largely from Ohio, Indiana, Kentucky, Virginia, Pennsylvania, and New York. They came by wagon, or by boat down the Ohio River and up the Mississippi. After 1836 the proportion of German settlers was large. Many of these settlers came direct from Germany to Galveston or New Orleans and thence up the Mississippi into this section.

The United States census shows that while from 1880 to 1910 the total population of the county has increased from 34,859 to 36,702, the proportion of rural population has fallen from 51.8 per cent to 37.6 per cent, and the density of rural population from 27 to 25.3 per square mile. At present not many settlers are coming into the county, and only a few are leaving it for regions where land is cheaper.

The water supply of the county is good. Every township, particularly in the hilly sections, is well supplied with springs, a majority of which, however, are dry during seasons of light rainfall. Good water is abundant over all the county at a very moderate depth, but in extremely dry seasons shallow wells sometimes fail. A great many farmers are having wells drilled, as there is an abundant and unfailing supply at depths of 80 to 200 feet. In the southeastern half, especially, and probably throughout the entire county, conditions are favorable for obtaining a supply of artesian water, as the great Keokuk syncline which underlies a large part of the county insures sufficient pressure for flowing wells. Several such wells have been drilled at Keokuk and Fort Madison.

Keokuk is the largest town in the county and one of the county seats. The population of Keokuk is reported, in the 1910 census, as 14,008. It is located in the extreme southern part of the county and is an important river town and trading center. It has a number of manufacturing interests and is reached by four railroads. The development of water power for generating electricity is an important industry. Fort Madison, the other county seat and the second largest town, with a population of 8,900, is located on the Mississippi River 18 miles north of Keokuk. It also is a prominent trading center and has several manufacturing interests. It is reached by branch lines of the Chicago, Burlington & Quincy and by the Santa Fe Railroad. Montrose, with a population of 708, is a river town on the Chicago, Burlington & Quincy Railroad about halfway between Keokuk and Fort Madison. West Point and Donnellson are small railroad towns

of local importance. Wever, Mount Hamill, Charleston, New Boston, Argyle, Croton, and Vincennes are smaller railroad towns, while Franklin, Denmark, St. Paul, and Primrose are villages without railroad facilities.

Lee County is well supplied with transportation facilities. Wholesale houses and distributors in St. Louis and Burlington use the Mississippi River boats in shipping to towns lying on the Mississippi River. The main line of the Atchison, Topeka & Santa Fe Railway, between Chicago and California, passes through Fort Madison and Argyle, crossing the county in a southwesterly direction. The St. Louis and Burlington branch of the Chicago, Burlington & Quincy runs through Keokuk, Montrose, Fort Madison, and Wever, following the Mississippi River. The Fort Madison and Ottumwa branch of the Chicago, Burlington & Quincy Railroad extends from Fort Madison in a northwesterly direction through West Point, leaving the county near the northwestern corner. The Keokuk, Laclede & Carrolton branch of the Chicago, Burlington & Quincy Railroad extends from Fort Madison almost directly west and passes through Donnellson. The Keokuk and Mount Pleasant branch of the Chicago, Burlington & Quincy Railroad runs north and a little northwest from Keokuk and passes through New Boston, Charleston, Donnellson, and Mount Hamill. The Keokuk & Des Moines branch of the Chicago, Rock Island & Pacific Railway, following the Des Moines River Valley, passes through Croton and Vincennes and terminates at Keokuk. A branch of the Wabash Railroad crosses the river from Illinois and terminates at Keokuk.

The wagon roads of the county as a rule are in good condition. Improved culvert crossings are being installed in all parts of the county. On the sandy terrace roads clay is hauled and mixed with the sand to form a firmer roadbed. Several through automobile routes cross the county and they are kept in especially good condition.

The principal local markets for agricultural products are Fort Madison, Keokuk, and Burlington. The latter is a city of about 25,000 population, about 10 miles north of the county. Some cream is shipped to Ottumwa and Mount Pleasant. The chief markets, however, are Chicago and St. Louis.

CLIMATE.

The climate of Lee County is typical of that of this general section of the Mississippi Basin. The winters are not unusually severe. The temperature for the winter months averages about 27° F., and temperatures below −20° F. are rare. There is generally sufficient snowfall to protect small grains, which, if not sowed too late, are rarely injured by the cold. Some varieties of peach trees are said to

winterkill. While periods of high temperatures occur during the summer, they are generally of short duration. Occasionally on the uplands corn yields are reduced and pastures are dried up by summer droughts. These droughts are less injurious to crops on the river bottoms, where the water table is near the surface. The mean temperatures for the summer months is about 75° F.

In average years by far the greater part of the precipitation occurs during the growing season, the average for the summer being about 12 inches. The mean annual precipitation for Lee County is slightly greater than the average for the State of Iowa. It amounts to about 35 inches.

There is an average growing season of about 200 days. The average date of the first killing frost in the fall is October 15 and of the last in the spring, April 1. The earliest date on record of killing frost in the fall is September 18, and the latest in the spring, May 4.

The data in the following table, compiled from the records of the Weather Bureau station at Keokuk, give the normal monthly, seasonal, and annual temperature and precipitation:

Normal monthly, seasonal, and annual temperature and precipitation at Keokuk.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	29.0	69	−22	1.72	1.45	0.23
January	23.7	72	−26	1.81	0.50	3.68
February	27.5	70	−27	1.62	0.53	1.45
Winter	26.7	.....	.....	5.15	2.48	5.36
March	40.4	88	− 6	2.44	1.71	3.45
April	52.3	89	14	3.18	1.56	3.99
May	63.1	92	28	4.27	2.27	5.28
Spring	51.9	.....	.....	9.89	5.54	12.72
June	72.1	100	43	4.40	2.63	6.73
July	76.9	108	50	4.08	1.98	6.79
August	74.9	102	47	3.19	4.57	4.03
Summer	74.6	.....	.....	11.67	9.18	17.55
September	67.1	99	30	3.85	1.12	11.08
October	54.4	92	20	2.49	0.28	2.12
November	39.7	79	− 3	1.93	3.91	2.82
Fall	53.7	.....	.....	8.27	5.31	16.02
Year	51.8	108	−27	34.98	22.51	51.65

AGRICULTURE.

The first settlements in Lee County were made about three-quarters of a century ago. The pioneers practiced agriculture on a small scale. Crops were grown mainly for food, houses were built of local material, usually logs, and live stock was pastured on the open range during the summer and given rough feed during the winter. The first products were general farm crops, including corn, oats, wheat, rye, timothy, and clover, and pumpkins, potatoes, turnips, and other vegetables.

Cattle, hogs, horses, and sheep were kept, and since they were raised mainly on the range considerable loss was sustained, by rapacious animals as well as from other causes. The settlers located in or on the borders of woods, the open prairie being the last land to be settled and put in cultivation.

The small grains have been grown since 1840, but extensively only since the introduction of harvesting machinery. Clover and timothy have been grown on a large scale for over half a century.

From the beginning general farming has been practiced throughout the county, and at the present time the majority of the farmers are engaged in this type of agriculture. They grow the extensive crops common to the region, raise enough work stock to operate their farms, with possibly a colt or two each year for sale, and keep cattle and hogs and occasionally a few sheep. They generally produce fruit, poultry, and vegetables for home use, with occasionally a small surplus for sale. From this type of general farming there are some departures in the case of farmers who specialize in the production of a single crop or in a certain animal industry.

Lee County is predominantly a corn-producing county. Corn and oats are grown mostly for stock feed. Corn occupies by far the largest acreage of all the crops. It is followed by hay and forage, with two-thirds the acreage of corn, and by wheat and oats, the last two nearly equal in acreage and together occupying a little less than the hay and forage acreage.

The 1910 census reports a total of 2,360 farms in Lee County, and 215,631 acres of improved land in farms, or an average per farm of a little more than 90 acres. A total of 60,700 acres, or about 28 per cent of the improved acreage, is reported in corn. Oats are reported on 18,447 acres, or about 8.5 per cent of the improved acreage, and wheat on 16,567 acres, or a little more than 7 per cent.

Tame and cultivated grasses were grown on 39,029 acres, or about 18 per cent, and rye on nearly 3,000 acres, or about 1.5 per cent. These are the principal crops, and together they occupy about 63 per cent of the total improved land area of the country.

The average yields of corn, oats, and wheat for the year 1909 were 33, 29, and 19 bushels per acre, respectively. Of the 99 coun-

ties in the State, Lee County is seventy-eighth in the total production of corn, eighty-first in the total production of oats, and fourth in the total production of wheat. It stands eighty-fifth among the counties in the tonnage of hay and forage produced, its potato production is somewhat above the average, and in volume of fruit production it ranks twenty-first.

The live-stock industries of the county are varied, and none is of predominant importance. In the number of sheep and goats Lee County ranks third in the State, and in the value of wool and mohair produced it has the same place. In poultry products sold the county stands sixteenth. The total receipts from the sale of poultry and eggs in 1909 are reported as $223,328. In the census year 1909 about 40,000 hogs were sold or slaughtered, and the receipts from the sale of animals amounted to about $1,250,000. In value of dairy products sold Lee County ranks sixty-fifth among the counties of the State. The greater part of the dairy income is derived from butter with milk next in importance, and cream and butter fat sold, last. The amount of milk sold is reported as 279,017 gallons, or an average of about 118 gallons per farm.

Formerly, many cattle were bought as "stockers" and fattened during the winter on the grain grown within the county, but this industry has been abandoned, except in isolated cases, the raising of "stockers" taking its place. This is a natural evolution based on a proper adjustment of industries to local conditions. Much of the land in the county is rough and difficult to cultivate, while the soil seems to be well adapted to bluegrass, making the maintenance of good pastures a simple matter. This does not apply, however, to the smooth prairie lands of the northwestern part of the county. The cattle are grades, as a rule, Shorthorn blood being predominant. The silo is becoming popular with dairymen and stock raisers, though it is by no means universally in use. (See Pl. LXIII.)

Almost all the farmers on the sandy terrace soils specialize in truck crops, including strawberries, watermelons, sweet potatoes, and tomatoes. Strawberries are grown to a small extent also on the bluff lands south of Montrose, and tomatoes are grown near the edge of the bluff, but more extensively on the slopes of small drainage courses.

There is a vineyard of about 30 acres near Fort Madison, the largest in the county. There are two canning factories for tomatoes at Montrose, two at Keokuk, and one at Fort Madison.

The 1910 census reports the production of 44,439 bushels of sweet potatoes on 400 acres in 1909. In good locations and during favorable seasons yields of 250 bushels per acre are obtained. In 1912 several hundred carloads of watermelons were shipped out of the county.

The terrace lands between Montrose and Fort Madison are used chiefly for specialized trucking. This is due to the facts that the

greatest development of sandy terrace soil occurs here and that it is close to the Santa Fe Railroad, which furnishes facilities for shipping products directly to Chicago and the East. It is becoming more generally recognized that the sandy terrace soils, designated locally as "sand prairie," can better be used for trucking than for general farm crops.

Probably no farmer in the county follows a definite rotation of crops. However, all follow about the same general plan of growing corn for two to four years, followed by small grain for one or two years or possibly more, then seeding the land to clover or timothy for two to four years.

Corn, the chief crop grown in the county, is generally planted on sod land, with the addition of stable manure when available, about the first week in May or, if weather conditions are unfavorable, somewhat later. Practically all of the corn is checked, only a small acreage being drilled. Some of the corn is cut for ensilage, some is cut and shocked in the field, and some is husked in the field when sufficiently mature. A few farmers shred the fodder, but probably the greater number use silos. The varieties of corn most commonly grown are the Boone County White and Reids Yellow Dent. The latter is grown mainly on the upland and the former mainly on the bottoms. The average yield is about 40 bushels per acre, although yields of 80 bushels are common in favorable seasons. Corn makes its best development on some of the bottom soils and on the darker upland soils. (See Pl. LXIV, figs. 1 and 2.)

Wheat is grown largely as a money crop. Both winter and spring wheat are grown in Lee County. Spring wheat, however, is grown to only a small extent. The land is prepared for winter wheat by plowing, disking, and harrowing to prepare a good seed bed. The wheat is seeded about the first week in October; if sown earlier it is injured by the Hessian fly and if sown later it is likely to winterkill. In recent years considerable damage has been done by the Hessian fly. Smut also is injurious to the wheat, and some farmers, in order to combat this disease, treat the seed with bluestone (copper sulphate) or formaline. A self-binder is used in harvesting the crop, and the wheat is shocked in the field. Some stack the wheat, but a majority thrash from the shock. The method of growing spring wheat is the same as for winter wheat, except that the land is generally fall plowed and the seed drilled in as soon as the frost is out of the surface soil in the spring. A beardless variety is commonly grown. Spring wheat averages about 15 bushels in yield and winter wheat about 20 bushels.

Oats are an important crop in Lee County, although probably very little more is grown than is needed to feed the work stock. Oats

are sown on corn or small-grain stubble, sometimes after only disking the field, but generally after plowing. Seeders are used to some extent, but drills are becoming popular. The average yield is 25 to 40 bushels per acre.

Rye is a crop of considerable importance in the county. It is generally drilled in, following corn or oats. Some farmers have found that seeding 2½ bushels per acre, one-half drilled each way, gives best results. Yields as high as 40 bushels per acre have been obtained. Very little barley is grown.

The small grains are grown in nearly all parts of the county. However, wheat and rye seem better suited to the lighter bluff soils than to the darker colored upland soils.

Clover is grown quite successfully on most of the soils of the county. It is generally sown in the early spring with some small grain which, as a nurse crop, is given a lighter seeding. When winter wheat or rye is used as a nurse crop clover is seeded broadcast in the spring; when spring wheat or oats is used it is seeded with the grain. It is generally used for pasture the first year, two cuttings of hay being obtained the second year. The yield of hay averages about 1½ tons per acre. Occasionally the second crop is hulled for seed.

Timothy when grown alone is generally sown in a manner similar to clover but without a nurse crop. Its average yield is about 1½ tons per acre. As a rule, however, timothy and clover are sown together. With this combination the timothy does not become very prominent until after the second year. This combination makes an excellent quality of hay. The average yield is about 1½ tons an acre.

Millet is of very little importance. Alfalfa is grown more extensively each year. It is grown on the silt loam, loam, and sandy loam soils. Three or four cuttings are generally obtained in a season, producing a total yield of about 2½ to 3 tons of hay per acre. Sorghum is grown to a small extent and is made into sirup at small local mills. The sirup is made almost entirely for home consumption.

The farm implements used are well adapted to the form of agriculture practiced. Owing to the rolling topography and rather small fields, heavy implements are not used here as they would be in more level country. Two-horse corn planters generally with a checkrower attached are used. Wheat drills are generally of the 2-horse variety. The disks used require two to four horses. Walking plows use two or three horses, sulky plows three horses, and gang plows four horses. The farm machinery is, on the whole, well cared for.

Practically no commercial fertilizer is used in the county. Stable manure, however, is seldom wasted, and probably over 10 per cent of the farmers have manure spreaders. The most common practice is to apply the manure to grass or clover sod before plowing for corn.

Manure is used in growing sweet potatoes and is placed in the hill for watermelons. It is used on all the soils. Probably more manure is applied to the lighter than to the darker soils.

In general farm labor in Lee County is comparatively scarce. It is difficult to keep laborers on the farm more than two or three years, at the end of which time they often rent land and farm for themselves. Day wages in the summer range from $1.80 to $2.50. By the month laborers are paid about $25 and board during the summer and when hired by the year about $20 and board. A total expenditure in 1909 of $157,278 for labor is reported for Lee County in the 1910 census.

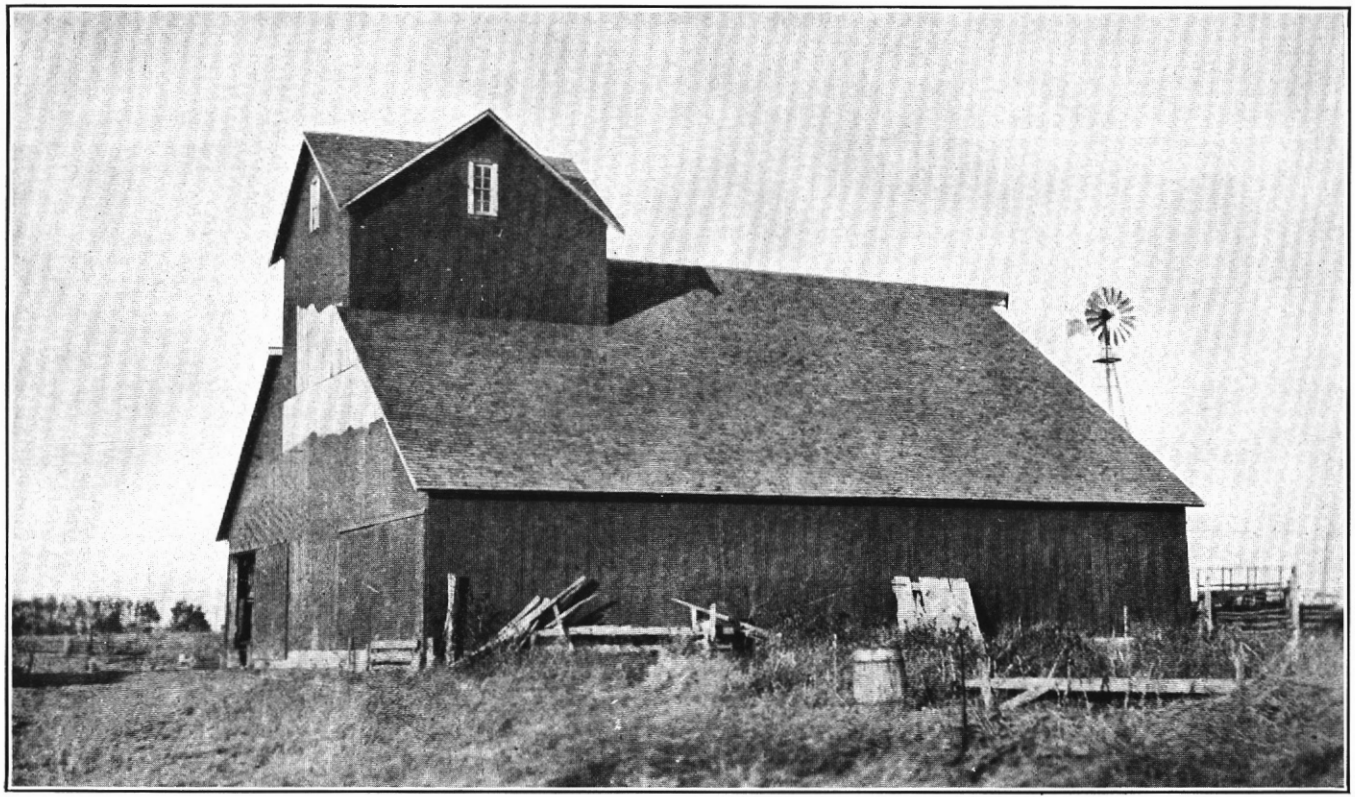
In the last 30 years there has been very little change in the area of improved land, as before that time nearly all the land topographically suited to crop production was in cultivation. Farm improvements are noticeably poorer in the rougher areas.

The size of farms has been gradually increasing, and the percentage of those operated by the owners has steadily decreased. The average size of the farms in Lee County has increased from 120 acres reported in 1880 to 131.6 acres reported in 1910. In 1880, 77 per cent of the farms were operated by the owners and 23 per cent by tenants, while in 1910 the census reports about 72 per cent operated by the owners and about 27 per cent by tenants. The size of the farms ranges from about 40 acres to 640 acres, with a majority between 80 and 320 acres.

The average value of land in Lee County has increased from $30.07 per acre reported in 1880 to $63.01 reported in 1910. The range in farm values is from $40 to $200 an acre. There is some land that is not considered worth $40, but it is doubtful whether a farm could be bought which does not include sufficient high-priced land to bring its value up to an average of at least $40 an acre.

SOILS.

The soils of Lee County are of loessial, glacial, residual, and alluvial origin. The loessial soils have a greater extent than those of any other group. They cover all the uplands except areas from which they have been removed by stream erosion. In general these types are characterized by light-brownish or grayish soil near the bluffs and the main stream valleys, and by dark soil in other places. They have silt loam surface soils and heavier subsoils, with, generally, silty subsurface layers. The most generally accepted explanation of this arrangement is that the percolation of water downward through the soil has caused the finer soil particles to be carried down to the lower depths, while the coarser particles have remained above. Another explanation that has been advanced is that the coarser material is of loessial origin, while the underlying heavier material is



SILO INSIDE BARN.

Showing method of remodeling barn to cover silo.

FIG. 1.—CORN ON LIGHT-COLORED UPLAND SOIL (MEMPHIS SILT LOAM) NEAR BLUFF.

FIG. 2.—CORN ON DARKER COLORED UPLAND SOIL (PUTNAM SILT LOAM) BACK FROM BLUFF.

residual in origin from the underlying substratum. While most of the soils are thought to have been formed in the manner described in the former theory, a few soils are generally believed to have been formed by the latter method. In such cases the loessial covering must of necessity have been very thin.

The loessial soils are believed to have been formed from deposits of wind-blown material. The loess in Lee County is only 4 to 10 feet in depth on an average, and is very thin in some areas. The lithological nature of the material forming the loess is undetermined, but probably it is very complex.

The soil map of Iowa [1] shows a division between what is called the Mississippi loess and the Southern Iowa loess. The boundary approximately follows Big Sugar Creek. No difference was recognized in this survey between the loessial soils in different parts of Lee County, except that the Memphis silt loam seemed a trifle coarser below Montrose than above.

The lighter colored loessial soils are mapped as the Memphis and Marion series, the silty subsurface layer being absent in the former and present in the latter. The Memphis is entirely composed of loessial material, while the subsoil of the Marion is thought to have been formed from till. The darker colored loessial soils are grouped in the Grundy and Putnam series. In the heads of draws above the point where an alluvial bottom has been formed a dark-colored soil of colluvial origin derived from both the glacial and loessial material is encountered. This is mapped as the Wabash silt loam.

Only one glacial soil is recognized in Lee County—the Lindley loam. This is, however, an important type, covering almost one-fourth the county. It occurs on slopes which are generally quite steep and lead to watercourses where the overlying loess material has been washed away. The glacial material is generally of a brownish color with a reddish or yellowish cast, and carries chert, quartz, limestone, and sandstone fragments, both angular and waterworn. Bowlders of various sizes frequently occur. Some of these have smooth sides and many are striated. The till has been described [2] as comprising a lower division of blue bowlder clay, varying from a few feet to 200 feet in thickness, and a higher portion comprising 30 to 75 feet of yellow clay.

The greater part of this glacial deposit is known as the Kansan drift. Recent geological works [3] state that the eastern part of Lee County was covered by the Illinoisan drift, a younger glaciation, after the deposition of the Kansan drift, which covered the entire county. It is further thought that there was an Illinoisan moraine

[1] Stevenson, Iowa Agr. Expt. Sta. Bul. 82.

[2] Geology of Lee County, Charles Rollin Keyes, Iowa Geol. Survey, Vol. III, 1895, p. 356.

[3] Iowa State Atlas, 1904. Outline Maps of the Drift Sheet of Iowa, Samuel Calvin, p. 25.

running in a rather narrow belt about 4 or 5 miles wide in a northerly direction from the west part of Fort Madison. During the Illinoisan invasion the course of the Mississippi River is thought to have been temporarily pushed westward and to have occupied a valley in Jackson County beginning where the Maquoketa River now empties into the Mississippi River, flowing through portions of the channels now occupied by the Maquoketa, Wapsipinicon, Cedar, and Skunk Rivers, Cedar Creek, and Big Sugar Creek, and returning at the mouth of the last named to its old channel.

During this survey no particular difference was noted between the character of the till in the area supposed to have been covered by the Illinoisan invasion and that of the rest of the county, except that in a few cuts a layer of black till about 8 feet below the surface of the ground was observed. There seemed to be no surface evidence of a moraine, but this would probably have been covered by loess. At the head of Big Sugar Creek, in the vicinity of the Henry-Lee County line, there is a large, nearly flat depression about one-fourth to one-half mile in width lying considerably lower than the surrounding country. This extends along the creek a few miles and indicates a possible effect of the temporary change of the Mississippi channel. There is no difference between the soil here and that of the surrounding country, except that it is slightly heavier.

The alluvial soils in Lee County rank third in importance. They comprise the small stream bottoms and the first bottoms of rivers, as well as the terraces along the rivers. The first bottoms are subject to overflow in times of flood.

The first-bottom soils vary in texture from fine sandy loam to heavy clay. In the small stream bottoms the soils are either silt loam or very fine sandy loam of light-brown or grayish color. These soils are grouped in the Genesee series. In the areas of larger first-bottom development along the rivers the soils comprise, in addition to those occurring in the small stream bottoms, soils of darker color, ranging from fine sandy loam to heavy clay. These soils are classed with the Wabash series. They have been formed by deposition from overflow waters. During flood periods the streams carry large quantities of soil material in suspension. Ordinarily the coarser material is deposited near the stream as the water leaves the main channel, and the finer particles farther back from the stream, where the water is more quiet. In some places heavier soils are found near the river, but in these cases the stream has meandered and cut away the area occupied by the coarser soil.

The terraces [1] represent the flood-water stages of the river in early times, yet following the deposition of the Kansan drift, which once

[1] Geology of Lee County; Charles Rollin Keyes, Iowa Geol. Survey, Vol. III, 1895, p. 314.

covered the area where the terraces now stand and which was removed by the river in the process of widening its valley. These terrace soils were formed in the same manner as the first-bottom soils, but at an earlier date. They vary in color from light brown to dark brown or black and in texture from fine sand to silty loam, the light-brown sandy material generally predominating. They are classed with the Buckner series. The lithological origin of the terrace soils is complex. It may be said in general that they are derived from soil and rocks lying to the north.

Only one residual soil type, the Union stony loam, is recognized in Lee County. The total area is very small, the residual material being the least important in Lee County. This type is developed on the steep slopes leading to the drainage courses, where either the overlying till has been washed off or the drainage courses have themselves cut down through the till. This soil is red to reddish brown in color. It is a silt loam at the surface, is derived from limestone, and has on the surface numerous fragments of limestone. The formations from which it is derived are the Burlington, Keokuk, and St. Louis limestones.[1]

The following table gives the name and the actual and relative extent of each of the soils mapped in Lee County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Grundy silt loam	89,920	27.5	Buckner very fine sandy loam	4,288	1.3
Lindley loam	77,568	23.7	Wabash silty clay loam	4,096	1.3
Putnam silt loam	37,184	11.4	Buckner fine sandy loam	3,392	1.0
Memphis silt loam	32,576	10.0	Buckner fine sand	3,392	1.0
Marion silt loam	21,760	6.7	Buckner loam	2,880	.9
Genesee very fine sandy loam	11,136	3.4	Union stony loam	2,432	.7
Genesee silt loam	10,368	3.2	Wabash fine sandy loam	1,920	.6
Wabash silt loam	5,056	3.1	Grundy silty clay loam	1,728	.5
Colluvial phase	5,120		Wabash loam	768	.2
Buckner silt loam	6,272	1.9			
Wabash clay	5,184	1.6	Total	327,040	

Memphis Series.

The soils of the Memphis series are light brown. The subsoils are yellowish brown in color and are slightly heavier than the soils in texture. Both soil and subsoil are derived from the loess, the underlying till being far enough from the surface to have no appreciable influence on the general character of the soil. These soils have good natural surface drainage. The topography is gently undulating to rolling. In Lee County the silt loam is the only type mapped.

[1] Geology of Lee County; Charles Rollin Keyes, Iowa Geol. Survey, Vol. III, 1895, p. 319.

MEMPHIS SILT LOAM.

The Memphis silt loam consists of a light-brown to buff-colored silt loam to a depth of 15 to 18 inches, underlain by a slightly lighter colored and somewhat more compact silt loam to silty clay loam. The surface soil when dry often has a gray appearance. It has a smooth, velvety feel and a rather loose, open structure. In some places the subsoil is heavier and more compact than in others. It is most often a silty clay loam to a depth of 28 inches, below which it sometimes approaches a silty clay. At 6 to 12 feet below the surface the Kansan till is encountered; this has very little effect upon the soil.

This type occurs near the margin of the uplands, along the three main river valleys, and also along some of the more important interior stream courses. It is found on the slightly convex tops of narrow ridges and tongues of land, and occasionally on some of the more gentle slopes. In similar locations, but where the surface is level instead of rounded or sloping, the Marion silt loam occurs. The Memphis silt loam has a gently rolling to rolling topography. The surface drainage is good.

The soil washes quickly once a draw is formed, and it is therefore customary with farmers to fill slight depressions with branches of trees or straw or manure. Plowed fields should be kept in a cover crop over winter to prevent washing and the forming of gullies. Shallow hollows are usually set in grass and are not cultivated.

The area occupied by this type was originally forested, but the greater part is now cleared. The native timber consists of scrub oak, black oak, black and shellbark hickory, elm, and evergreens.

The larger part of the type is in cultivation; the remainder is pasture land. Some of the strips of this type are narrow and surrounded on either side by land too rough to cultivate, and are more advantageously included with the rougher land in pasture than fenced and cultivated.

The soil is used for all the farm crops commonly grown in the county, including wheat, rye, oats, corn, clover, timothy, and alfalfa. The type seems to be better suited to wheat and rye than to corn. The extension of the alfalfa acreage in the county is especially noticeable on this type. Corn yields on this type range from 20 to 50 bushels per acre, oats 20 to 40 bushels, spring wheat 12 to 24 bushels, winter wheat 12 to 25 bushels, and rye from 12 to 30 bushels. Clover and timothy produce an average of about 1 ton and $1\frac{1}{4}$ tons of hay per acre, respectively, and alfalfa about $2\frac{1}{2}$ to 3 tons. In the vicinity of and south of Montrose strawberries and sweet potatoes are grown to a limited extent and are said to do very well. Sweet potatoes yield 100 to 200 bushels per acre.

The type is lacking in humus, as compared with the darker soils, and manure is used extensively. The soil is quite productive and is usually friable and easy to cultivate. However, it has the disadvantage of lying in such isolated areas in most cases that the fields are small and cultivation is expensive. It seldom happens that an entire farm consists of this soil alone. The type is valued at $60 to $100 an acre.[1]

Marion Series.

The soils of the Marion series are gray, white, or ash colored. The subsoils are white in the upper portion, the white layer varying in thickness from 2 to 12 inches. This layer is a compact, whitish silt or very fine sand, impervious to water, often containing iron concretions, and locally known as "hardpan." The true subsoil which lies beneath is a gray, light-yellow to reddish-yellow, or mottled brownish-yellow, hard, impervious clay, containing occasional concretions of iron and of lime. The soil is derived from a layer of silty material that may be loessial, water laid or residual from fine-grained rocks. In Lee County the series is represented by the Marion silt loam.

Marion silt loam.

The Marion silt loam is a light brownish gray to light-gray silt loam to a depth of 7 to 12 inches. Lying beneath this and above the subsoil proper is a very silty, flourlike, grayish or whitish layer, averaging 9 inches in thickness. The subsoil proper from about 16 or 20 inches to 36 inches is a heavy, plastic silty clay, very compact and tenacious and gray or grayish brown in color, becoming mottled with grayish brown, rusty brown or both at 24 to 28 inches. When dry the surface soil is often light gray. It has a high percentage of silt, which gives it a velvety feel.

Iron concretions are frequently present on the surface. The subsurface layer is generally very dry, except immediately after a very hard rain. Between the subsurface material and the subsoil proper is a very distinct line. The subsoil is generally moist. The subsurface layer seems to interfere with the rise of capillary moisture from below.

This type includes a slight variation, which occupies high terrace-like positions. It has a silt loam surface soil which in places approaches a silty clay loam and is grayish brown to dark brown in color. The surface soil extends to a depth of 6 to 8 inches and is underlain by a dark grayish brown silty clay subsoil, sometimes becoming yellowish brown at lower depths. The subsoil is practically similar to that of the typical upland Marion silt loam as mapped in

[1] Values given for this and other soil types are based on a few sale figures given by farmers, together with a study of comparative values as given by the tax books.

this county. It is very heavy, tenacious, and plastic. The total area of this variation is very small. It occurs in small areas along Big Sugar Creek, and, less frequently, along Sugar Creek.

The Marion silt loam is a timbered soil, and is locally known as "white-ash" or "chalk" land. The native forest growth consists of black oak, white oak, laurel or shingle oak, shellbark hickory, black hickory, and black locust, with some elm.

This type, like the Memphis silt loam, occurs along the margin of the plateau, near the three river valleys, and also near the more important interior stream courses. It is encountered on the level tops of narrow ridges and tongues of land and less frequently at a lower level, about 15 to 25 feet above the small-stream bottoms. The topography is level to gently undulating. Drainage is not well established.

The larger part of the area covered by this soil is in cultivation, but, as in the case of the Memphis silt loam, there are small, isolated areas, nearly surrounded by rough land, which are included in pastures with the rough land. The common farm crops, mainly wheat, oats, rye, corn, and grass, are grown on this type. Wheat and rye seem to do better than corn. In small home orchards apples do well on this type in favorable years and when properly cared for. Yields of 15 to 40 bushels of corn, 20 to 35 bushels of oats, 10 to 24 bushels of spring wheat, 14 to 32 bushels of winter wheat, 10 to 30 bushels of rye, 1¼ tons of timothy, and 1 ton of clover per acre are obtained. Stable manure is used as a fertilizer, generally on grass or clover sod preceding corn.

This land in general has a slightly lower value than the Memphis silt loam. Its value is about $50 to $80 an acre.

Grundy Series.

The Grundy series includes dark-colored upland loessial soils. They are thought to be similar in origin to the Memphis soils. They are distinguished from the latter by the greater quantity of organic matter in the surface soils, which gives them a dark-brown to black color. The subsoil is generally dark brown or mottled with bluish gray and yellowish brown. These soils are very productive. Artificial drainage is often needed. The topography is level to rolling. In Lee County the silt loam and silty clay loam types are mapped.

GRUNDY SILT LOAM.

The Grundy silt loam consists of a dark-brown to black silt loam to a depth of 12 to 14 inches, underlain by a dark-brown to black silty clay loam which at about 24 inches grades into a clay loam mottled with pale yellow, yellowish brown, and bluish gray. In the lower part of the subsoil the material is more plastic and borders on a silty clay. Where the type occurs in the more nearly level areas,

the subsoil has more of a dark-brown or bluish-gray color, with very little yellow or yellowish brown, and a heavier and more tenacious structure. The subsoil is underlain at depths of 4 to 10 feet by the Kansan till.

This type occurs on the smooth upland, and is the prevailing type in the northwestern part of the county. It covers the largest area of any type mapped, and is the most important soil in the county.

The topography is rolling to level. The surface drainage is good, except in level areas, where artificial drainage is needed.

The Grundy silt loam is derived from loessial material by processes of weathering under conditions favorable to the accumulation of large quantities of organic matter. Most of the subsoil is very heavy, owing either to the weathering and carrying down of finer soil particles from the surface or to the derivation of the type from till underlying a thin loessial covering.

This land was never forested, having a native growth of small bushes and prairie grass. The few trees it supports are elm and cottonwood.

This soil is the best corn soil of the county, and one of the most important corn soils in the United States. It is probably also the best soil for oats in the county and in addition produces good yields of rye, wheat, clover, timothy, and alfalfa. This is one of the last soils to be used for alfalfa, but this legume has proved successful. Corn yields range from 30 to 72 bushels per acre, though higher yields are obtained occasionally by some farmers. The soil stands drought better than the bluff soils. Oats yield 35 to 55 bushels per acre, spring wheat 12 to 26 bushels, winter wheat 16 to 35 bushels, and rye 14 to 32 bushels per acre, and timothy produces 1½ tons, clover 1¼ tons, and alfalfa 2¾ tons of hay per acre.

This is the most valuable soil in the county. Its value ranges from $140 to $200 an acre.

Mechanical analyses of samples of the soil and subsoil of the Grundy silt loam gave the following results:

Mechanical analyses of Grundy silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
330808	Soil	0.2	1.0	0.5	1.0	2.9	74.4	19.8
330809	Subsoil	.2	1.0	.4	1.5	4.4	64.2	28.2

GRUNDY SILTY CLAY LOAM.

The Grundy silty clay loam is a black silty clay loam to a depth of 14 inches, underlain by a black silty clay which below 18 to 22 inches is mottled with bluish gray and yellowish brown. The subsoil is

very compact, plastic, and tenacious. The type is underlain at 4 to 10 feet by the Kansan till, from which it is thought to have been derived.

There is only a small area of this soil in Lee County. It occurs in isolated bodies in areas of the Grundy silt loam in the northern and northwestern part of the county, on broad major divides. It has a level topography and fair to poor natural drainage. To be cultivated to best advantage it needs surface ditches and tiling.

The soil is locally known as "gumbo." If plowed when too wet it clods badly and sticks to the plow.

This is a good corn soil, but is not well adapted to the small grains, as they tend to lodge. Corn yields range from about 30 to 70 bushels per acre. Clover is grown successfully, but the type is better adapted to timothy, which yields about 1½ tons per acre.

The soil is very productive and there is little difference in its value and that of the Grundy silt loam. The necessity of artificial drainage and the difficulty of cultivation when it is too wet or too dry probably decrease its value to a slight extent. The type is valued at $150 to $180 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Grundy silty clay loam:

Mechanical analyses of Grundy silty clay 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.*
330813	Soil	0.0	0.2	0.2	3.4	5.5	65.6	25.0
330814	Subsoil	.2	.3	.1	1.1	4.7	68.4	24.7

PUTNAM SERIES.

The Putnam series includes gray to dark-gray soils, overlying impervious drab or brown subsoils of fine texture and close structure. One of its principal characteristics is the presence of a whitish silty layer between the soil and the subsoil. These soils occupy level to gently undulating upland prairies and are derived from loessial deposits. Owing to the rather level surface and the dense, "hardpan" structure of the subsoil, drainage is seldom adequate. The silt loam type only is mapped in Lee County.

PUTNAM SILT LOAM.

The Putnam silt loam consists of a dark-brown or grayish-brown to black silt loam to a depth of 8 to 14 inches. When wet the surface is almost black; when dry it is grayish brown. The material between depths of 8 to 14 inches and 20 or 22 inches is a dark-grayish

silty clay loam which has a somewhat more friable structure than the surface soil. In many places this layer is light gray. At 20 or 22 inches the soil changes abruptly to a clay loam to silty clay, which is dark brown in color, soon becoming mottled with yellowish brown, rusty brown, and bluish gray. In the more nearly level areas occupied by this type the subsoil is heavier in texture and the dark-brown to black coloration is more dominant, with less brown. The type is underlain at depths of 4 to 8 feet by the Kansan till.

This type occupies level and gently sloping areas. It occurs throughout the upland of the county, generally around drainage courses, extending back from where the land breaks into a slope to a drainage course, the type separating the Grundy silt loam from the Lindley loam on the slopes or from the Marion or Memphis silt loam extending out on tongues of land or narrow divides. In the northwestern part of the county it occupies more nearly level areas less dissected by drainage courses. All parts of the type are reached by draws which give good surface drainage. The underdrainage, however, is fair to poor. The silty layer, as in the Marion silt loam, intercepts the capillary movement of moisture to some extent.

This land was never heavily forested, but much of it supported a brushy growth of hazel, hawthorn, and the like, so that the term "hazel-brush land" is commonly applied to it. Some areas were sparsely timbered with maple, oak, and other hardwoods.

This type has been formed in the same manner as the Grundy silt loam, with the exception that there has probably been greater percolation of moisture through the soil, causing a rearrangement of the soil particles, the silt being left above the finer clay particles which compose the subsoil proper. The soil is similar in crop adaptation to the Grundy silt loam, but is not quite so productive. It does not withstand drought so well, and is not so good a corn soil. Corn yields 15 to 55 bushels per acre, oats 20 to 45 bushels, spring wheat 7 to 20 bushels, winter wheat and rye 10 to 25 bushels, and timothy and clover $1\frac{1}{2}$ and $1\frac{1}{4}$ tons of hay, respectively.

This type, in addition to being slightly less productive than the Grundy silt loam, is, in some places where it adjoins steep areas of Lindley loam, so located as to include more irregular fields. The land has a value of about $100 to $160 an acre.

Union Series.

The soils of the Union series have gray surface soils, with yellow subsoils which generally consist of silty clay and frequently are underlain by a reddish substratum. The depth to red material varies with the topography, being greater in the more nearly level areas. Cherty material is usually present in varying quantities, large areas being

gravelly from the surface downward. These soils occupy level and undulating uplands to rough, hilly land and steep slopes. In the smoother areas chert and stone are less abundant. The material in places is derived from cherty limestone. In gravelly and stony areas it apparently is derived from limestone carrying a relatively high percentage of chert. In Lee County only the Union stony loam type is identified.

UNION STONY LOAM.

The Union stony loam, as mapped in Lee County, is a grayish-brown to reddish-brown silt loam to a depth of 6 to 10 inches, underlain by a fairly friable yet compact silty clay of a distinctly reddish to reddish-brown color. Limestone and chert fragments are found on the surface and throughout the 3-foot section. Owing to the position the type occupies, the surface soil in many places has been washed away, leaving a silty clay loam to silty clay at the surface. On some precipitous slopes or in cuts the underlying rock is exposed. In general it is not more than 2 to 6 feet from the surface to the underlying limestone. Owing to the steep slopes, surface drainage is often excessive. The soil is derived directly from the weathering and breaking down of the limestone.

This type occurs on short, steep slopes leading directly to Skunk River, to the Des Moines River 3 miles above Vincennes, to the Mississippi River between Montrose and Keokuk, and along the smaller streams in various places. It also occurs in the hollows and draws leading back from these places for a short distance. In the smaller draws the removal of the Kansan drift has exposed the underlying residual material.

Directly east of Franklin along Big Sugar Creek there are a number of limestone sinks, which, however, are small, each containing only about half an acre.

Practically none of this soil is in cultivation, the surface being too steep and stony to permit the use of cultural implements. Bluegrass does well and the type is probably best adapted for pasture land.

The total area of this land in the county is small. It probably has a value of $30 to $40 an acre.

GENESEE SERIES.

The soils of the Genesee series are brown. The subsoils are somewhat lighter brown than the soils. The Genesee types are derived from alluvial sediments and are found along the streams draining the glaciated region of the United States east of the Great Plains. The material is from glacial deposits which contain varying quantities of limestone. The topography is smooth and the areas are subject to periodic flooding. The very fine sandy loam and silt loam members are recognized in this survey.

GENESEE VERY FINE SANDY LOAM.

The Genesee very fine sandy loam consists of a very fine sandy loam which is light brown in color when dry and brown when wet. It is underlain at 15 to 36 inches by a light-brown very fine sandy loam with a slight tinge of yellowish brown. In many places the subsoil seems to be slightly coarser than the surface soil. The surface soil is somewhat variable in texture, there being small spots near the stream channel approaching a fine sandy loam, and others approaching a silt loam. Small spots of fine to medium sand overlying the typical soil in a layer 6 to 18 inches deep occur along Lost Creek west and southwest of Wever, along Devil Creek just east of Viele, along Big Sugar Creek east of Franklin, and along the Des Moines River. These are not of sufficient extent to be shown separately on the map.

This soil occurs on the bottoms of the more important interior streams throughout the county; also along the Des Moines and Skunk Rivers, and in the Mississippi River bottom near Lost Creek southwest of Wever, and between Montrose and Keokuk. It is a first-bottom soil and is subject to overflow, though along the Des Moines and Skunk Rivers it is much less frequently overflowed than along their tributaries. The topography is level to gently undulating. The type is well drained.

This soil is well adapted to the production of the general farm crops and vegetables. Corn yields 25 to 65 bushels, spring wheat 10 to 22 bushels, winter wheat 10 to 28 bushels, and alfalfa about 3 tons of hay per acre. The soil seems to be well adapted to alfalfa. though but little is grown.

This soil is one of the earliest to be in condition for cultivation in the spring. It is well drained and quite productive, but it has the disadvantage of being subject to overflow, which sometimes causes the loss of a crop. As it occurs in strips, no farm is located entirely upon it. It has a value of about $60 to $130 an acre.

The results of mechanical analyses of samples of the soil and subsoil of the Genesee very fine sandy loam are given in the table following:

Mechanical analyses of Genesee very fine 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.*
330831	Soil	0.3	1.6	3.9	34.4	24.6	31.5	3.1
330832	Subsoil	.2	2.4	4.6	42.8	22.6	21.9	5.4

GENESEE SILT LOAM.

The surface soil of the Genesee silt loam is dark brown when wet and grayish brown when dry. It consists of a silt loam and has a depth of 13 to 15 inches. The subsoil to a depth of 36 inches is a

silt loam, dark brown when wet and yellowish to grayish brown when dry. The transition from soil to subsoil is gradual. The soil has a loose structure.

The type as encountered in the Mississippi River bottom comprises some local variations. There are spots having a silt loam surface soil which approaches a silty clay loam, others having a soil approaching a very fine sandy loam, and still others having a silty clay loam layer in the subsoil extending to depths of 20 to 30 inches. These spots while of frequent occurrence are of small extent.

This type occurs as first-bottom land, mostly in the creek valleys, but also in the Mississippi alluvial lands southwest and east of Wever. In the larger interior stream valleys the type occurs nearer the source, with the Genesee very fine sandy loam nearer the mouth. It has a level to gently undulating topography and is well drained.

The Genesee silt loam is well adapted to the general farm crops. Like the Genesee very fine sandy loam, it seems well suited to alfalfa, though this legume is not extensively grown. It is especially adapted to corn, which yields about 30 to 75 bushels per acre. Spring wheat yields 10 to 24 bushels, winter wheat 11 to 30 bushels, clover 1 ton, and alfalfa 3 tons of hay per acre. In some of the small stream valleys where it occupies only a few acres of a farm and is adjoined on either side by land best suited to pasturage this type is included in pasture land.

The soil is very productive but occurs in such narrow strips, except in the Mississippi River bottom, that only a few acres are included in any one farm. Its value ranges from about $70 to $150 an acre.

In the following table appear the average results of mechanical analyses of samples of the soil and subsoil of the Genesee silt loam:

Mechanical analyses of Genesee silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
330833, 330835.....	Soil.....	0.5	2.7	2.4	6.5	7.4	67.8	12.7
330834, 330836.....	Subsoil.....	.1	1.7	2.6	10.6	11.1	61.4	12.5

LINDLEY SERIES.

The soils of the Lindley series are yellowish gray or yellowish brown to brown in color. The subsoils consist of yellow or reddish-yellow to light-brown, tenacious sandy clays, noticeably lighter than the surface soils, which are to a considerable extent influenced by remnants of the former loessial covering. The subsoil frequently contains iron pipes, nodular masses, and streaks of calcareous material. These soils are derived from Kansan till. They occupy steep stream slopes and narrow divides, and are subject to erosion. Originally they were forested. The loam type is mapped in Lee County.

LINDLEY LOAM.

The Lindley loam consists of a silt loam or loam, reddish to yellowish brown in color and extending to a depth of about 10 inches. This is underlain by a reddish to yellowish-brown clay loam to silty clay or sandy clay. The surface soil is more nearly a silt loam at the tops of slopes and more loamy on the slopes themselves. This is due to a greater influence of the remnants of the loessial covering in the former situations. In places on the steeper slopes the surface soil has been washed away, exposing relatively small areas of the heavier textured subsoil. Numerous fragments, some angular and some waterworn, of chert, limestone, sandstone, quartzite, and granitic material, with some large bowlders, are found on the surface and throughout the soil section. Some of these fragments and larger bowlders are smooth on one or more sides, and some show striation. Iron concretions also are sometimes present. The subsoil frequently includes pockets of sand and clay. The structure of the subsoil varies from friable to tenacious.

This soil is widely distributed throughout the county, though it is less extensively developed in the extreme northwestern section. It occupies the slopes leading to upland drainage courses. It is of glacial origin, and is derived from the Kansan till, which underlies it. The type is found only where the loessial covering has been washed away. It is well drained.

The degree of slope of the draws varies from moderate to precipitous. Probably one-fourth or one-third of the total area of this type in Lee County is in cultivation. The remainder is in most cases unsuited for cultivation and under present economic conditions is best used for pasture land. Uncleared areas support a growth of scrub oak, white oak, red oak, and black and shellbark hickory.

In the portions of this type unsuited for cultivation where sufficient timber has been removed bluegrass thrives and makes an excellent pasture. Many of these old pastures may be improved by sowing sweet clover.[1] This might be done in the fall or spring. The seeds germinate best when the outer coat of the seed is loosened or removed. On the land in cultivation it is necessary to grow cover crops through the winter, as this type washes almost as badly as the Memphis silt loam.

The type is fairly productive. It is not as good for corn as are the darker soils, but oats, rye, and grass do well. Owing to the loamy character of the soil, alfalfa does fairly well, but this legume is not grown extensively. The yield of corn is 20 to 55 bushels per acre, of oats 20 to 45 bushels, spring wheat 5 to 20 bushels, winter wheat 7 to 22 bushels, rye 10 to 30 bushels, and of timothy 1½ tons per

[1] This method has been successfully used on the farm of Frank Coverdale, Clinton County, Iowa, on a similar type of soil. The same method is said to be used successfully in the renovation of bluegrass pastures in Kentucky.

acre. Tomatoes are grown on the gentler slopes in some locations near canning factories.

There are small areas where nearly all of the surface soil has been washed away, but which are not sufficiently sloping to prohibit cultivation. In these areas the heavy nature of the soil renders plowing and cultivation quite difficult unless performed within a narrow range of moisture conditions. This type is less well supplied with organic matter than are the darker upland types. Stable manure is used quite extensively.

Land values range from $30 to $80 an acre.

Buckner Series.

The soils of the Buckner series are brown to dark brown, and overlie brown to yellowish-brown subsoils of about the same texture as the soils. They occur on stream terraces or in other areas holding essentially the position of a terrace or second bottom in the alluvial plain of the Mississippi and Missouri Rivers and the more important streams of the Central West. The material is alluvial in origin. These soils are well drained. The fine sand, fine sandy loam, very fine sandy loam, loam, and silt loam types are mapped in Lee County.

BUCKNER FINE SAND.

The Buckner fine sand as mapped in Lee County consists of a fine sand throughout the 3-foot soil section, there being no great difference in the texture of soil and subsoil. The surface soil to a depth of about 12 inches is light brown when dry and brown when wet. Below this depth the color is very slightly lighter and the structure slightly more compact.

There is apparently no native timber, though artificially planted Osage orange and maple do well. Crab grass and sand bur are abundant. The sand is blown about by the wind considerably, sometimes forming ridges as much as 4 feet high along hedge fences.

The type occurs on the Mississippi terraces north of Montrose, generally out from the bluff and near the margin of the terrace nearest the river. It does not occupy a very large part of the terraces. The topography is undulating, and drainage is good.

This type is not well adapted to ordinary farm crops, though corn and wheat are grown to some extent. The yields are light. Corn produces about 10 to 30 bushels per acre. This type is used somewhat for truck crops, principally melons.

This soil is probably the poorest in Lee County, owing to its lack of fertility and its tendency to blow, together with the fact that it is susceptible to drought and is not well suited to the common farm crops. Its value is about $30 to $40 an acre. It is possible that more extensive use for truck crops may give it a higher value.

BUCKNER FINE SANDY LOAM.

The Buckner fine sandy loam consists of a fine sandy loam to a depth of 12 inches. The material is light brown when dry and brown when wet. It is underlain by material of the same texture, with possibly a little more body, slightly lighter in color, and more compact in structure. There is no distinct boundary between soil and subsoil.

Most of this land is prairie, though some areas support a natural growth of scrub oak.

The type occurs on the Mississippi terraces out from the bluff and close to the margin nearest the river. It is probably the most important terrace soil in the county. The topography is gently undulating, and the type is well drained.

The Buckner fine sandy loam is fairly well adapted to the general farm crops and also to trucking, a large proportion of its area being used for the latter purpose. It is slightly better adapted to small grains than to corn. Corn yields about 15 to 50 bushels, oats 20 to 45 bushels, spring wheat 10 to 20 bushels, and winter wheat 10 to 25 bushels per acre. Alfalfa produces about 2 tons of hay per acre, though but little is grown. Bluegrass grows naturally, though less thickly than on soils of heavier texture.

The principal truck crops grown are watermelons, sweet potatoes, and tomatoes. Sweet potatoes average 150 to 250 bushels per acre. All areas of this type are so located that these crops can be readily marketed. The tomatoes are sent to local canning factories. Strawberries are grown to a very small extent.

The land is well drained, easily cultivated, and quite productive. It is valued at $80 to $130 an acre.

BUCKNER VERY FINE SANDY LOAM.

The surface soil of the Buckner very fine sandy loam is light brown when dry and brown when wet. It consists of a very fine sandy loam extending to a depth of about 15 inches. The subsoil to a depth of 36 inches or more is also a very fine sandy loam, more compact and slightly lighter in color than the surface soil, and becoming redder with increasing depth. Below 24 inches the texture approaches a silty clay loam. The change from surface soil to subsoil is very gradual.

This type occurs principally on the Mississippi and Des Moines River terraces. The topography is level to gently undulating. The type is well drained.

The Buckner very fine sandy loam is well adapted to the production of both general farm crops and truck crops. Corn averages 30 to 70 bushels per acre, oats 20 to 50 bushels, spring wheat 10 to 22 bushels, winter wheat 10 to 28 bushels, clover 1 ton, and sweet pota-

toes 100 to 200 bushels. Alfalfa does well and yields about 3 tons per acre.

The type is easily cultivated and is ready to be worked earlier in the spring than some of the heavier types. It is valued at $100 to $160 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Buckner very fine sandy loam:

Mechanical analyses of Buckner very fine 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.*
330829	Soil	0.1	2.0	3.4	28.1	26.0	33.3	6.9
330830	Subsoil	.1	2.2	4.2	30.6	27.9	24.7	10.5

BUCKNER LOAM.

The Buckner loam as mapped in Lee County has a surface soil consisting of a dark-brown to black loam to a depth of 10 inches. The subsoil is also a dark-brown to black loam, which below 30 inches becomes more distinctly brown in color and contains larger quantities of gritty material. The subsoil is more compact than the surface soil, especially in the lower part.

This type occurs on the Des Moines and Mississippi River terraces, generally back from the stream. The total area of the Buckner loam in this county is small. The topography is level to gently undulating, and the drainage is good. The soil is not naturally forested. There are, however, a few wild cherry, poplar, and honey-locust trees.

Corn does much better on this soil than on the other sandy terrace soils, yielding from 25 to 65 bushels per acre. The type is also well adapted to wheat, oats, and grass. Spring wheat yields about 10 to 22 bushels per acre, winter wheat 10 to 28 bushels, oats 25 to 50 bushels, and timothy about 1½ tons. The type is used to some extent for trucking.

The soil is easily cultivated and is quite productive. It is valued at about $100 to $175 an acre.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Buckner loam:

Mechanical analyses of Buckner 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.*
330819	Soil	0.1	10.1	16.0	25.8	5.8	29.2	12.8
330820	Subsoil	.4	11.9	15.9	24.5	5.8	25.4	15.3

BUCKNER SILT LOAM.

The Buckner silt loam surface soil consists of a dark-brown to black silt loam extending to a depth of about 10 inches. The subsoil, to a depth of 36 inches or more, is a dark-brown to grayish-brown silty clay loam. Generally below about 16 or 18 inches it has a yellowish-brown color and a heavier texture, approaching a silty clay. Below 32 inches the material is frequently darker in color, and at the lower depths it is quite compact and tenacious. In some places near the bluff the soil is heavier than typical throughout the section, approaching a silty clay loam at the surface, and being a very compact and tenacious silty clay below the surface. In some places next the bluff, especially at the mouths of small drainage courses, the soil has been modified by material washed down from higher areas and varies slightly in color and texture from the typical soil.

This type occurs on the terraces, generally back from the river and along the bluff. It occupies a slightly lower position than the other terrace types. The two largest areas are along Jack Creek on the Mississippi terrace near Montrose and in the vicinity of Vincennes along the Des Moines River.

The topography is level and the drainage is fair to poor. Ditching and tiling improve the physical condition of the soil and result in increased crop yields.

The common farm crops are grown on this type, but very little if any trucking is practiced. It is an excellent corn soil and is well adapted also to small grains and hay. Corn yields from 30 to 75 bushels, oats 25 to 50 bushels, spring wheat 10 to 22 bushels, winter wheat 10 to 28 bushels, timothy about 1½ tons, and clover 1 to 1¼ tons per acre. The type is held at $80 to $175 an acre.

WABASH SERIES.

The soils of the Wabash series are characterized by dark-brown to black surface soils of high organic-matter content and by drab or gray, slightly lighter colored subsoils. They are of alluvial origin and occur in first bottoms of streams in the Central Prairie States, the material being derived principally from the loessial and associated soil of this region. Five Wabash types are recognized in Lee County, the fine sandy loam, loam, silt loam, silty clay loam, and clay.

WABASH FINE SANDY LOAM.

The Wabash fine sandy loam consists of a dark-brown to black fine sandy loam, underlain at about 12 inches by a slightly more compact fine sandy loam of similar color. At 20 inches the material becomes distinctly lighter in color, having a decidedly yellowish-brown cast. The lower subsoil has more body than the surface material and approaches a silty clay loam.

This type occurs for the most part in narrow, elongated ridges. It is well drained. The total area in the county is small. The type is encountered in the first bottom east and south of Wever and along the Des Moines River.

The Wabash fine sandy loam is used principally for corn and wheat and in some cases for pasture. It is probably suited to melons and sweet potatoes, though neither crop is grown. Corn yields about 20 to 50 bushels per acre, spring wheat 10 to 20 bushels, and winter wheat 10 to 25 bushels.

The type is easily cultivated and moderately productive. It is valued at about $60 to $135 an acre.

WABASH LOAM.

The Wabash loam is a dark-brown to black loam, underlain at a depth of about 16 inches by a brown loam, somewhat lighter in color than the surface soil. The texture is fairly uniform throughout the section.

The type is found only in the Mississippi River bottoms, mainly in the vicinity of Wever. It is the least extensive type mapped and is relatively unimportant. It occurs at a slightly higher elevation than the heavier textured types of the Wabash series and is well drained.

The soil is used for the production of general farm crops, chiefly corn and wheat. Corn yields 25 to 65 bushels per acre, spring wheat 10 to 20 bushels, winter wheat 10 to 25 bushels, and oats 20 to 45 bushels. The soil would probably produce good yields of sweet potatoes and alfalfa, but these crops are not grown.

The soil dries quickly, is easy to cultivate, and is quite productive. It is valued at $85 to $100 an acre.

WABASH SILT LOAM.

The surface soil of the Wabash silt loam is a dark-brown to black silt loam, with a depth of about 12 inches. The subsoil to 36 inches or more is a dark-brown to black heavy silt loam to silty clay loam. At about 18 inches it becomes mottled with yellowish brown and bluish gray, changing in texture to a clay loam. At about 28 inches the material is a silty clay, but the color does not change, except for the predominance of pale yellowish brown. In some places the material below 18 inches continues as a heavy silt loam to silty clay loam instead of becoming heavier, the color remaining the same.

This type occupies a considerable area in the Mississippi and Des Moines first bottoms. In the vicinity of Wever it is found back from the river, the soils nearer the river being heavier in texture. The topography is level. The type is fairly well drained.

The Wabash silt loam is well adapted to the production of the general farm crops. Owing to its alluvial origin it is a productive

type. It is used chiefly for corn, which yields 30 to 75 bushels per acre. Wheat is the principal small grain, and yields from 10 to 30 bushels per acre, depending on the season. The type is used to some extent for timothy and alfalfa. It makes good though high-priced pasture.

This is one of the most valuable of the first-bottom soils. It is held at about $100 to $170 an acre.

Wabash silt loam, colluvial phase.—The Wabash silt loam, colluvial phase, is a grayish loam or dark-brown to black heavy silt loam to a depth of 9 to 16 inches, underlain by a dark-brown to black silt loam which changes gradually at about 20 inches to a silty clay loam, frequently black in color, but occasionally dark brown or yellowish brown. Below 32 inches the texture is frequently a silty clay. In different locations there is a variation in the depth and uniformity of these layers. Gravel fragments are generally found in the lower part of the soil section.

This phase occurs throughout the upland of the county on the slopes along drainage courses above the point where they have developed first bottoms. It lies either below the Lindley loam or directly below the other upland soils.

This soil is of colluvial origin and is derived from loessial and glacial soils.

While the slopes this phase occupies are very gentle, the soil occurs in such narrow strips that practically none of it is in cultivation. Its total area is relatively small, and the phase is of little importance in this county. It is held only in conjunction with other soils and is valued at about $30 to $60 an acre.

The table following gives the results of mechanical analyses of samples of the soil and subsoil of the colluvial phase of the Wabash silt loam:

Mechanical analyses of Wabash silt loam, colluvial phase.

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.*
330817	Soil	0.0	0.9	0.9	6.8	9.3	67.8	13.9
330818	Subsoil	.0	.9	.6	4.8	11.2	66.2	16.0

WABASH SILTY CLAY LOAM.

The surface soil of the Wabash silty clay loam is about 9 inches deep. It consists of a dark-brown to black silty clay loam. The subsoil is a dark-brown to black silty clay, which at about 16 inches becomes a silty clay to clay, the color being tinged with rusty brown and bluish gray. Bordering the river there are a number of strips or small spots, too small to be mapped separately, where there is

considerable coarse sand mixed with the soil. The amount of included sand is not sufficient to influence the soil materially.

The type is found only in the Mississippi River first bottom, in the vicinity of Wever. Its largest development is along the Mississippi River near the mouth of Skunk River. A narrow strip occurs along the old channel of Lost Creek. The type occupies rather low lying areas of level topography and is only fairly well drained, the drainage being poor in some places. Ditches and tiles are used in places and are very beneficial.

The raising of the water level by the construction of the Keokuk Dam is the cause of the poor drainage of some of this land and has resulted in the inundation of a small proportion of this type as well as of the Wabash clay. It is expected that the water table will ultimately reach a higher level and considerably larger areas will be inundated. In addition to the land actually covered with water, adjoining land is injured by an excess of water in the soil and subsoil, resulting from seepage. The possibilities of diking this land and keeping it drained by pumping are being considered.

The soil has been quite productive in the past. It is adapted to the general farm crops and particularly to corn, which yields about 30 to 70 bushels per acre. Wheat is the principal small-grain crop and yields 10 to 25 bushels. Clover and timothy are grown to a small extent. Practically all of this land is owned by the Mississippi River Power Co. It has been valued at $75 to $140 an acre.

The results of mechanical analyses of samples of the soil and subsoil of the Wabash silty clay loam are given in the following table:

Mechanical analyses of Wabash silty clay 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.*
330843	Soil	0.1	0.4	0.2	5.6	12.0	57.9	23.5
330844	Subsoil	.2	.3	.2	3.3	13.0	58.3	24.6

WABASH CLAY.

The Wabash clay consists of a dark-brown to black silty clay to clay, underlain at a depth of about 10 inches by a dark-brown silty clay to clay. There is practically no change in color throughout the section. Both soil and subsoil are compact, plastic, and tenacious. In some places along the Mississippi River a very small percentage of gritty material is mixed with the soil and subsoil. This was probably washed in by the flood waters from Lost Creek or the Skunk River.

This type occupies the lowest situations along the Mississippi and Des Moines Rivers. In general it is rather poorly drained. A large part of this soil in the vicinity of Wever is covered by a few inches of water, and the inundated area is indicated on the soil map by swamp symbols. The greater part of the remainder of the type is so water-logged by seepage water that it is unfit for cultivation.

Before the construction of the dam a part of the type in the vicinity of Wever and most of that along the Des Moines River was in cultivation, being used principally for corn and timothy. The area along the Des Moines River is still cultivated. Corn yields range from about 15 to 50 bushels per acre.

The value of the larger development of this type near Wever, like that of the Wabash silty clay loam, is reduced by the high water table. Its former value ranged, as does the present value of some of the type, from about $30 to $75 an acre.

SUMMARY.

Lee County is in the southeastern corner of Iowa, within the Glacial and Loessial Province. It has an area of 511 square miles, or 327,040 acres.

The county comprises two main physiographic divisions. The upland plateau, with level to rolling topography, constitutes one division, and the alluvial river terraces and first bottoms the other. The former occupies about six-sevenths of the total area of the county.

The total population of the county is reported in the 1910 census as 36,702. Keokuk, the largest town in the county, has a population of about 14,000, and Fort Madison about 9,000.

The county is well supplied with railroads, which afford direct service to Chicago, St. Louis, and Kansas City, and has also river transportation.

The climate of Lee County is temperate, and though extreme temperatures occur, they are of comparatively short duration. The mean annual temperature is about 52° F. The average annual precipitation is about 35 inches. The average growing season of nearly 200 days is sufficient for all the general farm crops.

The agriculture of the county is based on general farming. A few farmers specialize in stock raising, dairying, and trucking. Corn is the principal crop. Winter and spring wheat, oats, rye, clover, timothy, and alfalfa also are grown. Bluegrass thrives throughout the county. Truck farming is practiced extensively on the terraces, watermelons, sweet potatoes, tomatoes, and strawberries being the principal truck crops. About 95 per cent of the land area of the county is in farms. Of the farm land about 69 per cent is improved. The aver-

age size of farms is reported as 131.6 acres, of which 91.4 acres are improved. The average value of land is given as $63.01 an acre.

Nineteen soil types are recognized and mapped in this county. These are grouped into nine series.

The Memphis and Marion silt loams are light-colored soils, occurring principally along the bluffs and near the margin of the plateau. Both are of loessial origin, though the subsoil of the latter is influenced by glacial till. They are used for the general farm crops and are better suited to wheat and rye than to corn.

The Grundy and Putnam soils are relatively dark, owing to the presence of organic matter. They lie back from the margin of the plateau. They are good corn soils, and in general are more productive for all farm crops than the other soils of the county.

The Union stony loam is too steep and stony for cultivation. It occupies a small total area, and probably is best adapted to pasture.

The Genesee series includes first-bottom soils occurring in the bottoms of small interior drainage courses and also in the more extensive first bottoms along the rivers. They are very productive and are used principally for corn and wheat.

The Lindley loam is derived from glacial till and occurs on slopes where the overlying loess has been washed away. Where not too steep to be cultivated this soil is quite productive.

The Buckner series includes the brown to dark-brown terrace soils. They are used mainly for general farm crops and are very productive. The lighter textured soils are used largely for truck crops, to which they are well suited.

The Wabash soils are dark colored, and occur in the larger areas of first bottom land along the rivers. The heavier types are in some places poorly drained, but elsewhere these soils are quite productive. Corn is the principal crop grown, with small grains where the soils are not too heavy.

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