

Issued April 26, 1913.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE UNIVERSITY OF MISSOURI AGRICULTURAL
EXPERIMENT STATION, F. B. MUMFORD, DIRECTOR.

SOIL SURVEY OF FRANKLIN COUNTY,
MISSOURI.

BY

E. S. VANATTA, OF THE U. S. DEPARTMENT OF AGRICULTURE,
AND H. G. LEWIS, OF THE UNIVERSITY OF MISSOURI.

HUGH H. BENNETT, INSPECTOR IN CHARGE SOUTHERN DIVISION.

Advance Sheets—Field Operations of the Bureau of Soils, 1911.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.

1913.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., October 3, 1912.

SIR: In continuation of the cooperative work in Missouri one of the projects of the field season of 1911 was the survey of Franklin County. The selection of this area was made after conference with State officials.

I have the honor to transmit herewith the manuscript report and map covering this area and to recommend their publication as advance sheets of field operations of the Bureau of Soils for 1911, as provided by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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SOIL SURVEY OF FRANKLIN COUNTY, MISSOURI.

By E. S. VANATTA, of the U. S. Department of Agriculture, and H. G. LEWIS, of the University of Missouri.

DESCRIPTION OF THE AREA.

Franklin County, Mo., lies in the eastern part of the State just south of the Missouri River, 34 miles southwest of St. Louis and 204 miles from Kansas City. On the north it is separated from St. Charles and Warren Counties by the Missouri River, on the west it is bounded by Gasconade County, on the south by Crawford and Washington Counties, and on the east by Jefferson and St. Louis Counties.

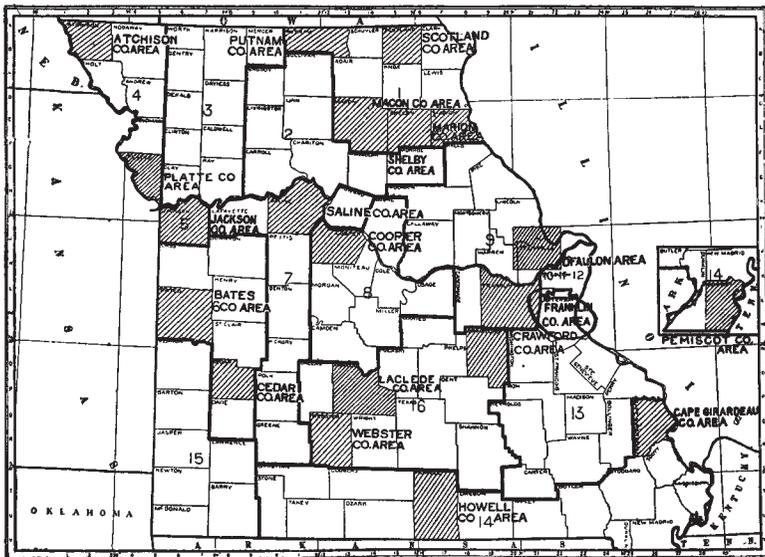


FIG. 1.—Sketch map showing areas surveyed in Missouri.

The county lies between parallels $38^{\circ} 12'$ and $38^{\circ} 42'$ north latitude and meridians $90^{\circ} 45'$ and $91^{\circ} 22'$ west longitude. It is nearly square in shape, with an area of 908 square miles or 581,120 acres.

The county is in the Ozark border region. Its topographic features vary from gently rolling to broken and ridgy, the greater part being strongly rolling, with numerous ridges and hills and a wide-reaching drainage system. Running in a northwest and southeast direction

through Jefferson County—its western boundary entering Franklin County at Pacific and crossing the Missouri River just east of Labadie into St. Charles County—is the Crystal City escarpment. Along its western boundary it rises to a height of nearly 200 feet, sloping gently to the northeast. The greater part of this area drains directly into the Missouri River. Deep, narrow stream valleys, with their south and west slopes as a rule stony, are characteristic features of this section.

The topography of the remainder of the county is for the most part gently rolling to hilly. Rough stony areas found in the south-central part of the county, narrow strips of stony land along valley walls of the larger stream courses, and three small prairielike regions—one south of Luebbering, one near Gerald, and one around Sullivan—are the only exceptions.

The greater part of the county was at one time heavily forested, and probably 50 per cent of the lower one-third is at the present time covered with a timber growth.

The altitude varies from 500 to 1,000 feet above sea level. The highest area occurs in the southwestern portion of the county, the lowest along the wide bottom of the Meramec River in the northeastern corner, and along the Missouri River where it forms the northern boundary of the county. The slope from the southwest to northeast is continuous and gradual.

Originally the county was a plain, with a gradual slope to the northeast. Erosion has dissected most of the original surface, leaving only occasional flat plateau areas, the dominant surface configuration being a series of ridges of varying width and fairly uniform height with intervening stream valleys.

The county is well drained as a whole, the drainage waters of the northern part flowing into the Missouri through the Berger, Boeuf, St. Johns, Dubois, and other smaller streams. A long ridge entering the county west of Gerald and running in a slightly northwest direction through Jeffriesburg, Villa Ridge, and Grays Summit across the Crystal City escarpment and out of the county about 3 miles north of Pacific, forms the divide between the Missouri River and the inland streams. The divide between the Meramec and Bourbeuse Rivers is formed by a ridge entering the county at Sullivan and running in a northeasterly direction to Moselle, where the two streams unite. From this point the Meramec takes a northeasterly course, leaving the county at Pacific. The extreme southeastern portion of the county drains to the northeast into Big Creek in Jefferson County.

The history of the county dates from 1802, when the early settlers located on the rich bottom lands along the larger streams. Many of them were of French descent. The first town, established in 1818 as St. Albans, was swept away by the flood of 1844.

Franklin County was organized in 1818, embracing what is now Gasconade, Osage, and parts of Maries and Miller Counties. The county seat was established at Newport, St. Johns Township, near the Missouri River. In 1820 Gasconade County was segregated, leaving Franklin County with practically the same boundary lines it has at the present time. In 1828 the county seat was moved to Union, its present site. Many of the settlers coming in at this time were Germans, and to-day a large proportion, if not the majority, of the population of the northern section of the county is of German descent. Aside from a settlement of Poles near Krakow, the remaining white population is largely American. The negro population is not large and is evenly divided between town and country.

The census of 1910 gives the population of the county as 29,830. Over one-half is classified as rural population. Washington, with a population of 3,670, is the largest town in the county. It is located on the river front in the north-central part of the area. It has direct rail connection with both St. Louis and Kansas City, and is the seat of a number of manufacturing interests. Pacific, a town of 1,400, was originally known as Franklin. It is the center of a thriving industry in glass and molding sand, the product being secured from the Crystal City escarpment, which crosses the northern part of the town. Large shipments of dairy and poultry products are made from this place. Union, the county seat, is a town of 934 inhabitants. It has some manufacturing interests. There are many smaller towns scattered over the county. Most of the towns, especially in the northern half of the county, possess at least one flouring mill.

Railroad facilities over most of the county are excellent. The Missouri Pacific enters the area at Pacific, following the foot of the Crystal City escarpment to Labaddie, whence it follows the Missouri River bottom to the northwestern corner of the county. The St. Louis & San Francisco Railroad enters the county at Pacific, crosses the Meramec River and follows the Meramec-Bourbeuse divide, leaving the county at Sullivan. The Chicago, Rock Island & Pacific follows the Missouri River into the northeast corner of the county, leaves the bottom at Labaddie for Union, where it strikes the Missouri and Inland stream divide or Gerald ridge, passing out of the county west of Gerald. The southeastern portion of the county is farthest from the railroads, and prior to the building of bridges across the Meramec a greater part of the produce was hauled overland to St. Louis. Even yet much of the farm products reaches St. Louis in this way.

The course of the roads in Franklin County has been determined largely by the topography and not by land lines. As a whole they

are poor, especially during the fall and spring months. With the abundance of road material available on the rocky hills and in the gravelly creek beds good roads might be had at a minimum cost. Rural free delivery of mail and telephone service reach all parts of the county.

The natural resources of Franklin County are varied and well developed. In addition to the mining of glass sand several large lead mines are in operation, and a great deal of ore is annually surface mined by the farmers in the southern section. A large iron, paint, and sulphur mine is in operation southeast of Gerald. Fire clay is mined to some extent in the western part of the county. Gravel and ballast is shipped out in large quantities. The cutting of ties, mine props, and cordwood is still an important industry. The supply of suitable timber is rapidly being cut off.

CLIMATE.

The climate of Franklin County does not differ materially from that of counties surrounding it. It is perhaps more equable in temperature than the level plains to the north, and slightly less so than those counties to the south. The county as a whole, with its high altitude, its rolling topography, and excellent water, has a very healthful climate.

Years of extreme variation are fortunately of rare occurrence. However, variations sufficiently serious to affect crops may be expected even during seasons in other respects normal. The most common of these variations are: An abnormally warm spring, followed by late frosts, short periods of drought during critical stages of the growing season, and the lack of a covering of snow, causing injury to wheat through repeated freezing and thawing.

There is a Weather Bureau station at Pacific, from the records of which the following table, showing the mean annual rainfall and temperature, was compiled. These figures are based upon records covering 20 years and should furnish a fair index of the conditions.

The average date of the last frost in spring is April 16 and of the first frost in the fall is October 22. This gives a growing season of nearly 189 days, or slightly over 6 months, an ample season for maturing any of the general farm crops. The latest recorded frost in the spring occurred on May 14 and the earliest in the fall on September 30. Such marked variations from the normal are very exceptional.

*Normal monthly, seasonal, and annual temperature and precipitation at
Pacific, Mo.*

Months.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow fall 1911.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	35.0	72	-16	2.10	5.01	2.65	3.5
January.....	32.8	76	-13	2.38	1.07	2.77	T.
February.....	31.8	85	-21	2.58	1.84	4.05	9
Winter.....	33.2	85	-21	7.06	7.92	9.47	12.5
March.....	46.2	92	0	3.71	3.02	3.80	8.0
April.....	55.9	90	22	4.15	3.17	5.91	0
May.....	65.9	94	31	5.39	2.04	7.38	0
Spring.....	56.0	94	0	13.25	8.23	17.09	8
June.....	74.4	105	41	4.65	1.18	4.01	0
July.....	77.4	112	53	4.81	.49	9.00	0
August.....	77.0	107	50	3.24	2.30	.47	0
Summer.....	76.2	112	41	12.70	3.97	-13.48	0
September.....	70.7	104	24	3.94	.72	6.82	0
October.....	58.7	93	23	2.6	3.00	3.23	T.
November.....	45.5	82	9	2.72	1.26	4.90	1.8
Fall.....	58.3	104	9	9.26	4.98	14.95	1.8
Year.....	55.9	112	-21	42.27	25.10	54.99	22.3

AGRICULTURE.

Agriculture has always been the leading industry of Franklin County. General farming is the prevailing type and has been from the time of settlement. In the northern half of the county a combination of grain farming and the feeding of stock is followed, as a rule, while in the southern half of the area farming and stock raising are more commonly combined. In the early days when shipping facilities were limited it was found that the only practical way to market the farm surplus was "on the hoof." The system of combined general farming and stock raising has done much to maintain the fertility of the soils of the county.

Wheat has long been the leading crop of the county. The output for 1911 was 933,563 bushels from 65,722 acres, a yield of slightly over 14 bushels per acre. The areas of the highest yields include the river bottoms and northern part of the county, these being counterbalanced by the lower yielding areas of the southern half of the county. Winter wheat varieties are the only ones grown

in the county. Of the smooth varieties Fultz is the most popular, and of the bearded varieties the Mediterranean leads. The bearded kinds, although disagreeable to handle, are better suited in some localities. The more systematic use of a crop rotation would greatly increase the yield per acre. The most common and perhaps the best rotation in use is one including corn, wheat, and clover, the periods given to the production of each varying, but the order usually remaining the same. Corn is usually cut and shocked in order to provide room for the wheat. The ground is then disked, harrowed down, and drilled to wheat. From the latter part of September to the middle of October is the usual time for wheat sowing. When wheat follows wheat the stubble is often pastured until early September and then plowed, harrowed down, and sown to wheat as before. The better farmers plow the land in July or August where possible.

The use of commercial fertilizer is becoming more prevalent with each succeeding season. Complete fertilizers of good grades have generally given good results.

As is the case in other portions of the State, Franklin County is troubled with the Hessian fly. By sowing the seed late the fall brood is avoided to some extent. Another method of combating the pest consists of planting a small strip early in the fall. The flies lay their eggs in this, and by plowing the strip under and reseeding with the remainder of the field the greater part of the fall brood will be destroyed.

Less than half of the wheat grown in the county is shipped out, the greater part being made into flour by the local mills.

Corn, the second crop in point of acreage, is grown in a general way throughout the county with varying degrees of success, but with generally good results. The average yield per acre in 1910 was 39 bushels.¹ Very little corn is shipped, the greater part being fed in the county. Little pure-bred seed corn is used as yet. Reid's Yellow Dent, Johnson County White, and St. Charles White are the prevailing types seen on the upland, where selected varieties are used. In the bottoms Boone County White and Cob Pipe corn are common varieties.

Both white and red cob strains of the Cob Pipe corn are grown. Careful selection of seed for years past has resulted in a large-cob variety. Since a strong soil is necessary for best results practically all of the Cob Pipe corn is grown upon Missouri bottom soils or upon the loessial soils of the "First Bluff" belt. The crop is a fairly profitable one, as, in addition to the moderate yields of grain, the cobs bring 25 to 40 cents per hundred.

¹ Missouri Crop Reporter, 1910.

In the system of rotation, as followed by the better farmers, corn follows clover, thus getting the first benefit from the organic matter and nitrogen left in the soil by the legume crop.

In the cultivation of the corn crop a system of deep plowing is too often followed. Frequent shallow cultivations continued until late in the season have given excellent results. The main advantage gained in shallow cultivation is that roots are not disturbed. Under the common system of deep cultivation a great deal of injury results to the crop by tearing out and cutting off the roots or feeders of the corn plants. A frequent shallow cultivation serves the double purpose of conserving the soil moisture with a surface mulch and in killing the weeds. During the field season of 1911, which was one of prolonged drought, a few instances of late cultivation, consisting simply of dragging a mower wheel between the corn rows, were observed. This cultivation was given every week or 10 days during the season and with excellent results in the final yield.

The greater part of the corn in the county is cut and shocked in order to clear the field for wheat. Some is also used for silage, and with the growth of dairying a larger acreage will be harvested in this way.

In this county oats are of minor importance. They are not necessary in the crop rotation and have not proved a paying crop. The season of 1911 being very dry, few fields of oats made a growth sufficient to warrant harvesting. During a normal season a fairly good crop is obtained. Practically all the oats grown are of spring varieties. A few trials with winter oats have been made, and in most cases reported have given good results.

Red clover is successfully grown in all parts of the county, especially in the loessial and limestone regions. It ranks high as a forage crop and forms an important member of the crop rotation. Clover is frequently, though not always, sown in the wheat during early spring, using the wheat as a nurse crop. After the wheat has been harvested the clover attains a good growth and the following fall may be either pastured or cut for hay. During the next season two crops of hay are usually cut. The second cutting of the second season is usually cut and thrashed for the seed. The stubble is pastured during the fall and turned under the following spring when the land is planted to corn.

On some of the poorly drained second-bottom areas, where the growth of red clover is uncertain, Alsike clover should prove a success. It is a short perennial clover which attains a growth about half that of red clover but is better adapted to wet lands. When Alsike and timothy are sown together a good crop of hay should result.

Cowpeas make an excellent growth and are coming into favor throughout the county. They are often sown alone for hay and forage and yield heavily. During the past season instances were observed when the spring sowing of clover had made an utter failure due to excessive drought. In the latter part of June to July a few of these areas were drilled to cowpeas and a good crop obtained. When drilled in with the corn at its last cultivation cowpeas make a good growth in favorable seasons. They may also be planted in the hill with the corn, this being the better way in most seasons.

Bluegrass is indigenous to the area and makes everywhere a luxuriant growth. Land seeded to clover and timothy if allowed to stand in pasture for any considerable length of time will run to bluegrass. Large areas of stony land, unsuited for cultivation and at present occupied by a scrubby growth of timber, could be advantageously cleared and sown to bluegrass, which as a pasture grass is unexcelled.

Alfalfa is being grown successfully upon a small acreage, mostly along the Missouri and smaller stream bottoms and along the loessial belt. These areas are well suited to the crop, and excellent yields of three to five cuttings are reported. The greater part of the county, however, is not adapted to the production of alfalfa.

Timothy, commonly used in connection with clover for hay, is rarely seeded by itself.

Sorghum, pop corn, broom corn, flax, buckwheat, rye, and tobacco are grown to a small extent. A considerable acreage of sorghum was planted during the past season for forage and made a good growth.

One large nursery is located in the county just south of New Haven, in connection with which is a commercial orchard. With this exception no large bearing orchards were observed. The better class of small orchards noted were in the northern part of the county. They apparently yield well and the trees are said to be long lived.

Small fruits and vegetables are grown only for local trade and family use.

The census of 1910 reported 87,853 head of live stock in the county. Of these 22,637 head were cattle valued at \$544,553; horses numbered 10,156 and were valued at \$1,016,993; mules, 4,477 at \$529,898; hogs, 39,549 at \$246,678; and sheep, 9,478 at \$36,141. Among the live stock hogs were formerly in largest numbers, but in late years epidemics of cholera have considerably reduced them. The Poland-China and Duroc-Jersey are the most popular breeds, although a cross of these strains is gaining in favor among the farmers.

Light-weight horses ranging from 1,000 to 1,200 pounds seem generally preferred for work stock, except in the northern section of the county. Sheep raising is not practiced extensively, and only a few flocks were seen. A good many cattle are grown in the southern part

of the county, feeding for market being the general practice in the north.

Dairy cattle of medium to good quality are numerous throughout the county. The nearness to market, excellent transportation facilities over a great part of the county, and moderate price of land, together with the excellent natural pasture and good water, combine to form conditions very favorable to profitable dairying. At present there are several first-class dairies, including the highest graded dairy of the State of Missouri, in Franklin County. A great many farmers milk a few cows and ship out one or more cans of milk or cream daily. Cows of the Holstein and Jersey breeds, together with grades of these bloods, compose the greater part of the dairy herds.

The character of the farm buildings and improvements varies greatly with the locality. In the northern part of the county the population is largely German. Here we find neat, well-kept buildings, surrounded by well-fenced fields in good state of cultivation. In the southern part, composed of the lighter soils and more broken areas, farm improvements are more temporary in character.

There are several large holdings of thousands of acres, but the farms usually range in size from 40 to 400 acres, the average farm being slightly over 100 acres. Land rents are generally on a crop basis and usually consist of one-third or two-fifths of the grain crop.

The price of Franklin County farms varies greatly, the Missouri River bottom lands being held at from \$60 to \$100 an acre. Considering the chance of overflow this seems rather high and little of this land changes hands. Bottom lands along the smaller streams range in price from \$40 to \$80 an acre where enough may be had to constitute a farm. As a rule, however, the strips of bottom land are contained in farms consisting of both upland and bottom. The loessial belt along the northern boundary of the county ranges from \$65 to \$100 an acre. The Union soils vary in value from \$20 to \$75 an acre, depending upon the proportion of arable land, character of the soil, state of cultivation, improvements, and location. The Glacial soils of the western part of the county range in price from \$10 to \$45 an acre, varying as do those of the Union series.

Farm labor may be had at \$18 to \$25 a month and board. Very little help is hired. The numerous manufacturing, mining, and lumbering enterprises of the county furnish employment to many of those seeking work.

SOILS.

Franklin County comprises two main soil divisions: (1) The uplands, which include the rolling loessial and residual soils, and (2) the bottoms, which embrace first bottoms, largely subject to overflow, the undulating to flat stream terraces, and abandoned stream valleys.

Four extensively developed series of soils and one other of little extent are developed in the upland division. The Knox series, of which one type, the silt loam, was mapped, is confined to a comparatively narrow strip along the Missouri River. This soil is a friable, light-brown silt loam, underlain by a lighter brown silt loam to silty clay loam. The material is believed to be of loessial or wind-blown origin. In road cuts the soil stands up in almost perpendicular walls such as characterize loessial soils in general.

The Union series, comprising the silt loam and two phases of this type, is believed to be loessial in the soil portion and mainly residual from limestone and sandstone in the subsoil portion. It is possible that the loess content diminishes toward the south, as one goes away from the area of its most typical development near the Missouri River. The Union soils are easily tilled, and are quite productive, with a wide range in crop adaptation.

Over the rolling and severely eroded areas there is an extensive development of stony loam which has been grouped with the Clarksville series. These soils are characteristically cherty, having been derived from cherty limestone, but in the type as mapped in Franklin County there are some included areas derived largely from sandstone. Such areas might have been separated from the typical cherty limestone soil, such as the belt in the southern part of the county, but this was not done on account of the thin surface soil, the abundance of stony material, and the steep slopes—conditions so unfavorable to agricultural operations as to make any separation of little or no practical value. That portion of the type derived from sandstone probably belongs properly in the Tilsit series.

In the western and southwestern part of the county there is an extensive development of a grayish-brown to light-brown silt loam which grades quickly into a yellowish-brown silty clay loam overlying a heavy plastic, impervious clay of a light-brown to dingy or snuff brown color. This heavy clay portion of the subsoil reaches a depth of 3 feet or more in places, but over considerable areas a friable or sandy layer is encountered within the 3-foot section. Oxide of iron concretions are common throughout the soil profile, especially in the heavy clay portion of the subsoil.

The surface drainage of this soil is mainly well established, owing to the prevailing rolling topography, but underdrainage is so poor that the type is one of imperfectly established drainage. This soil has been mapped under the name of Gerald silt loam. It is not so productive as the Union silt loam and probably differs from that type in origin. There is some uncertainty as to the origin of this soil, although it is probably formed from the same material as that giving rise to the Oswego soils, extensively developed in the Ozark border

region. The soils of the Gerald series are quite similar to those of the Oswego series in texture, structure, and profile arrangement, the essential difference being in the color, which is brownish in the Gerald and ashy gray to nearly black in the Oswego.

A small area of a dark-brown silt loam underlain by a yellowish-brown silty loam, which in turn is underlain within the 3-foot section by a stratum of mixed reddish-yellow clay and angular chert fragments, was mapped in the southern part of the county. This soil was called Lebanon silt loam. It resembles very much the Lebanon silt loam of Laclede County, Mo., especially the poorly drained phase found there.

A considerable area of Rough stony land without agricultural value was mapped throughout the county. The stone in this type consists of fragments of sandstone and limestone chert, and outcrops of ledges of this rock.

The material entering into the composition of the alluvial stream bottom soils varies in its source on the different streams, since such material represents wash from the soils of the several drainage basins. The soils of the Missouri River bottoms have been mapped separately from those of the tributaries of this stream because of such differences. In the bottoms of the Missouri River two series were mapped—the Wabash and Sarpy. The Wabash series, including one type, the clay, is a dark brown to black soil occurring in the depressions where poor drainage has caused the accumulation of dark-colored vegetable matter in the surface soil. The Sarpy series, including the silt loam, very fine sandy loam, and clay, is characterized by the dark-brown to nearly black color of its soils and by its lighter colored and lighter textured subsoils. In the Wabash series the texture remains about the same or becomes heavier with depth, whereas in the Sarpy series the subsoil is lighter and more friable than the soil.

The first-bottom alluvial soils of the smaller streams of the county are composed of material washed mainly from the residual limestone and sandstone material. The brown first-bottom soils have been mapped as Huntington, only one type—the silt loam—having been encountered. The poorly drained dark-colored soils which occur in only a few relatively small areas have been called Dunning clay.

The brown terrace soils representing alluvial material which was deposited when the waters of the streams reached higher levels was mapped as Elk silt loam. The gray soil occurring on stream terraces and in abandoned stream valleys no longer subject to overflow was given the name Robertsville silt loam.

In the following chapters the character of the various types has been brought out more in detail and the crop values and adaptations of the several soils discussed at considerable length.

The following table gives the name and extent of each soil mapped in the county:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Union silt loam.....	128,576	43.8	Riverwash.....	4,032	0.7
Sandy subsoil phase.....	116,416		Sarpy very fine sandy loam.....	4,032	.7
Gray phase.....	9,536		Wabash clay.....	3,776	.6
Clarksville stony loam ¹	99,712	17.2	Sarpy clay.....	3,520	.6
Gerald silt loam.....	80,000	13.8	Lebanon silt loam.....	2,432	.4
Huntington silt loam.....	49,600	8.5	Elk silt loam.....	2,304	.4
Robertsville silt loam.....	32,192	5.5	Sarpy silt loam.....	1,856	.3
Knox silt loam.....	24,832	4.3	Dunning clay.....	384	.1
Rough stony land.....	11,008	3.1	Total.....	581,120
Glade phase.....	6,912				

¹ Includes some Tilsit stony loam.

KNOX SILT LOAM.

The surface soil of the Knox silt loam consists of a smooth, velvety silt loam, light brown to brown with an ashy gray cast, varying in depth from 10 to 14 inches. It contains a moderate quantity of organic material and is very friable and easily tilled. Below 14 inches it grades into the subsoil—a compact, friable, light-brown silt loam to silty clay of uniform texture, extending to a depth of 3 feet or more. Occasionally faint mottlings of gray are encountered in the lower depths in the more level areas. Both the soil and subsoil are free of stone and are very uniform in texture throughout the extent of the type.

The type is susceptible to erosion, especially where a slight wash is once started. As is true with the loessial soils generally, the material stands almost perpendicularly in exposed sections or cuts, there being little tendency to wash down in long slopes. The weathering of the material in such cuts frequently develops a breaking away of sections of the soil from the main body, forming a peculiar system of isolated soil columns, a form of erosion characteristic of this type alone.

The topography of the type may be described as rolling to somewhat broken. In places the roughness of the surface is a serious impediment to successful cultivation. Drainage is well established. The friable structure of the soil and deep subsoil forms exceptionally good drainage, as a result of which the soil warms up quickly and is in shape for cultivation early in the spring. The Knox silt loam is undoubtedly derived from loess—a brownish stratum of silty material believed to have been laid down as a mantle over the underlying formations by wind action. The depth varies from a thin layer to about 60 feet.

The Knox silt loam occurs as a strip bordering the Missouri River along what is locally known as the First Bluffs. This strip varies in width from 1 mile to 3 miles and extends from Etlah, near the northwestern corner of the county, across the county, passing out near the northeastern corner. It also follows the valley of Labaddie Creek for a distance of nearly 4 miles.

Originally the type was covered by hardwood forests. Except areas immediately bordering the larger streams, very little is in timber at present. White and laurel oak, black walnut, hickory, elm, wild cherry, ash, honey locust, and paw paw are the most common trees at present. The soil is the best agricultural type in the county, but it is unfortunately of small extent.

Wheat is the leading crop, winter varieties being grown exclusively. The yields range from 18 to 30 bushels per acre with an average of 20 bushels, and of corn from 40 to 75 bushels with an average of 50 bushels per acre. Oats do well, but are not extensively grown. Alfalfa gives excellent results and is a profitable crop. Red clover and cowpeas are also successfully grown. Bluegrass and timothy make a luxuriant growth, although very little land is devoted to them.

Apples do well, and the trees are longer lived than those found on the thinner soils having a compact intractable subsoil. Vegetables and small fruits also give good yields, though grown only for home use.

General farm conditions and improvements are of a superior class, showing more care in the upkeep of the farm buildings than on any of the other soils.

Land values range from \$65 to \$125 an acre, depending on location with reference to markets.

GERALD SILT LOAM.

The Gerald silt loam consists of a gray to grayish-brown, smooth silt loam, varying in depth from 4 to 7 inches and grading into a yellowish-brown silty clay loam subsoil, which changes gradually with depth into a light to dingy brown, heavy, plastic clay, frequently mottled with gray in the lower sections. On the more level areas the surface soil is usually lighter in color and iron concretions more abundant than elsewhere, such areas being known locally as "shotty land."

On the crests of the ridges and on the small flat prairie areas the heavy clay of the subsoil continues to a depth of 36 inches or more. On the lower slopes, especially near the boundary of the sandy subsoil phase of the Union silt loam, the lower portion of the subsoil is

often more sandy than the upper section. The heavy, intractable clay subsoil makes root penetration of growing crops difficult.

A phase of the Gerald silt loam occurs in this area. Its most important difference from the typical Gerald silt loam is the compact layer of lighter textured material encountered at a depth of about 24 inches. The heavy plastic clay passes abruptly into this lighter material, which is a grayish silt loam with a quite noticeable content of sand. The yields on this phase average a little lighter than on the typical soil.

The Gerald silt loam is developed most extensively in the western and southwestern parts of the county. The topography is gently rolling to strongly rolling. The original surface configuration was probably an undulating to nearly flat plain resembling the flat section about Gerald, but the deepening of the drainage ways has largely destroyed the original smoothness of the country.

Surface drainage is good, except in case of the more nearly level areas, where the drainage is poor and the soil slow to warm up in the spring. Owing to the impervious clay subsoil the downward movement of moisture is extremely slow. The type is not particularly subject to erosion.

The Gerald silt loam is believed to be similar in origin to the Oswego silt loam, which it closely resembles in texture, structure, and profile arrangement. The main point of difference is the brownish color of the soil as compared with the ashy gray to nearly black color of the Oswego soils.

Originally the type probably existed as an undulating or nearly flat practically treeless plain, supporting a growth of prairie grass. Later, as erosion dissected this plain a scrubby growth of hardwood trees covered the broken areas and stream borders. The present tree growth is somewhat stunted, the trees not making the vigorous growth observed on the better soils. The timber consists mainly of scrub post oak, bur oak, and blackjack oak, with occasional small white oaks and hickories. The tree growth on the stony areas is especially stunted.

Owing to the heavy impervious subsoil the more level areas are inclined to heave in winter. This tendency of the soil has a decidedly bad effect on such winter crops as wheat and clover.

Wheat yields an average of 10 to 12 bushels per acre and corn averages very little over 20 bushels. Oats are grown to some extent and yield from 15 to 30 bushels per acre. Cowpeas make a good growth and are well suited to this soil. Red clover gives only a fair crop. Bluegrass does especially well and furnishes abundant pastures.

Owing to the character of the subsoil, orchards are not a success on this type. The roots are necessarily confined to a shallow zone

and are able to obtain the proper nourishment for only a few years. The trees also are very easily uprooted by windstorms.

Farm buildings and improvements on this type are not of the best, many of the houses being of logs, with only sheds for barns. Many of the fields are unfenced.

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

Mechanical analyses of Gerald silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
342129, 342131.....	Soil.....	0.4	1.5	1.2	2.3	2.4	72.2	19.7
342130, 342132.....	Subsoil.....	.1	.4	.7	1.7	1.3	55.8	39.9

LEBANON SILT LOAM.

The Lebanon silt loam, to a depth of 10 to 12 inches, consists of a mellow, dark-brown silt loam. Beneath this lies a heavy, slightly plastic silty clay, varying in color from yellowish brown to mottled reddish yellow or gray streaked with red. The yellow and gray mottlings are at times indistinct, but the red streaks are always prominent. Iron concretions are always numerous. At depths ranging from 24 to 36 inches a hardpan layer consisting of a mixture of reddish-yellow clay and chert fragments is encountered. This layer is practically impervious to water and impenetrable by the soil auger.

In the depressed areas, especially along the small stream courses, the surface soil has been increased in depth by wash from the slopes. The soil in such places consists of a dark-brown silt loam, grading into a lighter dull-brown silt loam, which at a depth of 20 to 24 inches passes into the mottled subsoil above described. Owing to its small extent, no attempt to separate the phase was made.

The area mapped as this type occurs immediately south of Luebbering, in the southeastern part of the county. Locally it is known as "Rucker's Prairie." It occupies a plateaulike region, with an elevation of 750 to 800 feet above sea level, or practically the same as the surrounding hills. The topography is that of an undulating plain.

Drainage varies from good to deficient. At all times the under-drainage is inadequate, and on the more level areas surface drainage is also slow.

The Lebanon silt loam is apparently derived largely from a limestone formation. Owing to its level topography and the close proximity of the underlying rocks, little modification in the soil has been caused by rainwash.

Formerly this region was probably a treeless plain. At present all except the occasional stony areas or those areas bordering the large streams is under cultivation. The present tree growth consists largely of black, scrub, and white oak, honey locust, wild cherry, and an occasional hickory.

The Lebanon silt loam is inferior in productivity to the surrounding types. The dark-colored surface soil has all the indications of a soil of high fertility, although this is not the case. Owing to its heavy subsoil, the type, especially on the more level areas, is seriously affected by either prolonged periods of drought or rain.

Wheat yields from 10 to 18 bushels and corn from 15 to 30 bushels per acre. Red clover does only fairly well, as it is apt to heave and freeze out during the winter months. Blue grass and timothy are a profitable crop and make an excellent growth for pasturage or hay.

In general the farm improvements are fair to good. The fences are of good construction and well kept.

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

Mechanical analyses of Lebanon silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
342120.....	Soil.....	1.0	3.1	3.6	5.5	2.2	61.9	22.7
342121.....	Subsoil.....	.6	1.7	2.3	4.2	2.4	48.6	40.0

UNION SILT LOAM.

The surface soil of the Union silt loam consists of a brown to grayish-brown, mellow silt loam, varying in depth from 8 to 14 inches. It has a smooth, floury feel and is well supplied with organic matter, except in areas where erosion has been active. The subsoil grades from a yellowish-brown or chocolate-brown, heavy silt loam or silty clay to a heavy, friable and brittle silty clay loam or silty clay of the same color as the upper portion but often faintly mottled with gray at depths below 26 inches. Iron concretions and brown or reddish oxide stains are occasionally noted in the upper portion of the subsoil, more particularly over the poorly drained areas. On some of the slopes erosion has carried away much of the soil, leaving the subsoil near the surface. Fields which through continued cropping are low in organic matter content show a blanched, grayish appearance. Few or no rock fragments are encountered in any part of the soil profile.

The soil is naturally mellow and if handled properly holds moisture and organic matter well.

The topography varies from gently rolling to hilly, with long gentle slopes and many low, rather smooth ridges. Both surface drainage and underdrainage are good. The many winding streams with their tributaries are well distributed for carrying off surplus water. Unless protected by some cover crop during the winter months the hillsides are likely to wash considerably, though not to such an extent as is common on the soils of coarser texture. In several instances, on bare, exposed hillsides, deep gullies were observed which, under proper methods of soil management, could have been avoided. Even now, by filling in with brush, straw, rock, etc., the extension of these washes can in many instances be checked.

The origin of the Union silt loam is not perfectly understood. The uniform friable brownish silt loam constituting the soil is very suggestive of loessial origin, and may represent a mantle of loess instead of residual material. A considerable proportion of the sub-soil shows traces of limestone and possibly sandstone origin. Presumably also the residual material increases to the south or away from the Missouri River.

The type is fairly extensive, occupying a considerable proportion of the large upland area of Franklin County. It occurs usually just back of the Knox silt loam. The main body of the type is found in the east-central part of the county, with smaller areas scattered through other sections.

Originally the type supported a heavy growth of oak, hickory, and walnut. The present timber consists of white, laurel, post, and black oak, walnut, hickory, cedar, wild cherry, and "buck brush."

Wheat is the principal crop on the Union silt loam, its yield varying from 15 to 25 bushels, with an average of 18 bushels per acre. Corn yields range from 35 to 40 bushels per acre. Red clover makes an excellent growth and is profitable both as a forage and seed crop. Cowpeas give good results, but the crop is not so popular as in regions unsuited to clover. Bluegrass grows luxuriantly and is seen in every pasture. Apples, small fruits, and vegetables all do well, though grown at present only for home use.

A more systematic rotation of crops should be practiced over a large proportion of the type. Too often a "strong" piece of land is sown to wheat year after year until a paying crop can not be produced from it.

The population on this soil, as on the Knox silt loam, is largely German. The improvements and outbuildings are good and well kept. Land values range from \$40 to \$75 an acre, depending upon location and improvements.

Union silt loam, gray phase.—The surface soil of the Union silt loam, gray phase, consists of a dark-gray to light grayish-brown smooth silt loam, varying in depth from 8 to 10 inches, and fre-

quently lighter colored in the lower portion. The subsoil is a gray or yellowish-gray, moderately friable silty clay loam grading at 24 to 28 inches into a mottled gray and yellow or yellowish-brown silty clay, mottled with shades of brown. Black iron concretions are abundant throughout soil and subsoil. These, and the gray color of the soil, strongly indicate deficient drainage.

The gray phase has been mapped most extensively in the northern part of the county, where it occurs as a strip bordering the Knox silt loam. Other areas lie on the upper level of the Crystal City escarpment and on the broad, gently sloping points found along the Meramec and Bourbeuse Rivers.

The topography varies from flat to gently undulating, the flat areas being found along the tops of the wider ridges, and the undulating areas near the Meramec and Bourbeuse Rivers. Owing to the general level topography, drainage conditions are rather poor. Tile drains and open ditches would materially improve these conditions. The area south of New Haven grades into the Knox silt loam, so that in places the boundary was difficult to establish. The soil material seems to be the same as that of the typical soil, the grayish character having apparently been brought about by inadequate drainage.

Practically all of the gray phase of the Union silt loam was originally covered with a growth of hardwood timber, consisting of white oak, hickory, elm, black walnut, and wild cherry. This has nearly all been removed and the phase is practically all under cultivation.

Wheat yields from 15 to 25 bushels per acre, the average being about 18 bushels. Corn averages about 40 bushels per acre. Oats also seem well adapted to this soil. As is the case over the rest of the county, however, oats are not considered a paying crop. Red clover and cowpeas make a good growth. The better drained areas and those having a friable subsoil, especially where bordering the Knox silt loam, would undoubtedly prove well adapted to alfalfa. Timothy and bluegrass make a luxuriant growth.

Larger and more numerous orchards are seen on this soil than on any other in the county, the one large nursery of the county being located upon it.

Vegetables make a good growth, but this soil warms too slowly in the spring to be well suited for commercial trucking.

Land values range from \$40 to \$75 an acre, depending on location, soil, and improvements.

Union silt loam, sandy subsoil phase.—The Union silt loam, sandy subsoil phase, consists of a brown to grayish-brown mellow silt loam from 6 to 8 inches deep, gradually changing at depths between 8 and 20 inches into a light-brown or yellowish-brown, friable silt loam to silty clay loam. Below 20 inches the texture usually becomes

slightly coarser and mottlings of gray appear. Medium sand in varying quantities, increasing with depth, is a constant feature of the subsoil. The rock fragments found scattered over the surface are usually of sandstone. In places the surface soil is somewhat coarser and more granular, owing to a higher content of fine or very fine sand.

On account of its rather open structure and the frequent steep slopes, this soil is more susceptible to erosion than the typical Union silt loam. The type embraces many badly gullied slopes, some hill-sides being rendered conspicuous for a distance by their denuded surface. If cropped continuously, the humus content is rapidly depleted and the soil presents a gray, lifeless appearance.

The sandy subsoil phase of the Union silt loam covers an extensive area of the uplands. Two large areas, one in the northwestern and one in the southeastern section of the county, have been mapped, in addition to which many smaller detached bodies are shown throughout the county. The transition from this soil to the limestone areas is usually very gradual, although in places sharply defined boundary lines were found.

The topography of the Union silt loam, sandy subsoil phase, is rolling to hilly, and some of the rougher portions of the county are included in this type. The drainage is uniformly thorough and in places excessive.

The silt loam surface soil of this phase, especially in the northern part of the county, is similar to that of the typical Union silt loam and is undoubtedly the same in origin. There is in many places a mixture of residual material from the Jefferson City limestone. Some Roubidoux sandstone material probably also enters into the composition of the subsoil in the southern part of the county. The Crystal City formation influences the soil most in the northern part of the area, although remnants of the formation are scattered over the greater part of the type. The sand content is highest in the subsoil, and much of the surface soil is almost lacking in this constituent. Some areas were included, however, that approached very closely the texture of a sandy loam, and these would have been mapped as a separate type—probably the Tilsit sandy loam—had they been of sufficient size.

The original timber growth of the Union silt loam, sandy subsoil phase, was practically identical with that of the typical Union silt loam. The present growth consists largely of white, black, post, and laurel oak, hickory, and an occasional walnut and elm. Sassafras is found on this phase to a greater extent than on any other soil in the county. Numerous rundown fields were observed where sassafras brush completely covered the ground. This growth is very hard to eradicate when the soil once becomes filled with its roots.

The Union silt loam, sandy subsoil phase, is more variable in productiveness than any other type in the county. It responds readily to good treatment, but is quick to deteriorate under poor management. It is very susceptible to erosion and rapid exhaustion of the organic content. Where it is farmed with good judgment, the yields compare favorably with those of the typical Union silt loam. On the other hand, if cropped continuously to corn and wheat, the yields soon decline, and are especially low during dry seasons.

Wheat yields on an average about 15 bushels per acre, and corn approximately 30 bushels. A small acreage is sown to oats. Bluegrass makes a good growth. Red clover and timothy give fair yields, but suffered severely from drought during the season of 1911. Fruit and vegetables are grown only for home use.

Land values range from \$20 to \$50 an acre, depending upon the location and the proportion of arable land.

Mechanical analyses of samples of the soil and subsoil of the typical Union silt loam and of its two phases gave the following results:

Mechanical analyses of Union silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical:		<i>Per cent.</i>						
342116, 342124...	Soil.....	0.1	0.3	0.5	2.3	2.9	76.7	17.1
342117, 342125...	Subsoil....	.1	.3	.8	3.3	2.1	62.5	30.7
Gray phase:								
342114.....	Soil.....	.6	1.2	.7	.8	3.4	78.1	15.2
342115.....	Subsoil....	.2	1.4	1.1	1.5	3.0	65.3	27.3
Sandy subsoil phase:								
342122, 342145...	Soil.....	.1	1.2	3.3	4.3	3.1	72.7	15.2
342123, 342146...	Subsoil....	.1	1.1	3.6	4.6	1.9	55.5	33.1

CLARKSVILLE STONY LOAM.¹

The Clarksville stony loam, to a depth of 3 to 5 inches, consists of a grayish-brown silt loam. Where there is any subsoil it consists of a light to yellowish-brown silty clay to clay. The soil material in most cases is probably residual, being derived from limestone and sandstone with some admixture of the material giving the Gerald and Union soils. The areas in the southern part of the county characterized by the presence of cherty fragments come nearest to conforming in general characteristics with the Clarksville series, the soils of which are derived from cherty limestone. Areas in which the sandstone fragments are the dominant rocks should probably have been mapped separately as a sandstone soil, possibly the Tilsit stony

¹ Includes some Tilsit stony loam.

loam. As a general rule the soil is so thin, the slopes so steep, and stone so abundant that the surface soil proves too variable to admit of an altogether satisfactory correlation with any definite soil type.

The distribution of the type is fairly general throughout the county, it being as extensive as any other of the upland soils. Areas vary in size from small patches just large enough to be mapped to bodies embracing several square miles.

The Clarksville stony loam is not used to any extent for farming. Most of the areas contain enough fragmental rock near the surface to interfere with cultivation. They occupy slopes, in many places extending down to the streams, the tops of hills, and the crests of ridges. As developed in the southern part of the county wide areas stretch uninterruptedly across ridges and valleys.

The character of the type varies widely with the original rock formation from which it is derived. Over the Jefferson City and Trenton formations limestone fragments predominate, while in those areas associated with sandstone fragments of this rock are the more abundant. In the southern part of the county the rock fragments are mostly chert. By picking up the loose stones, and in some cases by blasting out ledges, occasional areas can be fitted for cultivation.

Where cultivation is possible the type is moderately productive and gives good results with wheat. A large proportion of the type, however, aside from being stony, is too rolling and broken to admit of profitable cultivation. By partially clearing the timber and removing the loose stones such areas might be converted into profitable bluegrass pastures. Many areas occur as strips covering only a part of the different farms, and in such cases no attempt is made to use the soil for other purposes than pastures or woodlots. The better timber in most cases has been cut off. The remaining growth consists largely of scrub oak and blackjack oak, with a young and stunted growth of black oak and white oak and an occasional hickory.

HUNTINGTON SILT LOAM.

The surface soil of the Huntington silt loam consists of 10 to 14 inches of dark-brown, mellow silt loam, loose and friable in structure, and having a high humus content. At depths ranging from 12 to 16 inches the soil grades into a somewhat lighter brown, friable silt loam subsoil, slightly coarser than the surface soil, and extending to a depth of 40 inches or more.

Some variations were found along the Meramec River and its tributaries in the southern part of the county. Here the material is slightly coarser throughout the soil section, but with the same general color. The surface features of the area along this stream were also more rolling, small knolls and ridges of coarser material being scattered through it. A slight difference in favor of the finer textured

areas of the lower Meramec and Bourbeuse was noticed in the crops. The variation, however, was not considered of enough importance to necessitate a separation. A few narrow strips carry so many small chert fragments as to constitute essentially a gravelly loam, but these were not extensive enough to admit of a satisfactory separation. Sandy material is also encountered in the subsoil of some areas, often in thin strata alternating with silt loam.

The Huntington silt loam is an alluvial type comprising the brown first-bottom soil of the smaller streams of the valley. The material represents wash from the various soils of the drainage basins, including limestone and sandstone.

The greater part of the type is subject to annual spring overflows which by deposition add to the fertility of the soil, though often seriously injuring the growing crops. Aside from these occasional overflows the type is well drained.

Taken as a whole, the Huntington silt loam is probably the most productive soil in the county. Excellent specimens of shell-bark hickory, sycamore, cottonwood, white walnut, black walnut, white oak, elm, and hard and soft maple fringe the streams. Practically all of the arable areas are cleared and in cultivation. Corn produces from 40 to 75 bushels per acre. Wheat yields 15 to 25 bushels, but less is grown than on the upland. Alfalfa, cowpeas, red clover, and the various grasses make an excellent growth.

A number of vegetables do well, especially on those areas having a sandy subsoil, and where located convenient to shipping points the type could be profitably used for truck growing. General farming, however, is the type of agriculture at present practiced on this soil.

The land of this type sells as high as \$60 to \$90 an acre. Usually it occurs in strips too narrow to constitute a whole farm.

ROBERTSVILLE SILT LOAM.

The surface soil of the Robertsville silt loam consists of a gray to grayish-brown silt loam of smooth and floury feel, 6 to 12 inches deep, underlain by a light-gray to white, compact silt loam to silty clay loam. At depths ranging from 16 to 28 inches the silty layer grades into a compact, plastic, and impervious, gray to yellowish-brown or chocolate colored heavy clay, showing faint mottlings of reddish brown. Black iron oxide concretions are usually abundant throughout the soil profile, the amount increasing with depth. On this account the type is often known as "shotty land." The upper subsoil occasionally shows a grayish-brown to brownish-gray color rather than gray. If plowed when too wet the soil puddles badly and in dry weather becomes baked and intractable. Applications of lime would tend to correct these conditions, especially over areas

where drainage is poor. Crops are rather late in starting owing to the cold nature of the soil.

The type represents an old alluvial soil developed along stream courses throughout the county and includes the greater part of the second bottom or bench lands of the area. This material was deposited by streams when they flowed at higher levels. The most extensive areas of the type occur along the larger streams, smaller patches being found along some of the draws. The type occurs also in abandoned stream valleys and on well-defined stream terraces no longer subject to overflow. Such areas are found along the railroad between Moselle and Robertsville. Another area, known as "Indian Prairie," doubtless represents an old water course, the material being derived from soils of the drainage basin which include considerable areas of sandstone and limestone soils.

Corn, the leading crop, yields from 20 to 40 bushels per acre, depending upon the season. Wheat varies from 10 to 20 bushels and oats from 20 to 35 bushels per acre. Alfalfa and red clover do not thrive on account of the low lime content, the heavy subsoil, and the tendency of the soil to heave in freezing weather. Timothy yields well and when mixed with alsike clover should make an excellent hay crop.

The type responds readily to good farming methods. With the establishment of good drainage conditions and a more systematic crop rotation, including cowpeas or some other leguminous crop to be planted in the fall or spring to replenish the organic matter content, the type would be greatly improved. Wherever practicable, all barnyard manure should be preserved and applied to the soil.

Land of this type varies in price from \$30 to \$60 an acre, depending upon natural drainage conditions, location, and improvements.

The average results of mechanical analyses of samples of the soil, subsoil, and lower subsoil are given below:

Mechanical analyses of Robertsville silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
342111, 342126.....	Soil.....	0.6	1.8	0.9	1.1	2.2	75.8	17.4
342112, 342127.....	Subsoil.....	.4	2.4	1.3	1.2	1.1	78.5	14.9
342113, 342128.....	Lower subsoil.	.1	1.3	.9	1.1	1.5	55.9	38.9

ELK SILT LOAM.

The Elk silt loam consists of a rich, dark-brown, mellow silt loam with a uniform depth of about 18 inches. The underlying material is of a lighter color and somewhat more compact in structure, but

otherwise differs little from the soil portion. The subsoil is always friable.

Only a small area of this soil exists. It is found upon the second bottom or stream terrace lands, and has been derived chiefly from material washed from limestone and sandstone upland soils. Some wash from the loessial soils in the northern part of the county is also included with this type, but such areas are not representative, in point of material, of the Elk series, which properly represents terrace soils, composed of limestone, sandstone, and shale materials. A separation was not made in this area owing to the small extent of the loessial wash phase.

In topography the type is gently undulating, and both surface drainage and underdrainage are well established. The terraces are no longer subject to overflow. In no case observed is artificial drainage necessary, and owing to the position of the areas neither deficiency nor excess of rainfall has the marked effect on this soil that it has on the Robertsville silt loam.

Wheat is the main crop produced on this type, yields of 18 to 25 bushels per acre being the rule. Corn is grown to some extent, with yields ranging from 40 to 60 bushels per acre. Clover, alfalfa, and cowpeas give excellent results. The type would be an excellent one for trucking in situations near the railroad.

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

Mechanical analyses of Elk silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
342143.....	Soil.....	0.0	0.3	3.0	16.1	5.4	62.0	12.7
342144.....	Subsoil.....	.0	.1	.8	12.7	9.2	58.0	19.1

WABASH CLAY.

The surface soil of the Wabash clay consists of a dark-brown to black heavy clay loam of uniform color and texture, varying in depth from 10 to 12 inches. Below this the material grades into a plastic, tenacious, heavy clay of a drab to light-brown color. In the lower subsoil streaks of red are noticeable in places. This type of soil is fairly uniform throughout its development. When wet it is very tenacious and difficult to handle, and when dry it becomes very hard and compact, cracking badly and breaking into small cubes. Care must be taken to plow under proper moisture conditions to secure a good seed bed. Locally the type is known as "gumbo land."

The type occurs most extensively along the Missouri River bottoms and in the rather low areas back from the river.

Grain farming is followed almost exclusively on this soil. Wheat is the main crop. Yields of 20 to 25 bushels per acre are considered normal. Fultz and Mediterranean are the leading varieties, the former being more extensively sown. Corn yields from 50 to 65 bushels, and large, rank-growing varieties, such as Boone County White, are preferred. Oats yield from 30 to 50 bushels, but owing to the prevalence of rainy weather at cutting time the crop is rarely a success. Alfalfa gives three cuttings per year. Red clover does well.

A few small drainage ditches and the straightening of most of the stream channels is sufficient to provide fairly good drainage in the higher lying areas.

Farm buildings and improvements on this type are only fair. Land values range from \$75 to \$100 an acre, very little of the type being on the market. Although excellent crops may be grown during a normal season, the risk from inundation is a factor always to be considered.

DUNNING CLAY.

The Dunning clay consists of a dark-brown to black silty clay of uniform texture, extending to a depth of 12 inches, gradually changing below this depth to a heavy, tenacious, and plastic, drab to bluish-drab clay, frequently showing traces of yellowish brown in the lower portions. The soil is rather difficult to handle, except under proper moisture conditions, being very tenacious when wet and tending to bake and become hard and compact when dry.

The organic matter content is apparently high and the soil fertile. When properly cultivated excellent crops may be obtained. With adequate drainage and applications of lime the physical condition of the soil may be greatly improved.

The Dunning clay occurs in several small areas in abandoned stream valleys not generally subject to overflow. Owing to their low position, alluvial material has been deposited over the original stream bottoms since the abandonment of the valley by the stream. The type is usually covered by water during the late winter and spring.

Corn and wheat are the principal crops grown on this soil. Corn yields from 40 to 70 bushels per acre, a large, rank-growing variety like the Boone County White being generally preferred. Wheat yields from 20 to 30 bushels per acre, with a rank growth of straw. In one field a mixture of corn and cowpeas sown after wheat made a luxuriant growth and afforded good pasturage for hogs. A rotation of corn, wheat, and clover should prove advantageous. Owing to the small extent of this type the value is more or less dependent upon that of the surrounding types. When properly cared for it proves a valuable soil.

SARPY SILT LOAM.

The Sarpy silt loam consists of a dark-brown mellow silt loam, very friable and of high humus content, with an average depth of 12 inches. Below this the material changes gradually to a yellowish-brown silt loam or very fine sandy loam of slightly coarser texture.

The Sarpy silt loam occupies a slightly higher position along the streams than the heavier adjoining soils and is subject to overflow only during periods of unusually high water. Owing to this slight elevation and to the mellow, open subsoil, the drainage is good and the soil warms early in the spring.

The type occurs in two comparatively small areas in the Missouri River bottom.

Very good yields of the general farm crops are obtained from this type. Corn, to which crop the type is possibly the best adapted, yields from 40 to 75 bushels per acre, and wheat from 15 to 25 bushels. Alfalfa does well and should be more extensively grown. Corn, wheat, and corn are perhaps as good a rotation as could be devised for this soil.

Practically all of the type is in cultivation. Values range from \$60 to \$90 an acre, depending on location and improvements.

SARPY CLAY.

The Sarpy clay consists of a dark-brown to nearly black heavy clay loam to clay, 12 to 16 inches deep, passing abruptly into a subsoil of light brown to grayish-brown, very fine sandy loam to silt loam in which a noticeable amount of sand of the finer grades is found. This subsoil becomes lighter in color and texture with depth, changing at 40 inches to a loose, grayish sand of very fine texture. This soil is known locally as "gumbo land" and is developed in the Missouri River bottoms.

Running through the type north of Labaddie deposits of fine to very fine sandy loam from 2 to 8 inches deep are encountered in strips. These form low ridges, but were so narrow and irregular in outline as to make their separation as a phase of the type impracticable in a map of the scale used.

Care must be taken in working this soil to see that moisture conditions are favorable, as the soil tends to puddle when wet. When dry the surface is hard and plowing difficult. If plowed when in the proper condition the soil breaks into small cubes and a good tilth results.

The surface of this type is not as flat as that of the Wabash clay, and it occupies a higher position, which facts, together with the sandy subsoil, insure fair drainage. As a result plowing may be begun on this type earlier than on the Wabash clay.

The Sarpy clay owes its origin to the deposition of fine material from slowly moving water upon previously deposited layers of sand. Incorporation of decaying vegetable matter with the deposits has caused the dark color. Some areas of this type can be seen in course of formation at the present time, especially north of Etlah. The low, narrow sandy ridges occurring north of Labaddie have been thrown up during the high floods of recent years.

The greater part of this type is under cultivation. Wheat is the leading crop, of which an average yield of 15 to 30 bushels is obtained. The Fultz is the most popular variety. Owing to the heavy character of the soil and consequent difficulty of cultivation, corn is not extensively grown.

Cob Pipe corn and Boone County White are the leading varieties, giving practically the same results as obtained on the Sarpy silt loam. Alfalfa makes a profitable crop, yielding three to four cuttings per acre each season. When a field is to be left in alfalfa for a number of years, it should be cultivated after the first year in order to keep down the weed growth. Immediately after the second and third cuttings cultivation with a disk or spring-tooth harrow, followed by a drag harrow, would likely be beneficial. Red clover makes a luxuriant growth. It is usually sown in the spring in wheat and rarely left longer than one season after cutting the wheat.

Land values are about the same as for the Wabash clay. On account of its better drainage and less likelihood of damaging overflows it would seem that the Sarpy clay should be the more desirable type.

SARPY VERY FINE SANDY LOAM.

The Sarpy very fine sandy loam consists of a grayish-brown very fine sandy loam, about 7 inches deep, becoming somewhat lighter, almost gray, and decidedly more sandy with depth. In the greater proportion of the type these characteristics are fairly uniform, although several small areas of darker color and somewhat heavier surface texture are included. Near the boundary line of the Sarpy clay, where narrow ridges of very fine sandy loam are a feature, some areas of Sarpy clay were mapped in with the Sarpy very fine sandy loam.

Owing to its more elevated surface, this type overflows only during times of exceedingly high water. It is well drained.

Crops on this soil yield slightly less than on the heavier types. Wheat and corn are the most important crops. White cob-pipe corn is grown on the heavier areas with excellent results. The type is well adapted to alfalfa and clover, especially to the former.

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

Mechanical analyses of Sarpy very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
342109.....	Soil.....	0.0	0.1	0.2	0.8	25.9	59.6	13.4
342110.....	Subsoil.....	.0	.0	.2	.8	34.2	57.1	7.5

ROUGH STONY LAND.

The Rough stony land is encountered mainly along the courses of the larger minor streams of the county and along the Missouri River. The type comprises the rough rock outcrop forming bluffs along the various streams and areas so rough and stony as to be entirely unfit for agriculture. It was difficult to draw accurate boundaries between the rougher phase of the Clarksville stony loam and this type in many places.

The rock consists of both sandstone and limestone, much of which occurs in place. There is very little soil except such as is held in the crevices and depressions between the ledges. These spots are usually occupied by a growth of scrub oak and blackjack oak. Red cedar is in many places abundant, and it is probable that by encouraging its growth by cutting out the crowding oaks, this tree could be made profitable to supply pencil timber. Although a very slow-growing tree, cedar is certainly more valuable than the oak as developed on these areas.

Limestone and sandstone quarries are the main source of revenue from the Rough stony land.

Rough stony land, glade phase.—This phase of the Rough stony land occurs principally in the eastern part of the county. It consists of thin, level beds of gray limestone, immediately overlying the thicker beds of Jefferson City limestone proper, at or near the surface. In some cases the rock is bare with the exception of small patches of soil in the rock crevices, or the rock stratum may be covered with a soil layer 1 to 3 inches in depth. This shallow layer varies from a dark-brown to nearly black loam to a grayish-brown silt loam, the former usually occupying the more level areas.

These glade areas lie usually between the crests of the limestone ridges and the medial line of their slope. They are made conspicuous by the growth of red cedar, which here attains a good size. Other timber growth is sparse and very stunted, scrub oak being the most conspicuous.

Red cedar, although a valuable wood, is not yet of commercial importance in the county on account of its limited quantity. Its growth should be encouraged on these glade areas in particular, since no other crop of any value is known to be so well suited to them.

RIVERWASH.

Riverwash consists of a medium to coarse, grayish sand to sandy loam lying adjacent to the Missouri River and in places along the smaller streams. The greater part of the Riverwash is worthless for agriculture. In some places small portions of it are included in fields of adjoining soil types. As a rule crops give low yields. Owing to the frequent overflows and the cutting away of the areas by the streams little attempt is made to utilize such land. Where practical, trucking might be made profitable to a certain extent. Texturally the soil is especially well suited to the growing of watermelons.

SUMMARY.

Franklin County, located in the east-central part of Missouri, embraces an area of 908 square miles, or 581,120 acres. It lies in the Ozark border region of the State and consists of gently rolling to rough upland country and narrow river bottoms.

There are two main drainage systems—one to the north into the Missouri River and the other to the northeast through the Meramec to the Mississippi River.

The climate is temperate and equable, extremes of temperature being rare and seldom of long duration. The mean annual temperature is 60° F. The mean annual precipitation is about 42 inches.

General farming is the predominant type of agriculture and wheat and corn the important crops. Bluegrass, red clover, and cowpeas can be grown on nearly all the soils of the county and alfalfa on many of the better-drained types. Natural conditions and proximity to excellent markets should make dairy farming profitable, a fact which some of the more progressive farmers are already beginning to appreciate.

More attention to soil management through crop rotations adapted to the needs of individual soil types, maintaining the organic content of the soil through the use of leguminous crops, to be plowed under, and the conservation and application of all stable manure are the principal requisites to increase crop yields and maintain the productivity of the soils of the area.

Fifteen soil types, including Rough stony land and Riverwash, were separated and mapped. Of these the Union silt loam is the

most extensive. It is derived largely from the Jefferson City limestone and is found principally in the northern part of the county. It is well adapted to grain and clover. A gray phase and a sandy subsoil phase of this type were also recognized and shown upon the map by rulings.

The Lebanon silt loam is an inextensive prairie soil found south of Luebbering. Its productivity is low, and it is best adapted to bluegrass and timothy.

The Gerald silt loam found in the western and southwestern parts of the county gives slightly lower yields than some of the lighter-textured types.

The stony land of the county occupies an extensive area. The Clarksville stony loam, when cleared of the loose stones, produces fair yields of corn and wheat. It also provides good pasturage. Rough stony land and its glade phase are best adapted to the growing of red cedar for pencil stock.

The Huntington silt loam is a first-bottom soil. It is subject to occasional overflow, but otherwise well drained. It has a high agricultural value, producing heavy yields of wheat, corn, and alfalfa.

The Robertsville silt loam is the most extensive second-bottom soil. It is usually poorly drained and is known locally as "shotty land." It is likely to be acid, but is naturally adapted to corn, oats, and timothy.

The Elk silt loam is a second-bottom or terrace soil of small extent. It is well drained and productive.

The Knox silt loam is confined to a comparatively narrow strip along the Missouri River. It is well drained, producing heavy yields of wheat, corn, and forage crops.

The Dunning clay occurs in several small areas in abandoned stream valleys not at present generally subject to overflow. When properly cultivated this soil will produce excellent crops. It requires drainage and applications of lime to obtain the best results.

The Wabash clay, locally known as "gumbo," occupies the lower areas in the Missouri River bottom and some small areas in the bottoms of minor streams. It is a heavy soil and difficult to till, but very productive when well drained and properly handled.

The Sarpy silt loam occupies two comparatively small areas in the Missouri River bottom. Very good yields of the general farm crops are obtained. Practically all of it is under cultivation.

The Sarpy clay, also known as "gumbo," occupies slightly higher areas along the Missouri River bottoms. It is well drained and very productive.

The Sarpy very fine sandy loam occurs as a slight ridge following in a general way the course of the Missouri River. It is well

drained. This is not so productive a type as the heavier areas back of it.

Riverwash occurs as waste stretches of medium to coarse sand lying along the Missouri River and in places along some of the larger minor streams. Little of it is under cultivation, though some areas where favorably situated might be used for the production of truck crops, particularly watermelons.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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