

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; M. F. MILLER,
IN CHARGE SOIL SURVEY.

SOIL SURVEY OF CALLAWAY COUNTY,
MISSOURI.

BY

H. H. KRUSEKOPF, OF THE UNIVERSITY OF MISSOURI, IN CHARGE,
AND J. H. AGEE AND R. H. HALL, OF THE U. S.
DEPARTMENT OF AGRICULTURE.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1916.]



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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., May 31, 1918.

SIR: I have the honor to transmit herewith the manuscript report and map covering the survey of Callaway County, Mo., and to recommend that they be published as advance sheets of Field Operations of the Bureau of Soils, 1916, as authorized by law. This work was done in cooperation with the University of Missouri Agricultural Experiment Station.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

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

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SOIL SURVEY OF CALLAWAY COUNTY, MISSOURI.

By H. H. KRUSEKOPF, of the University of Missouri, In Charge, and J. H. AGEE and R. H. HALL, of the U. S. Department of Agriculture.—Area Inspected by THOMAS D. RICE.

DESCRIPTION OF THE AREA.

Callaway County, Mo., is situated on the north side of the Missouri River, in the central part of the State. Its eastern boundary is about 90 miles west of St. Louis and its western boundary about 140 miles east of Kansas City. The county has an area of 808 square miles, or 517,120 acres.

In its physiographic features Callaway County represents both the glacial plains of northern Missouri and the Ozark uplift of the southern part of the State. The former division includes approximately the northern half of the county, and consists of level prairies and gently rolling areas. The latter includes nearly all the southern part of the county, and consists of timbered and hilly uplands. That the surface was originally a plain is shown by the almost perfectly horizontal sky line seen from any elevated position.

Callaway County lies in a region where the general upland slope is northward, like that of the Ozark upland south of the river. The position of the county is at the foot of this slope, where the gradient is not pronounced, and in the northwestern part of the county, north and west of Fulton, the slope is southeastward, owing to the presence of an area unusually high for this region. The elevation of the upland in the southern part of the county is about 900 feet above sea level. In the southeastern part, north of Portland, it is a little more than 900 feet, and in the southwestern part, at Hibernia, a few feet less. The prairies in the northeastern part of the county lie a few feet above 800 and on the highest part of the northwestern corner they lie just above 900 feet.

The level prairies and gently rolling uplands include nearly all the northwestern part of the county, with narrow, undulating prairie areas extending southward and eastward between the larger streams.



FIG. 1.—Sketch map showing location of the Callaway County area, Missouri.

From the west county line north of Millersburg, to Auxvasse and McCredie, and as far east as Bachelor and Calwood, the surface is level to gently undulating, with narrow belts of rolling land bordering the streams. This region is locally known as the Grand Prairie. To the south and east this level area breaks up into several long, narrow divides, one of which extends as far south as Holts Summit. Another, which attains a width of 3 miles southwest of Fulton, extends southeast to Hams Prairie. The main eastern extension, known as Nine Mile Prairie, occurs south of Clarks Branch and extends to the east county line. Several isolated areas of level prairie, 2 to 4 square miles in extent, occur in the southeastern part of the county at Reform (Coates Prairie) and at Readsville and Garrett (Hancock Prairie), and probably represent remnants of a former prairie occupying practically the whole area of the county.

Throughout the northern and western part of the county, where the underlying rocks consist of soft shale and sandstones, the belts of rolling land bordering the streams are everywhere characterized by short and gentle slopes, and it is only where the streams have cut down into the underlying limestone, as along Auxvasse, Cedar, and Clarks Creeks, that strips of rough, stony land, locally known as "breaks," have been produced. The largest area of gently rolling land occurs in the northeastern corner of the county, and includes all the territory north of Clarks Branch. There is very little smooth land here, but none of the land is too broken for easy cultivation. One of the pronounced topographic features of the region is the gradual southward slope and the abrupt northward slope from upland to valley. This is especially marked along Richland Creek. These streams usually occupy the south side of the valley, where they are bordered by relatively high and steep bluffs.

That portion of Callaway County lying south and east of a line passing approximately through New Bloomfield, Fulton, and Williamsburg is hilly and completely dissected. This is a limestone region. The numerous streams have relatively narrow valleys. In general the higher slopes are gradual, but near the streams they are steep and stony, and nonagricultural. The edge of the prairie uplands is always marked by steep, dissected slopes, where erosion is most active. A detached area of broken, hilly land occurs along Clarks Branch, northeast of Williamsburg. Bordering the Missouri River bottoms, in the region of loess soil or "river hill land," although the surface everywhere is hilly, the slopes are rounded, stony areas are few, and in general most of the land is not too broken for cultivation. Throughout practically all the hilly land in the county the content of stone rather than the steepness of slope is the limiting factor in the utilization of the land. This hilly area represents roughly the western portion of the belt of broken country which extends to the

east through Montgomery and Warren Counties. It is similar also to the hill country lying immediately south of the Missouri River, and forms the northern edge of the Ozark uplift.

The Missouri River bottom land is a level plain, with occasional low ridges and intervening slashes representing abandoned stream beds and meanders. The prevailing though by no means uniform trend of these features is roughly parallel to the river or to a former channel. Practically the whole lowland is subject to overflow, but except in the case of the lower-lying areas inundations are rare. One of the striking physiographic features of the lowland plain is a steep-sided hill—Cote sans Dessein—southwest of Tebbetts, which rises approximately 60 feet. It is a remnant of upland reduced by the combined action of the Missouri and Osage Rivers.

With the exception of a few square miles along the Audrain County line the entire county is drained directly into the Missouri River. Middle River and Cedar, Little Murphy, and Auxvasse Creeks with their tributaries drain the greater part of the county. The north-eastern corner is drained by Loutre Creek, Clarks Branch, and Prairie Branch. In general these streams are of rather steep gradient, and have cut rather deep valleys. Only a few of the larger creeks are perennial. Springs are numerous throughout the limestone area.

The first permanent settlement in this area was made about 1803, by the French, at Cote sans Dessein. In 1815 the Boone's Lick Road (St. Charles Road) was surveyed and marked out from St. Charles to the lick in Howard County, and many settlers came into the county from Kentucky, Virginia, and other States to the southeast. During the last two decades many settlers have come from Illinois and neighboring States; in 1910 the population of Callaway County was 24,400. The rural population amounted to 19,172, averaging 23.7 persons to the square mile.

Fulton, the county seat, had a population of 5,228 in 1910. Westminster College, Synodical College, William Woods College, the State School for the Deaf, and State Hospital No. 1 are located here. Auxvasse, New Bloomfield, Mokane, Portland, and Tebbetts are towns on railroad lines supported mainly by agricultural interests.

The main line of the Missouri, Kansas & Texas Railway crosses the county along the Missouri River, and a branch of the Chicago & Alton crosses it north and south, extending from Mexico, in Audrain County, to Cedar City. Jefferson City, across the Missouri River, is accessible by wagon bridge. St. Louis, Chicago, and Kansas City are the principal markets for the agricultural products of the county.

Wagon roads reach all sections, but only a few of the more important highways radiating from Fulton are well improved. Rock and gravel for road building are abundant.

CLIMATE.

The climate of Callaway County is practically the average for the State. The mean annual temperature is 54.7° F. Periods of extreme cold are of short duration, and the temperature seldom falls lower than 5° to 10° below zero. The falls are usually warm and dry, often continuing to the middle of December. During the summer months the temperature occasionally reaches 90° to 95°, but the average annual number of days with a maximum temperature of over 90° is only about 30. Loss among live stock or serious injury to crops by reason of extreme climatic conditions are of rare occurrence. The occasional winter killing of wheat is due not to extreme cold, but to the formation of an ice crust over the field or to the alternate freezing and thawing which forces the plants out of the ground.

The average annual rainfall for the county is 40.49 inches. In a normal year the greater part of the rainfall occurs during the spring and summer. From April to September the rainfall averages more than 4 inches for each month. The average monthly rainfall in the winter is a little more than 2 inches. The snowfall is generally sufficient to protect wheat and grasses. Occasional periods of drought of several weeks' duration occur in late summer and early fall, but in this respect conditions are as favorable for agriculture as in most humid regions.

The average date of the first killing frost in the fall is October 11, and that of the last in the spring, April 20. The latest recorded date of killing frost in the spring is May 9, and the earliest in the fall, September 18.

The following table, compiled from the records of the Weather Bureau station at Fulton, gives the important climatic data for Callaway County:

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

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1901).	Total amount for the wettest year (1898).
	° F.	° F.	° F.	Inches	Inches.	Inches.
December.....	32.7	70	-18	2.25	3.57	2.73
January.....	31.1	83	-25	2.59	3.57	4.14
February.....	29.6	81	-26	2.14	1.37	1.86
Winter.....	31.1	83	-26	6.98	8.51	8.73
March.....	45.0	93	1	2.90	3.97	7.11
April.....	54.1	91	23	4.18	3.29	3.49
May.....	64.9	98	27	4.71	.40	7.46
Spring.....	54.7	98	1	11.79	7.66	18.06
June.....	72.7	102	40	4.89	1.69	7.21
July.....	77.0	110	48	4.67	1.41	6.75
August.....	77.0	107	39	3.30	2.38	1.29
Summer.....	75.6	110	39	12.86	5.48	15.25
September.....	69.2	106	32	4.12	1.75	6.35
October.....	57.7	94	19	2.46	1.16	4.23
November.....	45.2	84	5	2.28	1.50	2.70
Fall.....	57.4	106	5	8.86	4.41	13.28
Year.....	54.7	110	-26	40.49	26.06	55.32

AGRICULTURE.

Callaway County is known throughout Missouri as a live-stock region. Combined grain and stock farming is the prevailing type of agriculture. The soil and topographic conditions, and to a lesser extent the limited transportation facilities, have resulted in making live-stock raising the most important industry and all other phases of agriculture are made to conform. This type of agriculture has been practiced since the original settlement of the county. The extensive prairie lands and open woods furnished abundant pasture. Corn, wheat, oats, and tobacco were the principal crops, and were grown in sufficient quantity to supply the home demand. The exports, consisting mostly of tobacco and live stock, were shipped by boat on the Missouri River. With the completion of the Chicago & Alton Railroad through the county in 1871, agricultural development made rapid progress. Although the southern part of the county was the earliest to be settled, the northern half was completely occupied first, on account of the absence of large timbered areas and the smoother topography.

About two-thirds of the county was originally timbered, but only the rougher land in the southern part remains forested. The predominant growth consists of white, red, and black oak, although hickory, walnut, elm, and some other hardwoods are abundant. Cedar occupies many of the dry, stony slopes. At the present time practically all of the easily tillable land in Callaway County is under cultivation, although approximately one-third of the county still consists of unimproved, timbered, stony, and hilly areas, lying mainly in the southern and eastern parts of the county. No other county north of the Missouri River contains such a large area of unimproved land as Callaway County. Under the present conditions the scant grazing provided by the timbered areas is of negligible value.

The presence of a relatively large proportion of unimproved land on many of the farms has a depressing effect on land values in general. According to the census, the average land value per acre in 1910 was \$37.76, which is lower than in any other county in northern Missouri except Warren County. There are considerable possibilities for development both in more intensive agriculture and in extension of the area farmed. Of the total area of approximately 150,000 acres of unimproved land, probably 40 per cent can be cultivated, and a much larger percentage can be made of value for grazing purposes. The cultivable areas include several thousand acres of old tobacco land which virtually has been abandoned. The unimproved land is mostly steeply rolling and hilly, but practically all of it will grow clover and bluegrass. The removal of the brush and the thinning out of the timber is all that is necessary, and this is probably the most practical and profitable means of improvement. No seeding is needed, and a good stand of bluegrass is obtained in a few years. Many of the forested hills bordering the Missouri River bottoms are well adapted to orcharding. In general, land of this character varies in price from \$10 to \$25 an acre.

Corn is the leading crop of Callaway County. The normal acreage is about 97,000 acres. The average yield is 30 bushels per acre.¹ In recent years there has been a tendency to decrease the acreage, owing to economic and labor conditions rather than to any change in the general type of agriculture. Corn is grown mainly on the Putnam soils, which on account of their smooth surface can be cultivated most easily. Most of the bottom lands also are devoted to this crop, from which areas large yields are obtained. Practically all of the corn grown is used locally for feeding live stock, much of it in the form of ensilage. The prevailing practice is to follow clover or any of the grass crops with corn. On the bottom soils and on the better uplands the crop is grown two or three years in succession. Even on the poorer

¹ Missouri Crop Review for 1915, Missouri State Board of Agriculture.

hill lands no attempt is made to follow a regular rotation, and the yields obtained are often unprofitable. Commercial fertilizers are rarely used, but all the manure available generally is applied to the corn land. The practice of planting cowpeas or soy beans in the corn is becoming popular. After the corn is gathered the stalks and green crop are sometimes plowed under as a green manure, but more frequently they are pastured or put into the silo with the corn.

Wheat is an important crop in every part of the county, although the river bottoms and the loess hill lands are recognized as the best wheat soils. The average area in wheat for the last 10 years has been 26,789 acres, and the average yield 14.9 bushels per acre. On the bottom lands the yield averages higher, and 35 bushels per acre is frequently obtained. Clover is often sown in wheat land in the spring, and is sometimes plowed under with the stubble the following fall. It is more commonly allowed to stand a year or two for hay, timothy usually being seeded with it. The use of commercial fertilizers with wheat is growing in favor, especially on the prairie soils in the northern part of the county. Acid phosphate, bone meal, or a complete fertilizer containing 2 to 4 per cent of nitrogen, 8 to 12 per cent of phosphorus, and 0 to 4 per cent of potash, applied at the rate of 100 to 150 pounds per acre, give good results. The effect of the fertilizer is seen also in the clover or grass following the wheat.

The average area in oats during the last 10 years has been 11,419 acres. The average yield is 22.4 bushels per acre. This crop is grown mostly on the prairie soils and is used entirely for feed for work stock. In favorable seasons yields of 35 to 50 bushels per acre are obtained, but occasionally the crop is a total failure. Spring oats are grown almost exclusively. Oats are much in favor as a nurse crop for grass.

The various forage crops, such as rye, grain sorghums, millet, cowpeas, soy beans, and rape are given practically no attention. This is probably due to the large acreage in grasses, which is depended on to supply all the necessary pasture and green feed for the live stock. The growing of rye, both for winter pasture and as green manure, would be very beneficial. The value of rye for plowing under on much of the worn hill land of the Lindley and Union soils, where clover can no longer be grown, is very apparent. A few farmers grow rape in small fields for hog pasture. There is little need of growing forage crops extensively, but it is considered profitable to have a few acres of some green crop on each farm to supplement the pastures during late summer and in seasons of drought.¹ On much of the land where clover does not do well cowpeas or soy beans should be depended on. The value of these crops, both as hay and

¹ See Bul. No. 110, Missouri Agr. Expt. Sta., "Forage-crop rotations for pork production."

for improving the soil, is not fully appreciated. They can be planted with corn in the hill or drill. In favorable seasons cowpeas can be successfully grown on wheat land after the grain is harvested. When grown for seed they should be planted in rows and cultivated in the same way as corn. The yield of cowpea hay varies from 1 to 3 tons. The green crop can be used with corn in filling silos.

A large part of the agricultural land of Callaway County is in sod, and in general all the soils are well suited to the common tame grasses. Approximately 23,000 acres were devoted to timothy in 1909, and 10,000 acres to timothy and clover mixed. The largest yields are obtained on the areas of Putnam soil, where the crop is most extensively grown. The pastures consist almost exclusively of bluegrass, and the luxuriant growth and permanence of this valuable grass largely have made possible the important development of livestock farming. Little difficulty is found in getting a stand, and when once the grass is started it is practically permanent. In fact, the seed is rarely sown, for on fields left uncultivated two or three years, especially when pastured, or when woodland is cleared, bluegrass soon appears and spreads over the entire area. On the prairie soils, however, there are few permanent pastures. Land that is run down is usually seeded with timothy and clover, used for pasture for a few years, and then cultivated again to corn and wheat.

Less than 4,000 acres are devoted to clover alone in Callaway County. This surprisingly small acreage, averaging about 1 acre per farm, is out of all proportion when the value of this legume as a soil improver is considered. Most of the soils will grow clover, although much of the level prairie and the poorer hill land are not well suited to the crop. In most cases the use of lime and manure will make possible the successful growing of this legume. Sweet clover will grow on all soils containing sufficient lime. Excepting on the Missouri River bottom lands, alfalfa is not an important crop. The heavy clay subsoils and the low lime and humus content of all the prairie and gray timbered soils are not favorable to the growing of this crop. Of the upland soils the Memphis silt loam is best adapted to it.

The growing of fruit receives little attention, and only small quantities of apples and peaches are produced. The orchards are small, and the trees of poor growth and inferior varieties. Little or no attention is paid to pruning, spraying, or cultivating. The soils of the Memphis, Hagerstown, and Union series are well adapted to fruit growing, many desirable slopes affording good orchard sites.

Tobacco was originally an important crop in the southeastern part of the county, but its production, except in a few small areas for local use, was practically abandoned about 50 years ago. As much as 14,000,000 pounds per annum was produced at one time. The

Lindley and Union silt loams were the soils used. Burley tobacco was grown almost exclusively. Much of the tobacco land has been abandoned or allowed to grow up with brush.

As already stated, Callaway County is primarily a stock-raising county. In 1916, according to the records of the State auditor, there were 8,679 horses in the county, 5,743 mules, 18,023 head of cattle, 12,288 hogs, and 10,218 sheep. The cattle raised are of high grade; most of the larger herds are pure-bred Hereford, Angus, and Shorthorns. On the rolling land of the southern half of the county most of the cattle are sold as feeders, but on the prairie lands in the northern part feeding is carried on extensively and many farmers make this a specialty.

The raising of mules receives particular attention, and a large number are exported annually. The animals are noted for their size and quality and command high prices. The mules are generally bought at the age of 2 or 3 years by local buyers, who put them on feed for several months before shipping to the large markets. Horses are raised in large numbers for export.

Small flocks of sheep are kept in all parts of the county, and it is probable that their number could be increased with profit, especially in the hilly areas, where sheep would probably be more profitable than cattle. The feeding of western range sheep is of considerable importance in the northern part of the county.

One of the undeveloped industries in Callaway County that should and probably will become of considerable importance is dairying. The natural conditions are especially favorable. The pastures furnish nearly eight months' good grazing, and forage crops can readily be grown. Dairying would supply a large amount of manure, which is much needed on all the soils. The development of dairying, particularly near the railroads would unquestionably result in a more prosperous agriculture.

The prevailing crop rotation consists of corn one or two years, and timothy two or more years. An oat crop is frequently inserted between corn and grass. The better farmers mix clover with the timothy. On the prairie soils corn is frequently grown for three years. Grass land is usually pastured two or more years before being again used for corn.

Under the prevailing system of farming a relatively small amount of barnyard manure is produced. Little or no attention is given to the growing of legumes, such as clover or cowpeas, as green manure. The manure produced by the live stock in pastures is primarily depended on to maintain the productiveness of the soils, and the supply in general is not sufficient to maintain the organic content of the soils necessary for maximum crop production. All the soils of Callaway County are naturally low in organic matter, and in many

cases this condition has been aggravated by continuous cropping without manuring. A condition of poor tilth has followed, and in many cases this already limits crop yields. The remedy is to increase the organic-matter content by plowing under manure or crop residues such as cornstalks, straw, and clover. Selling these products from the farm, burning them, feeding them and not returning the manure, or allowing a very large part of the manure to be lost before it is returned to the land, are all wasteful practices.

The use of commercial fertilizers is increasing. According to the census the amount expended in 1899 for fertilizers was \$3,630; by 1909 it had increased to \$32,607, or an average of \$49 for the 668 farms reporting an outlay. Although fertilizers are now used only on the prairie soils it is probable that their use on all but the steeply rolling uplands would be profitable. The Missouri Agricultural Experiment Station has found, by numerous trials on similar soils, that a fertilizer containing a high percentage of available phosphorus, such as acid phosphate or bone-meal, can be applied with profit. Applications of 100 to 200 pounds per acre before corn or wheat are recommended. The rates of application of either phosphates or mixed fertilizer depends on both the productiveness of the soil and the system of farming practiced. It is doubtful if the use of commercial fertilizer would prove profitable on the better land in the county under the present extensive system of farming. Fertilizers alone will not maintain soil productiveness, but should be intelligently used in connection with a good system of crop rotation, legume growing, and the incorporation of organic matter.¹

A number of tests made during the progress of the soil survey indicate that much of the soil in Callaway County is deficient in lime or is acid. This condition is most pronounced in the Putnam, Marion, and Lindley soils and in the gray bottom lands. Even the loess soils and those derived from limestone are usually deficient in lime, particularly in the more level areas, owing to the leaching out of this element. Soil acidity is usually indicated by the abundant growth of certain weeds, such as red sorrel and sour dock, and by the fact that clover can not be grown. The deficiency can be corrected by the use of burnt lime or ground limestone. The latter in most cases is preferable, because it is less expensive. Applications of about 1 to 3 tons per acre every 4 to 6 years give good results. The thick beds of limestone throughout the southern part of the county are well adapted to crushing for agricultural use. Together with manure and fertilizers, the use of lime is essential in improving the productiveness of most of the upland soils.²

¹ Bulletins 126 and 128, Mo. Agr. Expt. Sta., give information on the use of fertilizer on northeast Missouri soils.

² See Bul. 146, Mo. Agr. Expt. Sta.

Except on the level prairies, erosion is serious on all the upland soils, especially the Memphis, Union, and Baxter types, owing to their steeper slopes. During a single rain more plant food may be lost on a slope through erosion than is required to produce an entire crop, for it is the upper soil horizon, highest in content of organic matter, that is washed away first. On all the steeper lands, the numerous "clay points" or "scalds" indicate the wide extent of erosion and the rapid rate at which it takes place. Nearly every farm contains some land so completely dissected by ditches and ravines as to make it unfit for farming.¹ To check erosion it is necessary to get the soil in condition to absorb and retain large quantities of rain water, so that rapid run-off will not take place. One way to accomplish this is to incorporate organic matter and plow deeply. Another way is to plow and cultivate the hillsides, so as to cause the water to take its way downward through channels of the least possible gradient; and still another way is to keep the surface covered during the winter with such crops as wheat or rye. On long slopes gullying can be overcome to a considerable extent by laying out the fields in long and comparatively narrow strips on the hillsides, so that the land in tilled crops alternates with land in grain and hay, thus greatly shortening the distance downhill through which the accumulation of water may take place, as the sodded strips absorb and check the flow of surface water.

SOILS.

The materials from which the upland soils of Callaway County have been derived consist in part of the products of local rock decay, such as clay, sand, and gravel resulting from the disintegration of limestones, shales, and sandstones which underlie the county, and in part of material disintegrated elsewhere and transported into this region by ice during the glacial period. The upland soils include two broad groups, light-colored soils developed in timbered areas and dark-colored soils developed in prairie or treeless areas. The alluvial soils, consisting to a considerable extent of sediments transported and redeposited from the upland rather than a uniform soil material, vary in color, but are predominantly rather dark.

Soils from glacial materials cover approximately two-thirds of the county. They include soils derived from both glacial and loessial deposits the loessial soils being most extensive in the extreme southern part of the upland of the county, while the true glacial soils are encountered in the northern part.

The soils derived from the materials resulting from local rock decay vary greatly in details of derivation, since Callaway County

¹ See Cir. 14, Mo. Agr. Ext. Service, "The soil-saving dam."

lies on the northern edge of the Ozark uplift, and therefore presents a wide range of geological formations and conditions. In the southern part of the county the Jefferson City limestone of Cambrian age is extensively developed. It consists of moderately cherty, crystalline, dolomite and thin sandstone lentils. Limestones of Ordovician, Silurian, and Devonian age occur to the north of the Jefferson City formation. In general, these several beds average less than 200 feet in thickness, and consist of rather hard, pure lime carbonate. The Burlington limestone, of Mississippian age, has its greatest development in the central and eastern part of the county. Approximately two-thirds of the county area is therefore underlain by limestone rock of various formations. The rocks of the northern and western parts of the county consist of interbedded shale, sandstone, and limestone of Pennsylvanian age.

During glacial times the invading ice sheet spread over the entire county and deposited a mass of soil material consisting in part of rock débris of local origin and in part of boulders and gravel of foreign origin. The former consisted largely of shale and sandstone. This material was carried southward and spread over the region underlain by limestone, thus concealing the latter and eliminating it as an important soil-forming agent. The depth of the glacial deposits varies from nothing, where they have been completely removed by erosion, up to 20 or 30 feet in the more level areas in the northern part of the county. In the hilly sections the till has largely been removed and is in places entirely absent. Such areas, where underlain by limestone, are covered by the residual Union, Baxter, and Eldon soils. Wherever the shale predominates as the underlying formation the soil is not essentially different from that in the areas of glacial deposits, as the parent material is the same. Thus, along Cedar Creek, in the western part of the county, much of the Lindley silt loam is residual in origin, but has the same characteristics as in the glacial areas of the type. In general, the glacial deposits in Callaway County are thinner, contain more local material, and are less calcareous than in most other portions of northern Missouri. The soil is therefore siltier in texture, and under timbered conditions, with a low content of lime, has accumulated little organic matter.

The southern part of the county, bordering the Missouri River flood plain, was covered by a layer of silty material known geologically as loess. This is supposed to be wind deposited—blown up from the river-flood plain during Pleistocene times. The loess belt averages about 2 miles in width. Its exact northern limit is very difficult to determine, but there is evidence that it originally extended much farther north and has been reduced to its present limits by the action of erosion. Unlike most of the loess in the western part of the State,

it is not calcareous, and therefore contains less organic matter and is less productive. The low content of lime is probably due to the leached condition of the material before it was deposited and to the excessive weathering it has since undergone.

What differences due to origin or mode of formation may have originally existed in the soils in the different parts of the county, have been modified to such an extent by the action of weathering that large areas are now essentially alike in all their important physical characteristics. This is especially true in the case of all the soils that were timbered. Gray surface soils predominate in areas of glacial, residual, or loessial origin. It is only in limited areas where the material was originally rich in lime carbonate that dark soils occur within the timbered area. The subsoils are predominantly some shade of brown and are moderately friable. They have a greater concentration of the finer clay particles than the surface soils, and are therefore heavier and more impervious. In the timbered areas conditions have been unfavorable to the accumulation of large amounts of organic matter, and the leaching of the soluble material, especially lime, was hastened. In general, however, all the upland soils are only fairly well supplied with organic matter, those of the timbered areas having the smallest content.

The soils of the Putnam series, which include most of the level prairies, are generally considered to be derived from loessial material deposited over glacial till. It seems very probable, however, that in Callaway County much of the Putnam soil consists of glacial drift, the same as that giving rise to the Lindley silt loam. In the case of these silty deposits, existing under poor drainage on the level prairies, conditions have not only favored the more rapid decay of all coarse mineral particles but have resulted in a greater accumulation and compaction of clay in the subsoil. It is frequently observable that on all the more nearly level areas, even where the soil material is entirely glacial, gravel and coarse sand are lacking or encountered only in the lower subsoil or that part of the soil profile in which weathering has been least active. On the rolling land the surface soil is constantly being removed by erosion and there remains more of the coarser particles which originally were present in all the till. The Putnam and Marion soils are believed to be both glacial and loessial in origin. They are distinguished by the darker color and the prairie condition of the former.

The typical glacial soils are included in the Lindley and Shelby series, the most important difference being the darker color of the latter.

The typical loess soil is classed as the Memphis silt loam. It is characterized by a light-brown color and silty texture.

The limestone soils are included in the Union, Baxter, and Hagerstown series. The Union and Baxter series have a grayish-brown surface soil and a yellowish-gray silty clay subsoil; the Hagerstown is brown to reddish brown in both soil and subsoil, and is thus easily distinguished. These series have a wide distribution throughout the Ozark border region.

The residual soil, dark in color and derived largely from limestone, with some included shale, is correlated as the Eldon silt loam. The dark soil residual from shale and sandstone is included in the Bates series. Both the Eldon and Bates soils occur also in the western part of the State in the old plains region.

The alluvial soils vary considerably on account of differences in the character of the original alluvium. They are classed in six series—the Robertsville, Genesee, Huntington, Lintonia, Wabash, and Sarpy. The Robertsville silt loam represents the light-colored second bottoms or terraces. The brown alluvial soil bordering all the smaller streams is mapped as the Genesee fine sandy loam. The Huntington soils are developed in the first bottoms of streams in the limestone region, and consist of material washed from the upland limestone soils. The brown, silty alluvial soil consisting largely of loess wash is mapped as the Lintonia silt loam. In the Missouri River bottom the soils dark in color and heavy in texture are included in the Wabash series. The Sarpy series includes the brown sandy soils, consisting of the most recent river deposits.

In following pages of this report the various soils of Callaway County are described in detail and discussed in their relation to agriculture. The distribution of the soils is shown on the map accompanying this report, and the table below gives the name and the actual and relative extent of each:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Putnam silt loam.....	109, 120	41. 8	Shelby loam.....	6, 464	1. 3
Rolling phase.....	42, 496		Lintonia silt loam.....	5, 760	1. 1
Dark-colored phase.....	10, 944		Sarpy very fine sandy loam...	5, 504	1. 1
Lindley silt loam.....	99, 264	19. 2	Wabash clay.....	5, 440	1. 1
Union silt loam.....	62, 272	12. 0	Huntington silt loam.....	4, 864	. 9
Baxter stony loam.....	39, 168	7. 6	Robertsville silt loam.....	4, 864	. 9
Memphis silt loam.....	38, 912	7. 5	Lindley loam.....	4, 032	. 8
Genesee fine sandy loam.....	15, 744	3. 1	Wabash silt loam.....	3, 712	. 7
Marion silt loam.....	13, 504	2. 6	Wabash silty clay loam.....	3, 456	. 7
Bates silt loam.....	10, 368	2. 0	Hagerstown silt loam.....	2, 688	. 5
Huntington fine sandy loam..	9, 472	1. 8	Sarpy fine sand.....	2, 176	. 4
Eldon silt loam.....	8, 448	1. 6			
Rough stony land.....	8, 448	1. 6	Total.....	517, 120

PUTNAM SILT LOAM.

The Putnam silt loam is the typical prairie soil of the county, and is characterized by its dark-gray color, nearly level topography, and heavy subsoil stratum. The surface soil to a depth of 8 to 10 inches is a mellow silt loam, which grades into a light-gray slightly heavier subsurface layer. The soil color, typically dark gray, varies from light gray when dry to almost black when wet. In flat and poorly drained areas the lighter colors predominate, while in areas of deeper soil and better drainage the darker shades predominate, the latter being due to the accumulation of organic matter. The light-gray subsurface stratum is almost everywhere present. It varies from 2 to 8 inches in thickness, being thinner in the more rolling areas and decidedly thicker and lighter in the more level areas. It is rarely reached at the ordinary depth of plowing, but when brought to the surface the material soon takes on the characteristics of the darker surface soil.

The subsoil, beginning abruptly at a depth of 16 to 18 inches, is a grayish-brown to dark-drab, heavy, plastic clay, faintly mottled reddish brown. At about 30 inches this grades into a gray or yellowish-gray, friable silty clay, mottled yellow and brown. The upper portion of the subsoil, on account of its fine texture and rather compact structure, tends to retard the movement of water, and therefore is locally known as "hardpan."

The Putnam silt loam is the most important and the most extensive soil type in Callaway County. It occupies the broad, level prairies in the northern half of the county. Smaller areas occur around Williamsburg (Nine Mile Prairie), Garrett (Hancock Prairie), Reform (Coates Prairie), Hams Prairie, and on the broad, level divides extending southward between the larger stream courses. There are few areas without apparently enough slope to afford good surface drainage, but the heavy subsoil does not permit of free downward movement of water, and crops sometimes suffer from excess moisture in wet seasons.

In origin the Putnam silt loam is either glacial or loessial. It is possible that the surface material is derived from the outwash of the retreating ice sheet, modified by a thin loessial deposit, but the proximity of the mass of sandy clay to the surface suggests strongly that the latter is merely a highly weathered part of the former in which all the coarse particles have disappeared. The heavy clay subsoil has probably resulted from the accumulation of clay particles carried down by percolating rain water from the overlying soil.

The original vegetation was a dense growth of wild prairie grasses. All the type is now farmed. The soil is easy to cultivate, and since

most of the fields are large—rarely smaller than 40 acres—the largest farm machinery can be used. This is one of the best upland types in the county and the most highly improved.

More than 50 per cent of the Putnam silt loam is in hay land and pasture. Hay yields 1 to 2 tons per acre. Clover and alfalfa will grow, but usually it is difficult to get a stand. Alfalfa does not make a vigorous growth and in most cases is soon crowded out by grass and weeds. Manuring and liming are necessary to make these legumes thrive.

Of the cultivated crops corn is by far the most important, and in normal seasons average yields of 40 bushels per acre are obtained. Larger yields are common under the best farm practices. Oats, which are extensively grown, yield from 25 to 50 bushels per acre, depending on the season. The wheat acreage is small. Yields range from 12 to 18 bushels per acre when commercial fertilizers are used. In general, the small grains are included in the rotation when the land is to be seeded to grass. The prevailing type of agriculture is live-stock farming, and for this reason grass and corn are the principal crops. The raising of mules is of especial importance.

Land of this type ranges in price from \$60 to \$130 an acre.

The productiveness of the Putnam silt loam has been fairly well maintained, but continued cultivation has greatly reduced the content of organic matter. "The important considerations, therefore, in handling soil of this type are the adoption of a good crop rotation; the application of 2 or 3 tons of ground limestone, thoroughly worked into the soil and followed by additional applications of a ton every six years; the use of all manure possible to secure at a cost not exceeding \$2 per ton, including hauling and spreading it on the field—this to be applied chiefly before the corn crop; and, finally, the application of 150 to 200 pounds of steamed bone meal or acid phosphate, to be drilled in with the wheat where this crop is used in rotation."¹ Green manuring would be beneficial. For this purpose the more extensive growing of clover is necessary. Alsike clover is much better adapted to this land than red clover. Under either a grain or live-stock system of farming the more extensive use of commercial fertilizers and ground limestone would be profitable.

Putnam silt loam, dark-colored phase.—The dark-colored phase differs from the typical Putnam silt loam in that the surface soil is darker in color and the gray subsurface stratum only faintly developed. Typically the soil is a dark-brown to very dark gray silt loam grading into a grayish-brown, heavy silt loam. The subsoil is essentially the same as that of the typical soil, although in places it averages a little more friable. This dark soil is similar to the dark prairie

¹ Bul. No. 126, Mo. Agr. Expt. Sta.

type, the Grundy silt loam, developed in the northern part of the State, but it is not as dark in color and not as productive.

The Putnam silt loam, dark-colored phase, occurs in two principal areas, one extending from McCredie eastward and the other including a large part of the level prairie land north of New Bloomfield. The boundaries drawn between the typical soil and the dark-colored phase are rather arbitrary. In general, the latter has a slightly more undulating surface, so that the run-off is good. Corn and grass are the principal crops. Clover does well, and it is probable that with manuring and liming alfalfa could be made to thrive. In general, on account of its favorable location and somewhat greater productivity, this phase represents some of the most valuable land in the county. The farm improvements are of excellent quality.

Putnam silt loam, rolling phase.—The Putnam silt loam, rolling phase, represents areas modified in surface features and in soil structure by erosion and the growth of vegetation. It includes the narrow ridges and gently rolling areas bordering the small streams. The surface soil is a grayish-brown to gray silt loam, 6 to 8 inches in depth, which grades into a somewhat heavier light grayish-brown silt loam. The gray subsurface horizon so characteristic of the typical Putnam silt loam is not present or only faintly developed, and in its place occurs light-brown silt loam similar to the surface soil. The subsoil is a brown to drab, heavy clay loam, mottled red and brown. It is not as compact or impervious as in the typical soil. Where the phase occurs as narrow ridges or flat divides it is gray in both soil and subsoil, and resembles somewhat the Marion silt loam.

The boundaries between the typical Putnam silt loam and its rolling phase are of necessity arbitrary, since the two soils grade into each other imperceptibly. Narrow belts of the rolling phase surround all the main type where it breaks off into the hill land, but it is only where the development of the phase is rather extensive that it has been indicated on the soil map. In general, the rolling phase has a gently rolling topography and originally was timbered, and these conditions account for its lighter colored surface soil and more friable subsoil. The slopes are rarely steep enough to cause serious erosion.

All of this phase is in cultivation. It is used for the same crops as the typical soil, although a larger proportion of it is in grass. It is not quite as productive as the typical soil and is more deficient in organic matter. It is somewhat earlier, however, and responds more readily to manuring. Where well supplied with organic matter it grows clover, and greater advantage should be taken of this fact in order to increase the productiveness.

The following table gives the results of mechanical analyses of samples of the soil, subsurface, subsoil, and lower subsoil of the typical Putnam silt loam:

Mechanical analyses of Putnam silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
344311.....	Soil.....	0.3	1.5	0.7	0.8	13.9	64.8	17.7
344312.....	Subsurface.....	1.4	2.6	.7	.7	10.7	59.9	23.7
344313.....	Subsoil.....	.1	.8	.3	.7	5.3	41.1	51.4
344314.....	Lower subsoil.....	.1	.6	.3	1.1	7.1	55.5	35.1

MARION SILT LOAM.

The surface soil of the Marion silt loam is a gray or light-gray silt loam containing some small, rounded iron concretions. When first plowed it has a slightly grayish color, but after exposure to rain is much lighter in color. The characteristic subsurface stratum, varying from 5 to 9 inches in thickness, is a light-gray or ashy silt loam, containing small iron concretions. The true subsoil, beginning abruptly at 16 to 18 inches, is a gray or drab, heavy, waxy clay, becoming somewhat lighter in texture and faintly mottled with brown below 30 inches. It is almost impervious to water, and is locally known as "hardpan." That part of the type occurring near Yucatan has a grayish-brown subsurface layer, in contrast to the typical light-gray layer. In general both soil and subsoil show a strong acid reaction.

The type is most extensive west of Auxvasse, south of Calwood, and near Yucatan. Small detached areas occur throughout the county, bordering the Putnam silt loam in places. The type occupies the crests of narrow, flat-topped ridges and projecting points of upland between drainage ways. It corresponds topographically, and is similar in origin, to the Putnam silt loam, but on account of the forest covering less organic matter has accumulated.

Because of its relative smoothness in comparison with the surrounding hill land all of the type is now under cultivation. Corn and oats are the principal crops. Yields are low and rarely profitable without fertilization. Clover can be made to succeed if lime is used. Liming is also beneficial in growing grasses. Where the soil is not well drained alsike clover will do better than red clover. Cowpeas should be grown more extensively. Pasturing is the best use that can be made of this land, and even when it is used for this purpose applications of limestone, organic matter, and phosphorus should prove profitable.

LINDLEY LOAM.

The Lindley loam, to a depth of 5 to 7 inches, is a yellowish-gray to grayish-brown loam, varying in texture from a somewhat sandy loam to a fine loam, but distinctly more gritty than the soil of the silt loam type. Immediately below the surface soil the material is yellowish-brown or grayish-brown. It grades at 12 to 15 inches into heavy sandy clay or clay loam, faintly mottled with gray and reddish brown. Below 30 inches the gray color predominates and the soil is more friable. Glacial pebbles and fragments occur throughout the soil section.

The Lindley loam differs from the Shelby loam in its lighter color and more rolling surface. Its coarser texture as compared with the silt loam is due to the larger amount of sand in the original glacial drift and to the fact that the loam, on account of having been more recently uncovered, has not been subjected to such long weathering, so that the coarse material has not been broken down into clay.

The Lindley loam occurs in the northeastern part of the county, occupying the steeper slopes along the head of draws. Numerous areas too small to indicate separately on the map are included with the Lindley silt loam. On account of severe erosion the soil is thin and rather unproductive, and cultivation is difficult.

In most physical features and in agricultural value this soil is essentially the same as the Lindley silt loam, and the same crops are grown. Owing to its low content of organic matter and its tendency to erosion it gives best results as pasture or timbered pasture land. Clover is successfully grown, and corn gives fair yields on the smoother areas.

LINDLEY SILT LOAM.

The Lindley silt loam to an average depth of about 5 inches is a gray or brownish-gray silt loam. On eroded slopes where the subsoil is exposed the color is decidedly yellow and the texture clay loam. When freshly plowed the soil appears yellow or brownish-yellow, but when it becomes dry after a rain it has a grayish color. The sub-surface soil is a friable, yellowish-brown silt loam to clayey silt loam. Its thickness varies from 5 to 10 inches, depending on the extent of recent erosion. The subsoil below 16 to 18 inches is a light-brown to pale-yellow, compact silty clay, changing at about 24 inches to a yellowish-gray, friable silty clay loam, which is highly mottled with gray, yellow, and brown. On all the more nearly level areas and where the type borders on the prairie soils, the subsoil averages heavier in texture, and usually is a stiff, light-yellow or drab clay. In general this type is characterized by a gray surface soil and a compact, yellowish-brown subsoil. The lower subsoil is character-

istically friable and mottled, owing to incomplete weathering of the material. Throughout the soil and subsoil are scattered sand, glacial gravel, and occasional large boulders.

Throughout the type there are numerous small areas that are a loam in texture, and have a yellowish-brown, sandy clay subsoil. Glacial sand and pebbles and lime concretions are present, as well as large boulders. This variation is developed most extensively in the northeastern corner of the county on steep slopes and near the heads of draws, where the flat Putnam soils break off into the rolling timbered land. It includes also most of the steeply rolling land along Richland Creek and other prairie streams. It is essentially Lindley loam, but on account of its irregular extent it could not be indicated separately on the soil map.

Another variation of the type occurs on the flat-topped ridges and the gentle slopes. Here the surface soil is a light-gray to pale-yellow silt loam, with a heavy, stiff clay subsoil, yellowish-gray to drab in color. These areas resemble somewhat the Marion silt loam, and like the latter are usually covered with scrubby post oak or other stunted trees.

In general the areas of the Lindley silt loam within the drainage basin of Cedar Creek have a deeper surface soil and a more friable subsoil than is typical. The former is predominantly a yellowish-brown silt loam and the latter a yellowish-gray silty clay. This part of the type is largely residual from shales and sandstones. It averages more productive than the typical soil. Originally this land was forested with oak, elm, and walnut.

The Lindley silt loam has been formed by the weathering of glacial material, derived largely from the local shales and sandstones of the Coal Measures. The resultant soil is therefore silty rather than loamy as is the case in the northern part of the State, where the glacial deposits contain much foreign material. Moreover, long weathering has destroyed such differences as may have existed in the original deposits, so that the material now is rather uniform. It is only in the western part of the county, where the glacial deposits are thinnest, that the soil in places may be entirely residual from the underlying rock.

The Lindley silt loam includes most of the rolling timbered land in the northern half of the county. In general its distribution is co-extensive with, and slightly south of, the occurrence of the Coal Measures rocks, giving way to the Union silt loam in the southern part of the county, where the limestones occur. The type occurs along all the streams and includes all the rolling to moderately hilly land. In general it is more rolling in the southern part of its occurrence than in the northern part, where the streams have cut to only a moderate depth. Although most of the land is arable, much of

it can be cultivated only with difficulty, because the numerous ravine-like branches and stream laterals limit the size of the fields. In general the north slopes are more decidedly rolling than the south slopes.

The entire type was originally forested, the edge of the forest growth practically marking the boundary between this type and the Putnam. All the more rolling land remains timbered at the present time, the growth consisting mostly of white oak, with red oak, elm, and hickory on the lower slopes.

The greater part of the type is used for pasture, for which purpose it is best suited. Bluegrass makes a good growth, and quickly spreads over cleared hillsides and uncultivated fields. Clover does fairly well where the soil contains sufficient organic matter. The principal cultivated crops are corn, sorghum, and oats. Yields of corn range from 15 to 35 bushels per acre.

In general, the Lindley silt loam is not very productive, primarily on account of its low content of organic matter. Its most important need is the prevention of surface washing. If the land is cropped at all, a rotation should be practiced that includes a cultivated crop as little as possible and allows the land to be kept in pasture and hay most of the time. If tilled, the land should be plowed deeply and contours should be followed in plowing, planting, and cultivating. Every means should be employed to maintain and increase the organic content, by plowing under manure, stalks, and other crop residues, or legume crops. The use of ground limestone would give good results. Most of this soil is acid, but with the use of lime clover can be grown successfully.

SHELBY LOAM.

The Shelby loam occurs principally in the northeastern part of the county, and represents the dark glacial soil of that region. The surface soil is dominantly a dark-brown loam, but varies from silt loam to sandy loam. In general, it is darker and siltier on the gentler slopes than on the steeper slopes, as it represents a transition into the lower lying Bates soils. The subsurface layer, from 12 to 18 inches, is a heavy loam or silty clay loam, grading into a yellowish-brown sandy clay subsoil which is mottled reddish brown. In general the subsoil is not as heavy and contains less sand than the subsoil of the typical Shelby loam in the northwestern part of the State. Variable amounts of gravel and small boulders are scattered throughout the soil section.

The surface of the Shelby loam is gently rolling. The soil is well supplied with lime, which has favored the accumulation of a comparatively high content of organic matter. Because of the loamy structure, the soil dries out earlier in the spring after rains, and

is therefore considered warmer and more easily tilled than the prairie soils.

The Shelby loam is one of the better upland types. All of it is highly improved. Corn, oats, and grass are the most important crops. Clover does well but little is grown. The raising and feeding of cattle is carried on in conjunction with general farming, and under normal conditions the productiveness of the soil is fairly well maintained. With the incorporation of organic matter and the use of phosphates, the soil can be brought to a high state of productiveness.

MEMPHIS SILT LOAM.

The Memphis silt loam includes the belt of upland bordering the Missouri River bottom, locally known as "bluff land" or "river hill land." The surface soil varies in depth from 6 to 12 inches, and consists of a brown or dark-brown to yellowish-brown, mellow silt loam. The surface 1 or 2 inches is usually gray or pale yellow, which tends to give fields a characteristic gray color. The upper portion of the subsoil is a yellowish-brown, heavy silt loam. This grades at about 24 inches into a compact yellowish-gray silty loam, which passes into friable, mottled silty material. Along the river bluffs the subsoil is not as heavy and compact as in the more inland areas. It consists of a brown silt loam throughout the 3-foot section or to the base of the loess deposit, which varies in depth from 10 to 30 feet.

The Memphis silt loam is most typical where it occurs as rolling land near the river bottom. In the bluff position it has more than its average thickness and coarseness of texture. Back from the river bluffs it grows thinner and finer in texture, and the material loses its distinctive characteristics. Along its northern border the type merges imperceptibly with the Union silt loam. Although this border does not mark the limit of the loess deposit, it marks the limit of the area where the soil is derived exclusively from this material. In general, the Memphis silt loam is finer grained and has been leached and weathered to a much higher degree than the corresponding deposits in the western part of the State. The greater concentration of clay in the subsoil and the disappearance of all calcareous material are evidence of this. Moreover, the type is not as productive as in other areas, and in many respects has assumed the characteristics of an old and worn soil.

The topography varies from hilly to rolling, the hilly areas predominating in the eastern and western parts of the county. Approximately one-third of the type is too broken for profitable cultivation. Where erosion has advanced to a mature stage the topography is characterized by smoothly rounded slopes and broad, shallow valleys; where conditions have favored the rapid cutting of small valleys

and deep ravines, the slopes are steep and short. Where such surface features exist the mantle of loess has in places been largely washed away, the limestone being exposed.

All of the type was originally timbered, the growth consisting mostly of white and red oak and hickory. On the river bluffs and along the creeks, walnut and elm were abundant. Much of the broken land remains timbered. Of the cultivated crops wheat is the most important, not only because the soil is well adapted to this crop, but because it does not require intertillage and thus retards erosion. The quality of the grain is exceptionally good, and the yields large, from 15 to 30 bushels per acre. Corn yields 30 to 50 bushels per acre. Clover and grasses do well. Alfalfa is grown successfully on the deeper soil on the bluffs, but manuring is usually necessary in order to get a stand. The soil is especially well suited for apples, small fruits, and gardening. The possibilities of development along this line are not yet appreciated. Thousands of acres that now provide only sparse pasturage are well suited for orcharding. Not only do the trees make a strong growth, but the fruit is of high quality, and transportation facilities and climatic conditions are favorable.

In addition to fruit growing, the development of dairying would be profitable. Since clover and grasses thrive everywhere, abundant pasture is easily supplied. The near-by bottom soils, well suited to corn production, could be depended on to supply the necessary grain. With the development of these industries, this can easily be made one of the most prosperous regions in the county. The present careless system of grain farming is destructive and rarely profitable, as frequent cultivation results in severe soil washing. Many of the pastures are gullied and brushy and have a poor stand of grass. With proper care and the more extensive growing of clover, this land could be brought up to a high state of productiveness.

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

Mechanical analyses of Memphis silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
344315.....	Soil.....	0.1	0.7	0.6	1.4	18.5	62.0	17.0
344316.....	Subsoil.....	.0	.6	.5	1.4	14.5	56.4	26.4

UNION SILT LOAM.

The Union silt loam represents the hilly limestone land in the southern half of the county. The surface soil to a depth of 5 to 7

inches consists of a grayish-brown to gray, mellow silt loam. When dry it appears gray, or nearly so, but on eroded slopes and in cultivated fields the color is a distinct brown or grayish brown. The subsoil consists of a yellowish-brown rather friable silt loam, which at about 18 inches changes to a grayish-brown or reddish-brown, compact silty clay or clay loam. The lower subsoil is uniformly a light-brown to gray silty material, highly mottled. In general the subsoil approaches reddish brown on the lower slopes and grayish brown in the higher areas. In every case, however, it is very compact, and has a tendency to be plastic rather than friable.

In general the Union silt loam differs from the Lindley silt loam in that the soil and subsoil of the former are brownish rather than yellow or gray. This difference is most pronounced when comparing the Union silt loam farthest south and on the lower slopes, where the subsoil has all the characteristics of a limestone soil and is undoubtedly residual from the local limestone. The occasional boulders and bits of gravel encountered in the surface soil on some of the ridges and near the northern border of the type would indicate that the soil here is from glacial material or has been subjected to glacial action. The boundary between the Union and Lindley silt loams is therefore arbitrary. Whatever differences may have existed in these soils owing to origin or mode of formation have long since been obliterated by the action of weathering.

Along its southern border the Union silt loam blends gradually into the Memphis silt loam and the boundary is also arbitrary. In this region much of the Union silt loam is unquestionably of loessial origin, as is indicated by its higher productiveness. In general the basis of separation has been the thinner mantle of soil, the more numerous outcrops of limestone, and the more steeply rolling topography in the case of the Union soil. It is thus evident that this soil type is derived only in part from the underlying limestones, and that it consists of this material intermingled with the glacial drift and loessial deposits.

Owing to the broken topography only a relatively small part of the Union silt loam is in cultivation. By far the greater part is used for pasture. All the type is hilly to rolling. Rolling areas are most extensive in range 9, to the north of Tebbetts. Not only are the ridges narrow, but the slopes are dissected by numerous draws, so that the cultivated fields are small, rarely exceeding 10 to 20 acres in extent. Erosion is everywhere severe.

The timber growth consists mostly of red and white oak, with some post oak on the ridges. Walnut, elm, and hickory are abundant on the lower slopes.

Corn is the most important crop, but the yields rarely exceed 30 bushels per acre. Little wheat or oats are grown, although these

crops do well. Timothy is an important crop, and clover is successfully grown, especially on the lower slopes where the red subsoil occurs. Fruit trees do well, especially on north slopes. With the exception of the smoother areas, this soil is best suited for pasture. Bluegrass will grow everywhere, but it does not form a thick sod, as on the glacial soils. The supply of organic matter was low, even under virgin conditions, and it has been further reduced by cropping and soil erosion, so that there is need of applying manure, both on cultivated areas and pasture land. With an increased content of organic matter all the grasses would make a stronger growth, and clover would thrive everywhere. The use of lime on the flat-topped ridges would be beneficial, since the soil here is usually acid. The numerous limestone outcrops would supply lime at a relatively low cost.

The following table gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the Union silt loam:

Mechanical analyses of Union silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
344328.....	Soil.....	0.1	1.0	0.6	2.3	11.7	65.3	18.9
344329.....	Subsurface.....	.2	.8	.7	2.4	8.6	54.0	32.9
344330.....	Subsoil.....	.7	2.6	2.2	11.5	17.0	35.1	30.6

BAXTER STONY LOAM.

The Baxter stony loam includes most of the stony land bordering the streams and draws throughout the county. Nearly all the type is nonarable, on account of the steepness of slope and the presence of stones and rock outcrops. There are included many tillable areas too small to be shown on the map used, but such areas are frequently so inaccessible and so small in extent as to be of very little agricultural value.

In general, the soil consists of gray to yellowish-brown silt loam, underlain by pale-yellow or reddish-brown silty clay or clay loam. The lower subsoil is nearly always reddish brown, particularly in the southern part of the county. In general, the soil is like the Union silt loam in physical characteristics. In both soil and subsoil chert and limestone fragments and rock outcrops are so numerous that cultivation is rarely possible. Each area of the type includes limestone ledges and bluffs which stand from a few feet to 150 feet above the floor of the adjoining valley.

All of the type is timbered, but much of the growth is brushy. The principal tree growth is red and white oak. In the southern part

of the county walnut, elm, hickory, and cedar are abundant. The type is best suited for the production of timber. It does not make good pasture, for the soil, on account of its shallow depth, is droughty, and when the forest is removed erosion is excessive, so that the ledge rock becomes exposed over large areas. This land, however, can be utilized as woods pasture, and where the trees are thinned out sufficiently bluegrass will make a fair growth. It is probable that orchard grass, on account of its stronger root development, would thrive better than bluegrass. In general, the north slopes have a deeper soil covering and are more productive than the south slopes.

HAGERSTOWN SILT LOAM.

The Hagerstown silt loam is frequently known as "red limestone land." The surface soil, 8 to 12 inches deep, consists of a brown or dark-brown, heavy silt loam, underlain by reddish-brown to yellowish-red silty clay or clay loam. The subsoil allows ready percolation of water. In general, the graduation of the surface soil into the heavy subsoil is accompanied by an increase in color intensity. The type is thus readily distinguished from the lighter colored Union soil.

The Hagerstown silt loam occurs in numerous small areas throughout the limestone region of the county, at the base of slopes bordering stream valleys. It occupies a position corresponding to a terrace, but does not have the characteristics of a terrace soil. It is usually bordered by a bottom-land soil on one side and stony land on the other. The surface is gently rolling, with a gentle slope toward the stream.

The type is derived mainly from the weathering of limestone, although colluvial material from the Union and Memphis soils has entered into its composition.

As a whole this is a very productive soil. It is especially well adapted to grasses and clover, for which most of it is used. Yields of corn and wheat are about the same as on the better areas of Memphis silt loam. It is also a good fruit soil. It has good natural drainage, warms up early in the spring, and is easily cultivated.

BATES SILT LOAM.

The Bates silt loam, to an average depth of 10 inches, consists of a dark-brown to grayish-brown silt loam, underlain by a brown, heavy silt loam. The subsoil below 18 inches is a dark-drab to yellowish-brown, friable silty clay, mottled red and brown, and becoming siltier in texture in the lower part of the soil section. On some of the gentle slopes, as at Fulton, this type closely resembles

the dark-colored phase of the Putnam silt loam, but it has a more friable and mottled subsoil. On some of the higher slopes the surface soil contains small amounts of sand and gravel, remnants from the higher-lying glacial soils.

A variation of the type occurs in the northeastern part of the county, where the surface soil is a heavy, black silty clay and the subsoil a drab clay. These areas are essentially Summit silt loam, but on account of their small extent they are not mapped separately. They generally occur near outcrops of limestone, where conditions are favorable for the accumulation of organic matter.

The Bates silt loam is widely distributed over the county, but in general its occurrence is coextensive with the southern edge of the Coal Measure rocks. It occurs on low slopes where the overlying glacial soils have been removed and the underlying shales and sandstones exposed. It is therefore residual in origin and, although some glacial material may have entered into its composition, it has not affected the character of the soil.

The topography is gently rolling to undulating. Both surface drainage and underdrainage are good. All of the type is highly improved. It has about the same agricultural value as the Shelby loam. All the staple crops are grown, with good results. Clover does fairly well. The soil is early and is easily worked, thus adapting it to a wide range of crops, including vegetables and fruits. It is responsive to manurial treatment, being superior in this respect to the prairie and glacial soils. Most of the type shows an acid reaction, and would be improved by the use of ground limestone.

The following table gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the Bates silt loam:

Mechanical analyses of Bates silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
344337.....	Soil.....	0.2	1.0	0.8	2.3	12.4	64.0	19.1
344338.....	Subsurface.....	.1	.7	.7	1.9	10.9	63.0	22.6
344339.....	Subsoil.....	.3	1.8	1.4	6.4	12.6	46.3	31.1

ELDON SILT LOAM.

The surface soil of the Eldon silt loam extending to an average depth of 8 to 10 inches, consists of a dark-brown to black silt loam. When moist the soil has a rather rich dark color, but upon drying out after a rain the surface of plowed fields is dark gray. Beneath the surface, however, the soil is always brown. The subsurface material is a brown to yellowish-brown, heavy silt loam. The subsoil

below 16 inches is a brown silty clay, highly mottled red and yellow. Both soil and subsoil are rather friable, with a loamy structure. Small angular chert fragments are scattered through the soil mass, and frequently form compact layers in the subsoil. In general the chert fragments are most numerous on the higher slopes, but they are rarely present in sufficient quantity to interfere seriously with cultivation. Associated with a higher content of gravel is a larger amount of sand, so that the soil approaches a loam in texture in places.

The Eldon silt loam occurs in the eastern part of the county, mainly in the drainage basin of Prairie Branch. It occupies long, gentle slopes on the gently rolling uplands. This land was originally timbered with oak, elm, and walnut.

The soil is derived mainly from the moderately cherty Jefferson City limestone, together with material from shales and limestones (Silurian) and from glacial deposits. Much of the sand is undoubtedly from the latter source. Occasional areas are essentially like the Bates silt loam, and are probably derived from shales, but the almost universal presence of chert and the numerous outcrops of bedrock prove that the soil is mostly of limestone origin.

Surface drainage is good, but along shallow draws and where the cherty subsoil lies near the surface the ground is seepy and hard to cultivate in wet seasons. Such areas could be improved greatly by tile drainage.

This is a fairly productive soil. All of it is highly improved. It is used for corn, grass, and clover. Wheat is not grown, on account of the distance from market. Corn yields 20 to 40 bushels per acre. The Eldon silt loam is among the soils best adapted to bluegrass.

ROBERTSVILLE SILT LOAM.

The Robertsville silt loam is locally known as "gray bench land." The surface soil is a gray silt loam grading at 7 to 10 inches into a very light gray or almost white silt loam. This is usually faintly mottled with yellow and brown and contains small iron concretions. The true subsoil begins at an average depth of 20 inches and consists of a drab or dull-gray, plastic clay, which changes downward to a friable silty clay mottled yellow and gray. The upper stratum of the subsoil varies from 8 to 12 inches in thickness. It is compact enough to interfere seriously with drainage.

The type occupies the second bottoms or terraces along the larger streams, and usually stands from 3 to 15 feet above the adjoining first bottom. It is alluvial in origin, but has received a large quantity of wash material from the adjoining uplands.

Practically all of the type is in grass, to which it is best suited. Owing to the deficiency of organic matter and to the impervious subsoil, the water-holding capacity is low, and in times of drought

crops frequently fail. In the use of this soil the first requirement is the turning under of organic material. The soil is almost invariably acid and acreage applications of 1 to 3 tons of limestone are needed.

GENESEE FINE SANDY LOAM.

The Genesee fine sandy loam is the most widely distributed and the most variable alluvial soil in the county. The surface soil to an average depth of 10 to 12 inches is a dark-brown, grayish-brown, or brown fine sandy loam. The subsoil consists of similar material, but is usually somewhat heavier in texture and lighter in color. It usually contains enough clay to give it a plastic, though not a tenacious, structure. The texture of both soil and subsoil shows considerable variation, from fine sandy loam to silt loam; they may consist of alternating layers of fine sand and silt. In general the soil averages sandier along the banks of streams, especially in the bends, and in the valleys of the larger streams where the currents are sufficiently strong to deposit sandy material. In the northeast corner of the county, along Loutre Creek and its tributaries, the type averages darker in color than elsewhere.

The Genesee fine sandy loam is a first-bottom soil, made up principally of material collected by streams from the glacial uplands. It is only fairly well supplied with lime and organic matter. Nearly all the type is subject to overflow, but the internal drainage is good on account of the loamy structure.

The soil is easily tilled, and where the areas are of sufficient extent they are usually in cultivation. This is one of the most valuable soils in the county. It is highly prized for the production of corn. Yields range from 35 to 60 bushels per acre. Alfalfa may be successfully grown on the better drained areas. A large proportion of the type is used for pasture, as it produces a luxuriant growth of bluegrass, and as water may usually be reached within a short distance of the surface, or is available in the streams, it is excellently adapted for this purpose. Little attempt is made to improve the productiveness of the soil. Fields that are badly worn are used for pasture for a few years and again planted to corn.

HUNTINGTON FINE SANDY LOAM.

The Huntington fine sandy loam consists of a brown to dark-brown mellow loam, containing a sufficient quantity of sand to give it a somewhat gritty feel. At a depth of 12 to 15 inches it gradually becomes lighter and more yellowish in color, although there is not much change in texture. It is not uncommon, however, to find layers of sandy loam or clay loam interstratified with the loam in the subsoil. In general, the type is variable, ranging from fine sandy loam to silt loam, the coarser texture prevailing on the stream banks.

The type occurs in first bottoms along streams in the southern part of the county, in the region of the limestone soils. It is used mainly for the production of corn, as this crop gives large yields and usually can be planted after danger from spring floods is past. As most of the type is subject to overflow almost every year, the need of crop rotation to maintain productiveness is not so great as upon the upland soils. Many fields have been in corn continuously for 20 to 30 years, and yield ordinarily 40 to 60 bushels per acre. Larger yields are often obtained. Wheat, clover, and alfalfa grow luxuriantly.

HUNTINGTON SILT LOAM.

The surface soil of the Huntington silt loam is a deep, dark-brown, mellow silt loam, well supplied with organic matter. The subsoil usually is slightly lighter in color and more compact. Small quantities of fine sand are present in both soil and subsoil, and the lower substratum frequently consists of coarse material such as sand and gravel.

The Huntington silt loam occurs in the larger stream valleys in the southern part of the county. It is a very productive soil, and has an ideal tilth. It is used for corn and wheat, of which large yields are obtained. It will grow good clover and alfalfa.

LINTONIA SILT LOAM.

The Lintonia silt loam consists of a yellowish-brown to darker brown, mellow silt loam without any appreciable change in color or texture to a depth of 3 feet or more. It is alluvial in origin, the materials having been washed from the loessial uplands. The content of organic matter is high, and the soil is loose and easily cultivated. Near the outer margin of the type in the river bottom the soil material gradually thins, and the subsoil here usually consists of some heavier material similar to the subsoils of the Wabash series.

The Lintonia silt loam occurs along the streams within the area of the Memphis silt loam, and in areas where talus from near-by valleys has been washed into the bottoms. In the latter position it occurs as fan-shaped deltas which vary in size with the size of the stream. On account of the frequent overflows, new material is constantly added, and its boundary is being gradually extended.

This is one of the most productive soils in the county. Corn yields 50 to 75 bushels per acre and other crops correspondingly well. Wheat, clover, and alfalfa thrive. This is also one of the best truck soils in the county.

A high-terrace variation of the Lintonia silt loam occurs in the southwestern part of the county. The soil here is a brown silt loam underlain by a grayish-brown, friable silty clay. The lower subsoil

is mottled brown, gray, and yellow, and much more compact than the typical subsoil. The surface soil is low in organic matter, and not very productive. In general this terrace soil resembles the Jackson silt loam in both physical properties and agricultural value, but owing to its small extent it was not mapped separately. It is not subject to overflow.

WABASH SILT LOAM.

The Wabash silt loam consists of black to very dark brown silt loam, grading at 12 to 15 inches into black or dark-drab, heavy silt loam or silty clay which continues throughout the 3-foot section. Thin lenses of fine sand sometimes occur in the lower subsoil. The surface soil contains a high percentage of organic matter and is easily kept in good tilth.

This type occurs in the Missouri River bottom, and is confined mostly to the higher ground. In places it represents the natural levees along abandoned streams or slashes. It is rarely overflowed and the drainage is comparatively good. It is a strong, productive soil, especially well suited to the growing of corn, wheat, and alfalfa. Crop failures are rare.

WABASH SILTY CLAY LOAM.

The soil of the Wabash silty clay loam is a black, heavy clay loam, high in silt. There is no sharp line of separation between surface soil and subsoil, but below a depth of 10 to 15 inches the color usually is somewhat lighter, often being dark drab. The lower subsoil is a rather heavy clay, with faint brown mottlings. The soil is rather sticky when wet, but its property of granulation causes clods to break down rather easily, and makes it possible to prepare an excellent seed bed. The type to a certain extent represents a transitional stage between the Wabash clay and Wabash silt loam, and varies in physical characteristics as one or the other of these types is approached.

The Wabash silty clay loam occurs mainly near the middle of the Missouri River bottoms, in long strips roughly paralleling the course of the river. It is rarely subject to overflow, but occasional areas have deficient drainage and could be improved by tiling. Wheat is the principal crop. Ordinarily the yield is between 25 and 35 bushels per acre. The type is well adapted to corn, alfalfa, and clover. It is very productive.

WABASH CLAY.

The soil of the Wabash clay, locally known as "gumbo," consists of a black clay loam to a depth of 7 or 10 inches. The subsoil is a black to very dark drab, heavy, sticky clay, changing to a drab clay

with brown mottlings in the lower part of the 3-foot section. The substratum frequently consists of fine sandy loam. The surface soil upon drying cracks and checks and breaks up into small cubes.

The Wabash clay occurs in irregular areas along the Missouri River, usually lying back from the stream front and near the bluff line. It is overflowed at rare intervals by the river, but is flooded more often by run-off from the hills. Most of this soil lies slightly lower than the surrounding types, but good drainage is easily provided by open ditches and tile drains. Cultivation may be somewhat difficult unless the soil is handled under proper moisture conditions. By keeping the soil well supplied with organic matter, through turning under straw, stalks, and other crop residues, the tilth is greatly improved. The soil is productive and well adapted to general farming. Wheat and grass are the principal crops.

SARPY FINE SAND.

The Sarpy fine sand, locally known as "made land," preavillingly consists of a grayish-brown fine sand which in most places extends, without any appreciable change, to a depth of 3 feet or more, though in low swales and near the river thin lenses of clay or silt may be interstratified with the sand. In some places a thin coating of clay has been spread over the surface, but with these minor variations the soil consists of loose fine sand, rarely containing enough fine material to be cohesive.

The Sarpy fine sand occupies the relatively low frontal lands bordering the Missouri River, and represents the most recent deposits and aggradations of the stream. In fact, the character of the soil is not yet established, for with each overflow new material of a different texture may be deposited. As a rule, however, the sediment is a fine sand, representing the coarser material carried by the river which is deposited upon the first checking of the currents, the finer material being carried farther inland. All of the islands of the Missouri River are of this soil type.

Some of the type, subject to overflow practically every year, remains covered with the characteristic growth of willow and poplar. The greater part of it, however, is in cultivation, being used exclusively in the production of corn. In favorable seasons the yields range from 40 to 70 bushels per acre.

SARPY VERY FINE SANDY LOAM.

The surface soil of the Sarpy very fine sandy loam varies from dark-brown or grayish-brown very fine sandy loam to fine sandy loam. The coarser texture prevails on low ridges and on the slopes to the higher bottoms. Back from the river the soil gradually becomes finer, and finally grades into the heavier soil of the Wabash

series. The surface soil extends to a depth of 18 inches, where it changes quickly to a yellowish-gray or grayish-brown very fine sand which usually continues to a depth of many feet. The almost universal presence and uniform character of this very fine sand subsoil are distinguishing characteristics of the type. Thin lenses of clay or silt loam are sometimes present in the lower subsoil, but as a rule there is not enough fine material to make the sand cohesive.

This type occurs in irregular strips and low first bottoms, and for the most part represents the old banks of the Missouri River. At times of overflow the coarse material was dropped nearest the stream, thus building up natural levees. The type is still in process of formation as each overflow leaves a thin deposit of fine sand.

The Sarpy very fine sandy loam is one of the most valuable and productive soils in the county. All the general farm crops are grown, and maximum yields are obtained. As an alfalfa soil it is excellent, and a large part of it is devoted to this crop. It is especially suited to potatoes and all truck crops. The soil is in ideal tilth, and about the only requirement is to keep it supplied with organic matter.

ROUGH STONY LAND.

Rough stony land is similar to the Baxter stony loam, but includes only those larger areas so marked by rock outcrops, steep hillsides, and cliffs as to be of no agricultural value. Rough stony land occurs along deep ravines and valleys in the more rugged parts of the county. Much of the Baxter stony loam should be included in this type, but it is only where the rough areas are of considerable size that they are indicated. All of the land is forested with oak, hickory, and elm.

SUMMARY.

Callaway County, Mo., is situated near the center of the State. It comprises 808 square miles, or 517,120 acres, 71 per cent of which is improved farming land. The unimproved land occurs largely in the southern half of the county, and consists for the most part of hilly upland, best suited for grazing.

The county includes part of the glacial plain of north Missouri and part of the Ozark region of the southern part of the State. The former division is characterized by broad, level prairies, with gently rolling areas along the streams. The latter division varies from rolling to hilly, but includes occasional small areas with level prairie topography.

The population of Callaway County in 1910 was 24,400. Fulton, the county seat, population 5,228, is the only town with more than 2,500 inhabitants. The rural population averages 23.7 persons to the square mile.

The agriculture is based primarily on live-stock raising. In the production of horses and mules this is one of the leading counties in the State. Corn is the most important cultivated crop. Oats and grass are extensively grown on the prairie lands. Wheat is the money crop on the loess and river-bottom soils. With proper fertilization, or with the use of lime, clover can be successfully grown on most of the soils. Dairying and fruit growing are undeveloped, but offer opportunities on much of the hill land in the southern part of the county.

In general the farm practices are good, but there is need of better crop rotation, the more extensive use of legume crops, such as clover, and the application of fertilizers and lime on the poorer lands. More intensive farming methods, such as would result in the greater production of manure for building up the land, are recommended.

Land values range from \$10 to \$125 an acre. The higher prices obtain in the river bottom and prairie areas in the northern part of the county. The lower values apply to the hill land, much of which is only partly improved.

The upland soils of Callaway County are glacial, loessial, and residual in origin. Glacial and loessial soils predominate in the northern part of the county, and residual soils in the southern part. Differences due to origin have been greatly modified by weathering and the influence of vegetation. In general the county is characterized by gray soils with heavy subsoils.

The prairie soils are included in the Putnam series. They have a dark-gray surface soil, heavy subsoil, and an almost level topography. They comprise the most desirable land in the county. These soils are fairly productive, being well suited to all the staple crops, of which corn, oats, and grass are the most important.

The soils of the timbered uplands, including the Lindley, Memphis, Union, Baxter, and Hagerstown series, are in general characterized by gray surface soils and brown or grayish-brown subsoils. They vary in topography from rolling to hilly, with occasional areas of Rough stony land. The dark-colored timbered soils are included in the Eldon and Bates series.

The alluvial soils along the smaller streams are predominantly dark brown in color, and silt loams and loams in texture. The black soils in the Missouri bottom are included in the Wabash series, and the brown sandy loams in the Sarpy series. All the alluvial types are highly productive. They are used primarily for the production of corn and wheat.

[PUBLIC RESOLUTION--No. 9.]

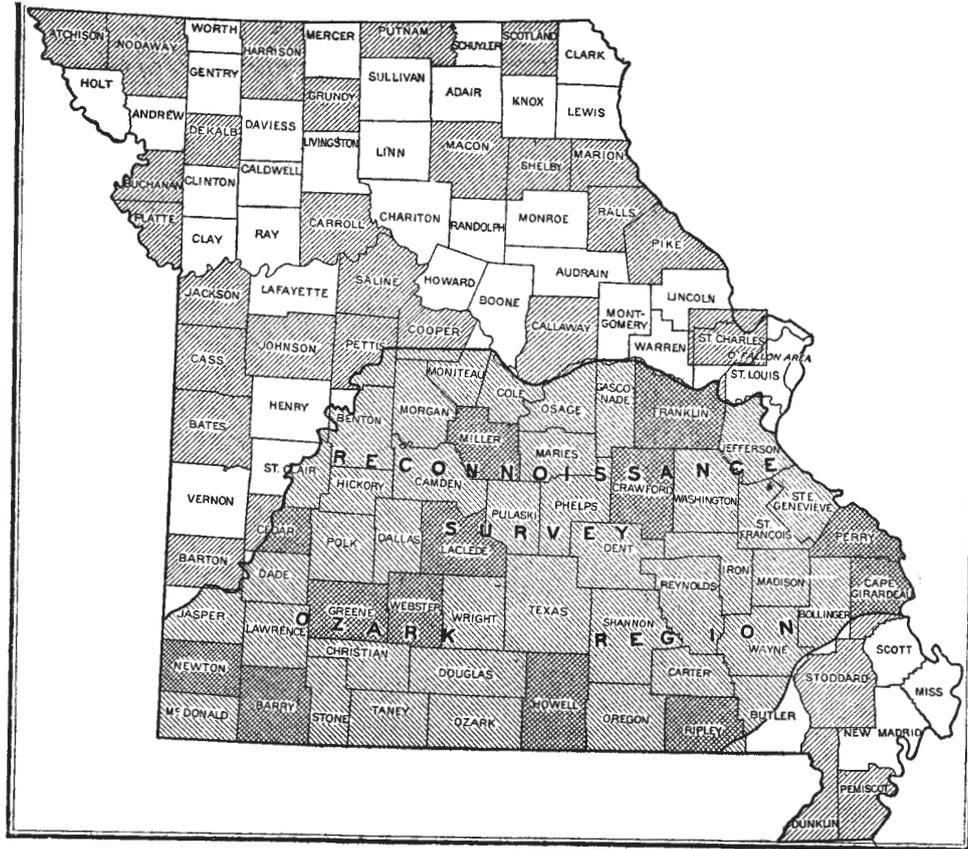
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture "

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.]



Areas surveyed in Missouri.

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