SOIL SURVEY OF ATCHISON COUNTY, MISSOURI

By CHARLES J. MANN, of the U. S. Department of Agriculture, and H. KRUSEKOPF, of the University of Missouri.

DESCRIPTION OF THE AREA.

Atchison County is situated in the extreme northwest corner of Missouri. Fremont and Page counties, Iowa, bound it on the north, Nodaway County, Missouri, on the east, and Holt County on the south, while on the west the Missouri River separates it from Otoe and Nemaha counties, Nebraska. Atchison County is approximately

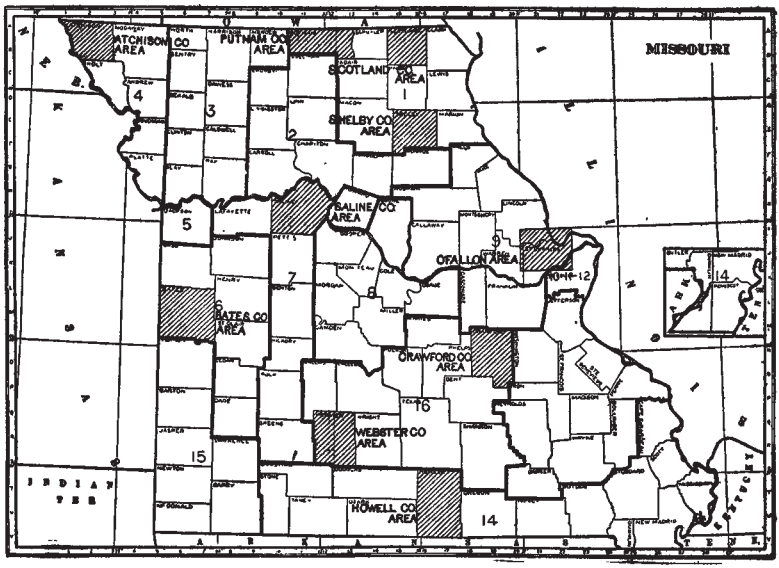

FIG. 42.—Sketch map showing location of the Atchison County area, Missouri.

26 miles east and west by 22 miles north and south, and comprises 534 square miles, or 341,760 acres. It is included between meridians 95° 10′ and 95° 42′ west from Greenwich and parallels 40° 17′ and 40° 36′ north latitude, which places it in practically the same longitude as Houston, Texas, and Western Minnesota and the same latitude as Philadelphia and Salt Lake City.

There are two prominent physiographic divisions of the county—the lowlands, or bottoms, and the uplands. The bottoms comprise

about 181 square miles, occurring as a strip varying from 2 to 7 miles wide east of the Missouri River. These lands, so far as the eye can determine, are characterized by nearly level topography, though consisting in detail of very low ridges and shallow depressions, but the few feet difference in elevation frequently determines what land shall be overflowed and consequently what may be cultivated and what can not.

Excepting the bluffs along the bottoms, which are steep and broken, the topography of the upland may be described as rolling, or maturely dissected. As a rule the divides are narrow and the draws numerous and rather steep-sided, though in some places in the northeastern part of the county the relief is not so prominent and the surface is undulating. A peculiar feature of most of the streams is their deep steep-sided ravine-like channels. No elevations in the uplands were available, but the station at Watson is 902 feet above sea level and at Nishnabotna is 878, and a bench mark in R. C. Christian's orchard near Nishnabotna shows 873 feet elevation. Fairfax is 898 feet. These figures show an extreme difference of 27 feet between Watson and Nishnabotna. It is estimated that the bluffs are 175 to 200 feet above the bottoms and are slightly higher than the upland back of them. Numerous draws and benches penetrate every section of the upland and insure thorough and frequently excessive natural drainage. The eastern half of the county is drained by Big Tarkio Creek and its large tributaries. Some of these streams have been straightened with large dredge ditches throughout most of their courses and much benefit to adjacent land has resulted. Rock Creek is the principal stream in the western part, while High Creek drains much of the northwest part of the upland. All of these streams have a general southward direction and empty into the Missouri River. Drainage in the bottoms is not so well provided for. The Nishnabotna River formerly followed the eastern bluff across the county, but about 1879 the Missouri River robbed it in the northern part of the county. The result is that the old channel has become nearly filled and is practically useless as a water carrier in times of severe overflow. A glance at the map to compare the number of drainage ways on the upland and bottoms will give a conception of the great need there is in the latter for more courses through which even the rain water may be carried off. A dredge ditch is now under way to reclaim and straighten the old course of the Nishnabotna River. If made deep enough to tile into this would not only receive the water from the upland drainage but would permit the water table to be lowered rapidly. General overflows in the bottoms are not common, but in 1843, 1867, 1889, 1893, and 1898 all but the highest parts were covered. The Missouri River, which forms the western boundary of the county, is not navigable.

The first settlement seems to have been made in this county in the spring of 1839, on what was afterwards the site of the town of Sonora, in the south half of sec. 5, T. 65, R. 42, about 2 miles west of Watson. Later in that year other settlers came, but most of them were of a roving disposition and did not stay many years before moving farther west. Early in the forty's a steadier class of pioneers arrived from Ohio, Indiana, Tennessee, Kentucky, and Virginia, and settled in the western part of the county. Germans and Irish formed a considerable percentage of the pioneers. Subsequent immigration has been principally from the States to the east. Except in the extreme eastern part of the county, where the land is in large holdings, the present population is well distributed over the county.

Atchison County was created in 1844, a year or two after the land survey was made. Linden remained the county seat until 1856, when it was removed to Rockport, now a town of about 1,200 population and the northern terminus of the Rockport, Langdon and Northern Railway. There are about 58 miles of railroad in the county. The Chicago, Burlington and Quincy Railroad (Kansas City, St. Joseph and Council Bluffs Branch) between Kansas City and Omaha operates 25 miles of road across the bottoms in the western part, on which are located the small agricultural towns and shipping points of Nishnabotna, Langdon, and Watson. The Tarkio Valley Branch of the Chicago, Burlington and Quincy Railroad runs for 24½ miles up the Tarkio Creek valley in the eastern part of the county. Fairfax, Tarkio, and Westboro are located on this road. Tarkio, with a population of 2,000, is the largest town of the county and supports some manufacturing enterprises. It is also the seat of Tarkio College. Fairfax and Westboro are small agricultural towns. The main line of the Wabash Railroad between St. Louis and Omaha passes through the northeast corner of the county and the town of Blanchard is situated partly in this county and partly in Iowa. Thus the county has very good shipping facilities and there are few sections 10 miles or more from a railroad. St. Joseph and Kansas City to the south and Omaha to the north are very conveniently reached markets, while St. Louis, Chicago, and Denver receive a part of the local products.

Except in the rough country along the bluffs, public roads almost always follow land lines. While this system is convenient in some respects in many cases it necessitates hauling over hilly roads, where the ridges or stream courses could have been followed with much easier grades. The main roads are kept in good condition most of the time, but the severe erosion which is characteristic of the upland soon renders almost impassable a neglected highway. Schools and churches are convenient to all sections. Rural free delivery and the telephone are enjoyed by practically everyone.

CLIMATE.

The climate of Atchison County is practically the same as that of Holt County, and in the absence of local data the following table compiled from the Weather Bureau station at Oregon is given:

Normal monthly, seasonal, and annual temperature and precipitation at Oregon, Holt County.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	28	75	−24	1.6	1.2	2.4	5.7
January	23	70	−30	1.6	1.2	1.4	7.1
February	28	79	−26	1.8	2.2	0.4	8.8
Winter	26			5.0	4.7	4.2	21.6
March	38	91	−12	2.1	2.0	0.9	5.3
April	53	94	8	3.4	1.3	1.3	0.8
May	64	98	26	5.0	2.4	6.4	0.0
Spring	52			10.5	5.7	8.6	6.1
June	72	106	41	4.7	4.8	7.5	0.0
July	75	107	47	4.6	0.5	10.8	0.0
August	75	108	37	4.3	0.0	4.4	0.0
Summer	74			13.6	5.3	22.7	0.0
September	67	104	25	3.3	3.6	7.7	0.0
October	55	93	8	2.7	2.2	4.7	1.1
November	40	82	−10	1.7	0.7	2.8	1.6
Fall	54			7.7	6.5	15.2	2.7
Year	52	108	−30	36.8	22.2	50.7	30.4

Average date of last killing frost in the spring, April 26; average date of first killing frost in the fall, October 10.

It will be seen from a study of this table that the climate is humid, the average annual rainfall being 36.8 inches, while in the driest year on record the precipitation amounted to 22.2 inches. The year of maximum precipitation shows 50.7 inches. Even if the extremes of dryness were more frequent, the character of most of the soil is such that sufficient moisture for the use of crops would be held in store.

The mean rainfall is very evenly distributed over the late spring, summer, and early fall months, which constitute the growing season. Droughts of over three weeks' duration are very infrequent, and nearly all the soil withstands these perfectly. Snowfall is never very great, though there is usually enough to protect the wheat.

Temperature data show considerable variation, but excessive cold or hot spells are not of long duration. Oats and wheat are sometimes injured more or less by both heat and cold. The falls are particularly characterized by open pleasant weather. Data regarding frost occurrence indicate on an average a growing season of one hundred and sixty-three days, which is ample for the maturing of all farm crops.

AGRICULTURE.

The prosperity which is in evidence throughout Atchison County has been brought about solely by the high development of its agricultural resources. At the time of settlement, during the forties, its natural advantages consisted of almost unlimited free range on the prairie, sufficient timber, abundance of wild game and fish, and proximity to the Missouri River, which offered the only means of transportation except by wagon. As timber occurred only along the bluffs and in small isolated areas in the bottoms and along the creeks and branches, the pioneer of necessity settled in these localities.

Gristmills were erected along Rock Creek as early as 1843, but flour had to be hauled from distant markets. For instance, the settlers hauled corn, wheat, and bacon to Cooks Landing, which was located on the river west of Phelps City, and there sold it to be transported to St. Louis. Packing houses for the curing of meat were finally established at Rockport and at Sonora, a small town established on the river west of Watson.

Spring wheat early became an important secondary crop, as did also barley, which was hauled to several stations in the surrounding counties for brewery purposes. Oats and rye were additional crops of considerable importance from the first. The effect of the war was disastrous to systematic agriculture. A large percentage of the inhabitants left, and only the necessities of life were produced by those remaining. But this period of depression ended with the war, as there were very few slaves in the county, and with the return of settled conditions agriculture again became flourishing and was given an important impetus by the completion of the Burlington Railroad through the bottoms in 1868. This made the present markets readily available and was of especial advantage to stock raisers, who had prior to that time driven their cattle sometimes clear across the State into Illinois for markets.

Upon the withdrawal of the free range in the early seventies and the coincident advent of wire for fencing and the introduction of the Osage orange for hedges, the eastern part of the county became more generally settled, but was denied railroad facilities until 1881, when the Tarkio Valley line was completed. Prior to that time the wealth of the county was centered in the Missouri River bottoms,

but the great flood of that year abated progress in that section for some time. This county suffered in the grasshopper scourge of 1874, when almost nothing was produced, and the following year was one of great drought, so that in 1875 corn was shipped in for subsistence purposes. This is the only time in the history when the county did not produce more than it consumed.

Spring wheat was abandoned as a crop in the early eighties because of the ravages of the chinch bug, which subsequently almost disappeared. Barley was given up largely during the same period because, it is claimed, the berry became yellow and dark colored and could not compete with the white grain of other localities. The acreage in rye has gradually decreased since 1880, until at present little is grown, so that now the great crop of the county is corn. This is largely fed to stock, while oats and wheat, clover, alfalfa, hay, orchard products, and truck crops are secondary. Cattle, hogs, sheep, and poultry are important sources of revenue.

Corn is and always has been the principal crop of the area. For the twenty-nine years, 1880 to 1908, inclusive, the average annual production of corn in the county is 6,596,717 bushels, or an average yield of 41 bushels per acre. This is a very high yield and ranks Atchison County as one of the first counties of the land in corn production. Since 1890 the average acreage has been about 164,346, or nearly one-half the area of the county and about 5½ times the acreage planted to wheat and oats combined.

Possibly two-thirds of the product grown on the upland is the Reid Yellow Dent, or strains closely allied thereto, and the remainder is mostly St. Charles White. In the bottoms the principal variety is the St. Charles White, though some Boone County White and some Reid Yellow Dent are also grown.

The methods of culture for this crop are practically the same on both upland and bottom land soils, but differ considerably from methods in vogue over a large part of the corn belt to the east. When grass land is to be planted it is fall plowed to a depth of 5 to 6 inches and then disked in the spring. And when corn is to follow corn the land is disked in the spring without plowing. The ground is then broken with a lister, which is merely a double plow which throws the dirt both ways and leaves a furrow about 5 inches deep. Frequently a double-row lister is used, which requires five or six horses and is rather an awkward implement to handle. The single-row lister takes at least three horses, is handy, and in most general use. The furrow is usually opened in the middle of last year's rows. The advantages of listing are considered to be the saving of considerable cost and labor in eliminating plowing and also the saving of the labor of laying off the land for planting, except in the first year that corn is planted, as each succeeding year the old rows can be followed.

There are two methods of seeding. Until recently the most common implement used for this purpose was a small drill which was attached to the lister or, as was frequently the case, the lister was fitted with a drill attachment and the ground was broken and planted at the one operation. It is claimed this method did not give a sufficiently firm seed bed and the two-rowed corn planter set as a drill is now the most commonly used implement. This follows the lister as soon as possible, drilling the kernels from 12 to 18 inches apart in the row.

For a short time after planting it is a common practice to harrow the land to kill weeds, but the first cultivation comes when the corn is a few inches high and is done with an implement commonly called a "snake killer" or "flying swede." These are a combination of disks and shovels and are set to throw dirt away from the corn. The second cultivation is done frequently with the same implement, but the dirt is thrown to the row. The third cultivation is always done with the cultivator, which has four large shovels, two on each side, and again throws the dirt to the row, making the ground as near level as possible at the third and last plowing, when the corn is considered "laid by" about July 4.

On much of the bottom land and occasionally on the upland it is the aim to throw enough dirt to the row to leave the corn on a slight ridge. This method of cultivation theoretically kills the weeds in the rows by covering them, but is frequently at fault in that it fails practically to kill them, to the great detriment of the crop. Some of the bottom land types are physically not adapted to this method as a whole, but recommended changes are reserved for the discussion of the individual soil types.

Corn is gathered in a variety of ways, but is mostly husked in the field and stored in cribs to be used for feeding purposes. A small part is simply pulled and considerable is cut with a harvester and either husked later or fed in the bundle. So far as known there is not a silo in the county and the shredder is also unknown. While on the upland almost the entire crop is fed, the demand by large northern seed houses for St. Charles White has created more or less of an industry to supply this trade. Considerable shelled corn for the market is also shipped from the bottom land and throughout the county corn is the basis of agriculture and prosperity.

For the county as a whole wheat is relatively a minor crop, but in the bottoms, where most of it is produced, it is of considerable importance. On an average there are about 7,000 acres planted, yielding 115,180 bushels, or approximately 17 bushels to the acre. Maximum yields of 40 bushels or more are reported. The varieties grown are invariably hard, winter, and bearded, but the names are not generally known. Land is plowed, disked, and harrowed for the

seed bed and the seed drilled in by the first week in October. The crop is seldom fall pastured, as could be done on the Marshall silt loam and Sarpy loam without injury to the soil. Harvesting is done by the middle of July and the wheat is most commonly stacked, as this increases the milling value of the grain. Some farmers make a practice of sowing clover in the wheat in the spring, then plowing it under in the fall; but this is not as general as it should be.

Though oats are usually regarded as a minor crop, the county is one of the foremost in the State in the production of this crop. On an average about 23,500 acres are sown and the production is about 540,000 bushels, or, roughly, 23 bushels to the acre. The variety most commonly grown is called the "Side oat." A few are growing the Texas Red oat and are enthusiastic, claiming much earlier maturity and increased yields over the common oat.

Land that has produced corn for several years is usually selected for oats and is sometimes plowed, though more frequently it is merely disked thoroughly. A few farmers drill the seed, but the bulk of it is broadcasted with an end-gate seeder and is harrowed or disked in. Harvesting is over by the last week in July and the grain is usually stacked, because the scarcity of thrashing machines prohibits thrashing from the field. The crop is largely fed in the county.

There is general complaint that oats do not yield as well as they did ten years ago, but the statistics, with the exception of 1907 and 1908, hardly bear out this opinion. It is also said that the seed deteriorates rapidly and new seed must be purchased frequently.

The growing of alfalfa was begun about 1897 and has since been taken up by a great many farmers. It is grown mainly in fields of 5 to 10 acres each. Alfalfa was seen on a number of different soil types, but was especially thrifty on the Marshall silt loam, Judson silt loam, Sarpy loam, Sarpy silt loam, and Sarpy clay loam. Inoculation has never been necessary even on the upland soils. Three or four cuttings are secured yearly, giving in all about 5 tons to the acre. It is claimed, however, that after a few years the fields become very weedy, and have to be plowed up, and some growers have had difficulty in securing a good stand. The fact that alfalfa must be planted on very clean ground seems to have been overlooked, and this may account for many of the failures. For best results it is recommended that oat or wheat stubble be given a top dressing of manure and plowed as soon after harvest as possible, disked immediately, and kept in perfectly clean fallow until the latter part of August or early September, when the seed should be sown. A light disking or harrowing after each cutting would also improve many of the fields.

The quality of the hay produced is not the best, but it is thought that it can be much improved by better methods of handling. The

free use of the side-delivery rake would insure thorough air-dried hay, whereas under usual methods it lies on the ground with the top exposed to the sun while the bottom is in contact with the damp earth and improperly cured.

The bulk of the money coming into the county is from the sale of cattle, hogs, and sheep, as nearly all the corn is marketed in this form. Most of the stock for fattening purposes is shipped in from Kansas City, St. Joseph, or Omaha. The cattle are usually a good grade of Hereford, Shorthorn, and Aberdeen Angus, with the Hereford breed greatly predominating. Stock feeding is, however, practiced chiefly in the uplands, for good feeding lots, those which will not be too muddy, can hardly be found in the bottoms.

This is the most highly specialized industry in the area and is engaged in on an extensive scale, principally by the larger landowners, who buy a large percentage of the corn they feed from surrounding neighbors. Even at the best this is considered to be a more or less hazardous business, and the novice had best begin it in a small way until he thoroughly understands every step from buying to selling. The natural advantages in this county, however, are of the best. Good cattle can be secured from near-by markets, good dry feed lots can readily be located, excellent pasture can be secured with abundant water supply, and plenty of corn can be purchased, if not grown, for feeding purposes. It only remains for the farmer to exercise good judgment to make a success of this type of farming.

Hogs are kept in conjunction with cattle, when corn is not fed to them direct, and make up an important item of income for the county. The Poland-China is the favorite breed, but some Duroc-Jersey and Chester White herds were also seen. A first cross between the Poland-China and Duroc-Jersey is considered a most valuable hog. Unlike cattle, nearly all of the hogs fed are produced in the county, though they are often bought by the larger farmers for feeding purposes. They constitute one of the surest and most remunerative products of the county.

For the supply of horses and mules the county is more or less dependent upon outside sources and large numbers are shipped in and sold. At present prices, at least, a greatly increased production of these animals would prove highly profitable. Thousands of sheep are also shipped in for feeding and much of the more rolling land is admirably adapted to them. They have proved remunerative in the past, but recently this industry seems to have suffered a decline. This is to be deplored and the resumption of the industry on its earlier basis should be encouraged.

Red clover is grown quite extensively, but is not as general a crop as it should be. It is usually sown in the oats and cut for hay the

second year. It yields on an average about 1½ tons to the acre. Sometimes the crop is plowed under in the fall of the year it is planted and the land sowed to wheat. When intended for mowing timothy is usually sown in the fall and oats and clover in the spring. The clover is intended to reseed itself year by year, but frequently becomes very thin. But little is cut for seed, although it is claimed good yields can generally be obtained.

Wild hay, mainly of bluestem grass, is quite an important crop in the bottoms, particularly on wet land. Much of the crop is purchased on the ground for $5 or $6 an acre and stacked to be sold in the spring for about $6 a ton. As the yield runs from two to four tons to the acre it proves a very valuable crop, especially for land that would otherwise not be utilized.

Permanent pastures frequently have a good stand of bluegrass and white clover, but they are generally in a deplorable condition because of the ragweed and foxtail in them. Much improvement could be effected in such cases by use of the mowing machine, the disk, and clover seed.

Some sorghum is raised in the rougher parts of the county, especially along the bluffs. A very good quality of molasses is made, and as much as 75 cents a gallon is received for the rather limited output.

There is no well-defined or systematic rotation in general practice. Agriculture has been based upon the one crop—corn—and it has been the custom to keep the land in corn year after year until yields deteriorate to the point where they were unremunerative, and then to grow a crop of oats or wheat and seed the land to grass. The field would then remain in mowing or pasture until the weeds choked out the grass, when it would be plowed in the fall to be put into corn for another series of years. This plan on an average would extend over nine years or more—four to corn, one to oats, and four to grass. This system applies particularly to the upland.

In the bottoms the practice is quite similar, however, for land which will grow corn is almost invariably planted to it. Here, on the other hand, oats are frequently followed with wheat, though in many cases the corn is cut and shocked early in the fall and wheat planted immediately. More wheat and less corn should be grown in the bottoms. The cropping system, however, depends a great deal upon the season and particularly upon the duration of overflows. In a dry year corn produces bumper crops upon nearly all of this land, while in wet years wheat does better than corn.

The main criticism of the rotation practiced is that not enough legumes are grown, but recommendations for changes in the system will be left for discussion in connection with the description of the individual soil types.

The orchard products consist principally of apples. A good many peach trees and some pears and plums are found here and there through the county, but rarely is any fruit except apples shipped to outside markets. There are sufficient apples, however, nearly every year to induce considerable competition among apple buyers, who come in great numbers. It is quite frequently the case that when the upland has a good crop of fruit the bottoms fail, and vice versa, but this year (1909) the crop is good in both sections and a great many carloads have been shipped out.

The most common and profitable varieties are the Wealthy, Red Astrachan, Grimes (Golden), Winesap, Jonathan, Ben Davis, York Imperial, and Ralls (Genet). The favorites are probably the Wealthy, Grimes (Golden), Jonathan, and Ben Davis. Grapes and small fruits are also quite extensively grown and find a ready local market.

Truck crops are grown only in a limited way over most of the area. A canning factory at Rockport and also one at Hamburg, Iowa, just outside of the county, use tomatoes, sweet corn, and some other products. Tomatoes are grown quite extensively on the slopes of the bluffs and upon the Sarpy loam and prove very profitable. The Stone variety is used nearly altogether and yields between 200 and 250 bushels to the acre.

Sweet potatoes are also grown upon the Sarpy loam and Laurel fine sandy loam and find ready local markets at good prices. They yield 150 to 175 bushels to the acre. Garden truck of all kinds is grown for home consumption, but Irish potatoes do not seem to yield enough for extensive cultivation.

Poultry and eggs constitute an important item in the total income of the county. From $1,200 to $1,500 is paid out by dealers in poultry products at Rockport and similar amounts at some other points in the county.

But small quantities of dairy products are shipped from the county. Clarinda, Iowa, is the main market for cream, poultry, and eggs.

The average size of the farms has been increasing since 1880. This is due to the accumulation of land by large owners, particularly in the east half of the county. The average size farm in 1850 was 134 acres; in 1890 it was 151 acres and in 1900, 156 acres, and the figure has probably increased somewhat during the last ten years. Since 1880 the percentage of farms operated by owners has been decreasing and in 1900 was about 50 per cent; that is, half of the farms were operated by tenants or by men paid as overseers or managers. The general rental is from $5 to $6 an acre.

The usual labor difficulties are met here as elsewhere, but the farmers have largely solved the problem by the use of improved

machinery, whereby one man can do the work which formerly required two or more. In fact, the labor-saving side of agriculture has been carefully studied and developed to a degree rarely seen. It is estimated that the larger corn planters can handle 100 acres of corn with the labor of one man.

SOILS.

The soils of Atchison County have been divided into sixteen distinct types. By natural physiographical divisions these are grouped first as upland and bottomland soils—three types in the former and thirteen in the latter. The upland is by far the more extensive, but the soil, owing to similarity of the formations exposed, is remarkably uniform in its physical characteristics. The limestone, shale, and sandstone rocks, which once formed the upland of this region and are now exposed in only a few places, principally on the west side of the bluffs, have been covered with extensive and deep deposits of Pleistocene age. The first of these was the drift of the Kansan glaciation, which is supposed to have covered the entire region, but which is lacking in several exposed cuts and leads to the belief that there was time for considerable erosion in this material prior to subsequent deposits.

The first of these later deposits seems to have been a strata of reddish clay, from 3 to 5 feet in thickness, the origin and formation of which is not understood. It seems to be continuous, except for a few miles back from the bluffs, indicating that it too was washed away in places before the deposits of brownish-yellow silty clay, which in the few places exposed weathers with a light-gray surface. This is probably material of the same deposit which forms the subsoil of the level prairie of northwest Missouri, but which was largely eroded away in this county. Finally occurred the vast aeolian deposit of loess which forms the present surface.

In the classification of the soil, the upland portion of the county is thus included within the Glacial and Loessial province. It is the remarkably uniform loess material with the dark-colored, humus-carrying surface soil which forms the predominating soil type of the area—the Marshall silt loam—a type which is elsewhere extensively distributed over the Mississippi and Missouri valleys and is notable for its productiveness. Along the bluffs this material is quite sandy and conditions have never been favorable for the accumulation of organic matter, with the result that the soil is very light colored and has been mapped as Hamburg silt loam. In the eastern part of the county, where the loess deposit becomes thinner, erosion has exposed on the hillsides some of the yellow sandy clay of the Kansan glaciation, together with narrow strips of the reddish clay

overlying. Exposures of the latter are too small to be recognized on the map, but the till gives rise to a loam which is recognized as Shelby loam and is quite similar to that type as extensively mapped on the hillsides of northeast Missouri.

The thirteen types in the bottoms belong to the soil province known as the River Flood Plains Province and are all alluvial, with one possible exception. The general details of their formation can easily be traced. The Missouri River is constantly changing its channel, cutting on one side and building up sand bars and flats on the other. A considerable part of such material occurs on the Atchison County side of the river and has been shown as Riverwash. Frequently the current changes to a new channel, leaving standing water in the old bed, and a thin deposit of silty clay is made, giving areas of uncertain texture, and these are called Meadow. These two miscellaneous and unclassified types represent conditions which at some time have existed over every part of the entire river bottom. At times of subsequent overflows deposits of fine sand, silt, and clay have occurred in immense quantities and developed soil areas differing in texture and other characteristics, giving rise to different types. But some of these, while differing in texture, are found to have other characteristics in common and are accordingly grouped to form series. Thus we have the Sarpy loam, Sarpy silt loam, and Sarpy clay loam, which have in common a very fine to fine sandy subsoil, and the Wabash silty clay loam, Wabash silty clay, and Wabash clay, which have a silty clay subsoil. The Sarpy clay loam might also be regarded as shallow Wabash clay. The Laurel fine sandy loam could be included as the Sarpy fine sandy loam were it not for the fact that it is a light-colored sand, containing little organic matter, while the Sarpy soils are dark and contain an abundance of humus. Along the streams which flow through the upland are found black soils with black, rather heavy subsoils. These belong to the Wabash series and are known as Wabash silt loam and Wabash clay loam. They differ materially from the other bottom soils in that they represent the accumulation of rather local glacial and loessial material, while the particles of the others have probably been transported great distances. The Judson silt loam is a miscellaneous type, and while it occupies bottom land must be regarded as partly if not entirely of colluvial origin, representing loessial material which has either been blown or washed to its present location from the upland section.

The Overwash is an unclassified type and is merely material which has been washed directly from the adjacent uplands or has been deposited at times of overflow or floods due to the breaking of a levee. In some respects this could be regarded as Wabash loam or fine sandy loam, but the subsoil, while usually heavy, represents different conditions than those accountable for the formation of the Wabash soils.

The following table gives the extent of the various soils mapped in Atchison County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall silt loam	208,896	61.1	Meadow	4,352	1.3
Wabash silt loam	36,800	10.8	Wabash clay loam	4,096	1.2
Wabash clay	14,272	4.2	Judson silt loam	3,072	.9
Shelby loam	13,824	4.0	Hamburg silt loam	3,008	.9
Sarpy clay loam	12,544	3.7	Wabash silty clay loam	2,752	.8
Sarpy silt loam	10,752	3.1	Laurel fine sandy loam	1,920	.6
Riverwash	9,408	2.8	Wabash silty clay	1,472	.4
Sarpy loam	7,360	2.1			
Overwash	7,232	2.1	Total	341,760	

MARSHALL SILT LOAM.

The Marshall silt loam is by far the most extensive soil type in Atchison County. Except for comparatively small areas of Shelby loam and Hamburg silt loam it comprises all the upland section and what has previously been said of the upland in the chapter on soils applies particularly to this soil type.

The soil and subsoil, not only to a depth of 36 inches but to depths ranging from 36 inches in the eastern part of the county to over 100 feet in the western part, is of practically the same texture and material throughout. The determination of the depth of surface soil then becomes a question as to the depth to which the organic matter has been incorporated, which is shown by the characteristic dark color imparted. The general profile of the type may then be described as consisting from 13 to 20 inches, with an average of 15 inches, of dark brownish-gray silt loam, underlain by a brownish-yellow silt loam subsoil. In many cases the surface soil feels slightly heavier than the subsoil, but this is due to humus rather than to a higher content of clay. The amount of organic matter decreases gradually with depth, causing a gradation in color as the subsoil is approached, so that judgment may vary somewhat in respect to the depth of the soil. There is a perceptible gradation in the particles composing the type in going away from the bluffs, for there is distinctly more clay and less of the coarse silt in the eastern part of the county than there is in the center.

There are outcrops of a very thin strata of clay in the eastern part of the county, which are locally known as hardpan. While these have some influence upon the agricultural value of the soil, they are really of little ultimate importance. The deep subsoil of most of the type is more or less mottled with yellow and light gray and lime concretions and iron pipes are of common occurrence.

The soil is very mellow and easily handled. The organic matter prevents the particles from running together and forming hard clods, so that even if worked in fairly wet condition, when some small clods may form, the soil is easily brought into good mellow tilth.

Except where interspersed with Hamburg silt loam, creek bottoms, or Shelby loam the Marshall silt loam is continuous east from the Missouri River bottom lands.

In topography the type varies from undulating to rolling, with rather narrow divides and long, steep approaches to the water courses. It is seldom the case, however, that a hillside is so steep that modern farm machinery can not be used satisfactorily.

The character of the surface and the open structure of the soil insure at all times thorough natural drainage. Drainage is even likely to be excessive and results in the removal of much valuable soil material. Light-colored spots, usually on the brows of slopes in fields which have been repeatedly cultivated to corn, bear evidence of this washing. In fact, prevention of erosion and the maintenance of organic matter are the only soil problems which owners of this type will ever have to solve. Erosion in this material is severe. It is of common report that as soon as the surface soil becomes washed away the subsoil washes very rapidly. Some gullies were seen in the open fields which were not over 10 feet across, but were 25 to 35 feet straight down, the loess having the peculiarity of standing in perpendicular walls. One striking example of the erosivity of the loess material was seen in a field where forty years ago a plow furrow was made to change the course of a small stream. Here there is now a gully varying from 40 to 100 feet wide and 30 feet deep. Great chunks of dirt along the banks give way and in times of high water are carried downstream. Because of the instability of the loess considerable difficulty is experienced in maintaining bridges in good order. When erosion reaches the gully stage it is very difficult to stop and no satisfactory method of doing so has yet been devised, though concrete walls and culverts seem to give the best satisfaction. It will be observed that unless the dark-colored surface soil is allowed to wash gullies do not start, and as the only difference between the surface and subsoil is that the former has organic matter incorporated in it, this fact offers the best solution of the whole problem. Plenty of organic matter in the soil will prevent the beginning of erosion. Any light-colored spots in the fields should be given an abundance of manure, thoroughly plowed in and then planted in clover, which should all be plowed under. Some of the smaller gullies could probably be filled in and immediate efforts made to incorporate humus in the exposed soil. It is and always will be one of the most valuable assets of this soil that the material at any depth, with the addition of decay-

ing organic matter and exposure, will produce as good crops as the present surface.

The Marshall silt loam is composed of material which is known as loess. The formation of this material seems to be plain. Whether it is associated with glacial action or not may be disputed, but the evidence seems to prove conclusively that it was lifted out of the Missouri River bottoms and distributed over the upland by the agency of wind. There are two phases of the loess which differ principally in color. Below the brownish-yellow upper deposit is a very light gray, almost white, loess, which forms the subsoil of the type on the lower slopes and constitutes a distinct phase of the main type in the one characteristic of color, as the texture and crop value are the same.

The first vegetation known on this land seems to have been buffalo grass, but this was later displaced by prairie grass or bluestem and at the time of settlement most of the type was in prairie, with isolated patches of elm, oak, and walnut timber along the water courses and in strips along the bluffs.

Corn has always been the principal crop produced on the Marshall silt loam. It yields from 30 to 80 bushels, with an average of about 45 bushels to the acre. Oats yield from 15 to 60 bushels, but the average is only 20 bushels to the acre. Wheat gives from 12 to 25 bushels per acre, averaging 18 bushels. Clover yields about 1½ tons, and alfalfa about 3 tons to the acre. Apples do exceedingly well, though the trees are not as long lived as might be desired. This natural weakness might probably be offset to a large extent by proper care. Wealthy, Jonathan, Winesap, and Ben Davis varieties do best.

The type is excellently adapted to corn, but the subsoil is rather open for small grain and it is rather difficult to secure a sufficiently compact seed bed for oats and wheat, though for the sake of rotation these crops should be grown and efforts made to increase the yields. As the secret of permanent agriculture on this soil is largely a matter of keeping up the humus content, the rotation should be arranged with that in view. Other conditions also being considered the following rotations would seem to be admirably adapted to this soil and climate: Corn, corn, oats or wheat, followed by timothy and clover two years. Wheat could be sown after oats the fourth year, in which case clover should be sown with the oats and plowed under for wheat. A good growth of clover should also be plowed under when the mowing land is broken up. This gives a five or six year rotation. It is not considered advisable to keep the land in corn over three years at most, so as to avoid danger from washing. Neither should the mowings be left until they become weedy.

Much of the humus now in the soil is very finely divided, and manure made with coarse straw or cornstalks as absorbent will place coarse, slowly decomposing material in the soil, greatly benefiting it. The steepest slopes and various draws can profitably be put into permanent pastures, but should be kept free from weeds, disked occasionally, and reseeded with clover when they show signs of deteriorating.

The lister is well adapted to this soil, but it is thought that the method of checkrowing the corn, allowing two or three stalks to the hill, is better than the present plan of drilling it in the row, especially if the land is not comparatively free from weeds, for with checkrowed fields the crop can be cultivated both ways. The method to be used will probably be to list as at present, checking the corn immediately with the corn planter. It can then be cultivated with the "snake killer," or common cultivator, following the row as planted the first two cultivations and throwing the dirt well to the corn the second. The third time it can be crossed and all the weeds gotten out of the row. By some it is claimed that a paying increase in yields is obtained by plowing before listing, but this is not a general practice, and it is doubtful if plowing, particularly fall plowing, except of mowing land, should be recommended, as it would unnecessarily expose the land to washing.

Practically all of the type is highly improved and sells for $75 to $175 an acre, depending upon improvements and convenience to markets.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Marshall silt loam:

Mechanical analyses of Marshall silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21697, 21699.....	Soil.....	0.1	0.3	0.1	0.4	22.4	54.1	22.4
21698, 21700.....	Subsoil.....	.0	.1	.1	.5	19.3	62.8	17.2

HAMBURG SILT LOAM.

The Hamburg silt loam consists of about 20 inches of light yellowish-gray silt loam, underlain to a depth of 36 inches by slightly mottled gray and yellow very fine sandy loam. Small iron stains and some small iron concretions occur in lower depths of the subsoil. The deficiency of organic matter makes it very loose structured, and the subsoil is usually open and loose.

This type occupies the bluffs which occur in a broken line along the Missouri River bottoms and from 50 to 200 feet above them. It

is characterized in general by steep, broken topography, which would be expected of eroded dune or wind-blown formations. In detail the surface of the land is very rough and irregular, giving the appearance from a distance of being minutely terraced.

As natural drainage is excessive, erosion is very active, and evidences of immense landslides were noted. The type represents the accumulation of the largest and therefore first particles dropped by the wind in the formation of the loess deposit of this region. Erosion has prevented the accumulation of much organic matter. The deposit in places is 200 feet thick and is practically uniform throughout, though large lime concretions occur at lower depths. Small shells are also in evidence in cuts and occasionally occur in the surface.

The topography, droughty condition, and liability to wash practically prohibit the tillage of this soil, and consequently little of it is cultivated. The yields of corn are very low. Some sorghum is grown, producing an excellent quality of sirup, but the yields are rather too low to encourage an extension of the acreage.

Most of the Hamburg silt loam is at present covered with a fairly good growth of elm, bur oak, post oak, linden, locust, and walnut timber, and systematic forestry offers the best utilization for the type as a whole.

Some of it is prairie, but supports a scant growth of what is locally known as sagebrush. The plant grows in bunches and is probably accountable for the rough surface. It is not, however, valuable for pasture. The more readily accessible areas would make ideal locations for apple or peach orchards.

If a stand of white clover and bluegrass could be secured it could be admirably utilized for sheep pasture. For any general farm products an abundance of humus must first be incorporated with the surface soil, and this would be difficult to do. But it is by no means a sterile soil and needs only the addition of decaying organic matter to make it very productive. The time may come when with terracing and some other intensive improvements areas of this type will be producing abundant crops.

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

Mechanical analyses of Hamburg silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21685	Soil	0.0	0.2	0.1	0.8	17.2	74.8	6.9
21686	Subsoil	.0	.2	.0	.4	11.1	82.5	5.6

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 21685, 10.18 per cent; No. 21686, 9.23 per cent.

SHELBY LOAM.

The Shelby loam consists of 8 to 12 inches of dark brownish loam, which grades rapidly into a brownish-yellow sandy clay subsoil, extending to a depth of 3 feet or more. There is considerable silt in the soil, and the percentage of medium sand in the total sand content is high. The subsoil contains considerable clay as well as sand, and is quite sticky when wet and hard when dry. Glacial bowlders and gravel are frequently disseminated throughout the soil and subsoil. The soil is usually mellow and works easily.

The type occurs in narrow bands or occupies positions on the hillsides in the eastern part of the county. The areas are never large and in some cases have been slightly exaggerated in order to show them on the map, while many areas occur which are too small to be indicated. It occupies fairly steep slopes and consequently has excellent natural drainage.

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

Mechanical analyses of Shelby loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21707	Soil	1.0	4.3	7.3	16.0	28.1	23.2	19.6
21708	Subsoil	1.4	4.5	5.0	15.4	13.8	37.7	22.0

WABASH SILT LOAM.

The Wabash silt loam consists of from 8 to 15 inches of very dark gray to black silt loam, underlain to a depth of 36 inches by nearly black very heavy silt loam or clay loam. It is characteristic of this type that the material becomes gradually heavier with depth, though in some areas the change from silt loam to clay loam is quite sharp. The soil is mellow and works easily.

This type is confined to narrow bottoms of the streams which traverse the upland, and along Big Tarkio Creek is practically limited to strips along the outer edges of its bottoms. Here it is associated with Wabash clay loam, which, however, is more extensive. In a great many locations it is covered with the Overwash from the hills, and is thereby obliterated. It is subject to occasional overflows of short duration, which makes cultivation on much of it more or less of a risk, but where it has been drained with artificial ditches, as much of it has, it is almost wholly put into corn and seems to stand the continuous cropping to one crop remarkably well.

In origin the Wabash silt loam is an alluvial soil and represents the accumulation of soil particles which have been washed from the loess

and glacial till and redeposited in the bottoms at times of overflow. It is a remarkably strong soil, as is evidenced by the fact that corn has been grown on it in places for fifteen or twenty years and still produces crops ranging from 30 to 60 bushels to the acre. No wheat was seen on this soil, and it would probably grow too rank for profitable culture. Where subject to overflow it is largely in pasture. It is valued at $80 to $125 an acre.

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

Mechanical analyses of Wabash silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21709	Soil	0.1	0.6	0.3	1.2	9.3	68.9	19.4
21710	Subsoil	.1	.4	.3	.9	2.2	76.8	19.2

WABASH CLAY LOAM.

The soil of the Wabash clay loam varies from a light to heavy black clay loam with a depth of from 10 to 18 inches. It is considerably heavier than most of the Wabash silt loam, and the particles are much more inclined to granulate and assume the "buckshot" characteristics of the "gumbo." It is also more stiff and tenacious than the Wabash silt loam, and consequently not so easily worked. The subsoil to a depth of 36 inches is a black heavy clay loam or clay, which is very plastic and adhesive.

This type is developed to considerable extent in the upper part of Big Tarkio Creek bottoms, and one area occurs in the Missouri River bottoms near the mouth of High Creek. Most of it was formerly subject to frequent injurious overflows, but since the channel of the Big Tarkio Creek has been straightened by dredging this condition has been greatly improved. The surface of the type is quite level, and rain-water is drained off slowly, but small, shallow ditches and tile drains have been constructed in much of it, which gives the Tarkio Valley areas efficient drainage. The Missouri River bottom area has not been improved by artificial drainage, and consequently is seldom cultivated, being mostly used for hay. The Tarkio Creek areas constitute a very valuable type of soil for the production of corn and wheat, and while it has only recently been reclaimed it can safely be predicted to be a lasting and very productive soil.

JUDSON SILT LOAM.

The Judson silt loam is fairly uniform over most of the area so mapped, and consists essentially of about 20 inches of very dark gray silt loam, underlain to a depth of 36 inches by somewhat lighter colored, brownish-yellow material of practically the same texture as the

soil. In some areas the subsoil is a trifle lighter textured than the soil, but it is usually slightly heavier. The soil is very mellow and easily worked, while the subsoil is somewhat friable. The difference in the amount of organic matter is the basis of the separation between soil and subsoil, and this may vary somewhat.

The Judson silt loam occurs in a broken strip of varying width at the foot of the bluffs and edge of the bottoms, and is usually characterized by a long, very gentle slope toward the lower bottoms, though it does not in any respect resemble a terrace or second bottom. The slope of the land and texture of the soil insure fairly good drainage. Little of the type is ever overflowed.

In some respects the profile resembles closely the upland soil or Marshall silt loam, though the material is usually a little heavier and the organic matter is incorporated to a greater depth. But it is undoubtedly loess material which was either arrested at the point of the bluffs, or, as is more probable, it is material washed from the hills or bluffs.

All the general farm crops are grown on this soil, corn occupying the greatest acreage. It is a very productive soil and well adapted to corn. Wheat is also grown extensively and yields from 15 to 25 bushels per acre. It is better adapted to corn, however, than to wheat. Alfalfa does exceptionally well on it also. A good stand of clover seems to be easily secured. A rotation consisting of corn, corn, corn, oats or wheat, and clover would seem to suit the requirements of this type very well.

Land of the Judson silt loam type is held at $100 to $125 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of the Judson silt loam.

Mechanical analyses of Judson silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21683	Soil	0.0	0.0	0.2	0.6	3.6	71.0	24.6
21684	Subsoil	.0	.1	.0	.2	7.1	79.4	13.1

SARPY LOAM.

The soil of the Sarpy loam is a dark-gray to almost black rather fine textured loam, with a depth of from 8 to 12 inches and an average depth of 10 inches. Small areas occur over which the soil is a fine sandy loam. An exposed surface of the soil when dry has a light-gray color, but upon wetting it becomes almost black. The soil is immediately underlain with the yellowish-gray subsoil, which in texture is generally a very fine sandy loam, containing considerable coarse silt. There are areas, however, in which the subsoil may be

a light fine sandy loam or a silt loam. The line of contact between soil and subsoil is fairly distinct. Both soil and subsoil contain a higher percentage of silt than would be expected from field examination, as the soil is very mellow and open structured, making it easily tilled.

The Sarpy loam is developed to considerable extent in the Missouri River bottoms, the areas near Watson and Langdon being the most important and extensive. It occupies the low ridges and higher elevations of the bottoms, rising probably 5 or 10 feet above the neighboring low lands. Because of its texture and structure, which allow rapid seepage of rain water, and its elevation, which is sufficient to prevent overflow, it has very good drainage. It also has a high capillary power and withstands droughts well. The three weeks' drought this season (1909) did not affect crops on it in the least, and in boring the subsoil was found at all times to be very moist.

This is a type of alluvial origin, but the exact process of formation has varied somewhat in the different areas. Those adjacent to the Nishnabotna River represent accumulations of the first particles deposited at times of overflow, and gradually built up into a ridge along the edge of the stream. Some of the areas represent sand bars or fronts thrown up by the river so high that they have never been covered by standing water and received the coating of silt and clay which constituted the other soils of this series. For instance, the Missouri River evidently at some time flowed on the north side of Langdon and also on the north side of Watson and the areas of the Sarpy loam at these points are old bars or fronts thrown up by the river.

All the general crops of the area are produced on this soil and crop failures are unknown. St. Charles White corn is grown almost exclusively and makes a much more slender stalk than on the heavier soils. As a rule corn is not planted as thickly on this soil as on most of the other types. The yields secured range from 35 to 60 bushels of shelled corn to the acre and even higher yields are reported. Wheat and oats produce from 12 to 25 bushels to the acre usually, though a yield of 44 bushels per acre was reported from one field. Alfalfa does exceptionally well and yields of 8 tons to the acre a season are reported. The average is considerably less than this. Tomatoes and sweet potatoes do well and are grown quite extensively. More of these crops should be produced as the soil is the best in the area for truck of all kinds. Clover does well and should be more extensively sown in order to keep up the organic content of the soil. The heavier types of soil will produce larger crops than will the Sarpy loam, but they are not nearly so certain and as a consequence land of this type is held at a relatively high price—$100 to $125 an acre.

SARPY SILT LOAM.

The Sarpy silt loam, like the Sarpy clay loam, is made up of three distinct sections. The upper comprises the soil and consists of about 10 inches of dark-gray to almost black silt loam or heavy silt loam. The subsurface soil, or the second section, extends from 10 to 18 inches and is somewhat lighter colored than the soil, being a dark yellowish-gray silt loam, which in some areas is slightly heavier and in others slightly lighter than the surface soil. The subsoil and third section extends from approximately 18 inches to 36 inches and is much lighter in color and texture than the overlying sections, being a light yellowish-gray very fine sandy loam. The several divisions in the soil profile are fairly uniform over a given area, but in different areas may show considerable variation. For instance, the area near Langdon is considerably heavier throughout the soil and subsurface soil than the area near Watson, though the subsoils are fairly similar. In other areas the surface soil approaches that of the Sarpy loam and the subsoil may be more sandy than the typical section. In fact, areas of Sarpy loam too small to be shown in the map not infrequently occur within areas of Sarpy silt loam. The soil has a distinctly smooth or floury feel as distinguished from the gritty, loose feel of the Sarpy loam.

Extensive areas of this type of soil are found in the Missouri River bottoms, particularly along the old channel of the Nishnabotna River. It occurs usually just back of the Sarpy loam and occupies fairly high land for the bottoms and is seldom overflowed. The texture and structure of the material permits rapid percolation of the rain water, and the natural drainage is good. The type endures drought remarkably well. Former sandbars and flats form the subsoil of this type, but over them at some time came slowly moving water from which depositions of silt and very fine sand occurred, thus forming the two upper sections of the profile. Subsequent withdrawal of the water and the growth of vegetation added organic matter in the upper stratum and distinguished the surface from the subsurface soil. In some places the type forms a distinct gradation between the Sarpy loam and Sarpy clay loam.

All the general farm crops of the area are produced upon this type and high yields are reported. Chiefly the St. Charles White corn is grown and yields ranging from 35 to 75 bushels per acre are obtained. Wheat of good quality is produced, of which yields of 20 to 40 bushels are reported. Oats yield from 20 to 50 bushels per acre, with an average of about 25 bushels. Areas which have a subsurface soil slightly heavier than the surface are better adapted to wheat and oats than to corn, while areas having a subsurface slightly lighter than the soil are better adapted to corn than to the small grains. Alfalfa does very well on this type and should be more extensively grown

than it is. Some of the lighter colored spots in the type are badly in need of organic matter, and in fact the entire type shows much benefit from green manuring with clover. The gray-colored surface of a bare field is also indicative that more humus is needed to make this soil produce its best. Corn, oats, or wheat, and clover is probably as good a rotation as could be adapted for this type.

The Sarpy silt loam is one of the most highly prized types of the area and prices run from $100 to $175 an acre, depending on location and improvements.

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

Mechanical analyses of Sarpy silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21691	Soil	0.0	0.4	0.4	2.0	11.7	73.7	11.8
21692	Subsoil	.0	.0	.0	1.6	7.4	77.2	13.7
21693	Lower subsoil	.0	.0	.0	.2	19.3	70.1	10.4

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 21693, 4.58 per cent.

SARPY CLAY LOAM.

The profile of the Sarpy clay loam consists of three distinct divisions. From 4 to 8 inches of almost black, very tenacious and sticky clay, commonly called "gumbo," constitutes the surface soil. The subsurface to depths ranging from 20 to 28 inches, with an average of 24 inches, is a rather dark yellowish gray silt clay or very silty clay loam. It is plastic, but not nearly so sticky as the surface soil. The subsoil of most of the type to a depth of 36 inches is a very fine sandy loam of yellowish-gray color and rather open, loose structure. The surface and subsurface are very uniform, but the subsoil presents considerable variation. In places it is a fine sandy loam or fine sand of very loose structure, but in others it is a fairly compact gray silty loam. There are also small areas of a distinct phase in which the subsoil is a black silt loam or clay loam. This phase was included with the Sarpy clay loam because of its similar agricultural value. A distinctive feature of the soil is its power of granulation, the dry soil breaking up into small more or less rounded cubes, notwithstanding the fact that when wet the particles run together and form a very sticky and tenacious mud. This characteristic is due to the mingling of a relatively large quantity of organic matter with just the right proportion of clay.

Several areas of the Sarpy clay loam are developed in the bottoms, the largest lying south of Langdon. It occupies a position slightly above the Wabash clay, but below the Sarpy silt loam. The topog-

raphy is practically level, though it may be broken by narrow abandoned channels. Natural drainage is deficient and in times of general overflow the areas are sometimes covered with water for a short time, but the water table remains close to the surface for considerable periods. While the removal of the rain water is a very difficult problem and causes more trouble than the overflows, the water drains off much more readily from this type than from the Wabash clay, for in that type there are 36 inches or more of clay for the water to penetrate, while in this type there are but 24 inches or less. As a consequence it can be cultivated nearly every year and fair crops can be depended on. It would seem practicable over most of this soil, in times when the water table was not too near the surface, to drain off the excess rain water by digging holes through the surface and subsurface strata, thus letting the water into the sandy subsoil.

The type owes its formation to the deposition of fine material from standing or slowly moving water upon sandy bars and flats. Subsequent growth and decay of vegetation has added much organic matter to the surface deposits.

Most of the Sarpy clay loam is under cultivation to corn, wheat, oats, and clover. The sandier the subsoil the better the crops appear. St. Charles White corn is the leading variety and yields from 10 to 50 bushels per acre, depending upon the season and the attention given the growing crop. It is the usual practice to list on this soil in the spring, but from the nature of the soil it would seem that better results would be secured by plowing the ground in the fall and letting it weather over winter. The freezing and thawing would mellow the surface so that it could be worked in the spring with ease. Great care should be taken, however, not to work this soil when wet, as it has a tendency to puddle and form clods which it is almost impossible to break up mechanically. Corn should also be check-rowed and cultivated both ways, and this thoroughly in order to form a good surface mulch. Where this is not done, large cracks form in the soil and injure the roots of the growing crop.

More wheat and oats and less corn should be grown, as they are somewhat surer crops on this land. If the ground has been kept in good condition, the corn may be cut in the early fall and wheat disked in immediately. Clover should be sown in the wheat in the spring. This is naturally a good oat soil and if proper attention is given to securing a mellow seed bed the yields from oats should be remunerative. It seems to be difficult to secure a good stand of clover, largely, it is thought, because of the poor seed bed in which it is sown. Considerable alfalfa was seen growing on the type and apparently it does well, particularly where the subsoil at 20 inches is very sandy. On account of the more or less uncertainty attending the cropping of

this land it is difficult to maintain a definite rotation, but as near as possible the following should be followed: Corn, corn, oats with clover, wheat with clover, and clover alone. All the straw and manure obtainable should be applied and thoroughly plowed in. Plowing is, as a rule, too shallow and should be gradually deepened until at least 8 inches of soil is turned.

The following table gives the results of mechanical analyses of the soil, subsoil, and lower subsoil of the Sarpy clay loam:

Mechanical analyses of Sarpy clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21694.....	Soil.....	0.0	0.0	1.2	6.3	13.7	52.9	25.9
21695.....	Subsoil.....	.0	.0	2.3	9.0	8.9	28.6	51.2
21696.....	Lower subsoil...	.0	.0	.1	.3	18.5	64.7	16.2

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 21696, 4.69 per cent.

WABASH CLAY.

The soil of the Wabash clay consists of 3 to 10 inches, with an average of about 6 inches, of grayish-black tenacious and sticky clay. The subsoil, which is separated from the soil by an abrupt change in color, is a dull yellowish-gray silt clay extending to a depth of 36 inches. When wet, the soil is very plastic and the soil auger inserted to 6 inches will pull up nearly all the soil within a radius of 6 inches, so great is its tenacity. When dry, it becomes very hard and large cracks are abundant in the fields. It is difficult material to work satisfactorily. The subsoil material is rather sticky, but is not nearly so tenacious as the soil.

The soil is locally known as gumbo and is one of the more extensive types of the Missouri bottoms. Its most important developments occur near Nishnabotna and Phelps City, though other smaller areas are numerous. It occupies the lower parts of the bottoms and, excepting abandoned bayous and some sluggish winding water courses, lies practically level. It is subject to deep and prolonged inundations at times of general overflow, and, as natural drainage is very poorly developed, heavy rains cause serious trouble. The deep stratum of clay prevents free movement of the water, and roadside ditches and some small ditches through some of the fields offer the only means of drainage, and even here the fall is so slight that water movements are slow.

The Wabash clay has been developed by accumulations of clay and silt in areas where water has stood for considerable lengths of time, thus allowing the finer particles of silt and clay carried in suspension by the Missouri River to be precipitated. The surface

soil has been modified by the accumulation of much organic matter—the remains of luxuriant vegetation.

Most of the type probably represents old river channels which lay below the general level and which, when the river suddenly changed its course, were left as large lakes. These have held the water emptied into them by each succeeding flood, and thus have gradually filled with fine soil particles. Such a condition is now found in the areas mapped as "Meadow," where deposits of the same yellowish silty clay are being made. In the latter case, however, comparatively little deposition takes place, for the water is not impounded and does not remain a sufficient length of time to permit all the clay and fine silt held in suspension to settle.

Little of the Wabash clay is under cultivation, but it supports a rank growth of wild grass, principally bluestem, which is cut for hay. In an exceptionally dry year a limited area of corn is planted, and this crop yields well, but crops are not at all certain.

Probably more of this land could be cultivated to wheat than to corn. Alfalfa does not grow on this deep clay at all. Apple trees do surprisingly well and are long lived.

If the drainage ditch on the east side of the bottoms is carried southward to the river much benefit will accrue to this land, as it will be feasible, provided the ditch has sufficient depth, to extend laterals into this type and by laying tile to reclaim the most of it.

The prices at which this land is held range from $50 to $70 an acre. These seem to be too high, considering the uncertainty with which crops can be produced, though with the present prices received for wild hay the investment is warranted if the land should be used for that product alone.

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

Mechanical analyses of Wabash clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21705	Soil	0.0	0.2	0.9	4.1	12.9	35.2	46.6
21706	Subsoil	.0	.0	1.9	7.3	7.9	42.9	40.3

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 21706, 2.52 per cent.

WABASH SILTY CLAY LOAM.

The soil of the Wabash silty clay loam is a dark-gray to almost black rather heavy silt loam, about 15 inches deep, and the subsoil to a depth of 36 inches is a dull yellowish gray silty clay. The subsoil differs from the other Wabash subsoils in that small lenses of

light-gray, compact silty material are likely to occur. The soil is quite mellow and is worked without much difficulty.

A few isolated areas of this soil occur in the Missouri River bottoms. These are usually associated with the Wabash silty clay, and gradations between the two types are common, so that boundary lines were sometimes poorly defined. It lies somewhat higher than the other soils of this series and the texture allows a greater freedom in the movement of water, and therefore the drainage is somewhat better.

Practically all the Wabash silty clay loam is under cultivation. The general farm crops of the area are grown. Corn yields from 25 to 50 bushels and wheat from 15 to 30 bushels per acre. Under the present conditions it is a slightly better soil than the Sarpy clay loam, though not as certain as the Sarpy loam and Sarpy silt loam. However, if it were adequately drained it would make a very valuable general farming soil.

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

Mechanical analyses of Wabash silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21701	Soil	0.1	0.6	0.2	1.6	18.9	53.0	25.5
21702	Subsoil	.0	.2	3.1	10.5	8.4	36.1	41.6

WABASH SILTY CLAY.

The Wabash silty clay consists of about 7 inches of very dark gray to black silty clay loam, underlain to a depth of 36 inches by dark yellowish gray silt clay. As compared to Wabash clay the surface soil is not nearly as sticky and tenacious and does not crack as badly. In fact, the soil works up into a fairly mellow and loose seed bed for a soil containing so much clay. The subsoils of the two types are practically of the same material.

Small isolated areas of this soil are found in the Missouri River bottoms. They occupy a position slightly higher than the Wabash clay and have better natural drainage. While these areas are sometimes overflowed, the water withdraws within a short time after subsidence of the floods, so that crops can be grown with more certainty than on the heavier type. Most of this soil is in cultivation, with corn as the principal product. It seems to be naturally better adapted to wheat than to corn, though in a dry year the returns from corn are much larger than from wheat. If possible, this land should be fall-plowed and allowed to weather over winter.

Artificial drainage to care for the rain water would greatly improve the type as a whole.

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

Mechanical analyses of Wabash silty clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21703	Soil	0.0	0.0	0.6	2.5	19.9	43.9	33.3
21704	Subsoil	.0	.0	3.5	10.3	6.7	34.0	45.7

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 21704, 2.17 per cent.

LAUREL FINE SANDY LOAM.

The Laurel fine sandy loam consists of light yellowish gray fine sandy loam, with a depth of 10 to 12 inches, beneath which, to a depth of 36 inches, is a very light gray fine sandy loam or fine sand. Both soil and subsoil have a loose open structure. The textural characteristics of the type are not very uniform in that the percentage of medium sand varies widely, some of the subsoil even containing sufficient to make it a sand.

This type is not extensive. It is developed in the northwestern part of the county in the vicinity of the old river bed surrounding McKissick Island, Nebraska. It represents recently formed sand bars and flats and is to be distinguished from the type of Riverwash only by the fact that it lays above the flood level and is not subject to frequent overflow. It is therefore not likely that it will receive any further deposition and can be considered as a permanent body of soil material, and was accordingly separated as a type. Other areas of such material undoubtedly occur within the Riverwash, but as that is mostly inaccessible, no attempt was made to distinguish the two.

At present little of the Laurel fine sandy loam is under cultivation, and while it is probably fertile soil and would stand drought fairly well, considerable preliminary cultivation would be necessary to adapt it to the general farm crops. The soil contains little or no organic matter, and it is advised that the first year Whippoorwill cowpeas be planted in June and the entire crop plowed under, when the first peas begin to mature. This will put an abundance of leguminous green manure in the soil. The second year either the same operation should be repeated or clover substituted for the cowpeas. The third year clover should be used and by the fourth year corn could be planted, though a catch crop of cowpeas should be sown in the corn at the last cultivation. All the stable manure obtainable should also be applied to this soil. By this method it would be possible to incorporate as much organic matter in this

soil in a few years as there would naturally be accumulated in a lifetime.

The type is naturally a good truck soil and tomatoes, sweet potatoes, and watermelons should do exceptionally well.

OVERWASH.

There are several areas in the Missouri bottoms and the southern part of the Big Tarkio bottoms which have been covered with wash either brought down from the adjacent hills by the smaller streams, as in the case along Big Tarkio Creek and the bluffs, or by the breaking of a dike, as in the areas along the river. The material deposited in this way consists usually of light-colored coarse silt or fine sand, though the texture is extremely variable. The depth of the material ranges from 6 inches to over 3 feet and the underlying material may be either black clay (gumbo) which originally would have been Wabash clay, or Sarpy clay loam, or a black silt loam, or clay loam, which would have been Wabash silt loam or Wabash clay loam. As no consistent distinctions could be made in this material it is all mapped as Overwash.

It may be regarded as a permanent soil, however, as the conditions which caused it are not necessarily continuous. Permanent dikes can be made and the streams from the uplands can be ditched or leveled so that their deposition will not interfere with cultivation. In many respects the wash is a desirable soil. It is strong and productive and is highly prized, many farmers claiming it the best land to be had. But to be valuable it must after deposition be protected from future coverings and be thoroughly drained. Most of these areas are greatly deficient in organic matter and efforts to increase such material should be made. Land of this type protected from further deposition and well drained will make 75 bushels of corn per acre.

On account of its variability no sample of this type was taken for analysis.

RIVERWASH.

Riverwash includes the areas along the Missouri River which are composed of alternating sand bars and sand flats and narrow depressions covered with a silty clay. These areas can not be considered as final soils, as they are but the basis for further depositions in times of overflow. They will in time probably give rise to soils such as are now found over the main bottoms.

Very rarely a small part of these areas is cultivated, but the returns seldom are remunerative and as overflows are frequent they can not be utilized to any considerable extent for agriculture. They are usually covered with a growth of willow.

MEADOW.

Old river beds, low wet places, and land within levees form areas of very uncertain and varying texture which have been shown on the map as Meadow. For the most part they are waste land, though in places they support a valuable growth of cottonwood. More frequently willow is the dominant growth. Meadow is all subject to frequent overflow and can not be considered as a true soil, since there will undoubtedly be much further deposition over it. If possible, this land should be forested to cottonwood, which would not only hasten the deposition of soil, but would make the land pay revenue during the time of formation.

SUMMARY.

Atchison County lies in the prairie region of the extreme northwestern corner of Missouri and comprises 341,760 acres, or 534 square miles.

The climate is moderate, though marked by rather pronounced extremes of cold and heat, and humid, having an average rainfall of about 37 inches. There is a growing season of one hundred and sixty-three days, which is sufficient for all general farm crops.

There are two paramount physiographical divisions of the county—the gently rolling to rolling uplands with good drainage, and the broad nearly level bottom lands of the Missouri River, with drainage poorly developed.

Agriculture is based upon the production of corn, which on the upland is all fed to cattle, hogs, and sheep. Some of the grain is shipped from the bottoms. Wheat is an important crop of the bottoms, and oats, clover, and alfalfa are secondary crops of the county.

Sixteen types of soil were mapped—three on the upland and thirteen in the bottoms.

The Marshall silt loam is the most important and covers practically all of the upland. It is a loess soil and is well adapted to all the crops of the area and to corn in particular.

The Shelby loam is derived from glacial till, which is exposed along the streams in the eastern part and is well adapted to all general crops.

The Hamburg silt loam, occupying the steep and broken bluffs, is a light-colored soil and is not under cultivation. It is generally forested and for the most part should be left in this condition.

The Judson silt loam is a colluvial loess soil occupying long gentle slopes along the bluff side of the bottoms. It is a strong soil well adapted to all the farm crops.

The Sarpy and Wabash series comprise alluvial soils found in the Missouri bottoms or along the other streams.

The Sarpy loam occupies the higher ridges and flats and has good drainage. It is highly prized for the certainty with which it produces good yields of the general farm crops.

The Sarpy silt loam also lies high, has good drainage, and is a valuable soil.

The Sarpy clay loam is sometimes overflowed, but can usually be cultivated, and gives fair yields of the general crops.

The Wabash silty clay and Wabash silty clay loam are sometimes overflowed, and good crops are not expected every year. As a rule these soils are better for wheat than for corn.

The Wabash clay has very poor drainage, and crops are very uncertain. Little of this type is cultivated, though it produces a good yield of valuable wild hay.

The Laurel fine sandy loam is a light-colored, high-lying truck soil.

The Wabash silt loam and Wabash clay loam, which lie along streams through the upland, are excellent corn soils where well drained.

Meadow represents untillable soil, usually of heavy texture.

Riverwash applies to untillable sand bars and flats.

Overwash is material washed down and deposited over other soil types. It is often cultivated, and is a very fertile soil.

Erosion and drainage are important problems of the area. More organic matter should be incorporated in the light-colored parts of the upland soils and the land cultivated less frequently to corn, with a view to control erosion. In the bottoms, drainage ditches should be constructed to insure good drainage to all the valuable soils in the section.

While land is held at high prices—the range is from $50 to $175 an acre—the yields obtained warrant such valuation, and the industrious farmer can make a good percentage of profit on the investment on this basis. This is evidenced by the universal prosperity of the farming class in Atchison County.

NRCS Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.