

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
In cooperation with the Iowa Agricultural Experiment Station

SOIL SURVEY
OF
BUCHANAN COUNTY, IOWA

BY

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and M. H. LAYTON and J. H. ZENTMIRE
U. S. Department of Agriculture

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COUNTY SURVEYED

Buchanan County is in the eastern part of Iowa. Independence, the county seat, is about 135 miles northeast of Des Moines, the State capital, and about 250 miles west of Chicago. The county contains 16 full townships and includes an area of 567 square miles, or 362,880 acres.

The surface features of Buchanan County are those of a till plain on which erosion has as yet had little effect. This constructional surface is characterized by gentle swells and broad, poorly drained sloughs. Except along drainage courses the configuration was caused by ice. The larger streams have cut only shallow channels, and their tributaries have cut back but slight distances into the upland. The smoothest large area, typical of the Iowan drift plain, is in the northeastern corner of the county. Here the few streams flow in shallow channels with low gradients. In other parts of the county very little relief has developed on the uplands, but a greater part of the surface is occupied by streams and alluvial flood plains. The greatest relief in the county is in the high hills which lie mainly east of Wapsipinicon River northwest of Quasqueton, where the river flows through a gorge from 130 to 150 feet deep. A large body of alluvial land lying between Independence and Quasqueton attains its greatest elevation in section 29 of Liberty Township, at which point the terraces near the river are higher than the drift plain farther back. It is believed that this part of the county was not penetrated by the Iowan ice sheet.

The drainage of the greater part of Buchanan County is carried by Wapsipinicon River and its tributaries. This stream enters the county near the northwest corner and flows in a southeasterly direction. Most of its branches enter from the north. The extreme northeast part of the county is drained by Maquoketa Creek and the southwest corner by tributaries of Cedar River. The greater part of the uplands and a large part of the interstream areas have a constructional relief and lack adequate drainage.

Independence, the county seat and largest town, had a population of 3,672 in 1920. A few small manufacturing plants and a canning

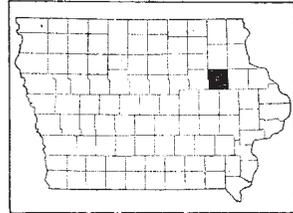


FIGURE 1.—Sketch map showing location of Buchanan County, Iowa

factory are located here. Jesup, Lamont, Winthrop, and several smaller towns are important local trading centers and shipping points.

The interests of the county are almost entirely agricultural. The principal products sold from the farms are hogs, cattle, poultry, milk, and cream. The hogs are either shipped to Chicago by rail or to local packing plants at Cedar Rapids and Waterloo by truck. Very little grain or hay is shipped from the county, and in some years feed is shipped in. Eggs are shipped mainly to Boston and other eastern markets and dressed poultry to Rhode Island.

Buchanan County is traversed by the main line of the Illinois Central Railroad which extends from east to west across the middle of the county, furnishing direct shipping facilities to Chicago. A branch line of the Chicago, Rock Island & Pacific system crosses the county in a north and south direction. Both these roads pass through Independence, which is near the geographical center of the county. A main line of the Chicago Great Western Railway crosses the northeastern corner, and an electric line, the Waterloo, Cedar Falls & Northern, crosses the southwestern corner.

Buchanan County has a good county-road system. A concrete highway, United States Highway No. 20, extends east and west through the center of the county. A bond issue already voted provides for a paved road running north and south through Independence. Many of the township roads are surfaced with gravel and provide easy access to all parts of the county.

CLIMATE

The climate of Buchanan County is favorable to the production of all general farm crops. The mean annual precipitation of 31.94 inches is well distributed throughout the growing season. The average frost-free season is 149 days, from May 6 to October 2, a period sufficient to allow the corn crop to mature. The latest recorded frost occurred on May 31 and the earliest on September 11. A wet season in spring and early summer sometimes delays corn planting, and later in the summer drought may lower the yields on the lighter and sandier soils, but total crop failures are unknown. Hailstorms are rare and are local in extent. Occasionally windstorms damage growing crops.

Table 1, compiled from the records of the United States Weather Bureau station at Independence, gives the normal monthly, seasonal, and annual temperature and precipitation for Buchanan County.

TABLE 1.—Normal monthly, seasonal, and annual temperature and precipitation at Independence

[Elevation, 921 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1876)	Snow, average depth.
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
December.....	23.6	60	-26	1.31	0.30	0.30	7.2
January.....	16.9	57	-32	1.17	2.25	2.10	8.1
February.....	21.2	60	-29	1.05	.12	1.36	7.0
Winter.....	20.6	60	-32	3.53	2.67	3.76	22.3
March.....	34.1	87	-14	1.72	.00	2.91	4.6
April.....	48.7	89	9	2.51	1.47	3.34	1.3
May.....	59.6	95	21	4.27	2.63	3.99	.0
Spring.....	47.5	95	-14	8.50	4.10	10.24	5.9
June.....	68.3	100	35	4.62	1.49	8.66	.6
July.....	73.0	106	44	4.14	.51	11.92	.0
August.....	71.3	103	34	3.21	2.36	7.19	.0
Summer.....	70.9	106	34	11.97	4.36	27.77	.0
September.....	63.9	100	18	3.95	3.19	7.20	.6
October.....	52.1	89	14	2.55	.65	1.80	.2
November.....	36.5	78	-10	1.44	.05	2.05	2.2
Fall.....	50.8	100	-10	7.94	3.89	10.05	2.4
Year.....	47.4	106	-32	31.94	15.02	51.82	30.6

AGRICULTURE

The first permanent settlers arrived in Buchanan County in 1841 and located on the timbered slopes along the larger streams. The broad interstream divides covered with heavy prairie grasses were used as pasture. Gradually the settlers moved out on the higher prairie lands, leaving the flat or depressed poorly drained upland tracts for pasture. At first, agricultural efforts were limited to growing small patches of flax, corn, buckwheat, and wheat for sustenance. Wild game was abundant. Cattle grazed on the open range. Agriculture has progressed steadily during the last 50 years but has changed only slightly in character. The raising of livestock, together with the growing of grain, has always been the chief agricultural pursuit. Dairying has also been extensively developed. The production of wheat, formerly an important crop, has been practically abandoned.

Corn has been the leading crop from the earliest settlement of the county. The 1928 Iowa Yearbook shows a production of 4,018,650 bushels of corn, averaging 36.5 bushels to the acre. About 5 per cent of the crop was cut for silage, 6 per cent was hogged down, and 22 per cent was cut for fodder. The principal varieties of yellow corn are local strains of Reid Yellow Dent, Golden Glow, a small 60-day dent corn, and Black Hawk Yellow Dent, the last named being grown largely in the western part of the county.

Most of the white corn grown is Silver King. A little Calico and Bloody Butcher is planted. Probably 40 per cent of the seed is field selected, but a number of farmers grow improved seed for the local market. Corn is grown on all soils of the county but most extensively on Carrington loam and Carrington silt loam. Most of the corn is fed on the farm to hogs and dairy and beef cattle, but some is shipped. In some seasons some corn is shipped in for feed.

Sweet corn is grown, principally around Independence, and sold at the canning factory located there. The waste is hauled away from the factory by farmers and fed to livestock. Popcorn is grown in small patches for local consumption.

Oats are second in importance to corn. The ratio is about 10 bushels of oats to about 17 of corn. The principal oat varieties are Iowar, Schoolma'am (a big yellow oat), Early Champion, and Albion (Iowa 103). The last-named variety is particularly well adapted to sandy ground. Oats were grown on 65,110 acres in 1927, and the average yield was 34.1 bushels to the acre. Most of the crop is fed to hogs and cattle. Several carloads are shipped yearly to Cedar Rapids, and some goes to Kansas City. Damage is occasionally caused by smut and rust. Much of the seed is treated with a formalin solution.

Hay is an important crop. It is practically all fed to livestock. In 1927 wild hay was cut from 6,632 acres and averaged about $1\frac{1}{4}$ tons to the acre. It is cut mostly from poorly drained Clyde silt loam and Clyde silty clay loam. In 1927, 36,428 acres were in tame hay, of which 23,528 acres were in mixed timothy and clover. Of the 10,994 acres in timothy alone in 1927, 410 acres were cut for seed, averaging 2.6 bushels to the acre. Clover alone was grown on 2,300 acres.

Alfalfa is grown only in small plots. In 1927, 830 acres were cut and an average yield of about $2\frac{3}{4}$ tons to the acre was reported. Inoculation and liming are essential in seeding alfalfa, clover, and sweetclover. Careful preparation of the seed bed is also important. Three or four cuttings are made each season, and the stand is left for three or four years. All the crop is fed on the farm. Acidity and poor drainage are the limiting factors in the production of alfalfa and sweetclover. The farmers report a number of failures, most of which were from plantings on sandy ground which was limed but not inoculated. Inoculation is especially necessary on light sandy soils. Sometimes the crop is lost through winterkilling.

Sweetclover is successfully grown where limed and inoculated. In 1927, 512 acres were reported in this crop. When harvested for seed it produces 2.9 bushels to the acre. The white sweetclover is grown almost exclusively. It is practically all pastured for one year and then turned under as a green-manure crop, for which purpose it is valuable.

Soybeans are increasing in acreage. They are mostly planted with corn for silage or for hogging down. In 1927 there were 4,961 acres grown with corn and 1,140 acres grown alone, of which 484 acres were harvested for seed, yielding an average of 16.6 bushels to the acre.

Millet is grown mainly as an emergency crop. Sudan grass is raised in small acreages and does well. Cane is grown in considerable quantities in a Dutch neighborhood north of Winthrop and is also produced to some extent around Quasqueton and Fairbank and in small scattered patches throughout the county.

Barley was grown on 3,773 acres in 1927 and produced an average of 28.7 bushels to the acre. It is mostly fed to hogs and calves. Buckwheat is occasionally grown on sod. Only 95 acres were reported in this crop in 1927. Flax was grown in that year on only 35 acres. Rye, of the Rosen variety, is sown mostly on sandy soils, such as the sandy loam and sand types of the Carrington, Dickinson, and Lindley series. The total acreage in 1927 was 1,036 acres, and the average yield was only 11.1 bushels to the acre.

Wheat is a minor crop of little importance or value. Only 142 acres of spring wheat and 13 acres of winter wheat were reported in 1927. In that year spring wheat averaged 20.9 bushels to the acre and winter wheat 13.4 bushels. Practically all the wheat is grown in the northern part of the county.

The acreage in pastures was reported as 107,906 acres or 29.7 per cent of the total acreage of the county. Pastures are mostly of bluegrass with some redtop. The most troublesome weed pests are morning-glory, smartweed, some Canadian thistle, dock, cocklebur, sandburs on sandy land, and watercress on the more poorly drained areas, especially in wet seasons.

Potatoes are grown for local consumption, but not in sufficient quantities to supply the demand, and many carloads are shipped in annually. Early Ohio, Irish Cobbler, Rural New Yorker, Triumph, Strawberry (a strain of Early Rose), and local varieties of Russet are the principal varieties grown. The average yield is about 145 bushels to the acre. Considerable acreages of potatoes are grown around Otterville. Truck crops are grown mostly around Independence, Otterville, and Hazelton on the sandier terrace soils.

Fruit growing is not extensively developed, being largely restricted to small farm orchards of 1 to 3 acres. A few orchards range from 10 to 30 acres in size. Apples are the most common fruit, the principal varieties being Summer Duchess, Yellow Transparent, Greening, Salome, Jonathan, and Delicious. Barrel sprayers are generally used in spraying the orchards. The fruit is grown on the gently rolling or rolling uplands and is all sold locally. The Iowa State census reports 6,598 bushels of apples harvested in 1927. Plums, cherries, and pears thrive, but few are grown. Small quantities of strawberries, raspberries, blackberries, gooseberries, currants, and grapes are successfully grown. Strawberries are the principal small fruit grown, and the local market consumes the entire crop.

Beef cattle, dairy cattle, hogs, and sheep are important sources of income on most farms. Hog raising is the most extensive animal industry and brings in the largest income.

The principal breeds of hogs are Poland China, spotted Poland China, and Duroc-Jersey, and some Chester White, Berkshire, and Hampshire are seen. There are many breeders of purebred hogs in the county. The average number of hogs kept on a farm is about 30 head. Nearly all the boars used are purebred. Several carloads of feeders weighing from 100 to 125 pounds each are shipped in an-

nually from South Dakota and from the Sioux City and Omaha markets. Most of the hogs are marketed in November and December, when they weigh about 250 pounds. They are shipped mainly to Waterloo and Cedar Rapids, but many are shipped to Chicago. Eight cooperative shipping associations in the county handle about 60 per cent of the hogs marketed. Epidemics of cholera are disastrous at times, but the disease is kept pretty well under control. Flu, swine influenza, also takes considerable toll.

Dairying is an important industry which is carried on in all parts of the county. However, less dairying and more cattle feeding is carried on in the eastern and the southeastern parts. Holstein is the leading breed of dairy cattle, and Jersey and Guernsey rank next in importance. Some Ayrshire and a few Brown Swiss are raised. Milking Shorthorns and cows of mixed breeds are depended on for much of the milk supply. Seven or eight cows is the average number per farm. Most dairy farms are equipped with silos. Cream is separated on the farm and collected daily by trucks which cover regular routes. Although most of the product is marketed as butterfat, considerable whole milk is sold. Nine creameries, six of which are cooperative, are scattered in various parts of the county, and there is a condensery at Independence. Most of the butter made is shipped to New York. In 1927, 15,010,683 pounds of milk and 9,064,805 pounds of cream were marketed, and a total of 3,985,155 pounds of butter was made. In the same year the total value of dairy products produced in the county was \$1,859,941.67. More than 90 per cent of the products were sold outside the State.

The raising of beef cattle is important and is extensively carried on. Most of the animals are grade Shorthorns, but some Aberdeen Angus and Herefords are raised. The average number to the farm is 8 or 10 head. A number of herds are purebred. Feeders are shipped in by the carload from Sioux City and Omaha. The cattle are pastured, then finished on cottonseed meal, oil meal, clover hay, and fodder. They are marketed principally in May, June, and December. Chicago is the principal market for the finished cattle.

Sheep raising is of minor importance. Most of the animals are raised in the hillier sections of the county and are marketed in Chicago. Grade Shropshires predominate. Very few western sheep are brought in for feeding. Wool had a value of \$21,924 in 1919, according to the United States census report for 1920. About 10,000 pounds were pooled and shipped through the county agent in 1927.

Horses average about four to the farm. Only a few mules are used. The principal breeds of horses are Belgian and Percheron. A few colts are raised each year, thus maintaining the supply of work animals.

Poultry raising is carried on extensively, and poultry is an important source of revenue on nearly every farm. The average flock numbers about 150. Most of the flocks are mixed, but more purebred flocks are being raised than formerly. Rhode Island Red, Barred Plymouth Rock, White Plymouth Rock, White Leghorn, Brown Leghorn, and White Orpington are the chief breeds. Considerable culling is being done with good results. Eggs and poultry are marketed locally, and through poultry shipping houses in Winthrop, Jesup, and Independence, with stations in all the smaller

towns. Most of the eggs are shipped to Boston and the dressed poultry to Providence, R. I.

The adaptation of certain crops to certain soils is recognized by most farmers, but with the exception of growing truck crops and potatoes on the sandier terrace soils near Independence, Hazelton, and Otterville no effort is made to observe this adaptation. The lighter-colored Fayette and Lindley soils are particularly suited to small fruits, tree fruits, and small grains. The heavy Clyde soils, where well drained, Carrington loam, and Carrington silt loam are recognized as strong corn soils. However, corn is grown on all soils.

Crop rotation is practiced by most farmers, but not systematically. The most common rotation and the one which seems best suited to most of the soils is corn, oats, and clover. Rye is grown as a cover crop on the sandier soils, which are badly in need of organic matter. Cover crops should be used as much as possible. Sweetclover, alfalfa, and clover would furnish an abundant supply of humus.

On account of the sandiness of much of the land, considerable fertilizer is used in Buchanan County, especially in Perry, Westburg, Sumner, Homer, and Cono Townships. Complete commercial fertilizers analyzing 2-10-2¹ and 2-10-4 are used mostly, but other combinations, such as 1-12-1, are also applied. Some superphosphate (acid phosphate) alone and some fertilizers high in potash are used. These fertilizers are mostly applied, by means of an attachment on the corn planter, to cornland. Results vary, but where fertilizer is intelligently used, especially on the lighter soils, increased yields have been common. Manure is usually applied to cornland before it is broken and is used as a top-dressing on the lighter soils. Limestone is used extensively in Perry, Westburg, and Washington Townships and in the central and southern parts of the county. About 100 carloads of limestone were used in 1927. Several marl pits of good quality occur in the county. Near Brandon a pit tested 96 per cent, one near Littleton tested 70 per cent, and one near Jesup 70 per cent. The average cost of limestone is about \$2 a ton, although good limestone has been obtained through the county agent for as little as \$1.26 a ton.

Most of the farm buildings are well constructed. They include barns, hog houses, machine sheds, corncribs, and poultry houses. Many barns, especially on dairy farms, have basements and are equipped with stanchions, litter carriers, and other labor-saving devices. Nearly every dairy farmer has a silo. Many of the farmhouses are equipped with electric lights, particularly those around Jesup, Hazelton, Winthrop, and Independence.

The number of tractors in the county in 1927 is reported as 299, of auto trucks 171, and of automobiles 2,125. Radios are installed in 679 farm homes.

Consolidated schools are located at Jesup, Brandon, Rowley, Lamont, and Stanley. Rural schools and rural mail delivery routes are scattered over the county, adequately serving every part.

Most of the farmers are native-born whites. Settlements of people of Irish descent are in Middlefield and Newton Townships, of German descent in Westburg Township and the northwestern part

¹ Percentages, respectively, of nitrogen, phosphoric acid, and potash.

of the county, Mennonites have settled in the northwestern corner of the county north of Littleton, and Danish settlements are southeast of Independence and in Liberty Township.

Although the chief industry is agriculture, several factories and other manufacturing plants are scattered throughout the county.

Farm labor is plentiful. Most farm help is hired by the month at prices ranging from \$40 to \$55. Harvest hands receive from \$2.50 to \$3 a day and ordinary day laborers from \$2 to \$2.50. Help employed by the year is paid from \$40 to \$45 a month and in addition is furnished a house, garden, chickens, and cow. Corn pickers receive 5 or 6 cents a bushel.

According to the 1927 Iowa Yearbook, owners operate 44 per cent of the farms in Buchanan County and tenants 56 per cent. In the same year the 2,286 farms included 353,826 acres and averaged 155 acres in size. Land rental is on the livestock-share or grain-share basis. When land is rented on the grain-share basis pasture and hay land rents for \$4 or \$5 an acre. Very little land is rented for cash. It brings from \$5 to \$7 an acre.

Land values are influenced by many factors, such as buildings, roads, location, soils, general condition of fields and buildings, extent of improvements, drainage, schools, and community interests. In 1927 the price of farm land averaged between \$125 and \$150 an acre. Farms with exceptional improvements brought from \$175 to \$225, depending on the character of the soils. The poorer sandy lands and river bottoms range in price from \$35 to \$90 an acre.

SOILS

In this report the soils of Buchanan County have been grouped into a number of series and types on the basis of their physical and chemical characteristics, so far as these could be ascertained by observation in the field or by simple laboratory tests. The characteristics of the soils of any region are controlled by the character of the material from which they were derived and by the processes of soil formation, including all those physical and chemical forces to which the soils have been subjected during their development. The nature of the soil-forming processes and the rapidity with which they act are determined to a large extent by climate.

Buchanan County lies in the prairie region of the United States where the surface features and an adequate supply of moisture favor a grass vegetation over the smooth upland. The treeless condition was not produced by climate alone, for where the smooth upland surface has become broken by erosion, resulting in better surface and subsoil drainage, a timber growth covers the slopes. The native vegetation at the time of the settlement of the region by the white man was grass over the comparatively smooth uplands and forest along the deeper stream valleys.

The soils which have been influenced by a grass vegetation for ages have accumulated a large quantity of organic matter in their upper layers. This organic matter incorporated in the soil through the decay of grass roots imparts to the prairie soils their characteristic dark color. The soils on the forest areas have not accumulated any large quantity of organic matter and have light-colored surface

layers. The soils of the county may, therefore, be separated on the basis of their most striking characteristic, color, into dark-colored and light-colored soils.

The dark-colored soils of the county fall into two subgroups which are differentiated on the basis of characteristics of either surface soil or subsoil, or both, which have been produced by drainage conditions during the development of the soil.

The soils of the first subgroup, of which members of the Carrington series are representative, were developed under conditions of good surface drainage and subdrainage. Under these conditions the soil-forming forces controlled by climate have acted on the soil material without interruption, so that the profile developed may be regarded as normal for this region. The typical profile shows a surface layer ranging in color from dark grayish brown to almost black. The structure is single grained or finely granular. In the virgin soil the topmost 3 or 4 inch layer is filled with grass roots forming a turf. In the lower part of the surface layer, grass roots are also present but not so abundantly as in the upper part. The material is also more distinctly granular in the lower part. The next lower layer, in which the material is distinctly granular, is transitional in color between the dark-colored surface soil and the brown layer below. The texture becomes heavier, changing downward from loam or silt loam to silty clay loam. This transitional layer is underlain between depths of 24 and 36 inches by a brown or yellowish-brown layer, the heaviest layer in the soil. Beneath this is the less weathered parent material, which in this county may be glacial drift, loess, or an alluvial deposit. In most places the material is yellowish brown, friable, and except in the Dodgeville soils, which overlie limestone, low in carbonates to a depth of many feet. Iron stains and concretions are common in the parent material below a depth of 4 feet. Besides the Carrington soils this group of soils includes members of the Dickinson and Thurston series on the upland and of the Waukesha and O'Neill series on the high terraces. With this group also is placed the Dodgeville soils which are developed from unconsolidated material overlying limestone.

The soils of the second subgroup are dark colored and have developed under conditions of more or less excessive moisture. Therefore they have not developed the normal soil profile of the region. The broad swales, large depressions, and immature drainage courses scattered throughout the upland plains collectively cover a large area. Water accumulated on these areas during rains and remained on the surface until, through the slow processes of seepage and evaporation, it was finally removed. Conditions were favorable for the growth of water-loving plants but were unfavorable to the formation of extensive peat and muck areas. These soils, however, accumulated a large proportion of organic matter and as a result the surface layers are very dark grayish brown or black. The structure is nearly everywhere finely granular. The surface soils are underlain by gray or moderately gray, yellow, and brown subsoils which are heavier in texture than the surface soils. The profiles of these soils vary considerably, depending on the depth to which good drainage and oxidation have reached. With this group of poorly drained soils may be placed the members of the Clyde series which have developed on

glacial material, the Bremer soils which occur on poorly drained terraces, and the Wabash and Cass soils which have developed on recently deposited alluvial material.

Areas of light-colored soils are very nearly coextensive with the areas which were covered by forest when the country was first settled. The surface layers of the forest soils are thinner than those of the smooth upland soils. Over most of the county the surface soils of the light-colored soils range from 3 to 8 inches in thickness, the color is grayish brown, the consistence loose, and the texture silty. This layer is underlain to a depth of 2 or 3 feet by heavy brown or yellowish-brown material, below which is the parent material, commonly yellowish brown, lighter in texture, and more friable than the layer above. The Fayette soils derived from loess and the Lindley soils derived from glacial drift, both of which occur on eroded uplands, belong to this group, as do also the Bertrand, Jackson, and Sparta soils on the terraces and the Genesee soils of the first bottoms.

The principal soil characteristics mentioned have been imparted to the soils by the soil-forming processes. The soils of Buchanan County have been grouped in series on the basis of these characteristics and those resulting from the composition and processes of accumulation of the mineral matter from which the soils have developed.

The entire county was probably covered by drift material by the last (Iowan) ice invasion. As the relief ranges from level to rolling, drainage conditions have been favorable for the formation of soils under both optimum and excessive moisture. The dark-colored well-drained soils in the drift-covered area include members of the Carrington, Dickinson, and Thurston series. The Dickinson and Thurston soils have developed over a sandier drift than the Carrington. The drift material that has weathered under conditions of excessive moisture has produced the Clyde soils on the imperfectly drained valleys and swales. Drift materials similar to those that have produced the dark-colored soils have weathered into the light-colored soils of the Lindley series on the eroded and timbered stream slopes. Small areas of silty material believed to be loess have developed the light-colored soils of the Fayette series. Areas of dark-colored Tama soils also occur, but on account of their small extent they are included with the Carrington soils.

On the basis of age and stage of development the alluvial soils may be divided into two groups, the terrace and first-bottom soils. The terrace soils represent old flood plains of the streams which have been left high above overflow by the lowering of the stream channel. The soil material ranges from heavy clays to unassorted sands and gravels. The dark-colored terrace soils have been placed in three series, as follows: The Waukesha, which have developed over heavy material under good drainage conditions; the Bremer, which are heavy, compact, and poorly drained; and the O'Neill, which have sandy or gravelly subsoils. The light-colored terrace soils belong to three series: The Jackson, which are fairly heavy in texture but are well drained; the Bertrand, which have a uniform texture throughout but are fairly retentive of moisture; and the Sparta, which have loose gravelly subsoils and are somewhat droughty.

The flood plains or first bottoms are covered by materials of recent origin, consisting of sand, silt, and clay washed down from the uplands. The Wabash series includes dark-colored soils with rather heavy subsoils; the Cass series, dark-colored soils with sandier gravelly subsoils; and the Genesee series, light-colored soils with subsoils consisting of alternate bands of sand, silt, and clay.

The soils of Buchanan County are grouped in series on the basis of the thickness and arrangement of the soil layers, such physical properties as color, texture (except in the surface layer) and structure, and chemical properties and reactions. The soil type is a subdivision of the series based on the texture of the surface soil.

The distribution of the soils of Buchanan County is shown on the soil map which accompanies this report. The acreage and proportionate extent of the various soils mapped are given in Table 2.

TABLE 2.—Acreage and proportionate extent of the soils mapped in Buchanan County, Iowa

Type of soil	Acre	Per cent	Type of soil	Acre	Per cent
Carrington loam.....	159,104	43.8	O'Neill loam.....	12,608	} 3.6
Carrington silt loam.....	12,928	3.6	Light-colored phase.....	320	
Carrington sandy loam.....	31,936	8.8	O'Neill loamy sand.....	192	.1
Carrington loamy fine sand.....	128	.1	Bremer loam.....	832	.2
Clyde silty clay loam.....	45,184	12.4	Bremer silt loam.....	2,176	.6
Clyde silt loam.....	21,696	6.0	Bremer silty clay loam.....	3,328	.9
Dickinson sandy loam.....	8,704	2.4	Sparta fine sand.....	768	.2
Dickinson loamy sand.....	1,024	.3	Bertrand sandy loam.....	2,176	.6
Dickinson loam.....	384	.1	Bertrand loam.....	768	.2
Lindley loam.....	5,824	1.6	Jackson silt loam.....	320	.1
Lindley sandy loam.....	3,648	1.0	Wabash silty clay loam.....	5,184	1.4
Lindley silt loam.....	1,664	.5	Wabash loam.....	8,256	2.3
Lindley sand.....	1,152	.3	Wabash silt loam.....	1,600	.4
Fayette silt loam.....	1,536	.4	Cass sandy loam.....	4,800	1.3
Fayette sand.....	256	.1	Cass loam.....	3,072	.8
Thurston loam.....	256	.1	Sarpy fine sandy loam.....	320	.1
Dodgeville loam.....	320	.1	Genesee fine sandy loam.....	256	.1
Waukesha silt loam.....	1,088	.3	Muck and peat.....	512	.1
Waukesha loam.....	7,296	2.0			
Waukesha sandy loam.....	128	.1	Total.....	362,880	
O'Neill fine sandy loam.....	5,952	1.6			
O'Neill sandy loam.....	4,416	} 1.4			
Light-colored phase.....	768				

CARRINGTON LOAM

The surface layer of Carrington loam, to an average depth of 3 inches, is finely granular dark grayish-brown friable loam which when wet appears almost black. It is underlain to a depth of about 12 inches by very dark grayish-brown loam containing considerable very fine sand and silt and a few small gravel and coarse sand grains. Below this layer, between depths of 12 and 24 inches, is a transitional zone. The color changes with depth from very dark-grayish brown to brown. The darker color in this layer is imparted by black organic matter which has seeped from the surface soil or been brought down by worms and insects. It forms a coating over the soil granules, but the greater part occurs as casts in wormholes. Worms also bring up lighter-colored material from below. The texture ranges from loam in the upper part of the layer to heavy loam or silty clay loam in the lower part. The structure in the upper part is granular, and the material in the lower part of the layer is struc-

tureless. The next lower layer, which reaches a depth of about 35 inches, is structureless yellowish-brown clay loam which breaks up into small irregular clods. Streaks of dark material penetrate this layer in a few places, and here and there rust-brown iron stains are seen. This layer is underlain to a depth of about 50 inches by yellowish-brown gritty clay loam which is slightly lighter in texture and more friable than the layer above. This is the parent material of glacial drift which is little modified by weathering. In many places the material is spotted with red or gray from the parent rock. A few small gravel, rotten greenstone, stone fragments, and sand pockets are present. To a depth of many feet no changes in the material are noticeable, except that the iron stains and gray spots become more numerous and many iron concretions are found.

Though fairly uniform throughout the county, a few minor variations are found in this soil. In the northeastern part of the county on nearly flat areas the percentage of silt is higher than in the typical soil. The silt is not so abundant in the surface soil but is present in all the lower layers. Small pockets of sand and gravel occur in many areas, in some places reaching the surface. The soil mapped in the northwestern part of the county has a sandier surface soil than the typical soil.

Carrington loam is the principal upland soil of Buchanan County, except in the southeastern corner. Most of it follows the stream slopes down to the alluvial lands. The land is naturally well drained, the slope everywhere insuring rapid removal of surplus rainfall.

With the exception of a small acreage of sharply rolling land, which is used only for pasture, all the Carrington loam in Buchanan County is cultivated. Corn is the most successful, most profitable, and most extensively grown crop, but the oat acreage nearly equals that of corn. Hay crops, principally timothy and timothy and clover mixed, occupy the next largest acreage. The average yields of nearly all crops on Carrington loam are slightly higher than the average for the county as a whole. Corn yields an average of about 40 bushels to the acre, and some farmers, situated in the better locations, may obtain an average of 60 bushels. Oat yields average about 30 bushels, but a yield of 60 bushels is sometimes obtained. The average yield of timothy and clover hay is about 1½ tons to the acre.

CARRINGTON SILT LOAM

The surface soil of Carrington silt loam, to an average depth of about 15 inches, is very dark grayish-brown friable silt loam which when wet appears black. A part of the material composing this layer is finely granular, and the remainder is loose silt. The underlying layer, to a depth of 20 inches, is brown silty clay loam, which is imperfectly granular in the upper part but not in the lower. The next lower layer, which continues to a depth of about 42 inches, is yellowish-brown clay loam containing considerable coarse sand and a few iron stains. The material is structureless and breaks up into clods, irregular both in size and shape. Below a depth of 42 inches the color remains the same but sand and gravel are more abundant and the material is plastic clay. The lower layers are derived entirely from glacial drift, but the surface soil probably owes its tex-

ture to an admixture of loessial material. The thickness of the silt and the content of sand differ in different parts of the county.

Small areas that have been modified by silt deposits or by pockets of sand, usually occurring on the slopes but occasionally on the tops of knolls, have been included with mapped areas of Carrington silt loam. With these exceptions the soil is very uniform throughout its occurrence.

The silty areas occur on a few of the highest knolls on the west side of Buffalo Creek. Here the subsoil materials, instead of being composed of coarse drift, are fine pale-yellow silt containing a very small proportion of very fine sand and no coarse sand or gravel. The entire subsoil is highly calcareous. In the large development of Carrington silt loam in the southeastern corner of the county, the subsoil in many places is much siltier than typical.

Carrington silt loam occurs in a number of areas in the northwestern part of the county and in a few scattered areas in the north-central part. The largest development, however, is in the southeastern corner on the divides east and west of Buffalo and Dry Creeks. The last-described area lies about twice as high as the typical Iowan drift plain. Most of the slopes are long and gentle, insuring good drainage. Almost all this soil is in cultivation. The crops grown and the proportion of the land devoted to each crop are about the same as for Carrington loam. Yields average slightly higher.

CARRINGTON SANDY LOAM

The surface soil of Carrington sandy loam to a depth of about 15 inches is loose, incoherent, and structureless, moderately dark grayish-brown friable sandy loam. The next lower layer, which reaches a depth of 22 inches, is grayish-brown or brown sandy clay loam. This material breaks down into small clods which crush readily. Streaks of dark color penetrating from above form a coating on the clods, and when these are crushed the resulting powder is lighter than the broken surface material. Below this layer and continuing to a depth of 32 inches is structureless yellowish-brown sandy clay loam which contains coarse sand. Dark streaks continue in this layer, and rust-brown iron stains are noticeable in places. Between 32 and 45 inches the material is lighter yellowish-brown sandy clay loam free from dark streaks and contains numerous small gravel and rock fragments.

This soil is uniform throughout the county, with the exception of a few areas, which usually occur on the shoulders of the slopes and are modified by pockets of sand. Carrington sandy loam occurs in many small areas scattered over the uplands within areas of Carrington loam. In the southwestern part of the county the areas are larger and border the stream slopes. The soil occupies slopes or rolling areas where drainage ranges from good to excessive. It is nearly all in cultivation to about the same crops grown on Carrington loam, but yields are lower, except in seasons of exceptional rainfall.

CARRINGTON LOAMY FINE SAND

The surface soil of Carrington loamy fine sand is dark grayish-brown loamy fine sand to a depth of 8 inches. Below this and con-

tinuing to a depth of 22 inches is similar-textured loamy fine sand, the color of which gradually changes with depth from that of the dark surface soil to brown. This layer is underlain by light-brown or yellowish-brown fine sand or loamy fine sand.

This soil occurs in a few small areas in the southeastern part of the county. It has developed over sandy ridges which are outliers of sandy drift deposits that cover extensive areas to the south. The surface soil has been shifted about and modified to some extent by wind.

Areas of this soil have a rolling surface and are susceptible to erosion. The greater part of the land is cultivated, and crop yields are lower than on the heavier Carrington soils. The steeper slopes are kept in grasses to prevent erosion by wind and water.

CLYDE SILTY CLAY LOAM

The surface soil of Clyde silty clay loam ranges in thickness from 10 to 18 inches, but the average is about 12 inches. It consists of black heavy silty clay loam containing a noticeable quantity of fine sand, which is more abundant near the edges of the area, having been washed in from the higher-lying Carrington loam or Carrington sandy loam and spread over the surface. When wet this soil is very sticky, when moderately dry it is friable, and when very dry cracks appear on the surface. The surface layer is underlain by dark grayish-brown or almost black silty clay loam or clay loam which is heavier than the material of the surface layer and is very plastic. The dark color, which is not uniform, is caused by dark organic matter that has penetrated from the surface soil and formed a coating along cracks and over the soil particles. The next lower layer, which occurs between depths of 19 and 33 inches, is grayish-brown or gray silty clay faintly mottled with lighter gray and brown. A few iron concretions and glacial gravel and boulders are present in places. At one time glacial boulders, consisting chiefly of granite, were scattered over the surface. These boulders ranged from 2 to 4 feet in diameter, but a few measured 8 or more feet across. Nearly all of them have been removed from uncultivated fields used for pasture and from fields that are cropped. The lower part of the subsoil, to a depth of 44 inches, is dull yellowish-brown silty clay highly mottled and streaked with gray and some lighter yellowish brown. Glacial gravel and boulders are common at this depth. This material continues to a depth of many feet without marked change.

Several variations from typical occur within areas of Clyde silty clay loam. In the centers of very poorly drained areas, small patches, most of them ranging from 25 to 50 feet in diameter, are covered by accumulations of organic matter, mostly muck, having a maximum thickness of about 6 inches, with an average thickness of 3 inches. Another variation consists of small areas in which an accumulation of soluble salts has become sufficiently strong to injure crops.

Clyde silty clay loam occurs in irregular winding strips or finger-like lobes which extend into all parts of the upland without well-defined drainage channels. The soil occurs mainly in depressions, and drainage was originally very poor. A part of the land has been

improved by tile drainage and a part by surface ditching. More than half the land area, however, is undrained and is utilized only for pasture. The original vegetation consisted of slough grasses and other water-loving plants. At present the better-drained parts are cultivated, mainly to corn. Corn yields from 40 to 60 bushels to the acre and hay from 1½ to 2 tons. Small grains are not grown extensively, as they make too rank a growth and are likely to lodge. The undrained areas are used for hay meadows and pastures.

The land is rather difficult to handle. Under favorable moisture conditions it works up into a mellow seed bed, but when plowed too wet it bakes and forms hard clods. The first step in improving the greater part of the land is to establish better drainage. This can best be accomplished by tile laid closer together than customary. The soil is acid, and lime is highly beneficial.

CLYDE SILT LOAM

The surface soil of Clyde silt loam to an average depth of about 8 inches is very dark grayish-brown or almost black heavy silt loam or moderately fine granular structure. This is underlain to a depth of 18 inches by uniform very dark grayish-brown silty clay loam. When wet both these layers appear deep black. The structure is not well developed, but the material has a tendency under certain moisture conditions to break up into small clods or granules. This layer is underlain to a depth of 27 inches by gray clay loam faintly mottled with brown and dark streaks caused by infiltrations of organic matter from the surface soil. A few faint rust-brown iron stains may be seen in places. This material is structureless, but it breaks up into clods which are irregular both in size and shape. The next lower layer, which continues to a depth of many feet without noticeable change, is yellowish-brown clay loam or silty clay, strongly mottled with orange-brown iron stains and gray spots. Fine sand and boulders may be present throughout the soil, but they are more abundant below a depth of 3 feet. Large boulders were originally scattered over the surface, but most of them have been removed. No lime occurs at any depth, and most of the surface soil is very acid.

Clyde silt loam is rather variable in different parts of the areas in which it occurs. On the borders of many areas the surface soil contains a quantity of sand which has been washed down from the higher loam or sand areas. In a few narrow strips containing from 10 to 20 acres the proportion of the various grades of sand washed down has been sufficient to give a loam texture. The largest areas of this sandy soil are southeast of Lamont and south and southwest of Rowley. The method of utilization of these areas and crop yields obtained are about the same as for typical Clyde silt loam. In other places small areas of Clyde silty clay loam have been included.

Clyde silt loam occupies numerous small constructional flats or swales where the lower-lying areas merge into the uplands. Most of it occurs in association with Clyde silty clay loam, which occupies the lower drainage ways and swales. The soil owes its development to poor drainage conditions. A small part, however, has been drained more or less efficiently by tile drains.

About one-half this soil is under cultivation, and the remainder is used mainly for pasture. When well drained the land is probably as productive of most crops as any soil in the county. Corn is the principal crop, and large yields are obtained. Oats have a tendency to lodge because of the high organic-matter content of the soil. Timothy and clover yield from 1½ to 2½ tons to the acre.

Neither lime nor commercial fertilizer is used to any extent. The use of lime has proved beneficial, particularly as a help in growing legumes. Drainage is the first necessity in the successful handling of this soil. Tile should be laid at intervals close enough to insure quick removal of soil water. The land should be plowed under proper moisture conditions, as when it is plowed too wet it clods badly and makes later cultivation difficult.

DICKINSON SANDY LOAM

Dickinson sandy loam, to a depth of 14 inches, is dark-brown or very dark-brown fine sandy loam or sandy loam. This layer is underlain by brown fine sandy loam or sandy loam to a depth of 19 inches, and this material, in turn, is underlain to a depth ranging from 40 to 50 inches by yellowish-brown or light-yellow fine sandy loam which becomes lighter in color with depth.

Soil of this kind occurs mainly in small areas, widely scattered over the uplands of the county. It may occupy ridge tops or hill slopes. It is closely associated with Carrington sandy loam, from which it differs only in having from 36 to 40 inches of looser sandy material overlying the clay. In places it was difficult to establish exact boundaries between this soil and Carrington sandy loam. Many areas of Carrington sandy loam too small to separate were included.

The land ranges from undulating to rolling and in this respect is similar to the Carrington soils. In the morainic hills south of Rowley the land is more rolling than in other parts of the county. Drainage, owing to the loose incoherent consistence of the subsoil, is at all times adequate and at times is excessive. In periods of dry weather crops are affected, and after prolonged droughts are seriously injured. High winds cause some shifting of the surface soil on freshly plowed and cultivated land before the crops can get sufficiently established.

As areas of this soil are included in farms composed chiefly of Carrington soils, it is difficult to obtain close estimates of crop yields, which, however, are lower than on Carrington loam and slightly lower than on Carrington sandy loam except in exceptionally wet seasons when they may be almost as high as on the heavier soils.

The principal need of this soil is organic matter. The growing and plowing under of legumes or cover crops should be practiced regularly in the rotation. The incorporation of additional humus would greatly increase the moisture-holding capacity of the soil as well as the amount of plant food available. The soil is strongly acid. By proper liming and inoculating practices, alfalfa and clover can be successfully grown.

DICKINSON LOAMY SAND

The surface soil of Dickinson loamy sand is dark grayish-brown fine sand or sand to a depth of 12 inches. It is underlain by a 3 to 6

inch layer of yellowish-brown fine sand streaked with organic infiltrations. This is a transitional layer beneath which the soil between depths of 16 and 72 inches is yellow fine sand, uniform in texture and color. The soil is loose, incoherent, and of low moisture-holding power. Gravel and coarse sand are scattered over the surface of a few small areas.

This soil occurs in small areas, principally in the southern part of the county, mainly on shoulders or hill slopes on the more rolling uplands. Most of the land is cultivated to the common field crops of the region, and yields are low as compared to those obtained on Carrington loam and the better soils of the county.

This soil is droughty and somewhat subject to wind shifting after plowing and early cultivation. It is low in organic matter, nitrogen, phosphorus, and potassium and is strongly acid. The incorporation of organic matter is its first need. Lime should be used where legumes are to be grown. Wind erosion is particularly destructive to young corn plants, as it removes the soil from the roots of some plants and buries others, necessitating replanting. Cover crops should be grown where possible. The soil is better suited to melons and small grains, particularly rye.

DICKINSON LOAM

The topsoil of Dickinson loam to a depth of 10 inches is dark grayish-brown friable loam containing much fine sand. Below this and continuing to a depth of 16 inches is grayish-brown silty clay loam streaked with dark organic infiltrations. This layer is underlain by loose friable dull yellowish-brown sandy loam containing considerable clay. The material gives way, at a depth of 26 inches, to yellowish-brown or light-yellow fine sand containing a small amount of clay and continuing uniform in texture to a depth ranging from 40 to 45 inches. There is considerable variation within areas of this soil. In many places sticky sand containing much clay occurs in the lower part of the subsoil, the material of which is very friable and loose when dry.

Practically all the land is under cultivation, principally to corn, average yields of which are a little less than on Carrington loam. In dry weather this soil is more droughty than Carrington loam, with which it is closely associated. It is handled and farmed in the same manner as Carrington loam.

LINDLEY LOAM

The surface soil of Lindley loam in uncultivated areas is dark grayish brown to a depth of 1 or 2 inches, the dark color being due to leaf mold. This layer is underlain to a depth of about 12 inches by irregularly granular grayish-brown friable loam, stained with a few dark organic infiltrations. In cultivated areas the surface soil is uniformly grayish or yellowish brown to a depth of 12 inches. Underlying the surface layer is grayish-brown or yellowish-brown friable silty clay loam which contains considerable fine sand. Between depths of 17 and 23 inches, the soil is yellowish-brown clay loam mottled with brown and a little gray. A few iron stains occur in this layer. The lower part of the subsoil is light yellowish-

brown clay loam faintly mottled with orange-brown iron stains and containing many reddish-brown iron nodules. Much coarse sand and a few small gravel occur in this layer. In some places the texture of the surface soil varies from typical. A high proportion of silt occurs in part of the areas between Independence and Quasqueton.

Lindley loam occurs in scattered areas throughout the county, principally on slopes adjacent to the larger creeks and rivers, which are or formerly were timbered. The largest areas are between Quasqueton and Independence north of Wapsipinicon River and in the vicinity of Hazelton along Otter Creek and its tributaries.

The land ranges from gently rolling to rough and broken on the steeper stream slopes. Drainage is good and on the steeper slopes excessive. In extremely dry weather, the soil is inclined to be droughty.

Probably 65 per cent of the land is in cultivation to the general farm crops. The soil is handled and cultivated in a similar manner to Carrington loam, but crop yields are lower.

This is a moderately or strongly acid soil. Its color indicates a low organic-matter supply. Lime should be used in growing alfalfa or clovers, to insure a good crop. A definite rotation should include a legume crop. In a short 3-year rotation red clover or sweetclover could be used. Increasing the organic matter will increase crop yields, particularly corn.

LINDLEY SANDY LOAM

The surface soil of Lindley sandy loam is light-brown or light grayish-brown friable sandy loam which has no definite structure. Between depths of 9 and 18 inches the material is light-brown sandy loam, which contains more silt and clay than the top layer. Very faint gray or brown streaks or mottles appear when the soil is moist. The next layer, between depths of 18 and 32 inches, is light-brown heavy plastic silty clay containing a few distinct gray and brown mottles and a few iron stains. A considerable quantity of coarse sand and some gravel are incorporated in the soil mass. The lower subsoil layer, which extends to a depth of 60 or more inches, is uniformly light-brown or yellowish-brown clay or silty clay mottled with gray and yellowish brown. It contains much grit and coarse material, together with numerous iron stains.

The most extensive development of Lindley sandy loam is $2\frac{1}{2}$ miles southeast of Independence on the north hill slopes adjacent to the Wapsipinicon River bottoms. Smaller areas occur southward along the river. Other areas lie northwest of Littleton along the rolling uplands adjoining the Wapsipinicon River terraces and bottoms and along Buck Creek. It also occurs east of Lamont and in small areas scattered along many creeks and their small tributaries.

The land occupies rolling uplands and moderate or sharp stream slopes. More than 50 per cent is in cultivation, but, owing to lack of sufficient organic matter and to droughtiness in dry weather, crop yields are lower than on the darker upland soils. The subsoil is retentive of moisture, and if additional organic matter were incorporated crops would be less affected by dry weather.

All farm crops are grown, but corn is the principal crop. Yields range from moderate to poor. Watermelons, vegetables, and truck

crops do well on this soil. A small part of the land is covered with a scattered timber growth.

Practically no commercial fertilizer is used on this soil. The soil is acid and low in organic matter. Legumes should be used in regular rotation in order to build up the humus content. Lime would be beneficial in securing a stand of legumes. The addition of organic matter would largely prevent surface shifting of the soils by strong winds early in the spring when the fields are freshly plowed and cultivated.

LINDLEY SILT LOAM

Lindley silt loam to a depth of 10 inches is uniformly fine-textured grayish-brown silt loam containing a very high proportion of very fine sand. The subsurface layer is yellowish-brown or grayish-brown light silty clay loam which contains much very fine sand and fine sand. Between depths of 16 and 25 inches, the material is heavier in texture, being yellowish-brown clay loam faintly mottled with brown and a few orange-brown iron stains. The lower part of the subsoil, which extends to a depth of 44 or more inches, is light yellowish-brown gritty clay, highly mottled with yellow, brown, and orange-brown iron stains. Dark reddish-brown iron nodules and streaks occur in many places.

The surface soil varies in texture, ranging from silt loam to fine sandy loam in spots. These textural variations occur in small areas so closely interlaced as to be impossible of separation on a small-scale map. The soil was mapped as silt loam because of the predominantly silty texture of the surface soil, which seems to be of loessial origin.

This is not an extensive soil, being largely restricted to one area 3 miles west of Winthrop, four areas 2 miles north of Quasqueton, and two areas 1½ miles north of Littleton.

The land is gently rolling or rolling. Drainage is adequate and on a few steep slopes is excessive.

Most of the Lindley silt loam is in cultivation to the common field crops. Small fruits and tree fruits do especially well. The land originally supported a luxuriant forest growth. Small patches of timber, consisting principally of oaks with scattered hazel brush, remain, mostly on the steeper slopes.

The topsoil is mellow and easy to plow and cultivate. The same methods of farming are employed as on Carrington loam. The soil is acid, and in a few small level areas on the tops of the divides drainage is somewhat restricted because of the heavy subsoils and slow percolation of moisture.

No commercial fertilizer is used. Some barnyard manure is applied but the supply is inadequate. Organic matter is the chief requirement for the improvement of this soil. Clover should be grown systematically in the rotation and turned under. Soybeans could be profitably grown with corn. The steeper slopes, because of their tendency to erode, should remain in pasture.

LINDLEY SAND

Lindley sand to a depth of 14 inches is loose, open, incoherent, light-brown uniform-textured sand or loamy sand. The next lower material is slightly lighter-brown uniform sand which continues to

a depth of about 18 inches, where it gives away abruptly to light yellowish-brown or light-yellow uniform sand. Pockets of gravel and coarse sand occur in a few places, and small spots of coarser materials occur locally in the upper part of the surface soil.

This is an inextensive soil in Buchanan County and consequently is of minor importance. Included in mapping are small areas of Lindley loamy sand which differ from Lindley sandy loam only in having a little more organic matter in the surface layer to a depth of 10 or 12 inches, and in being finer textured, approaching fine loamy sand. Because of the greater quantity of organic matter in the top layer, this included soil does not shift quite so badly as Lindley sand.

The largest areas of Lindley sand occupy the higher morainal ridges 4 miles south of Rowley and in the southwest corner of Newton Township. One fair-sized area is 4 miles north of Littleton. Only a few small scattered areas occur elsewhere. The included areas of Lindley loamy sand are along Wapsipinicon River.

The general relief is rolling, and the soil is subject to shifting by winds. Drainage, owing to the openness and porosity of the soil, is excessive. On a few gravelly spots and small sandy knobs or knolls, ranging from 50 to 100 feet in diameter, nothing is produced. On the higher knolls wind erosion is active, to some degree, much of the time.

Most of the soil is farmed, but yields are low as compared with yields on the black soils of the county. In extremely dry seasons crops suffer severely from drought. Corn, rye, oats, and a few melons are grown.

The soil is badly in need of organic matter to supply plant food, help conserve moisture, and check wind erosion. Cover crops should be used as much as possible. The soil is strongly acid.

FAYETTE SILT LOAM

Virgin areas of Fayette silt loam are covered by a 2-inch layer of grayish-brown silt loam which contains much very fine sand and is darkened by organic matter. Between depths of 2 and 10 inches the material is single-grain light grayish-brown silt loam containing much very fine sand. Streaks of gray and dark-brown infiltrations have percolated downward along roots. The next layer, which extends from 10 to 16 inches, is yellowish-brown faintly granular but almost structureless very fine sandy clay loam. When moist this layer has a distinct bronze-brown color. Between depths of 16 and 24 inches is yellowish-brown silty clay loam containing some very fine sand. The material of this layer breaks up into coarse irregular structure particles from one-sixteenth to one-fourth inch in diameter, but it does not have the characteristic cube structure of the Clinton subsoils. The next lower layer, which lies between depths of 24 and 36 inches, is light yellowish-brown or light pale-yellow clayey very fine sandy clay loam, which breaks into small irregular thin plates from one-fourth to three-fourths inch in length. A few gray mottles and numerous faint iron stains occur throughout this layer. The next lower layer, between depths of 38 and 60 inches, is light pale-yellow very fine sandy loam. All layers, except the lowest

which is about neutral, are acid or slightly acid. In places the subsoil is heavy yellowish-brown silty clay to a depth of 3 or 3½ feet, resembling the Clinton subsoils.

Fayette silt loam occupies an area of less than 3 square miles in Buchanan County. All the bodies are north, northwest, and west of Quasqueton, within a distance of 4 miles from that town. The area in the north half of section 20 of Liberty Township, those to the north, and an area 2 miles west of Quasqueton, contain a very high proportion of very fine sand and average very fine sandy loam in texture, with many included spots of silt loam. The rest of the soil, which comprises more than half the total area, is predominantly silt loam with some very fine sand in the topsoil and a large quantity of very fine sand in small spots. The surface soils of the silt loam areas are light yellow and the rest of the soil is dull gray. Where in pasture or timberland, the upper part of the surface soil is darker than typical, owing to the presence of organic matter from grass roots or leaf mold.

Areas of this soil were formerly timbered, and considerable timber remains, mostly on the steeper slopes. Oaks, maple, basswood, and other hardwood trees constitute the forest growth. Practically all the area 2 miles west of Quasqueton is timbered.

The land ranges from rolling to hilly, long high ridges with well-rounded shoulders and moderately steep slopes paralleling the stream courses. Although some surface wash takes place on cultivated slopes, erosion is not serious except on a few very steep slopes most of which are in timbered pasture. Drainage is adequate and is excessive on the steeper slopes as a result of surface run-off.

Probably 65 per cent of the land is in cultivation. Corn yields from 30 to 50 bushels to the acre, oats from 30 to 40 bushels, and hay from 1 to 2 tons. Clover does well and in favorable seasons produces heavily. Trees and small fruits are well suited to this soil. A good many cattle are raised on the timbered and pasture areas.

If the organic content of the soil is not maintained, crops are affected in periods of drought. More barnyard or green manures should be used, and the steeper slopes should be kept in pasture or in apple orchards. Contour plowing should be practiced on the slopes to minimize sheet erosion.

Farms composed of this soil vary greatly in value, depending on the gradient, the proportion of land in cultivation, timber growth, buildings, and other conditions.

FAYETTE SAND

The topsoil of Fayette sand to a depth of 10 inches is grayish-brown uniform sand. This is underlain by yellowish-brown or reddish-brown sand which continues to a depth of 18 inches, where it gives way to yellowish or reddish-brown uniform sand extending to a depth of 50 or more inches.

This soil is closely associated with Fayette silt loam and is unimportant because of its small total area. It occurs only in small areas lying from 3 to 4 miles northwest of Quasqueton. Most of the areas border or occupy the lower slopes along Fayette silt loam areas.

The land is rolling and drainage is excessive owing to the openness, porosity, and rolling surface of the soil. Most of the soil is cultivated, but yields are low, even in normal seasons, and crops burn badly during dry periods. The soil is highly acid. Organic matter is badly needed to conserve moisture and furnish plant foods, which leach out rapidly.

THURSTON LOAM

Thurston loam to a depth of 9 inches consists of dark grayish-brown friable heavy sandy loam. Some of the sand is of coarse grades. In some places the surface soil is variable in texture, ranging from loam to very fine sandy loam. Small gravel is scattered over the surface in some places. Below the surface layer is brown or yellowish-brown silty clay loam containing some grit. The structure is rather indefinite but tends to coarsely granular. Below a depth of 18 inches is yellowish-brown fine sand mixed with a few gravel and containing sufficient clay to render it very sticky when wet. At a depth of 26 inches this material passes into gravelly sand which in places is almost pure gravel of assorted sizes.

Thurston loam occurs in small isolated areas within bodies of the Carrington soils. Many small gravelly knolls have not been separated in mapping, as it was impossible to show them on a small-scale map.

Most of the areas of Thurston loam are in cultivation in connection with the closely associated Carrington soils. Owing to the openness and coarseness of the substratum, this soil is droughty except in wet seasons. Crop yields vary according to the rainfall, but they average much lower than on Carrington loam. Gravel for road-building purposes has been removed from many of the knolls, especially the smaller ones.

The sandier areas of this soil should receive special applications of barnyard manure in order to help conserve moisture and supply plant food.

DODGEVILLE LOAM

The topsoil of Dodgeville loam, an upland drift soil, is dark grayish-brown friable loam to a depth of 6 inches. It is underlain by grayish-brown friable loam containing much fine sand and a high proportion of clay. In many places the subsoil is yellowish-brown friable silty clay loam, similar to the Carrington loam subsoil. The comparatively thin soil layers lie on limestone bedrock or marl at a depth ranging from 18 to 30 inches. The limestone substratum is a characteristic of the Dodgeville soils.

Only a few small areas of Dodgeville loam are mapped. Bodies are $2\frac{1}{2}$ miles east of Independence, $1\frac{1}{2}$ miles south of Aurora, and $3\frac{3}{4}$ miles east of Fairbank, and others are widely scattered over the uplands.

Areas of this soil range from gently undulating to sloping, with drainage from fair to good. Practically all the land is in cultivation, except a few spots where limestone outcrops at the surface. It is farmed in connection with Carrington loam with which it is closely associated.

WAUKESHA SILT LOAM

The topsoil of Waukesha silt loam is finely granular dark grayish-brown friable silt loam to a depth of about 10 inches. It is underlain by brown or dark-brown light silty clay loam continuing to a depth of 18 or 20 inches. This layer is colored with dark organic infiltrations from above and is irregular and coarsely granular in structure. The lower subsoil layer, to a depth ranging from 40 to 45 inches, is light yellowish-brown or yellowish-brown uniform silty clay which contains some coarse sand and fine sand but which is free from rock fragments and pebbles.

As a whole this soil is uniform throughout Buchanan County, but a few small included spots have a loamy surface layer. The soils are noncalcareous throughout.

Waukesha silt loam is not an extensive soil. It occurs in small irregular bodies on level terraces from 20 to 45 feet above overflow. Small areas occur along Buck Creek $3\frac{1}{2}$ miles south of Fairbank. Another typical area is located on a high terrace from 40 to 45 feet above the river just west of Quasqueton. Other small bodies occur along Prairie, Buffalo, Buck, Pine, and Otter Creeks and Little Wapsipinicon River.

Natural drainage is good. A few trees fringe the outer edge of some areas.

Crops, yields, and general methods of farming are the same as those on Carrington silt loam of the uplands, and the land is valued about the same. The soil is naturally fertile, has excellent physical properties, and is little affected by seasonal moisture extremes.

The growing and turning under of legumes in systematic rotation would be highly beneficial in maintaining the humus supply. Deeper plowing should also be practiced.

WAUKESHA LOAM

The surface soil of Waukesha loam is finely granular dark grayish-brown friable loam to a depth of 14 inches. The upper subsoil layer, which lies between depths of 14 and 21 inches, is dark yellowish-brown granular friable silty clay loam containing considerable coarse sand and streaked with dark organic infiltrations brought down from the topsoil. The lower subsoil layer, between depths of 21 and 28 or more inches, is yellowish-brown sandy silty clay loam containing a few iron stains. The soil is noncalcareous throughout.

This soil is extensively developed along the larger streams and many of their tributaries, principally Buffalo Creek and Wapsipinicon River. The most extensive areas are in the northwest corner of the county along Little Wapsipinicon River and Buck Creek.

Waukesha loam occupies terraces lying from 8 to 30 feet above the stream bottoms. Areas lying nearest the river usually contain more sand than those farther back, adjoining the upland. On some of the lower terraces, spots of heavier texture, either silt loam or silty clay loam, may occur in small depressions or swales.

The land is almost flat, sloping slightly toward the stream. Drainage is good, except in a few low spots. This soil is little

affected by drought, except in a few small sandy spots. Although the soil is naturally very fertile, it needs more organic matter. Several tests indicated a lime requirement of 2 or 3 tons to the acre. Before the land was cultivated a few trees were scattered over the benches, but the principal vegetation was tall native grasses. Nearly all the soil is now under cultivation, mainly to corn, which yields from 30 to 60 bushels to the acre, depending on the handling of the soil and seasonal conditions. Oats do well, yielding from 30 to 45 bushels to the acre, and hay yields from 1 to 2 tons. Clover ordinarily does fairly well, but liming and inoculating the land would prove profitable.

The soil is mellow and easy to cultivate. It is farmed in conjunction with the closely associated upland or bottom-land soils, the last-mentioned furnishing excellent pasture for livestock.

As the principal need of this soil is maintenance of organic matter, more legumes should be grown in the rotation.

WAUKESHA SANDY LOAM

Waukesha sandy loam is dark-brown sandy loam to a depth of 10 inches, at which depth lighter-brown lighter-textured sandy loam occurs. At a depth of 20 inches this layer passes into a sandy clay or clayey sand layer 8 or 10 inches thick. These lighter-textured layers overlie yellowish-brown or yellow friable silty clay loam which lies at a depth ranging from 28 to 34 inches.

This is an unimportant soil, occurring only in a few small areas scattered along Wapsipinicon River. A typical area is 6 miles southeast of Quasqueton on the west side of Wapsipinicon River.

Areas of this soil are flat, and drainage, because of the looseness and openness of the surface soil, ranges from good to excessive. Because of the sandiness of the upper layers, drought affects crops somewhat during dry periods, as the heavier silty clay subsoil lies at too great a depth to prevent drying out of the sandier surface layers. The land occupies terraces lying from 10 to 15 feet above the bottom lands and it is not subject to overflow.

All the land is in cultivation, and crop yields average less than on Waukesha loam.

O'NEILL FINE SANDY LOAM

The topsoil of O'Neill fine sandy loam to a depth of 8 inches is dark grayish-brown sandy loam. The subsoil between depths of 8 and 15 inches is grayish-brown sandy loam streaked with a few organic infiltrations. The next lower layer is yellowish-brown sand, extending to a depth of 29 inches. This is underlain by light yellowish-brown or yellow uniform sand. The soil is noncalcareous throughout.

This is a fairly extensive soil occurring in small irregular-shaped areas along Wapsipinicon River and all the creeks. It occupies flat terraces, lying well above overflow. The surface is generally flat but has been somewhat modified in many areas by wind erosion, and it occurs as shallow ridges. Owing to the openness and sandiness of the soil, drainage is thorough, and in periods of drought crops are likely to be injured.

Most of the land is farmed. Corn is the principal crop, and some oats, rye, and hay are grown. Crop yields are about the same as on O'Neill sandy loam, probably slightly higher.

Very little commercial fertilizer is used, and the supply of barnyard manure is inadequate. As most of the soil is badly in need of organic matter, green-manure crops should be grown and turned under. Legumes can be grown by liming and inoculating. Commercial fertilizers used in an experimental way have proved profitable.

O'NEILL SANDY LOAM

The topsoil of O'Neill sandy loam to a depth of 4 inches is dark grayish-brown sandy loam containing much fine sand. This is underlain to a depth of 18 inches by grayish-brown sandy loam which contains some small pieces of gravel. The next lower layer, which lies between depths of 18 and 28 inches, is yellowish-brown or yellow coarse sandy loam or loamy sand containing much coarse sand and some small gravel. The soil is strongly acid. The layers described overlie coarse yellowish-brown sandy gravel. The texture of the surface soil ranges from fine sandy loam to gravelly sandy loam. The depth to gravel may range from 18 to 30 or more inches.

This is a fairly extensive soil, being developed along all the larger streams. It occupies almost flat terraces ranging from 15 to 40 feet above overflow. The largest areas are about 1 mile east and 4 miles north of Otterville, an extensive area is northwest of Hazelton on the west side of Otter Creek, and others occur in disconnected strips along all the larger streams.

The surface is nearly flat, with here and there slight swells and shallow depressions, caused by deposits from streams flowing from the upland and dissecting the benches or formed by wind shifting. Drainage is thorough. The soil is strongly acid.

Nearly all of the land is cultivated to the common field crops, especially corn, which yields from 20 to 40 bushels to the acre, depending on seasonal moisture. Oats yield from 15 to 35 bushels. Rye, sorghum, cane, and some Sudan grass are grown. Melons and truck crops are well suited to this soil, but only small patches are grown. Where special care is given to fertilizing with barnyard manure, crop yields are greatly increased.

Because of the strong acidity of the soil, it is difficult to get a good stand of clover. The soil should be limed and inoculated for legumes. The soil is badly in need of organic matter, as rapid leaching and oxidation quickly destroy and remove plant foods. Green-manure crops should be grown and turned under. A roller or subsurface packer has proved beneficial in conserving moisture. The openness of the soil allows rapid escape of soil water, causing severe damage in droughty weather. Corn fires badly in long dry periods.

O'Neill sandy loam, light-colored phase.—The surface soil of O'Neill sandy loam, light-colored phase, is grayish-brown or dark grayish-brown friable sandy loam to a depth of 16 inches. In timbered areas faint gray mottles and faint reddish iron streaks are present. The subsoil is yellowish-brown friable sandy clay loam containing a few faint gray and brown mottles. Much grit and a few gravel occur in this layer, which is 6 or 8 inches thick. The next

lower layer, between depths of 23 and 32 inches, is light yellowish-brown sandy silty clay loam or clayey sand highly mottled with yellowish brown and numerous iron stains. This layer also contains a few gray mottles and much coarse sand and gravel. These layers overlie a bed of stratified gravel. The soil is noncalcareous throughout.

Soil of this phase is very inextensive. It occurs in small areas, principally along Wapsipinicon River and Buffalo and Otter Creeks. Most of them are flat, though a few billowy ridges are scattered over the surface. In a few places the gravel substratum comes within 12 inches of the surface. This phase of soil differs from typical O'Neill sandy loam only in its lighter-colored surface soil. It is inclined to be droughty.

All the land is in cultivation and is cropped similarly to O'Neill sandy loam, producing about the same yields.

As the soil is low in humus, it needs heavy applications of barnyard manure. Legumes should be grown and turned under to improve the physical condition of the soil and to aid in the conservation of moisture.

O'NEILL LOAM

The surface soil of O'Neill loam, to a depth of 10 inches, is friable, granular, dark grayish-brown or very dark-brown loam which when wet appears almost black. The subsoil between depths of 10 and 14 inches is brown clay loam containing much grit, and it is practically structureless though it breaks out into coarse clods. The next lower layer, which extends to a depth of 28 inches, consists of practically structureless light-brown gritty clay loam containing much coarse sand and a few small gravel. Below this is a layer from 4 to 6 inches thick of clayey coarse sandy assorted gravel. A bed of stratified assorted gravel and coarse sand underlies these layers. Along some of the larger streams the substratum of small areas of this soil consists of loamy sand or sand.

O'Neill loam is widely developed along all the streams of the county. The largest area is $1\frac{1}{2}$ miles southwest of Hazelton. The soil is extensively developed along East Branch and West Branch Buffalo Creeks and along Buffalo Creek. Along the smaller streams the gravel bed usually lies at a depth ranging from 40 to 50 inches, and the lower layer of the soil is gravelly gritty clay loam.

This soil occupies flat benchlike areas or terraces lying from 3 to 30 feet above overflow. It occurs in narrow disconnected strips, many of which are cut through by small drainage channels issuing from the uplands.

Owing to the openness of the substratum, drainage is good. In places where the gravel bed lies near the surface, the soil is seriously affected by drought. In average seasons, when the rainfall is well distributed, crops do well on this soil. On the higher-lying benches, where the water table is lower, crops are likely to be injured during prolonged droughts.

Almost all the land is under cultivation, and about 10 per cent is in pasture. Corn, which is the principal crop, yields from 25 to 50 bushels to the acre; oats from 25 to 40 bushels, depending on seasonal conditions; and hay from 1 to $1\frac{1}{2}$ tons.

This is an easy soil to handle and farming methods used are the same as on the upland soils. There are practically no trees, with the exception of a few scattered along the outer edge of some of the lower terraces just above the bottom lands.

The organic-matter supply should be carefully looked after especially on the higher-lying benches, which are most affected by drought. Clover ordinarily does fairly well in some seasons, but this crop is subject to more or less winterkilling. The soil is acid, and liming and inoculation would greatly aid in obtaining a healthy stand of legumes.

O'Neill loam, light-colored phase.—The surface soil of O'Neill loam, light-colored phase, consists of gray or grayish-brown smooth loam containing much very fine sand and silt to a depth of 6 inches. This grades into yellowish-gray sandy loam or fine sandy loam containing considerable coarse sand. From 20 to 24 inches the material is coarse and gravelly mixed with coarse loamy sand. This layer rests on a thick stratified gravel layer containing considerable coarse sand.

This light-colored soil varies greatly, from place to place, in the texture of the surface soil. Areas having a floury silt loam surface soil with proportionately more clay and silt in the subsoil overlying the gravel substratum are 1 and 1½ miles southwest of Aurora on East Branch Buffalo Creek and 6 miles north of Winthrop on Buffalo Creek. Other small areas which are loamy in texture, ranging from very fine sandy loam to sandy loam, lie one-half mile north of Hazelton and 4 miles north of Winthrop.

This soil is very inextensive and consequently unimportant. Only a few small patches are in cultivation, mainly to corn; the remainder is in timber and pasture. All the land was originally timbered with oak, hickory, elm, basswood, and other native hardwood trees.

The soil occupies flat terraces, some of which slope perceptibly toward the stream. Drainage is good, and, despite the gravelly substratum, all except the sandy spots seem retentive of moisture under cultivation.

As the light-colored surface soil indicates a low organic-matter content, the incorporation of green-manure crops and heavier applications of barnyard manure are needed.

O'NEILL LOAMY SAND

O'Neill loamy sand occurs in only a few small areas, principally along Buffalo Creek. It differs from O'Neill sandy loam only in surface texture. Coarse sand and gravel occur in many places on the surface. The subsoil overlying the gravel substratum is about the same as that under O'Neill sandy loam, except in the upper part, which is a little sandier.

Areas of this soil are somewhat more droughty than O'Neill sandy loam areas. The content of plant food is low, and organic matter is badly needed.

BREMER LOAM

The topsoil of Bremer loam to a depth of 9 inches is finely granular very dark grayish-brown or black friable loam which contains a high

proportion of clay. Below this, and extending to a depth of 17 inches, is structureless, heavy, plastic, grayish-brown silty clay loam or clay loam. This layer is underlain by heavy, intractable, gray clay loam or silty clay, mottled with a few yellowish-brown and a few iron stains. The next lower layer, between depths of 26 and 40 inches, is light yellowish-brown sandy silty clay loam highly mottled with gray and orange brown.

The surface soil of Bremer loam is fairly uniform in texture, but a few heavier spots of silt loam or silty clay loam occur in shallow narrow swales too small to separate on the map. In places, at a depth ranging from about 30 to 36 inches, sticky light-yellow sand is present.

This is not an extensive soil. All the areas are small. The largest single area is $1\frac{1}{2}$ miles southeast of Fairbank along Little Wapsipinicon River. A number of other bodies are scattered along Wapsipinicon River and Buck Creek.

This soil occupies the higher terraces which are from 25 to 40 feet above the floor of the bottom lands. Most of them lie at the back of the terraces in flat or slightly depressed situations. Surface drainage is good, but owing to the heavy subsoils, internal drainage is restricted.

Practically all the land is in cultivation to common field crops, and yields compare favorably with those on Carrington loam, except in wet seasons. The soil is fertile, but it needs more organic matter. Legumes should be planted regularly in the rotation. No commercial fertilizer is used.

BREMER SILT LOAM

The topsoil of Bremer silt loam is dark grayish-brown heavy silt loam 10 inches thick. It is underlain by very dark grayish-brown clay loam, containing a few faint iron mottles in the lower part of the layer. The next lower layer, which lies between depths of 22 and 38 or more inches, is dull-gray clay loam or silty clay loam, faintly mottled with brown and a few faint iron stains.

The texture of the surface soil is heavy, in most places approaching silty clay loam. As in many black soils having a normally high clay content, it is difficult to distinguish between Bremer silt loam and Bremer silty clay loam when the soil is wet. Shallow ridges having a loamy texture occur in some areas.

Bremer silt loam occupies terraces well above overflow and occurs also in small isolated irregular bodies. The areas are flat, causing poor surface drainage, and the heavy subsoil causes restricted underdrainage.

Areas occur along Wapsipinicon River and along most of the creeks and their larger tributaries. The soil usually occupies depressions at the back of the terraces as does Bremer silty clay loam. Many short drainage lines from the uplands empty into these depressions or cut shallow channels through them to the master stream.

Probably 65 per cent of the land is under cultivation, the remainder being used for pasture or hay land. Some wild hay is cut from this soil and from Bremer silty clay loam. Corn and hay yield particularly well. Oats produce good crops except in wet seasons, when they are likely to grow rank and lodge. The land is always

farmed with associated terrace or upland soils. It is highly productive when well drained and well farmed. It warms up slowly in the spring, but the natural high fertility causes rapid crop growth.

Better drainage is needed on most areas of this soil. The heavy subsoil retards the downward percolation of water, and, on account of the flat and depressed surface, crops are likely to be injured in wet seasons.

BREMER SILTY CLAY LOAM

The 8-inch surface layer of Bremer silty clay loam is almost structureless dark grayish-brown or black heavy silty clay loam which has a tendency to break up into small clods. Between depths of 8 and 17 inches the material is dark grayish-brown or almost black tough plastic silty clay or silty clay loam. The next lower layer, between depths of 17 and 25 inches, is dull grayish-brown silty clay mottled faintly with brown and gray and a few iron stains. Below this layer is yellowish-brown or gray silty clay deeply mottled with gray and some yellowish brown. Many iron stains, increasing in number with depth, are present in this layer which extends beyond a depth of 38 inches. The soil is not calcareous.

Spots in which the texture of the surface soil is silt loam are included. Where the soil adjoins the uplands, wash consisting of fine sand and coarse sand occurs on the heavier surface soils. In many such places the surface soil, to a depth ranging from 2 to 4 inches, is loam in texture.

Areas of Bremer silty clay loam are widely scattered. Most of them occur in small oblong bodies in depressions at the back of the terraces nearest the uplands. The surface is flat or depressed, and natural drainage is poor. Along Wapsipinicon River the areas lie on higher benches from 30 to 40 feet above the bottoms.

More than 50 per cent of the land has been under cultivation. At present very little of it is tilled. The fertility is high, and with sufficient underdrainage and proper management the land is highly productive. This is a particularly strong corn soil, and, when drained, it produces heavy crops of hay. Small grains tend to grow rank and lodge. Corn yields from 35 to 60 bushels to the acre on the better-drained areas, and hay yields from 1½ to 2½ tons.

Adequate drainage is the first requirement for maximum crop production. The application of barnyard manure and the growing and turning under of legumes would greatly improve the tilth of the soil and thus increase crop yields.

SPARTA FINE SAND

The 6-inch surface layer of Sparta fine sand is grayish-brown uniform fine sand or sand. This passes into yellowish-brown or yellow uniform fine sand. The lower subsoil layer, between depths of 14 and 50 or more inches, is light-yellow uniform fine sand or sand.

The texture of the surface soil varies considerably, ranging within the same area from sand to loamy sand or fine sand. At a depth of 6 or 7 feet the gravel beds of the geologic formation known as Buchanan gravel are reached.

This is an inextensive soil. It occurs in small disconnected areas, principally along Wapsipinicon River and Otter Creek, where it occupies high terraces from 30 to 40 feet above the stream channel. The flat surface is modified here and there with low narrow wave-like ridges of aeolian formation. At the edge of the benches the soil materials are coarser, containing much coarse sand and some gravel.

Drainage is excessive and crops suffer from drought in dry seasons. Most of the land is used for crop production, mainly corn, and yields are low except in wet seasons. The soil is suited to truck crops and melons, though very few are grown at present. The land requires the same treatment as Bertrand sandy loam.

BERTRAND SANDY LOAM

Bertrand sandy loam to a depth of 6 inches is grayish-brown sandy loam. This is underlain by light grayish-brown or yellowish-brown sandy loam or loamy sand. The lower subsoil layer, between depths of 15 and 40 inches, is light yellowish-brown loamy sand containing a few faint gray mottles and iron stains. This soil differs from O'Neill fine sandy loam chiefly in having a light-colored surface soil.

The texture of the surface soil is modified in some small areas, the material being mixed with coarse sand and some gravel. Most of these spots are on the tops of shallow billowy ridges scattered here and there throughout the areas. In a few depressions the surface soil approaches loam in texture.

The land, except for the few ridges formed by wind or water action, is flat. The soils lie well above overflow on terraces, usually from 10 to 40 feet above the bottom lands.

Areas of this soil occur principally in the vicinity of Otterville and north of that place along Otter Creek. A few bodies lie along the southern course of Wapsipinicon River, along Maquoketa and Buck Creeks, along Little Wapsipinicon River, and along Wapsipinicon River northwest of Otterville.

Included with this soil because of its small total area is a soil very similar to Jackson sandy loam. To a depth of 10 inches this included soil is grayish-brown sandy loam, with a few pebbles scattered over the surface. Between depths of 10 and 16 inches is friable grayish-brown sandy silty clay loam, which is very sticky when wet. The next lower layer, between depths of 16 and 32 inches, is brown or yellowish-brown tough plastic silty clay loam, containing much grit. Below this is yellowish-brown fine sand or sand. In some places the heavier sticky subsoil is not reached within a depth ranging from 24 to 30 inches. The only areas of this included soil occur 1 mile east of Independence and along Wapsipinicon River 2 miles west and 2½ miles northwest of Quasqueton. They are not quite so droughty as typical Bertrand sandy loam in dry periods, and consequently they have a slightly higher yielding capacity. They are equally in need of organic matter.

Nearly all the land is in cultivation, mainly to corn, which yields from 20 to 40 bushels to the acre, depending on seasonal moisture. Small grains do well in seasons of well-distributed rainfall, and hay yields average about 1 ton to the acre. Very little of a former scattered timber growth remains. Owing to the looseness of the soil,

drainage is thorough. In periods of drought crops suffer considerably because of the poor moisture-holding qualities of the soil.

The soil is mellow, loose, and easy to cultivate. The organic content is low, and the soil is acid. The limestone requirement ranges from 2 to 4 or more tons to the acre. Green-manure crops are badly needed to supply the deficiency of organic matter. Legumes should be grown in the rotation, and good stands should be obtained with proper liming and inoculation. The barnyard manure available is inadequate to keep up the organic matter.

BERTRAND LOAM

The 4-inch surface layer of Bertrand loam consists of grayish-brown friable loam containing much very fine sand. It is underlain to a depth of 13 inches by light-brown friable loam which also contains much very fine sand. The next lower layer, between depths of 13 and 19 inches, is light grayish-brown very fine sandy loam containing a high proportion of silt. This layer is underlain by yellow very fine loamy sand containing enough silt and clay to make it very sticky when wet. At a depth ranging from 5 to 6 feet this material is underlain by sand and gravel. The soil is noncalcareous throughout.

Most of this soil occurs in small areas north of Otterville along Otter Creek and along Little Wapsipinicon River in the northwest corner of the county, and a few areas lie along Wapsipinicon River and its larger tributaries.

Included with this soil in mapping are a few small areas of Jackson loam which differs from Bertrand loam in having a heavy yellowish-brown gritty silty clay loam subsoil. The texture of the surface soil ranges from floury loam to sandy loam with a high proportion of silt in places and much sand in others, the loam texture predominating. Practically all of this soil occurs along short tributaries of Wapsipinicon River from 1 to 4 miles northwest of Quasqueton. This included soil is low in organic matter and has about the same cropping value as typical Bertrand loam in normal years. It is, however, less droughty in prolonged dry periods.

Areas of Bertrand loam occupy flat terraces, most of which lie back from the stream near the uplands. Drainage ranges from thorough to excessive, owing to the open, porous subsoils. The land was originally forested with hickory, oaks, ash, and other hardwood trees. At present most of it is cleared and in cultivation to the staple crops. The remainder is used for pasture. Corn yields from 25 to 45 bushels to the acre, oats from 25 to 35 bushels, and hay does well.

The soil needs organic matter in order to improve its moisture-holding capacity and furnish nitrogen, which it lacks.

JACKSON SILT LOAM

The topsoil of Jackson silt loam, to a depth of 12 inches, is grayish-brown or light grayish-brown floury silt loam containing much very fine sand. Below this is gray heavy silt loam or silty clay loam mottled faintly with gray and brown. The next lower layer, which lies between depths of 20 and 26 inches, is grayish-brown or brown-

ish-gray silty clay loam mottled with gray and brown. Underlying this layer to a depth of 40 or more inches is light-yellow clay loam or silty clay loam faintly mottled with brown or yellow.

Nearly all this soil occurs in small areas on flat terraces along small tributaries on the east side of Wapsipinicon River, extending 4 miles northwest of Quasqueton. Where the soil adjoins the upland soils, it is more or less colluvial in origin, and some fine sand and coarse sand are washed over the surface. Surface drainage is good, but underdrainage is inclined to be restricted.

All the land is farmed. Corn yields from 25 to 40 bushels to the acre, oats from 30 to 40 bushels, and hay from 1 to 1½ tons.

This soil is rather low in humus and needs the incorporation of legumes in the regular rotation in order to increase the organic-matter content.

WABASH SILTY CLAY LOAM

The 8-inch surface layer of Wabash silty clay loam consists of coarsely and irregularly granular very dark grayish-brown or black heavy sticky silty clay loam. This is underlain by similar-structured very dark grayish-brown or almost black silty clay or clay loam, continuing to a depth of 20 inches. The next lower layer, between 20 and 30 inches, is structureless grayish-brown or dark grayish-brown silty clay mottled with orange, gray, and brown iron stains. Below this layer and extending to a depth of 45 or more inches is heavy tenacious gray or dark-gray silty clay mottled with brown and orange-brown iron stains and containing considerable grit and a few small gravel.

This soil is widely developed along the first bottoms of the smaller creeks and their tributaries, where drainage is restricted. It occupies depressed sloughs and basinlike areas at the outer edge of the flood plain along the larger streams. Along the smaller streams it extends to the stream banks, where the meandering channels have cut to a depth of only a few feet, barely affording drainage for the flood plain lying more than 5 or 6 feet away from the stream.

On account of its poor natural drainage, owing to its occurrence in depressions, and its heavy intractable soils and subsoils, much of the land remains in a swampy condition for long periods. Consequently small areas of peat or muck have developed on the surface of former ponds. This cumulose soil is shallow, rarely more than 4 to 6 inches thick, and occurs in only a few places.

All the land is subject to overflow during periods of excessive rainfall. Only a few small patches, probably not more than 5 per cent of the total area, are under cultivation. The land supports a heavy growth of coarse grasses, which furnish pasture for adjoining farms. A little wild hay is cut. Although this soil could be artificially drained, this would probably not be economical at present.

The soil is high in natural fertility. Owing to the heavy texture and plasticity of the topsoil, care must be taken in plowing and cultivating the land in order to prevent clodding and baking. Adequate drainage is the first need of these soils.

WABASH LOAM

Wabash loam to a depth of 12 inches is dark grayish-brown or black friable loam. Underlying this material is dark grayish-

brown or almost black silty clay loam containing much fine sand. The next layer, between depths of 19 and 28 inches, is dark grayish-brown clay loam or silty clay, mottled faintly with brown and a few iron stains.

As with all bottom-land soils, many variations from typical occur throughout the soil. Many areas of other soils, too small to map separately, have been included. In depressed areas, usually lying at the outer edge of the flood plain, small silty clay areas are included. Near the banks of streams or along old stream channels or cut-offs, the texture in many places is fine sandy loam or sandy loam, and this texture may continue to a depth of 3 or 4 feet. Ridges of sandy materials having a sandy substratum would have been mapped as members of the Cass series if they could have been separated.

This is the most extensive bottom-land soil in Buchanan County. It occurs along all the principal streams and their tributaries. Along Wapsipinicon River it occupies small disconnected areas at the back of the bottom lands beyond the sandier soils lying nearest the river. It extends in ribbonlike strips, ranging in width from a few hundred feet to a quarter of a mile, along the larger creeks and their tributaries.

Included with Wabash loam are a few small areas of Wabash fine sandy loam which differ from Wabash loam only in having a higher proportion of fine sand in the surface soils. Practically all this included soil lies along Buffalo Creek and is used as pasture land.

The surface of Wabash loam is almost flat, sloping slightly toward the streams. Along Wapsipinicon River and the larger creeks the relief is broken by old isolated channels, oxbows, sloughs, and shallow flats, which are filled during high water and remain ponded most of the year.

Only about 15 per cent of this land is in cultivation. The soil is rich and produces crops equal to those obtained on the best upland soils, if they are not harmed by flood waters. However, the flood hazard minimizes the average crop return, so that extensive cultivation is unprofitable. The land affords fine pasture and is used as such.

WABASH SILT LOAM

The 10-inch topsoil of Wabash silt loam is dark grayish-brown or almost black silt loam containing some fine sand. The subsoil, between depths of 10 and 19 inches, is dark-brown or almost black silty clay loam, uniform in color but becoming slightly heavier in texture with depth. The next lower layer, between depths of 19 and 28 inches, is dark grayish-brown silty clay containing a few iron mottles and streaked somewhat with organic infiltrations brought down from the humus above. The lower subsoil layer, which extends from a depth of 28 to 40 or more inches, is heavy plastic gray silty clay mottled in many places with yellow and brown and with iron stains, all of which become more numerous with depth.

As in all bottom-land soils which are subject to periodic overflow and reworking, the texture of the surface soil varies considerably from place to place. Included in mapping are small depressed poorly

drained bodies and narrow strips of silty clay loam too small to separate.

This soil occurs almost entirely in the southeastern part of the county along Buffalo Creek and a few small tributaries. A few areas lie along Prairie Creek in Fremont Township.

This soil covers only a small total acreage. It extends in narrow strips along the flood plains. Drainage ranges from fair to poor. Scattered clumps of trees grow, mainly along Buffalo Creek, but other areas support only a rank growth of native grasses.

Only a few small patches are cultivated, practically all of which are planted to corn. The land is used almost entirely for pasture, which affords excellent grazing. Because of frequent overflows the land is best suited for grazing purposes.

CASS SANDY LOAM

The 9-inch topsoil of Cass sandy loam is dark grayish-brown sandy loam, containing much fine sand. Between depths of 9 and 16 inches the material is grayish-brown loamy sand which is underlain by lighter grayish-brown or yellowish-brown loam or sand. The next lower layer, between depths of 39 and 45 or more inches, is yellowish-brown coarse sand containing many rock fragments one-sixteenth inch and less in diameter.

A few small areas of Cass fine sandy loam were included in mapping. Most of these lie along the lower course of Buffalo Creek. They differ from the typical areas only in their loamier surface soil which contains a higher proportion of fine sand. None of the fine sandy loam is cultivated but is all in pasture.

The total extent of Cass sandy loam is 7.5 square miles. The soil is of alluvial origin, consisting of glacial materials washed from the uplands and deposited by flood waters. It is now subject to periodic overflow, being completely inundated at times.

Although the areas are almost flat, with small pockets, depressions, and shallow ridges, the texture of the surface soil varies and may be silty clay loam, silt loam, or assorted sandy materials. Originally the land was forested with walnut, willow, oak, elm, and a few other hardwood trees. Clumps of these trees are now found mainly bordering the stream channels. Drainage is good.

Cass sandy loam is extensive along Wapsipinicon River and Otter Creek, and small areas lie along Buffalo Creek, Little Wapsipinicon River, and nearly all the larger creeks.

The land is used mainly for pasture, for which purpose it is best suited. Corn is the principal cultivated crop. Owing to the high water table, the soil is not seriously affected by drought, except some spots of loamy sand or sand. Corn and small grains do well where not injured by floods. The streams flowing through this land afford good water for livestock.

CASS LOAM

The surface soil of Cass loam to a depth of 8 inches is dark-brown or almost black friable loam containing much sand and fine silt. The structure is granular, the particles being one-tenth inch and less in diameter, with a few larger ones. Below this layer and extending

to a depth of 15 inches is dark-brown structureless fine sandy loam. The next lower layer, between depths of 15 and 18 inches, is brown fine sandy loam or loamy sand, discolored with dark streaks or organic filtrations. Below this layer and extending to a depth of 38 inches is yellowish-brown sand containing a few streaks of lighter or slightly darker sand. Underlying these layers is grayish-brown coarser sand.

In depressed areas, where the strong currents during high-water periods do not penetrate, small bodies of silt loam have been included in mapping. Narrow strips of Cass sandy loam from 10 to 20 feet in width, skirting the stream channels along old cut-offs and oxbows, are also included. Some lighter-colored silts and very fine sands cover or are mixed with the typical soil, principally along the outer edge of the bottoms where the river has cut deeply through the high light-colored loess hills between Independence and Quasqueton.

Cass loam covers a small total area in Buchanan County. It occurs chiefly along Wapsipinicon River. Other small bodies and narrow ribbonlike strips lie along Bear, Lime, Otter, Buck, and Buffalo Creeks and Little Wapsipinicon River.

The surface is generally smooth, broken only by a few old stream beds with shallow ridged banks. The bottoms occupied by this soil were originally forested with walnut, ash, willow, cottonwood, and a few other hardwood trees. Only scattered groves and thin fringelike groups are left, largely along the stream banks. A luxuriant growth of native grasses covers the surface and furnishes excellent pasturage. Drainage is good. Owing to the high water table, little trouble is experienced with droughts.

Probably 12 per cent of the land is in cultivation, mainly to corn, which is grown for a period of years on the same ground without appreciable decrease in yield. It yields from 40 to 65 bushels to the acre in favorable seasons.

SARPY FINE SANDY LOAM

The surface soil of Sarpy fine sandy loam to a depth of 18 inches is uniform light-brown fine sandy loam containing much very fine sand. It is underlain to a depth of 25 inches by lighter-brown fine sandy loam or loamy sand which is uniform both in color and texture. The lower subsoil layer, which continues to a depth of 40 or more inches, is light yellowish-brown or yellow incoherent sand.

The surface soil and subsoil vary greatly in texture. Thin layers of coarse sand, gravel, and in some places silt may be present at almost any depth in the soil. A small gravelly sand area is in the southeast quarter of section 23, Cono Township. Other gravelly spots, most of which occur as small pockets or ridges, are scattered throughout the areas of this soil.

This is an inextensive soil. Practically all of it is covered with a scattered timber growth. It occurs along Wapsipinicon River between Quasqueton and the south county line.

Only a few acres are under cultivation, the land being used principally for pasture. It supports only a thin grass growth and is barren on the gravelly spots. The soil is inclined to be droughty in spite of its high water table.

GENESEE FINE SANDY LOAM

Genesee fine sandy loam to a depth of 12 inches is light-brown or yellowish-brown fine sandy loam. This is underlain by light yellowish-brown fine sandy loam containing a high proportion of silt. At a depth of 18 inches the material grades into loam in which both silt and fine sandy loam layers occur. This lower subsoil layer varies considerably in texture. It is more or less layered, but in most places it is more compact than the topsoil. Along stream banks the materials are usually coarser and sandier, the subsoil being of about the same texture as the topsoil.

This soil occurs along Wapsipinicon River, particularly along its lower course. It is inextensive and the areas are small, broken, and irregular and are mixed with other bottom-land soils. A small body is mapped at the point where Maquoketa Creek leaves the county, in the northeast corner. Here the surface soil is darker than typical.

Most of the land is in cultivation. The principal tree growth consists of a thin, scattered covering of walnut, oak, ash, and red haw. Owing to frequent reworking by water and the subsequent shifting and deposition of coarse and fine materials in shallow ridges, the surface is rather uneven. The land is subject to periodic overflow and is all used for pasture.

MUCK AND PEAT

The muck and peat soils, as mapped in Buchanan County, consist of an accumulation of fibrous organic materials in different stages of decomposition. These soils have formed, under poor drainage conditions, in low upland areas or undrained sloughs where water formerly stood throughout most of the year. The original materials were water-loving plants and grasses, which, through subsequent growth and decay, have formed a light, porous spongy vegetable mat, ranging in thickness from a few inches to several feet. In places where the vegetable matter is highly decomposed the soil is black, and the particles are so finely divided that the original plant remains are not discernible. The surface soil to a depth of 9 inches is black mucky material, sticky when wet and light and fluffy when dry. Below this layer, and continuing to a depth of 16 inches, is similar soil containing some reddish-brown material, which is more fibrous peaty material not fully decomposed. This material extends to a depth of 3½ feet or more and is underlain by grayish-brown or gray silty clay mottled with gray and some brown and a few iron stains and nodules. Considerable fine sand and coarse sand occur in many places in the heavy subsoil.

Muck and peat areas are closely associated with the Clyde soils, occurring in small patches from 2 to 6 inches deep within areas of Clyde silt loam and Clyde silty clay loam. In Buchanan County only a few scattered areas are large enough to map separately. Most of them occur along the bottoms of small tributary streams whose channels have cut only from 1 to 3 feet below the surface. The largest body is 3 miles southeast of Fairbank. Several small areas are about 3 miles northeast of Littleton, and one is 2 miles northwest of Lamont.

All the muck and peat land is used for pasture at present. It supports a rank growth of coarse native grasses. These soils are particularly suited to special truck crops, such as onions and celery. Good crops of corn can be grown, but small grains are likely to grow too rank and lodge. Timothy hay makes an excellent growth. Where the land is pastured, cattle prove a valuable aid in compacting the soils and hastening decomposition. Potash is beneficial to cultivated crops. The muck and peat areas can be reclaimed by drainage.

SUMMARY

Buchanan County is in the eastern part of Iowa about 135 miles from Des Moines, the State capital. It includes an area of 567 square miles, or 362,880 acres.

The relief ranges from gently undulating to gently rolling, which is typical of the Iowan drift region. High rolling or steeply rolling loessial hills between Quasqueton and Independence form less than 1 per cent of the area of the county. The alluvial lands are well developed and are characterized by rather narrow first bottoms and wide flat terraces.

Although regional drainage is generally well established, many small, depressed, poorly drained areas are scattered over the uplands. The greater part of the county is drained by Wapsipinicon River and its tributaries. Except in the southwest quarter, where the streams flow southwesterly, drainage is toward the southeast.

The population of the county, according to the 1920 United States census, is 16,218, of which 81.5 per cent is rural. In that year Independence, the county seat, had a population of 3,672.

The climate is well suited to general farming and livestock raising. The mean annual precipitation is 31.94 inches, and the mean annual temperature is 47.4° F. The average frost-free period is 149 days.

The raising of hogs and cattle, together with dairying, is the principal source of farm income. Corn is the principal grain crop, and oats rank second.

The selling price of land ranges from \$75 to \$200 an acre, depending on improvements, roads, location, and other features.

The soils of Buchanan County, although they range widely in texture and crop-producing power, are predominantly dark-colored loams, high in natural fertility and productive power. Dark-colored soils of glacial origin predominate. The glacial upland soils having dark-colored topsoils are grouped in the Carrington, Clyde, Dickinson, Thurston, and Dodgeville series. Light-colored drift soils of the uplands are members of the Lindley series; those of loessial origin belong to the Fayette series. The dark-colored alluvial soils of the second bottoms or terraces are included in the Waukesha, O'Neill, and Bremer series; and the light-colored soils are represented by members of the Sparta, Jackson, and Bertrand series. The dark-colored first-bottom or overflow soils are the Wabash and Cass soils, and the light-colored ones are the Genesee and Sarpy soils.

Carrington loam is the most extensive soil in the county. The Carrington soils are excellent corn soils, as they are very fertile and in good tilth.

The Clyde soils have poor natural drainage, but when properly drained they are good corn and hay soils.

The Dickinson soils have sandy subsoils and are inclined to be droughty in dry seasons. Where properly farmed they produce fair crop yields.

The Lindley are light-colored drift soils. The loam and silt loam are suited to general farming and good crops are produced, particularly of small grains and hay. The sandy loam and sand members require careful handling, and crop yields average lower.

The Waukesha soils are dark-colored terrace soils, most areas of which are highly productive.

The O'Neill soils are fertile and produce good crops in normal seasons.

The Bremer soils produce good crops when well drained and properly handled.

The Wabash soils are the most widely developed bottom-land soils in Buchanan County. They are subject to periodic overflow and are nearly all in pasture. A scattered timber growth occurs along the larger bottoms.

The Thurston, Dodgeville, Fayette, Sparta, Bertrand, Jackson, Cass, Sarpy, and Genesee soils are inextensive and agriculturally unimportant. They remain mostly in pasture.

Muck and peat areas are small, undrained, and used only for pasture at present.



[PUBLIC RESOLUTION—No. 9]

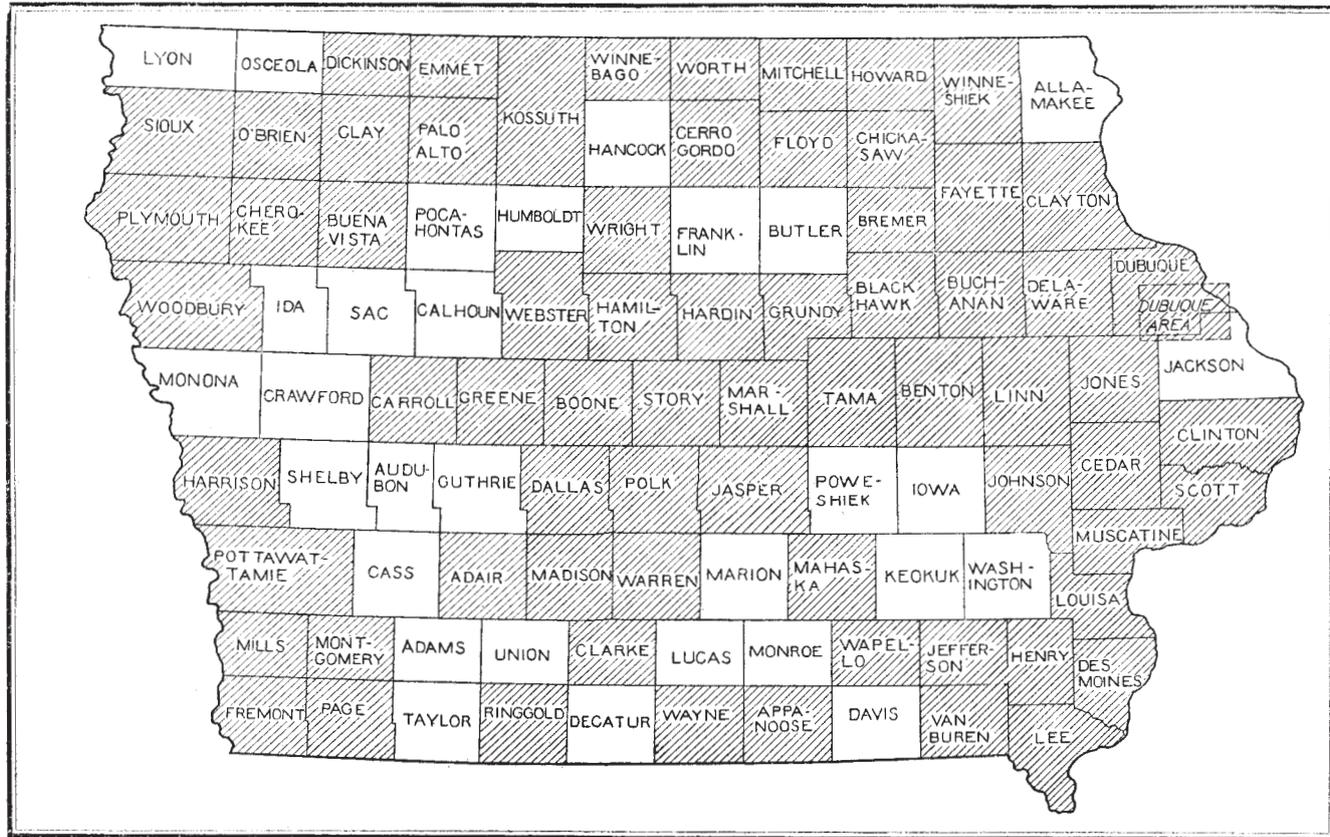
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

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, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



Area surveyed in Iowa, shown by shading

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