U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE STATE OF NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION, P. F. TROWBRIDGE, DIRECTOR; AGRICULTURAL AND GEOLOGICAL SURVEY, R. C. DONEGHUE, DIRECTOR.

SOIL SURVEY OF TRAILL COUNTY, NORTH DAKOTA.

BY

F. Z. HUTTON, OF THE U. S. DEPARTMENT OF AGRICULTURE, IN CHARGE, AND EARL NICHOLS, OF THE NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1918.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1920.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., June 24, 1919.

SIR: I have the honor to transmit herewith the manuscript report and map covering the survey of Traill County, N. Dak., and to recommend that they be published as advance sheets of Field Operations of the Bureau of Soils, 1918. This work was done in cooperation with the State of North Dakota Agricultural Experiment Station and Agricultural and Geological Survey.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

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

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SOIL SURVEY OF TRAILL COUNTY, NORTH DAKOTA.

By F. Z. HUTTON, of the U. S. Department of Agriculture, In Charge, and EARL NICHOLS, of the North Dakota Agricultural Experiment Station.

DESCRIPTION OF THE AREA.

Traill County lies in the extreme eastern part of North Dakota and midway between the South Dakota and the Canadian boundary lines. Hillsboro, the county seat, is equidistant from Fargo on the south and Grand Forks on the north. The county is a square in outline, each side being approximately 30 miles long. Its area is 865 square miles, or 553,600 acres.

Traill County includes three distinct topographic divisions—the moraine region, the delta of the glacial Elk River, built into glacial Lake Agassiz, and the region occupied by that glacial lake other than the delta just mentioned.

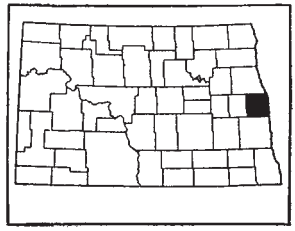

FIG. 1.—Sketch map showing location of the Traill County area, N. Dak.

The last two, which are parts of the Red River Valley lowland, comprise practically the entire area of the county. The glacial till division covers but a small area in the southwestern part of the county, about a mile west of Galesburg. It is characterized by rolling to hilly topography, with intervening sloughs and depressions. Many small, intermittent streams and draws toward the east. Some gravel and bowlders are scattered over the surface and mixed with the soil material.

The delta of glacial Elk River occupies the northwestern two-thirds of the county. It has a level to sloping and ridgy topography.

The third division, consisting of the area formerly covered by glacial Lake Agassiz, lies mainly in the southeastern and eastern parts of the county. The topography here is level to gently undulating.

There is a range in elevation in the county of about 200 feet. On the Red River, 3 miles north of Caledonia, the elevation is 862 feet,[1] and at the county line west of Portland, 1,060 feet[2] above sea level.

[1] Bul. 189, N. Dak. Expt. Sta. [2] Willard Story of the Prairies.

The general slope of the county is toward the east, and the drainage of the county ultimately finds its way into the Red River of the North. The drainage is performed by the Elm and Goose Rivers and their tributary forks and coulées.[1] The drainage system is very young, none of the streams having a well-developed system of tributaries. While all of the western part of the county is well drained, owing to the slope of the surface and to the open structure of the soils the drainage of the entire eastern part is deficient. The poor drainage of this section and especially of the southeastern part is due to several causes. During earlier geological times the streams flowing across this county deposited silt along their courses, thus building their banks several feet higher than the country a few miles back from the stream. The drainage surveys made in 1907 by the Office of Experiment Stations, United States Department of Agriculture, show that the banks of the Red River and of the streams flowing across the county are from 1 to 2 feet higher than the country a few miles inland. These higher banks act as natural levees and prevent the water in the interstream areas from draining quickly into the streams. Moreover, the nature of the soil and subsoil over these flat interstream areas is such as to hold a large volume of water and to retard its movement into the subdrainage. Thus these areas, over much of this part of the county, carry an excess of water for long periods. Ditches have already been dug and more are being constructed each year to assist the natural drainage. The average fall per mile in the eastern part of the county varies from 4 to 8 feet.[2]

Parts of Traill County were among the earliest settled regions of North Dakota, and as early as 1870 the towns of Quincy, Caledonia, and Belmont had been founded. Before the days of the railroads most of the travel was by boat down the Red River of the North, and the first settlements were made along the other streams in this region. The early settlers found a region of open prairie, with timber belts only along the larger streams, and this distribution of the woodland also tended to keep early settlement near the streams, as did also the question of water supply and transportation of the crops. Prior to the building of railroads the farmers marketed their products at Fargo. During the winter grain was carried overland to this place and supplies brought back by wagon, and during the spring and summer by boat. Most of the early settlers were of Norwegian, Swedish, or German nationality and from the States of Wisconsin, Iowa, and Minnesota.

[1] The word "coulée" is here used as locally understood.

[2] Office of Experiment Stations, Bulletin 189. Drainage of Eastern Parts of Cass, Traill, Grand Forks, Walsh, and Pembina Counties, North Dakota.

The county was organized from parts of Burchard, Cass, and Grand Forks Counties in 1875. The county seat was at Caledonia, where it remained until 1891, when it was removed to Hillsboro. A part of the territory originally included in the county was taken in forming Griggs County in 1881 and Steele County in 1883.

The first railroad, a branch of the Northern Pacific, between Casselton and Mayville, was built into Traill County in 1880. In 1881 the St. Paul, Minneapolis & Manitoba Railroad, now a part of the Great Northern system, extended its line from Fargo to Grand Forks, passing through Hillsboro. Three separate lines of the Great Northern Railroad system now cross the county north and south.

By 1880 the eastern part of the county was settled and settlements were scattered along the Elm and the Goose Rivers to the western part of the county, but the entire population was only 4,123. During the following decade, as a result of the building of railroads, settlements extended to all parts of the county, and the population increased to 10,217. In 1900 the population was 13,107, but during the succeeding decade it will be noted there was a slight decrease, owing to the fact that from 1900 to about 1907 a great many people left the county to take up homesteads in Montana. People from the county also migrated to the northern and western parts of the State, where they could homestead or buy cheap lands. Furthermore, many people went from here to western Canada looking for cheaper lands. The State census of 1915 gives the population of the county as 12,838, all of which is rural, giving a density of 14 inhabitants per square mile. The population of the county is increasing steadily. Many farmers in Illinois and Iowa have invested in Traill County land and have moved to this State.

Hillsboro, the county seat, is the largest town in the county. It is situated in the east-central part of the county, on the main line of the Great Northern Railroad, midway between Fargo and Grand Forks. Excellent train service and shipping facilities are making Hillsboro the principal marketing place for a large territory. Blanchard, Galesburg, and Clifford, of about 200 population each, are marketing and shipping points for the southwestern parts of the county. In the central-western part of the county, Mayville, the second largest town in the county, with a population of 1,200, and Portland, with a population of 600, are marketing centers for a large territory. Hatton, on the main line of the Great Northern Railroad, with a population of about 900, is a marketing center for the northwestern part of the county. The towns of Reynolds and Buxton, with populations of about 400 each, furnish good shipping facilities. The northeastern part of the county has access to a shipping point at Climax, Minn., just across the river from Belmont. Farmers in the eastern part of the county, in the vicinity of Caledonia, usually

market their produce at Shelly, Minn. About 7 miles south of Shelly, the town of Halstad furnishes shipping facilities for a large territory. At Hendrum, Minn., are shipping facilities for the southeastern corner of the county. Grandin, just across the county line, receives the produce of the southern part of the county. In addition to the above towns there are numerous sidetracks with elevators for the loading of grain and other products. The railroad facilities for the county as a whole are good. All points in the county are within 6 miles and most farms are within 3 or 4 miles of some shipping point.

The educational facilities of Traill County are above the average for North Dakota. One of the four State normal schools is located at Mayville. There are 81 common schools in the county; six consolidated schools, three of which give work that meets college or university entrance requirements. All schools teach agricultural science. Every town has a high school. All persons within the county wishing to secure a higher education than that offered by the high schools or the normal school have easy access to the agricultural college, and other colleges and schools in Fargo, or to the university at Grand Forks.

The public roads throughout the county are good, especially in the summer and fall when much of the hauling is done. The county and State are building a number of graded roads throughout the county. Every section line is a highway and nearly all are traveled to some extent

CLIMATE.

Weather records have been kept at various points in the Red River Valley since 1859, although these have not been continuous. According to the records of the Weather Bureau the climate of the Red River Valley is warmer in summer and colder in winter than any other section of North Dakota. The records of the stations at Hillsboro and at Mayville, covering a period of nine years, show the range between the annual maximum temperature and the annual minimum temperature to be from 145° to 149° F. The maximum temperature occurs during June to August, and ranges from 101° to 108° F. However, such extremes do not often occur and when they do they are of short duration. The mean temperature for the county is 40° F. The wide variation between the extreme summer temperature and the extreme winter temperature is due to the absence of timberlands and to the geographic position of the area in the center of a large continent, at a high altitude with a level topography. The seasons are rather sharply defined, warm weather coming in April, which has a mean temperature of 43° F. The mean for July is 69° F. The

weather is usually cool in the spring and plant growth is comparatively slow until about May 15, after which the higher temperature and the long hours of sunshine result in a much more rapid growth, which continues until the small grains mature. In some years there is excessive rainfall during the growing season, and at such times the crops on the heavier soils are often drowned out. Occasionally crop growth is retarded by periods of drought. While the climate of this region may be said to be subhumid, the normal rainfall according to the records being about 22 inches per year, there is great variation from year to year. It is a matter of common observation that wet and dry seasons occur in cycles of a greater or less number of years. The precipitation for a number of years may be deficient or not above normal. Such a period is usually followed by years in which the rainfall exceeds the average, or, if it does not, the precipitation may be so heavy for a month or two during the growing season as to occasion serious loss to crops.

Hail occasionally also injures crops, but ordinarily the percentage of the planted area suffering damage is small.

The valley is fully exposed to all air currents, and winds, usually light, but on many days heavy, are moving almost continuously. Winds are especially prevalent in fall, winter, and spring. Occasional hot winds damage crops in summer.

The fall season is somewhat dry and includes many days of fair weather; very often an early cold spell accompanied by frost will kill corn and vegetables. This is usually followed by several weeks of warm, mild weather. In many years fall plowing may be continued until the middle of November. Winter is usually ushered in by a sudden cold wave in November, when the ground freezes and further plowing is impossible. According to records of frost occurrence at Hillsboro and Mayville the average length of the growing season is 130 days. The average date of the last killing frost in the spring is May 20 and of the earliest in the fall is September 21. Killing frosts have occurred as late as June 9 and as early in the fall as September 10.

The following tables compiled from the records of the Weather Bureau stations at Hillsboro and Mayville show the normal monthly, seasonal, and annual temperature and precipitation for the county.

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

[Elevation, 901 feet. Record, 9 years.]

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1910).	Total amount for the wettest year (1916).
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	12.6	53	−34	0.96	0.40	1.94
January	3.9	46	−39	0.77	0.16	1.95
February	8.5	46	−38	0.70	0.27	0.95
Winter	8.3	53	−39	2.43	0.83	4.84
March	24.7	78	−31	0.91	0.58	1.55
April	43.6	85	8	2.12	2.09	3.35
May	53.2	93	20	3.87	0.80	3.54
Spring	40.5	93	−31	6.90	3.47	8.44
June	64.4	98	29	3.67	0.77	3.44
July	69.5	106	39	2.80	1.86	5.07
August	66.9	99	34	3.09	1.78	5.37
Summer	66.9	106	29	9.56	4.41	13.88
September	59.0	93	20	2.73	3.08	3.97
October	46.0	89	5	1.00	0.48	0.33
November	28.8	68	−15	0.75	0.62	0.15
Fall	44.6	93	−15	4.48	4.18	4.45
Year	40.1	106	−39	23.37	12.89	31.61

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

[Elevation, 975 feet. Record, 9 years.]

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1913).	Total amount for the wettest year (1916).
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	11.3	55	−33	0.47	0.01	1.35
January	6.6	47	−41	0.37	0.40	1.66
February	8.4	48	−39	0.40	T.	0.79
Winter	8.7	55	−41	1.24	0.41	3.80
March	23.2	81	−26	0.68	0.78	2.37
April	42.7	84	8	1.67	0.95	2.50
May	55.1	96	19	2.95	1.81	3.70
Spring	40.3	96	−26	5.30	3.54	8.57

Normal monthly, seasonal, and annual temperature and precipitation at Mayville—Continued.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1913).	Total amonnt for the wettest year (1916).
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
June	65.3	97	26	3.01	1.70	4.71
July	69.1	108	37	3.36	2.59	3.87
August	66.0	101	30	3.23	1.91	3.35
Summer	66.8	108	26	9.60	6.20	11.93
September	56.5	94	21	2.56	2.02	4.31
October	45.2	89	1	1.24	1.73	0.14
November	27.8	68	−16	0.67	0.16	0.10
Fall	43.2	94	−16	4.47	3.91	4.55
Year	40.0	108	−41	20.61	14.06	28.85

AGRICULTURE.

The early settlers in Traill County soon discovered that the soil and climatic conditions were suitable for the production of small grains. Crop records as early as 1880 show that the production of the cereals had at that time become important, wheat being the principal crop, followed by oats and barley, the last two being used mainly as feed for the work animals and other stock, only the surplus being sold. To supplement these crops there was a luxuriant growth of grasses on the prairie which afforded fine pasturage and hay.

The following table gives the acreage and production of the principal crops of the county for the census years 1880, 1890, 1900, 1910:

Acreage and production of principal crops—1880 to 1910.

Crop.	1880		1890		1900		1910	
	Acres.	Production.	Acres.	Production.	Acres.	Production.	Acres.	Production.
		Bu.		*Bu.*		*Bu.*		*Bu.*
Corn	57	1,916	82	2,024	1,754	47,470	6,416	151,529
Oats	3,057	114,575	28,264	517,547	40,180	1,369,210	46,498	1,456,106
Wheat	13,707	333,409	227,998	2,957,360	305,735	4,924,850	211,680	3,189,902
Rye			19	260	82	2,170	3,289	57,632
Barley	513	13,339	7,022	111,303	13,943	360,230	38,444	815,673
Potatoes		16,781	699	68,885	1,099	126,816	1,094	127,875
		Tons.		*Tons.*		*Tons.*		*Tons.*
Hay	5,513	7,064	53,925	32,031	68,600	58,665	50,075	50,878
Tame					44,417	33,995	37,693	38,916
Wild					24,183	24,670	12,382	11,962

In preparing the land for cropping the prairie sod was broken in the spring or early summer, backset in the fall, and harrowed and sowed with grain the following spring. While this method of tillage usually produced good crops the returns were slow. The introduction of flax in the nineties made possible a change in methods, for the land could be broken in the spring and immediately seeded to flax, the sale of which gave the farmers some income the first year. As long as there was an abundance of unbroken land flax was one of the leading crops; but where flax is grown several seasons on the same ground, it is subject to attack by wilt, and after a number of years flax production declined. Under present conditions, with old timothy and clover sod to be broken, and with the present high prices for the crop, flax is again being grown to considerable extent.

Spring wheat is, and always has been, the leading crop in this region. The continuous growing of wheat on the same ground year after year has caused a gradual decrease in the yield, which, with increase in weeds, has made it necessary to introduce other crops for purposes of rotation. The average yield of wheat in the county for 1909 is stated as 15 bushels per acre, but in the average year the yield on many farms will run as high as 30 bushels. This year (1918), which was an exceptionally good year for wheat, some farmers reported average yields as high as 40 bushels per acre for their farms. The hard wheats, Fife, and Bluestem, Marquis, and Velvet Chaff, are the chief varieties. Some macaroni or durum wheat is grown. This variety, while grown to some extent all over the county, is sown mostly on the light sandy soils. It seems to do better on sandy land than the hard wheats. A considerable acreage is planted in the vicinity of Galesburg. Of all varieties grown in the county, the Marquis seems to find the most favor. Both Bluestem and Velvet Chaff shatter badly, especially if they become a little overripe before cutting. Marquis ripens a few days earlier than other varieties, and for this reason in most seasons suffers less from rust than some of the others. A study of the census returns shows that in recent years the acreage of wheat has decreased. This is due to the fact that the farmers are changing from the one-crop system of all wheat to one of a variety of crops and to one in which more and more cattle are being kept. From 4 to 6 pecks of wheat are usually sown per acre. There are several flour mills in the county, but most of the wheat is shipped to Duluth or Minneapolis.

Oats, next to wheat, is the most important crop in point of acreage and production. The 1910 census shows 46,498 acres devoted to oats, producing 1,456,106 bushels. This gives an average of over 31 bushels per acre for the county. In normal seasons oats yield as much

as 50 bushels per acre, and in favorable years yields of 70 bushels have been reported. Oats are the staple stock feed of the county. Both late and early, or 60-day, oats are grown. On an average the early oats ripen from 10 days to 2 weeks before the late varieties. In some seasons this is a distinct advantage, as hot, dry weather usually does not occur until after the middle of July, at which time the early crop has matured. The acreage of oats has steadily increased from year to year, while the yield averages about the same as in the earlier years. From 7 to 10 pecks of oats are usually sown per acre.

Barley is grown in all parts of the county and ranks close to oats in point of acreage and production. Barley has been grown as feed for live stock from the early days of settlement. A large proportion of the barley shipped is of high quality. The six-rowed barleys are grown principally. The census reports show a steady increase in acreage and production. The 1910 report gives the acreage in 1909 as 38,444 acres and the production as 815,673 bushels. Barley is a short-season crop and is grown largely to clean the land of weeds and to prolong the seeding season, since fairly good yields can be obtained even when seeding is done late in the spring.

Flax was first grown in the county some time between 1890 and 1900 and by 1900 had become an important crop. Although flax is declining in relative importance, present prices and farm practice indicate that it will continue to be grown, especially on sod land where timothy or other grass land is broken. As these grasses are entering more and more into the rotations, it is quite probable that the acreage in flax will be increased in the future. The census report for 1900 shows 18,523 acres, and that for 1910, 11,252 acres seeded to flax. The yield of flaxseed per acre varies widely, in some years averaging as high as 15 bushels and in others as low as 5 bushels. A fair average for the county for a period of years is about 8 or 10 bushels. Flax is grown exclusively for the seed, and all not needed for sowing is shipped out of the county. At the current prices, which range from $3 to $5 per bushel, it is a paying crop, especially where it is the means of subduing old sod land and fitting it for grain. Flax wilt is destructive in places, and in order to hold this disease in check wilt-resistant varieties are being introduced. In good practice the crop should never be grown on the same ground more than once in five years. Under the present system of farming flax fits well into the rotation. The usual method is to break sod land for flax after the other crops have been seeded. The seed is sown on a bed prepared by going over the ground with a spike-tooth harrow. In many places the preparation is so little that the marks of the furrows can be plainly seen at harvest time.

Corn is becoming a more important crop each year. The continuous growing of wheat on the same ground causes the soil to become so badly infested with weeds that wheat and other small grains can no longer be grown profitably. Summer fallowing is beneficial in cleaning up weed-infested land. This practice, however, leaves the land unproductive for a year and besides is becoming more costly with the increased price for labor. For these reasons corn is entering into the rotation to a greater extent each year. In earlier times corn was grown largely for fodder, frost preventing maturity of much of it, and the crop was harvested with the binder and fed from the shock. Under the present system of farming a great deal of corn is grown primarily for the fodder. In addition the crop is used for ensilage, and silos are increasing in popularity, because of the greater convenience in handling silage than fodder during the severe winter weather. Furthermore, the chances of making efficient use of the immature crop are better where silos are available. The average yield of shelled corn is about 25 bushels per acre. The 1900 census gives the acreage of corn as 1,754 acres, and the census of 1910 as 6,416 acres. The yield remains about the same as formerly, although in general more of the crop matures than formerly, owing to the introduction of varieties bred for this region, and to the selection of locally grown seed. The flint varieties are most commonly grown, both for grain and fodder. The leading varieties are Dakota White, Gehu, Squaw, and Mercer. The Dakota white flint, Gehu, and Squaw are the earliest strains of corn grown in this region. They yield well but the ears are borne low on the stalk, making harvesting difficult. They are often used for hogging off. The dent varieties commonly grown are the Northwestern, Minnesota 13, and Rustler white. The dent corns mature later than the flint corns, but they are used largely for silage purposes, to which they seem well adapted.

Farmers in general throughout the country find corn a valuable crop for roughage for the cattle and work stock during the winter. Renters of wheat farms find corn a valuable substitute for hay, which produces a smaller tonnage per acre than corn. Most tenants pay a cash rent for corn land.

Considerable winter rye is grown in Traill County. The acreage has greatly increased during the last decade. In 1900 only 82 acres were devoted to rye, with a total production of 2,170 bushels. In 1910 the acreage had increased to 3,289 with a total production of 57,632 bushels. The average yield given for the county is about 19 bushels per acre. In favorable years, where properly seeded rye yields as much as 40 bushels per acre. Rye is grown both as a cash crop and for feed. It is a comparatively inexpensive crop to grow. The common practice is to sow the seed on disked wheat stubble, between the middle of August and the middle of September. Rye

is also grown to some extent in cornfields after the corn is harvested. Rye is grown on the sandy soils in the western part of the county.

Potatoes occupy a considerable acreage. Since 1900 the annual acreage of potatoes has been approximately 1,000 acres. The yield averages from 75 to 150 bushels per acre, and yields as high as 200 bushels per acre have been obtained. Potatoes are grown in all parts of the county for home consumption, and in many parts commercially. A relatively large acreage is planted in the vicinity of Hillsboro, whose shipping facilities are good and where there is a warehouse for storing the crop. Some farms also are equipped with storage houses and thus are in a position to hold a considerable proportion of the crop for better prices than usually are received at the time of harvest. Potatoes are grown on all types of soil, but the largest yields and the best quality usually are obtained from the more sandy soils. The crop seems to give better results on the heavy lands in dry seasons and on the light sandy lands in seasons of normal or heavy rainfall. Potatoes, like corn, are being grown more generally to supply the need of a tilled crop in the rotation, and to make summer fallowing unnecessary. Eighty to 100 bushels of potatoes per acre is considered a profitable crop. Wheat grown after potatoes in many cases yields as high as 35 to 40 bushels per acre. Potatoes are grown on the small or medium sized farms rather than on the large farms, on which as a rule barely enough for home use are grown. The Early Ohio and Irish Cobbler are the leading varieties. The potatoes from this region are noted for their quality and much of the crop is shipped to southern markets, where it is sold for seed.

Legume crops such as the clovers, alfalfa, Canadian field peas, and beans, are grown in all parts of the county to a certain extent. Alfalfa and red clover are being grown more extensively each year. Farmers and stockmen recognize the need of these crops in their rotations to supply feed and to improve the soil in many sections. While the acreage given in 1910 for alfalfa was only 95 acres and for clover 292 acres, the acreage of alfalfa has greatly increased since then, and is probably considerably more than 1,000 acres at present (1918). Considerable sweet clover is grown in the county, the crop on some farms occupying several hundred acres. In most cases it is easier to grow than alfalfa or red clover. The roots penetrate deeply into the soil and the crop is a valuable one for soil improvement. Sweet clover in most cases is pastured during early summer, after which it is left to grow and mature a crop of seed. The crop usually yields three bushels of seed per acre. Alfalfa ordinarily yields two and in some seasons three cuttings. In order to avoid the danger of winterkilling hardy strains, such as Grimm, should be grown.

In addition to the hay made from clover and alfalfa there is a considerable production from timothy and from German, Hungarian,

and broom-corn millet. In some sections of the county there still remains some unbroken prairie where the native prairie grasses are used for hay and pasturage, but as soon as the land is broken the prairie grasses disappear and hay must be provided by growing the cultivated grasses.

The hardy vegetables, such as cabbage, tomatoes, carrots, onions, radishes, peas, and beans, do well in the county. They are grown only for home use. Small fruits, such as raspberries, currants, and gooseberries, are produced in small quantities. Some of the more hardy varieties of apples and plums succeed in favorable locations.

The principal noxious weeds of the county are wild oats, pigeon grass, yellow mustard, French weed, quack grass, Russian thistle, Canada thistle, and sow thistle. The first five of these become so plentiful in some localities that they reduce the yield of small grain materially. Quack grass is a very troublesome weed, especially in low ground. Hemp was introduced into the Red River Valley a few years ago as a possible crop to exterminate quack grass. Its growing for this purpose is still in the experimental stage. Russian thistle, more widely distributed, does the most damage in dry seasons. Sow thistle is gaining a foothold in many places, and unless vigorous measures are taken to exterminate it it is likely to become serious in all parts of the county.

The live-stock industry is of minor importance in the county. The 1910 census gives the number of calves sold or slaughtered as 1,405; other cattle sold or slaughtered, 3,151; horses, mules, etc., sold, 422; swine sold or slaughtered, 6,420; sheep and goats sold or slaughtered, 1,698. The value of dairy products, excluding home use, amounted to $130,679; poultry and eggs, $89,283.

The more important breeds of horses and cattle are fairly well represented, the Percheron being the most popular horse and the Shorthorn the most popular breed of cattle, several herds of pure-bred cattle being owned in the county. At present more attention is being given to live stock than formerly. Larger and better herds are being bred up by selection and the use of pure-bred sires. Dairying is still in an early stage of development. Some cream, the product mostly of mixed herds of grade Shorthorns with some Jersey and Guernsey cows, is shipped from the county. More cattle are raised for beef production than for dairying, the dairy products usually coming from the surplus milk produced by the beef cattle rather than from strictly dairy herds. Quite a number of sheep are brought into the county every fall and after a period of feeding on pasture supplemented with silage and screenings are sent to the eastern markets.

As far as possible the land is plowed in the fall. This permits early spring seeding, which minimizes injury by diseases. Plowing

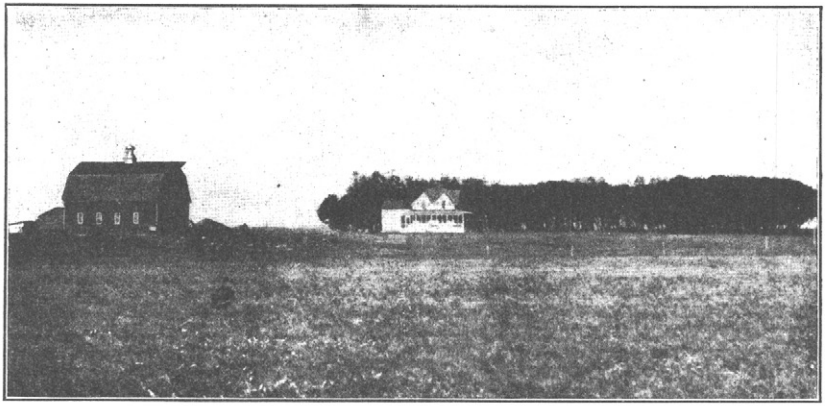

FIG. 1.—TYPICAL FARM BUILDINGS, WITH GROVE PLANTED FOR PROTECTION FROM WINTER WINDS.

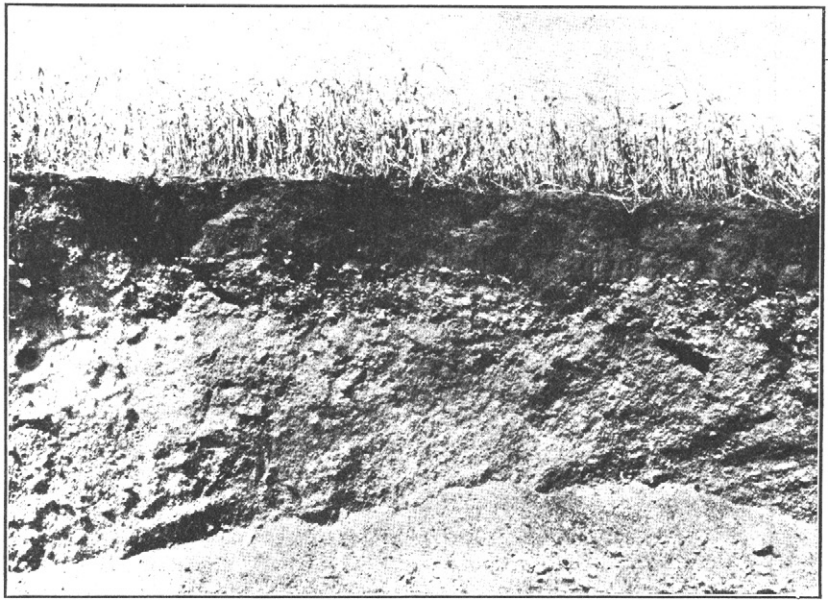

FIG. 2.—EXPOSURE IN PIT, SHOWING STRATIFIED GRAVEL UNDERLYING SIOUX SOILS.

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begins as soon as practicable after harvest and continues until the ground freezes. Land for wheat is plowed as early as possible, often before the preceding crop has been thrashed. Early plowing encourages the germination of weeds in the fall and usually gives better yields than late fall plowing. For wheat the land is often harrowed twice before seeding and once after seeding. Some farmers double disk fall-plowed land the first thing in the spring. Summer fallow is usually disked during the fall. Land intended for barley and oats does not usually receive as much attention as land for wheat. Often barley is seeded on spring breaking without any additional preparation. Both the double gang plow, to which five or six horses are hitched, and the tractor outfit are used in plowing. Tractor outfits, consisting of from 2 to 8 or 10 plows, are used, the most common being a three or four plow outfit. In former years larger gangs were in common use, but with the breaking up of the large farms into smaller units the smaller, one-man outfit has grown in favor. This is not so large as to be unwieldly in the fields, and at the same time is large enough for thrashing and other work about the farm where belt power is needed. Oil-burning tractors are largely used.

In the spring there is usually a rush of work until the small grains are seeded, and again at harvest, when there is a scarcity of men until after the crops are thrashed.

The average time of seeding is about as follows: Wheat, April 1 to May 10; oats, April 10 to May 20; barley, April 20 to June 1; corn, May 10 to June 10; and flax, May 20 to June 20. From the latter part of August to the 20th of September is considered the best time to sow winter rye.

The grain is usually harvested with 7 or 8 foot binders. On the large farms it is common to see four or five binders following each other around the field. Owing to the scarcity of labor two binders are often attached to a tractor and the outfit operated by a man and a boy. The grain is shocked and generally remains in the field until thrashed. Thrashing from the shock usually delays fall plowing, but with the shortage of labor many farmers prefer to leave the grain in the shock until it is thrashed, especially when the weather is favorable. The thrashing is usually done as soon after harvest as possible.

The thrashing is usally done by a large blow stacker separator using a 25 to 30 horsepower tractor engine. The larger outfits go from farm to farm and usually require from 14 to 20 men and teams to keep them running to full capacity. Smaller outfits run with gasoline tractors are becoming popular. These require fewer hands to operate, and two or three of the small farms can cooperate and do their thrashing quicker and cheaper than where traveling outfits

are employed. Most of the larger farmers own their own thrashing outfits, these usually employing enough labor at all times to have sufficient for thrashing.

While there are in the county large farms containing from four to eight sections and employing large crews of men throughout the summer season, these, owing to the scarcity of labor in recent years, are being broken up and sold in smaller tracts. Most farms in the county are of such size that they can be operated by the farmer and his family, with some additional help for 7 or 8 months during the busier part of the year. The ordinary wage during the summer is about $60 per month, with board and lodging in addition. Wages by the day average from $3 for ordinary labor, such as plowing and harrowing, to $5 or $6 a day during harvesting and thrashing. These wages are high, owing to abnormal conditions brought about by the war. Before the war labor could be obtained at from $30 to $40 a month, and for $2 to $3 a day.

According to the census there were 590 farms in Traill County in 1880, 1,151 in 1890, 1,296 in 1900, and 1,150 in 1910. The average size of farms has increased from 347 acres in 1880 to 460 acres in 1910. Of the total area of the county 95.5 per cent is reported in farms, and 96.4 per cent of all the land in farms is improved.

In 1910 owners operated 71.7 per cent of the farms in the county, tenants 26.2 per cent, and managers 2.1 per cent. Tenant farming is becoming more general. Many farmers who operated their own farms a few years ago have retired and leased their farms. Under the terms of the leases the tenant and owner ordinarily share the crops equally, the tenant furnishing the labor, work stock, and implements, as well as paying half of the cost of the twine and thrashing, while the owner furnishes the seed. Special arrangements are usually made where the land is used for cultivated crops or pasture, the tenant usually paying a stipulated cash rent for such land or giving the owner an equivalent in small grain. As a rule the term of tenure is short and the farm practice poorer than on land operated by the owner.

The development of Traill County has been rapid, its present prosperous condition having been reached in about 35 years. In the early eighties the best land in the county could be bought for $8 or $10 an acre. At the present time (1918) well-improved farms are selling for $50 to $100 an acre, depending upon location as to shipping facilities. Of the total value of farm property in the county in 1910, 78.4 per cent was represented by the land, 10.5 per cent by buildings, 3.6 per cent by implements and machinery, and 7.5 per cent by live stock.

A good class of dwellings and farm buildings is general throughout the county. In some of the better agricultural sections many of the

farms are improved, with houses lighted by electricity and supplied with running water and with large well-equipped barns. In the northern and central parts of the county the houses in general are not so good. Little attention is paid to protection of farm machinery.

All of Traill County was originally treeless except for belts of timber along the Red River and other rivers. As a protection against the severe winds during winter nearly every farmer set out a grove of trees on the north side of his buildings. Such rapid growing trees as boxelder, cottonwood, elm, and willow were used. Most farms now have well-established groves and windbreaks about the farm buildings. Plate I, figure 1, shows such a grove. A few groves remain from the original tree claims by which some land was taken up in the early days.

There are three sources of water supply in Traill County—surface wells, rain water caught in cisterns, and artesian wells. The former furnish a sufficient supply, except in some dry seasons. The artesian supply may be had at a depth varying from 200 to 500 feet. The water from these deep wells is usually slightly alkaline, but is suitable for household purposes and for stock. Several wells in the vicinity of Mayville and Blanchard range in depth from 300 to 400 feet, water being obtained from white sandstone lying below the glacial drift.

Much interest is taken at the present time in the question of drainage. Large areas in the eastern part of the county are being organized into drainage districts. Open ditches have been constructed along some of the section lines leading to the Red River. Other ditches have been dug draining other areas into the Goose and the Elm Rivers. According to drainage survey made by the United States Department of Agriculture, Office of Experiment Stations, there are approximately 233,900 acres in Traill County that would be benefited by artificial drainage.[1] The wet seasons for the last few years have brought the poorly drained parts of the county to the attention of the farmers, who have seen the benefits derived from the few ditches constructed some years ago. At the present rate of progress it is quite probable that in a few years all of that part of the county in need of draining will be covered by drainage ditches.

SOILS.

The soils of Traill County fall naturally into four main groups, namely, those of lacustrine origin, those of delta origin, those of glacial origin, and those of alluvial origin. Almost all of Traill

[1] Office of Experiment Stations, Bulletin No. 189. Drainage of Eastern Parts of Cass, Traill, Grand Forks, Walsh, and Pembina Counties, N. Dak.

County lies within the region known to geologists as glacial Lake Agassiz, and in common parlance as the Red River Valley. The lacustrine deposits, which form the soil material in this region, were carried out into the glacial lake by water coming from the melting ice. These deposits, owing to the manner of their formation, consist mainly of silt and clay. The deposits give rise to soils of the Fargo series.

The Fargo series includes types with black soils and dark drab or mottled drab and gray heavy subsoils. They are derived from reworked glacial till laid down in quiet lake waters and subsequently weathered under poor drainage conditions. A large percentage of organic matter is usually present in the soil, in some cases enough to make it slightly mucky. There is also present a large percentage of lime, the quantity being greater in the subsoil. The topography is for the most part level. In Traill County the Fargo series is represented by four types—the very fine sandy loam, silt loam, silty clay, and clay. These soils occupy approximately two-fifths of the area of the county.

The types of the Maple series are dark brown to gray or drab in the surface layer and light brown to gray in the subsoil. The series is of alluvial origin and occurs along streams in subhumid glaciated regions of the North-central States. Drainage is poorly established and the greater part of the series is in a condition of wet meadow. The soil and subsoil are in most places calcareous. In Traill County the series is represented by two types, the silt loam and the very fine sandy loam.

In the large area of sandy soils in the western part of the county the soil material was deposited by running water flowing from the melting glacier, the numerous ridgy, gravelly deposits in different situations representing material laid down by torrential streams. These sandy deposits in general were laid down by a swiftly flowing stream carrying a heavy load of débris, known to geologists as glacial Elk River, which had its origin in the region known as the Golden Valley in Walsh and Pembina Counties at the time that the Dakota lobe and Minnesota lobe of the great ice sheet came together at that point. As the water from the river entered Lake Agassiz the current slackened, and its load of sediment was dropped, forming the fan-shaped deposit of sandy material in the western part of the county. The influence of the glacial Elk River upon the soils of the northern part of the county is also strongly marked, the delta deposit reaching to the Red River. In the northeastern part of the county the delta deposit is modified by lacustrine material deposited over it. The soils of delta origin are marked by lighter texture, more open structure, and more undulating or ridgy topography than the

soils of lacustrine origin, and have been classed with the Bearden and Sioux series.

The types included in the Bearden series are characterized by brown to black surface soils overlying gray or yellow or light-brown subsoils. The series is derived from old alluvial material, probably deposited for the most part following the recession of the last ice sheet. The subsoils have a texture similar to or slightly heavier than the surface soil, and are friable and open in structure. In Traill County the series represents material carried down by the Elk River during the glacial times and deposited at the edge of the lake. Six types of the series—the silty clay loam, silt loam, very fine sandy loam, very fine sand, fine sandy loam, and fine sand—are mapped in Traill County.

The types included in the Sioux series typically consist of dark-brown to black surface soils with lighter colored subsoils, underlain by gravel beds sufficiently near the surface to have a marked effect upon the drainage and to cause crops to suffer in times of drought. (Pl. I., fig. 2.) These soils are found within the glacial region of the Central and Northwestern States. In Traill County the series occupies old beach ridges and terraces or outwash plains along streams. The very fine sandy loam and silt loam are mapped in this county.

Extending across the southwestern corner of the county is a range of low round-topped hills. These hills are thoroughly dissected by small draws leading into the lower part of the county to the east. The topography is quite rolling. The soil material is of a sandy nature, the subsoil being heavier than the surface, and contains gravel and bowlders. These hills are of glacial origin and a part of the upland which marks the edge of the Red River Valley. The soil on these hills belongs in the Barnes series.

The Barnes series includes types with black to dark-brown soils and gray, yellow, greenish-yellow, or brownish-yellow, highly calcareous subsoils. The soils rarely effervesce in hydrochloric acid and in extreme cases the effervescence will not take place above 30 inches. Below that depth the material everywhere contains enough lime carbonate to cause effervescence, and this is the case with samples taken in most places to within 18 inches of the surface. The lime may be uniformly distributed or may be concentrated in masses, but not ordinarily in well-defined concretions. The soils are derived from glacial till, and occur in regions that have a predominantly constructional topogrophy,[1] where the material, though well drained, has been subjected to very little erosion or leaching, as in regions of low to moderate rainfall. In Traill County the series

[1] In this case a topography due to the deposition of material and not to removal of material by erosion.

is represented by the Barnes very fine sandy loam. In the northern part of the county, extending from Reynolds west along the county line a distance of 9 miles, then in a southeasterly direction, almost to Cumings, then swinging northward again to Reynolds, covering a section of country roughly semicircular in outline, is a series differing distinctly from the other soils of the county. These soils have some of the characteristics of lake-bottom soils. Their rather uneven topography, and the presence of stones and bowlders scattered over the surface and through the soil and subsoil, indicate that they are derived from glacial drift, but the black color of the surface soils and the gray or mottled subsoil show that weathering has taken place under poor conditions of drainage. This region was probably for a long time the part of a low island in the lake, at certain periods being entirely submerged, at other times standing slightly above the water of the lake. The soils have been classified with the Webster series.

The Webster series, as mapped in Traill County, includes types having black surface soils, underlain by brown subsurface soils and light brown, olive drab, or grayish drab subsoils, in most places heavier in texture than the soils. The subsoil layer is hard, tough, and close structured, approaching a hardpan in character. Bowlders are scattered over the surface and throughout the soil. Small gravel is common throughout the soil section. A distinct layer of large gravel and small stones, 2 to 6 inches thick, lies about 18 inches below the surface. Below the gravelly layer, the subsoil usually becomes lighter gray in color. The topography is rolling, undulating, or choppy, with many irregular sloughs and poorly drained spots and knolls. The material seems to be glacial drift, and the soils have developed under poor drainage conditions. The series covers about a township in the northern part of the county. Five types of the series are mapped in Traill County, namely, the Webster loam, silt loam, very fine sandy loam, silty clay loam, and clay loam.

The third class of soils in the county have developed along the streams flowing across the county or along its boundaries. These streams, the Red, Elm, and Goose Rivers, have cut channels into the floor of the valley since the present Red River Valley was formed by the receding of the old glacial Lake Agassiz, and in places have developed bottom lands. The soils derived from these flood-plain deposits are classified in the Lamoure, Laurel, and Maple series. The area of such soil is small, as the streams are young geologically, and owing to the light rainfall have not developed into a well-defined drainage system.

The types included in the Lamoure series have dark-brown to black surface soils and yellowish-brown to gray or dark-drab or mottled gray and brown subsoils. The subsoil is usually much heavier in

texture than the soil, though both may have about the same texture. They are derived from the alluvium of streams that drain calcareous soils and occur in glacial regions with a moderate to low rainfall, so that they are highly calcareous. These soils are moderately to poorly drained and are subject to periodic overflows. Local accumulations of alkali may be present. In Traill County the Lamoure series is represented by two types—the very fine sandy loam and silty clay.

The Laurel series comprises types with light-gray to light grayish-brown soils and lighter-colored similar or slightly heavier textured subsoils. As a rule the underdrainage is good, but surface drainage of the heavier types may be deficient. The topography is flat to undulating. Both soil and subsoil contain a high percentage of lime and often contain alkali. The series occupies low first bottoms, subject to overflow. In this area the Laurel silt loam has been mapped.

The types of the Maple series are dark brown to gray or drab in the surface layer, and light brown to gray in the subsoil. The series is of alluvial origin and occurs along streams in semiarid and subhumid glaciated regions of the North Central States. Drainage is poorly established and the greater part of the series is in a condition of wet meadow. The soil and subsoil are in most places calcareous. In Traill County the series is represented by two types—the silt loam and the very fine sandy loam.

The four soil groups in Traill County thus include 8 series, embracing 23 soil types.

Descriptions of the individual types are given in subsequent pages of this report. The actual and relative extent of the several types is given in the following table, and their distribution is shown on the accompanying map.

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Bearden very fine sandy loam	121,856	22.0	Webster silt loam	6,592	1.2
Fargo clay	103,232	18.7	Lamoure very fine sandy loam	4,096	.7
Fargo silty clay	74,176	13.4	Bearden fine sand	4,032	.7
Bearden silt loam	72,896	13.2	Barnes very fine sandy loam	2,624	.5
Bearden silty clay loam	56,512	10.2	Bearden fine sandy loam	1,600	.3
Fargo silt loam	29,440	5.3	Lamoure silty clay	1,344	.2
Bearden very fine sand	15,680	2.8	Maple silt loam	960	.2
Webster loam	11,136	2.0	Sioux silt loam	960	.2
Sioux very fine sandy loam	10,816	2.0	Webster clay loam	768	.1
Fargo very fine sandy loam	10,368	1.9	Maple very fine sandy loam	512	.1
Webster silty clay loam	8,896	1.6			
Laurel silt loam	7,808	1.4	Total	553,600	.....
Webster very fine sandy loam	7,296	1.3			

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FARGO VERY FINE SANDY LOAM.

The surface soil of the Fargo very fine sandy loam is a dark-brown to black very fine sandy loam, with an average depth of 15 inches. At depths between 15 and 20 inches the subsoil grades quickly into a dark-drab stiff plastic clay. The lower part of the subsoil becomes somewhat lighter colored and faintly mottled with lighter gray. The surface soil contains a large percentage of organic matter, which gives it a smooth feel.

The Fargo very fine sandy loam is not an extensive type in the county, but the several areas mapped are all under cultivation and well improved. One of the larger areas occupies a narrow strip of country adjacent to the "sand ridge" west of Hillsboro. Several small areas lie in the southern and southwestern parts of the county. Areas, each about 1 square mile in extent, are mapped north of Mayville and north of Portland. In the northwestern part of the county there is an area separating the sandy Hatton country from the lower soils to the east.

The Fargo very fine sandy loam usually has considerable slope, so that the type is well drained. The type seems to be made up of a veneer of sandy material over a typical Fargo clay subsoil. The sandy surface soil and heavy subsoil make an ideal combination.

The Fargo very fine sandy loam is used for the production of the small grains, corn, potatoes, timothy, and clover. Spring wheat yields about 30 bushels per acre, oats from 60 to 70 bushels, and barley about 40 bushels. Very little corn was growing on the soil at the time of the survey, but the fields seen had made a vigorous growth. Timothy and clover seem to do well. Potatoes and other vegetables, grown for home use, do well.

The type, usually in connection with other types, is held at $60 to $90 an acre.

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

Mechanical analyses of Fargo very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351715	Soil	0.0	0.6	0.3	10.1	47.0	29.4	12.8
351716	Subsoil	.0	.2	.2	3.7	23.7	28.1	44.4

FARGO SILT LOAM.

The Fargo silt loam consists of a light-textured, mellow, silt loam, black in color to a depth of from 12 to 14 inches. The soil becomes somewhat heavier with depth, and below 14 inches grades quickly into

a grayish-drab silty clay, which in some areas continues without change to 3 feet or more. In other areas it passes at 24 to 30 inches into a grayish-drab or bluish-drab clay. Variations in the type consist of differences in texture and structure of the subsoil rather than in differences in the soil or in the topography. The areas along the streams have a more silty and more open-structured subsoil than areas lying back from the streams.

The more important areas of the Fargo silt loam lie in the vicinity of Hillsboro, along the Goose River, and from Hillsboro southward to and beyond the Elm River. Several areas are in the vicinity of Portland and Mayville, and many small areas occur in the southwestern part of the county in association with other types.

The Fargo silt loam has better drainage than the silty clay or clay of the series, yet, owing to its mellow soil, which never cracks or bakes as badly as the two heavier soils, the supply of moisture is somewhat better maintained and sufficient to carry crops through most droughts. The type is practically all under cultivation, and it includes some of the older and best improved farms in the county.

All the farm crops commonly grown in this region are produced on this type. Wheat, oats, barley, corn, potatoes, and flax are grown. Wheat yields from 25 to 40 bushels per acre, averaging around 30 bushels. The ordinary yield of oats is about 40 bushels, of barley from 30 to 50 bushels, and of corn from 25 to 35 bushels (shelled) per acre. The soil dries and warms up early in the spring, so that it is fairly well suited to corn. Timothy, alfalfa, red clover, and sweet clover are all grown on the type with success. While timothy does not yield heavily, it grows well and is used for hay and pasturage. Alfalfa is grown both for hay and for seed. Two cuttings of hay, each of about three-fourths to 1½ tons, are obtained. Red clover is sown in places with timothy. Sweet clover is grown as a pasture crop and for the seed. It makes a vigorous growth and can be pastured when young and tender and later allowed to mature a crop of seed, of which the yield is about 3 bushels per acre. Potatoes are grown for home use and as a cash crop. The average yield on a number of the farms is about 100 bushels per acre.

The Fargo silt loam is regarded as among the best soils in the county. Fall plowing for small grain is generally practiced. The soil warms up early in the spring and cultivation in the fields usually begins from a week to 10 days before that on the heavier types.

The value of farms on this type ranges from $65 to $100 per acre, depending on location. Very little of the type is changing hands.

FARGO SILTY CLAY.

The Fargo silty clay consists of about 5 inches of heavy silt loam, underlain by a plastic silty clay extending to depths of 10 to 15 inches, averaging about 12 inches. The subsoil from 12 to 24 inches is generally a black stiff plastic clay, and below 24 inches a gray or drab crumbly clay with some mottling of white and rusty brown. In places along ditch banks lime concretions are present. The substratum at a depth of about 8 feet becomes a yellowish drab rather silty clay. The type, which varies in texture from a heavy silt loam to a clay, in many places marks a transitional stage from a silt loam or a very fine sandy loam soil on one side to a heavy clay soil on the other side.

The Fargo silty clay is found mostly in the southern half of the county, and while there are several important bodies, much of the type occurs in small irregular areas or as narrow belts associated with other types. The largest single area is found in Elm River Township in the southeastern part of the county. There is an occurrence of the type just east of Mayville. Extending east of the town several miles the areas cross Goose River, running in a southeasterly direction, east of Murray, to within a few miles of Blanchard. Small areas lie around Blanchard. A fourth important area lies at Portland and extends in a narrow irregular belt southeastward to the bank of the Elm River about 4 miles east of Clifford. This last area seems to form a transition zone between the sandy soils in the western part of the county and the heavy clay soils to the east. The character of the surface is one of the features besides texture that distinguishes this soil from the Fargo clay. From a distance the type appears to be perfectly flat, but in detail it consists of numerous low swells with slight depressions intervening. The soil on the higher places is lighter and well drained and that in the depression is heavier and not so well drained. In ordinary seasons water does not stand in the depressions; in a wet season the low places are often so wet and soft that horses and implements bog in the fields. This condition exists over most of the main areas of the type, and while the type seems to be better drained in general than the Fargo clay the numerous depressions cause local areas to be poorly drained. The areas west of Hillsboro and in the southwestern part of the county are better drained than those east of Hillsboro and in the southeastern part of the county. The small areas are adequately drained.

The Fargo silty clay, though similar to the Fargo clay, is somewhat easier cultivated and cultivation can be started earlier in the spring and sooner after rains. The soil does not crack and bake quite as badly as the clay and a fine soil mulch is easily maintained.

In small grain fields even after a protracted dry spell the soil feels soft under foot. The soil is high in organic matter, and this in connection with its silty texture gives it a spongy structure. The type is well suited to the production of small grains. Corn does fairly well if the weather conditions in spring favor the preparation of a suitable seed bed. The type retains moisture well, so that when once started corn makes a vigorous growth. Corn yields from 25 to 40 bushels, and wheat from 12 to 30 bushels. Where a crop rotation is followed wheat has yielded as much as 40 bushels per acre. The yield of oats ranges from 35 to 60 bushels per acre; and of flax the ordinary return is 12 to 15 bushels, although as much as 20 bushels per acre is sometimes obtained. A considerable acreage of potatoes is planted in the vicinity of Hillsboro. The yields range from 75 to 150 bushels per acre without fertilizer, depending on the season and the care in cultivation.

Most of the farms on this type are well improved, the farm buildings usually being substantial. The type is used primarily for the production of small grain. Some beef and dairly cattle are kept on most farms, and some butter and cream are produced for sale. The butter is marketed locally while the cream usually is shipped to the larger cities.

FARGO CLAY.

The soil of the Fargo clay consists of about 3 inches of a black, crumbly clay, in places somewhat silty, grading into a black heavy plastic clay. The subsoil encountered about 10 inches below the surface is a bluish-drab plastic clay, which grades between 20 and 36 inches into a dark-drab or a grayish-drab plastic clay, the color in most places becoming lighter with depth, although here and there the material is black throughout the 3-foot section. In other places a tough gray layer lies near the surface, and here a grayish shade appears in freshly plowed fields. This variation, locally called gray gumbo, is more difficult to cultivate than the typical Fargo clay, being very hard to plow unless the moisture conditions are favorable. Another variation in the type is caused by an unusually large content of organic matter, the soil being of jet black color and mucky consistency, and the subsoil being dark in color to a depth of nearly 3 feet. In these places the soil is very sticky and plastic when wet, but friable when dry. When plowed under good moisture conditions it crumbles and slakes to a loamy mass. This variation is locally called "black gumbo." These two variations were too irregular and patchy to separate from the typical soil. They represent extremes in the type, which seems to fluctuate between the two throughout the areas mapped. In all sod land and in grain fields the soil becomes hard and compact in dry weather and wide cracks show on the

surface. In cultivated corn and potato fields a loose mellow mulch is easily produced. When properly managed this type can be maintained in good tilth.

The Fargo clay, though comparatively inextensive, occurs in several large bodies. One of these is situated in the southeastern part of the county, extending from east of Kelso south to Grandin and thence northward along the Red River. Another important area lies along the Mayville branch of the Great Northern Railroad from the county line northward through Blanchard to within a few miles of Mayville. The topography is almost level, with very slight swells here and there, and the natural drainage is poor. Before artificial drainage was supplied the soil was covered with water until late in the season. Even yet there are places where the crops drown out badly during wet seasons. With the construction of more drainage ditches, so that individual farms have an outlet, most of the type will be put in a condition to give good crops each year. Many of the ditches dug in the past are too small to carry off the surplus water efficiently at critical times.

The Fargo clay is regarded as one of the best soils for small-grain crops, large yields being obtained where the type is well drained naturally or artificial drainage has been successful. On a large part of the type, the continuous growing of small grains has resulted in the land becoming infested with weeds. Early fall plowing of stubble lands is advisable, as this tends to destroy weed seeds and favors the decay of vegetable matter before frost, and the severe freezing and thawing that follows in the fall, winter, and spring improves the physical condition of the soil. The small grains are seeded as early as possible in the spring so as to get some growth before the soil dries out and begins to drift. Wheat, according to local estimates, yields from 10 to 40 bushels, oats from 30 to 70, and barley from 20 to 60 bushels per acre. The yield of flax is comparatively small. This is probably due to the fact that it is sown later, on spring breaking, and that it is a poor weed fighter. Corn is not extensively grown, although in some places good yields are obtained. Potatoes are grown to some extent. In dry years they do well, yielding from 75 to 150 bushels per acre. In wet years the crop is hard to harvest, owing to the plastic nature of the soil. Where the land is well drained good stands of alfalfa are ordinarily obtained, tests on the experiment station farm at Fargo, which is located on this type, show it to be well adapted to both alfalfa and clover.

In places the type has become badly infested with weeds and quack grass, whole sections having been abandoned to quack grass. On account of the moisture conditions prevailing in wet years, the type can not receive the thorough cultivation it should have to prevent weed growth. Wild oats, yellow mustard, and French weed are the

most troublesome weeds. The Fargo clay is naturally a strong soil, but little effort has been made to maintain or to increase its productiveness. To make possible the highest development of the type, better drainage must be established. More main ditches should be dug along section lines, so that outlets for farm ditches will be available.

BEARDEN FINE SAND.

The Bearden fine sand consists of a black loamy fine sand 20 inches deep, grading into a brown or yellowish brown loose fine sand. In places the lower subsoil becomes grayish brown. Some small gravel is mixed with the soil and subsoil.

An area of the Bearden fine sand occupies a long ridge beginning about 2 miles northwest of Clifford and extending for 8 miles in a northwesterly direction. Its total area is about 8 square miles. The topography is rolling and in places choppy and has been influenced by glacial action. The drainage is good to excessive.

Wheat, oats, barley, flax, corn, alfalfa, and potatoes are grown on this soil. The ordinary yield of wheat ranges from 10 to 15 bushels, barley 25 bushels, oats 30 bushels, flax about 10 bushels, and corn about 35 bushels per acre. Considerable corn is grown for silage. There are some small patches of alfalfa. Potatoes are grown, principally, for home use. While the soil is easy to work the yields do not average as high as on the finer textured types of the series. In places where there has been a marked tendency to drift the native grasses have been allowed to take possession of the land. These are used for pasturage and hay production.

BEARDEN VERY FINE SAND.

The surface soil of the Bearden very fine sand consists of a dark-brown heavy very fine sand 12 to 14 inches deep, overlying a light-brown or yellowish-brown very fine sand of loose, open structure. The type is free from stone or bowlders.

Soil of this description occurs mainly in the southwestern part of the county, in the vicinity of Clifford and Galesburg. Other areas lie near Buxton and Reynolds. This soil seems to have been formed partly by wind and partly by wave action. It occupies long ridges only a little higher than the adjacent soils. The topography is gently undulating to ridgy; in places, apparently as the result of drifting, it is somewhat choppy. The drainage is good and in places excessive, and small-grain crops suffer for lack of moisture in some seasons.

The Bearden very fine sand does not have as high an agricultural value as the very fine sandy loam with which it is associated. Corn, potatoes, beans, and alfalfa do well. Wheat, oats, barley, and flax are less satisfactory. The yield of corn averages 30 bushels per acre,

and of potatoes ranges from 50 to 150 bushels per acre. Wheat yields from 10 to 15 bushels, oats 25 to 35 bushels, barley 25 bushels, and flax about 10 bushels per acre. Winter rye is grown, yielding on the average 15 bushels per acre. In the vicinity of Galesburg macaroni wheat is grown, giving better results than the hard wheats.

The Bearden very fine sand has a tendency to drift and care must be taken to prevent injury to land and crops from this cause. In plowing and cultivation it is best to leave the surface ridgy, as this reduces the movement of the soil and thus protects the seed and seedling plants. Rotations in which grass crops play an important part are also to be recommended as affording valuable cover and adding organic matter. Alfalfa and sweet clover do well on this soil and should be utilized more than at present.

The farms are generally well improved, but land values do not average as high as on the very fine sandy loam.

BEARDEN FINE SANDY LOAM.

The surface soil of the Bearden fine sandy loam consists of a dark-brown to black fine sandy loam, the dark color being due to the presence of a relatively high percentage of organic matter. The subsoil is similar to the soil to a depth of 20 inches, where it changes to a yellowish-brown very fine sandy loam, with an open, porous structure. Both the soil and subsoil are free from stones and gravel.

There is very little typical Bearden fine sandy loam in the county. Two small areas, with a combined area of 1 square mile, are mapped in the northern part of the county in Garfield Township. Another small area covering about one-half square mile is found about 5 miles northwest of Clifford, in Norman Township. Another quite small ridge of the same soil occurs in association with the Bearden very fine sandy loam north of Hatton.

The Bearden fine sandy loam occupies high, narrow ridges and seems to have been formed partly by wave action and partly by drifting of the coarser particles from the very fine sandy loam.

The type is used for the same general farm crops as the Bearden very fine sandy loam, but the yields do not average quite as high. There are variations in the type sufficiently marked to affect crops. In one the surface soil is a black medium sandy loam to a depth of 12 inches, grading below to a brown loose medium sand, which passes at about 20 inches into yellowish-brown material of similar texture and structure. The phase occupies a small ridge in sec. 21, T. 147 N., R. 50 W. It is rather droughty, so that crops suffer from lack of moisture. The other variation occurs in secs. 7, 18, and 19, T. 145 N., R. 53 W. where the type is poorly drained. The surface is a medium sandy loam to a depth of 12 to 18 inches, grading below to a grayish-

brown fine sandy clay, which extends to about 24 inches, where the material is a gray sandy clay. A large part of the type here is used for the production of hay or as pasture land.

The following table gives the results of mechanical analyses of the Bearden fine sandy loam:

Mechanical analyses of Bearden fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351754	Soil	1.1	6.1	8.8	61.1	5.3	10.7	7.1
351755	Subsoil	.8	4.8	8.6	68.6	5.0	6.5	5.9

BEARDEN VERY FINE SANDY LOAM.

The typical soil of the Bearden very fine sandy loam consists of dark-brown to black very fine sand to very fine sandy loam, varying in depth from 8 to 20 inches. The soil grades downward into a brown very fine sandy loam, which extends to a depth of from 14 to 24 inches, where it rests generally upon a layer of dark-gray very fine sandy clay of an open, friable structure. Where this layer is not present the brown very fine sandy loam extends to a depth of 30 inches. The lower subsoil is a yellowish-brown loose friable very fine sandy loam or very fine sandy clay. Mottlings of gray and rusty brown are generally present in the lower subsoil.

The Bearden very fine sandy loam is the most extensive soil in the county. The main body of this soil, covering about three townships, is situated in the northwestern part of the county. Other areas lie in the western part of the county from Clifford and Galesburg to the Cass County line. Another ridge of the same type extends from north of Cumings southward, crossing the Goose River about a mile west of Hillsboro and continuing to the Elm River. Smaller areas are scattered over the county, especially in the vicinity of Buxton and Reynolds.

The topography of the Bearden very fine sandy loam varies from level to slightly rolling. In the northwestern part of the county the country has considerable fall southeastward, many streams and draws flowing from this region. The surface of the remaining areas is rather ridgy, the soil occupying the crest and upper slopes of the ridges. The drainage is good, the rainfall usually being absorbed and passing into the subdrainage. At the same time the soil is retentive of moisture and the subsoil is moist even after protracted dry periods.

The mode of occurrence, the topography, and the soil material show that the type was deposited by moving water, probably as a

delta of glacial Elk River where it entered the glacial Lake Agassiz.[1] The areas forming ridges have resulted, it is thought, from wave action.

All general farm crops of the region are produced on the Bearden very fine sandy loam. Planting is from one to two weeks earlier in the spring than on the heavier soils, and growth generally continues, as crops rarely suffer seriously from drought. Yields may not average quite as high in some years as on the heavier soils, but complete failure seldom results either in seasons of excessive or deficient rainfall.

The average yield of the general farm crops taken from the Portland Junction State Demonstration Farm are about as follows: Wheat following corn, 25.3 bushels per acre; wheat after oats, 18 bushels per acre; barley, 24.2 bushels per acre; oats, 48.9 bushels per acre; corn (average of three crops), 47.4 bushels per acre; corn fodder (average of 7 crops), 3.67 tons per acre; oats and pea hay (3 crops), 1.76 tons per acre. A study of the records of the yields of this farm show that wheat has yielded as high as 34.66 bushels per acre. The highest yield of timothy and clover hay recorded was 3 tons per acre, and that for oat and Canada field peas was 2.05 tons per acre. The data show that the best yields of corn were obtained by plowing under a clover and timothy sod, and that the best wheat followed. The rotation outlined for the demonstration farm is corn, wheat, oats, wheat, barley, clover.

All the small grains are grown on the farms located on this type, and in addition a considerable acreage is planted to corn and potatoes. Corn is grown for grain, fodder, and silage. The yields of crops on the farms practicing a good system of rotation are about the same as on the demonstration farm. Potatoes are an important crop on this type in the vicinity of Hillsboro. The yield is from 50 to 200 bushels per acre, depending on the season. In most years potatoes do well, but occasionally a protracted dry spell cuts down the yield. At such times potatoes tip-burn badly. The production of potatoes on this soil in other parts of the State is large, and it seems well adapted to the crop. The tubers are clean, smooth, of uniform size and high quality. Much of the crop is shipped south for use as seed.

The acreage in winter rye is increasing from year to year. It is usually seeded on stubble land, from which spring grain has been harvested, the only preparation being disking. The seed is usually sown from the latter part of August to the middle of October. The old stubble helps to hold the snow in winter, and reduces the loss from winterkilling. When seeded to spring grain, this soil under

[1] Willard, Story of the Prairies.

certain conditions drifts, sometimes so badly that much of the seed is lost. This is one reason for the growing popularity of winter rye which by the time of high spring winds has made sufficient growth to prevent drifting. The yield ranges from 15 to 20 bushels per acre, and as much as 40 bushels per acre has been obtained under the most favorable conditions. The hardier varieties, such as Dakota No. 959, should be grown.

Weeds are not as troublesome on the Bearden very fine sandy loam as on the heavier soils. This is due in part to the fact that moisture conditions do not interfere so much with cultivation on the lighter types. Moreover, corn is grown more generally on this type and this helps considerably in keeping the soil free from weeds.

The ease with which the soil can be cultivated, its earliness, its capacity for absorbing moisture, and the good drainage make it a most desirable soil. The assurance of a crop every year is reflected in the large substantial farm buildings and the general appearance of prosperity of the farms over these areas. The farms are well equipped with stock and implements, cattle being kept to consume the roughage. Manure is generally applied to corn land and has helped materially to maintain the productive capacity of the soil. Fall plowing is generally practiced. Care must be exercised to prevent the soil from drifting, and the surface is usually left somewhat uneven after plowing.

Farms on this type are held at $65 to $100 per acre.

The following table gives the results of mechanical analyses of the soil, subsoil, and lower subsoil of the Bearden very fine sandy loam:

Mechanical analyses of Bearden very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351701	Soil	0.0	0.6	0.6	9.0	51.2	28.6	10.2
351702	Subsoil	.0	.5	.6	4.6	43.6	34.2	16.2
351703	Lower subsoil	.0	.4	.4	3.4	35.8	48.6	11.6

BEARDEN SILT LOAM.

The surface soil of the Bearden silt loam consists of very dark brown to black silt loam, 12 to 14 inches deep, underlain by a dark-drab to grayish-drab or gray heavy silt loam or silty clay loam, the color becoming somewhat lighter with increase in depth, and at 20 to 24 inches grading into a brown, yellowish-brown or olive-drab silt loam somewhat mottled with rusty brown.

The surface soil is almost jet black when moist, but has a brownish cast when wet. It is high in organic matter, has a smooth fluffy structure, and is easily kept in excellent physical condition. The

subsoil is also friable and retentive of moisture. A few shale fragments are found in some parts of the type; otherwise the soil is free from stone and gravel.

The largest area of the Bearden silt loam lies in the eastern part of the county, extending from Taft to Cumings, and running eastward almost to the Red River. A narrow belt extends from this area northward almost to the county line a few miles east of Buxton, and another follows along Buffalo Coulée to the Red River. Another large area, comprising about 8 square miles, is situated about 4 miles southwest of Blanchard in the southwestern part of the county. The remaining areas are small and found along the streams or mixed with other types. There is some variation in the type. East of Taft it contains considerable alkali in places, and in dry years alkali appears on the surface of slight knolls and other elevations. Where the soil is strongly impregnated yields are low. In places the type contains poorly drained spots, a considerable area of this character appearing about 2 miles southwest of Cumings. Relatively large quantities of alkali occur here also, and the land is used for pasture and hay production.

The topography of the type varies from level to very slightly rolling. Most of the type is well drained, except in the spring, when with the melting of the snow it receives drainage from higher areas. Ditches are being dug to remove the excess water.

The Bearden silt loam occurs at slightly higher elevations than the Bearden silty clay loam, but seems to have been formed in about the same way. Most of the area is bounded on one side by a very fine sandy loam and on the other side by a heavy soil.

The Bearden silt loam is used for the production of all the staple crops grown in this region. It is practically all under cultivation, is highly developed, and considered one of the best soils in the county. Wheat yields from 15 to 35 bushels per acre, and oats and barley about the same as on Fargo silt loam. Considerable corn is grown on the type. The yield of grain ranges from 35 to 50 bushels per acre. Most of the crop is cut for silage. Potatoes are grown to some extent in the vicinity of Hillsboro and Buxton. From 100 to 200 bushels per acre is about the range in yield. The tubers are of good quality. Timothy and clover are grown, yielding from three-quarters to one and one-half tons of hay per acre. Some sweet clover is grown. Alfalfa occupies a considerable acreage and sweet clover is grown to some extent. Timothy and clover or alfalfa sods are allowed to stand for several years. The old fields are generally plowed and seeded either to flax or planted to corn or potatoes. Flax does well, the yield sometimes running as high as 20 bushels per acre, and fields in ordinarily good condition averaging 15 bushels per acre. The wilt attacks this crop and it is not advisable to put flax

on the same ground more than once in five years. The poorly drained areas support a good growth of native grasses, which make excellent hay and pasture.

The farms are well improved and well stocked with horses and implements for cultivating the soil and with cattle for utilizing the roughage.

The herds of cattle usually consist of mixed dairy and beef breeds, with a predominance of Red Polled blood. Butter and milk are produced for home use. Some cream is shipped from the farms. Most of the farms are held at $60 to $90 per acre.

BEARDEN SILTY CLAY LOAM.

The soil of the Bearden silty clay loam consists of a surface layer of black silt loam about 3 inches thick and a subsurface layer of black silty clay 5 to 7 inches thick. The soil grades into a grayish brown or a grayish drab heavy silt loam to silty clay subsoil, extending in most areas to a depth of 20 inches, but in places 24 to 30 inches. Ordinarily this gray layer in the subsoil changes gradually with increase in depth, giving way to grayish-brown, then to yellowish-brown, and finally to a yellow silty clay, silt, or very fine sandy clay, very friable and open in structure. The lower subsoil has a bright yellow color, with some mottling and brown iron strains.

Though dense black when wet, the soil on drying has a somewhat brownish cast. It is high in organic matter and has a smooth, flourlike feel. It is easily kept in good physical condition. In making borings the texture becomes noticeably more silty and the structure more open with increasing depth. The subsoil is retentive of moisture. Some sand streaks are found in places at about 30 inches below the surface. The soil has a high lime content and some alkali occurs in spots, but the concentration of soluble salts is not enough to interfere seriously with the growing of crops.

There are two important areas of Bearden silty clay loam in the county. The largest lies in the northeastern corner and covers the greater part of Belmont and part of Bingham Townships. The other area, with an extent of approximately 8 square miles, lies southeast of Portland and south of Mayville. In addition to the above there are numerous small areas throughout the southern part of the county. The topography is somewhat like that of the Fargo silty clay in that there are high and low places of irregular outline, but the differences in elevation are not as marked as in the latter type. The topography in general is level. The drainage, which is mainly by percolation into the subsoil, is usually efficient, except in places where water coming from higher lying soils collects. This excess water is removed to a

large extent by drainage ditches. The mode of occurrence, level topography, and character of the soil material show that the type is of alluvial origin. The indications are that it was deposited by the glacial Elk River at the same time as the sandier soils. The finer materials forming this type were carried farther into the lake and modified by deposits of lacustrine origin. Most of the type is bordered by lighter textured Bearden soils on one side and by heavier Fargo soils or by stream-bottom types on the other.

Practically all of the Bearden silty clay loam is in cultivation and in a high state of development. It is used almost exclusively for the production of small grain, wheat being the most important, followed by oats, barley, and flax. Some corn and potatoes are grown, as well as timothy, clover, and millet. Wheat ordinarily yields from 15 to 40 bushels, oats from 30 to 60 bushels, barley about 40 bushels, and flax 15 bushels per acre. Corn is grown to clean the land of weeds, and is used mostly for silage. In some years the production of potatoes is large; in other years few are planted. Several large fields were observed this year (1918). The yield varies considerably, ranging from 75 to 200 bushels per acre. Few farms on the type are equipped to store any considerable quantity of potatoes, and as most of the farms are some distance from a shipping point the growing of potatoes is not receiving much attention. The fact that the cultivation of potatoes cleans the soil of weeds and increases the yield of wheat leads many farmers to grow the crop.

Aside from a few sections badly infested with quack grass, the type is comparatively free from weeds, though considerable wild oats, mustard, and patches of sow thistle are found in places. The farms are well improved. Large houses and barns with well-established groves prevail over the type. Very little land of this type is changing hands at the present time.

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

Mechanical analyses of Bearden silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351732	Soil	0.0	1.0	0.9	7.2	19.0	52.4	19.9
351733	Subsoil	.0	.6	.4	2.6	28.6	25.2	42.8
351734	Lower subsoil	.0	.0	.7	1.2	24.1	56.9	17.3

SIOUX VERY FINE SANDY LOAM.

The surface soil of the Sioux very fine sandy loam consists of about 12 inches of a black very fine sandy loam, containing some

fine gravel. Below 14 inches the material changes abruptly into a subsoil of grayish-brown sandy loam which passes into a brown loose sand and gravel. Some streaks of lime carbonate are noticed and much of the gravel has a coating of lime. The substratum below 3 feet shows stratification and cross bedding.

Soil of this type is mapped in the southwestern and northern-central parts of the county. In the vicinity of Buxton and Reynolds it is closely associated with soils of the Webster series.

The Sioux very fine sandy loam occupies long, narrow ridges varying from a few rods to a quarter of a mile in width and having a general northwest-southeast trend. In the southwestern part of the county the ridges are very narrow, have relatively high crests, and abrupt slopes to the east. In the west there is little or no slope; in many places after a slight fall the surface continues level or rises slightly until the foot of the next ridge is reached. In crossing the county on the section line north of Greenfield toward Galesburg, the resemblance to a series of steps or terraces is striking. The areas in the north-central part of the county vary greatly in width and in their direction. The ridges here are gently rolling in topography, with abrupt slopes on each side. However, many of the areas here are not so distinct, owing to the general rolling character of the country about them.

The surface soil of the type is quite uniform in texture. The structure is compact in native sod land, while in cultivated fields it is rather loose and open. Where the subsoil has not been disturbed it is compact, but the movement of ground water is not retarded and there is a marked tendency toward droughtiness.

The underlying material of this type as well as the other Sioux types is valuable for road, railroad, and concrete construction. Many gravel pits have been opened.

All the Sioux very fine sandy loam is under cultivation, except a few areas around gravel pits. For the most part the type is farmed in connection with other soils. It is rather droughty for small grains, but corn, potatoes, and truck crops do fairly well, the type holding moisture fairly well where a surface mulch is maintained. Many farmsteads are placed on the type owing to good drainage conditions. Gardens on the slopes produce early vegetables. In late summer the type usually suffers from drought. Winter rye should be a good crop for this soil. In other areas[1] in the same general region winter rye has been found to be the most dependable small-grain crop to grow. It is seeded in September and reaches maturity before the hot summer weather begins.

Farms having a considerable acreage of this soil are not considered as valuable as those on either the Bearden or Fargo soils.

[1] Pennington County, Minnesota, soil report.

A slightly heavier soil has been included with the Sioux very fine sandy loam. The soil consists of a black loam containing considerable fine sand and very fine sand, to a depth of about 8 inches. The subsoil, from 8 to 20 inches, consists of a dark-brown gravelly loam, the lower part being quite compact. Below 20 inches the material is a gray coarse sand and gravel. In gravel pits stratified sand, coarse sand, and gravel occur at about 3 feet and extend from 8 to 10 feet or more below the surface. This layer is underlain in most places by silt or very fine sand.

This slightly heavier soil occurs in ridges, varying in width and outline as well as direction. The topography is in general like that of the typical Sioux very fine sandy loam.

There are several areas of this heavier soil in the county. An area of considerable size lies about 2 miles southwest of Clifford. Several large areas are found in the northern-central part of the county in T. 148 N., Rs. 51 and 52 W.

On account of its small area, the Sioux sandy loam has been mapped with the Sioux very fine sandy loam. The soil is a black sandy loam, 8 inches deep, containing some fine sand and fine gravel. From 8 to 24 inches the subsoil consists of a brown coarse sandy gravelly loam, which changes below to stratified coarse sand and gravel. Only one area of the sandy loam occurs in the county. This lies about 7 miles southwest of Hillsboro, in section 36, T. 145 N., R. 51 W. on a rather broad ridge adjacent to the North Fork of the Elm River. The soil is apparently derived from deposits laid down by this stream when it flowed at a higher level. The topography is level to gently rolling. While the soil is well drained, crops do not suffer badly from drought.

SIOUX SILT LOAM.

The Sioux silt loam consists of a black silt loam, about 20 inches deep, rather light on the surface but heavier and more compact below. At 20 inches there is a change to grayish-drab gravelly silty clay. A gravelly sandy layer lies within 3 or 4 feet of the surface. In the area in T. 144 N., R. 53 W., sections 2 and 11, the gravelly layer is apparently rather thin and underlain by silty material.

The total area of the Sioux silt loam in the county is less than 2 square miles. The surface is gently rolling. The soil is well drained, but the rather heavy subsoil retains moisture well and crops do not suffer badly from drought, and in seasons of average rainfall it produces good crops. Wheat yields from 10 to 25 bushels per acre, oats 30 to 50 bushels, flax 10 to 15 bushels, barley 25 to 40 bushels, and corn about 40 bushels per acre. The type in general is in a high state of cultivation.

WEBSTER VERY FINE SANDY LOAM.

The Webster very fine sandy loam consists of 12 to 18 inches of black loamy very fine sand to a very fine sandy loam, underlain to a depth of 24 to 30 inches by a yellowish-brown to grayish-brown or drab very fine sandy clay. Below 24 to 30 inches the material is an olive-drab, stiff, plastic, impervious clay, with grayish-drab and rusty-brown mottlings.

A high percentage of organic matter gives the surface soil a light, mellow structure. In many places the upper part of the subsoil has the characteristics of the Bearden very fine sandy loam. The type is almost free from stones and bowlders throughout the soil, but a gravelly layer is often present at about 24 inches below the surface.

The topography of the Webster very fine sandy loam varies from level to gently undulating, with many slight depressions. The type is subject to extremes of moisture conditions, but not to so great an extent as the loam and the silt loam of the series. In years of heavy rainfall the swales are too wet for cultivation, the impervious subsoil preventing the downward movement of the water. When the dry season comes, the upper layer above the subsoil dries out quickly, and as the reserve in the substratum can not be drawn upon crops suffer. During seasons of normal rainfall the crops do not ordinarily suffer for lack of moisture. Wheat, oats, barley, corn, and flax are the leading crops. Wheat yields 20 bushels, oats 40 to 60 bushels, barley 40, and corn about 40 bushels per acre. Some potatoes are grown, but principally for home use. The crop seems to be rather uncertain.

Farms are generally better improved and show a more prosperous condition than those of the other Webster types.

The following table gives the results of mechanical analyses of the soil, subsoil, and lower subsoil of the Webster very fine sandy loam:

Mechanical analyses of Webster very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351751	Soil	0.6	2.8	3.3	30.1	35.0	19.9	7.8
351752	Subsoil	.7	2.7	2.4	31.6	37.5	14.7	10.5
351753	Lower subsoil	1.0	3.5	3.6	17.8	13.3	40.9	19.9

WEBSTER LOAM.

The surface soil of the Webster loam consists of a black loam, 16 inches deep, rather light at the surface but becoming heavier in texture and more plastic with depth. The subsoil between 16 and 20 inches is a brownish-drab heavy and plastic very fine sandy clay; at about 20 inches a distinct layer containing gravel and stones occurs,

below which there is a grayish-drab stiff plastic clay, mottled with streaks of gray and grayish-brown. Both the soil and subsoil contain bowlders, gravel, and angular rock fragments.

The Webster loam occurs in several large areas in the northern part of the county. One is crossed by the Great Northern Railroad about 3 miles north of Cumings and two others lie about 5 miles west of Buxton. Small areas are scattered throughout the same general region.

The topography of this soil varies from level to gently rolling and choppy. While some areas are well drained, the greater part of the type is rather poorly drained. More or less alkali occurs in the soil and subsoil.

The well-drained parts of the type are in cultivation and used largely for production of wheat, oats, barley, and flax. The yields as a rule are moderate, wheat returning 10 to 15 bushels, oats 25 to 30 bushels, barley 20 bushels, and flax from 5 to 10 bushels per acre. A great deal of the type is too poorly drained, at least at certain times of the year, to allow cultivation, but good crops of hay are cut from such areas and they make fine pastures during the drier part of the season.

The type is not very thickly settled and the farmsteads do not indicate as great prosperity as those on many other soils in the county. More cattle are kept on these farms, and dairying is being extended from year to year.

Land of this type ranges in price from $10 to $30 an acre.

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

Mechanical analyses of Webster loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351743	Soil	2.0	4.0	1.9	14.0	35.8	24.2	18.5
351744	Subsoil	4.4	6.5	2.1	18.0	37.0	13.9	18.0
351745	Lower subsoil	1.6	2.6	1.4	5.7	13.5	33.0	42.4

WEBSTER SILT LOAM.

The surface soil of the Webster silt loam consists of 5 to 10 inches of a black silt loam which becomes somewhat heavy with depth. The upper subsoil from 10 to 20 inches, is a black or dark-brown heavy silty clay containing gravel. At about 20 inches a gravelly layer is encountered below which is an olive-drab silty clay, mottled with gray and yellowish-gray. The lower subsoil is plastic and rather impervious. It contains bowlders and smaller stones.

Areas of this type lie from 1 to 5 miles west of Buxton and in the country extending northward toward Reynolds. The topography is similar to that of the loam, being rolling to choppy in the broader areas, and rather smooth to gently sloping on the narrower ridges. In some places the type forms an intermediate zone between lighter and heavier types. Some parts of the area are well drained and others poorly drained. Considerable accumulation of alkali occurs in both the soil and the subsoil.

About the same proportion of the silt loam is cultivated as of the Webster loam. The leading crops are wheat, oats, barley, corn, and flax. Yields are about as follows: Wheat 10 to 15 bushels, oats 25 bushels, barley 21, corn 25, and flax 7 to 10 bushels per acre. A large proportion of the type is in grass, much of it virgin sod. The native grasses produce from one-half to three-fourths ton of hay per acre, and afford good pasture after the hay is taken off.

The yield of the general farm crops averages lower than for the rest of the country, and the farmsteads are fewer and not as well kept as in other sections. The type seems best suited to dairying. Much of the type is too wet in wet years and too dry in dry years for the production of small grain.

WEBSTER SILTY CLAY LOAM.

The soil of the Webster silty clay loam consists of a black plastic silty clay loam ranging from 8 to 14 inches and averaging about 10 inches in depth. The subsoil is a yellowish-drab or dark-drab plastic clay, streaked with gray and mottled with brown, resting at 20 to 26 inches on a stratum of stone and gravel. Below this stratum the material is olive-drab to grayish-drab plastic clay, with a plastic impervious structure.

The best drained area of this type lies about 2 miles south of Buxton. Most of this area is in cultivation and producing fair crops. The areas lying to the north and west of Buxton are rather poorly drained.

The topography of this soil is gently undulating to choppy, with many sloughs and small depressions, which remain in a wet condition for a long time after rains, while the soil on the intervening knolls dries quickly. This lack of uniformity in moisture content makes cultivation difficult. Many stones and bowlders are scattered about over the surface and throughout the soil and subsoil.

The type has never been extensively farmed, owing to the many sloughs and the large quantity of stones and bowlders. Much of the type has never been broken. Some of the higher lying, smoother areas, where they are of sufficient size, are used for small-grain production. The poorly drained areas contain considerable alkali and

would probably give low yields on this account even if other conditions were favorable. Wherever the type is covered with native grass, it makes fine pasture and produces large yields of hay.

This soil seems best adapted to some system of stock farming, either dairying or the raising of beef cattle. The number of cattle now carried on the farms is relatively large. Many of the farms are so situated as to include some more sandy or better drained soil, and here small grains and corn are grown, while the Webster silty clay loam is utilized for pasture and hay production.

The type is rather thinly settled, the farmsteads generally are not well improved, and the land can be bought at a low price.

WEBSTER CLAY LOAM.

The Webster clay loam consists of a black mucky clay loam, about 8 inches deep, resting on a black stiff clay which at about 10 inches changes to a drab clay of plastic, tenacious structure. In the lower part of the subsoil the material becomes lighter-drab, splotched with olive-drab and greenish-yellow mottlings.

This soil is of small extent. It is developed in several small areas in the general region in which other types of the series occur. The topography is flat, the type occupying the lowest depressions and sloughs in this region. The drainage is poor, water standing over the land far into the summer. The type is used for the production of hay and summer pasturage.

The following table gives the results of mechanical analyses of the soil and subsoil of the Webster clay loam:

Mechanical analyses of Webster clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351746	Soil	0.6	3.7	3.0	16.8	20.9	30.5	24.4
351747	Subsoil	1.1	3.2	2.8	10.8	13.7	39.7	28.6

LAMOURE VERY FINE SANDY LOAM.

The soil of the Lamoure very fine sandy loam consists of a light-brown to dark-brown smooth friable-textured and open-structured very fine sandy loam, from 16 to 24 inches deep. The subsoil to 36 inches is a dark brown very fine sandy loam somewhat heavier in texture and more compact in structure than the surface soil, though in places it has the same structure. The subsoil is calcareous.

This type occurs in the first bottoms of Elm and Goose Rivers along their course across the western part of the county. The type

is typically developed along the South Fork of Elm River east of Galesburg and along the forks of the Goose River west and north of Portland, where these streams have cut wide channels and built a flood plain of sandy material. These bottoms vary in width from about one-fourth mile to one-half mile. The topography is level, but the surface is cut in many places by abandoned stream channels. At present they are rarely overflowed, and the drainage is good. In many places the type is heavily forested with maple, elm, and other hardwoods. The narrow areas, crossed by meandering channels, are used principally for pasture and hay land. The broader areas above Portland are farmed to wheat, oats, barley, corn, and potatoes. Wheat yields as high as 30 bushels, oats 60 bushels, barley 35 bushels, and corn 50 bushels per acre. Potatoes, which yield well, are grown principally for home use.

The type is considered a strong soil and desirable to include in farms with the adjacent soils. The farms containing areas of this soil are well improved.

LAMOURE SILTY CLAY.

The Lamoure silty clay varies from a heavy silt loam to a heavy silty clay, the prevailing texture being a silty clay loam of dense black color resting below 20 inches on a black crumbly silty clay subsoil. Both soil and subsoil contain accumulations of alkali salts.

Soil of this description occupies narrow first bottoms along the Elm River and its tributaries. It is typically developed west of Kelso. It is the most poorly drained soil of the series and is subject to overflow nearly every spring. A small part of it, included in fields of upland soil, is cultivated. Good yields of wheat, oats, barley, and flax are obtained. The greater part has never been cultivated, but is valuable as pasture land.

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

Mechanical analyses of Lamoure silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351756	Soil	0.1	0.8	2.9	15.6	17.6	39.6	23.9
351757	Subsoil	.1	.6	1.5	21.4	11.2	38.2	26.0

LAUREL SILT LOAM.

The surface soil of the Laurel silt loam varies from a light-brown to a brown or grayish-brown friable mellow silt loam. The subsoil encountered between 14 and 20 inches is like the soil in texture but

slightly more compact in structure and streaked with dark-brown. The type is generally uniform in texture over the wider bottoms, but on the narrow bottoms it often approaches a very fine sandy loam. In places thin layers of very fine sand are present in the subsoil.

Soil of this type is developed along the Goose River west of Hillsboro and in the larger bends of the Red River. It is well drained.

The larger areas of this soil are cleared and cultivated. Good crops of wheat, oats, barley, corn, and potatoes are obtained. Wheat yields 20 to 40 bushels, oats 40 to 60 bushels, barley 40 bushels, corn 50 bushels, and potatoes from 100 to 250 bushels per acre. The type is considered a strong soil, especially for wheat, potatoes, and corn. The yields of corn are among the largest in the county. The narrower bottoms are used for pasture and hay production. A considerable area of the type is still heavily forested with elm, maple, oak, and cottonwood. The wooded area makes good pasture.

Improved farms of this type of soil can not be bought for less than $60 per acre and some are held for as much as $100 per acre.

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

Mechanical analyses of Laurel silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351713	Soil	0.0	0.2	0.3	3.4	18.8	64.2	13.5
351714	Subsoil	.0	.1	.2	4.0	24.5	56.9	14.6

BARNES VERY FINE SANDY LOAM.

The Barnes very fine sandy loam consists of 7 to 9 inches of a dark-brown very fine sandy loam grading downward into a brown very fine sandy loam, which below 24 inches changes to a yellowish-brown very fine sandy loam, mottled with greenish-brown and gray. The surface soil is high in organic matter, which gives it a light fluffy structure. The subsoil becomes more compact with depth until in the lower part it is quite hard. When exposed to the weather this hard material assumes a mellow open structure.

The surface of the type is rolling to hilly and the drainage good, many draws leading off into the lower country.

The Barnes very fine sandy loam covers about 3 square miles in the southwestern corner of the county. The type is devoted to the production of wheat, oats, barley, corn, and potatoes. Wheat yields, 15 to 30 bushels per acre, oats 40 to 50 bushels, barley about 30 bushels, and corn 25 to 30 bushels per acre. The type is practically all under cultivation and well improved. It is in most cases included in farms with other soil types.

The following table gives the results of mechanical analyses of the soil, subsoil, and lower subsoil of the Barnes very fine sandy loam:

Mechanical analyses of Barnes very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351792	Soil	1.2	4.0	3.1	34.8	22.2	26.4	8.0
351793	Subsoil	2.0	5.8	3.6	32.8	23.7	21.1	10.6
351794	Lower subsoil	2.0	3.6	2.7	29.4	23.9	22.2	16.3

MAPLE VERY FINE SANDY LOAM.

The Maple very fine sandy loam consists of about 12 inches of a black very fine sandy loam, underlain by a grayish drab very fine sandy loam and at about 24 inches by a yellowish and grayish drab mottled very fine sandy loam.

Two small areas of the Maple very fine sandy loam are mapped in the southwestern part of the county, one about one mile southwest of Galesburg and the other about two miles northeast of Galesburg. The topography is low and flat and the soil is poorly drained. Considerable alkali is present in soil and subsoil. The type is used for hay production and for pasture.

MAPLE SILT LOAM.

The surface soil of the Maple silt loam consists of a black silt loam, somewhat mucky in places, but becoming heavy with depth. The subsoil encountered at about 18 inches is a dark grayish drab to light grayish drab silty clay loam or very fine sandy clay. There are usually some streaks of sandy material through the subsoil.

This type of soil is generally low and poorly drained, water standing over the surface during a considerable part of each year. Alkali is found both in the soil and subsoil. None of the type is in cultivation, but it makes good pasture and hay is cut from the drier areas.

This is an inextensive soil. The principal areas lie in the southwestern part of the county. Another is mapped in secs. 9 and 16, T. 146 N., R. 53 W.

SUMMARY.

Traill County lies on the eastern boundary of North Dakota. It comprises three main physiographic divisions: (1) Glacial Lake Agassiz, (2) a glacial river delta, and (3) upland or rolling prairie. The eastern and southern part of the county are level and in places rather poorly drained. The northwestern part is level to gently undulating, high and well drained. The southwestern corner of the

county is high and well drained, with a rolling to hilly topography. The county ranges in elevation from 860 to about 1,060 feet above sea level. The streams flowing across the county find their outlet into the Red River of the North, which forms the eastern boundary of the county.

The total population of the county in 1915 is given by the State census as 12,830, all of which is classed as rural. The two principal towns are Hillsboro, the county seat, with a population of 1,299, and Mayville, with a population of 1,200. Other towns are Galesburg, Portland, Hatton, Reynolds, Buxton, and Cumings. The county is largely settled by people of Scandinavian and of German birth.

The three lines of the Great Northern Railroad crossing the county furnish good transportation facilities. Practically all of the farms are within 6 miles of some shipping point. The roads are good and are gradually being improved.

The water supply for the farms is obtained from deep wells or from artesian wells.

The educational advantages of the county are above the average.

The climate is subhumid, with comparatively long winters and short, cool summers. The mean average temperature is 40° F. The average date of the last killing frost in spring is May 20 and that of the first in fall September 21. The average growing season is 164 days. The mean annual rainfall is 20 inches.

Agriculture was first carried on by a few settlers along the streams as early as the seventies, but with the building of the railroads in the early eighties it was extended to all parts of the county. From the first wheat has been the most important crop, but within recent years a more diversified system of farming has developed. After wheat, oats, barley, flax, corn, and rye rank in importance in the order named. Stock raising is receiving more attention from year to year.

The price of agricultural land ranges from $40 to $100 per acre.

The soils of the county fall naturally into four main groups—glacial, glacial-lake, delta, and river-flood-plains soils.

In the glacial group are the Barnes and Webster series.

The Barnes very fine sandy loam has a dark-colored surface soil and a yellowish-brown compact subsoil. The soil is retentive of moisture and productive.

The Webster soils have dark-colored surface soils and mottled gray and drab and drab to olive-drab subsoils. The topography is gently rolling. Stones and bowlders are present. The series is poorly drained, and the soils have been developed under conditions of restricted drainage.

The glacial-lake and delta groups comprise the Bearden, Fargo, and Sioux.

The Bearden very fine sandy loam, silt loam, and silty clay loam are valuable soils for all types of farming developed in this northern subhumid region. The Bearden very fine sand, fine sandy loam, and fine sand have a tendency to be droughty in seasons of less than normal rainfall.

The Fargo series is characterized by dark-colored soils and drab to grayish-drab calcareous subsoils. The clay and silty clay are inherently productive, but in places need artificial drainage. The silt loam and very fine sandy loam are well-drained, productive soils.

The Sioux series is characterized by a gravelly subsoil. The Sioux silt loam is a productive soil. The Sioux very fine sandy loam is ridgy and too droughty for satisfactory production of small-grain crops.

The Lamoure, Laurel, and Maple series comprise the soils of recent alluvial origin.

The Lamoure very fine sandy loam is a highly productive soil and rarely overflowed. The Lamoure silty clay is subject to overflow nearly every spring. This type occupies narrow stream bottoms and is used principally for pasture.

The Laurel silt loam is a lighter-colored soil of the first bottom. It is rarely overflowed and is a valuable soil for general farming.

The soils of the Maple series are poorly drained and contain considerable accumulations of alkali. They are used principally as hay and pasture land.

[PUBLIC RESOLUTION—No. 9.]

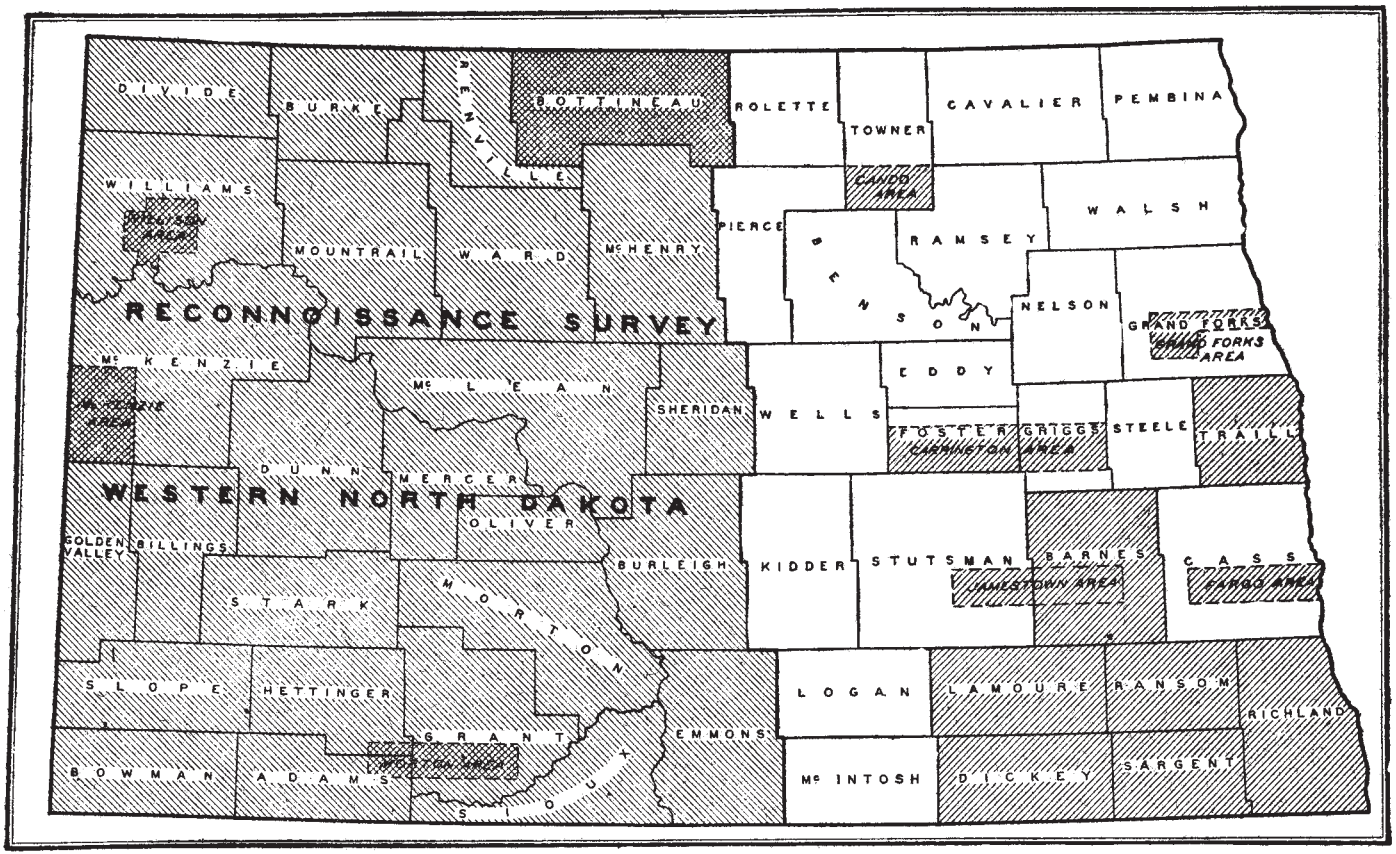
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

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

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

Approved, March 14, 1904.

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



Areas surveyed in North Dakota.

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