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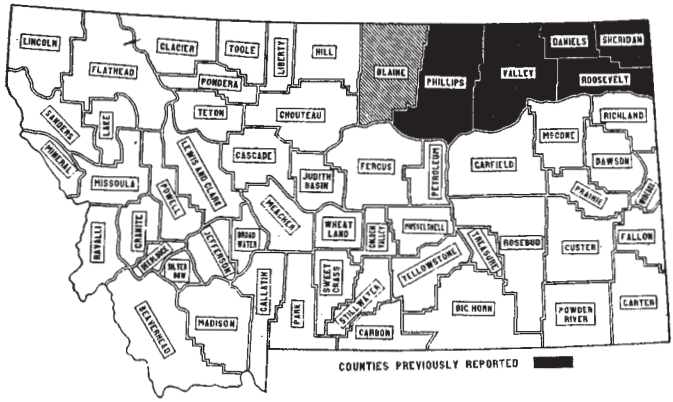
SOILS OF BLAINE COUNTY



SOIL RECONNOISSANCE OF MONTANA

PRELIMINARY REPORT

BY

L. F. GIESEKER

IN CHARGE OF SOIL SURVEY
COOPERATING WITH THE BUREAU OF SOILS
UNITED STATES DEPARTMENT OF AGRICULTURE

UNIVERSITY OF MONTANA
AGRICULTURAL EXPERIMENT STATION
BOZEMAN, MONTANA

CONTENTS

The primary purpose of this soil reconnoissance of Montana is to obtain general information in regard to (1) the soil resources of the state, (2) the adaptability of the topography to agriculture, and (3) the carrying capacity of the different soil areas for live stock. Such a survey is of a general nature and the areas shown on the soil and topographical maps simply represent the prevailing character of the soil and topography.

The Blaine County report is the sixth to be issued. Reports on Sheridan, Daniels, Roosevelt, Valley, and Phillips counties are also available and may be obtained from the Montana Experiment Station, Bozeman, Montana.

SOILS OF BLAINE COUNTY

BY

L. F. GIESEKER, ASSOCIATE AGRONOMIST

LOCATION

Blaine County is one of three large, elongated counties extending from the Canadian line to the Missouri River in the north-central part of the state of Montana. During the time when stock raising was the chief industry of the eastern plains of the state, the counties were very large and often the county seats were long distances apart. With the settlement and breaking out of the prairies in the so-called "cow counties" came a demand for smaller county units. Among the first of these counties to be reorganized was Chouteau — then the largest county in the state and second largest in the United States. Out of its northern portion Blaine and Hill counties were created in 1912. Hill covered a much larger area at that time and Blaine included within its borders the western one-third of what is now Phillips County. The boundaries of Blaine have not been changed since 1915, when Phillips was created.

Blaine County covers an area of 4229 square miles, the greater part of which lies north and northeast of the Bear Paw Mountains. Its boundaries are quite regular except for the southern line, which follows the Missouri River for a short distance and then passes to the north and east around the Little Rocky Mountains. The county lies between Townships 23 and 37 North of Base Line Montana and Ranges 17 and 36 East of Principal Meridian Montana. It has an extreme length of over 90 miles and a width which varies from 37 miles north of the Missouri River to 57 miles along the Canadian line. The Fort Belknap Indian Reservation, which extends across the county line into Phillips County, lies in the southeastern part between the Milk River and the Little Rocky Mountains.

PHYSIOGRAPHIC FEATURES

The greater part of Blaine County lies in the glaciated portion of the Great Plains, which extends north into Canada and east into North Dakota. The major streams are rather deeply

intrenched and their courses are bordered by rugged breaks which are often eroded into bad lands. The Little Rocky and Bear Paw mountains rise from 1500 to 2000 feet above the rolling plains in the southern part and Cherry Patch Ridge stands out prominently in the north-central part. Dissected plateaus occur in the northeastern corner and about the mountains the higher ridges are locally covered with breccia, a rock composed of irregular fragments cemented together. The southern slopes of the Milk-Missouri River divide are badly eroded into broken ridges and buttes. The glaciated plains underlain with the Bear Paw shales have a much more gentle relief than those underlain with the sandstones of the Lance and Judith River formations. Erosion has not greatly changed the surface of the drift-covered area since the time of glaciation, except along some of the perennial and intermittent streams and on the more lightly drift-covered divides.

Wisconsin glaciation: The continental ice sheet which developed in central Canada, probably during the late Wisconsin glaciation, spread over the greater part of north-central Montana. It extended well up the northern slopes of the Bear Paw and Little Rocky mountains but apparently did not cross the low divide between these mountains into the drainage basin of the Missouri River.

The drift-covered plains have a hummocky, billowy relief. Shallow lake depressions and low mounds and stony ridges are conspicuous in the more intensely glaciated sections. The thicker deposits of drift, such as are found in the northeastern part of the county and on the slopes of the mountains and plateaus, range from 25 to 50 feet deep, except in some of the pre-glacial valleys, where they may exceed 100 feet in depth. The more shallow deposits occur in the drainage basin of the West and North forks of the Milk River, on the Phillips loam tracts shown on the soil map south of Milk River, and on the more feebly glaciated divides. Stony morainic ridges are found on the slopes of the plateaus, along the Milk River, Woody Island and other creeks, and in the foothills of the mountains. In the more eroded sections, such as are found along some of the streams and coulees, boulders often overlie heavy residual material, derived from the underlying shales.

The glaciated plains range in elevation from 2400 to 2600 feet along the Milk River to 2800 to 3000 feet along the international line. Most of the agricultural land south of Cherry Patch Ridge and the Big Flat is below 2800 feet in elevation. South of the Milk River, the land rises quite rapidly in the direction of the Bear Paws but more moderately toward the Little Rockies. The greater part of the drift-covered area below the foothills is below 2800 feet in elevation.

Big Flat: A high bench, known locally as "Big Flat" and also as "Turner Bench," rises in the northeastern corner of the county and extends east into Phillips County. It belongs to the Flaxville group of plateaus, which occur in this part of the state below the Canadian line. The surface of these plateaus is covered with an ancient stream deposit, which is semiconsolidated, with lime as the cementing agent.

The Big Flat has an elevation of approximately 3000 feet and stands out very prominently several hundred feet above the rolling glaciated plains to the south. The slopes of the bench are heavily covered with stony, hummocky drift, which forms the so-called "ridges" on its southern slopes. Similar moraines are also found along Woody Island Creek to the north. The surface of the bench between the intrenched coulees is level to undulating. The high hills on the lower slopes of Cherry Patch Ridge, west of the Big Flat, also are capped with Flaxville gravels.

Lone Tree and Raglin benches: Isolated irregular benches, which have been protected from erosion by a covering of gravel and rock fragments, occur on the broader divides south of the Bear Paw Mountains and west of Bullwhacker Creek. These benches lie several hundred feet higher than the barren clay hills and ridges, which form the broken slopes of the divides. The rock fragments found on the higher benches have been carried out of the mountains, but the water-worn quartzite gravel on the lower benches has been transported from a more distant locality. Quartzite gravel also forms a light covering on some of the divides east of Bullwhacker Creek. On Lone Tree Bench, between Bullwhacker and Black Coulee, the quartzite gravel deposit is about 30 feet in depth, and lies at an elevation of approximately 3300 feet. Its borders are indented with deep coulees.

Raglin Bench is located above the breaks of the Missouri River and Black Coulee. It is several hundred feet lower than Lone Tree Bench, has a more shallow surface covering of gravel, and is deeply dissected with coulees. The high benches at the foot of the Bear Paws are heavily covered with rock fragments carried out of the mountains. These benches are very irregular and stand out prominently above the breaks of the streams.

Rattlesnake and other benches: The southeastern slopes of the Bear Paw Mountains are broken with intrenched streams, above which rise bold sandstone cliffs. Rattlesnake Bench is one of the larger tracts on the southeastern slopes of the mountains above the breaks of Spring and Rattlesnake creeks. Slabs of red sandstone, which also cap the mushroom rocks on some of the smaller benches farther north, outcrop on the surface of the bench. The so-called benches extending out from the Little Rockies are covered with fragments and slabs of limestone. These ridges are rather narrow and their surface broken with deep coulees.

Cherry Patch Ridge, one of the more prominent ridges in north-central Montana, is located in the north-central part of the county and stands out prominently at an elevation of approximately 3300 feet above the rolling, glaciated plains. Its southern slopes are broken with outcrops of shale and sandstones.

The Bear Paw Mountains rise in Chouteau and Hill counties to the west and extend into the southwestern part of Blaine County as two fairly well-defined ridges separated by a broad basin drained by Peoples Creek. These mountains have an elevation of approximately 5000 feet in the vicinity of Cleveland and rise to over 7000 feet in Hill and Chouteau counties. The Bear Paw Mountains are past maturity as indicated by the fact that their peaks and ridges are well rounded. Large dikes of ancient trap rocks radiate from the peaks and ridges and seam the mountain slopes and basins which are underlain largely with sedimentary rocks. The northern ridge terminates in groups of high buttes, known as Snake and Wild Horse, in the plains northeast of the mountains.

The Little Rocky Mountains lie about 50 miles southeast of the Bear Paws and their northern and western slopes are within

Blaine County. These mountains have a rugged relief and the Mission Peaks and others attain elevations of over 5000 feet. The Little Rockies stand out as an isolated group 1500 feet or more above the plains. The mountains are composed largely of porphyry and carboniferous limestones, which are cut with dikes of gneiss and schists. Igneous exposures occur largely on the eastern and southern slopes, and also as buttes in the plains south of the mountains. Streams have eroded canyons, some of which are 500 feet deep, in the massive limestones on the northern and western slopes.

The Milk-Missouri River divide, in the southern part of the county, lies between high ridges extending out from the Little Rocky and Bear Paw mountains. The lower part of the divide has an elevation of about 3000 feet. Its northern slope has a rolling relief and is well covered with drift. Its southern slope is badly eroded and broken with intrenched streams.

Milk-Missouri River valleys. The Milk River occupies a broad, ancient stream valley bordered with gently rising bench lands. The Missouri River has developed its course in more recent time, and flows through a narrow valley enclosed with high, rugged sandstones and shaly breaks. Both streams have eroded their beds to about the same level, which ranges between 2300 and 2500 feet in elevation in this county.

Bad lands: The area south of the Bear Paw and Little Rocky mountains is one of the very broken and rugged sections of the state. The land slopes steeply in the direction of the Missouri River and its surface is cut with deeply intrenched streams. The gullied clay hills and ridges, formed by the weathering of the Bear Paw shales in the eastern part, are scantily covered with vegetation. The intermittent streams are of a cut-bank type and their flood plains are often alkali flats. In the western part the Judith River sandstones rise as bold cliffs along the streams and in the uplands are eroded into irregular tracts between the deep coulees. In the breaks along the Missouri River, these sandstones often rise in a series of steps or levels, and also cap the mushroom rock, formed by the weathering of the softer shales.

Bad-land basins cover an ancient stream depression lying north of the Little Rocky Mountains. This depression is an

alkali flat drained by Lone Tree Coulee and is poorly covered with vegetation.

DRAINAGE

The major streams in the eastern part of north-central Montana are the Milk and Missouri rivers. The latter carries the greater volume of water, but its drainage basin in Blaine County is restricted to a comparatively small area, lying south of the Bear Paw and Little Rocky mountains. The Milk River parallels the Missouri River for some distance in northern Montana before uniting with it in the northeastern part of the state.

The continental ice sheet which covered the greater part of Blaine County did not greatly modify the surface features nor appreciably influence the drainage of the area. The larger streams were temporarily diverted and their valleys partly filled with drift. One of the more important changes made in the drainage of this part of the state was the diversion of the Missouri River from its preglacial course. Geologists claim that before the time of glaciation the Missouri River occupied the present valley of the Milk River as far west as Havre. The present course of this stream south of the Bear Paws and Little Rockies is said to have been developed during the time its waters were impounded in the north-central part of Chouteau County.

Milk River Drainage Basin

The northern two-thirds of Blaine County is drained by the Milk River, which flows in a general southeasterly direction. The important perennial streams entering this river from the north are West and North forks of the Milk River, and Parallel Creek, also known as Thirty-Mile Creek, while from the south flow Clear, Snake, and Peoples creeks.

The Milk River follows a meandering course through its valley, especially in the eastern part, where many ox-bow lakes and swampy depressions are found. During low water the stream flows sluggishly in a narrow channel 10 to 15 feet below its flood plain. The Milk River drains a large area in northern Montana and during the spring run-off, which usually takes place in March and April, is likely to overflow and flood a portion of its valley. Danger from overflow occurs again in May

and June, due to the spring rains and the melting snow in the mountains and on the higher divides.

The valley of the Milk River east of the mouth of Clear Creek is fairly uniform in width, averaging more than 4 miles through the county. The land along the stream has been built up with alluvium deposited during high water and in some sections it is a foot or more above the lower part of the valley. Broad, heavy alluvial fans are conspicuous at the mouths of some of the streams, especially those entering from the north, which have eroded their beds into the soft Bear Paw shales. A few gravelly hummocks rise in the valley west of Chinook and glacial stream terraces occur locally.

The bench lands, bordering the valley on the north, rise 100 feet or more and their faces are eroded into gravelly slopes and ridges. The larger streams are very deeply intrenched and are usually bordered by breaks, averaging one-half to two miles apart. The land south of the valley has a more rolling relief and the streams are not so deeply intrenched.

Red Rock Coulee is an intermittent stream heading in Hill County and draining a rather sharply rolling area in the west-central part of the county. Its narrow valley is inclosed in breaks, in which the Judith River sandstones are exposed. After emerging from the uplands, the stream parallels the Milk River for 8 to 10 miles before entering it south of Chinook. Red Rock Coulee carries a fair volume of water during the spring run-off and inundates a portion of the Milk River valley west of Chinook.

The West Fork of the Milk River is one of its larger tributaries and has its source in Canada. It enters the county in the northwestern part and joins the Milk River east of Chinook. The stream flows through a narrow valley 75 to 100 feet below the scabby, undulating uplands. Its flood waters are diverted near the county line into several reservoirs, which supply water for the irrigation of 10,000 to 12,000 acres northwest of Chinook.

The North Fork of the Milk River also heads in Canada and enters the county in the northwestern corner. It follows a general southeasterly course, emptying into the Milk River a few miles west of Zurich. About 12 miles below the international line it is joined by its East Fork. The valley of the North Fork is similar to that of the West Fork, while the valley of the East

Fork is more open. The land west of the North Fork has an undulating glacial relief. East of the stream along the international line the land is hilly and 8 to 10 miles south of the mouth of the East Fork lies a sharply rolling area, known as the "Rat-bit Hills." The intermittent streams heading on Cherry Patch Ridge drain a rolling prairie, in which the streams are not deeply intrenched.

Parallel Creek is a fair-sized stream heading on Cherry Patch Ridge. It flows in a southeasterly direction and empties into the Milk River east of Harlem. Its valley is very narrow and bordered by rugged breaks, which rise more than 100 feet. Dark-colored shales are exposed below the covering of drift. The uplands along the stream grade from gently sloping bench lands above the Milk River to stony morainic ridges on the lower slopes of Cherry Patch Ridge. The intermittent streams heading on the ridge are deeply intrenched and drain a stony broken section.

Wayne and Savoy creeks: The land north of the Milk River in the eastern part of the county rises in a series of gentle slopes to the north and northeast. The lower levels, forming the bench lands along the Milk River, grade into more rolling land to the north. About 15 miles north of the river the land rises quite sharply and becomes quite stony and hilly, while farther north lie the moraines, known as the Ridges, on the slopes of the Big Flat. Wayne and Savoy creeks head in the broken area below the Ridges and flow south, emptying into the Milk River east of Matador. The streams are enclosed in narrow valleys, bordered by steep breaks, as are also other intermittent streams entering the Milk River from the north.

Clear Creek rises in the Bear Paw Mountains, about 40 miles south of Lohman, and flows almost due north a few miles east of the Hill County line. The basin of Clear Creek widens out to about one mile towards the north, but below the mountains it is enclosed in a narrow valley 75 feet or more lower than the rolling glaciated uplands. The coulees entering the valley are intrenched within one mile of the stream.

Snake Creek heads in the Bear Paw Mountains and follows a southeasterly course except within a few miles of the Milk River where it swings to the north, entering the Milk River east of Madras. The upper part of the stream drains a broken foot-

hill section, while lower down it meanders through a rolling glaciated area. Box Elder Creek—its largest branch—is a perennial stream flowing through the foothills. Other streams entering Snake and Box Elder creeks head on a broken divide, extending east as far as Snake Butte. The northern slope of the divide is quite rolling.

White Bear Creek and its southern branch have their sources on a stony ridge which lies between Wild Horse and Snake buttes. The main stream takes an easterly course and empties into the Milk River in the eastern part of the county. The land along the stream is quite hilly but farther back it becomes more gently rolling. The valley of White Bear Creek averages about one-half to one mile in width and is included in one of the proposed irrigation projects on the Fort Belknap Indian Reservation.

Peoples Creek is one of the larger streams in the southern part of the county. It rises in the central part of the Bear Paw Mountains and flows in a general easterly direction, emptying into the Milk River across the county line in Phillips County. The stream drains a large stony basin and a broken foothill section below the mountains. In the plains it flows through an open valley bordered by rolling uplands.

Little Peoples Creek, a perennial stream, heads in the Little Rockies, flows north and northeast, and joins Peoples Creek in the eastern part of the county. Lodge Pole and Brown creeks enter this creek from the southeast and Duck Creek joins it from the southwest. The valleys of Little Peoples and Lodge Pole creeks are about one mile in width through the foothills and are under irrigation in the vicinity of Hays and Lodge Pole. The bottom lands of Brown and Duck creeks average about one-half to one mile in width and during the spring run-off are usually flooded. Fair-sized tracts of tillable rolling upland occur along Little Peoples and Duck creeks. The foothills of the Little Rockies rise rather abruptly and are deeply intrenched with coulees.

Lone Tree Coulee, an intermittent stream, heads on a broken ridge north of the Little Rockies, and flows north, joining Peoples Creek near the county line. It meanders through a badland basin bordered by scabby, undulating uplands.

Missouri River Drainage Basin

The Missouri River drains the southern one-fourth of Blaine County. The larger tributaries of the stream head in the Bear Paw Mountains although several branches of Cow Creek rise on a high ridge extending out from the Little Rockies. The perennial streams entering the river are Cow and Bullwhacker creeks. Black Coulee has a continuous flow during most of the year, while other intermittent streams often have springs and water-holes along their courses, especially during the spring and early summer months. The water-holes are likely to become very stagnant and alkaline late in the summer.

Missouri River.—South of the Bear Paw and Little Rocky mountains, the Missouri River flows through an enclosed valley, averaging about one mile in width. It is bordered by rugged sandstone cliffs which give way on the east to shaly breaks, rising 300 to 500 feet. It meanders between the barren colluvial slopes extending down from the breaks and its flood plain is confined largely to the bends in its course. The stream averages about 100 yards in width and during low water is intrenched 15 to 20 feet below its flood plain. The gravelly alluvial fans found at the mouth of some of its larger branches are of importance to stockmen as watering places in the shaly section. The stream is at flood stage in May and June, when the snow melts in the main range of mountains to the west and south.

Cow Creek is the largest of the three perennial streams entering the Missouri River from the north in Blaine County. The stream has its source in the eastern part of the Bear Paw Mountains and flows southeast, emptying into the Missouri River in a bad-land section in the southeastern corner of the county. Cow Creek flows through a narrow valley bordered by high, rugged, shaly breaks along most of its course. Above the breaks, irregular sandstone-capped benches lie on the southeastern slopes of the mountains and a broken shaly divide lightly covered with gravel on the west. In Township 27 North, Range 19 East, gravelly terraces extend along the stream for some distance. Above the mouth of Suction Creek the bottom lands are valuable for hay but below the mouth of this stream they are quite barren and alkaline. The bad lands consist largely of barren, gullied clay hills and ridges.

Suction Creek, which is the north fork of Cow Creek, heads in the eastern part of the Bear Paw Mountains and drains the broken slopes and foothills below the mountains. It is a fair-sized perennial stream and enters Cow Creek about 15 miles above its entrance into the Missouri River. The stream meanders through a stony valley, which widens out locally below the rugged sandstone and shaly breaks. Its western branches, Spring and Rattlesnake creeks, have a continuous flow the greater part of the year, and drain the irregular bench lands on the southeastern slopes of the mountains between Suction and Cow creeks. The valleys of these streams are very narrow and bordered by high sandstone cliffs. The divide east of Suction Creek is stony and broken, but in the vicinity of Sand Cliffs it has the physical features of Rattlesnake Bench, except for mushroom rocks which rise 15 feet or more above its surface. The eastern branch of Suction Creek heads on a stony ridge extending west from the Little Rockies. It is a small perennial stream draining a sharply rolling area along most of its course.

Bullwhacker Creek heads in the Bear Paw Mountains and flows south and east, emptying into the Missouri River. This stream, its valley, and the area drained by it are in many respects the same as Cow Creek. Below the mountains and gravel-capped benches the land along the stream is eroded into gullied clay hills and ridges, the more barren portion of which is shown as bad lands on the topographic map. Lion Coulee is an intermittent stream which rises in a broken area south of the mountains and flows southeast below Lone Tree Bench, entering Bullwhacker Creek about 8 to 10 miles above its mouth. The stream is very deeply intrenched below the barren clay hills. Other intermittent streams, all deeply intrenched, enter Lion Coulee and Bullwhacker Creek and drain a heavy soil area.

Black Coulee has its source in the southern part of the Bear Paw Mountains and flows almost due south, emptying into the Missouri River across the county line in Chouteau County. Below the mountains it has eroded a narrow valley in the Judith River sandstones which rise as bold cliffs. The land above the stream is cut into irregular sloping tracts by deep coulees.

SETTLEMENT

The area north of the Missouri and Marias rivers as far west as the main range of mountains was an Indian Reservation almost up to the time of the construction of the Great Northern Railway through the northern part of the state in 1888. The present boundaries of the Indian reservations were not established in this part of Montana until after 1885 and the unreserved public lands were not thrown open for settlement until 1887. The Milk River valley, the bench lands bordering it, and the grazing land adjacent to the Bear Paw Mountains were largely surveyed and sectionized during the late eighties and nineties; while the remainder of the county was not sectionized until after 1910.

History.—The early inhabitants of Blaine County were the Blackfeet Indians and their allied tribes. At the time of the Lewis and Clark Expedition in 1804-1806, the Gros Ventres, who usually wintered about the Bear Paw Mountains, were found in this part of the state. Fur trading companies began exploiting the territory soon after the expedition returned to St. Louis, but none of these early fur companies established permanent posts in the area now included in Blaine County. Fort Browning was built as a trading post at the mouth of Peoples Creek in 1868, but it had a very brief existence because of the continual tribal warfare between the Blackfeet and the Sioux Indians. Later, Fort Belknap was located farther up the Milk River in the Blackfeet territory near the present site of the town of Chinook. It was an important trading post and Indian agency up to about 1888, when the agency was moved to its present location near Harlem.

Cow Island, located on the Missouri River in the southern part of the county, was a noted place during the development of the gold fields in western Montana. During low water, many of the boats were not able to navigate the river at the mouth of Cow Creek and their cargoes were often unloaded and forwarded overland to Fort Benton and other points. A few of the early Indian trails leading from the Cow Island ford, such as "Cow Island Trail," became well-known highways in the early days.

The chase and capture of the Nez Perces, non-treaty Indians, in the late summer and fall of 1877 was one of the more famous Indian campaigns. These Indians, under the leadership of Chief Joseph, éluded General Howard through the mountains of Idaho, Wyoming, and Montana. General Miles, who came to Howard's assistance with a small detachment from Fort Keogh, overtook the Indians on Smoke Creek about 16 miles south of the present site of Chinook and after a skirmish, known as the battle of the Bear Paws, captured the band. The Blackfeet and Gros Ventres Indians were hostile to the encroachments of the white man up to about 1880.

The Stevens expedition in 1853-1855 was organized to investigate the feasibility of constructing a railway through Northwest Territory. It was followed by several similar expeditions, which made known the resources of the territory. These surveys finally resulted in the construction of the transcontinental railways through the state in 1883 and 1888.

Boats were withdrawn from the upper Missouri River soon after the completion of the Northern Pacific Railway through the southern part of the state in 1883. The Indians by this time were under control and confined to reservations. Stock raising, which had been growing steadily in the more protected localities, was taken up in the plains as soon as the Indian depredations were brought to a close, and it became the chief industry for many years. The development of irrigation in northern Montana was closely connected with the stock industry as much of the land brought under irrigation during the nineties and the overflowed bottom land were devoted to pasture and hay. Since the settlement of the public range land, which began in this part of the state about 1908, dry and irrigated farming has largely replaced stock raising in the more desirable agricultural sections.

Time of settlement.—No permanent settlement was made in the area north of the Missouri River prior to the setting aside of the Indian reservations, except for a few squatters located near trading posts and military forts. The land taken up by stockmen during the late eighties and nineties was largely bottom land along streams and water-holes and winter grazing lands around the mountains. The possession of the water-holes

by the large stock companies controlled largely the grazing of stock in the area. The settlement of the irrigated lands began shortly after water was turned into the Harlem and Paradise canals in 1895 and was later encouraged by the opening up of other private and reclamation projects. The bench lands above the Milk River Valley were largely settled in tracts of 160 acres between 1908 and 1910, while the more distant agricultural lands were not filed upon until the land had been sectionized. Most of this land was taken up in tracts of 160 and 320 acres in 1912 and 1914, although a few squatters appeared on the Big Flat soon after 1906 when the Montana Experiment Station established there a demonstration farm. A very small acreage has been homesteaded in tracts of 640 acres under the Stock Raising Act.

Settlers.—The early settlers of Blaine County were chiefly Indian traders and stockmen, some of whom intermarried with the Indians. Their descendants form a fair percentage of the population about the borders of the Fort Belknap Indian reservation. The people attracted to the irrigated lands within recent years have come largely from the intermountain states, while the dry lands have drawn more heavily from the north-central states. The early Indian traders were chiefly of French descent while the stockmen were largely English and Scotch. In a few localities, certain nationalities, such as the Scandinavians on the Big Flat, the Bohemians on the Raglin Bench, and Russians north of Chinook, predominate. A few Japanese, Chinese, and Negroes are found in the larger towns, while a smaller number of Mexicans have come in as laborers within recent years.

Population.—The area was sparsely settled during the time stock raising was the chief industry, but between 1908 and 1917 the urban and farm populations increased rapidly with settlement of the agricultural range lands. The population of the county was estimated at 10,800 in the spring of 1917 or just preceding the severe three-year drought. The United States census report for 1920, which was the first to be made after the creation and reorganization of the county, places the total population at 9057, of which slightly over 2000 were located in urban centers. This number included about 1100 Indians on the Fort Belknap Indian Reservation. The farm population was approxi-

mately 4700 in 1925 when the last agricultural census was taken. The present population of Blaine county is estimated at approximately 8100.

Towns.—Chinook and Harlem, with populations of around 1200 and 700 respectively, are the largest and most important towns in the county. Chinook, the county seat and site of a beet-sugar factory operated by the Utah-Idaho Sugar Company, is located in the west-central part; while Harlem is located in the east-central part near the Fort Belknap Indian Agency. These towns are in the Milk River Valley on the main line of the Great Northern Railway and have most of the modern municipal improvements such as light, water, and sewerage. Zurich, Lohman, Savoy, and Coburg are smaller trading points on the railway. Hogeland, located west of the Big Flat in the northeastern part of the county, is the terminus of the Saco-Hogeland branch of the Great Northern Railway. Turner is a new town on the Big Flat in a large spring-wheat-producing section. Cleveland, Lloyd, and Riedel are local sources of supplies in the southern part of Blaine county. Hays and Lodgepole are sub-agencies on the reservation, and St. Paul's is a Catholic mission established among the Indians in 1885 at the mouth of an attractive limestone canyon leading back into the Little Rockies. The accredited schools in the urban centers are among the best in the state, but in the more sparsely settled rural districts they do not rank so high.

Transportation and markets.—The main line of the Great Northern Railway follows the Milk River through the central part of the county. The Saco-Hogeland Branch of this railway, which was completed the past year, enters the northeastern part of the county and terminates at Hogeland. The main line and its new branches provide facilities for the direct shipment of grain, live stock, and live-stock products, which make up most of the exports to eastern and western markets, such as Chicago, St. Paul, Spokane, and Portland. Markets for perishable farm products are limited since Butte, Helena, and Great Falls are the largest industrial centers within a wide radius.

The Roosevelt Highway, also known as the Glacier Trail, parallels the railway through the county. Along most of its course in the county it has a crushed gravel surface and is main-

tained in fair condition during the tourist season. The post roads from the larger towns, such as Chinook and Harlem, into the more distant agricultural sections are improved and are maintained in fair condition, except during the late summer and fall, when because of the heavy grain traffic they become very dusty and rutty. Most of the upland roads in the rural districts are unimproved but are passable during the greater part of the year. The Clear Creek road from Chinook through the Bear Paw Mountains to LeRoy is improved as is also the road between Chinook and Sand Cliffs, Rattlesnake, and Hays. Big Sandy, in Chouteau County, is the chief trading and shipping point for a large area south of the Bear Paw Mountains. Cow Island Trail is the main highway into Big Sandy from the east. Most of the roads on the Fort Belknap Indian Reservation are unimproved. The main roads run from Harlem to Lodgepole and Zortman.

STATE LANDS

The state lands in Blaine County for 1924 totalled 154,127 acres, all of which are included in the state school lands. The sale or lease of these lands is in charge of the Register of State Lands, located in the Capitol Building at Helena. A minimum sale price of $10 per acre has been set by legislative enactment.

FORT BELKNAP INDIAN RESERVATION

The Fort Belknap Indian Reservation, created in 1885, extended from the Milk River to the Missouri River, but in 1888 the gold fields in the Little Rockies and the grazing land south of these mountains were withdrawn and added to the public domain. The entire reservation averages about 50 miles long and from 25 to 30 miles wide. It covers a total area of approximately 973 square miles of which 189 square miles are in Phillips County. The Milk River and the northern slopes of the Little Rockies form the northern and southern lines, respectively. The western line runs due south from a point on the Milk River about 5 miles west of Harlem in R. 22 E. The Indians on this reservation belong to the Gros Ventres and Assinniboine tribes and number about 1500. The land on the reservation has been classified during the past few years, for the purpose of prorating it among the Indians.

CLIMATE

The climate of this part of the state is characterized by a moderately low rainfall, a dry atmosphere, hot summers, cold winters, and a large proportion of sunny days. The midsummer temperatures are not oppressive since the humidity is low, and the winter extremes are not especially severe, as the cold waves are usually not accompanied by high winds. The Bear Paw Mountains have a more enjoyable climate than the plains during the summer months.

Tables 1 and 2 give the normal monthly seasonal and annual temperatures and precipitation at Havre, Chinook, and Clear Creek. Havre has the longest weather record in north-central Montana, dating from 1880. Clear Creek, located in the Bear Paw Mountains at an elevation of 3300 feet, has an incomplete record—between 1903 and 1920—while the record at Chinook dates from 1896.

Precipitation.—The average annual precipitation in the Milk and Missouri River valleys ranges between 12 and 14 inches. The longer records show an average of approximately 13.5

TABLE 1.—PRECIPITATION*

Months	Mean			Total amount, driest year			Total amount, wettest year			Snow, average depth (inches)		
	Havre	Chinook	Clear Creek	Havre 1905	Chinook 1918	Clear Creek 1918	Havre 1884	Chinook 1925	Clear Creek 1911	Havre	Chinook	Clear Creek
December	0.63	0.40	0.76	0.12	0.11	0.08	0.72	0.22	0.50	5.7	2.6	9.1
January	.69	.60	1.06	.85	1.36	1.08	.16	.47	1.45	7.9	7.0	14.1
February	.47	.32	.57	.14	.31	.44	.44	.56	1.45	5.4	4.4	6.1
Winter	**1.79**	**1.32**	**2.39**	**1.11**	**1.78**	**1.60**	**1.32**	**1.25**	**3.40**	**19.0**	**14.0**	**29.3**
March	.48	.40	.54	.15	.33	.16	.53	.82	0.56	5.0	3.5	6.3
April	1.01	.69	.86	.70	.35	.55	.25	1.62	1.35	3.2	1.1	4.0
May	2.09	2.37	2.34	.83	.15	.65	3.05	.36	2.48	1.8	0	0
Spring	**3.58**	**3.46**	**3.74**	**1.68**	**.83**	**1.36**	**3.83**	**2.80**	**4.39**	**10.0**	**4.6**	**10.3**
June	2.82	2.72	3.20	1.72	.26	.14	4.72	4.34	2.62	T	0	0
July	1.92	1.30	1.73	.86	.82	.77	9.67	1.64	2.64	0	0	0
August	1.26	1.26	1.29	.30	2.25	2.53	2.61	1.28	2.89	0	0	0
Summer	**6.00**	**5.28**	**6.22**	**2.88**	**3.33**	**3.44**	**17.00**	**7.26**	**8.15**	**T**	**0**	**0**
September	1.03	1.27	2.14	.12	.76	.90	2.69	3.84	5.65	0.5	T	1.5
October	.50	.76	1.14	.37	1.16	.77	.41	.71	1.30	2.2	.4	5.0
November	.77	.61	.66	.60	.51	.08	.42	0	1.85	4.6	3.2	5.6
Fall	**2.30**	**2.64**	**3.94**	**1.09**	**2.43**	**1.75**	**3.52**	**4.55**	**8.80**	**7.3**	**3.6**	**12.1**
Year	**13.49**	**12.76**	**16.29**	**6.76**	**8.01**	**8.67**	**25.67**	**15.86**	**24.74**	**36.3**	**22.2**	**51.7**

*This table is based on the data available from Havre between 1880 and 1927, Clear Creek between 1903 and 1920, and Chinook between 1896 and 1927.

inches; while the shorter records average between 12.5 and 13 inches. The lowest annual precipitation reported in the area is 6.76 inches and the highest 25.67 inches. The greater part of the precipitation falls during the spring and early summer months when the spring and fall-sown grains are making their heaviest use of soil moisture. From 65 to 70 per cent of the total rainfall for the year is received between March first and September first; May and June are the months of heaviest rainfall, each averaging between 2 and 3 inches. The rainfall during the summer months is received largely in local showers and on the heavier soils the run-off is large. The fall and winter seasons are usually open but occasionally the snowfall is heavy. Elevation probably more than latitude influences the amount of precipitation as indicated by the Clear Creek record. The dense stands of grass and the darker-colored soils are found on the northern and western slopes of the mountains and plateaus.

Temperature. — The mean annual temperature at points such as Chinook and Havre is between 41 and 42 degrees. The temperature extremes recorded at Chinook for the winter and summer months are respectively –50° F. and 102° F. January, with a mean of 12.6° F., is the coldest month; and July with 69.7° F. is the warmest. An annual difference of

TABLE 2.—TEMPERATURE*

Months	Mean			Absolute maximum			Absolute minimum		
	Havre	Chinook	Clear Creek	Havre	Chinook	Clear Creek	Havre	Chinook	Clear Creek
December	20.4	20.8	21.0	63	65	60	–35	–45	–31
January	12.9	12.6	15.2	61	65	61	–57	–45	–37
February	13.6	14.8	19.2	63	65	63	–45	–50	–38
Winter	**15.6**	**16.1**	**11.8**	**63**	**65**	**63**	**–57**	**–50**	**–38**
March	27.1	26.7	30.4	77	78	76	–26	–36	–20
April	43.7	42.5	44.0	94	94	90	–4	–13	–5
May	53.4	55.5	51.0	96	98	94	20	13	10
Spring	**41.4**	**41.6**	**41.8**	**96**	**98**	**94**	**–26**	**–36**	**–20**
June	62.0	63.3	60.2	108	109	98	29	29	28
July	68.3	69.7	67.0	103	110	102	37	36	34
August	65.4	68.0	64.2	106	109	103	27	30	29
Summer	**65.3**	**67.2**	**63.8**	**108**	**110**	**103**	**27**	**29**	**28**
September	56.4	57.7	55.3	94	96	90	19	20	21
October	44.5	43.7	41.5	89	89	86	–7	–9	–8
November	31.2	27.5	33.5	75	82	69	–30	–30	–18
Fall	**44.0**	**43.0**	**43.4**	**94**	**96**	**90**	**–30**	**–30**	**–18**
Year	**41.3**	**41.9**	**41.9**	**108**	**110**	**103**	**–57**	**–50**	**–38**

*This table is based on the data available from Havre between 1880 and 1927, Clear Creek between 1903 and 1920, and Chinook between 1896 and 1927.

from 5 to 6 degrees between the northern and southern parts of the county is indicated by the data. The average frost-free period in the Milk River Valley dates from May 14 to September 18, although temperatures of 32° or lower have been recorded in every month of the year except July. Small grains seeded during the latter part of April are rarely injured by late spring frosts, but early fall frosts occasionally damage the late maturing irrigated crops.

Winds.—The county is subject to rather strong, persistent, westerly and southwesterly winds, which are likely to be more severe during the early spring months and in dry seasons may cause some damage to early seeded crops. The lower plains of Blaine County lie within the chinook belt. The early stockmen depended upon these warm winds to clear their winter grazing lands of snow. Hot winds which usually blow from the southwest occur in dry seasons and have caused serious crop losses. Hail storms of more or less severity occur locally during the summer months, but are no more frequent than in other parts of the Great Plains of Montana and the Dakotas.

MAPS

The four maps accompanying this report show (1) the location and extent of different soils; (2) the main physiographic and geographic features; (3) the location and percentage of each section under cultivation; and (4) the United States geological land classification which indicates the adaptation of the land to agriculture.

Soil map.—The soil map accompanying this report is based on the properties found in the soils under field conditions. It shows the relationship of the soils in different parts of the county. A soil section such as is found in road cuts and coulees shows distinct layers or horizons which can not be attributed to the origin or manner of deposition of the parent material. The number, arrangement, and stage of development of these layers are largely the result of the common soil-forming processes which have varied in intensity under the climatic conditions prevailing in the different localities. Their physical properties, such as color, structure, thickness, and relative position, depend upon the length of time the soil material has been exposed to the weathering agents and many other influencing factors, such

as topography, drainage, vegetation, etc. These layers are the means of dividing the soils into large groups known as the "soil series" which are further divided into soil types on the basis of the variation in texture, that is the proportion of sand, silt, and clay in the surface layers. The soils of each series have the same general profile in which the number, arrangement, and general character of the layers are the same. Reconnoissance surveys deal primarily with the identification and isolation of the larger soil groups, and less attention is given the soil type. On the soil map the types most prevalent in each series are shown as loams, sandy loams, etc., but each type may contain small tracts of heavier or lighter soils and in some cases small tracts of other soil series. Physiographic features such as mountains, bad lands, and bad-land basins are shown separately and are not included in any of the soil series.

Topography map.—The chief physiographic and geographic features of the county are shown on the topographic maps. The location and extent of such physiographic features as mountains, lakes, bad lands, and bad-land basins, and such geographic features as towns, post offices, railways, and the more important stream courses are represented on the map. The general relief of the land is divided into three phases, namely, (1) level, (2) rolling, and (3) sharply rolling or land too steep or broken for cultivation.

Area under cultivation.—A very large acreage was broken out and placed under cultivation between the years of 1908 and 1917, when the public range land was being settled. Some of this land was of doubtful or marginal agricultural value and during the years of drought and adverse agricultural conditions the cropped acreage was greatly reduced and in some localities largely abandoned. A record of the approximate acreage under cultivation was made at the time of this survey for the purpose of locating the more intensely cropped sections and studying the conditions which make these sections more favorably adapted to agriculture than others. The approximate percentage of each section in crop, fallow, and tame pasture is shown on the map.

Land classification map.—The Sixteenth Legislative Assembly of the State of Montana provided for a classification of all lands in the state for taxation purposes. The manner of carry-

ing out the provisions of the act was left to the county authorities. In 1916 the United States Geological Survey undertook a classification of the public lands in the western states for the purpose of designating these areas in which 640-acre tracts could be homesteaded under the Stock Raising Act. The state and government classifications were based largely upon the topographic and vegetative features and in no instance was any information obtained in regard to the soil relationships in any one county or between two or more counties.

The land classification map prepared by the United States Geological Survey is incorporated in this report to supplement the soil and topographic maps. The untillable land shown in black on the map includes both soil and physiographic features. For example, the heavy, alkaline stream bottoms and the stony and very sandy soils are shown as untillable, as well as the mountains, sharply rolling land, and breaks along streams. In Blaine County the more scabby phases of the uplands are designated as grazing land. The locations of the larger irrigation projects are also shown on this map.

DESCRIPTION OF SOILS

The soils of the northern part of the Great Plains are characterized by rather dark-colored surface soils and by gray carbonate zones, consisting chiefly of lime in the lower soil depths. In north-central Montana the soils have developed under a wide range of conditions. In the lower plains they have developed under a moderately low rainfall, great temperature extremes, and a short grass cover. In the mountainous sections the rainfall has been greater, the temperature lower and more uniform, and the vegetative cover consists largely of timber and shrubs. The oldest agricultural soils in the area are found on the bench lands around the mountains and on the plateaus. The deposits of gravel and rock fragments capping these table-lands are supposed to have been laid down during late Tertiary times. Erosion has been active in the area and the drainage has been good to excessive, except locally in the glaciated area.

The soil profiles in Blaine County vary with the elevation, climate, age of the soils, and locally with the drainage and erosion. In the mountains above 5500 feet in elevation, the

surface soils are almost black and the heavy lime-free subsoils are dull reddish brown. On the high plateaus, the surface soils are reddish brown and the gravelly subsoils below 19 to 30 inches are rather firmly cemented with lime. The benches about the mountains are in various stages of erosion and the lime-coated stony subsoils are often exposed on the surface. The younger soils of the drift-covered area are brown to dark-brown with friable carbonate zones below 7 to 15 inches. The soils developed over sedimentary rocks in the lower plains are usually immature and are often without distinct soil horizons.

The soils developed over drift in the more intensely glaciated sections of Blaine County are included in the Scobey series. The members of this series cover the rolling prairies between the Milk River and the mountains on the south and the northeastern portion of the county below the Big Flat. The darker-colored phase with lime horizons below 7 to 15 inches is found on the slopes of the mountains and plateaus, while the lighter-colored phase occurs chiefly on the bench lands south of the Milk River and on the lower slopes of Cherry Patch Ridge.

Scab lands cover most of the northwestern portion of the county and the bench lands north of the Milk River. Isolated tracts of such land also occur on the more level prairies south of this stream. Scab lands have developed in a feebly glaciated area, which is underlain at comparatively shallow depths with dark-colored, non-calcareous marine shales. The land is characterized by depressed, irregular, bare spots locally called "slick spots" and "blow outs." The bare spots range in depth from 1 to 3 inches on the heavier loams, to 8 inches or more on the lighter soils, and in some localities cover 50 to 60 per cent of the total surface of the land. In north-central Montana, slick spots are common on the more level phases of the drift-covered area, especially at the head of drainage basins. The less scabby phases were not isolated unless more than 20 per cent of the total surface of the land was occupied with slick spots. The soils of the scab lands in northern Montana are grouped in two series, Content and Phillips. The Content series includes the more scabby and barren phases, largely of reworked residual material derived from the dark-colored marine shales. The Phillips series, which has developed over less modified drift, rep-

resents the less scabby phase. In Blaine County the scab lands along Lone Tree Coulee, north of the Little Rockies, belong to the Content series but because of the small area are included in the Phillips series.

Glacial stream deposits occur as terraces and valley slopes in the Milk River Valley. The soils developed over these stratified, sandy, gravelly deposits have a brown surface and fairly deep calcareous zones, and are grouped in one series, the Cheyenne.

The soils of the mountainous sections are grouped in three series—Blaine, Belknap, and Zortman. The Blaine series, which is the most extensive, includes a group of very dark-brown, deep, stony loams found on the broken, unglaciated mountain slopes. The members of the Belknap series are confined largely to small tracts within the mountains and were largely isolated because of their dull reddish colors, which are imparted to them by the parent hardened red sandstones and shales. The Zortman series includes another group of dark-colored, stony soils, underlain with semiconsolidated stony lime zones and occurs chiefly on the eroded benches around the Little Rocky Mountains. The black soils at the higher elevations within the mountains were not separated since they are within the area mapped as rough, broken land.

The soils on the high plateaus are grouped in two series, Turner and Lloyd. The Turner soils cover the Big Flat in the northeastern part of the county. The surface soils are reddish brown and the gravelly subsoils are rather firmly cemented with lime below 10 to 30 inches. The lower depths are stratified, semiconsolidated sands, silts, and gravels. The soils on the gravel-capped benches south of the Bear Paw Mountains are grouped in the Lloyd series, which includes the lighter-colored and more shallow-horizoned soils of the plateaus. The soils developed over dark-colored, non-calcareous shales are grouped on the basis of their maturity in two series, Lismas and Pierre. The heavy soils of the Lismas series cover the gullied, clay hills and ridges south of the Bear Paw Mountains and the more eroded breaks along some of the streams such as Parallel Creek. The Lismas soils are immature and do not have distinct soil horizons. The surface mulch is non-calcareous and the humus-

bearing layer is poorly developed. The platy structure of the parent material is usually found in the second or third foot and fragments of shale in the lower soil depths. The soils composing the Pierre series are usually associated with those of the Lismas series and occupy the less eroded sections. These soils have a calcareous surface mulch and a faint humus-bearing layer. The lower depths are olive-brown, non-calcareous clays containing fragments of shale below 4 to 6 feet.

The soils developed over light-colored, calcareous sandstones and shales are represented in the county by one series, the Bainville. These soils cover the irregular benches on the southeastern slopes of the Bear Paw Mountains and above the breaks of the Missouri River and Black Coulee in the southwestern part. The soils of this series are immature and have developed shallow, light-brown, humus-bearing layers. The lower depths have the structure of the parent material and are often mottled with rusty brown streaks.

The recent stream deposits and wash below the breaks of streams were undifferentiated and in the reconnoissance survey

TABLE 3.—SOIL AND TOPOGRAPHY—BLAINE COUNTY

SOIL			TOPOGRAPHY			
			Level to sharply rolling		Sharply rolling	
Type	Total area in sq. miles	Per cent of county	Sq miles	Per cent under cultivation	Sq miles	Per cent under cultivation
Scobey loam	1137.8	26.8	822.3	9.29	315.5	0.07
Scobey sandy loam	187.5	4.4	187.5	12.85	.....	.....
Scobey stony loam	268.4	6.3	193.3	1.76	75.1	.11
Phillips loam	786.5	18.5	786.5	4.99	.....	.....
Turner fine sandy loam	165.2	3.9	162.5	29.34	2.6	.00
Bainville loam	167.9	3.9	50.1	5.68	117.8	.51
Pierre clay loam	138.1	3.2	33.8	2.80	104.3	.03
Lismas clay loam	292.8	6.9	58.8	.07	234.1	.00
Zortman gravelly loam	52.4	1.2	16.8	4.17	35.6	.00
Blaine loam	269.0	6.3	90.6	15.17	178.4	.61
Belknap loam	31.9	0.7	4.5	14.31	27.3	1.09
Lloyd gravelly loam	32.6	0.8	32.6	13.94	.....	.....
Cheyenne gravelly loam	39.1	0.9	39.1	6.39	.....	.....
Laurel loam	200.0	4.7	200.0	20.77	.....	.....
Laurel clay loam	20.7	0.5	20.7	21.76	.....	.....
Bad-land basins	12.6	0.3	12.6	.00	.....	.....
Bad lands	173.9	4.1	.....	.....	.....	.....
Rough broken land (mountains)	251.8	5.9	.....	.....	.....	.....
Lakes	10.7	0.2	.....	.....	.....	.....

are designated as Laurel. This group of soils is usually calcareous at the surface and the humus-bearing layer is poorly developed. The lower depths are stratified sands, silts, and clays. In this group of soils are also included the old glacial lake beds.

Table No. 3 gives the name and actual and relative extent of each soil mapped in the area. It also shows the topographic adaptation of each type to agriculture at the time of the survey.

Scobey Loams

Description.—The Scobey loams, such as are found on the slopes of the Big Flat and the Bear Paw Mountains and about Three Buttes, north of the Little Rockies, have a grayish brown, loose, shallow (1 to 2 inches), fine sandy mulch on the surface. The humus-bearing layer is a brown to dark-brown, friable loam, averaging 5 to 7 inches thick. The subsurface layer is a light-brown, columnar-structured and somewhat heavier-textured loam. It is faintly calcareous in the lower part and the surface of the clods is often stained with organic matter. The gray to grayish-brown, compact, structureless, silt to silty clay carbonate zone below 10 to 15 inches grades into yellowish-brown loamy drift at 30 to 40 inches. The lime is uniformly distributed through the upper part of the carbonate zone but in the lower part it often occurs in streaks and blotches.

The lighter-textured phase of the Scobey loams is found in the uplands 5 to 10 miles south of the Milk River. The surface 2 to 3 inches is a sandy mulch, which develops a compact, laminated structure in wet seasons. The brown, humus-bearing layer averages 5 inches thick and locally has the texture of a sandy loam. The carbonate zone lies 10 to 16 inches below the surface and on the bench lands grades into gravelly and bouldery material at 4 feet or more.

The heavier phase of the Scobey loams occurs on the lower slopes of Cherry Patch Ridge and in the area south of the Ridges. The surface mulch is well developed and the dull brown, humus-bearing layer is rather shallow and grades into the texture of a silt loam. The carbonate zone lies 8 to 12 inches below the surface, and the parent drift below 3 feet is quite heavy. Slick spots are common on this phase.

Sufficient red quartzite gravel and sand to modify slightly the color and texture occur in the soils (1) on the upper slopes of the Big Flat, (2) in the basin west of the high bench, and (3) in the area north of Woody Island Creek. Locally the subsoils are very gravelly and north of Woody Island Creek the lower soil depths grade into semiconsolidated sands, silts, and gravel such as are found on the Big Flat.

Soils developed over drift are rarely uniform over a large area and variations in texture often occur within short distances. Glacial boulders are usually present in sufficient quantity to preclude farming unless the land is cleared. The more stony phases are found on the slopes of the Big Flat, Bear Paw and Little Rocky mountains, and Cherry Patch Ridge, and in the area bordering the moraines north of Woody Island Creek.

Topography.—Scobey loams have a rolling, billowy relief in the central part of the county along the Milk River, but in the more distant uplands they become more rolling and on the slopes of the Big Flat, Pear Paw and Little Rocky mountains, and Cherry Patch Ridge are locally sharply rolling. Glacial mounds, ridges, and shallow lake depressions are very numerous in some localities. Drainage has not been well established in the northeastern part of the county and on the broader divides south of the Milk River.

Tillable area. — Scobey loams cover approximately 1138 square miles or 27 per cent of the total area of the county. Of this area, 203,929 acres or 28 per cent is too broken for cultivation. The land classification map, prepared by the United States Geological Survey, shows about 60 per cent of the Scobey loams area to be untillable, but in this classification the more scabby, stony, and rolling land is included in the untillable class.

Utilization.—The Scobey loams in the central part of the county were homesteaded in tracts of 160 acres in 1908 and 1909. The more distant farm lands were not filed upon until after the land had been sectionized between 1910 and 1914. Most of the land under cultivation in the county was broken out before the year 1915. In 1923 approximately 9 per cent of the tillable land was under cultivation. The improved land is located chiefly in the uplands south of the Milk River and in the area north and west of the Big Flat. The Scobey loams on the Fort

Belknap Indian Reservation are largely under lease as grazing lands and are therefore not under cultivation. The more rolling and stony phases are used chiefly for grazing. In the northeastern part of the county a fair acreage was broken out at the time of settlement, but during the dry years was largely abandoned. A rapid development of this area may be expected with the completion of the Saco-Hogeland branch of the Great Northern Railway.

The most important type of farming practiced on the Scobey loams is grain growing, although in the vicinity of grazing land stock raising is often combined with grain growing. The farms are large, often covering one or more sections of land. The annual cropped acreage per farm ranges from 200 to 400 acres with spring wheat the most important cash crop. Other small grains, such as oats, barley, and rye, are grown chiefly for feed or harvested for forage. The corn acreage, which was rather small in 1923, is confined largely to the lighter soils south of the Milk River. Forage crops, such as sweet clover, alfalfa, and brome grass are not grown extensively, except in some of the older farming districts. Continuous cropping to small grains is generally carried on until the land becomes foul, when a clean summer fallow is introduced every second or third year. Duckfoot cultivators and similar implements, which reduce the cost of production and are efficient in controlling weeds and soil drifting, are largely replacing the more common farm implements in preparing the land for spring seeding and for summer fallow. Tractors and large horse outfits are commonly employed on the large grain farms. The number of small combined harvester-threshers increased rapidly during the past few years.

Scobey loams are among the better agricultural soils in the county; they are easily maintained in good physical condition and have a good water-holding capacity. The surface acre foot* contains from 3080 to 3990 pounds of nitrogen, 1365 to 1820 pounds of phosphorus, and 8400 to 30,100 pounds of calcium. In the central part of the county the soils are lower in nitrogen and higher in lime than those on the slopes of the mountains and the plateaus. The yield of spring wheat has probably not

*An "acre foot" is an area one acre in extent and one foot deep. Most loam soils weigh about 3,500,000 pounds per acre foot and the above calculations were based on this weight.

averaged more than 10 bushels per acre since the land was broken, but during the past ten years the yields have averaged a few bushels higher. Farmers expect spring wheat to yield from 15 to 25 bushels per acre on well-prepared, summer-fallowed land in favorable seasons.

Improved land is held at $20 to $30 per acre, while unimproved land is valued at $10 to $20 per acre. The value of grazing land depends upon its location, carrying capacity for live stock, and water-holes, but is usually priced below $3 per acre. Clearing unimproved farm lands of boulders costs a few dollars per acre.

Vegetation.—Grama grass *(Bouteloua gracilis)* and its associated species form the principal cover on the Scobey loams. Western wheat grass *(Andropogon smithii)* is usually associated with grama on the heavier types and on the darker-colored loams in the northeastern part of the county. Other grasses such as needle grass *(Stipa comata)* and June grass *(Koeleria cristata)* are more or less common and in the overgrazed sections may form the predominating cover. All these grasses are considered excellent range forage.

Mountain sage *(Artemisia frigida)* and gum weed *(Grindelia squarrosa)* are the most common shrubs on the Scobey loams. Match-weed *(Gutierrezia sarothrae)* and black sage *(Artemisia tridentata)* creep in on the loams in the southeastern part of the county. None of the shrubs is important range forage, although mountain sage is eaten readily by sheep. North of the Milk River native trees and large shrubs are not found in the uplands, except those that have been transplanted.

The grass cover is heaviest in the northeastern part of the county and on the foothills of the mountains. Near the Canadian line and about the mountains 15 to 20 acres would be sufficient to carry a 1000-pound steer through the grazing season of 10 to 12 months. In the central part of the county, 25 acres or more per steer would not be too much in average seasons.

Scobey Sandy Loams

Description.—The surface 2 to 3 inches of the Scobey sandy loams is a loose, grayish-brown, sandy mulch. The humus-bearing layer is a light-brown, friable to loose, fine sandy to coarse sandy loam averaging 5 to 7 inches thick. The lighter-colored

and faintly columnar-structured subsurface layer is compact and slightly heavier in texture. In some localities, the subsurface layer of the coarser-textured loams has a distinct dull, reddish cast. The gray compact carbonate zone below 10 to 18 inches is a gritty loam, grading into loose sand and gravel at 3 feet or more.

Coarse sandy loams predominate along the North Fork of the Milk River and locally in the central part of the county south of the Milk River. Red quarzite gravel and sand modify the character of the sandy loams along Woody Island Creek. On the Fort Belknap Indian Reservation, slick spots, depressed 8 to 10 inches or more, are quite common on the more level phases. Boulders are not abundant on the Scobey sandy loams, but the low mounds and ridges are often very gravelly.

Topography.—Scobey sandy loams are distributed over the glaciated portion of the county in tracts of varying size. The larger areas are found in the central part south of the Milk River and in the north-central part, east of the East Fork of the North Fork of the Milk River. The larger upland tracts are gently rolling, while those along streams often have a bench-like form. Low mounds and ridges are distributed over the uplands, but lake depressions are not very numerous. The sandy loams have very good drainage, although the bottoms of intermittent streams are usually strongly impregnated with alkali.

Tillable area.—Scobey sandy loams cover 187 square miles or about 5 per cent of the total area of the county, all of which is shown on the topographic map to be suitable for cultivation. On the land classification map the more sandy phases are shown as non-agricultural, and about 36 per cent of the total area is included in the untillable class.

Utilization.—Outside of the Fort Belknap Indian Reservation the Scobey sandy loams were settled and broken out about the same time as the Scobey loams. During the dry years the more sandy phases were abandoned and have not been reclaimed. Since the drought the homestead units have been consolidated into farms of 640 acres or more. In 1923, 13 per cent of the Scobey sandy loams was under cultivation. More than one-half of the total area lies within the Indian Reservation and was under lease as grazing land.

Some of the better improved farms in Blaine County are located on the very fine and fine sandy loams. The type of farming on these loams is somewhat more diversified than on the Scobey loams, except in the more distant agricultural sections. Spring wheat is the main cash crop, while other small grains are grown chiefly for feed and forage. A fair acreage is devoted to corn, which is cut for fodder or hogged off by swine and sheep. Legumes and grasses cover a small acreage, especially in those localities where soil blowing is becoming more difficult to control. The cropping and tillage methods are much the same as on the Scobey loams. Corn replaces summer-fallowed land to some extent and duckfoot cultivators and weeders are in more general use.

Scobey sandy loams rank with the better agricultural soils in the county. These soils are open and porous and have a fair water-holding capacity. The surface acre foot contains from 2500 to 3500 pounds of nitrogen, 1200 to 1400 pounds of phosphorus, and 8400 to 10,000 pounds of calcium. The surface foot contains a smaller amount of nitrogen than the Scobey loams, and the fertility will probably decline more rapidly as the root fiber is destroyed by cultivation and soil drifting. The yields of spring wheat have been fairly consistent on the sandy loams since the land was broken out, but during the past few years have not averaged as high as on the Scobey loams.

Vegetation.—Sand grass *(Calamovilfa longifolia)* and nigger wool *(Carex filifolia)* are commonly associated with grama grass on the sandy loams. Needle grass and June grass are in evidence in the overgrazed sections. The tall grasses, adapted to droughty conditions, are found on the more sandy and gravelly hillocks and ridges. In addition to the shrubs found on the Scobey loams, valley sage *(Artemisia cana)* occurs on the more sandy phases. The density of the grass cover on the bench lands along the Milk River is somewhat lighter than in the uplands, such as found on the Indian Reservation. Twenty to thirty acres would be required to carry a steer through the grazing season on the Scobey sandy loams.

Scobey Stony Loams

Description.—The profiles of the Scobey stony loams are in general similar to those on the Scobey loams and sandy loams, found in the vicinity of the stony tracts, except for a greater quantity of rock and gravel in the soils and on the surface. The surface soil on the top of the mounds and ridges is usually shallow and around the potholes and depressions is fairly deep. Along some of the coulees north of the Milk River, boulders overlie heavy residual material derived from the underlying shales. Red quartzite gravel is conspicuous in the stony drift on the slopes of the Big Flat and some slabs of local trap rock are found on the moraines below the Bear Paw Mountains.

Topography.—Scobey stony loams cover morainic ridges on the slopes of Cherry Patch Ridge, Big Flat, and the Bear Paw and Little Rocky mountains. Stony tracts also occur along some of the streams, such as Woody Island Creek and in the foothills of the mountains. Most of the tracts consist of low hummocks, stony ridges, and potholes. Drainage has not been established and many small lakes are found in the area.

Tillable area.—Scobey stony loams cover 268 square miles or 6 per cent of the county, of which 28 per cent or about 48,025 acres is too broken for cultivation.

Utilization.—Scobey stony loams are among the better grazing types in the county, but in general are too stony for farming. Less than 2 per cent of the total area was under cultivation in 1923. The cropped acreage was confined largely to the less stony phases on the lower slopes of Big Flat. The surface acre foot contains about the same amount of plant food as found in the darker-colored phase of the Scobey loams.

Vegetation.—The grass and shrub cover on the stony loams does not differ greatly from that on the loams and the carrying capacity for live stock is about the same.

Phillips Loams

Description.—Phillips loams are characterized by numerous depressed bare spots, locally called "slick spots" and "blow outs." The character of the bare spots varies with the texture and probably with the stage of development. On the heavier phases, such as found on the bench lands east of Parallel Creek and along

Lone Tree Coulee, the bare spots cover from 40 to 50 per cent of the total surface of the land. South of the Milk River on the lighter phases they occupy from 25 to 35 per cent and in the northwestern part of the county from 20 to 40 per cent.

The soil profiles on the grassed-over portion of the Phillips loams are much the same as for the Scobey loams and sandy loams. The soil mulch is more pronounced and the subsurface layer is more compact. On the heavier loams the carbonate zone lies 8 to 12 inches below the surface and grades into heavy-textured drift at 35 inches or more. On the lighter loams, the lime zone below 10 to 16 inches grades into more friable drift at 40 inches or more.

The bare spots on the heavier phase are depressed 3 to 5 inches and have a gray glazed crust on the surface, in which glacial gravel is conspicuously embedded. The crust has the texture of a silt to silty clay loam and averages less than one-quarter of an inch in thickness. It overlies a shallow, honeycombed or vascular-structured layer, grading into a compact, granular, impervious material, which rarely exceeds 7 to 8 inches in thickness. The texture of this so-called hardpan is a gritty silty clay without definite structure. The lower part of the hardpan is flecked with white alkaline material, which effervesces faintly with acid. The carbonate zone below the hardpan is well developed. The parent drift material often contains fragments of shale. In the northwestern part of the county the bare spots average somewhat deeper and the upper part of the hardpan is not so compact as the lower part.

On the sandier phases the bare spots are often depressed 8 to 10 inches. These spots have the same glazed crust and honeycombed layer on the surface, but above the hardpan is an intermediate layer, which is a very compact sandy loam averaging 3 to 5 inches thick. The hardpan has the texture of a gritty loam, and is flecked with lime and alkali in the lower part. The lower soil depths are the same as those of the Scobey sandy loams.

Topography.—Phillips loams cover the more level undulating sections of the drift-covered area. Low, gravelly hillocks and ridges and shallow lake depressions are very numerous in

the northwestern part of the county. Drainage has not developed on the Phillips loams.

Tillable area.—Phillips loams cover 786 square miles or about 18 per cent of the county. The more scabby portion of the loams is shown as grazing land on the land classification map. On the map 29 per cent of the total area is represented as untillable.

Utilization.—Phillips loams constitute one of the marginal agricultural types in Blaine County. It was homesteaded in tracts of 160 and 320 acres and before the drought was well broken out. The cropped acreage was greatly reduced during the dry years and has continued to decline until within the past few years. In 1923 the acreage under cultivation, which included several thousand acres on the North Chinook Irrigation Project, was approximately 14 per cent of the total area. The cropped acreage was fairly well distributed over the less scabby phases such as are found on the irrigation project and along the East Fork of the North Fork of the Milk River in the vicinity of Irving Creek. Most of the irrigated land was in pasture and hay and the non-irrigated land under cultivation was largely devoted to spring wheat. Land on which more than 35 per cent of the surface was occupied with bare spots was largely used for the grazing of live stock. The cultural and cropping methods are the same as on the Scobey loams.

The soils in the slick spots present a problem. In dry seasons satisfactory stands of small grains are difficult to obtain on these spots, and the grain that does catch is usually stunted and is the first to show signs of firing, although water may have stood on the depressions for several weeks in the spring. In wet seasons the growth is more favorable. The surface acre foot of the Phillips loams contains from 2590 to 4480 pounds of nitrogen, 1365 to 1575 pounds of phosphorus, and 8750 to 19,950 pounds of calcium. These loams average lower in nitrogen than the better agricultural soils in the county. The yields of small grains in wet seasons are fair but average much lower than those on the Scobey loams.

Vegetation.—The plant relationships on the Phillips loams are much the same as for the Scobey loams, except for the prevalence of prickly pear. Salt sage and black sage are found

on the more barren phase along Lone Tree Coulee. Annual shrubs are somewhat more conspicuous than on the other glacial loams. The live-stock carrying capacity of the Phillips loams varies greatly, but on an average 30 to 40 acres would probably carry a steer through the grazing season. The vegetation found on the Phillips loams is considered somewhat better adapted to the grazing of sheep than cattle during the early spring months, when the water-holes are filled.

Turner Fine Sandy Loams

Description.—Turner fine sandy loams have a local, shallow, grayish-brown, fine sandy mulch on the surface. The humus-bearing layer is a reddish brown, friable, fine sandy loam, averaging 5 inches thick. The subsurface layer is a light reddish brown, faintly columnar-structured, gravelly sandy loam. Over a portion of the Big Flat the color of this layer changes at depths of 10 to 14 inches to a light yellowish-brown. The gray to pinkish-gray carbonate zone below 19 to 30 inches is weakly cemented with lime. It grades into semiconsolidated sands, silts, and gravels below 4 to 5 feet or more.

Fine sandy loams predominate on the Big Flat but locally grade into sandy loams and sandy gravelly loams. Drift modifies the character of the surface soils about the borders of the bench. A small tract of scab land occurs on the bench south of Turner. Red quartzite gravel is conspicuous in all the soil layers, but becomes more prominent below 10 to 14 inches.

Topography.—Turner fine sandy loams have a level to gently rolling relief between the intrenched coulees on the Big Flat. South of Twete is a small tract of sharply rolling land, where several coulees unite. The detached tracts west of the Big Flat are very rolling and hilly. The soils have very good drainage.

Tillable area.—Turner fine sandy loams cover 165 square miles or 4 per cent of the county, all of which is shown on the topographic map to be tillable. The land classification map shows about 8 per cent of the total area to be non-agricultural. In this map the indented borders of the bench and stream bottoms are classed as untillable.

Utilization.—Squatters appeared on the Big Flat soon after the Montana Experiment Station established a demonstration

farm here in 1906. Most of the land on the Big Flat was homesteaded in tracts of 160 acres after it was sectionized in 1910. Before the drought a fair acreage was broken out, but during the dry years the cropped acreage was greatly reduced. Since that time the cropped acreage has steadily increased and will probably be maintained with the construction of a branch railway line on the bench. The homestead units have been consolidated into farms of 480 to 640 acres or more, and the annual cropped acreage on most of the farms is large. In 1923, 20 per cent of the land on the Big Flat was under cultivation. The cropped acreage was fairly well distributed over the tillable area. Exclusive growing of spring wheat is the chief enterprise, although about the borders of the bench, where grazing land is available, small herds of cattle are often found. Flax is an important cash crop on new breaking, while the other small grains are grown chiefly for feed and forage. The elevation of the bench is rather high to successfully mature the varieties of corn grown in the lower plains in normal seasons. The cultural and cropping methods are the same as on the Scobey loams.

Turner fine sandy loams are among the better agricultural soils in Blaine County. The soils are open and porous and readily absorb the limited rainfall. The subsoils have a fair water-holding capacity. The surface acre foot contains an average of 4000 pounds of nitrogen, 1600 pounds of phosphorus, and 12,000 pounds of calcium. In plant food these soils rank with the darker-colored phase of the Scobey loams. The yields of small grains have averaged somewhat higher than on the Scobey loams since the land was broken out. Because of the distance to market, land values in the Big Flat have been very low, but with the completion of the Saco-Hogeland branch of the Great Northern Railway there has been a rapid advance in land prices.

Vegetation.—The Turner fine sandy loams were very well grassed over before the bench was broken out. The species relationships were much the same as found on the Scobey sandy loams, and the carrying capacity for live stock is similar to that of the Scobey loams.

Bainville Loams

Description.—The more mature phase of the Bainville loams, such as is found on Rattlesnake and other benches on the southeastern slopes of the Bear Paw Mountains, has a light-brown, loose, shallow, non-calcareous mulch on the surface. The humus-bearing layer is a rather dark-brown, friable, feebly columnar-structured, calcareous sandy loam, averaging 3 to 4 inches in thickness. Below the humus-bearing layer, the subsoil is a grayish-brown, compact, calcareous, slightly heavier-textured sandy loam grading into yellowish compact sands at 17 inches or more. Decomposed sandstones and shales occur at depths of 3 feet or more. The subsoils often have the structure of the parent material and are mottled with rusty iron streaks. The subsoils on some of the benches are not so sandy as on Rattlesnake bench.

The more immature phase of the Bainville loams, such as is found in the breaks of streams and in the more broken sections, consists largely of sandy, silty, calcareous, colluvial material. The light-brown humus-bearing layer is usually very shallow and grades into unmodified colluvial material at 3 or 4 inches. Shales and sandstones are encountered at various depths below the colluvial material.

The soils on the Raglin bench are not typical of this series. The surface mulch is well developed and the humus-bearing layer is a light-brown, slightly plastic, calcareous silt loam averaging 5 to 7 inches thick. The lower soil depths are stratified grayish-yellow and yellowish cast loams, sands, and silty clays. A poorly defined calcareous zone occurs on the bench at 22 inches. Quartzite gravel is distributed over the surface of the bench and in the surface soils.

Topography.—Bainville loams cover irregular benches on the southeastern slopes of the Bear Paw Mountains and along Black Coulee in the southwestern part of the county. It also covers broken tracts below the mountains and the breaks of some of the streams.

Tillable area.—Bainville loams cover 167 square miles or 4 per cent of the county, of which 70 per cent is too broken for cultivation. The land classification map shows 78 per cent of the total area to be untillable.

Utilization.—Bainville loams are used chiefly for the grazing of live stock. Rattlesnake bench was fairly well settled and broken out before the drought, but during the dry years was largely abandoned. Raglin bench was not so well settled as Rattlesnake bench because of its distant location. Corn was the principal crop grown on the benches in 1923, chiefly for hogging off to supplement the winter grazing lands, and also for fattening lambs. The Bainville loams on the higher mountain slopes are well supplied with nitrogen, phosphorus and lime in the surface acre foot, but at the lower elevations are usually low in nitrogen.

Vegetation.—Grama grass and nigger wool form the principal cover on the Bainville loams. The density of the grass cover varies with the elevation and ruggedness of the tracts, but on an average 25 to 30 acres would carry a steer through the grazing season.

Lismas Clay Loams

Description.—Lismas clay loams have on the surface a loose, granular, dull-brown, silty clay mulch which forms a compact checked crust during the summer months. Below the surface layer the soil is a compact, cloddy, tenacious, non-calcareous, olive-brown clay, mottled and streaked with rusty brown, silty material. The platy structure of the parent material is usually found in the second foot, and fragments of shale at depths of 3 feet or more. Fragments of gypsum are distributed over the surface and through the soil.

In the timbered sections along the Missouri River, and along Cow and Bullwhacker creeks, the surface soils are modified slightly with vegetable matter. A shallow covering of pine needles occurs on the surface, below which the soils are loose and granular for a few inches, grading into olive-brown clays. These soils are somewhat lighter in color and more plastic at depths of 6 to 10 inches. The lower soil depths are similar to those in the untimbered sections.

Wash gravel covers lightly the Lismas clay loams on the slopes of the divides south of the Bear Paw Mountains and in the stream bottoms it is often abundant. Wash from the yellowish-brown sandstone breaks on the higher divides also modi-

fies the surface soils along the upper stretches of Cow and Bullwhacker creeks.

Topography.—Lismas clay loams cover the barren, gullied clay hills and ridges along Bullwhacker and Cow creeks in the southern part of the county and occur locally along the more deeply intrenched streams north of the Milk River. Isolated tracts are found in the more broken sections underlain with the Bear Paw shales in the central part of the county, north of the Little Rockies.

Tillable area.—Lismas clay loams cover 293 square miles or 7 per cent of the county. Over 80 per cent of the total area is too broken for cultivation. On the land classification 87 per cent is shown to be untillable.

Utilization.—Lismas clay loams are among the poorest grazing lands in the county. The soils are too heavy for farming unless the surface is modified with colluvial wash.

Vegetation.—Black sage, grease wood, isolated plants of western wheat grass, and such annuals as sunflower and cocklebur largely compose the vegetation on the Lismas clay loams. The land is usually grazed only during the time that water-holes are filled, unless adjacent to perennial streams. The carrying capacity of the Lismas clay loams for live stock is very low.

Pierre Clay Loams

Description.—The top 2 to 3 inches of the Pierre clay loams is a loose, granular, calcareous, grayish-brown, silty clay mulch which develops a compact crust on the surface during the summer months. The faintly developed, humus-bearing layer of 5 to 7 inches is a slightly calcareous, brownish-drab, compact, cloddy, plastic clay, grading into non-calcareous, massive, olive-brown clays. Below 12 to 16 inches the soil material is streaked and blotched with gray, ashy, alkaline material, consisting chiefly of gypsum. Fragments of shale and gypsum occur at depths of 2 to 3 feet. The soils are cracked for 10 to 15 inches below the mulch. The Pierre clay loams in the basin of Clear Creek in T. 30 N., R. 17 E., show a more mature development. The surface mulch is highly calcareous, and the humus-bearing layer is more distinct. Free lime is distributed through the lower soil depths.

Topography.—Pierre clay loams cover the rolling clay hills and ridges in the more broken sections. The larger bodies are found at the head of White Bear Creek and in the vicinity of the foothills of the mountains. North of the Milk River the heavy loams are confined largely to the northwestern slopes of Cherry Patch Ridge and to the breaks along Parallel Creek.

Tillable area.—Pierre clay loams cover 138 square miles of which 70 per cent is too broken for cultivation. About 85 per cent of the total area is shown as untillable on the land classification map.

Utilization.—Pierre clay loams are also among the poorer grazing lands in the county and are not adapted to dry-land farming. Under irrigation, grasses and legumes do fairly well, but the yields of small grains are likely to be low until the soil has been built up. The heavy clays are high in phosphorus and have a fair amount of lime but are usually low in nitrogen.

Vegetation.—The Pierre clay loams are poorly covered with vegetation. Grama grass predominates over other species but does not form a continuous cover. Black sage, western wheat grass, and the annual shrubs and weeds are widely distributed, and in some localities form the chief cover. The live-stock carrying capacity of the heavy loams is low, 40 to 50 acres probably being required to carry a steer through the grazing season.

Blaine Stony Loams

Description.—On the lower northern slopes of the Bear Paw Mountains the surface 1 to 2 inches of the Blaine stony loams is a dark, organic sandy mulch. The humus-bearing layer is a dark-brown, friable stony loam, averaging 5 to 6 inches thick. The heavier-textured subsurface layer grades from brown to reddish-brown in the upper part to a brown in the lower part. The carbonate zone is compact, grayish-brown silt to silty clay loam below 15 to 30 inches depending upon the elevation. The lower depths below 4 to 5 feet are dull-brown, gravelly stony loams. Fragments of rock ranging in size from gravel to boulders are distributed over the surface and through the soil, becoming more numerous with depth. Red sandstones and shales often modify the color of the soils about the larger dikes.

On the eastern slopes and at the lower elevations within the mountains the surface mulch and humus-bearing layer of the

Blaine stony loams are much the same as on the northern slopes. The subsurface layer ranges from reddish-brown to yellowish-brown loams and silt loams and the carbonate zone often lies within 16 inches of the surface. On the eastern slopes, the lower soil depths consist largely of stratified yellowish sands and silty clays, derived from the sedimentary rocks underlying the colluvial material on the mountain slopes. Within the mountains stony silt and silty clay loams predominate and bed-rock is often encountered at fairly shallow depths. In the vicinity of the dikes the soils grade into the Belknap stony loams.

The breccia-capped ridges extending out from the mountains, chiefly on the south, are covered with dark-colored stony loams, underlain with very stony subsoils. The more shallow phases occur on the lower ridges.

Topography.—Blaine stony loams cover the broken stony slopes and basins within the mountains. The slopes and basins are cut with dikes, which often have the proportions of small ridges. The breccia-capped ridges have a bench-like relief. The southern slopes are more broken than the northern slopes.

Tillable area.—Blaine stony loams cover an area of 269 square miles or close to 6 per cent of the county. About 66 per cent of the total area is too broken for cultivation. On the land classification map 90 per cent of the area is classed as untillable.

Utilization.—Blaine stony loams are among the better grazing lands in the county. The agricultural land is confined to small irrigated tracts in the larger basins, and to the less stony and broken slopes. In 1923 less than 15 per cent of the area suitable for cultivation was in crops. The cropped land was confined largely to the basins of Peoples and Clear creeks and to the northern slopes of the mountains. Small grains and forage crops are grown for winter feed to supplement the winter grazing lands. Winter wheat is grown with fair success on the lower slopes. The soils are very high in all the plant foods, and the crop grows very rapidly during the short growing season.

Vegetation.—Grama grass and its associated species predominate on the foothills and lower slopes of the mountains, but at the higher elevations give way to vegetation consisting largely of shrubs and the tall grasses. This latter type of vegetation is not considered so nutritious as the short grasses. Fifteen to

20 acres are considered sufficient on the Blaine stony loams to carry a steer through the grazing season. Snow covers the higher elevations for several months in the year.

Belknap Stony Loams

Description.—The surface of the Belknap stony loams is a dark reddish-brown, friable, stony sandy loam to loam averaging 3 to 4 inches thick. The subsurface layer is a compact reddish-brown loam, the upper part of which is somewhat more compact and granular at the higher elevations. The carbonate zone below 8 to 15 inches is a reddish-gray compact structureless silt to silty clay loam, grading into decomposed red sandstones and shales with depth. More or less rock occurs on the surface.

Topography-Utilization.—Belknap stony loams cover rolling to broken basins within the mountains underlain with indurated red sandstones and shales. These stony loams cover 32 square miles, of which 86 per cent is too broken for cultivation. On the land classification map less than 1 per cent is classed as tillable. The stony loams are used chiefly for the grazing of live stock.

Vegetation.—The vegetation on the Belknap stony loams is similar to that on the Blaine stony loams except in some of the lower basins where grama is found, and the carrying capacity of these two types of soil is practically equal.

Zortman Gravelly Loams

Description.—The surface mulch is poorly developed on the Zortman gravelly loams. The humus-bearing layer of the less eroded phases is a rich-brown, friable loam averaging 5 to 7 inches thick. The subsurface layer is a brown, compact, calcareous, weakly columnar-structured stony loam to silt loam. The carbonate zone below 12 to 16 inches is a grayish-brown, structureless, compact, stony silt to silty clay loam, which is locally cemented with lime. Below 4 to 5 feet, the lower soil depths are very gravelly and stony. Fragments of limestone and lime-coated gravel and rock are usually distributed through all layers. On the more eroded benches the surface soil is often very shallow, and the stony subsoils often occur close to the surface or are exposed.

The surface soil on the isolated bench north of the Little Rockies is a friable brown silt loam averaging about 7 inches in depth. The lower soil depths grade from yellowish-brown, calcareous loams to compact, plastic, gray silty clay loams. Lime-coated gravel and rock are distributed through the soils and become more abundant with depth.

Topography.—Zortman gravelly loams cover eroded benches extending out from the Little Rocky Mountains for 8 to 10 miles, except for the isolated bench north of these mountains. The borders of the benches are indented with deep coulees. Springs and water-holes are numerous on the slopes of the benches.

Tillable area.—Zortman gravelly loams cover 52 square miles, of which 68 per cent is too broken for cultivation. On the land classification map 90 per cent of the total area is classed as untillable.

Utilization.—The Zortman gravelly loams are used chiefly for the grazing of live stock, although on the larger benches stock raising is combined with grain growing. The benches lie at too high an elevation and too far from railway points for more intensive farming. In 1923 less than 4 per cent of the tillable land was under cultivation. The cropped acreage would be slightly increased if the tillable land on the Fort Belknap Indian Reservation were broken out. Spring and fall wheat were the chief cash crops grown on the Zortman gravelly loams. Other small grains are grown chiefly for feed and forage. The soils are well supplied with nitrogen, phosphorus, and lime.

Vegetation.—Zortman gravelly loams are well grassed with grama and its associated species. The carrying capacity of the gravelly loams for live stock is slightly lower than that of the Blaine stony loams.

Lloyd Gravelly Loams

Description.—The surface 2 to 3 inches of the Lloyd gravelly loams on Lone Tree Bench is a grayish-brown, loose loam, approaching the character of a mulch. The humus-bearing layer, averaging 4 to 6 inches thick, is a brown, rather compact, gritty gravelly loam. The carbonate zone is a light grayish-brown, calcareous, silty gravelly loam below 20 inches and locally is weakly cemented with lime. The soil below 3 to 4 feet consists largely of lime-coated gravels and sands.

The surface soil of the Lloyd gravelly loams on the bench south of Cow Creek is a dark-brown, friable loam to a depth of 6 inches. The subsurface layer is a compact, light-brown silt to silty clay loam. The carbonate zone below 18 inches is a dull grayish-brown, compact, silty clay to plastic clay. It grades into dark-colored stratified material consisting chiefly of sand and gravel at 3 feet or more. The benches north of Cow Creek have similar surface and subsurface soils, but the subsoils are grayish-brown, gritty clay loams. Subangular rock carried out of the mountains and water-worn gravel are distributed over the surface and through the soil in varying amounts.

Topography.—Lloyd gravelly loams cover irregular benches with deeply indented borders south of the Bear Paw Mountains.

Tillable area.—There are about 33 square miles of Lloyd gravelly loam, all of which is shown to be tillable on the topographic map. Fifty-five per cent of the total area is untillable according to the land classification map.

Utilization.—Lloyd gravelly loams are too irregular and lie too far from railway points to be included among the farm lands of the county. In 1923, 14 per cent of the tillable land was under cultivation. The cropped land was confined largely to Lone Tree Bench. Corn was the chief crop grown. The surface acre foot of Lone Tree Bench contains a fair amount of nitrogen and is well supplied with phosphorus and lime. The higher benches along Cow Creek have a greater nitrogen content in the surface acre foot.

Vegetation.—Grama grass forms the principal cover on the Lloyd gravelly loams, and the carrying capacity for live stock will average from 20 to 30 acres per steer.

Cheyenne Gravelly Loams

Description.—The surface soils of the Cheyenne gravelly loams on the low benches along Woody Island Creek are reddish-brown, loose to friable, gravelly loams and sandy gravelly loams averaging 5 to 6 inches deep. The subsurface layers are light reddish-brown, compact, sandy gravelly loam and gravelly loams. The carbonate zone below 12 to 20 inches is made up of rather loose lime-coated sands and gravels, grading into stratified gravelly material with depth.

The surface soils of the Cheyenne gravelly loams in Milk River Valley are brown sandy loams and gravelly loams, underlain with rather compact, lighter-colored subsurface layers. The carbonate zone below 12 to 30 inches grades into stratified material with depth. The higher terraces on the slopes of the valley are usually more sandy and gravelly than the lower terraces located in the valley.

The Cheyenne gravelly loams along Cow Creek are not representative of this series, since they have developed over alluvial material carried out of the Bear Paw Mountains, and are dark-colored, gravelly, and underlain with stratified water-worn gravel and sand, and silt.

Topography-Tillable area.—Cheyenne gravelly loams occur on high terraces in the valleys of preglacial streams and cover an area of 39 square miles, of which 60 per cent is shown to be tillable on the land classification map.

Utilization.—Cheyenne gravelly loams are adapted chiefly to the grazing of live stock, unless water is available for irrigation. The soils in general are poorly adapted to dry-land farming. In 1923 less than 6 per cent of the benches were under cultivation. The cropped land was found largely on the irrigated tracts in the valley of Milk River. The soils are rather low in nitrogen, and their phosphorus and lime content are quite variable.

Vegetation.—The vegetative cover of the Cheyenne gravelly loams is similar to that found on the Scobey sandy loams. The density of the grass cover is somewhat greater on the lower benches along Woody Island Creek than in Milk River Valley. About 25 acres are required for a steer through the grazing season.

Laurel Loams

Description.—The heavier phases of the Laurel clay loams, which predominate in the valley of the Milk River, have a grayish-brown, granular silt to silty clay mulch on the surface which becomes very compact or crusted during the late summer months. The poorly developed humus-bearing layer is a dull grayish-brown, compact, cloddy silt to silty clay loam, averaging 5 to 8 inches thick. The lower soil depths are chiefly stratified silts

and clays. In the western part of the valley yellowish stratified sands underlie the heavy loams at depths of 3 feet or more. Free lime occurs in all the soil layers and in the heavier phases an alkali zone is usually found at depths of 18 to 24 inches.

The lighter-textured phases of the Laurel loams in the valley of the Milk River are found within one-fourth to one-half mile of the streams. These soils often show no distinct soil horizons and are stratified sands and silts. West of Chinook the Laurel loams include some glacial deposits which were not indicated separately on the maps. The southern slope of the valley is quite sandy, and scabby depressions occur between the low mounds.

The Laurel loams in the valley of the Missouri River consist largely of wash from the breaks. The colluvial material derived from the Bear Paw shales consists largely of dark-colored silt and silty clays; while that from the Judith River sandstones has the texture of gray, calcareous, sandy loams and silt loams. The sandy loams have developed a faint humus-bearing layer, averaging about 3 inches thick. The soils of the flood plains of the stream are usually very heavy except for small tracts of sands and gravels, deposited during high water.

The soils in the stream bottoms in the glaciated area are usually poorly drained gravelly loams and sandy loams, unless the streams have eroded their beds into the sedimentary rocks. In the vicinity of the Big Flat, the bottoms of the streams are covered with red quartzite gravelly, sandy loams. Dark-colored, non-calcareous, stony loams predominate in the mountain basins. The flood plains of streams below the Little Rockies are heavy alkaline clays.

Topography.—The valley of the Milk River is quite level, with many ox-bow lakes and poorly drained depressions along the stream. The land along the river is locally 1 to 2 feet higher than the lower part of the valley. The colluvial slopes in the valley of the Missouri River are cut into irregular tracts by the meandering of the stream. The narrow valleys of many of the upland streams are locally terraced. South of the mountains the stream bottoms often approach the character of bad-land basins. In the mountains the tillable land is confined largely to stony terraces in the larger basins.

Tillable area.—Laurel loams cover 200 square miles, of which the greater part lies in the Milk River Valley. On the land classification about 81 per cent of the area is in the tillable class.

Utilization.—Laurel loams are not under cultivation except where the land is subirrigated or where water is available for irrigation. The heavy bottoms of some of the streams are valuable hay lands, where they are irrigated or receive the spring flood waters. In 1923, 21 per cent of the Laurel loams was under cultivation. The cropped acreage was largely confined to the irrigated projects in the Milk River Valley and to small tracts along streams heading in the mountains. The non-irrigated lands are largely used for grazing.

The heavy loams in the Milk River Valley are rather difficult to handle and several years are usually required to bring them to a fair state of productiveness. The soils are fairly well supplied with nitrogen, phosphorus, and lime. The more important crops grown under irrigation are spring wheat, oats, barley, alfalfa, and such intensive crops as beans, potatoes, and sugar beets. A fair acreage in the Milk River Valley is in native blue-joint, which makes an excellent quality of hay under irrigation. Flood control, drainage, and alkali are important problems in the valley of the Milk River. The irrigated land adjacent to the mountains is devoted largely to the growing of forage crops and the small grains, such as oats and barley, for winter feed.

Vegetation.—The bottom lands in the Milk River Valley are well grassed. Western wheat grass predominates on the heavier loams and grama and nigger wool on the lighter loams. Valley sage is conspicuous on the lighter soils. Blue-joint *(Andropogon spicatum)* thrives on the heavier soils which are annually flooded. Trees and large shrubs are confined chiefly to the better-drained loams along the streams.

The colluvial slopes extending down to the river in the Missouri River Valley are lightly covered with black sage, greasewood, and western wheat grass. Grama grass is found on the lighter loams in the western part of the valley. Fair stands of blue-joint grow on the heavy overflowed bottoms and the tall grasses predominate on the sands and gravels. Trees and large shrubs are abundant on the subirrigated land.

The bottom lands of streams in the northern part of the county are well grassed, unless the streams have eroded their beds into sedimentary rocks. In the southern part the alkaline stream bottoms are more scantily covered. In the mountain basins a mountainous type of vegetation is usually found. The carrying capacity of the Laurel loams for live stock is usually low unless the land is flooded, subirrigated, or irrigated.

Laurel Clay Loams

Description.—Laurel clay loams usually have a compact, grayish-brown crust on the surface. The humus-bearing layer, consisting of a dark-colored, heavy, cloddy, plastic, platy-structured clay, is poorly defined. The lower soil depths are massive olive-brown, compact, stratified clays and silty clays. Pockets of gray, ashy, alkaline material occur at depths of 18 inches or more. The soils effervesce weakly with acid, both at the surface and in the lower depths. Below the crust, deep cracks penetrate the soils for a foot or more.

Topography-Tillable area.—Laurel clay loams cover depressions in the valleys of the larger streams, such as the Milk River, and also the heavy alluvial fans below the mouth of streams which have eroded their beds into sedimentary shales. Laurel clay loams cover 21 square miles in the valley of the Milk River, of which about 65 per cent is shown as tillable on the land classification map.

Utilization.—Laurel clay loams are difficult to handle, and under irrigation are used chiefly for pasture and hay lands. In 1923 about 20 per cent of the heavy loams was in irrigated native blue-joint, which was grown chiefly for hay. The soils are fairly well supplied with the mineral plant foods.

Vegetation.—Laurel clay loams are not well grassed unless the land is flooded or is under irrigation. Blue-joint thrives on the better-drained, flooded heavy bottoms, while squirrel-tail grass *(Hordeum jubatum)* grows well on the tracts which are covered with water for several weeks in the spring. The higher tracts are usually barren, except for light stands of annual shrubs and weeds such as sunflower and cocklebur. The carrying capacity of the Laurel clay loams for live stock is very low unless the land is flooded or irrigated.

Bad-land Basins

Description.—Bad-land basins have a compact gray crust on the surface, which gives them a glazed appearance. The heavy clay below the crust is honeycombed for an inch or more and grades into compact, non-calcareous, dull olive-brown, stratified clays and silty clays. Pockets of gray, ashy, alkaline material are usually distributed through the lower soil depths. In the basin along Lone Tree Coulee fine sandy material underlies the heavy clays at depths of 3 or more feet.

Topography-Utilization. — The bad-land basin along Lone Tree Coulee covers about 13 square miles and on the land classification map it is shown as grazing land. None of the basin is under cultivation.

Vegetation.—The vegetation in bad-land basins consists chiefly of salt sage, shad scale, and prickly pear. Black sage and greasewood grow about the borders and squirrel-tail grass in the poorly drained sections. Salt sage makes a fair range forage, where the stand is sufficient and located near waterholes. The carrying capacity of bad-land basins for live stock is very low.

Bad Lands

Bad lands cover 174 square miles in the southern part of the county along the Missouri River and Cow and Bullwhacker creeks and are important only for grazing.

The stand and the character of the vegetation in the bad-land sections depend largely upon the geologic formations exposed. The gullied clay hills and ridges formed by the weathering of the Bear Paw shales are poorly covered with vegetation. Black sage, greasewood, rabbit brush, and isolated plants of western wheat grass compose most of the vegetation on the barren shales. The plant relationships on the eroded sandstones of the Judith River formation are the same as on the Bainville loams. The breaks above the Missouri River and Cow and Bullwhacker creeks have a light stand of pines and cedars distributed over the surface. The carrying capacity of bad-land areas for live stock is very low.

Rough Broken Land

Rough broken land covers 252 square miles in the Bear Paw Mountains. It consists chiefly of bald peaks, barren ridges, rocky ledges, and talus-covered slopes.

The soils developed in the quaking-aspen belt above 4500 feet in elevation have black surface soils, consisting largely of organic matter and averaging about 6 inches thick. Between 6 and 14 inches in depth, the soils are light-brown, compact loams grading into reddish-brown, structureless silts and silty clays. The carbonate zone below 30 inches is a grayish-brown silty clay loam, grading into a brown and more friable silt and silty clay loam with depth. Angular fragments of rock are distributed through all layers and become more abundant with depth. Carbonate zones were not found where the denser stands of lodge-pole pine grow on the mountain slopes. The subsoils of these tracts were reddish-brown, heavy-textured loams, grading into more friable, dull-brown silt loams with depth.

Fair stands of lodge-pole pine are found on the higher mountain slopes, and quaking aspen and willows in the poorly drained gulches and basins. On the lower outlying ridges, light stands of yellow pine occur. Sedges predominate over the grasses in the more moist parks. Shrubs are very abundant and form the greater part of the undergrowth. Rough broken land has a low carrying capacity for live stock, except for such animals as sheep and goats. Snow covers the higher elevations for several months in the year.

AGRICULTURE

The chief industry in this part of the state up to 1908 was stock raising. It declined during the time the public lands were being settled and fenced under the so-called "dry-land movement" but by 1912 the number of herds which sprang up in connection with the dry-land farms more than offset the loss sustained by the dissolution of the large cattle companies. The acquisition of land and the breaking out of the prairies were the more noticeable features between 1908 and 1917. Crop yields were fairly good during this period and land values increased rapidly. In 1917 this part of the state experienced a severe drought which continued for the next two years and at

the close of that period the cropped acreage was greatly reduced and the marginal agricultural lands were largely abandoned. The stockmen who continued to operate in the vicinity of the Bear Paw and Little Rocky mountains and in the more broken and remote sections of the county suffered heavy losses during the winter of 1919. The economic depression following the drought, combined with heavy stock losses, resulted in many failures and the concentration of a large acreage of the land in the hands of mortgage-holding companies. Many of the local banks and trust companies, which had loaned heavily on land and live stock during the favorable years, went into the hands of receivers during the deflation period. In 1925, 57.4 per cent of the farms in operation in the county carried a mortgage indebtedness averaging $5.20 per acre on land valued at $11.08 per acre. Land values which range from 50 cents to $3 for grazing land to $10 to $25 per acre for the better improved non-irrigated lands have not been definitely established since the drought but the conditions have greatly improved during the past two years. The agricultural trend in Blaine County is shown by data taken from the census reports for the years 1920 to 1925. The proportion of the county in farms in 1920 amounted to 42.8 per cent and by 1925 it had decreased to 33.1 per cent. During this period the number of farms decreased from 1761 to 1135 while the average size increased from 608 to 789 acres. The loss in farm acreage was almost entirely in the unimproved class or marginal agricultural land, which is best adapted to grazing under normal conditions. The cropped and fallow acreage was greatly reduced at the close of the drought, but in 1925 it amounted to 180,497 acres or nearly 7 per cent of the total area of the county. Most of the dry and irrigated farms are operated by owners or part-owners as less than 20 per cent of the total number were farmed by tenants in 1925. Share renting, in which the owners receive from one-fourth to one-third of the crop, is the common practice. Blaine County is one of the few counties in the state in which the gross agricultural income the past few years has been about equally divided between the major branches of agriculture, namely stock raising, dry farming, and irrigated farming.

Stock raising.—The first stock to be run at large in the county belonged probably to Peppin and Broadwater, who operated in the west-central part of the county soon after Fort Assinniboine was established in 1879. Beilenburg, Kohrs, and others did not move their herds across the Missouri River on to the Indian Reservation until the dry summer of 1886. The Bear Paw Pool was one of the first cattlemen's protective and marketing associations to be organized in northern Montana. Members of the pool ranged their stock in the northern part of the county during the summer months and wintered them near the Bear Paw and Little Rocky mountains. Large tracts of winter grazing lands were taken up in the well-watered Bear Paw Mountain area during the late eighties and nineties and many stockmen were firmly established at the time of the dry-land movement and, except for changing their range practices, continued to operate after the so-called "dry-land farmer" made his appearance on the public range. Since the settlement of these ranges, most stockmen provide winter feed for one or more months or move their herds to the irrigated sections where feed is available during the winter months. The Fort Balknap Indian Reservation has been under lease by several large cattle companies for a number of years. Some of the better grazing lands in the county are found on the reservation. The number of cattle has remained nearly stationary, being around 29,000 head annually since 1920. The beef breeds, such as the Herefords and Shorthorns and their crosses, make up over 90 per cent of the total number. The census report for 1925 shows 3545 milk cows, about one-third of which are probably beef breeds used for dairy purposes on the dry and irrigated farms. In the irrigated districts some fine Holstein herds are being built up by the introduction of young calves from the dairy sections on the Pacific coast and the importation of mature animals from Wisconsin and other states.

Sheep were brought into the county during the early nineties. The number has varied greatly with the fluctuation in price of wool, but they have never attained the importance of cattle. The vegetation in some sections of the county is better adapted to the grazing of sheep than other stock, especially during the spring and early summer months when the water-holes

are filled. At the present time sheep are confined largely to the more broken and abandoned farm sections in the northwestern and southern parts of the county. During the past few years sheepmen have contracted for a fair acreage of corn on the dry-land farms to pasture off during the fall and winter months. Between the years of 1920 and 1925 the number of sheep increased from 109,000 to 116,000 head. Most of the sheep found on the range belong to the finer wool breeds, such as the Rambouillet.

Horse raising was never popular in the county as the range conditions were more favorable for the grazing of cattle and sheep. The total number of horses reported on the farms in 1925 was 14,634 head, of which about 2000 were less than two years of age. A large number of horses were turned loose on the range during the drought and these have increased rapidly. These semiwild bands have been rounded up during the past year or two and shipped to eastern markets or slaughtered by packing companies in Butte.

The swine industry has developed rapidly since the drought in those sections of the county where corn can be successfully matured. In 1925 there were 5760 head of hogs, of which nearly 1100 were breeding sows. Duroc Jersey and Hampshire appear to be the most popular breeds.

Dry-land farming.—At the time of settlement of the range lands a large acreage was broken out and placed in crops. Some of this land was of marginal agricultural value and should have been left as grazing land. The elimination of this marginal farm land has been going on steadily until the boundaries of the better agricultural districts are fairly well defined, as indicated on the cropped area map. The acreage and yields of the chief dry and irrigated crops grown in Blaine County are presented in Table 4. The state and Federal reports from which this material has been compiled do not show separately the acreage and yields of the different crops grown under dry and irrigated conditions, but a general idea of the crop production in this county on the dry and irrigated lands may be obtained. During the past few years approximately two-thirds of the total acreage under cultivation was above the ditch and farmed by the so-called "dry-land methods."

Under dry-land conditions the early and medium-early varieties of grain and forage crops are best adapted to the climatic conditions prevailing in this part of the state. The more important small grains grown above the ditch include such varieties as Marquis wheat, N. D. R. No. 114 flax, Markton and Sixty-Day oats, Horn barley, and Rosen rye. Winter grains, except fall rye, winter-kill frequently in the plains sections, but Karmont and Newturk winter wheat are grown with fair success on the higher slopes and benches about the Bear Paw and Little Rocky mountains. In the lower plains sections, Northwestern Dent corn and the early flint varieties are successfully grown for feed. Spring wheat and flax are the most important cash crops. The acreage of corn harvested for grain is very small as most of it is cut for fodder and ensilage or harvested by swine and sheep. About two-thirds of the acreage of oats and barley grown on the dry-land farms is cut for hay in normal seasons. Since the time of the drought the acreage of small grains has not changed greatly except for a few crops. The acreage of rye which was devoted to forage for a few years after the drought has steadily declined while spring wheat has shown a slight increase. The yields of the small grains, such as spring wheat, have varied greatly since the land was broken out, being influenced by the season as well as by the cropping and tillage methods.

The hay crops include alfalfa, sweet clover, brome grass, slender wheat grass, and the small grains and native grasses. The legumes and grasses produce rather low yields under dry-land conditions and many farmers prefer to run their stock on the open range, which is supplemented during the winter months with straw and small grains and native grasses cut for hay.

In general the yields of potatoes and other root crops are low and only a sufficient quantity for home consumption is produced. The production of seed potatoes on the lighter soil types has been fairly successful in certain sections, but so far the crop is of limited importance. Gardens and small fruiting shrubs are usually located in some protected nook where snow accumulates during the winter months or in stream depressions which are flooded during the spring run-off.

One of the more noticeable features of the dry-land agriculture in this part of the state the past few years is the efficient use of tractors and "big-team" outfits in the production of spring wheat and other cash crops on the large grain farms. The yearly acreage in crops on many of these large grain farms runs from 200 to 600 acres or more. Spring wheat and other small grains are grown continuously until the land becomes foul, when clean summer fallow is introduced every second or third year. Duckfoot cultivators and similar implements are largely replacing the more common farm implements on the large grain farms in preparing the land for seeding and for summer fallowing. These implements are efficient in producing a cloddy mulch, in destroying weeds, and in leaving the stubble and trash on the surface to prevent or reduce soil blowing. Headers and push binders are in general use in harvesting the large acreage, although during the past two years the number of small combine harvesters has increased rapidly. Summer fallowing of land is more consistently followed on the higher benches and on the slopes of the Bear Paw Mountains, where the soil is less likely to blow, than in the plains sections.

On the smaller dry-land farms considerable diversification is usually found. Corn replaces summer fallow to some extent and a greater portion of the land under cultivation is in legumes and grasses, which are utilized for hay and pasture. Only a small portion of the corn is harvested for grain, since most of it is cut for fodder or hogged off. During the past three or four years, the seasons have been unfavorable for the production of corn in north-central Montana and the acreage has decreased materially. Small herds of cattle and occasionally a band of sheep are usually run in connection with grain growing on the smaller farms. The annual income from these farms is largely derived from the sale of grain, live stock, poultry, and dairy products. The raising of turkeys has been a profitable enterprise during the past few years in some sections.

Irrigated farming.—Irrigation in the Milk River valley owes its initial development to the foresight of some of the early stockmen who saw the need of supplementing their winter ranges with native hay to prevent an occasional heavy winter loss of stock. Irrigation in this part of the state dates from 1890 when

TABLE 4.—ACREAGE AND YIELDS OF THE MORE IMPORTANT DRY AND IRRIGATED CROPS

	*†1919		*1924		**1928		**1922-1928	
	Acreage	Acre yields Bu. or T.	Acreage	Acre yields Bu. or T.	Acreage	Acre yields Bu. or T.	Average acreage	Average acre yields Bu. or T.
Cropped land harvested	100,324	.....	133,616	.....	191,590	.....	170,263	.....
Fallowed land	.....	.....	40,396	.....	.....	.....	.....	.....
Cropped land total	.....	.....	180,496	.....	.....	.....	.....	.....
Alfalfa seed	.....	.....	.....	.....	100	2.0	.....	.....
Barley	1,230	3.9	1,421	17.9	2,600	35.0	1,962	23.8
Beans	.....	.....	580	.....	300	15.0	‡476	14.2
Corn total	84	19.1	6,088	.....	5,000	24.0	5,927	20.2
Corn harvested for grain	.....	.....	445	17.0	.....	.....	.....	.....
Corn cut for fodder and ensilage	.....	.....	2,406	.....	.....	.....	.....	.....
Corn hogged off	.....	.....	3,237	.....	.....	.....	.....	.....
Flax	8,075	1.5	6,262	7.4	9,000	11.0	5,894	8.0
Hay, tame total	29,675	.....	27,857	2.2	25,400	1.8	24,037	1.9
Hay, wild total	13,895	0.5	16,170	0.8	15,200	0.9	17,681	0.9
Hay, alfalfa	9,420	1.4	11,125	.....	.....	.....	.....	.....
Hay, other legumes and grasses	3,412	.....	6,227	.....	.....	.....	.....	.....
Hay, small grains cut for hay	16,843	0.2	5,460	.....	.....	.....	.....	.....
Oats	5,689	7.0	11,828	23.8	22,000	39.0	17,118	30.6
Potatoes	472	82.0	413	68.8	1,100	155.0	816	116.0
Rye	8,214	2.9	2,637	10.1	20,000	10.0	18,891	11.6
Sugar beets	.....	.....	77	10.6	2,890	8.0	‡2,063	9.6
Vegetables grown for sale	8	.....	66	.....	.....	.....	.....	.....
Wheat total	33,815	2.9	63,948	14.7	88,000	22.7	72,421	.....
Wheat, fall	.....	.....	**1,000	20.0	3,000	14.0	2,577	16.6
Wheat, spring	.....	.....	*63,000	17.0	85,000	23.0	69,855	16.3

*United States Census Reports. **Montana—Reports of Department of Agriculture and Publicity. †Extremely dry year. ‡Less than 7-year average.

Tom Everett and others took out a small ditch in the Milk River valley at the mouth of Thirty-Mile Creek, now called Parallel Creek. The Harlem and Paradise projects were organized in 1895 and water was turned into the canals a few years later. The more desirable irrigable land in the Milk River valley was in local projects at the time the Milk River project of 192,000 acres was undertaken by the United States Reclamation Service. Since that time several of the older projects have been enlarged and new canals constructed and extended. Water for 92,000 acres is diverted from the Milk River in the vicinity of Chinook, while several other dams and diversion weirs are located at the mouths of the larger streams entering the Milk River.

Since 1920 several irrigation districts have been created in the Milk River valley under the state laws for the allocation of construction charges, water, etc. The Paradise Irrigation District was among the first to be created, and covers 11,500 acres lying south of the Milk River between Chinook and the Indian Reservation. The Alfalfa Irrigation District includes 4000 acres north of the river between the West and North forks of the Milk River; while the Zurich Irrigation District comprises 12,000 acres extending from the North Fork to Harlem. Petitions have also been circulated for the creation of the Fort Belknap Irrigation District of about 9000 acres north of Chinook and the Savoy-Coburg Irrigation District, which includes nearly 12,000 acres between Harlem and Coburg. All of these districts have early water rights in the Milk River and have also entered into contracts with the United States Reclamation Service, which has its headquarters at Malta, in Phillips County, for additional water from the St. Mary's reservoir.

The United States Bureau of Indian Affairs has undertaken the reclamation of 38,000 acres on the Fort Belknap Indian Reservation. Nearly one-half of the total acreage lies in the Milk River valley, while the remainder lies along White Bear, Peoples, Lodge Pole, and Big Warm creeks. Water is available for about one-half of the area at the present time. The North Chinook Irrigation Association impounds the flood waters of the West Fork of the Milk River in several large reservoirs in the northwestern part of the county. Under this project about 10,000 acres are irrigated. Small tracts of irrigated land are also found along the perennial streams in the Bear Paw Mountains and below storage reservoirs and diversion weirs in other parts of the county. During the dry years the flood waters of many of the small streams in the dry-land areas were stored in small reservoirs, which were used for water-holes and the irrigation of small tracts. At the time of this survey (1923-1924) most of these reservoirs had been abandoned except those maintained by stockmen as water-holes.

The natural flow of the Milk River, supplemented by the water stored in St. Mary's reservoir, is sufficient to meet the irrigation requirements of the Milk River valley under normal conditions. Water has been short for late irrigation during the

past two or three years because of the low level maintained in the St. Mary's reservoir during the winter months. Fear of ice damage to the head-gate house has been removed during the past year and plenty of water should be available in the future. A secondary reservoir, known as the "Chain Lakes," has been proposed to insure an abundant supply of water for irrigation and also to assist in controlling the annual floods in the valley. The project has been investigated and is said to be feasible.

The development of the irrigated lands in Blaine County has been rather slow, due in part to the large acreage on the local projects held for speculation and partly to the difficulty encountered by settlers in becoming established on unimproved irrigated lands. The agricultural depression, which has prevailed since the World War, probably has been the chief factor retarding the development of these irrigated tracts. Under the prevailing conditions prospective settlers with limited capital have hesitated to assume fixed overhead charges on fairly high-priced land, especially when it required several years to bring the land to a fair state of productiveness. The conditions on the irrigated projects have improved since the creation of the irrigation districts and the change in policy of the Reclamation Service.

The varieties of small grains grown under irrigation are practically the same as those grown under dry-land conditions, except that the medium-late varieties are generally selected. Marquis wheat, Victory oats, and Trebi barley are the leading varieties of small grains, since flax, fall wheat, and rye do not ordinarily compete with these crops under irrigation. Northwestern Dent corn, (preferred to such varieties as Dakota White and Gehu), is grown on a limited acreage for silage and for hogging-off. Great Northern beans have been tried out on a small scale on the lighter types of soil with fair success in favorable seasons. Peas for seed have possibilities within the area, but so far the acreage has been small.

Alfalfa is the chief forage crop, although sweet clover competes with it in short rotations and as a pasture crop. The Milk River valley has been one of the more important Grimm alfalfa seed-producing sections in the state for a number of years. Other legumes and grasses or their mixtures are not grown to any

great extent as much of the unimproved irrigated land is in native blue-joint, which makes an excellent hay and pasture crop on the heavier loams.

The growing of potatoes and sugar beets is of comparatively recent development on the irrigated lands in the county. The acreage of Bliss Triumph and Irish Cobbler potatoes which is grown for seed production to supply southern markets has increased steadily during the past few years. Netted Gem, an important variety for table use, is grown for the commercial market. Since the establishment of a beet sugar factory at Chinook in 1925, a small acreage of sugar beets has been grown on many of the irrigated farms in the Milk River valley and surrounding irrigated territory. The growth, yield and sugar content have been good. Other root and vegetable crops also do very well under irrigation.

Mixed grain and stock raising is generally practiced on the older irrigated farms, although dairying and the growing of specialized crops, such as beans, potatoes, and sugar beets have increased, but on many of the farms such crops are grown as side-lines. Dairying has made rapid growth in some of the irrigated districts and in connection with sugar beets and alfalfa may greatly change the type of agriculture practiced on the irrigated lands within the next decade. There is a fair acreage of poorly drained land in the valley and a large acreage of untillable grazing land above the ditch, which can be best utilized for grazing at the present time. Stock raising and the feeding of live stock is an industry which will remain important on the irrigated lands of the Milk River valley.

SOIL PROBLEMS

How to utilize the isolated tracts of grazing land and the abandoned marginal farm lands, either alone or in combination with the dry and irrigated farms, has been one of the more important problems in the county since the time of the drought. Except for the state and government lands, title to much of this land is held by non-residents and before stockmen can be encouraged to increase the size of their herds these lands must be regrouped into larger holdings of five to ten or more sections. The establishment of grazing reserves, which may be

leased for a number of years, is probably the most practical means of utilizing these lands.

The yields of small grains in the better agricultural districts have varied greatly since the breaking out of the prairies. The differences in amount and distribution of the annual rainfall probably account for 80 to 90 per cent of the variation in yields of crops rather than any inherent differences in the fertility of the soil or in the cropping systems. Crops are grown under a rather low margin of rainfall and any variation in the total amount or in its normal distribution is likely to be reflected in the crop yields. Under irrigation, physical problems are equally important with those of fertility. A more intensive and diversified type of agriculture on the irrigated and dry lands will probably develop fertility problems which are now attributed to poor farming and low rainfall.

Dry-farm problems.—Exclusive grain farming is not generally considered a permanent system of agriculture, but where clean summer fallow is introduced every second or third year it can probably be continued for several generations without an appreciable decline in the average yields of grain. However, the future productiveness of these dry lands is of importance to the state and where possible this cropped land should be seeded down to grasses and legumes for short periods.

Soil blowing, which is largely the result of exclusive grain farming, is probably the most serious problem on the dry-land farms at the present time and is likely to become more serious as the root fiber is destroyed by improper cropping and tillage methods. In some localities duckfoot cultivators, slickers, and similar implements, which leave the stubble on the surface and do not greatly pulverize the soil, are used in preparing the land for spring seeding and for summer fallowing. Grasses and legumes are not grown extensively as a check to soil blowing except on the lighter soils.

"Slick spots" or the so-called "scab" or "blow out" spots are quite common on the glacial loams, especially at the head of drainage basins. On the heavier loams where the spots cover more than 35 per cent of the area, their influence shows up for several years after breaking the sod; but on the lighter loams when the spots are not too deep or too numerous, their influence

on crop yields after breaking is less noticeable. A great portion of the scabby sections should be included in the grazing lands, since the costs of reclamation except for small tracts are prohibitive at present land values.

Irrigation problems.—Fertility problems have not been considered important under irrigation where the legumes and grasses are systematically rotated with the small grains and root crops. However, farmers generally recognize the fact that the yields decline rapidly if these crops are not introduced every three to seven years. The land under irrigation in the Milk River valley consists largely of recent stream deposits, and the few chemical analyses available indicate that the mineral constituents, which are considered important to plant growth, vary greatly with the character of the material carried in and deposited. The lighter well-drained soils found along the river are the most productive while the heavier loams, which cover more than half of the valley, are not well improved. Little investigational work has been carried on in the Milk River valley to determine the means of maintaining the fertility and productiveness of the soils and the management of the heavier soils. Other important problems which need attention are the duty of water and the time and method of applying water to the more specialized crops.

The Milk River is likely to overflow and flood a portion of its valley when the run-off from the mountains and higher divides is accompanied by heavy rainfall. Flood control is very serious in some parts of the valley, especially in wet seasons. In places the sediment deposited during high water has raised the level of the land near the stream one foot above the general level of the valley. Drainage of these low sections is rather complicated, but dikes and deep ditches properly located would give relief to a large portion of the poorly drained areas. Alkali occurs in many of the more poorly drained sections and will probably become more serious as a larger portion of the valley is placed under irrigation.

WATER AND FUEL RESOURCES

The agricultural development of certain sections of Blaine County is retarded by the limited supply of water and fuel for domestic use. The quality of the water found in the different geological formations, which are exposed or underlie the superficial glacial and stream deposits, varies greatly. The grayish to yellowish sandstones and multi-colored shales of the Lance formation give rise to rather poor water for domestic use unless obtained from the coarse and more massive sandstones which underlie the drift and ancient stream deposits in the northeastern corner of the county. The formation extends well up the eastern slopes of Cherry Patch Ridge and its glaciated escarpment forms the so-called "ridges" on the southern slopes of the Big Flat. The dark-colored shales of the Bear Paw formation, from which water is rarely obtained for domestic use, lie below the sandstones and shales of the Lance formation. The shales underlie the greater part of the drift-covered area north of the Milk River and east of the West Fork of this stream. They are also found below the covering of drift on the Plain sections of the Fort Belknap Indian Reservation and are exposed south of the Bear Paw Mountains and the Milk-Missouri River divide. The Bear Paw exposure in the southern part of the county is one of the more barren and broken sections in the state and is very poorly watered. The gray sandstones of the Judith River formation, which predominate over the shaly members, lie below the Bear Paw shales. The formation underlies the drift along the Milk River valley and the area west of the Fort Belknap Indian Reservation. It also underlies or is exposed below the glacial, volcanic, and colluvial deposits on the eastern slopes of the Bear Paw Mountains on the Milk-Missouri River divide and in the southwestern part of the county along the Missouri River. The massive sandstones of the formations are reservoirs for a fair quality of water for domestic use and the shaly members are interbedded with veins of sub-bituminous coal, a few of which are worked in the vicinity of Chinook. In the area underlain by the Bear Paw shales, the deeper deposits of drift are the chief source of water for domestic use, while in the more lightly glaciated sections the supply is obtained from

water stored in reservoirs. An excellent quality of water is found in the Bear Paw Mountains and in the gravels of the high bench in the northwestern part of the county.

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