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UNIVERSITY OF ALBERTA
COLLEGE OF AGRICULTURE

Soil Survey of Blackfoot and Calgary Sheets

BY

F. A. WYATT AND J. D. NEWTON
(With Appendix by J. A. Allan)
University of Alberta

W. E. BOWSER AND W. ODYNSKY
Dominion Department of Agriculture
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Distributed by
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TABLE OF CONTENTS

CONTENTS—Continued

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The soil survey report of the Blackfoot and Calgary sheets is the result of co-operation between the Dominion Department of Agriculture, the Soils Department of the University and the Geology Department of the University.

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PREFACE

The farmer is among the first to recognize the fact that soils vary greatly in their power to produce crops. This variation is due to differences in physical, chemical, and biological relationships within the various soil types.

This report describes the properties of the surface and subsoil of the various soil types, and gives the fertility invoice of the principal areas. It describes the topography, drainage, water supply, and alkali problems of the area. Methods of soil management and possible utilization of the area are discussed. It also contains a brief discussion of the climate and agricultural development of the area, together with the important farm crops and transportation facilities.

The soil map is an important part of this report. It is made on the scale of three miles to the inch, and shows not only the different soil types represented by different colors, but also important physical features such as topography, railroads, streams and towns. The soil map serves as a basis by which the better land can be distinguished from the poorer land as well as indicating the better methods of utilization. Two other maps accompany this report; one shows the distribution of the cultivated, abandoned, and virgin lands in the area, and the other shows the possible utilization of the area.

The area covered by this survey, namely, the Blackfoot and Calgary sheets, extends across five soil color zones—from the semi-arid brown soils of the east side to the humid gray wooded soils adjacent to the forest reserve. Over a large percentage of the area there is sufficient average rainfall to produce a crop.

In the drought area of Alberta a definite problem exists. The value of a soil survey here is obvious, for under the limited rainfall of the drought area only the better soil types can be considered arable. Outside the drought area, however, the need for soil classification does not appear, on the surface, to be so urgent. Here mass abandonment of land areas has not yet taken place. However, observation has shown that soil deterioration is taking place in most cultivated areas; this is manifest in wind erosion, water erosion, alkali accumulation and a general drop in fertility over a long period of years. Such a deterioration of productive land, often so gradual as to remain unnoticed, is serious both from the individual and from the national viewpoint. Our soils are still our greatest national resource, but if they are to remain as such this waste must be as far as possible eliminated. To facilitate taking adequate measures to combat this deterioration an inventory of these soil resources is necessary. Soil types vary in their response to rainfall, to irrigation water, to specific crops and to farm management methods. The soil survey, by mapping the soils of the area, has determined the boundaries of the various soil types, and has recorded the chemical and physical properties of each type. Such information is necessary if each land parcel is to be utilized to its best advantage, that is, if it is used to give the most profitable production without inducing any serious deterioration.

As this report is written, the problem of a Canadian wheat surplus is of paramount importance. If the solution of this problem entails a reduction of seeded acreage, then the productive capacity of the various soil types will undoubtedly receive consideration.

An inventory of the soil resources is necessary before the adequate size of a self-sustaining farm unit can be calculated, and hence the maximum number of such units that an area will economically carry over a long period of years.

The results of crop, fertilizer and cultural method experiments obtained at the larger government experimental stations in our province do not necessarily apply to all parts of the province. Similarly, results from local illustration stations apply particularly to the soil types similar to the one at the station. In the planning of experiments in various parts of the province the soil maps should prove very valuable, since they would show where plots should be placed in order to represent important or extensive soil areas. Also the soil reports tend to place the information of one farmer at the disposal of other farmers.

The need for a planned agriculture that will stabilize the farming industry of our province is becoming more and more apparent. The uneconomic use of land units as well as soil deterioration are wastes; and the importance of these losses has not yet been fully realized. An inventory of the soil resources, obtained through a soil survey, is a first step in obtaining the goal of a planned land use—a use that gives best to the individual and to the nation the greatest agricultural security.

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DESCRIPTION OF THE AREA

This section of the report gives a description of the main physical features of the Blackfoot and Calgary sheets, a brief story of its agricultural development, and an outline of present transportation facilities. The purpose of this is to provide a background for a study of the soils of the area.

LOCATION

The Blackfoot sheet, number 115, is located in south central Alberta and comprises an area approximately 83 miles east and west by 48 miles north and south. More exactly, it consists of townships 17 to 24 inclusive within ranges 16 to 29 inclusive, west of the 4th meridian. Included in this report is that portion of the Calgary sheet, number 114, that lies east of the Rocky Mountains forest reserve. The Calgary sheet lies immediately west of the Blackfoot sheet; that is, west of the 5th meridian. Townships 17 to 24 inclusive (or portions thereof) in ranges 1 to 5 inclusive were covered by the survey. For the purpose of this report the two sheets shall be considered as one area.

The southern boundary of the surveyed area lies 96 miles north of the United States-Canadian boundary and the eastern edge of the sheet is 90 miles west of the Alberta-Saskatchewan boundary. The surveyed area extends in the east from a point about 12 miles south by southwest of Brooks to a point about 12 miles north by northeast of Gem, and in the west to the Rocky Mountain forest reserve. The city of Calgary is in the

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northern boundary of the area and the town of Vulcan lies along the southern boundary.

The soil map for the area described above represents about 144 townships or 3,300,000 acres.

AGRICULTURAL DEVELOPMENT

Agriculture in the Calgary district, as in most of southern Alberta, had its beginning during the decade 1870 to 1880. The reason for this, stated in general terms, was that at this time the people of eastern Canada, of Great Britain and of other countries were becoming conscious of the agricultural possibilities of the western plains. The coming of the Royal Northwest Mounted Police, the settling of the Indians on reservations, and the prospect of a transcontinental railway line were some of the immediate reasons for this interest.

Due partly to the relatively fewer fur bearing animals in the southern part of the province, as well as to the warlike nature of the Indians of the Blackfoot confederacy, very few trading posts were built in this section of the province. Some authorities believe that a Fort La Jonquiere was erected in 1751 near the present site of Calgary; this, however, has never been clearly proven. But it is known that Bow Fort, farther up the Bow river, was built in 1802. About 1875, a year after their arrival at Fort Macleod, the Mounted Police built a post near the present site of Calgary and at that time a Montana trading company had already established a trading post there. In 1871 this same company built a trading post near the present site of the town of High River. It is also known that a trader operated a store at Blackfoot crossing (near the present village of Cluny) prior to 1877. It is recorded that cattle were wintered at the High River post in 1872, and in this connection it is also recorded that Rev. J. McDougall brought cattle to the Indian reserve at Morley (west of Calgary) in 1871.

Shortly after 1880 some of the large ranches of south and southwestern Alberta had their beginning. The Cochrane ranch west of Calgary, founded by Senator Cochrane, and the Bar U west of High River, founded by a member of the Allan Steamship Company, were two of the first in the area. The Brand 76 ranch along Mosquito and Little Bow creeks followed shortly after. In referring to these early beginnings of the ranching industry in this area the name of George Lane, who joined the staff of the Bar U in 1884, should be mentioned.

In 1877 at Blackfoot Crossing on the Bow River the tribes of the Blackfoot confederacy, namely, the Bloods, Peigans, Blackfeet and Sarcees, signed a treaty with the Dominion Government. As a result they ceased to be the nomads of the prairie and settled down on definitely outlined reservations. The Blackfeet were given land along Bow river. When the boundaries were finally determined their reservation extended from Bassano to Namaka, north to the main line of the C.P.R. and south to the top of township 19, ranges 19 to 24; 300,000 acres in all. In 1910 they sold slightly over 100,000 acres of land lying in township 20. The Sarcee tribe was given land southwest of Calgary along Elbow river. At present this reserve comprises township 23, ranges 2, 3 and 4, W. 5th—nearly 75,000 acres. The Stony Indians, who are of Sioux stock, were given a reservation at Morleyville, just west of the area covered by this survey report.

In 1883 the Canadian Pacific Railway reached Calgary from the east and about ten years later the branch line from Calgary to Macleod was built. The coming of these railways marked the beginning of an influx of farmer settlers. This influx, however, did not reach large proportions in the immediately succeeding years. By 1900 practically all the foothills country was covered by ranchers' leases and many leases were being taken up in the plains region to the east. Estimates calculated from available data show that in 1900 there were only about 10,000 acres of cropped land in the Calgary and Blackfoot sheets, and that most of this was in the Calgary-High River section.

However, with the turn of the century the influx of settlers greatly increased. These settlers built their homes, fenced their land, and began plowing up the sod. The day of the large ranch was over, particularly on the more arable portions of the plains area. The only large blocks of range land left at present lie in the brown soil zone along the east side, in the Indian reserves, and in the foothills area.

The discovery of oil in Turner Valley in 1913 started a development in this area that is still in progress. Today oil wells are found from Pekisko to Bragg Creek, with the main development concentrated between Millarville and Little New York. Although not agricultural, this oil development warrants mention in a story of the development of the area. It can be justly stated, however, that the availability of fuel oil from Turner Valley has had an influence on the agricultural practices of the surrounding area.

Table I gives a summary of the cultivated acreage on the Calgary and Blackfoot sheets at various intervals of time from 1905 to 1940. The figures prior to 1920 are taken from Provincial Government thresher returns, the figures for the years 1920 to 1935 are from the Dominion Government census returns, and the 1940 figure is an estimate made by this survey. To obtain total cultivation figures it should be suggested that during the earlier years possibly not over one acre in three or four were fallow, whereas today nearly one acre out of every two is fallow.

TABLE I.—Acreage in Crop in the Calgary and Blackfoot sheets

	Wheat	Oats	Barley	Rye	Total
1905	5,000	26,000	4,000	....	35,000
1910	60,000	40,000	5,000	....	105,000
1920	400,000	260,000	24,000	16,000	700,000
1925	510,000	135,000	26,000	4,000	675,000
1930	660,000	150,000	42,000	6,000	858,000
1935	620,000	160,000	58,000	9,000	847,000
1940	....	....	....	....	1,000,000

From Table I it is seen that in 1905 a large percentage of the cultivated crop was oats. By 1910, however, wheat had become the dominant crop and has remained so ever since. In the eastern three-quarters of the surveyed area wheat is grown almost to the exclusion of all other crops. In the foothill district north and west of High River oats still exceed wheat in total acreage. Besides the crops listed in Table I there are some grasses and legumes grown on the irrigated areas, and some hays (principally brome grass) grown on the darker colored soils in the western portion of the area.

The cultivation map (see Plate 5) gives a general picture of the distribution of cultivated lands at the present time. This survey calculated a total of 1,680,000 acres of cultivated land in the two sheets (the figure of 1,000,000 reported in Table I is an estimation of the amount actually in crop). This total acreage is distributed as follows: 140,000 acres in the brown soil zone, 865,000 acres in the dark brown soil zone, 660,000 acres in the shallow black soil zone, and 15,000 acres in the black and gray wooded soils. If the cultivation map (see Plate 5) be compared with the land rating map that accompanies this report it is seen tnat most of the arable land in the area is at present under cultivation so that no appreciable increase in total cultivated acres can be expected. In general, the farm homes are fairly good. Although some shifting of population is still taking place due to an absorption of small units by larger ones, there is, in the main, a tone of permanency throughout the area.

Not all of the land that has been brought under cultivation, however, has remained so. This survey has estimated that in 1940 there were over 80,000 acres of abandoned cultivation in the Blackfoot sheet. (No abandoned land was mapped in the Calgary sheet.) Most of this abandonment has taken place in the brown soil zone, the largest single block being in the Kinnondale district nortn of Travers. This is a relatively level area of medium to light textured solonized soil. Another area where there has been considerable desertion lies between Crowfoot and the base of Wintering Hills east of Hussar. In general, the soils of this area are mixed glacial loams, some on relatively rough topography. The deserted land southeast of Bassano consists of mixed soils of glacial and alluvial deposition, many of them having solonized profiles. In the main the deserted lands are of a sub-marginal type and should never have been cultivated. Considerable time will elapse before these fields are completely regrassed and once more desirable pasture lands. Artificial regrassing will undoubtedly hasten this process. It is in order to say here that the waste attendant with abandoned land and homes should teach this lesson: the long-time possible productivity of a land area should if possible be determined before such an area is allowed to be brought under cultivation.

Table II gives the wheat yield for the zones of the Calgary and Blackfoot sheets, as well as figures for other representative soil areas of the province. These figures are estimations from census returns, station yields and Provincial Government records.

TABLE II.—Comparative Wheat Yields in Alberta

Brown soils—Blackfoot sheet	10	bus.
Dark brown soils—Blackfoot sheet	14	"
Shallow black soils—Blackfoot and Calgary sheets	20	"
Black soils—Calgary sheet	23	"
Black soils—Edmonton district	23	"
Brown soils—Rainy Hills sheet	9.5	"
AVERAGE for province	17.0	"

From the figures in Table II it is seen that there is considerable spread between the yields obtained on the brown soils and those obtained on the black soils. Since the greater percentage of the cultivated land lies in the dark brown and shallow black soil zone, the average yield for the area could be placed at about 17 bushels. A 15-year wheat yield average for census division 4, which roughly includes the area between Calgary and Claresholm, and between the Rocky mountains and Lomond, is 17.5 bushels. These average yields are estimations from all available figures. They include yields from poorer soil types and yields produced under many different types of farm practice. Many of the better soil types have given a greater average yield than this and some individual farmers have exceeded this average by a considerable margin. From the above statement it can be inferred that, although most of the arable land is at present under cultivation, the maximum production compatible with adequate soil conservation has not been reached. The figures given above represent an efficiency of about one bushel of wheat for each inch of rainfall. Higher yield averages obtained on individual farms naturally represent a greater rainfall efficiency.

This area, similar to many others in Alberta, has changed from a ranching area to one of crop production growing principally wheat. What the future trend will be is largely beyond the scope of this report. It is, however, in order to say that apart from the economic aspect of the problem, the wheat fallow rotation must be modified. This is discussed in fuller detail under the section "Farm Practice". The brown soils, and to a large extent the dark brown soils, have a limited range of possible crops. Wheat in these areas may continue to be the major crop. In the darker, more humid soil area a more diversified system of farming should ultimately be established. These practices must be related to the average rainfall, the fluctuation in rainfall as well as other climatic factors, the soil type, and, from a national viewpoint, the productive possibilities of other agricultural areas. Any increase in irrigated acreages, at present, depends to a large measure on market requirements.

TRANSPORTATION

The main transcontinental line of the Canadian Pacific Railway traverses this area from east to west. The city of Calgary with a population* of 83,407, is on this railway. Bassano —population 574, Gleichen—population 458, and Strathmore—population 531, and the villages of Cluny, Carseland, and Langdon, are on this line. The Calgary-Macleod branch of the C.P.R. traverses the sheet from north to south. The towns of Okotoks—population 571, and High River—population 1,359, as well as the villages of Midnapore, De Winton, Aldersyde and Cayley are on this railway. The Aldersyde branch railway to Lethbridge branches from the Calgary-Macleod line at Aldersyde in a south-easterly direction. The town of Vulcan —population 869, as well as the villages of Blackie and Brant are on this railway. Branching off from near Blackie is a railway whose eastern terminus is Suffield, 25 miles west of Medicine Hat. The villages of Arrowwood and Milo are on this railway. This railway skirts the north side of Buffalo hills and then turns south along the east side of the Lake McGregor drainage. Branching off from Bassano is the Bassano-Irricana railway. On this line is the village of Hussar. Branching off from Rosemary is a short spur line to the village of Gem serving this irrigation community. Cutting the southeast corner of the Blackfoot sheet is a branch line from Brooks to Scandia. Three railway lines radiate north and northeast from Calgary. The area is, then, well supplied with railway facilities. No place in the Blackfoot sheet is more than about 12 to 15 miles from a railway. The Calgary-Macleod railway (which runs very close to the 5th meridian) is the farthest west railway line south of the Elbow river. Some of the more sparsely settled portions of the Calgary sheet are, therefore, a considerable distance from railway facilities.

The area is also fairly well supplied with highways. Number 2 highway traverses the area from south to north through

*Population figures given in this section are from the 1936 census.

Calgary and High River. It is a hard surfaced road. A gravelled highway from Calgary to the Saskatchewan border goes via Strathmore and Bassano. The first twenty miles of this road east of Calgary are hard surfaced. Gravel highways also connect the last mentioned road to Vulcan via Cheadle and a branch from this road joins No. 2 highway at High River. A gravel highway joins the Turner Valley oil fields to Okotoks. The towns of Turner Valley—population 475, Black Diamond—population 657, Little Chicago and Little New York are on this road. These towns, particularly the last two mentioned, have had a very rapid growth. Their permanency depends very largely on the future oil production of Turner Valley.

Among the better dirt roads might be mentioned the Calgary-Bragg Creek road, the Little New York-High River road, the Vulcan-Majorville road, the Vulcan-Arrowwood-Gleichen road, the Bassano-Hussar road, the Countess-Gem road, and the Brooks-Bow City-Lomond road. Trails lead into the forest reserve up the Pekisko creek, in from Little New York up Highwood river, in from Turner Valley via Sheep river, in from Priddis, and in from Jumping Pound.

The Bow river is crossed by bridges at Calgary, Carseland, Arrowwood, Cluny and Bow City, and by ferry at Crowfoot and southwest of Latham. The Elbow is crossed by bridges at Calgary, in the northeast corner of the Sarcee Indian reserve and in township 24, range 2, W. 5th. The Highwood is crossed by bridges in township 21, range 28, at Aldersyde, at High River, and approximately twenty miles west of High River near Little New York in township 18, range 2, W. 5th. Sheep river is crossed by bridges at Turner Valley, Black Diamond and Okotoks.

TOPOGRAPHY

The Rocky mountains on the west side of the area are the most prominent topographic feature. The main mountain range, however, lies some distance west of the surveyed area; that is, west of the east boundary of the forest reserve. A large portion of the Calgary sheet covered by this survey is foothills country and Sitook Spagway, just south of Okotoks, is possibly the eastern limit of the foothills range. The foothills in this area are mainly high hills containing many rock outcrops and covered by a fairly heavy tree growth. In this area cultivation is confined principally to the valleys.

Buffalo hills, lying between Arrowwood and Vulcan, are a prominent topographic feature. The main portion of these hills covers about one township in area—township 19, range 23. These hills reach an elevation of 3,850 feet, the same elevation reached by Sitook Spagway mentioned above. A fairly large range of hills occurs in the Majorville district between Lake McGregor and Bow river. At the highest point, namely, in township 18, range 21, these hills reach an elevation of 3,400 feet. The southern tip of Wintering hills touches the area east of Hussar in township 24, ranges 18 and 19. Eagle hill and Hammer hill, each with an elevation of approximately 3,200 feet, are prominent landmarks in the area near Namaka lake.

The remainder of the area is mainly undulating to gently rolling; a relatively small percentage of the area can be considered as level land. Large sections of the area, particularly the west side of the Blackfoot sheet, when viewed in perspective from an elevation, appear level, but when seen at shorter range are areas of low gentle rolls. It is typical ground moraine country.

There is a gradual slope of the entire area from west to east. The approximate average elevation of the foothills at the forest reserve boundary is 5,000 feet; the approximate average elevation of the creek valleys at the reserve boundary is 4,500 feet. The east side of the Blackfoot sheet has an elevation of 2,400 to 2,500 feet. The low point of the area is possibly Matzhiwin creek north of Rosemary, an elevation of less than 2,400 feet. The Bow river enters the surveyed area west of the city of Calgary at an elevation of approximately 3,500 feet and leaves the area in the southeast corner of the Blackfoot sheet at an elevation of approximately 2,400 feet. Turner Valley has an elevation of about 3,950 feet, High River 3,400 feet, Calgary 3,440 feet, Vulcan 3,440 feet, and Bassano 2,600 feet.

This survey mapped four topography classes. They are shown on the soil map by means of a cross hatching. The data in Table III gives the acreage and percentage distribution of the main topographical classes on the Blackfoot and Calgary sheets. From these figures it is seen that about 47 per cent of the area is composed of level to undulating topography. In general, the area east of Bassano, an area south of Chancellor, the large flat north of Lake McGregor extending west along Bow river to Carseland, the area between Carseland and Calgary, the area between Vulcan, Blackie and High River, the Black Diamond flat, the alluvial benches between the Pekisko and Stimson creeks and along the Highwood river, as well as many other smaller areas, are all relatively level land.

TABLE III.—Extent of Topography Divisions in Blackfoot and Calgary sheets

Division	Acres	Per cent
Hilly	370,000	11.2
Rolling	325,000	9.8
Gently rolling	900,000	27.3
Level and undulating	1,560,000	47.3
Erosion	75,000	2.3
Lakes and marshes	40,000	1.3
Rivers	30,000	0.9
Total	3,300,000	100.1

About 27 per cent of the area is mapped as gently rolling. Land of this topography class offers little obstruction to cultivation; the slopes are gentle and, in general, the hills are very low. Pockets of gently rolling land are mapped in the hilly and rolling areas, particularly along the edges, and also as isolated patches throughout the level to undulating area. Fairly large areas of gently rolling topography are mapped in the morainal country between Vulcan and Majorville, and between Crowfoot, Hussar, and Gem. In that portion of the Blackfoot sheet lying west of an approximate line through Vulcan and Strathmore topography separation between undulating and gently rolling was very difficult. It has been stated elsewhere that this area is mainly ground moraine generally of undulating character, varying from nearly level to a roughness approaching gently rolling. The patches of gently rolling mapped in this area are generally not distinct areas but rather places where the undulating character of the terrain became a little more choppy. Between Strathmore and Cluny there is mapped a fairly large area of gently rolling topography. This area is made up largely of ridges separated by wide draws. Although the general area appears quite rolling when viewed from some angles, the predominance of long gentle sweeps was sufficient to warrant mapping the main portion of the area as gently rolling. Other areas of gently rolling topography are mapped east of Okotoks, along the Herronton ridge, in and around the Sarcee Indian reserve, and along the draws in the foothills region.

Rolling land makes up approximately 10 per cent of the total area. Rolling land is, if other conditions are favorable, considered as arable. This class includes low choppy hills and fairly high ridges with long uniform slopes. Cultivated areas of rolling topography generally cost more to farm than the more level areas; they are subject to greater harm from water erosion and the crops tend to ripen unevenly. Large areas of rolling topography are mapped between Hussar and Gem, surrounding the hilly area at Majorville, and surrounding the foothills of the Calgary sheet.

Hilly land is considered, excepting under unusual circumstances, as being too steep to cultivate and is therefore generally considered as pasture land. Hilly areas are mapped in the Blackfoot sheet, east of Hussar, south of the Bow river at Bassano, east of Lake McGregor, and in the Buffalo hills. In the main, these all lie in a large terminal moraine at the head of one of the continental ice advances. In the Calgary sheet large hilly areas are mapped west of Okotoks and De Winton to Priddis, just east of Little New York, and all along the forest reserve boundary. This last mentioned area is a mixture of from gently rolling to near mountainous topography, with small relatively level areas occurring throughout the area. Where accessible to this survey these areas have been separated on the map, but in many cases large blocks of the foothills had no road facilities and so this separation was not made. The foothills area, cut by many mountain streams, most of which are stocked with fish, is mostly wooded and contains many delightfully scenic spots.

DRAINAGE

The Blackfoot and Calgary sheets are drained by the South Saskatchewan-Nelson river system. The southwest corner of the area is drained by Little Bow and its tributary Mosquito creek. Little Bow carries only a small quantity of water at present and it appears to follow an old drainage way of Highwood river. It flows in a southeasterly direction and empties into Old Man river just north of Chin. Crawling valley and a tributary of Matzhiwin creek, both seasonal, drain the northeast corner of the Blackfoot sheet and empty into Red Deer river. Some of the draws northeast of Strathmore, at the extreme north boundary of the sheet, drain north via Rosebud creek to Red Deer river. The remainder of the two sheets drain east by way of Bow river.

Highwood river has its source well into the mountains, west of the Highwood mountain range. This river with its tributaries, which include Trap, Sullivan, Pekisko, Stimpson, and Tongue creeks, drains the southern portion of the Calgary sheet. Sheep river which flows through the towns of Turner Valley and Okotoks joins Highwood river in township 20, range 28, W. 4th. Highwood river joins Bow river about six miles north of its confluence with Sheep river. Fish creek and its principal tributary, Priddis creek, rises in the edge of the mountains west of Priddis and empties into Bow river just east of Midnapore in township 22, range 1, W. 5th. Elbow river rises in the mountains west of Bragg creek and empties into Bow river at the city of Calgary. Jumping Pound creek drains the northwest corner of the surveyed area. It turns north to leave the sheet in township 24, range 4, W. 5th, to join Bow river. Bow river rises in the glacier-fed Bow lakes north of Banff. It enters the Calgary sheet in township 24, range 2, W. 5th, travels in a general southeasterly direction to leave the Blackfoot sheet in the southeast corner, that is, in township 17, range 16, W. 4th. The tributaries of Bow river that rise in the mountains generally carry water all year although the volume varies greatly with the seasons and the removal of timber from the mountain slopes, either by industry or by fire, adds to the seasonal fluctuations. Such removal of the protective vegetative cover increases soil erosion, increases the danger of spring floods, and increases the danger of obtaining sufficient water during the late summer months. With increased demands being made on these streams for irrigation and other uses such fluctuations may be serious. The remedy seems to lie in the direction of maintaining as adequate a forest cover as possible, and in the construction of reservoirs.

The Blackfoot sheet is practically all prairie land and hence the streams originating in this area are mainly seasonal. East and west Arrowwood creeks drain the area north of Vulcan. They both empty into Bow river in township 21, range 23, W. 4th. Coulees drain from the Majorville area north into Bow river. Crowfoot creek, also seasonal, drains a large area north of Bow river between Strathmore and Hussar. It empties into Bow river in township 21, range 20, W. 4th. At present this stream carries irrigation spill water from the C.P.R. western irrigation project during most of the summer. Snake creek drains the area east of Vulcan into Lake McGregor.

Very few springs were found in the Blackfoot sheet. There are a few on the rim of the Buffalo hills and one was found in the hills northeast of Majorville. Many springs flow from the eastern rim of Sitook Spagway, south of Okotoks. Closer to the mountains in the Calgary sheet springs become quite numerous. A few flowing wells, particularly east of Okotoks, were seen.

Lake McGregor in township 17 and 18, range 21, is the largest lake in the area. It is a reservoir for irrigation water and lies in an old drainage way. Dams are constructed at both ends of the reservoir. The lake is fed by an irrigation canal that is diverted from Bow river at Carseland. Water is drawn from the south end of the lake to irrigate an area in the vicinity of Vauxhall.

Chestermere lake, now a popular pleasure resort, is located in township 24, range 28. It also is a reservoir for irrigation water. It is fed by an irrigation canal from Bow river and in turn it supplies water to the C.P.R. western project between Strathmore and Gleichen.

A dam on Bow river at Bassano forms a large reservoir at this point. Water is diverted from this reservoir to feed the Eastern Irrigation district by a series of canals leading northeast, east and southeast. The main canal leading off in a southeasterly direction follows an old drainage course by way of Latham to Coyote valley in township 18, range 16. Here the canal branches, one branch crossing the valley by means of a flume to feed Lake Newell south of Brooks and the other leading southeast towards Rainier.

Eagle lake, Namaka lake and Stobart lake, all lying southeast of Strathmore, are not used as reservoirs but receive considerable irrigation spill water. Frank lake in township 18, range 27, and Dead Horse lake in township 24, range 20, are both seasonal lakes. Frank lake was dry in 1940; Dead Horse lake was practically dry in 1939 but contained some water in the summer of 1940. Both of these lakes are the centre of small inland drainage systems. Lloyd lake in township 21, range 2, W. 5th, is the only lake of any size in that portion of the Calgary sheet covered by this survey. Many of the low marshy areas east of Bassano now contain water collected from irrigation seepage and irrigation spill. Very few large hay meadows were found in the area.

SOIL FORMING FACTORS

This section of the report gives a general discussion of the factors that have been responsible for forming the soils of the Blackfoot and Calgary sheets. The long term climatic conditions that have prevailed have induced a particular vegetative growth. These two inter-related external forces acting on the original surface mantle have produced the present soil profile. Since the soil profile is the basis of soil classification a study of the soil forming factors operative in the area is essential. (For a more complete description of the geology of the area see appendix by J. A. Allan.)

CLIMATE

The climate of the Calgary and Blackfoot sheets varies somewhat from west to east. Since the west side of the Calgary sheet is in the Rocky mountains and the east side of the Blackfoot sheet projects into the plains area of southeastern Alberta, the reason for this variation becomes apparent. Certain general statements, however, can be made regarding the climate of the area; the total annual rainfall decreases from east to west, the mean annual temperature varies only slightly from west to east, and the prevailing wind is westerly over the area although possibly more pronouncedly so in the western than in the eastern portion.

Both of these sheets lie along the northern edge of the Chinook winds belt. These are warm winds of low relative humidity and therefore have considerable drying power. During the winter they have a distinctly moderating effect on the climate and often remove the snow from the hills and permit stock to get winter pasture. During the summer months these warm drying winds may cause damage to growing crops, especially during prolonged dry spells. In general, these winds are more effective near the mountains than farther to the east.

Table IV is included here to show the relative wind directions at Calgary. From this table it is seen that the prevailing direction is northwest, there being nearly as many winds from this direction as from the other seven points combined. It may be of interest to note here that at Macleod, 100 miles south, which is directly in the Chinook path, the prevailing direction is west.

TABLE IV.—Relative wind directions at Calgary, Alberta, 1911-1915

N.	24	S.E.	46
S.	13	S.W.	16
N.E.	28	W.	24
E.	13	N.W.	144

During the years 1932 to 1935 inclusive the average annual mileage at Calgary was 79,000 miles. The average annual mileage for similar years at Lethbridge was 82,000 and for Lacombe 39,000. For the years 1911 to 1921 the average mileage at Calgary was 45,000. During this period, however, the weather station was in the river valley over 100 feet lower than its present site. An average of 13 gales per year was registered at Calgary for the four-year period 1932 to 1935. For the same years Lethbridge averaged twenty-four gales per year. Although the presence of the Chinook winds does affect the agricultural practices of the Calgary and Blackfoot sheets, this effect may not be as great as it is in the extreme south portion of the province.

Calgary receives an average of about 2,300 hours of bright sunshine per year out of a possible total of approximately 4,450. By way of comparison, Edmonton receives about 2,200 hours and Medicine Hat about 2,350 hours. Table V below gives the average monthly hours of sunshine at Calgary for the period 1928 to 1937.

TABLE V.—Average monthly hours of sunshine at Calgary, Alberta, 1928-1937

January	102	July	347
February	145	August	277
March	158	September	196
April	186	October	154
May	262	November	120
June	253	December	105

All the meteorological data given in this report are compiled from Dominion meteorological records. Reports from the following stations are included: Brooks, just east of the surveyed area, and Gem, both in the brown soil zone, Gleichen and Hearnleigh in the dark brown soil zone, Calgary and High River in the shallow black soil zone, and Pekisko in the foothills near the black soil zone.

Table VI gives the average monthly, seasonal and annual precipitation at Brooks, Gem, Gleichen, Hearnleigh, Calgary, High River, and Pekisko. In this table the year is divided into three sections, namely, the previous fall, winter and growing season. This is done because it is felt that the previous fall and growing season's moisture is fairly closely related to crop production. Table VI shows the gradual increase in precipitation from east to west. Brooks and Gem in the brown soil zone receive about 12 inches annual precipitation. Gleichen and Hearnleigh in the dark brown zone receive about 13.75 inches annual precipitation. Calgary and High River in the shallow black soil zone receive 17.30 and 18.74 inches respectively, and Pekisko receives over 23 inches. Lethbridge in the dark brown soil zone receives an average annual precipitation of 15.66 inches, whereas Gleichen in a similar color belt receives 13.98 inches; Pincher Creek in the shallow black zone receives an annual precipitation of 19.93 inches whereas Calgary in a similar soil color zone receives 17.30 inches. The figures given immediately above suggest that the Calgary and Blackfoot sheets have developed a darker soil color for a given annual precipitation than the Lethbridge and Pincher Creek sheets which lie geographically farther south. The greater annual wind velocity and higher evaporation in the latter two sheets is at least a partial explanation. Edmonton, located over 200 miles north of High River, receives an annual precipitation of 18.08 inches, but the soils of the Edmonton district have a much deeper black horizon than do those surrounding High River.

TABLE VI.—Precipitation in inches. Monthly and seasonal distribution for points on or near the Blackfoot and Calgary sheets

	Brooks 1916-1935	Gem 1917-1935	Gleichen* 1903-1939	Hearnleigh 1922-1939	Calgary 1900-1939	High River* 1903-1939	Pekisko 1905-1939	Calgary: Greatest amt. in one mth.
August	1.33	1.27	1.69	1.26	2.35	2.19	2.44	6.67
September	1.20	1.07	1.02	1.36	1.68	1.73	2.26	5.08
October	0.55	0.54	0.80	0.90	0.83	1.18	1.38	1.83
Previous fall	3.08	2.88	3.51	3.52	4.86	5.10	6.08	......
November	0.44	0.72	0.55	0.63	0.70	0.89	1.18	1.84
December	0.48	0.59	0.54	0.48	0.55	0.85	1.06	2.24
January	0.50	0.60	0.64	0.39	0.49	0.82	1.07	1.69
February	0.41	0.67	0.56	0.51	0.53	0.89	0.88	1.95
March	0.49	0.79	0.69	0.81	0.83	1.46	1.48	2.25
Winter	2.32	3.37	2.98	2.82	3.10	4.91	5.67	......
April	1.03	1.26	1.02	1.15	1.14	1.54	2.11	3.87
May	1.51	1.35	1.85	1.78	2.24	2.08	2.93	8.06
June	1.83	1.75	2.47	2.76	3.54	3.52	4.18	8.45
July	1.68	1.46	2.15	1.53	2.42	1.59	2.10	9.66
Growing season	6.05	5.82	7.49	7.22	9.34	8.73	11.32	......
TOTAL	11.45	12.07	13.98	13.56	17.30	18.74	23.07	......

*Data for some months have not been recorded. These, however, will not materially affect the averages.

A large percentage of the precipitation that falls during the winter months in Alberta is lost during the spring run-off. As a result the moisture that falls during the previous fall and the growing season is largely effective in determining the crop produced. Fortunately in Alberta a large percentage of the annual precipitation comes during this effective period. Taking the figures presented in Table VI, it can be calculated that Brooks receives 80 per cent of its annual moisture during this effective period, namely, during the growing season and the previous fall; Gem receives 72 per cent; Gleichen and Hearnleigh each 79 per cent; Calgary 82 per cent; High River 74 per cent, and Pekisko 75 per cent. Calculations of rainfall data from other parts of southern Alberta indicated much lower percentages close to the mountains. In the figures given in this table Gem does not follow this trend. If between nine and ten inches of rainfall during the previous fall plus growing season be considered the border between those years that are considered drought years and those that are not, then at Calgary seven years out of the forty have been drought years and two have been border-line years; that is, about one year out of four has been a drought year. At Pekisko during the last 28 years only once did the effective precipitation fall below 10 inches. At Gleichen during the last 36 years 13 years have been drought years and two have been border-line years. At Gem, during the period 1918 to 1935 the effective precipitation was over 10 inches in only three years out of eighteen.

During the important growing months of May, June and July there is an average of 5.02 inches of precipitation at Brooks, that is, 44 per cent of the total rainfall received. Gleichen receives 6.47 inches or 46 per cent of the total fall; Calgary receives 8.20 inches or 47 per cent of the fall, and Pekisko 9.21 inches or 40 per cent. By way of comparison, Lethbridge receives 43 per cent, Medicine Hat 48 per cent, and Edmonton 50 per cent during these three growing months. Beaver Mines, situated about 10 miles west of Pincher Creek in the foothills—a position somewhat similar to Pekisko—receives only 29 per cent of its total precipitation during these three months. This indicates a somewhat different precipitation distribution in the foothills of the southwest corner of the province than west of High River.

Table VII shows the annual variation in total precipitation at Calgary, Gleichen, Pekisko and Gem, as well as the previous fall plus growing season totals. The total annual precipitation at Calgary has varied between 9.03 inches in 1918 to 34.19 inches in 1902. The highest recorded rainfall at Pekisko is 37.95 inches in 1915 and the lowest recorded at Gem is 6.91 inches in 1931. Although total annual rainfall data are of value, their interpretation must consider various factors. It may be said, however, that below a certain minimum precipitation it is practically impossible to grow a crop and that what rain does come will have a very low efficiency factor; but it should also be remembered that such factors as rainfall distribution,

TABLE VII.—Precipitation record for stations on the Blackfoot and Calgary sheets together with stations at Edmonton, Lethbridge and Medicine Hat

	Calgary		Gleichen*		Pekisko		Gem*	
	Total	Previous fall and growing season	Total	Previous fall and growing season	Total	Previous fall and growing season	Total	Previous fall and growing season
1900	17.59	......	......	......	......	......	......	......
1901	21.54	20.05	......	......	......	......	......	......
1902	34.19	27.07	......	......	......	......	......	......
1903	21.30	16.83	15.83	......	......	......	......	......
1904	15.22	17.94	10.22	12.16	......	......	......	......
1905	14.74	15.23	11.94	12.29	......	......	......	......
1906	16.60	12.38	17.73	12.20	......	......	......	......
1907	15.18	11.92	......	14.79	......	......	......	......
1908	18.25	20.43	......	16.33	......	......	......	......
1909	16.08	14.82	19.71	17.46	......	......	......	......
1910	13.03	4.95	10.51	4.80	......	......	......	......
1911	19.37	16.84	......	13.96	......	......	......	......
1912	21.40	18.74	......	11.63	25.96	20.02	......	......
1913	17.08	13.64	......	8.91	25.80	17.29	......	......
1914	18.40	13.00	......	8.11	22.68	18.58	......	......
1915	17.85	16.70	......	16.85	37.95	31.00	......	......
1916	13.97	11.71	......	12.65	32.28	20.99	......	......
1917	11.26	9.00	9.07	10.22	24.89	26.91	13.13	......
1918	9.03	7.09	7.09	5.45	20.66	13.87	7.92	6.90
1919	12.37	6.91	13.12	6.88	16.81	10.72	13.92	7.82
1920	14.42	15.33	10.92	10.90	17.43	18.98	8.68	9.60
1921	13.49	7.86	17.33	9.65	18.20	9.26	15.74	6.00
1922	10.68	8.68	13.03	12.03	14.15	11.10	11.61	6.83
1923	23.88	20.67	15.16	13.39	33.55	26.04	11.68	6.52
1924	22.37	11.41	16.53	7.26	22.13	15.07	11.16	7.64
1925	18.06	13.82	19.56	14.94	19.34	11.29	13.91	8.13
1926	24.39	15.30	19.58	9.98	23.67	15.20	10.55	7.74
1927	29.85	29.92	21.08	21.01	32.35	27.78	20.90	14.32
1928	16.65	19.27	11.22	12.55	21.38	20.91	12.30	14.64
1929	14.47	9.78	11.86	7.18	27.95	18.74	9.36	4.76
1930	14.49	10.96	10.88	8.14	17.19	14.14	12.67	8.68
1931	11.84	8.72	11.47	8.48	16.30	11.63	6.91	6.97
1932	21.03	16.54	18.29	11.90	27.06	17.75	15.13	10.08
1933	13.68	10.40	11.63	10.45	22.18	13.30	12.02	9.03
1934	14.04	11.69	10.88	8.05	24.45	19.50	9.03	9.29
1935	17.83	14.42	18.75	16.15	22.03	16.16	11.07	7.30
1936	9.79	8.67	11.29	7.78	14.37	10.77	......	......
1937	20.18	12.99	9.44	5.16	24.08	15.96	......	......
1938	16.73	15.18	9.83	6.99	20.84	17.24	......	......
1939	19.08	14.82	15.25	11.28	25.84	17.52	......	......
Average	17.29	14.20	13.98	11.05	23.07	17.42	12.07	8.46
	82%		79%		75.5%		70%	

Edmonton, 1904-1935	18.08
Lethbridge, 1900-1938	15.66
Medicine Hat, 1904-1935	12.04

*Data from nearby stations have been supplied for months that were not reported.

the amount of evaporation, the soil type and the type of farm management, influence the efficiency of the rainfall. It was stated earlier in this section that going from south to north in Alberta the rainfall became more effective; this is mainly due to a decrease in the rate of evaporation from south to north. By using the previous fall plus growing season total rather than the annual fall, the distribution factor is partially eliminated. The other factors, namely, soil type and farm management, are discussed elsewhere in this report.

Table VIII gives the monthly, seasonal and annual snowfall at Gleichen, Calgary, High River and Pekisko. From this table it is seen that Pekisko with 88.4 inches receives over twice as much as Gleichen with 39.7 inches. High River, 70.4 inches, has a much greater snowfall than Calgary, 49.2 inches. This is probably due to the closer proximity of High River to the foothills. Practically no snow falls during June, July and August. At Calgary, High River and Pekisko there has been considerably more snowfall during the months of March and April than during any of the other months. It was stated earlier in this section that much of the snow is lost in the spring run-off. This is particularly true on the open prairie. In this part of the province where moisture is one of the greatest limiting factors in crop production the conservation of as much of this spring run-off water as possible is vitally important.

The frost-free period has a considerable bearing on the risk of producing certain crops and on the variety of crops grown. It must be noted that the frost-free period is ended as soon as the temperature reaches 32°F., yet this temperature will not damage most farm crops. Thus the frost-free period is seldom as long as the growing season. It should also be noted that the amount of frost will vary locally with changes in relief or topography. Certain low lying areas often receive fall frosts considerably earlier than nearby higher land.

TABLE VIII.—Snowfall in inches. Monthly and seasonal distribution for points on the Blackfoot and Calgary sheets

	Gleichen* 1903-39	Calgary 1900-39	High River 1903-39	Pekisko 1905-39
August	....	0.1	....	0.1
September	1.0	3.0	3.0	5.8
October	4.0	4.7	6.1	8.9
Previous fall	5.0	7.8	9.1	14.8
November	5.0	7.0	8.8	11.3
December	5.3	5.4	8.5	10.3
January	6.4	4.9	8.2	10.7
February	5.5	5.0	8.5	8.8
March	6.3	7.9	13.6	14.3
Winter	28.5	30.2	47.6	55.4
April	4.7	7.7	10.6	13.2
May	1.4	3.2	3.0	4.8
June	0.1	0.3	0.1	0.2
July	....	Trace	....	....
Growing season	6.2	11.2	13.7	18.2
TOTAL	39.7	49.2	70.4	88.4

*Data for some months have not been recorded. These, however, will not materially affect the average.

In a statistical atlas published by the Dominion Bureau of Statistics in 1931 the killing frost is placed at 29°F. Using these limits the authors of this atlas have prepared a killing frost-free map of the prairie provinces. This map shows Calgary as having an average of about 115 days free of killing frosts, High River 110 days and Pekisko about 90 days. Gem on the eastern side of the Blackfoot sheet is mapped at 120 days. Very little change occurs from Calgaray east, but from the west side of the Blackfoot sheet there is a rapid decline in the frost-free period. Using 32°F. as ending the frost-free period, during the 21-year period 1916 to 1936 Calgary has had an average of 102 days. The longest frost-free period was in 1933 with 123 days and the shortest was in 1918 with 50 days. Generally speaking, the growing period in the Blackfoot sheet is of such a length that frost is not considered a hazard to crop production. In the foothills regions, however, frost can be considered as a hazard, particularly to wheat production.

The climate of the Calgary and Blackfoot sheets is characterized by warm summers and relatively cold winter temperatures subject to fairly rapid fluctuation due to the Chinook winds. Table IX gives the temperature variations at Calgary and Gleichen. In order to clarify the column headings the August figures in Table IX may be considered. The first column, first line, gives the mean or average August temperature for Calgary over the 40-year period. Column two, first line, gives the mean or average maximum temperature for August over the same period. It is obtained by adding the daily maximums for that period and finding the average. The mean minimum, column three, is found in the same manner. In the fourth column is given the highest monthly mean, which in this case represents the average temperature of the warmest August during the period; the fifth column gives the year or years in which this highest mean occurred. The sixth and seventh columns deal with the coldest August recorded in a like manner. The eighth and ninth columns give respectively the warmest and coldest August temperatures recorded. Column ten gives the mean or average temperature at Gleichen for the period 1903 to 1937.

The yearly mean or average for Calgary for the period 1900 to 1939 is 38.9°F. This is about one degree warmer than the average at Gleichen for the years 1903 to 1937. By way of comparison, Lethbridge has a recorded average yearly temperature of 41.0°F., Medicine Hat has a mean of 43°F., and Edmonton a mean of 37°F. The mean maximum at Calgary is 50.9°F. and the mean minimum is 26.9°F.; that is, an average fluctuation of about 24 degrees between the days maximum and the days minimum readings. The highest temperature, 97°F., was recorded in July of 1933 and the lowest tempera-

TABLE IX.—Monthly, seasonal and annual mean and extremes at Calgary, Alberta, 1900 to 1939. Also mean at Gleichen, 1903 to 1937. Temperatures in degrees Fahrenheit.

	Calgary 1900-1939									Gleichen* 1903-37
	Mean	Mean maximum	Mean minimum	Highest monthly mean	Years occurring	Lowest monthly mean	Years occurring	Extreme highest	Extreme lowest	Mean
August	58.8	72.4	45.2	80	'22 & '15	41	'00	96	30	60.3
September	50.6	63.7	37.5	72	'18 & '22	31	'01	90	8	50.9
October	41.8	54.4	29.3	64	'01 & '18	19	'19	85	— 7	40.7
Previous fall	50.4	63.5	37.3	....				96	— 7	50.6
November	28.5	29.5	17.4	56	'17	6	'27	70	—30	27.2
December	19.1	29.4	8.9	43	'30	— 6	'27 & '33	62	—45	15.2
January	15.1	25.3	4.9	42	'19 & '31	—15	'07	60	—45	10.1
February	18.3	29.3	7.3	47	'31	—21	'36	76	—40	13.3
March	28.2	38.4	18.0	52	'10	0	'04	73	—33	25.1
Winter	21.8	32.4	11.3	....				76	—45	18.2
April	40.1	53.0	27.1	65	'15	20	'27	85	—16	40.0
May	49.2	62.2	36.3	72	'28	31	'03	90	16	49.6
June	56.3	69.3	43.2	77	'18	37	'01	95	25	58.1
July	60.8	74.2	47.5	84	'36	42	'03	97	31	64.8
Growing season	51.6	64.7	38.5	....				97	—16	53.1
Year	38.9	50.9	26.9	....				97	—45	37.9

*There are some months during this period for which no data have been recorded.

ture, —45°F., was recorded in December, 1924, and January, 1929. The mean winter temperature at Calgary is about 3 degrees warmer than at Gleichen and the mean growing season temperature is about 2 degrees cooler. In general, the summers in the entire area are warm and permit of rapid growth. The temperature usually drops fairly rapidly after sunset, making the nights cool.

VEGETATION

Five soil color zones cross the Blackfoot and Calgary sheets, and the vegetation of the area is characterized by a gradual change from the strictly prairie vegetation of the brown soil zone through a parkland belt to a mountain flora. There are, however, local areas that differ slightly due to soil texture, or changes brought about by irrigation.

Blue grama grass (Bouteloa gracilis), a low-growing, fine-leaved grass having a curved, one-sided, nodding type of head which becomes a deep purple upon curing, is the dominant grass in the area east of range 21. It occurs, however, as far west as High River and Calgary and is occasionally found on the south slopes of the lower foothills. Stipa comata, the common spear grass, is found over most of the area, particularly east of the 5th meridian, and becomes quite abundant in the brown soil zone. It provides a valuable source of pasture in its early stages of growth, before the spear-like seeds have developed, and in the winter when the seeds have dropped out leaving the culms and leaves standing. Green spear grass (Stipa viridula) is a taller growing grass than Stipa comata and tends to remain greenish or tawny at maturity. It is not as abundant as Stipa comata, though it is frequently seen, principally in the dark brown and shallow black soil zones. Sand grass (Calamovilfa longifolia) is a characteristic plant of the sandy soils of the area. It is the dominant grass in the sandy area east of Bassano, growing with sage and rose bushes. It is a tall, fairly coarse grass with an open panicle head. Although appearing quite green and succulent and remaining so until late in the summer, it is not relished by stock. It does, however, serve a useful purpose in helping to keep sandy areas from drifting.

June grass (Koleria cristata), a fine leaved grass with a compressed panicle type head, is common over most of the surveyed area. It was probably one of the dominant grasses in the brown to shallow black soil zones prior to cultivation. It is fairly prevalent in the valleys of the Wintering hills. June grass and the Agropyrons are the dominant grasses in the Buffalo hill area. The June grass found in the foothills, due to a higher rainfall, is a taller, more luxuriant plant than the one found on the prairie farther east. Tufted hair grass (Deschampsia caespitosa), a moderately tall, slender plant with a loose, open, nodding panicle, and having branchlets more or less originating in whorls, is found over the entire area. In the eastern part of the Blackfoot sheet it is confined to low marshy areas, but in the foothills of the Calgary sheet it may be found growing on the north slope and in the valleys.

Some five or six species of wheat grasses (Agropyrons) are found over the surveyed area. They are medium to tall growing perennials, often with creeping rhizomes. They usually have erect culms (stems) and green or purplish erect spikes (heads). A. Smithii, sometimes called bluestem or bluejoint, is found over most of the area and is often fairly abundant in the less well drained spots. A. dasystachyum is quite common in the foothills region. A. Richardson is found in the foothills and as far east as the brown soil zone. A. Griffithsii and A. tenerum are found in the drier soils of the surveyed area. A. repens (couch grass), found principally in the west half of the surveyed area, constitutes a weed problem in some areas. In places the Agropyrons, particularly A. Smithii, make up about half of the grass cover.

Cultivated grasses that have seeded themselves along the road and in waste places gradually take the place of the native flora. Crested wheat grass (A. cristatum) is restricted to places along fields that have at one time been seeded to this grass or are at present supporting a growth of it. Brome grass (Bromus inermis) and timothy (Phleum pratense) are found along the roads and in waste places in the west portion of the surveyed area, the former extending farthest east. In certain localized spots of the foothills area, brome or timothy or both make up about half the grass growth along the roadside. They are also found in the irrigation districts.

Some grasses are confined to localized areas. Salt grass (Distichlis spicata), a low growing plant with numerous florets arising from one culm, grows in mat-like fashion on alkaline soils, particularly in the seepage areas of the irrigation districts. Wild barley (Hordeum jubatum) is the principal grass found in dry sloughs and lake beds, particularly in the unirrigated land of the Blackfoot sheet. Mixed with this is the occasional plant of alkali grass (Puccenella nuttalliana), a tall growing, fairly coarse grass with an open panicle head. These grasses have some forage value. A slough grass (Bechmania syzigachni) is found in the ditches and low spots in the irrigated area east of Bassano but is not common to the immediately surrounding area. It is found in sloughs and marshes of the western portion of the surveyed area. It is a large, erect, coarse growing plant with broad flat leaves, and numerous short appressed or ascending spikes in a narrow, more or less interrupted panicle. It gives a rank growth, is edible by stock, and makes fairly good hay.

A number of grasses of varying importance are found in the western half of the surveyed area. Blue joint (Calamagrostis canadensis), a moderately tall grass, culms suberect, panicle relatively open and nodding, and with creeping rhizomes, is usually found in places where there is a good moisture supply. Spike oat grass (Avenae hookeri), a rye grass (Elymus innovatus), meadow barley, some of the Poa's (Poa trivialis), and some of the bent grasses (Genus Agrostis) are all found in the western half.

Bromus polyanthus, a large, stout growing brome, is confined to the foothills in the black and grey soil zones. Timber oatgrass (Danthonia intermedia), a somewhat tufted, moderately tall perennial with a few-flowered spike-like panicle of rather large oat-like spikelets, is also found in the foothills. Although not noticed by this survey, two fescues, namely, rough fescue (Festuca scrabella) and blue bunch fescue

(Festuca idaoensis), are reported to be found in the foothills area.

The control of weeds presents a major problem to the farmers of Alberta. Weeds take the moisture that should go to the growing crop and increase the cost of tillage. Russian thistle (Salsola kali) and tumbling mustard (Sisymbrium altissimum) present a serious weed problem in the brown soil zone and, to a lesser degree, in the dark brown soil zone; they do occur as far west as the foothills. Both of these weeds are able to make considerable growth even with limited rainfall, and in the drier eastern section they seriously compete with the growing crop. Flixweed (Descarania sophia), often miscalled green tansey mustard, is found over most of the surveyed area and is the dominant weed in parts of the dark brown and the shallow black soil zones.

Stinkweed (Thlaspi arvense) is abundant in the dark brown and black soil zones. It was also on the irrigated lands of the brown soil zone. Canada thistle (Cirsium arvense) has a distribution similar to stinkweed, although it grows in patches and is quite a problem in the irrigation districts. Field bindweed (Convolvulus arvensis) is quite a bad weed in the west and northwest part of the Blackfoot sheet and in the Calgary sheet. Leafy spurge has a distribution similar to bindweed. Wild oats are confined to the western half of the surveyed area and constitute a weed problem in these areas of higher rainfall.

In areas where there is considerable abandoned cultivation weed control becomes quite difficult. Large blocks of abandoned farms are located north of Kinnondale and between Wintering hills and Bassano. On these areas Russian thistle and tumbling mustard are found in abundance. Russian thistle and tumbling mustard are the first weeds to cover deserted farm lands. Spear grass (Stipa comata) seems to be one of the first grasses to make its appearance in the natural regrassing cycle. In some areas wild barley gradually spreads in clump-like fashion over the fields. Prairie sage is fairly abundant on some fields that have beeen abandoned for several years. The natural regrassing process is very slow and experiments are at present under way to determine possible means of hastening the regrassing of these deserted areas.

Hoary cress (Lepidium draba), a deeply rooted perennial weed, occurs in greatest numbers in the Strathmore irrigation district. This weed is becoming a serious problem in some fields. Russian knapweed (Centaurea picris) is usually found along with hoary cress. Other weeds with a widespread distribution, but more numerous in the irrigation districts, are lambs quarters (Chenopodium album), red root pigweed (Amaranthus retroflexus) and Russian pigweed (Axyris amarantoides). Downey brome grass (Bromus tutorum) has been reported around Calgary, particularly close to feed lots where hay is brought in from infested areas of the south. Green foxtail (Setaria viridis) is reported around Gem. A salt sage (Astriplex nuttalli), found in alkaline areas and strongly solonized flats, is abundant on seepage areas, particularly in the irrigation area east of Bassano. This differs from pasture sage in having fewer and broader leaves. Alkali blight (Chenopodium humile) was found on some of the bad seepage areas. Wormwood (Artemisia biennis), a tall growing, green, bushy plant with a strong odor, is frequently seen in low spots and in the irrigation districts.

Some of the less common plants that are found in the area should be mentioned. Prairie cone flower (Lepachys colomifera), a small yellow flowered plant which develops a conspicuous elongated brown cone, and gum plant (Grindelia squarrosa), a medium to tall yellow flowered plant which secretes a gum-like substance, are found over most of the Blackfoot sheet but are more numerous in the eastern than in the western half of the sheet. Mare's tail (Leptilon canadense), an erect, bristly, hairy, medium to tall plant with numerous narrow leaves and numerous small yellow flowers, is found in places of poor drainage in the dark brown and brown soils and particularly around the irrigation east of Bassano. Prickly lettuce (Lactuca virosa) is found in scattered patches along the roadside in the east half of the dark brown and in the brown soil zone. Wild liquorice (Glycyrrhiza lepidola) is more abundant in sandy areas, although it is found in other places in the brown soils. Narrow-leaved dock, and occasionally wild parsnips, are found in many of the marshy areas and in the bottom of ravines over most of the area. Cat tails (Typha), a large, very tall, reed-like plant with a brown, furry, compressed spike, is found only in the very wet places of the irrigation districts. Fireweed (Erilobium angustifolium), a tall plant with a wand-like, non-branching stem, terminating in a compound flower spike of pink flowers which later produce seed pods full of "cotton", are found in the scrubby patches of the black soil zones. White asters are common over much of the area. Yarrow (Achillia lanulosa), a small, serrated-leaved plant with a wide, dense cluster of small, white flowers, is common to the entire surveyed area. A plant common to the heavy soils is the wild sunflower (Helianthus arida). It is quite common in the clay area south of Chancellor. Goldenrod is found over the entire surveyed area. In the eastern portion it is more confined to the more moist places.

Several plants might be named which occur in the pasture areas and have seriously reduced the grazing value of such lands. Perhaps the most serious of these, particularly in the Wintering hills just east of Hussar, and also in the range area south and east of Bassano, is the common club mass (Selaginella densa). This is a very low growing club moss that spreads in patches over the ground surface to the exclusion of the forage grasses. Pasture sage (Artemisia frigida) is abundant, particularly on the range areas of the brown soil zone. In some places it makes up about one-half of the total vegetative cover. It is found as far west as Bowness, just west of Calgary. However, it has probably been encouraged in this latter area by over-grazing and by the fact that the high lime soil found here is rather droughty. Cactus plants are numerous in the range area east of Southesk, particularly in the areas of solonized soils. The common castus with yellow flowers (Opuntia polyacantha) occurs in the greatest numbers. The small "pincushion" variety (Apuntia neomanillania) is also found. Prairie phlox (Phlox Hoodii), a low growing plant which, though not a moss, has the appearance of such, is only of minor importance on the range areas. Over-grazing tends to weaken the pasture grasses and gives the above-mentioned plants a chance to spread over the ground surface.

Natural tree growth is mainly confined to the foothills area. A few scattered willows along the roadside as far east as Mossleigh indicate that here some trees may have been removed when the land was broken. On the northeast slope of Buffalo hill there are some stunted poplars and saskatoon bushes. A line drawn through Buffalo hill and Strathmore would be about the eastern limit of natural tree growth. Along the Bow river valley, however, there is a good growth of trees as far east as Bassano; very few evergreens are found east of Barstow. East of Bassano the tree growth in the Bow river valley is limited to a few willows and saskatoon bushes, but farther east, in the Medicine Hat sheet, poplars are again found along this river.

Aspen poplar (Populus tremuloides) is the dominant tree of the lower foothills region, growing mainly as saplings in dense thickets rather than as large, solitary, individual trees. Along the rivers and streams the aspen poplars give way to the black poplar (Populus tachamahacca) and, to a smaller degree, white spruce (Picea glauca). Farther west, beyond Turner Valley, Priddis and Jumping Pound, the tree growth is composed of poplar, spruce and lodgepole pine (Pinus contorta), the latter making its appearance particularly on the gray wooded soils. Wolf willow (Elacagnus argenta) is confined mainly to the foothills area, but occurs east a considerable distance along the river valleys. Dwarf birch (Betuta glandulosa) is very common in the foothills region, generally growing in the lower areas. It makes up a considerable part of the undergrowth in places that have been burnt over. Shrubby cinquefoil (Dasiphora fruticosa) is common in the lower foothills area, particularly in open places away from the larger tree growth. Some of the small fruits—chokecherry (Prunus melanocarpa), saskatoon (Amelanchier alnifolia), etc.—are found in the foothills region and east along the river valleys for considerable distances. Buck brush (Symphoricarpus occidentalis) is found over most of the two sheets. However, in the brown and dark brown soil zone it is confined to slopes facing the north or where the irrigation affords a moisture supply.

Rose bushes (Rosa sp.) make up an important part of the undergrowth in the wooded areas. They are also found in the parkland and open prairies, particularly along fence lines and on the sandy soils. Bearberry (Arctostaphylos Uva-ursi), a low creeping plant with a red fruit, is found covering the ground in mat-like fashion, particularly in the tree covered area of gray wooded soils.

ORIGIN OF THE SOIL MATERIAL

Practically all of the Blackfoot sheet was covered by the Hudson's Bay glaciation, and most of the Calgary sheet was covered by the Rocky mountain glaciation; that is, the meeting of the two continental ice sheets in this area was not far from the 5th meridian. (For a more complete discussion on the geology of the Blackfoot and Calgary sheets the reader is referred to the appendix by J. A. Allan.) These ice sheets in passing over the area mixed materials they had carried for considerable distances with the immediately underlying bedrock. This glacial drift, as it is called, was deposited as a mantle over the glaciated area, the depth varying greatly from place to place. Over most of this area the present surface mantle is glacial till so deposited. In a few places, however, the agents of erosion have removed all of this till, with the exception of the larger erratics, so that the surface mantle in these portions is the original parent rock. In some other places wind and water have carried in and deposited a coating of eolial and sedimentary materials over this glacial drift. Some of the glacial till is piled up in the form of terminal or lateral moraines, but the greater portion is in the form of a ground moraine. This ground moraine has in many places had its surface material subsequently sorted by post-glacial winds and water. The large hilly area east of Lake McGregor, the hills east of Hussar, and the Buffalo hill, are terminal or lateral moraines. Some of the hills of the Calgary sheet are of glacial origin but most of the foothills which are closely allied with the Rocky mountain uplift, are composed mainly of local bedrock.

A large area of sandy soils is mapped between Gleichen and Strathmore. These are possibly lake shore sands. Lying east of this sandy area is a large area of uniformly deposited soils. The soils of this area, extending from Strathmore to Hussar and south across Bow river to the edge of Buffalo hill, gradually get heavier in texture from west to east. A fairly large area of lacustrine clay is mapped south of Chancellor. This appears to be the centre of the laking area. Bordering this clay area is a silt loam area and between this and the sands is a large area of loam textured soils containing considerable very fine sand and coarse silt.

Two other fairly large laking areas are mapped in the surveyed area, one south of Gem and one in Turner Valley. The heavy textured soils of Turner valley are possibly water lain, but have their origin from the immediately surrounding Alberta shales which form the uppermost bedrock in much of the area immediately west of Turner Valley.

West of High River there are large gravelly areas that are of alluvial and glacial outwash deposition. Their origin is associated with the mountain streams that have traversed the area.

Soils, mainly of alluvial origin, having a fairly high concentration of lime carbonate are found principally along the Bow drainage. These possibly had their origin in material carried down by the Bow river from the limestone ranges of the Rocky mountains.

Bedrock outcroppings occur over the entire sheet. Generally these rocks are from upper Cretaceous to lower Tertiary in age. In some places these outcroppings are extensive enough to be locally called bad lands. Possibly the most extensive of these are found on the Bow river south of Bassano (Plate 8, fig. 2). The differential weathering of the bedrock often produces results that are quite picturesque. They are found principally along the stream cuts. Most of these outcroppings are overlain by varying amounts of glacial till. In some areas, however, this till has been eroded off leaving only the scattered erratics on the surface and, therefore, the weathered bedrock forms the present surface mantle. Two fairly large areas of residual or sorted residual soil have been mapped. One of these areas is south of Lathom, principally in township 18, range 17, and the other is in the foothills west of Black Diamond and Priddis.

As stated earlier in this section, a large percentage of the soils in this area is formed on the glacial till, and much of this till, particularly between Calgary, Strathmore and Vulcan, is in the nature of ground moraine that has very probably been subjected to some post-glacial sorting by wind and water.

In general it can be said that in an area affected by both east and west glaciations and cut by numerous streams carrying materials from the mountains, a great diversity of parent soil material can be found. This variation in parent material is indicated in the soil profile; in the soil textures and in the chemical composition.

SOIL CLASSIFICATION

This section of the report gives an outline of the system of classification used by the Alberta Soil Survey in separating one soil type or one series type from another. Each of the factors used influences the soil's character which in turn affects its utilization. Included is a short description of the methods used by this survey.

SYSTEM OF SOIL CLASSIFICATION

The soils of Alberta are divided into broad soil zones. These zonal divisions are based principally on the color of the soil profile; these color differences have developed as the result of certain soil moisture and vegetation conditions over a long period of time. The soils of the respective zones are again divided on the following bases: (1) the texture of the surface soil, generally of the A horizon; (2) the dominant characteristics of the soil profile; (3) the mode of deposition of the parent material, that is, its geological deposition. Such factors as topography, stoniness, alkali accumulation, grass or tree growth and degree of erosion all influence the soil type finally designated. The combination of all the factors that characterize a given soil, other than its surface texture, gives that soil its series designation. On the Blackfoot and Calgary sheets there are five color zones, namely brown, dark brown, shallow black, black, and gray wooded. On the map accompanying this report the soil classes, determined by the surface texture, are shown in different colors. Each textural class, however, may be subdivided into smaller areas, and each of these areas carries a three digit number. This number determines its series. Although the complete legend for the classification of the soils of this sheet appears on the map, an explanation of the legend is in order here to facilitate the interpretation of the next section in this report, namely, the soils of the Blackfoot and Calgary sheets.

Soil Zone.

The 1.0.0 soils are those in the brown soil zone. This zone corresponds to the bald prairie of southeastern Alberta. These soils are relatively low in nitrogen and have a shallow profile. They have developed under a low annual rainfall and a relatively high evaporation.

The 2.0.0 soils are those in the dark brown soil zone. This zone forms a broad transition belt between the brown and black or parkland soils of the province. It averages about 50 to 75 miles in width. This area has developed under somewhat more humid conditions than prevail in the brown zone.

The 3.0.0 soils are those in the shallow black soil zone. Although they are formed under a fairly high annual rainfall a relatively high evaporation rate has restricted depth of organic matter accumulation. A shallow profile with a correspondingly shallow Black A or surface horizon has developed. (See Plate 7, fig. 1.)

The 4.0.0 soils are those in the black soil zone. These soils have a fairly deep profile and a black A horizon generally over 6 to 8 inches deep. They have developed under a fairly humid soil moisture condition. This zone corresponds fairly closely with what is commonly called the parkland area.

The 5.0.0, 6.0.0 and 7.0.0 soils are those of the wooded soil zone. Only a small area of these soils is mapped, located northwest of Millarville. Soils of this zone, formed under fairly heavy tree growth, are degraded soils. Since no large area of these soil types has been mapped by this survey no definite attempt has yet been made to define any limits. However, in a general way, it can be said that 5.0.0 soils are black-gray transition soils; 7.0.0 soils are strongly degraded, podsolic or gray wooded soils; and 6.0.0 soils are intermediate between these two.

Mode of Deposition of Parent Material.

This column deals with the parent material on which the soil profile developed. Glaciers, wind, and water all played a part in the transporting and sorting of this parent material. In many cases it is impossible to determine what agency has been most active. In this classification certain type profiles most characteristic of the mode of deposition were set up. It is possible that in many cases the geological agency indicated in the legend may not have been solely responsible for the deposition of the parent material.

0.0—These soils are residual soils, that is, soils formed in situ from the weathering of the underlying rock formations. Since most of the consolidated rock formations of Alberta were formed in association with large bodies of water, this material is relatively stone free and the soil that has formed from their weathering is also stone free. In most cases the topography is uniform, level to undulating, and the unweathered parent rock is fairly close to the surface.

1.0—These soils are termed sorted residual. They are formed principally from the weathered material of the underlying parent rock that has undergone some surface sorting.

Many of these soils may have been glaciated at one time, but most of the drift material has been eroded off, leaving only the transported stones on the surface. The depth of unconsolidated material over the parent rock varies greatly, but in these areas exposures of the underlying formation are quite numerous.

2.0—These soils are unsorted glacial soils, that is, soils which have developed on the unsorted till just as left by the receding ice. These soils are characterized by a rough topography and few to many stones scattered throughout the profile. Due to the broken nature of the topography and the absence of gravel and sand lenses the areas often contain numerous sloughs and meadows. The till or glacial drift in this area was partly transported by the Keewatin or Hudson's Bay glaciations and partly by the Cordilleran or Rocky Mountain glaciations. The eastern and central portions of the area are principally of the former material and the western portion is principally of the latter. Some of the material naturally is of local origin, but some has been transported long distances. Because of the variety of sources of this material the texture of these soils is often quite variable.

3.0—These soils are termed resorted glacial. They have developed on glacial till that has undergone a surface sorting. Generally these areas have level to undulating topography, that is they are ground moraine. There are glacial stones throughout the profile, particularly in the unsorted subsoil, and the surface material may contain some waterworn gravel and stones. Wind, as well as water, may have been responsible for the formation of this surface layer. These soils are of a more uniform surface texture than the unsorted glacial soils and agriculturally are generally good soils.

4.0—These soils are a grouping under the title, "gravelly outwash". They are characterized by being very gravelly and often stony. In many cases they are non-arable. The gravelly nature may be due to an alluvial deposition or to the removal of the finer particles from glacial dumps. In either case the coarser gravel and stones predominate due to the washing out of the finer material. They are generally light textured soils with level to undulating topography.

5.0—These soils are of alluvial origin. They are characterized by the presence of some water worn stones in the profile and by the presence of gravel and sand lenses throughout the profile. The variable deposition is the result of water moving at different speeds or carrying loads of various materials. These soils vary in their utility with the percentage of gravel and the frequency of sand lenses. These sandy lenses affect the drainage and the water holding capacity of the soil.

6.0—These soils may be alluvial or eolian. In this class are put the fairly uniformly deposited soils, generally light to medium textured. They are practically stone free and on undulating to gently rolling topography. That is, they are relatively unform throughout the profile depth and throughout the area. The sand dune areas fall in this grouping. In the areas of restricted rainfall the lighter textured phases of these soils are rarely better than fair arable land.

7.0—These soils may be lacustrine or eolian. In this class are put the uniform medium to heavy textured soils. Most of the soils of this class are of lacustrine formation, that is, they have formed from the material that settled out of still water. As a result the texture of these soils is fairly uniform throughout the profile. They are practically stone free and generally on level to undulating topography. Post-glacial winds may have been responsible for deep silt deposits, particularly in the glaciated areas. In general this eolian deposition is shallower than the average lacustrine deposition.

Profile Variation.

This column deals with the variations that are found in profile development as well as the degreee of salinization of the soil. Chemical and physical weathering of the parent material, the movement of soluble substances throughout the soil profile by the percolating rain water, the addition of organic matter due to vegetative growth and the activity of soil microorganisms are some of the agencies that have aided in creating the soil profile.

0—These soils have very little profile development. The sands, recently flooded river bottoms, and areas that have recently been severely drifted lack profile development. They may be considered as raw or undeveloped and in general have a single grain structure.

1—These soils are hillside soils. As a result of loss of run-off water these soils are locally more arid than the surrounding soils and generally they are of a lighter color and have a shallower profile. The run-off water carries with it surface soil from the slopes.

2—These soils are non-saline and have a normal profile development; that is, they are normal for their texture and the amount of rainfall they receive. Their structure in this area is commonly wide prismatic to columnar. They are generally the good arable soils.

3—Soils of profile 3 are non-saline, but are developed in local depressions. Due to a lower position they receive run-off from the higher soils near-by and as a result may develop a deeper and darker profile than the normal soils of the area.

If these soils do not have a drainage problem they are among the best arable soils.

4—These soils are characterized by a weak saline or alkaline profile development. That is, they are intermediate in character between soils of profile 2 and 6 and between soils of profile 2 and 5. In this area practically all the soils of group 4 fall in the second category. They were not saline enough to warrant placing in group 5, but there was evidence of alkali salt accumulations. In most cases the alkali salt content was not great enough to materially affect the profile structure.

5—These soils are somewhat saline and are generally found in areas that have poor to fair drainage. Due to the poor drainage a normal soil profile does not develop and the profile has very little differentiation from the surface down. They are often of quite a heavy texture. The alkali salts move up and down in the soil depending on the direction of the movement of the water in the soil. Many of these soils grow good meadow hay and some might produce certain cultivated crops if properly drained.

6—These soils generally contain less salt than do the soils of 5. They are characterized by a hard impervious subsurface layer. This hard B_1 horizon has a well developed columnar structure with the top often looking much like a cauliflower head; the A_2 horizon that lies immediately above this layer is often very light in color and of a layered or platy structure. Although there are exceptions, most of these solonized soils are found on level to undulating areas where possibly at one time drainage was not adequate. The areas are often characterized by a patchy micro-relief (eroded-pits) due to the erosion of the A horizon. If the hard layer is close to the surface they are generally inferior soils.

7—These soils have a high concentration of lime carbonate practically to the surface and are, in general, much lighter in color than the soils normal for the area. Since much of the parent rock in the Rocky mountains is limestone it is thought that the origin of these soils is associated with this parent material. Many of these soils have a lifeless appearance and are generally of low productivity.

Each soil area outlined or described, then, carries a three digit series number. Each of the digits is separated by a dot, e.g. 1.2.1. This number (1.2.1) represents a brown, glacial soil profile developed on fairly steeply sloping ground. It is quite possible that two modes of deposition may be found, one over the other within the profile depth; for example, some of the clay laking basin is mapped as 7/2. In these areas there is a thin coating of lacustrine material over the glacial till, and the till can usually be found within the profile depth. It should also be recognized that the profile development in a given soil area is not entirely uniform. If one form of development is quite dominant a single number is used in the units column. However, if there are two distinct forms of development so intermixed that separation is not practical, a fraction may be used in this column. For example, the complex 2/5 would indicate a normal soil profile over most of the area with patches of saline soils scattered throughout the area. Such a soil area might carry the number 2.3.2/5. This indicates a dark brown soil formed on sorted glacial parent material having generally a normal profile development, but containing patches of saline soil within the area. The profile 2/7 used in this area indicates that the B_{ca} (lime) horizon is close to the surface; that it is between profiles 2 and 7.

There are eight main texture classes mapped. These are, going from the lightest to the heaviest, sand, sandy loam, fine sandy loam, loam, silt loam, silty clay loam, clay loam and clay. There is also a mixed class that is used where the surface is so badly mixed that separation is not practical. Some of these classes are subdivided into light, medium and heavy phases; on the map Lt. refers to the light phase and H to the heavy phase. A description of the soil texture classes is found in a later section of this report.

Topography, the presence of eroded surface patches in the solonized soils, and rock outcrops are indicated on the soil map by symbols.

SOIL SURVEY METHODS

The soil survey was generally carried out by driving along the roads and stopping frequently to take notes regarding class of soil and subsoil, topography, stones, suitability of soil for cultivation, etc. The roads running north and south are one mile apart, and the roads running east and west are two miles apart. In most cases the area was traversed at intervals of one mile. In some cases, however, roads had not been opened up, and it was then necessary to drive across the prairie. The location was usually obtained from corner posts and speedometer readings. In some places one soil class changes abruptly to another, and here there is no doubt regarding the point at which the boundary line should be placed; but more often one soil class merges gradually into another, and here the point at which the boundary line is placed must be chosen arbitrarily. Then, of course, it is necessary to draw in the boundaries arbitrarily between roads, or between points of observation. After the boundaries of the various soil areas had been established in this way, the areas were sampled systematically and the samples were sent in to the laboratory for analysis.

Most of the field notes were recorded on township maps obtained from the Topographical Surveys Branch of the Dominion Department of the Interior. The township map is made with a scale of two inches to the mile. Further notes were recorded in convenient field note books.

In a survey carried out in this manner, and recorded finally on a map of a scale of three miles to the inch, minor areas cannot be outlined, and boundaries between lines of traverse cannot always be accurately established. Hence, although the extensive soil types are outlined fairly accurately, further inspection should be made in determining the soil types on individual quarter sections.

DESCRIPTION OF SOILS

In the description of the soil areas of the Blackfoot and Calgary sheets the following arrangement is made:

The areas are first divided into their respective color zones, then the major soil areas within each zone are described. These major areas include, in a general way, those soils that are somewhat similar in morphology and utilization. Following these descriptions of each zone there is a table in which the principal characteristics and total acreage of each series class is listed. In this table the following abbreviations are used: In the location column the first number refers to township, the second to range. In the topography column L. is level, U. is undulating, G.R. is gently rolling, R. is rolling and H. is hilly. In the classification column Pr. is poor, F. is fair, F.G. is fairly good, G. is good, V.G. is very good, P. is pasture and A. is arable.

Included in this section is a discussion of the chemical composition of the typical soils of the area. In certain portions of the area there is an alkali problem. This is also discussed.

SURFACE TEXTURE

The data in Table X show the acres and percentage distribution of the textural soil classes on the Blackfoot and Calgary sheets. From this table it is seen that the loam textured soils make up the greatest percentage. Considering the three loams, light, medium, and heavy, together they make up about 68 per cent of the total area. Loam soils are medium textured soils generally underlain by a subsoil heavier than the surface soil. A true loam soil has the three fractions—sand, silt, and clay—mixed in such proportions that no one fraction predominates. The light loams have more sand and less clay than the medium loams. A fairly large percentage of the soils of this area is graded a heavy loam. This class includes loams that are heavy due to a fairly high clay content and loams that have a fairly high silt content. In other words the heavy loam class includes those soils that fall between loam and clay loam, or between loam and silt loam. Loam soils generally do not drift as readily as do the soils of either a lighter or a heavier texture; they are relatively fertile and in areas other than those of restricted rainfall are texturally good soils.

Sandy loam and fine sandy loam make up about 8 percent of the total area. Fine sandy loam soils contain about 65 to 75 percent sand and sandy loam soils about 80 to 85 percent sand. The former contains enough of the finer soil particles to give the soil some firmness, and they are fair arable soils excepting under quite dry conditions. Sandy loam soils are very loose, often low in fertility, will drift readily and, excepting under exceptional circumstances or an adequate rainfall, should not be considered as arable land. As stated earlier in the report, most of the sandy loams occur in the Strathmore and in the Countess areas. Only 0.4 percent of the area is mapped as sand. These are mainly sand dune areas. Most of the sand is of medium grain size and contains very little fine binding material.

TABLE X.—Soil Classes

Division	Acres	Percent
Sand	14,000	0.4
Sandy loam	97,000	3.0
Fine sandy loam	174,000	5.3
Light loam	228,000	6.9
Loam	1,140,000	34.4
Heavy loam	872,000	26.4
Silt loam	143,000	4.3
Silty clay loam	111,000	3.4
Clay loam	200,000	6.1
Clay	171,000	5.2
Mixed	5,000	0.2
Eroded land	75,000	2.3
Marshes	40,000	1.3
Water	30,000	0.9
TOTAL	3,300,000	100.1

Silt loam forms approximately 4 percent of the total area. Silt loam soils contain a predominance of silt particles, usually over 50 percent. Silt loam is generally associated with water deposition or water sorting, although many silt loam soils are the result of post-glacial wind deposition. Most of them have few to no stones. They are not as heavy to cultivate as the clay soils, but they have a high water retention power and are usually well supplied with the plant food elements; as a result of these factors they are generally among the best arable soils. Three fairly large silt loam areas are mapped—one north of Gleichen, one north of Queenstown, and one west of Calgary.

Silty clay loam forms about 3.5 percent of the total area. In general silty clay loam soils have a high content of both silt and clay; they could be described as heavy silt loam soils. Like the silt loams they are associated with water deposition and often form the outer fringes of the laking basins. Clay loam forms about 6 percent of the total area of the two sheets. Clay loam soils average between 15 and 25 percent clay particles and are therefore fairly heavy soils. Clay loam differs from the silty clay loam in that it usually has a greater percentage of sand. It is often stonier and rougher and is not necessarily associated with water deposition. Texturally clay loam soils are generally intermediate in utilization between heavy loam and clay. A large portion of the clay loam appearing in this mapped area is in the foothills region, particularly north and west of Turner Valley.

Clay forms approximately 5 percent of the total area of the two sheets. Clay soils contain about 25 percent or more of clay particles, that is, of the smallest soil particle fraction. They are commonly called heavy soils. Clay areas are generally associated with laking, the fine particles having settled out of still water. Clay soils with a normal profile are good dry land soils. They have a high water holding capacity and generally contain a fairly large amount of available plant foods. There is a large clay laking area south of Chancellor and one south of Turner Valley. Much of the clay in the foothills valley has been mapped as residual; the parent material of these soils being associated with a laking deposition of an earlier geological age.

About 0.2 percent of the area is mapped as mixed soils. They are principally those river bottom soils that it was found impractical to separate on a map of the scale of three miles to the inch. Many of these areas are at present liable to flooding during periods of high water.

Approximately 75,000 acres, that is 2.3 percent of the area, is mapped as eroded lands. These areas are located principally along the stream courses. In general these eroded lands are too steep or broken to cultivate and are from poor to good pasture land.

On the soil map that accompanies this report the soil textures are designated by different colors. Each soil area on the map carries a three digit number; this number indicates the soil series to which the area belongs. The first or hundreds digit refers to the color zone, the second or tens digit refers to the way the parent material upon which the soil profile has formed was deposited, and the third or unit digit indicates the form of profile that has developed. In the section on "System of Soil Classification" these factors were broadly defined and the method of using them indicated.

COLOR ZONES

Five soil color zones are mapped in the Blackfoot and Calgary sheets. These color zones have developed as a result of different soil moisture relationships. For example, the brown soils on the eastern side have been formed over a long period of time under drier soil conditions than those forming the black soils on the western side. Drier soil conditions may be due to a lower rainfall, higher temperature, or a greater evaporation; the last one is influenced by the vegetative cover.

The line dividing the brown and dark brown soil zones in the Blackfoot sheet starts at Armada in township 17, range 20. From this point it makes a wide turn east to township 19, range 18. From this point it turns northwest to Crowfoot in township 21, range 20. This wide extension to the east is due to the presence of dark brown soils on the higher land of the Majorville moraine. From Crowfoot the line runs northeast to leave the sheet in township 24, range 17.

The line dividing the dark brown from the shallow black starts near the Little Bow river in township 17, range 27, and excepting for a small eastward extension around the Gladys-Dinton ridge, runs practically due north to leave the sheet in township 24, range 26.

The line dividing the shallow black from the black zone is started at the forest reserve boundary in township 19, range 4, W. 5th. From here it is drawn east to Turner Valley, then northeast to a point just east of Lloyd lake in township 22, range 1, W. 5th, and then northwest to leave the sheet in township 24, range 4, W. 5th.

The line dividing the black zone from the podsolic soils is started at the forest reserve boundary in township 21, range 4, W. 5th. From here it is drawn northeast to near Priddis in township 22, range 3, and then northwest to leave the sheet in township 24, range 5, W. 5th.

In general, any soil color separation line actually represents a fairly broad strip of land, that is, there is a gradual change from one zone to the next. In the foothills where there is a fairly rapid elevation change the color transition is also quite rapid. It should also be stated that due to differences in soil types, in relief, and in local precipitation, islands of one soil color may be found within another zone. Examples of this occur in this area, namely, the Buffalo hills black soil in the brown zone, the black Pekisko clay in the shallow black zone, and the black valley clays in the podsolic zone.

The color of the soil, the method of deposition of the parent material and the type of profile all imprint certain characteristics on the final soil area, each factor contributing to the soils morphology and to its utilization. It must be recognized that natural objects—and soil is a natural object—commonly do not fall into hard and fast classifications. There are variations within any given series and within any given type, and one series or type gradually changes into another. Such variations must be expected in any soil area, but in general within any given soil boundary the profiles do not deviate far from the average for that particular area.

BROWN SOIL ZONE

In general the brown soils are characterized by a shallow profile and a light color. The brown color of the A horizon indicates that these soils are relatively low in organic matter content when compared with the soils of the more humid sections of the province. These soils are fairly well supplied with the mineral constituents, and in years of sufficient rainfall there has been enough available plant food to produce good growth. The lime carbonate horizon is found at from 10 to 20 inches and averages about 14 inches in this area. The brown soils of the Blackfoot sheet lie on the western rim of the large brown soil zone of southeastern Alberta; however, the change from dark brown to brown is quite rapid and portions of this section of the brown soil zone are quite arid.

Below is given a description of the major soil groupings of the zone. Table XI gives the main characteristics of each individual soil area.

Brown Sandy Soils of the Countess Area.

Between Countess and the eastern edge of the Blackfoot sheet and extending north towards Red Deer river is a fairly large area of sandy soils. This is the western extension of the large sandy area in the northwest portion of the Rainy Hills sheet. The soils are generally stone free and vary in surface texture from sand to light loam. The sandy deposition varies from one to six or seven feet in depth over a fairly heavy textured substratum that seems to be closely allied with the residual Bearpaw shales of the area. This heavy textured layer often causes the formation of a water table fairly close to the surface. It is medium sand and generally no appreciable lime concentration horizon can be found.

Under dry land conditions the area is definitely pasture land. Sand grass, rose bush and sage make up a large percentage of the plant growth, particularly on the sand and sandy loam soils. Portions of the area are irrigated and have produced some fairly good crops; however, seepage occurs and many of the lower portions are now quite marshy.

Solonized Sorted Residual Loams Southwest of Brooks.

Between Southesk and Bow river is an area of solonized loam whose parent material is mainly the underlying Bearpaw shale. The entire area has been glaciated. At present, however, the scattered surface erratics are practically all that remain of the deposited glacial drift. Relatively unaltered parent sandy shale can often be found within two or three feet of the present surface. The area is undulating to gently rolling, consisting of long low ridges with uniform sweeping slopes. The entire area is pock-marked with the eroded pits typical of the solonized areas of southeastern Alberta. These pits cover from 10 to 50 percent of the surface.

The following profile, taken in section 24, township 18, range 17, W. 4th, is fairly typical of the degraded portions:

0″- ″2 A_1—Loose, light brown.
2″- 4″ A_2—Platy, gray-brown.
4″-12″ B_1—Gray-black. Hard, waxy, narrow columns. These columns break into small cubes with staining on the cleavage faces.
12″-24″ B_{ca}—Grayish, dark brown. Hard, tightly packed; very little lime accumulation.
At 30″ Upper C—Very hard massive sandy clay.

A less degraded profile taken nearby had five inches of a friable, somewhat prismatic A_1, brown to light brown in color. This breaks sharply to a dark brown, fairly hard, columnar B_1. The vertical cleavage lines in this horizon are wider apart than in the profile described above.

The area is pasture land under dry land agriculture. The hard B_1 horizon makes rain and root penetration very difficult. Under irrigation, however, this horizon appears to soften considerably and appears to cause little trouble. Although the parent material (Bearpaw shale) is quite high in salts, this salt is mainly calcium and sodium sulphate and therefore not toxic unless present in considerable quantities.

A small portion of the area is irrigated but the major portion is at present used as pasture. Attemps at cultivation in the more badly eroded portions have generally been failures; however, some land is still being dry land farmed in the less solonized soil south of Lathom.

Solonized Soils of the Kinnondale Area.

South of Bow river centering in township 17, range 18, is a fairly large, undulating to gently rolling basin. The underlying bedrock, a sandy shale, is relatively close to the surface in this area, but there appears to have been considerable waterworking of and some deposition over this parent material. The soil is mainly a loam to light loam in texture with the occasional sandy streak. Gravel stones are quite numerous and there are a few larger boulders. The profile is generally shallow, the lime concentration horizon averaging 10 to 12 inches from the surface.

Nearly all the soil shows evidence of the solonization process, namely, a light gray-brown A_2 and a hard waxy B_1 horizon. The eroded pits, however, are not deep and often are grassed over. In these last respects this area differs from the sorted residual solonized area described immediately above.

At least three-quarters of the area has been cultivated at one time; less than 10 percent still remains under cultivation. In general it is not arable soil and when returned to grass should remain as pasture land.

Medium to Heavy Textured Deposition Soils of Gem Area.

Lying in a fairly level basin south of Gem is an area of lacustrine deposited silt loam and silty clay loam soil. This area is bounded on the west by morainic soils and on the east by light textured alluvial materials. The area is stone free and contains some marshes—these marshes are somewhat alkaline. The entire area contains solonized soil but the percentage of degraded soil and of surface erosion is much greater in the southern portion of the area. In the southern half of the basin eroded pits cover practically 50 percent of the surface.

The following profile taken in section 17, township 22, range 16, W. 4th, represents a slightly degraded silty clay loam soil:

0″- 6″	A—Brown to dark brown. Firm, prismatic to columnar.
6″-11″	B_1—Brown. Fairly hard, narrow columnar, widening towards the base. A little staining on the cleavage faces.
11″-17″	B_{ca}—Friable. Fairly heavy lime deposition, irregular clods.
24″-30″	Upper C—Friable, mellow, yellow brown. Contains a little less lime than the B_{ca} horizon.

The irrigation is mainly confined to the northern portion of the area that is slightly lighter in texture and, as stated above, has much less solonized soil than the southern half. See Plate 4, fig. 3. The remainder is pasture. There is no dry land cultivation in the area. The badly eroded areas are only fair pasture land; the less eroded are fairly good pasture. In the latter blue grama is one of the principal grasses.

Glacial Loams from Crawling Valley to Crowfoot.

This area of glacial loams is the southern rim of the Wintering hills moraine. It borders the western edge of the Bassano-Gem alluvial-lacustrine basin. The area has a gently rolling to hilly topography. The rolls are generally low but quite steep and somewhat choppy. The area contains many sloughs and short drains. Sandy streaks and the occasional gravel lense indicates that there has been considerable post-glacial water sorting. Although some alluvial sorting has taken place in most morainal areas it seemed to be of sufficient scale in this area to warrant giving much of the area the deposition number 5/2., (alluvial glacial). Small stones are quite numerous on the knolls. It is suggested that the glacial drift in this area contains a fairly large number of small stones originating from the pre-glacial, Oligocene conglomerates. The area is quite variable both in surface texture and in profile.

Most of the area is at present fairly good pasture land. Blue joint and blue grama are the dominant grasses. On some of the more arid slopes, however, club moss has reduced the grass stand. Patches of abandoned cultivation are scattered throughout the area. A strip extending for two or three miles north of Bassano and Crowfoot is still being cultivated. This in general is a more uniform phase: more uniform in texture and more level in topography. The major portion of the area should remain as pasture land.

TABLE XI.—Soil areas of brown soil zone

Series	Location	Topography	Acres	Class	Remarks
Sand					
1.6.0.	22-16, 20 & 21-17	G.R.	3,500	Pr.-F.P.	2 areas. Duned. Rosebush and sand grass growth. Fine to medium sand.
Sandy Loam					
1.4.0 G.V.	17-16, 21-18	U.-G.R.	2,500	F.P.	2 areas. Commercial gravel pit in 21-18 area.
1.5.0.	22-17	L.	500	F.P.	Shore line of dry lake.
1.5.2.	20-17 to 20-18	U.-R.	14,000	F.P.	2 areas. Contains glacial knolls; partly irrigated; medium to coarse sand.
1.6.2.	21-16 & 17 to 23-17	U. & R.	30,000	F.P.	2 areas. Deep sandy deposition. Occasional alkaline and occasional solonized spots.
1.6.2.	17 & 18-16 & 17	L.-U.	2,200	F.P.	4 areas. Portions irrigated. Abandoned portions drifted. Few stones.
1.6.5.	20-16	L.	500	Pr.-F.P.	A drain collecting seepage water.
Fine Sandy Loam					
1.4.2.	23-18	G.R.	600	F.P.	A gravelly slope to drain.
1.5/2.2.	21 & 22-17 & 18	G.R.-R.	11,000	F.P.	Variable area; stony knolls. Patches cultivated.
1.5.2.	17 to 24-16, 21-17	U.-R.	20,000	F.P.	3 areas. Patches irrigated; alkali seepage spots. Occasional gravel streaks.
1.5.2.	21-19	U.-G.R.	3,500	F.P.	2 areas. Cultivated patches badly drifted. Variable texture.
1.6.2.	20 & 21-16 & 17	U.	8,500	F.P.	3 areas. Portions irrigated. Fairly uniform; stone free.
1.6.2.	21-18	U.	1,500	Pr.-F.A.	Contains some alkali spots.
1.6.2/6.	18 to 20-16	L.-U.	27,000	F.P.	Portions irrigated. Contains marshes and solonized patches.
1.6.5.	22-16	L.-U.	2,200	Pr.-F.P.	Alkali and solonized soil; salt grass growth.
1.6.6.	21 & 22-16 & 17	L.-U.	2,500	F.P.	2 areas. About 25% solonized; stone free; portions irrigated.
Light Loam					
1.0.6. St.	20-16	U.	1,000	Pr.-F.P.	Shale exposed to surface; 50% surface eroded off.
1.1.2/6.	20-16	R.	600	F.P.	Subsoil heavy and salty; gravel stones.
1.1.6.	18-16 to 20-17	L.-G.R.	25,000	F.P.	Some irrigation in south end. Deep eroded pits.
1.4.2.	21-20	L.-U.	500	F.P.	River flood plain; very gravelly.
	28-18 to 21-19	U.-R.	12,000	F.P.	Few stones, gravel streaks and outwashed ridges.
	23-18 to 24-17	G.R.-H.	3,500	F.P.	Very stony. Variable, sandy loam to loam.
1.5/2.2	22 & 23-16 & 17	G.R.-R.	5,500	F.G.P.	2 areas. Sand and gravel streaks. Some abandonment.
1.5/2.2. St.	22-17 & 18	G.R.-H.	5,000	F.P.	Outwashed edge of drain. Brown to dark brown.
1.5.2.	17-20 & 21	U.-G.R.	500	Pr.A.	Shore line slope; sandy.
	20-18	U.-G.R.	2,000	Pr.A.	Nearly all abandoned. Badly drifted; stone free.
1.5.2/6.	17, 18 & 20-17 & 18	U.-R.	20,000	F.G.P.	4 areas. Some abandoned cultivation. Few stones; patches drifted.
1.5.2/6.	23 & 24-16	L.-U.	7,000	F.-G.P.	5 areas. Stone free. Portions irrigated.
1.5.6.	20-17	U.	1,500	F.P.	Generally 5″ of A over hard subsurface. Portions irrigated.
1.6.6.	19 to 21-16	U.-R.	15,000	F.P.	4 areas. 30% surface eroded off. Much fine sand; very few stones.

TABLE XI.—Soil areas of brown soil zone—Continued

Series	Location	Topography	Acres	Class	Remarks
Loam					
1.0.6.	18-18	G.R.	400	Pr.P.	Very stony; surface washed.
1.1.2/6.	17 & 18-17	U.-R.	3,500	F.P.	Upland area with patches of solonized soils.
	19-18	U.-G.R.	1,000	Pr.-F.A.	Gradual slope to river bank. Portions cultivated.
1.1.6.	18-16 to 19-17	U.-G.R.	40,000	F.P.	Area of long gentle sweeps; 25% surface eroded off; contains marshes with irrigation water.
1.1.6.	19-18 to 20-19	U.	5,000	Pr.-F.P.	2 areas. River benches and washed slopes. 20-18 area upland; some abandonment.
1.2/0.2/6.	20-18	G.R.-R.	2,000	F.P.	Considerable stones; some abandoned cultivation.
1.2.2.	22 & 23-17, 21-18	G.R.-H.	5,500	F. & G.P.	2 areas. Stony; steep slopes.
	19-18 to 17-19	G.R.-H.	38,000	F.P. to F.A.	Some stones. Hills good pasture; profile generally shallow.
1.2.2/6.	17-18	G.R.-R.	4,000	Pr.-F.A.	Contains a very stony ridge. Patches cultivated.
1.4.0.	19-18	U.	300	Pr.-F.P.	Gravelly and stony; lower river bench.
1.4.2.	17 & 18-17 & 18	L.-U.	2,000	F.-G.P.	3 areas. Variable gravelly benches.
1.4.2.	19-18, 24-17	U.	1,600	F.P.	Somewhat stony slope.
1.4.2. St.	17-20	R.	800	F.P.	Very stony outwashed ridge.
1.5/2.2.	24-16 to 22-18	G.R.-H.	63,000	F.P. & F.A.	Some stones. Contains outwash knolls and sandy pockets.
1.5/2.2/6.	17 & 18-18	U.-G.R.	14,000	F.P.	Some stones; lower portions contain solonized soil.
1.5.2.	17-16, 20-17	U.	3,000	F.P. & F.A.	Slopes to drain; first area partly irrigated.
1.5.2.	19 & 21-18 & 19	U.-G.R.	9,000	F.A.	2 areas. Partly cultivated; variable areas.
1.5.2/6.	23-17	G.R.-R.	4,500	F.-G.P.	2 areas. Heavy subsoil; few stones.
1.5.2/6.	19 & 20-18 & 19	U.-G.R.	10,000	Pr.-F.A.	3 areas. Few stones; deep eroded pits; some abandonment.
1.5.2/6.	24-16, 19-17	U.-G.R.	5,500	Pr.-F.A.	2 areas. Some stones; eroded pits; generally grassed over.
1.5.2/6. St.	17-17	G.R.-R.	1,600	F.P.	A draw and its banks.
1.5.6.	19 & 20, 17 & 18	U.-G.R.	17,500	F.-G.P.	3 areas. Some abandonment. Some stones; areas variable.
1.5.6.	17-16 & 17	U.	8,500	F.P.	Slope to river. Deep eroded pits; portion irrigated.
1.6.2.	23-16	L.-U.	3,000	Pr.-F.A.	Stone free; medium textured subsoil; irrigated.
1.6.5.	23-16	L.	1,000	Pr.-F.P.	Washed surface; quite alkaline.
1.6.6.	21-16	U.	600	F.P.	2 areas. Stone free. 25% surface eroded off; portions irrigated.
Heavy Loam					
1.3.2.	17, 21 & 22-19 & 20	U.-G.R.	9,000	F.A.	2 areas. Shallow profile; few stones; cultivated.
1.3.2/7.	17-20	G.R.-R.	15,000	F.A.	Profile fairly shallow; drifted in spots to lime. Texture banding in profile.
1.3.6.	17-16	U.	5,000	F.-G.P.	Some stones; eroded pits; generally grassed over.
1.5/2.2.	24-17 to 23-19	G.R.-H.	18,000	F.P. & Pr.-F.A.	Variable area; gravelly streaks; many low steep hills.
1.5.2.	21 & 22-19 & 20	U.-G.R.	6,000	F.A.	2 areas. Variable texture. Part in river flat. Some cultivation.
1.5.2/6.	17-18	U.	6,500	Pr.-F.A.	A large basin. About half abandoned.
1.5.6.	21-17	L.	2,200	F.P.	Variable texture; somewhat alkaline. Portion irrigated.

Silt Loam					
1.3.6. Lt.	17-16	U.	1,800	F.-F.G.P.	Some stones. Portion irrigated, remainder fair grass.
1.5.0.	18 & 19-18	L. & U.	600	Pr.-F.A.	2 areas. Stone free; river flats.
1.5.2.	17-17	L.-U.	1,000	Pr.-F.A.	River benches; portions irrigated. Contains much very fine sand.
1.6.2.	20-16, 21-18	L.-U.	1,000	F.A.	2 areas. Portions irrigated. Heavy subsoil; marshy spots in 20-16.
1.6.2/6.	20-16, 23-16	L.-U.	2,000	Pr.-F.A.	3 areas. Stone free; some low spots; 23-16 area irrigated.
1.6.6. Lt.	21-16	L.	1,500	F.P.	Stone free. Irrigated.
1.6.6. Lt.	17 & 20-16	L.-U.	5,500	Pr.-F.A.	Portions irrigated; 15% eroded pits. Good depth of surface soil.
Silty Clay Loam					
1.6.2.	17-17	L.	300	Pr.-F.A.	Surface has a light colored, washed appearance.
1.6.2/6.	22 & 23-16 & 17	L.-U.	12,500	Pr.-F.A.	Irrigated, seeped spots. Area long slope, heavy soil.
1.6.5.	22 & 23-16 & 17	L.	2,500	Pr.P.	3 areas. Low marshy areas collect seepage water.
1.6.6.	20 & 21-16	L.-U.	7,500	F.P.	Irrigated; 35% eroded pits; some alkali spots.
1.6.6.	21-16 to 22-17	L.-U.	18,500	F.P.	[illegible]% eroded pits; washed surface. Sage and salt grass growth.
Clay Loam					
1.0.6. St.	19 & 20-18	U.	1,500	Pr.-F.P.	Stony washed slope.
1.1.2/5.	18 & 19-18	U.	1,800	Pr.-F.P.	3 areas. Washed slopes to draw. Variable texture.
1.1.5.	17 & 18-16	U.	1,000	F.P.	Bottom of drain; alkali seepage.
1.1.6.	19-18	G.R.	800	Pr.-F.P.	Washed slope to river.
1.5/2.2.	23-18 & 19	G.R.-R.	5,500	Pr.-F.A.	Few stones; contains gravel streaks. Some abandonment.
1.5.5.	20 & 21-16	U.	1,000	Pr.-F.P.	A drain; very alkaline.
1.5.2/6.	17-17 to 18-18	L.	1,600	Pr.-F.A.	River benches. Deposition over residual shale. Portions cultivated.
1.5.6.	17-17	U.-R.	1,000	F.-F.G.P.	2 areas. Low solonized areas.
1.6.2.	24-16	L.	200	F.A.	A basin area.
1.6.6.	24-16, 23-17	L.	1,600	F.P.	2 areas. Fairly shallow surface. 23-17 a draw.
Clay					
1.1.2/5.	19-18	L.	400	Pr.P. to F.A.	Partly cultivated. Stone free. River benches.
1.1.5. Lt.	19-18, 18-17	L.-U.	1,000	Pr.-F.P.	2 areas. Badly washed surface.
1.7.5.	22 & 23-17	L.	800	Pr.-F.P.	2 areas. Dry lake bed; fairly alkaline.

For a description of solonization and of eroded pits see division 6, page 37.

For topography and class abbreviations see page 39.

DARK BROWN SOIL ZONE

The dark brown soil zone forms a transition belt between the brown soil zone of southeastern Alberta and the black, more humid zone to the north and west. In the Blackfoot sheet the average nitrogen content of the dark brown soils is about midway between the average content of the brown and shallow black soils; that is, between 0.18 and 0.20 percent in the surface foot. In general the lime carbonate horizon is found at from 6 to 24 inches from the surface and averages about 16 inches in this sheet. The annual precipitation averages about 14 inches. This is a lower annual rainfall than occurs in the dark brown soil zone farther south in the Lethbridge sheet. However, the mean annual temperature is slightly lower and the evaporation not quite as high in this sheet as in the Lethbridge sheet. The arable areas of dark brown soil are generally good wheat lands.

Below is given a description of the major soil groups of this zone. Table XII gives the main characteristics of each individual soil area.

Wintering Hills Moraine.

Lying between Hussar and the Crawling Valley alluvial-glacial loams and extending south towards Crowfoot is the southern portion of the Wintering hills moraine. In general this is a gently rolling to hilly area of light loam to clay loam. The area is dotted with kettle holes, most of which are dry at present. The largest of these, Deadhorse lake, is on the western edge of the area. East of Hussar the hills are high and generally dome shaped. In township 24, range 19, these hills reach an elevation of over 3,150 feet. Towards the south the elevation drops and the topography is more of the gently rolling type.

Portions of the area show evidence of post-glacial water sorting. Towards the southwest, particularly in township 23, range 20, outwash sand and gravel streaks are quite numerous. Much of the area is quite stony. The profile varies throughout the area. However, in general, the B_1 horizon is of a wide prismatic structure and the parent material is not high in lime. The soil is quite dark colored. Due at least in part to the elevation, the change from brown to dark brown is quite rapid. Much of the area is good pasture land. Blue joint, blue grama, and stipa are the principal grasses. Wells are used as a source of stock water. See Plate 3, fig. 1. There is considerable abandoned cultivation, particularly on the areas of rougher topography. The abandoned fields are covered with weed and sage growth and therefore are of little value, at present, as pasture. Some of the more level benches are still cultivated and are fairly good arable land. These arable patches are mainly medium heavy textured and relatively stone free.

Lying within this general area is a heavy textured lacustrine deposition area near Makepeace, mapped as silty clay loam. This is a basin area having a uniform stone free profile. It is cultivated and is fairly good arable land.

Loams of the Lake McGregor Moraine.

Lying west of Bow river between township 19, range 19, and Lake McGregor is a glacial morainal area mapped mainly as 2.2.2. loam. The area is of gently rolling to hilly topography and reaches an elevation of 3,400 feet in township 18, range 21. In general it is typical kettle hole topography. Stones are fairly numerous throughout the area; there are some quite large boulders.

As in the Wintering hills area described above, the change from brown to dark brown is very rapid. In the northwest corner of township 19, range 19, areas with two or three inches of black surface soil are found. The more gently rolling edge east of Armada is in the brown soil zone.

In the northeast corner of the moraine is an area of 2/0. clay loam. In this area stones are relatively few and the influence of the residual shale appears in the profile.

In general the profile is quite variable in depth, depending mainly on its position and the percentage slope of the land. The subsoil has a medium content of lime and the profile is stony throughout. The area is generally good pasture land, although there is considerable distance between water supplies. One spring was found in the east portion of the area. There are, however, some draws suitable for dam-sites. Most of the rolling to hilly portion should remain as pasture land.

Lying towards the southern edge of the moraine and centering in township 17, range 20, is a gently rolling to rolling area that is about one-half cultivated. The parent material here is quite high in lime carbonate content. In places where soil drifting has occurred this limy subsoil is present surface soil. In many places throughout the area the profile shows a banded appearance suggesting a sorting of or a deposition over the moraine. It is only fair arable land.

Sorted Loams of the Majorville Area.

Lying as a large basin at the western edge of the Lake McGregor moraine is an area of sorted glacial loam. The surface is a silty loam containing considerable very fine sand. There are very few stones. It is thought that both post-glacial wind and water were responsible for its sorted surface material. The topography is gently rolling, composed of long gentle sweeps.

The following profile taken in section 21, township 19, range 20, is fairly typical of the area:

0″- 8″ A—Dark brown. Friable prismatic, stone free.

8″-20″ B_1—Friable. Fairly wide columnar; some evidence of deposition stains. Contains a few pebbles.

24″-30″ B_{ca}—Compact but friable. Noticeable lime carbonate accumulation. Some stones and pebbles in this horizon.

Note: Since severe drifting has taken place, what is reported here as A horizon may be partly upper B_1.

The area has drifted very severely. Towards the west side the lime subsoil is exposed in many parts. The entire area is cultivated and should have been, prior to drifting, fairly good to good arable land. It is estimated that, on the average, at least four to five inches of the more valuable surface soil has been lost.

Silt Loams and Clays of the Queenstown Area.

Starting in the basin immediately adjacent to Lake McGregor and fanning out northward towards Bow river is a relatively level area of sedimentary deposition soil. Immediately adjacent to the lake the soil is a silty clay loam to light clay in texture. The larger area to the north is a silt loam. The soils are classed as deposition 6 and 7.

The heavy textured soils adjacent to Lake McGregor are stone free, have a friable cloddy profile, and are relatively high in lime carbonate. The high lime subsoil is found at 4 inches to 8 inches from the surface. It is all cultivated and is good arable land.

The large 2.7.2. silt loam is, in general, of a light to medium phase silt loam containing considerable very fine sand. It is stone free. A fairly heavy lime horizon is found at about 14 inches. The subsoil is not heavy textured. The area has drifted rather severely and in many fields white patches are found indicating an exposed limy subsoil. The area is all cultivated and at present is fairly good arable land. Just north of the lake there are some low marshy flats that are somewhat alkaline.

Occurring at the same general elevation as this large silt loam basin, and possibly belonging to the same laking period, is a clay area between Cluny and Bow river. The clay deposition in this area carries over the top of the knolls. A fairly heavy lime subsoil is found at about 8 inches. The surface texture is heavier than is found in the areas south of the river. Portions are marshy and somewhat alkaline. It is fairly good arable land.

Silt Loams of the Ouelletteville Area.

Lying principally in townships 22 and 23, ranges 21 and 22, is an area of medium textured soil, mainly 2.6.2. silt loam. Some lower portions of the area are somewhat heavier textured and have been mapped as silty clay loam. This area is bordered on the north by a clay laking basin and on the west by an area of low glacial moraine that has had a thin deposition of loamy material.

The area is mainly undulating with the occasional gently rolling ridge. However, there is a predominance of long, uniform, very gentle slopes, making for a well drained profile and little waste land. The area is particularly stone free.

The following profile taken in section 3, township 23, range 22, is fairly typical of the main silt loam area:

0″- 6″ A—Dark brown, with 1″ to 2″ of black top; prismatic, fairly friable.
6″- 14″ Upper B_1—Brown to red brown. Columnar; breaks up into friable granules.
14″-20″ Lower B_1—Brown to light brown. Wider columns than horizon above and less granular.
20″-30″ B_{ca}—Lime concentration horizon. Cloddy with some evidence of vertical cleavage.

Note: This profile is stone free and is quite uniform in texture throughout.

The entire area is cultivated and part of it is irrigated. It is good arable land.

Some of the silty clay loam areas are slightly saline and have a gray-brown profile in contrast to the red-brown of the upland silt loam. However, most of the area is cultivated and there is little waste land.

Clays of the Chancellor Area.

Lying in a basin along the headwaters of Crowfoot Creek is a large area of lacustrine, stone free clay. Although, as suggested in the Ouelletteville area described above, deposition has taken place over an area extending from Strathmore to Cluny, the Chancellor basin has received most of the fine textured material. The clay deposition varies from a foot or two in depth on the knolls to several feet in the valleys. The area is undulating to gently rolling, having many long gentle slopes to the wide drainage ways. The deep deposition in the valleys is a heavy clay. Towards the edges of the area the texture becomes somewhat silty and consequently lighter.

The following profile taken in section 33, township 23, range 20, is typical of the lower basin—2.7.2. clay:

0″- 7″ Grayish dark brown; large hard clods.
7″-14″ Compact and waxy.
14″-28″ Compact. Lime and some salts visible.

Towards the edge of the area on higher land much is mapped as 2.7/2.2/6. The 7/2. indicates that the lacustrine deposition over the glacial till is relatively shallow. The lighter textured, somewhat stony till can often be found at two or three feet. The 2/6. indicates a patchy solonization. Along some of the hill slopes or at the edges of slight depressions the following profile can be found:

0″-3″ Grayish dark brown. Silty clay loam.
3″-4″ Ashy gray leached A_2 horizon.
4″- A hard, waxy, heavy clay B_1 horizon showing a tendency towards columnar structure.

Practically the entire area is cultivated and is fairly good arable land. There has been very little soil drifting. The fairly high calcium content to the surface should help to maintain a granular structure making for good tilth and aiding in resistance to soil drifting. See Plate 3, fig. 3.

Loams of the Gleichen Area.

Lying between the medium to heavy textured areas of Ouelletteville and Chancellor on the east and the Strathmore sandy area on the west is a fairly large area of loam textured soil. Going from west to east across this area there is a gradual increase in weight, accompanied by a decrease in the particle size of the sand fraction. This area is mapped principally as 2.6.2 loam and heavy loam. The medium textured deposition over the glacial drift carries over the hills and varies considerably in depth. In places the underlying till is found within the profile depth. The residual Edmonton sands and sandy shales come to the surface in spots and possibly at no place is the mantle over this residual rock very deep. There is a general slope from west to east and the topography is mapped mainly as gently rolling. The topography can be described as fairly high knolls and ridges with long, smooth, gentle slopes. The occasional gravel lense, as well as a few glacial stones and sandstone slabs, is found scattered throughout the profile. In general, however, the profile is quite uniform throughout the area.

The following typical profile was taken in section 7, township 24, range 22:

0″- 3″ A—Dark brown to black (top 1½″ black). Elongated clods.
3″-15″ B_1—Dark brown to reddish brown (brown when crushed). Prismatic to columnar, slightly stained; breaks into small cubes.
At 20″ B_{ca}—Friable lime carbonate horizon; massive to blocky with a suggestion of vertical cleavage lines.

Note: the thin black layer on top varies from 1″ to 3″ in depth. In many places the B_1 horizon is less columnar than in the above profile and is more of a reddish brown. In general the subsoil is not heavy. The parent material is fairly high in lime carbonate.

The area is practically all cultivated, some irrigated, and is fairly good to good arable land. See Plate 4, fig. 2.

Scattered throughout the area along the draws and in the basins are soils that are slightly saline and soils that are solonized. These are outlined on the map mainly as profile 2/6. and 2/4. The solonized areas, having in places a fairly hard round topped B_1 horizon, are found mainly near the residual outcrops. The saline basins have in most cases received seepage from nearby irrigated lands. Some waste land is found in these lower areas.

Loams of the Arrowwood Area.

On the north slope from Buffalo Hill moraine between the Queenstown silt loam basin and Carseland lies an area of practically stone free deposition loam, mapped mainly as 2.6.2. The topography is level to gently rolling, with a general slope to the north and east; in the south portion of the area the slope becomes quite pronounced.

Although the area is quite uniform throughout, the following changes from west to east can be noted: the depth of deposition increases, the sand particle size decreases, and the lime subsoil is somewhat nearer the surface. The texture at the eastern end. is characterized by a high content of very fine sand.

The following profile taken in section 8, township 20, range 22, is fairly typical:

0″- 4″	A—Very dark brown. Prismatic; firm, breaking into a fine grain structure.
4″-10″	B_1—Brown to dark brown. Columnar, breaking into small irregular clods; slightly stained. The break between A and B is quite distinct.
10″-16″	Lower B_1—Brown. Tapered columns.
16″-24″	B_{ca}—Friable, marl-like horizon; suggestion of vertical cleavage lines.

Note: There is very little increase in weight throughout the profile depth.

In most of the area the subsoil contains a very high content of lime carbonate. In the above profile the B_{ca} horizon contains about 25 percent calcium carbonate. In a few fields where there has been soil drifting white patches of exposed subsoil can be seen. (See Plate 6, figs. 2 and 3.)

Due primarily to the uniform even slope, the area is well drained and there is practically no waste land. It is all cultivated and is fairly good arable land. Any appreciable amount of soil drifting would seriously damage this soil.

The 6/2. deposition area at the western end is a transition area between the deeper deposition in the flat and the glacial soils to the west. In it the glacial till is generally within profile depth.

The Strathmore Sandy Area.

Lying along the western side of the Gleichen-Chancellor deposition area is a grouping of light textured soils. These are quite probably the shoreline sands of the laking area. There are, however, no gravel deposits in the area and practically no gravel lenses in the profiles. The area extends from south of Gleichen, west and north to Strathmore, and thence for a considerable distance north of the Blackfoot sheet in the direction of Irricana. The strip is approximately six miles in width. The area is undulating to gently rolling, composed mainly of undulating crowns and long slopes to the drainage basins. Three large laking basins, namely, Eagle, Namaka and Stobart lakes, lie within this sandy strip. These basins at present all contain water—water coming largely from irrigation spill. The soil varies from sand to light loam in texture, being mainly sandy loam to fine sandy loam. There is considerable variation in weight within any of the soil areas as well as a variation in the depth of sandy deposition. On some of the slopes stony glacial till can be found at one or two feet.

No single profile description can be given that would be entirely representative; however the following profile taken in section 7, township 24, range 24, is fairly representative of the deeper sandy loam to fine sandy loam areas:

0″- 6″	Very dark brown. Massive, easily crushed.
6″-16″	Brown to dark brown. Massive to elongated cloddy.
16″-28″	Brown to dark brown. Large clods; some evidence of vertical cleavage lines showing deposition stains.
35″-40″	Brown to light brown. Fairly loose sand.

Note: There was no lime concentration at 40 inches.

In that portion of the area north of Stobart lake there is a large number of shallow depressions. Most of these collect some irrigation seepage waters and are quite alkaline. These areas vary from slightly saline to virtually alkaline wastes. None are arable; some are fairly good pasture.

At the eastern end there are two fairly large sand dune areas—one southeast of Gleichen and the other south of Bow river in township 21, ranges 23 and 24. In these areas are open sand dunes, partially held by a bunchy growth of tall sand grass and creeping ground cedar. Some of the sandy loam and fine sandy loam south of Gleichen is extremely high in lime, this lime horizon coming practically to the surface. These high lime sands are possibly more intimately associated with the Bow drainage than with the general Strathmore sandy area. South and east from Stobart lake there is no irrigation in the sandy soils. Consequently the heavier textured depressions are all fairly good pasture lands.

In general these sandy soils are poor arable lands under dry land farming: some severe drifting has taken place where they are so farmed. Under irrigation they may be fairly productive, but it is practically impossible to prevent lateral seepage and hence the collection of alkali in the lower areas.

Loams of the Vulcan Area.

Lying in a quadrangle extending roughly from Reid Hill to Little Bow drainage in township 17, range 26, and from Hearnleigh to Herronton is an area of loam soil mapped principally as 2.3.2. The area is mainly undulating, composed of long, low slopes. There are a few stones throughout the area although they are not a handicap to cultivation.

At various places throughout the area bedrock sandstone comes very close to the surface—so close that it is within the plow depth. However, these form a very small percentage of the total area. The remainder is typical sorted ground moraine. The till mantle appears to be deeper towards the west.

The following profile, taken in section 34, township 17, range 25, is fairly typical:

0″- 5″ A—Dark brown to black loam. Cloddy.
5″-16″ B_1—Brown to dark brown. Prismatic to columnar; a little deposition staining.
16″-24″ Lower B_1—Brown. Columns wider than in the horizon above.
24″-32″ B_{ca}—Compact; heavy lime deposition; suggestion of lamination.
32″-40″ C—Gray-brown. Structureless; less lime than in the horizon above. Contains a gravel lense.

Note: There is considerable sand throughout the depth of this profile: this is typical of the area. In general the surface foot is stone free. The occasional stone may be found below this depth.

Along some of the drainage ways the soil may be quite alkaline and may also contain some patches that are solonized. These are generally non-arable. In part of the area, particularly the portion between Vulcan and Brant, natural seepage often brings salts to the surface. These salt collections can be noticed on hill slopes and along road cuts. See Plate 8, fig. 1.

In general the profile is of medium depth, is a good dark brown color, and the area as a whole has very little waste land. It is all cultivated and is good arable land. See Plate 5, fig. 1. In the few places where the bedrock is very close to the surface the productive ability of the soil will be lower.

Buffalo Hills Moraine.

The Buffalo Hills moraine extends from Lake McGregor northwest to the West Arrowwood creek. In general it consists of a high crown (elevation over 3,850 feet) in township 19, range 23, and the broken slope that encircles this crown. In general the topography is from gently rolling to hilly, from rough morainal hills to fairly long, uniform slopes. Only a small portion of the area is mapped as unsorted (2.2.2) since much of the area has been subjected to outwash or sorting action. In this grouping, then, are 2.3.2, 2.5/2.2 and 2.4.2 areas.

The 3.2.2 and 2.2.2 hilly areas, located principally in township 19, ranges 22 and 23, are mainly good to very good pasture lands. On the "top" of the hills in township 19, range 23, is a level to undulating crown of good to very good arable land. The soil on this crown has from 3 inches to 6 inches of black top. The B_1 horizon is dark brown to reddish brown, and the lime concenetration or B_{ca} horizon is found at about 30 inches from the surface. It is a shallow black sorted soil of good depth. Portions of the crown are quite gravelly. There is a fairly rapid drop in elevation from this crown east and south. The portion in township 19, range 22, has in places a relatively shallow profile. There has been some soil drifting. Where topography permits, it is cultivated and is fair to fairly good arable land. Southeast from this crown, through township 18, ranges 22 and 23, the soil has had considerable waterworking. This has resulted in a very variable area, varying from quite uniform patches of sorted material to gravelly outwashed ridges and knolls. Sandy streaks and gravel lenses are found in many profiles. This general area, mapped mainly as 5/2 deposition, varies from poor to fairly good arable land. Most of it is cultivated, some is abandoned.

Between the east and west Arrowwood creeks is a second crown. For convenience it has been placed in with the Buffalo hills moraine. A thin glacial mantle covers much of this crown, but the underlying bedrock is quite close to the surface. Sandstone exposures are found along the draws well up to the top of the hill. The rough kettle hole topography found east of the East Arrowwood is absent here. In general the area centering in township 19, range 24, is a single large domeshaped hill. On top of the hill there is an area of fairly deep shallow black soil. On the slopes the profile is shallower. To the north the area gradually merges with the Arrowwood deposition loams and to the south with the Vulcan sorted glacial loams. The west side is particularly shallow and residual sandstone is found often at plow depth. This area ranges from poor to good arable land.

The shallow black soil areas found in this group are on the high elevations. They will be found tabulated in Table XIII, that is, in the shallow black soil areas.

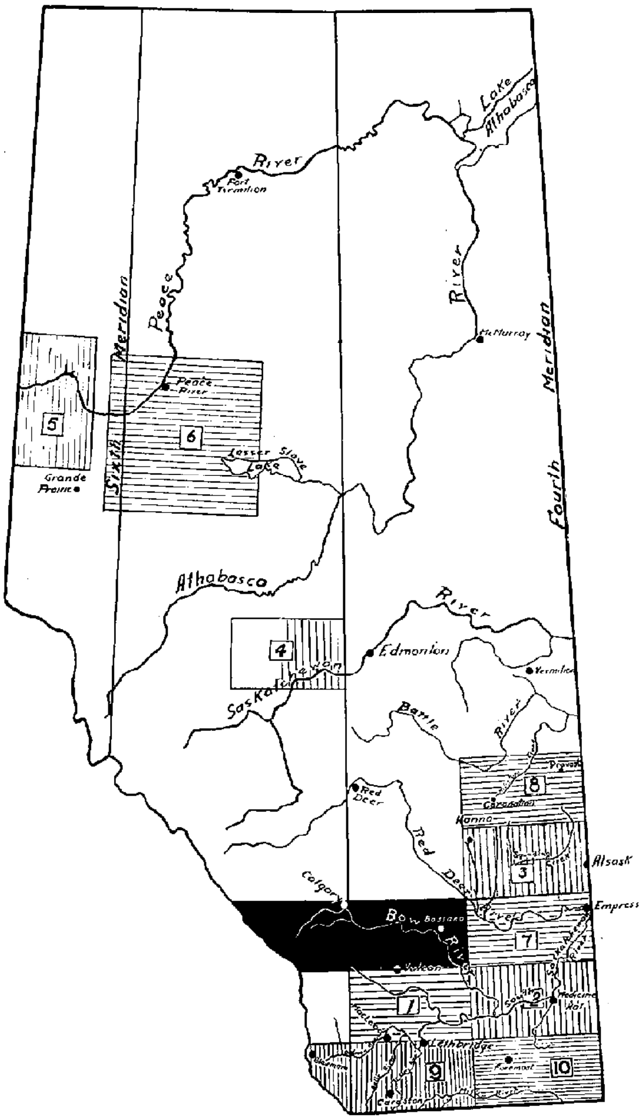
TABLE XII.—Soil areas of dark brown soil zone

Series	Location	Topography	Acres	Class	Remarks
Sand					
2.6.0.	21-22	R.	6,500	F.P.	Some active dunes. Scrub tree growth.
	24-55	U.	800	F.P.	Cultivated portions severly drifted.
	21-23 & 24	R.	2,700	F.P.	Some active dunes; inter-dunes flats somewhat heavier.
Sandy Loam					
2.5.2.	23-19	R.	200	F.P.	Variable area; portions several drifted.
2.6.2.	21-20 to 22	G.R.	2,500	F.P.	2 areas. Deep sandy deposition.
	22-23, 21-24	G.R.	6,500	F.G.P.	2 areas. Medium weight subsoil; some low spots.
	23 & 24-24 & 25	U.-G.R.	15,000	F.P.	5 areas. Variable depth; glacial till close on the draw slopes; some irrigation; portions badly drifted.
2.6.2/4.	23 & 24-25	U.-G.R.	6,500	F.P.	Deep sandy deposition; some marshy spots; portions drifted.
2.6.2/5.	24-25	L.-U.	3,500	F.P.	A basin area; many bad seepage areas.
2.6.2/7.	21-22 & 23	G.R.	10,000	F.-F.G.P.	Deep sandy deposition. Heavy lime at 6 inches.
Fine Sandy Loam					
2.1.2.	20-20 & 21	U.-R.	5,500	F.P.-Pr.A.	2 areas. Stone free. Cut by erosion; subsoil sandy.
2.4.0.	21-21	L.	500	F.P.	River flat; mostly gravel bars.
2.4.2. Gv.	18 & 19-26	G.R.	1,000	F.P.	2 areas. Ridged; some commercial gravel.
2.4.2. St.	19 & 21-25	G.R.-R.	700	F.P.	2 areas. Stony and gravelly outwash ridges.
2.5.0.	21-19 to 21-23	L.-U.	16,000	F.P. & F.A.	River bottom; has had recent floodings.
2.5.2.	17-22 & 23	U.-G.R.	700	F.A.	2 areas. Shoreline deposition. Stone free; some drifting.
	20-19 & 20	U.-R.	4,000	F.-G.P.	3 areas. A few stones. Variable texture; some drifting.
	21-20 & 21	U.-G.R.	2,000	Pr.-F.A.	Few stones; fairly heavy lime at 10 inchees. Some abandonment.
	21-24 & 25	U.-R.	3,000	Pr.-F.A.	2 areas. Variable surface texture; some bad drifting.
	24-24	G.R.	600	F.A.	Slope to draw; stone free.
2.5.2/4.	23-24 to 24-25	U.-G.R.	11,000	F.A.	Slope to draws, drains and lake shore. Variable texture and depth.
2.5.2/5.	24-24	U.-G.R.	1,000	Pr.-F.A.	Low area; alkali seepage.
2.5.5.	17-23, 24-24	L.-U.	2,000	F.P.-F.A.	2 low areas. Marshy and solonized.
2.5.2/6.	23 & 24-25	U.-G.R.	2,000	Pr. & F.A.	2 areas. 23-25 area high land; other area a basin with some seepage.
2.6.2.	21-21 to 23	U.-G.R.	9,000	Pr.-F.A.	3 areas. Stone free. Fairly high lime subsoil at 10 inches.
	22-24 & 25	U.-G.R.	3,500	F.A.	2 areas. Some drifting; surface light, 22-25 has fairly heavy subsoil.
2.6.2/4.	23-24	L.-U.	1,500	F.A.	Flat low area but no alkali visible; cultivated.
2.6.2/7.	22-22 & 23	U.-G.R.	2,500	Pr.-F.A.	Variable. Transition area.

TABLE XII.—Soil areas of dark brown soil zone—Continued

Series	Location	Topography	Acres	Class	Remarks
Light Loam					
2.1.2.	20-20, 21-21	G.R. & R.	3,500	F.P. to F.A.	2 areas. Near erosion. Occasional solonized spot.
2.4.2.	21 & 22-25	L.-U.	2,000	F.-F.G.P.	2 areas. Has a gravelly subsoil. A little cultivation.
2.4.2. Gv.	17-26	G.R.	600	F.-F.G.P.	Gravelly and stony ridges.
2.5/2.2.	21-25 & 18-23	G.R. & R.	5,500	F.A.	2 areas. Areas contain outwash ridges and sandy pockets; some drifting.
2.5.0.	21-23 to 21-25	L.	4,500	F.-F.G.A.	3 areas. River bottom very fine sand; flood plain.
2.5.2.	20-20	U.	600	Pr.-F.A.	A creek flat; fairly badly drifted.
	22-24	L.	1,200	F.G.A.	2 areas. River benches, deep profile. Stone freee.
	17-23, 24 & 26	U. & G.R.	8,000	F.A.	2 areas. Slopes to basins. Some stony knolls.
2.5.2.	24-23 & 24	G.R.-R.	1,200	F.A.	Ridges somewhat stony.
2.5.5.	22 & 23-25	L.-U.	2,000	P.-Pr.A.	A salty flat. Cultivated patches.
2.5.2/6.	23-25	U.-G.R.	800	F.G.A.	Transition area between complete solonized and normal area to the east.
2.5.6.	23-25 to 24-24, 17-23	L.-U.	5,500	P. & Pr.-F.A.	Low areas containing alkali and solonized soil.*
2.6/2.2.	23 & 24-25	U.-G.R.	16,000	F.G.A.	2 areas. Deep light textured surface; some low marshy spots.
2.6.2.	20 & 21-23	L.-U.	3,500	F.-F.G.A.	Stone free. High lime subsoil at 8 inches; some drifting.
	18-26, 20-24, 21 to 23-23 & 24	U.-R.	17,500	F.-F.G.A.	4 areas. Slope to drains and basins; fairly deep stone free profile; some drifting.
2.6.2/7.	20-21	G.R.	800	Pr.A.	A badly drifted area; contains coarse sand.
Loam					
2.1.1.	22 & 23-23	R.-H.	800	F.A.	Eroded knolls and slopes from these.
	19 & 20-24 & 25	G.R.-R.	4,500	P. & F.A.	A long slope to a wide draw. Sandstone often at plow depth.
2.1.2.	20-20, 21-21	G.R.-R.	2,000	P.-F.A.	2 areas. Fairly shallow profile; few stones.
	19 & 20-24	G.R.	4,500	F.-F.G.A.	High crown. Bed rock rarely within 2 ft. of surface.
2.1.2/6.	20-19	G.R.-R.	4,000	P.-F.A.	Some stones; some abandonment.
	18-25	U.	3,000	F.A.	Edge of an alkaline basin. Water table close.
2.1.6.	19-25 & 26	U.-G.R.	2,000	P.-F.A.	4 areas. Few stones. Mostly cultivated. Hard subsurface horizon.
	20-19	U.-G.R.	3,000	F.P.	A washed slope to the river.
2.2.1.	24-23	R.-H.	1,000	F.A.	A high glaciated knoll.
2.2.2. St.	17-21	H.	1,500	F.G.P.	West edge of lake.
2.2.2.	17-21 to 19-19	R.-H.	85,000	G.P. & F.A.	2 areas. Large moraine; stones variable; good grass.
	21-20	R.	300	F.-F.G.P.	Stony. Edge of draw.
	17 & 20-20, 22-25	U.-R.	1,000	P.-F.A.	3 areas. Stony; soil drifting on 17-20.
	17 & 18 & 24-23	G.R.-R.	3,500	F.-F.G.A.	Crown and slopes somewhat stony.
2.3.2.	17 to 23-17 to 27	U.-G.R.	150,000	F.G.A.	3 areas. Few stones. Fairly heavy lime at 20 inches; some residual ridges; long gentle sweeps.
	21-25 to 22-25	U.	10,000	F.G.A.	Eastern edge of large 3.3.2 area. Fairly deep profile.
	24-25	U.	1,000	F.G.-G.A.	Uniform area with deep profile.
	19-26	U.	500	F.G.-G.A.	A lower area somewhat silty.

PLATE 1



Sketch map of Alberta showing locations of surveyed areas for which reports have been published: (1) Macleod sheet; (2) Medicine Hat sheet; (3) Sounding Creek sheet; (4) St. Ann sheet; (5) Dunvegan area; (6) Peace River-High Prairie-Sturgeon Lake area; (7) Rainy Hills sheet; (8) Sullivan Lake sheet; (9) Lethbridge and Pincher Creek sheets; (10) Milk River sheet; (In black) Blackfoot and Calgary sheets.

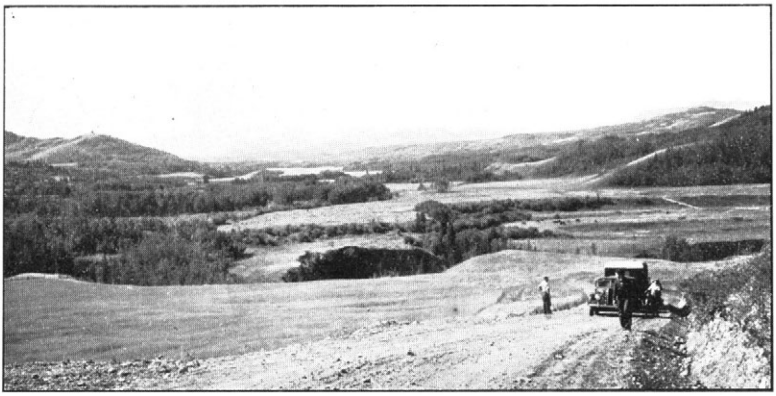


Fig. 1—Looking southwest up Highwood river valley. Arable lands in a range area are a valuable asset.

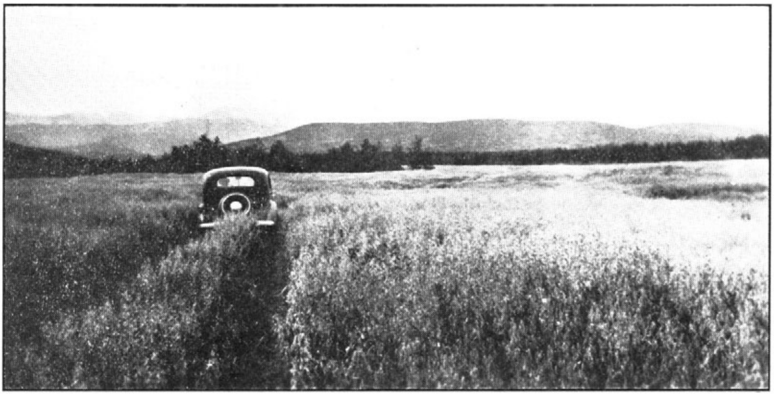


Fig. 2—In the foothills north and west of Turner Valley there are many wide valleys. Due, in part, to a frost hazard these are used to grow coarse grains and hay crops.

Fig. 3—At the eastern edge of the foothills many wide valleys cut through an otherwise fairly level plain. This is typical of the country west of High River.

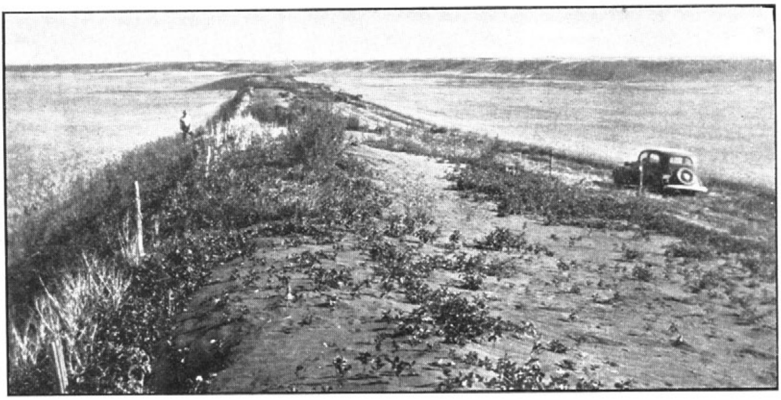


Fig. 1—There is a considerable acreage of alluvial soils associated with the drainage ways in the west half of the area. Those of light texture will drift readily. This is a drift from a fine sandy loam field on the Little Bow drainage.

Fig. 2—Lying between Calgary and Carseland is a large area of shallow black loam on undulating topography. In general it is good soil and is devoted mainly to the production of wheat.

Fig. 3—South of Chancellor is a fairly large clay laking basin. It is good soil, but precautions should be taken to prevent wind and water erosion in soil of this texture.

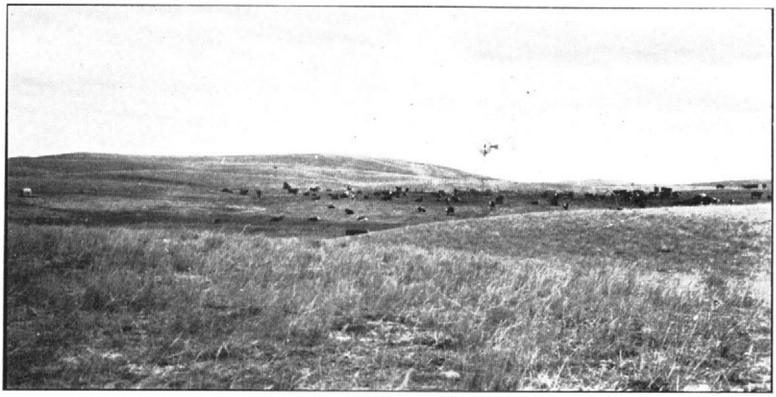


Fig. 1—Pasture land east of Hussar. The construction ot stock water dams to supplement the well water would tend to spread the stock out and reduce over-grazing around the water supply.

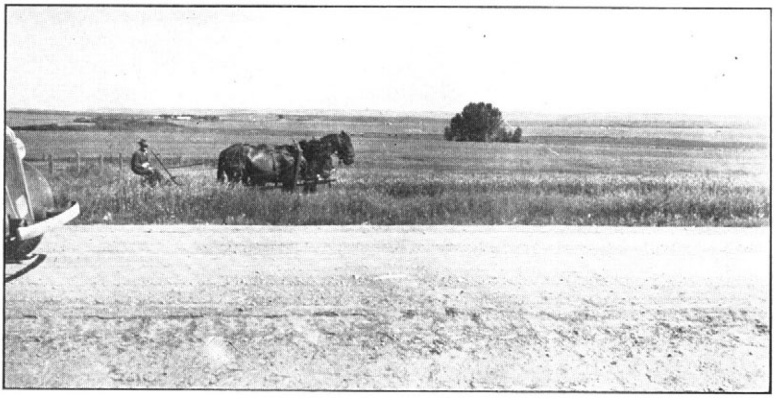
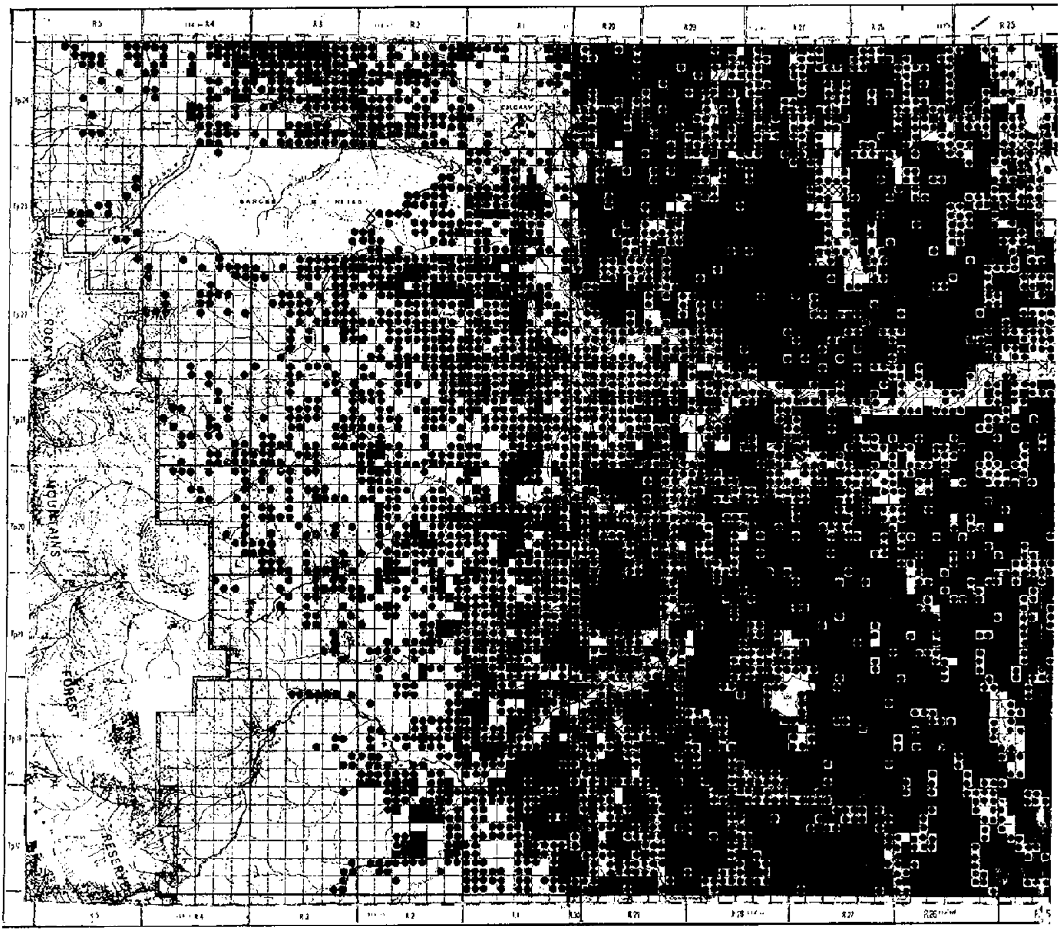


Fig. 2—The gently rolling area north of Gleichen has, in general, had a thin deposition of loam soil over the glacial till. Portions are irrigated. Keeping the headlands clear of weeds is profitable.

Fig. 3—Irrigation on the level laking soil around Gem. Water on the semi-arid soils has wrought a great transformation. On these areas cereal grains must give way to more specialized crops.

PLATE

Present Cultivated, Abandoned and Virgir

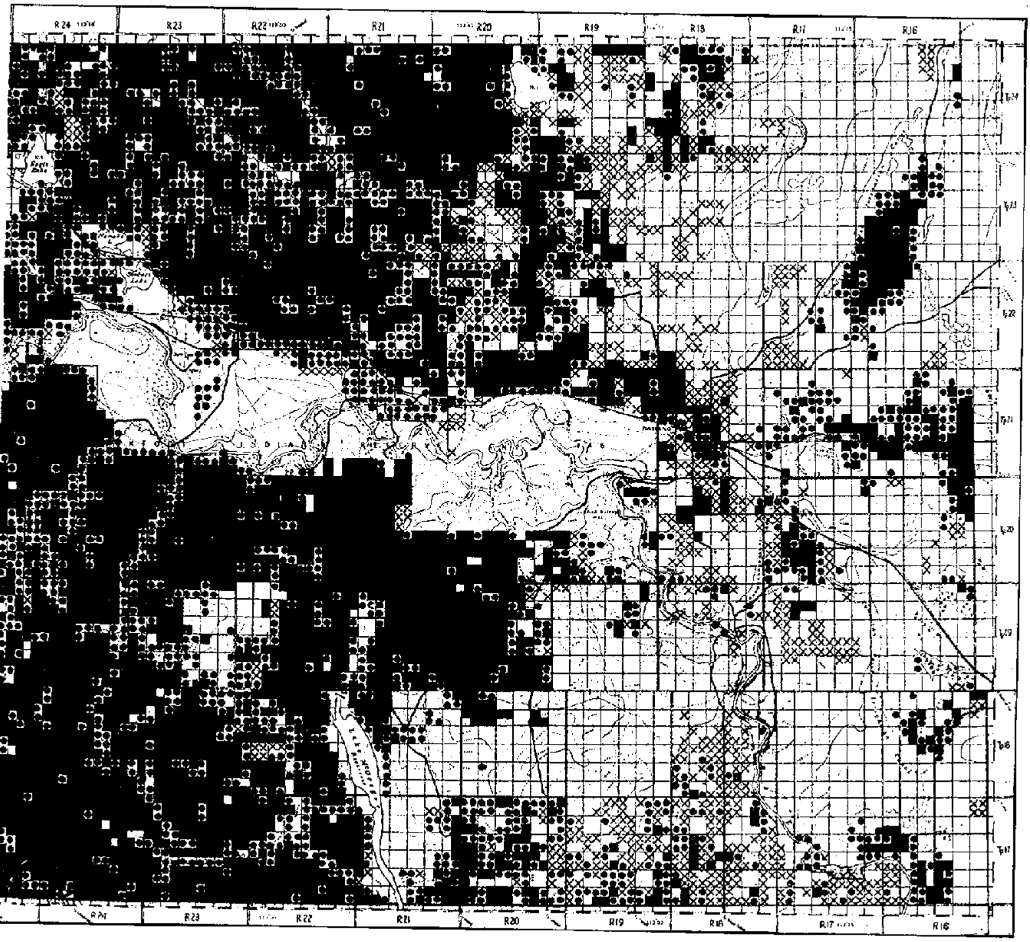


LEGI

Completely Cultivated (140-160 acres) ....

Partially Cultivated (10-140 acres) ....

ı Lands of Blackfoot and Calgary Sheets



ND

Abandoned Cultivation (10-160 acres)........................ ☒
Virgin Lands (Idle and Pasture)...................................... ☐

Fig. 1—Sorted glacial, dark brown loams of the Vulcan area. Note the alternate grain and fallow strips. Where possible land of this topography should be cultivated across the slope to conserve the run-off water and to prevent water erosion loss.

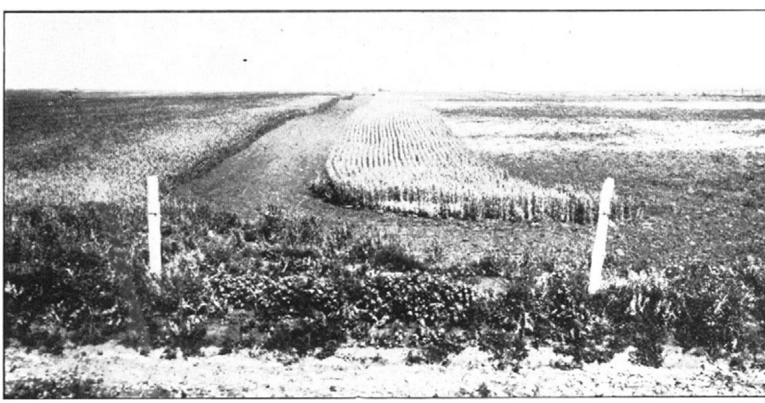


Fig. 2—The level deposition loams of the Arrowwood area. Note the high lime subsoil exposed on the fallow due to soil drifting. The double or trap strip is for the control of sawfly.

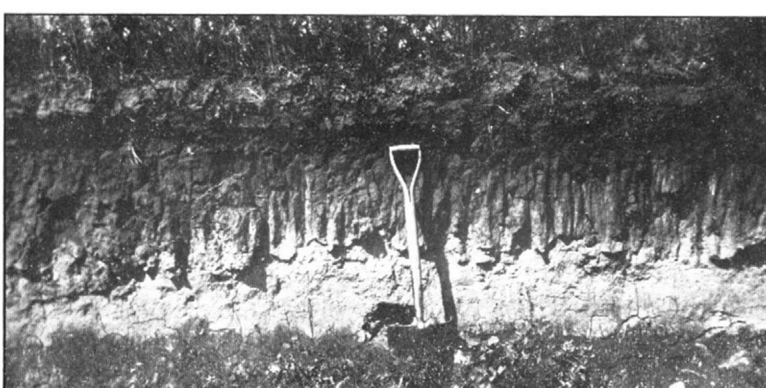


Fig. 3—2.6.2. Loam. This is characteristic of the area described in Fig. 2 above. Note the drift accumulation and the high lime subsurface.

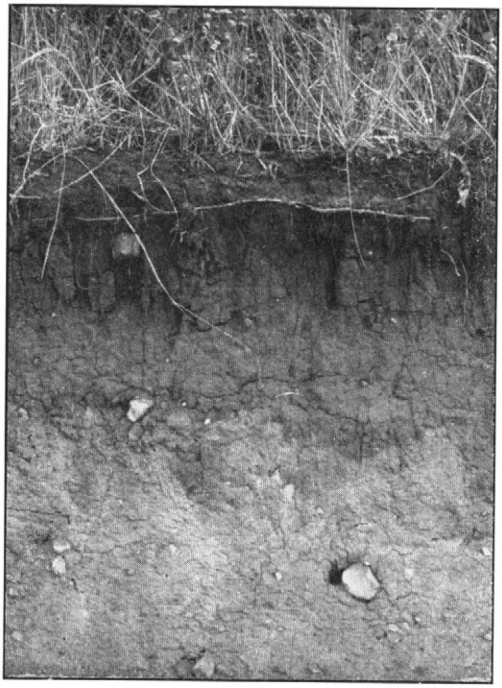


Fig. 1—3.3.2 loam. This is a typical normal profile of the Carseland-Calgary area illustrated in Plate 3. Fig 2. There is an average of 3″ to 4″ of black top. The subsoil is a mottled glacial till containing some stones.

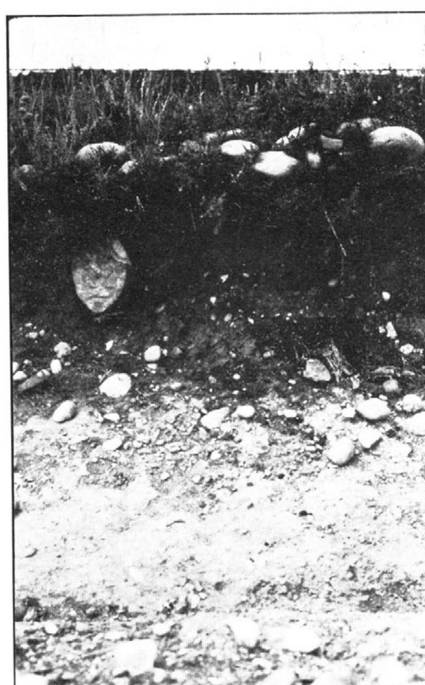


Fig. 2—3.4.2. loam. Many of the soils in the west portion of the area have been water worked and contain considerable gravel. The high lime subsoil is also characteristic.

PLATE 8

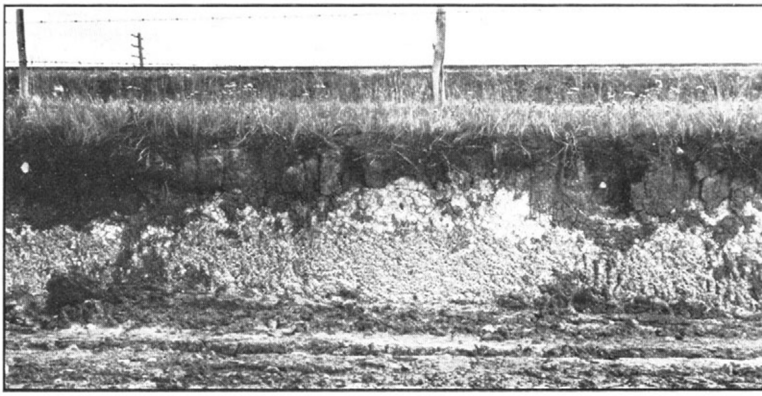


Fig. 1—3.3.4. loam. This profile was found only a few yards from the one illustrated in Plate 7, Fig. 1. The glacial soils between Calgary and Vulcan had originally an appreciable alkali salt content. This tends to collect in the lower basins.

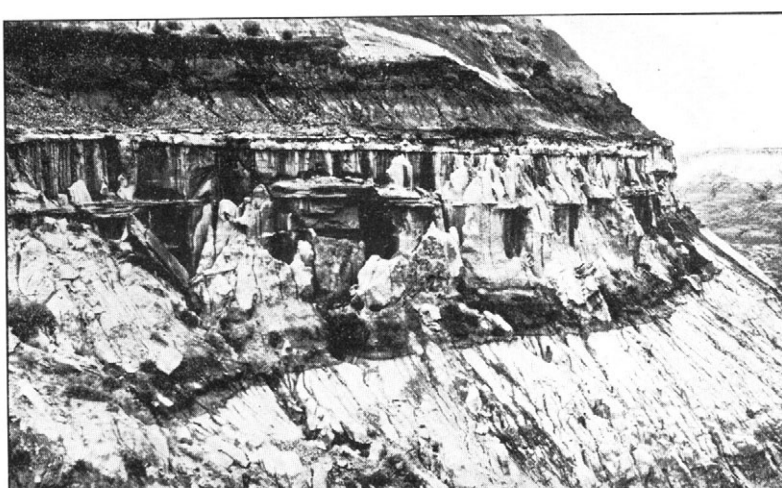
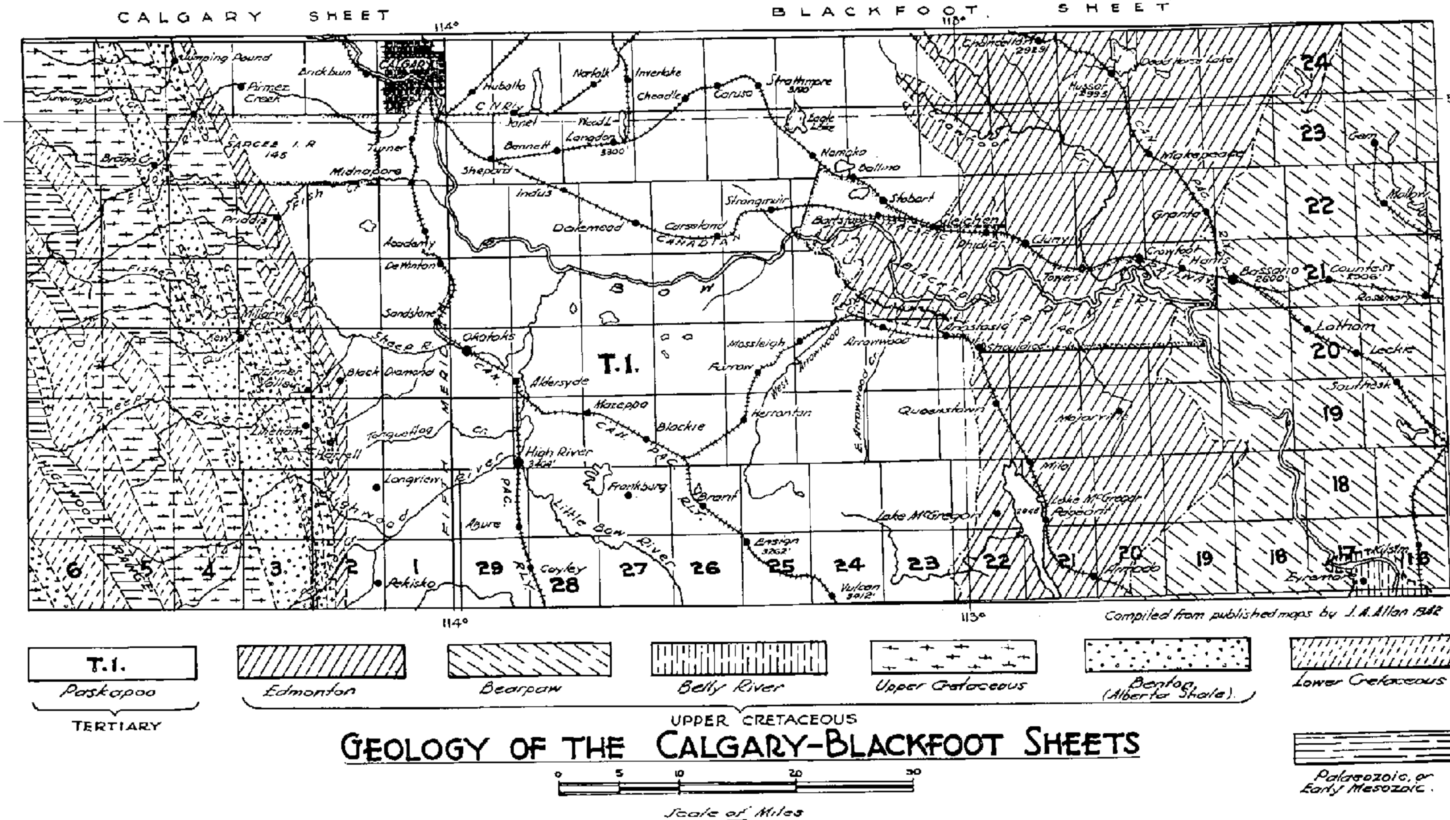


Fig. 2—The underlying parent rock was a factor in determining the character of many of the soils of this area. This is an exposure of Edmonton formation south of Bassano.



GEOLOGY OF THE CALGARY-BLACKFOOT SHEETS

2.3.2/6.	19 & 20-19	U.-G.R.	7,500	F.A.	A slope to the river; fairly dark colored.
2.3.6.	17-24, 19-26	L. & U.	500	Pr. & F.A.	2 areas. Low areas; salt grass in 17-24.
2.4.2. St.	21-20, 18-25	G.R.	2,500	F.P.	2 areas. Outwash stony ridges; some cultivation near edge of 18-25
2.4.2.	21-20	L.	300	F.P.	Fairly stony.
	17-22, 18-23, 22-21	G.R.-R.	12,000	Pr.-F.A.	3 areas. Gravelly knolls and ridges.
2.5/2.2.	18-22 to 19-26	U.-G.R.	36,000	F.G.A.	2 areas. Variable, water worked, glacial till; some drifting; 2 inches black to west side.
2.5.0.	21-23 to 20-24	L.	2,200	F.-F.G.P.	Creek flat; variable; contains some alkali.
2.5.1.	23-25	G.R.	400	Pr.-F.A.	An escarpment.
2.5.2.	18 to 22-20 & 21	U.-G.R.	3,500	F.A.	3 areas. High land and slopes; some drifting.
	17-23 to 18-24	U.-R.	5,500	F.A.	Slope; stony along the creek.
	21-20	U.	1,000	Pr.-F.A.	Variable area.
	17 to 19-25	U.	26,000	F.G.A.	Deep profile; fairly uniform. Lower area.
2.5.2/4.	24-25	U.	1,200	F.-F.G.A.	Contains some marshes.
2.5.5.	20-23, 22 & 24-25 & 26	L.	1,500	Pr.-F.G.P.	4 areas. Drains, alkali and solonization.
2.5.2/6.	20-19	U.	800	F.A.	Deep profile; fairly heavy loam.
	18-25	U.	800	F.A.	Slope to low area.
2.5.6.	21-19 & 20	U.-G.R.	800	F.-G.P.	A river bench.
	18-23, 20-25, 17 & 18-26	L.-G.R.	2,500	Pr.-F.A.	3 areas. Low basins; some alkali patches.
	17-22	L.	600	P. to Pr.A.	An alluvial fan.
2.6./2.2.	21-24 to 23-25	G.R.	15,000	F.G.A.	2 areas. Fairly deep profile; 1 inch black on surface; few stones.
2.6.1.	20 to 23-20 to 24	R.	4,000	F.A.	4 areas. Steep slope. Areas cultivated.
2.6.2.	20-22 to 21-25	U.-G.R.	60,000	F.G.A.	Gradual slope to river; lime subsoil at 10 inches; a little drifting.
	22 to 23-23 & 24	U.-G.R.	9,500	F.G.A.	Area of long gentle slopes; fairly heavy lime 15 inches.
	19-26, 17-23	L.-U.	4,500	F.G.A.	Uniform; nearly stone free. 19-26 deep and silty.
2.6.2/4.	23-23 to 24-24	U.-G.R.	6,500	F.-F.G.A.	Basin and its slopes; some marshy and seepage spots.
2.6.6.	24-23	U.-G.R.	2,200	F.A.	A slope to draw; irrigated.
2.6.2/7.	19 to 22-22	U.-G.R.	5,500	F.A.	2 areas. Lime near surface; some drifting.
Heavy Loam					
2.2.2.	24-17 to 23-20	G.R.-H.	55,000	G.P. to F.A.	2 areas. Some stones; cultivated patches and some abandonment; dark color to west.
	22-19 to 23-21	G.R.-H.	25,000	G.P. to F.A.	3 areas. Some stones; fairly shallow profile; portions cultivated.
	17-21 to 19-23	R.-H.	33,000	G.P. to F.A.	2 areas. Good dark color; portions waterworked; portions cultivated.
	17 & 18-21	G.R.-R.	2,000	Pr.-F.A.	A slope to the lake; fairly heavy texture.
	18-27 to 19-26	G.R.	6,000	F.G.A.	2 areas. Some stones; 2 inches black surface.
2.3.2.	17-21 & 22	U.-G.R.	4,500	F. & F.G.A.	3 areas. A few stones; lime subsoil close to surface.
	24-19 & 22	G.R.	1,500	F.-F.G.A.	2 areas. Slopes to lower basins; some stones; fairly shallow.
	21 & 22-26	U.	7,500	F.G.-G.A.	Very few stones; uniform 2 inches black surface.
2.3.2.	21 & 22-20 & 21	G.R.	16,000	F.-F.G.A.	Some stones; lime at 10 inches to 16 inches; some drifting.
	24, 18 & 19-20	G.R.-R.	12,000	P. & F.A.	2 areas. 24-20 upland bench; south area has some meadows.
	17-27 to 19-26	U.	18,000	F.G.-G.A.	Profile depth variable; some gravel stones. Edge of black zone.

TABLE XII.—Soil areas of dark brown soil zone—Continued

Series	Location	Topography	Acres	Class	Remarks
2.3.2/6.	24-19	U.	400	F.A.	A fairly level crown.
2.3.2/7.	17-20 & 21	G.R.	2,000	Pr.-F.A.	Shallow high lime; some deposition banding in profile; drifted.
2.4.2.	17-27	L.	400	F.G.P.	A river bench; stony and gravelly bar; cultivated patches.
	23-20	G.R.-H.	6,000	F.P. & Pr.-F.A.	A slope to creek; stony.
2.5.0.	21-20	L.	600	F.-F.G.A.	Creek flat; silty.
2.5.2.	17-26 & 27	L.-U.	1,500	F.G.A.	River benches. Stone free; fairly dark color.
2.5.2.	23-21	G.R.	600	F.A.	A crown at edge of drain; occasional solonized patch.
2.5.5.	17-25	U.	800	Pr.-F.A.	A basin; receives seepage from high land.
2.5.6.	19-20	G.R.	500	F.-F.G.P.	A slope to the creek.
2.6/2.2.	19 & 20-20 & 21	G.R.-R.	28,000	F.A.	A fairly uniform, silty basin. Drifted.
	17-22 & 23	U.-G.R.	9,000	F.G.A.	Gentle slope to basin; L. to Si.L. texture; some drift.
2.6.2.	23-22 to 24-24	U.-G.R.	20,000	F.G.-G.A.	Long gentle slopes; deep profile; good dark brown.
	20-24	U.	600	F.G.-G.A.	Lower area; stone free; lime at 15 inches.
2.6.2/4.	23-23	U.-G.R.	3,000	F.-G.A.	Contains seepage spots.
2.6.2/6.	23-22 to 24-23	U.-G.R.	17,000	F.G.A.	Partly irrigated. L. to Si.L. surface; very dark brown.
2.6.6.	23-22	L.	1,000	F.A.	Creek flat; irrigated.
Silt Loam					
2.1.2/6.	23-23	U.	800	F.G.A.	Lower area at base of eroded hill; irrigated.
2.1.6.	23 & 24-23	U.	600	F.A.	Draw and its banks. Hard round tops at 6 inches.
2.3.2.	18-21	G.R.	1,200	F.-F.G.A.	Fairly shallow profile; drifted.
2.5.2/5.	17-25	L.-U.	800	Pr.-F.A.	Stone free; alkaline spots.
2.6.2.	17-20 to 23	U.-G.R.	5,500	F.G.A.	3 areas. Deep profile stone free.
	22-21 to 23-22	U.	27,000	F.G.-G.A.	2 areas. Very few stones; some irrigation; fairly heavy subsoil.
	21-24	L.-U.	2,000	F.G.-G.A.	Basin. Deep dark profile; fairly heavy subsoil.
	24-20	L.-G.R.	2,000	F.-F.G.A.	Stone free; a little drifting; occasional solonized patch.
2.6.2/4.	24-23	L.-U.	2,000	F.G.A.	Basin area. A few slightly alkaline spots.
2.6.2/5.	22 & 23-23	L.-U.	600	F.A.	Edge of lake. Stone free; somewhat saline.
2.6.5.	22-22	U.	200	F.P.	Seepage basin.
2.6.2/6.	17-22	L.-U.	800	F.A.	Creek basin. Cultivated patches; badly drifted.
2.6.2/7.	19 & 20-21 & 22	L.-G.R.	26,000	F.A.	4 areas. Basin and slope to basin Si.L. to Lt.Si.L.; badly drifted.
Silty Clay Loam					
2.3.2.	22 to 24-19 & 20	U.-G.R.	16,000	F.A.	4 areas. Cultivated; fairly heavy lime at 12 inches.
	18-21	G.R.	5,000	F.-F.G.A.	Slope to lake. Few stones; a little drifting.
2.5.0.	22-20, 21-21	L.-U.	2,000	F.-F.G.A.	2 areas. Creek flats; fairly deep profile.
2.5.5.	17-25 & 26	U.	3,000	Pr.-F.A.	Solonized and saline soil; cultivated patches.
2.5.6.	20-24 & 25	L.-U.	1,500	Pr.-F.A.	A wide flood plain.
2.6/2.2.	17-21 to 22-21	U.-G.R.	17,000	F.G.A.	3 areas. Fairly high lime subsoil; some drifting.
2.6.2.	20-21 to 22-22	U.-G.R.	5,000	F.G.A.	2 areas. Lime subsoil close to surface; some drifting.
2.6.2/4.	22-22	L.-U.	4,500	F.G.A.	Lime 10 inches. Has clay and alkaline spots.
2.6.4.	19-21	L.-U.	2,000	P.-F.A.	Edge of lake; marshy and washed.
2.6.2/5.	22-21	U.-G.R.	2,000	Pr. & F.G.A.	Area at base of hills. Seepage from ditch.
2.6.5.	22-21	L.	300	Pr.-F.A.	Low seepage basin.

TABLE XII.—Soil areas of dark brown soil zone—Continued

Series	Location	Topography	Acres	Class	Remarks
2.6.2/6.	23-21, 24-22	U.-G.R.	4,500	F. & F.G.A.	Slopes; few stones.
	22-23	L.	1,000	F.A.	Patches of hard, solonized subsoil near to surface.
2.6.6.	17-22, 22-21	L.-U.	1,000	P. to Pr.A.	2 areas. Drainage basins; many eroded pits.
Clay Loam					
2.1.2.	19-18 to 18-19	R.	8,000	G.P. to F.A.	Lime horizon at 10 inches. Very few stones; few marshes.
	20 & 21-20	L.-U.	1,000	F.P. & F.A.	Stone free. Washed surface; deposition in west end.
2.1.6.	18-25	L.-U.	3,500	Pr.-F.A.	Salty spots. Subsoil wet at 20 inches.
2.2/0.2	19-18 & 19	R.-H.	5,500	G.P. & F.A.	Some stones. Cut by erosion coulees.
2.2.2.	23 & 24-19, 17, 21 & 22-21	R. & H.	8,000	G.P. to F.A.	4 areas. Shallow; variable; profile stony.
2.3.2.	24-18	R.-H.	8,000	G.P. to F.G.A.	Few stones. Fairly dark deep profile.
	22-19 & 20	U.-R.	7,000	F.A.	Shallow profile; somewhat silty; some drifting.
	23-21, 24-20	G.R.-H.	3,500	F.A.	2 areas. High land. 24-20 variable area.
2.3.2/6.	24-20	U.-G.R.	3,200	F.A.	Practically all cultivated.
2.4.2.	22-20	R.	1,800	F.-F.G.P.	Outwashed area; some arable patches.
2.5/2.2.	23 to 24-18	G.R.	6,500	Pr.-F.A.	A lower basin area; shallow profile. Some abandonment.
2.5.2.	18-22 to 19-21	G.R.	600	Pr.-F.A.	Shoreline area. Considerable drifting.
2.5.5.	22 to 24-23 & 24	L.-U.	4,800	F.-F.G.P.	3 areas. Alkaline area in tp. 22 and 23 is abandoned.
2.5.6.	23 & 24-21 to 23	L.	5,500	F.P.	2 areas. Creek flat; cultivated patches.
2.6.1.	21-23	R.	800	F.P.	Washed river bank.
2.6.2.	19-21	L.-U.	300	F.-F.G.A.	Upper bench; deep profile.
Clay					
2.1.2.	24-22	U.	200	F.G.A.	Parent shale very close to surface; occasional solonized spot.
2.1.5.	18-25	L.	1,000	Pr.-F.P.	Salty marsh.
2.3.2.	24-19	G.R.	600	F.A.	Edge of lake.
2.5.0. Lt.	21 & 22-23	L.	2,000	F.A.	River flat; somewhat marshy; portions irrigated.
2.5.2./6. Lt.	23-20 to 24-21	L.-U.	3,000	F.A.	Drainage channel. Alkali spots.
2.5.6.	23-11 to 24-22	L.	1,400	F.P.	Washed, marshy.
2.6/2.2. Lt.	18 & 19-22	L.-U.	6,500	F.G.A.	A lake bed. Fairly shallow profile.
2.7/2.2.	22 to 23-20 & 21	U.-G.R.	6,500	F.G.A.	Shallow clay deposition over till; a little drifting.
2.7/2.2/6. Lt.	23-20 to 24-22	U.-G.R.	37,000	F.-F.G.A.	Edge of basin. Solonized patches on the hill slopes.
2.7.2.	17, 18 & 19-21 & 22	L.	2,000	F.G.A.	2 areas. Part of lake basin. Spots drifted.
	21-21	U.-R.	6,000	F.G.A.	Fairly heavy lime at 8 inches; some marshes.
	23 & 24-20 & 21	L.-U.	15,000	F.G.A.	Centre of laking basin. Heavy, waxy subsoil.
2.7.2/6.	24-22	U.-G.R.	3,000	F.-F.G.A.	
2.7.5.	23-17, 24-20, 19-22	L.	1,400	F.P.	2 areas. Low basins; salty.
2.7.6	24-20	L.-U.	500	F.P.	Hard round tops at 2 inches.
Mixed					
2.5.0.	21-23 to 21-25	L.	5,000	F.P.	River flood plain. Tree growth; some arable patches.

*For a description of solonized soil see division 6, page 37.

For topography and class abbreviations see page 39.

SHALLOW BLACK SOIL ZONE

This color zone in the Blackfoot and Calgary sheets has been formed under an annual rainfall of about 16″ to 18″. The evaporation rate is fairly high, although not quite as high as in the shallow black zone farther south. The black surface varies from 3″ to 8″ in depth and the lime carbonate horizon in this area is found from about 16″ to 30″ from the surface and averages about 20″. Although most of the soils of this area were formed under a rainfall as high as in the deep black parkland soils of central Alberta, the higher evaporation rate has resulted in a shallower profile. In general the area in its native state is grass land although clumps of willow and poplar dot some of the lower, locally more humid, spots. The soils of this zone in general are quite productive and are good wheat producing areas.

Below is given a description of the major soil groups of the zone. Table XIII gives the main characteristics of each individual soil area.

Mixed Loams of the Cayley Area.

Lying south of Little Bow river between township 17, range 27, and township 17, range 1, W. 5th, is an area of mixed loam on undulating to rolling topography. The area is characterized by deep channels cut through relatively high land (see Plate 2, fig. 3). These channels have associated with them alluvial and outwash soils. In general the soil is from loam to light loam in texture.

At the extreme eastern end of the area is a fairly large silt loam basin of deep uniform soil. Between this silt loam area and Cayley, however, the soil gradually gets lighter in texture. The soils in this area average about 4″ of black surface. A brown subsurface horizon overlies a mottled drift parent material. It is fairly good to good arable land.

North of Cayley there are some sandy soils and some gravelly outwash areas. These vary considerably in their arable value. West of Cayley the soil is principally of glacial origin. Where topography permits, it is good arable land. Some of the steep slopes are subject to sheet erosion and might be better seeded to grass.

Loams of the Blackie Area.

Lying in a fairly level basin centering in township 19, range 27, is an area of heavy loam soil mapped mainly as 3.3.2 and 3.3.2/4. The profiles in this area vary from normal, well-drained to quite saline. In general there are from 4″ to 6″ of black heavy loam top; 8″ to 12″ of dark brown to gray brown, prismatic to columnar subsurface or B horizon of clay loam texture; and a fairly heavy textured subsoil or C horizon somewhat stony and mottled with lime.

Although most of the area shows evidence of restricted drainage and some alkali accumulation, it is farmed and is fairly good arable land. Some of the lower portions, however, are saline enough to seriously restrict the growth of grain crops. In general these more saline areas are found as extensions of Frank lake and along the drainage ways leading to the lake. Salts move up and down in the profile with the capillary water, and in dryer periods when the movement of water is principally up, the concentration of salt within root depth may reach harmful proportions.

Although not a soil factor, it is in order to say here that portions of this Blackie basin appear to have a definite frost hazard.

Loams of the Gladys Ridge.

Extending from the Highwood river east of Okotoks to township 20, range 25, is an undulating to gently rolling ridge of loam to heavy loam soil, mapped mainly as 3.3.2. Although parent sandstone appears close to the surface in a few places, in general glacial till forms the parent material for most of the soil. It would appear as though there has been a limited amount of sorting of the surface material and the average profile is intermediate between deposition 2 and 3.

There is an average of 3″ to 5″ of black surface soil. The chocolate brown, in places almost a red brown B_1 horizon is prismatic to columnar in structure, often breaking into fairly firm granules. A uniform buff colored lime concentration B_{ca} horizon is found at 16″ to 24″. The C horizon below is a mottled till. Stones occur throughout the profile. The texture of the subsoil is considerably heavier than that of the surface soil.

Scattered throughout most of the area are low marshy depressions, a few containing water at present. Around these depressions, and often well into them, is found solonized soil. In these areas there is a well developed round topped columnar B_1 horizon under a thin gray leached A_2 horizon. These areas appear on the map mainly as 3.3.2/6. These low spots are generally pasture lands.

The upland soil in this area is good arable land and is practically all cultivated. Some artesian wells are found in the south half of the area.

Loams of the Carseland-Calgary Area.

Lying between Carseland and Calgary, from the Bow river to the north side of the Blackfoot sheet, is a large area of sorted glacial loam soil. This area is mapped mainly as 3.3.2

heavy loam. It is of level to gently rolling topography; mainly of low, fairly frequent, rolls. Viewed in perspective this area of ground moraine appears on a level plain. Some stones are found throughout the area, although, in general, the surface horizon is relatively free of stones. Although the area extends east and west for about twenty-five miles, there is little change in the depth of black surface across it.

The following profile taken in section 12, township 24, range 28, is fairly typical of the sorted glacial soils of this area (see Plate 7, fig 1).

0″- 4″	A—Black. Friable, some vertical cleavage lines. Tongues of the black surface penetrate somewhat into the lower horizon.
4″-12″	B_1—Dark red-brown. Somewhat columnar breaking out into a nut *micro*-structure. Slightly waxy.
12″-20″	B_1—Brown to dark brown. Prismatic, vertical cleavage lines wider apart than in upper B_1.
20″-28″	B_{ca}—Dark gray-brown. Medium lime deposition. Contains lime flecking and a few pebbles.
At 36″	C (upper)—Tightly packed. Mottled glacial till containing stones. Although medium heavy textured it contains a fairly high percentage of sand. Has a faint suggestion of a blue-gray color.

The 4″ layer of black surface, the slightly waxy B_1 horizon, the medium lime concentration, and the mottled parent material are characteristic of the area. The red-brown B_1 horizon is fairly characteristic although in the lower areas and towards the west (around Shepard) the red-brown gives way to a gray-brown. This area is practically all cultivated and is good arable land (see Plate 3, fig. 2).

Throughout this grouping are many somewhat saline areas. These have been mapped as profile 2/4, 2/5, and 5, depending on the degree of alkali accumulation. These lower basins are generally waste or pasture land. Some salt accumulation can be found on hill slope depressions indicating, firstly, that the parent material contains some salt, and, secondly, that these salts have been able to move laterally under normal moisture conditions. The fields are not irrigated.

This complex of normal, saline and alkaline soils characterizes this group and the two previously described groups, namely the Blackie and the Gladys Ridge loams. That is, this entire sorted glacial area from Blackie to Calgary is dotted with salt accumulations and solonized spots (see Plate 8, fig. 1).

Between Calgary and Chestermere lake there is some unsorted glacial loam mapped 3.2.2. These areas have mainly a gently rolling topography and are somewhat stony. They lack uniformity and often have a shallow profile. They are fairly good to good arable lands.

The Okotoks Glacial Loams.

Extending from the Highwood river in township 21, range 28, west to Sandstone in township 21, range 1, W. 5th, and thence along the east side of the foothills from Lloyd lake to Longview, is a group of glacial soils mapped as 3.2.2 and 3.3.2. It is, in general, high land of gently rolling to rolling topography. Stones, mainly of Rocky mountain origin, are fairly numerous.

The profile has from 4″ to 8″ of black surface, a dark brown to red brown B_1 or subsurface horizon and a fairly high lime concentration horizon. It is somewhat variable in texture and in profile. There are some sandy streaks across many of the areas, and also solonized soil in some of the lower spots.

The area north of Okotoks is a high crown sloping fairly rapidly to the main drainage channels. It is somewhat stony and quite variable. The area between Sandstone and Lloyd lake is a mixture of sorted and unsorted moraine. The topography is mainly gently rolling, with long uniform slopes. The soil in this portion of the area is fairly deep, a good dark color, and relatively uniform throughout. The area west of High River, particularly the portion in townships 18 and 19, range 1, W. 5th, has a fairly shallow, stony profile. A limy till is often encountered at 10″ to 15″ from the surface.

Portions of practically every quarter-section are cultivated but solid blocks of cultivation are not common. It is a mixed farming area, but wheat is still the principal crop. The soil varies from fair to good arable land.

Alluvial Loams of the Highwood Drainage.

Lying along the basins of the Highwood river and its tributaries is a group of water-worked alluvial soils grading in texture mainly from light loam to clay loam. They have, in general, level to undulating topography. Large stones are few but there are varying amounts of gravel and the alluvial benches merge into the surrounding higher land that is of glacial or glacial residual origin. These rivers at one time must have carried a large volume of water affecting a wide area.

In general there are from 4″ to 6″ of black surface and a medium to high lime concentration horizon at 12″ to 20″ (see Plate 7, fig. 2). The arable value of these soils depends in a large measure on the amount of gravel present and on their uniformity. The 3.4.0 and 3.4.2 areas are generally not good arable lands. Flood plain soil, if not gravelly, is generally quite productive since it is composed of the surface soil eroded from surrounding higher land.

The Little Bow drainage basin included in this grouping is mainly good arable land. The texture is a very fine sand, the stone-free deposition is deep, and it is of level topography. It is nearly all cultivated. Along the edges of this drainage are some areas of sandy loam and fine sandy loam, particularly in township 18, range 28. These areas of high land have been cultivated and have drifted very badly (see Plate 3, fig. 1). In places they have blown out to the heavier textured subsoil.

The Sheep River basin is quite wide from Okotoks to its junction with the Highwood. This flat varies from fine sandy loam to clay loam in texture and from deep uniform deposition to very shallow gravelly bars. West from Okotoks the valley is not wide, and generally is quite gravelly.

The Highwood basin west as far as Little New York is quite wide. The soils vary from recent alluvial flood plains to old glacial-alluvial, slightly water-worked material. North of High River is a large heavy textured solonized flat. It is not good arable land. Although in the river basin, much of the salts found in this area possibly came from the residual parent rock of Sitook Spagway. These solonized soils, then, are associated with the alkaline and saline soils found well up along the eastern slope of Sitook Spagway in tp. 19, range 29. West of High River the valley is a series of river benches or terraces. The lower ones are quite gravelly. The 3.6.2 heavy loam in township 18, range 1, is a deep, uniform, dark colored soil. It is good to very good arable land. West of Little New York the river has cut a recent deep gorge so that the old river basin would not be expected to receive any recent alluvial material. This flat, partly tree covered, is quite variable. Patches are cultivated (see Plate 2, fig. 1).

Pekisko creek flat is relatively narrow. There are some arable patches of fair size towards its upper reaches. Some of the high land at the confluence of Pekisko and Highwood rivers is water-worked and is fairly good arable land.

These alluvial areas in general are quite variable and are rarely conducive to large cultivated fields. They are best suited to a mixed farming agriculture.

Soils of the Bow Valley.

This group is placed in the shallow black zone because most of the arable soil of the Bow Valley is in this zone. However, a brief description of the soils in the other zones will be included.

Three general observations regarding the Bow Valley soils might be made: The gravel deposits of this river are, in the main, relatively close to Calgary; much of the Bow river alluvial material had a high content of lime carbonate; and the river basin material contains a large percentage of very fine sand.

From Bassano east the river runs in a fairly narrow channel walled in by high banks of residual shale. The sloping basin is often fairly heavy textured and presents a washed appearance. Practically none of it is cultivated.

Between Bassano and Barstow (just west of Gleichen) the river valley is from one-half to two or three miles in width. The soils in this valley are all fairly light textured and some are quite gravelly. Portions of the flat are flood plains covered with a fairly heavy growth of trees. Southwest of Gleichen there is an old ox-bow lake. This is heavy textured and slightly saline. Most of it is pasture at present.

From Barstow west to its junction with the Highwood river, the valley averages about one-half mile in width. In this strip there are some patches of good arable land. Most of them, however, are somewhat sandy and often have a decided slope to the river.

From its junction with the Highwood to west of Calgary, the basin associated with the Bow drainage is quite wide. In this basin are many large gravelly areas, some of commercial importance. These areas are mainly non-arable. Towards the rim of this river basin there are some light textured areas that have a marl-like subsoil coming close to the surface. Even where topography permits, these are at best only fairly good arable lands. The remainder of this portion of the Bow basin is mapped mainly as deposition 5. These areas are variable, often containing many sand and gravel lenses throughout the profile. In general there are 4″ to 8″ of black surface. Where these areas do not have a rapid slope to the river, they are usually fairly good arable lands. Along the north slope of the glacial crown north of Okotoks there is a fairly large sandy area. This area, partly in fairly rough topography, slopes towards the river. Unless carefully farmed it will be subject to considerable erosion.

The Elbow basin is generally quite gravelly and does not contain much arable land.

Immediately west of Calgary, mainly in township 24, range 2, is a group of gravelly and stony loam areas. These lie on the east side of the high crown in section 20. They are mainly areas of outwashed glacial till. A large percentage of these areas is too stony to permit satisfactory cultivation. The high crown in section 20, although somewhat gravelly, is fairly good arable land.

Glacial Residual Loams of the Foothills.

Lying along the western edge of this shallow black soil zone is a large acreage of 3.2/0.1 loams. These soils are mapped from township 17, range 4, to township 22, range 2. They are mainly the lower foothills. Although bedrock outcrops are numerous throughout the area, glacial till depositions occur particularly along the outer fringes of the area.

The foothills that are mapped in the shallow black zone are mainly grass covered; southwest of Little New York they are practically completely grass covered. At the northern end of the area (southwest of Lloyd lake) there is some tree growth and in this portion soils with a deep black and soils with a podsolic profile can be found.

The profile varies from a shallow, purely residual profile on the steep hill slope to a deep alluvial profile in many of the valleys. In general they are very good pasture lands. However, throughout the area are some fairly level valleys and some level hill crowns. These are often very good arable lands. In the large block west of Pekisko creek and south of the Highwood there is practically no cultivation. However, in the remainder of the area there is a patchy cultivation, the fields varying in size from ten to one hundred acres. Fields are often difficult to get at and the moving of machinery from one field to another can be a difficult problem.

This area is fairly desirable for mixed farming. However, any cultivation on the steeper slopes is very liable to cause serious erosion. Since the average annual rainfall is 18″ to 20″, there should not be any great difficulty in getting a good stand of tame grass on these more erodible slopes.

Sitook Spagway in townships 18 and 19, range 29, mapped mainly as 3.1.2, might well be included in this grouping. It is an eastern extension of the foothills formation. Sandstone bedrock outcrops on the crown, along the escarpment and along the slope away from this escarpment. The undulating crown has a deep profile, practically stone free. It is all cultivated and is good arable land. The west slope from the crown is quite steep and is cultivated with difficulty. The east slope is more gradual. Just below the escarpment that rims the east and north edge of the crown are numerous springs. These springs carry some alkali salt which collects in the depressions along this slope. These depressions are saline and often contain solonized soil.

TABLE XIII.—Soil Areas of Shallow Black Soil Zone

Series	Location	Topography	Acres	Classification	Remarks
Sandy Loam					
3.6.2.	18-28	U.-G.R.	3,000	Pr.A.	High land; deep sandy deposition; portions badly drifted.
Fine Sandy Loam					
3.4.2.	23-1*	U.	800	F.G.P.	High crown. Some commercial gravel.
3.5.0.	24-3*	L.	1,000	F.G.P.	River flat. Considerable tree growth.
3.5.2.	21-28 & 29	U.-R.	6,000	Pr.-F.A.	2 areas. Sloping areas; 5 inches black, variable.
	22 & 23-1*	U.	4,000	F.A.	3 areas. River basin. Heavy lime in sandy subsoil; drifted.
	19-28	U.	1,000	F.A.	High land. Sandy subsoil.
3.5.2/7.	23 & 24-1*	G.R.	1,500	F.G.P.	2 areas. Edge of river; sandy subsoil.
3.5.7.	24-1*	G.R.-H.	2,500	F.G.P.	Very heavy lime at 3 inches to 5 inches.
3.6.2/7.	18-28	U.	1,200	F.A.	Slight slope to draw. Badly drifted, exposing subsoil.
Light Loam					
3.3.2.	18-28	U.	2,000	F.G.A.	A transition area.
3.4.0.	20 & 24-1 & 2*	L.	6,000	F.-F.G.P.	2 areas. Gravelly river flat; occasional arable patch.
3.4.0 Gv.	17 & 18-29	U.	600	F.-F.G.P.	Gravelly to surface.
3.4.2.	23-1*	U.	1,500	F.G.P.	Draw and slopes. Some commercial gravel.
3.5/2.2.	20-29	G.R.	1,200	F.G.A.	Highland; variable texture. Fairly deep black surface.
3.5.0.	17-27 & 18-28	L.	2,800	F. to G.A.	Alluvial very fine sand; deep deposition.
3.5.0.	17-29, 30 & 1*	L.-U.	3,000	P. & F.G.A.	Creek flat; portions badly cut by stream courses.
	21-25 to 22-28	L.-U.	1,500	P. & F.G.A.	River flat; some recent flooding. Quite variable.
	23 & 24-1*	L.	2,500	F.G.A.	Deep, very fine sand deposition.
	20-29 to 21-28	L.	2,500	P. to F.G.A.	Creek flat. Some recent flooding.
3.5.2.	17 to 20-28	U.-G.R.	15,000	F.G.A.	7 areas. Average 5 inches black. Variable, associated with drain.
	21-29, 17-2*	G.R.	3,500	F.G.A.	3 areas. High land. 21-29 area has heavy subsoil.
	20-28 & 29	L. & U.	2,200	F.G.A.	River bench. Quite variable S.L. to L.
	21 & 22-28 & 29	U.-R.	9,000	P. to F.G.A.	2 areas. In river basin. Some portions quite sandy.
3.5.2/7.	23 & 24-1	G.R.-H.	1,200	P. & F.A.	2 areas. Alluvial deposition over glacial remnant.
Loam					
3.0.2.	17 & 18-29	G.R.	200	F.A.	High land. Sandstone at plow depth.
3.1.2.	21-29	R.	200	F.A.	A residual knoll; patches cultivated.
	19 & 20-29	G.R.-R.	3,600	G.A.	High crown; deep profile; 6 inches black surface.
3.1.2/6.	20-29	G.R.	500	F.A.	Marshy spots in area; few stones.
3.2/0.1.	20-29	R.-H.	1,500	P. & F.A.	A steep slope to the west.
3.2/0.1.	17-1 & 2*	R.-H.	10,000	G.P. & F.G.A.	Outer foothills. Wide valleys.
3.2/0.2/5.	20-29	G.R.	3,000	P. & F.G.A.	Slope from crown; alkali seepage. Sandstone close to surface.
3.2.1.	20-28, 17-29	R.	2,000	F.A.	2 sloping areas. Shallow profile.
	19-23	R.-H.	3,500	F. & F.G.A.	Escarpment and slope. Some cultivation in lower portion.

TABLE XIII.—Soil Areas of Shallow Black Soil Zone—Continued

Series	Location	Topography	Acres	Classification	Remarks
3.2.2.	17 & 18-28 to 1, 21-29*	U.-R.	32,000	F.G.-G.A.	5 areas. Some stones; sloughs. 4in. to 6in. black top.
	20-25 to 19-26	U.-R.	22,000	F.G.A.	Some sloughs. 2in-3in. top. Frequent stones.
	17 & 18-1 to 3*	G.R.-R.	6,500	F. & F.G.A.	At base of foothills. Variable texture and profile.
	19-23	R.-H.	8,000	V.G.P.	Quite stony.
	21 to 24-1*	G.R.-H.	6,000	P. to G.A.	4 areas. Stony. 6 inches black top. North areas quite sloping.
	23 & 24-28 & 29	G.R.	20,000	F.G.A.	2 areas. Variable, fairly shallow profile. Choppy topography.
3.2.2/7.	24-29 & 1*	U.-R.	7,500	F.A.	High land on river bank. High lime subsoil.
3.3.2.	20 & 21-27 to 29	U.-G.R.	21,000	G.A.	2 areas. Few stones. Fairly heavy lime at 15 inches. 21-27 somewhat variable.
	19 & 20-23	G.R.	5,000	G.A.	5 inches black top. High crown.
3.3.2 Gv.	19-23	G.R.	1,600	F.G.A.	Contains gravel knolls and streaks.
3.3.2.	17 & 18-27 to 29	U.-G.R.	30,000	F.G. & G.A.	5 areas. Some stones. 3in. to 5in. black top. Fairly heavy subsoil.
	20-26	U.	6,000	F.G.-G.A.	Contains many sloughs. Columnar subsoil.
	22 & 23-26	U.	32,000	G.A.	Somewhat choppy. Slightly more stony in north.
3.3.2.	18 & 19-1 & 2*	U.	4,200	G.A.	7 areas. These are the more uniform portions of the glacial area.
	22-29 to 24-28	U.-G.R.	34,000	G.A.	Long gentle slopes. Some alkali spots. 5 inches black top. subsoil slightly heavy.
	19 & 20-29	U.-G.R.	5,000	F.G.A.	Slope from crown. Stony subsoil.
	22-1*	U.-R.	6,000	G.A.	Silty loam texture; fairly deep profile.
	23 & 24-1*	U.-G.R.	1,500	F.G.-G.A.	Fairly shallow profile; 4 inches black top.
3.3.2/4.	21-28	G.R.	1,200	F.G.A.	Relatively low land. Sloughs and willow growth.
3.3.2/5.	23-24 to 26-29	L.-U.	25,000	F.P.-F.G.A.	8 areas. These are low, seeped and alkaline areas. Profile often gray.
3.3.2/6.	21-29	U.	800	F.-F.G.A.	Low area. Solonized patches.
3.3.6.	21 & 23-28	L.-U.	700	F.A.	Slope. Heavy subsoil.
3.3.2/7.	22 to 24-29	U.-G.R.	6,000	F.G.A.	High land near river. Some alkali spots.
3.4/2.2.	24-2*	U.-H.	12,000	P. & F.G.A.	Slope to east. Outwash. Streaked.
3.4.0.	22-29 to 24-1*	L.-U.	2,000	F.P.	River flat. Cultivated patches.
	18-29 & 1, 19-3*	L.	1,000	F.G.P.	2 areas. River flat; quite gravelly.
	17-2 & 3*	L.	1,500	P. & G.A.	Creek flat. Quite variable.
3.4.0 Gv.	23 & 24-1 & 3*	L.	3,000	F.P.	Bow and Elbow flats; mainly gravel bars.
3.4.2 Gv.	24-3 to 23-4*	L.	2,000	F.-F.G.P.	Elbow flat; gravelly river bench.
3.4.2.	17 & 19-29	U.-G.R.	5,500	F.A.	3 areas. Gravelly subsoil, some larger stones in 19.
3.4.2.	20-28 & 29 18-29 & 1*	L.-U.	1,000	F.G.P.	Some commercial gravel. River basin.
	22 to 24-1*	L.-U.	5,000	Pr.-F.A.	4 areas. River benches. Variable gravelly subsoil.
	20-1, 24-2* 20-2 & 3*	G.R.-R.	1,000	F.-F.G.P.	2 areas. Very stony outwash. Commercial gravel in 24.
	18-1 to 17-4*	L.-U.	6,000	G.P.	3 areas. River valleys; some portions arable.
3.4.2 Gv.	22 & 24-1*	G.R.	1,000	F.G.P.	2 areas. Some commercial gravel. South area high land.
3.5/2.2.	24-25 & 26	G.R.	6,000	F.G.A.	Medium to light subsoil; sandy streaks.

3.5.0.	22-28 to 24-1*	L.-U.	4,500	P. to G.A.	5 areas. Bow flat; recent deposition; much V.F.S.
	23-1 to 24-2	L.-U.	4,200	P. to F.G.A.	Elbow flat. Some tree growth.
	18-29 to 1*	L.-U.	8,000	P. to G.A.	Highwood flat. Arability may depend on amount of gravel.
	20-2, 22 & 23-1*	L.-U.	3,000	P. to F.G.A.	Creek flats. Quite variable.
	17-3*	L.-U.	500	F. to G.A.	Creek flat. Nearly all cultivated.
3.5.2.	20 & 21-29 to 22-1	U.-G.R.	3,500	G.A.	3 areas. Fairly deep profile. Cultivated.
	17 to 19-29 to 2*	L.-G.R.	18,500	F.G.-G.A.	5 areas. River benches and basins. Stone free; some gravel.
	23 & 24-1 & 2*	U.-G.R.	3,300	F. to G.A.	4 areas. River benches. Lime subsoil fairly close to surface.
	17 & 18-3 & 4*	L.-U.	800	G.A.	2 areas. Fairly deep black top.
3.5.2/4.	24-26	U.	4,000	F.-F.G.A.	Lower area somewhat marshy; profile variable.
3.5.2/5.	23 to 24, 25 to 27	U.-G.R.	6,500	F.P. to F.G.A.	3 areas. Low areas; some very bad alkali spots at east side.
3.5.3.	17-29	L.-U.	200	F.-G.A.	Mostly cultivated.
3.5.5.	24-28 to 23-29	L.	3,200	F.P.	An alkaline drain. Not cultivated.
3.5.2/6.	19-28	U.	500	F.A.	Lower area. Also some alkali spots.
3.5.2/7.	23 & 24-1 & 2*	U.-G.R.	9,000	F.A.	7 areas. River bank; sandy streaks.
3.6.2/4.	24-27	U.	2,200	F. to G.A.	Basin and slope. Also some solonized patches.
Heavy Loam					
3.2/0.1.	17-2 to 19-4 21-1*	R.H.	100,000	V.G.P.&F.G.A.	Foothills, grass covered. Arable patches throughout.
3.2.2.	23 & 24-1 to 3*	G.R.-R.	7,500	F.G.-G.A.	3 areas. Some stones and gravel; deep profile.
	17-2 to 22-1*	G.R.-H.	60,000	F. to G.A.	7 areas. Some stones. Fairly heavy subsoil; north areas less variable.
3.3.2.	18-27 to 24-28	L.-G.R.	195,000	G.A.	3 areas. Large area of ground moraine; good dark color; occasional stones. All cultivated.
	24-2 to 4*	G.R.-R.	10,000	F.G.-G.A.	3 areas. Portions stony. 6 inches black top. Much of area sloping.
	19 & 20-24	U.-G.R.	5,000	G.A.	A high crown. 2 inches to 3 inches black top.
	18-2 to 23-1*	U.-G.R.	8,000	G.A.	6 areas. Some stones throughout the profile. 4in. to 6in. black top.
	17-28	L.-U.	4,400	G.A.	A deep profile 5 inches black top. Few stones.
	17-29 to 1*	G.R.	7,000	F.G.-G.A.	Long slopes from high crowns.
	19-29 to 18-1*	U.	3,600	G.A.	L. to Si.L. surface; heavy subsoil; lime at 10in. to 15in.
3.3.2/4.	19-26, 22-26 to 23-29	L.-U.	12,500	F.-G.A.	6 areas. Areas contain marshy spots; some gray profile.
3.3.2/6.	20 & 21, 26 to 29	L.-U.	12,000	P. & F.G.A.	7 areas. Low areas; marshes and patches of hard round top (solonized) subsoil.
3.3.6.	20-26 & 28	L.-U.	3,000	F.A.	5 areas. Subsoil hard and waxy.
3.4/2.2.	18-29	U.G.R.	2,600	F.A.	Series of outwash ridges or streaks.
3.4.2.	22-2*	U.	300	F.A.	Marshy and gravelly along drain.
3.5.0.	19-2*	L. & U.	1,500	P. & F.G.A.	Creek flats. Stone free.
3.5.2.	17-3 to 20-1	U.-R.	7,500	F.G.-G.A.	5 areas. Upper river benches and slopes; quite variable.
3.5.2/4.	19-28	U.	800	F.G.A.	A basin area. Many heavy textured spots.
3.5.2/5.	18-27 to 20-28	L.-U.	9,000	P. & F.G.A.	Lake edge and drains to lake. Some solonized soil.
3.5.5.	21-27	L.	200	F.G.P.	Alkaline marsh.
3.5.2/6.	17-28 to 20-27, 17 & 19-1*	L.U.	5,000	P. & F.A.	5 areas. Draws; variable texture; patches cultivated.
3.5.6.	21-29, 18 & 19-1*	L.-U.	3,300	Pr.-F.A.	4 areas. Low areas. Alkali and solonization.
3.6.2.	18-29 & 17-1*	L.-U.	3,500	G.-V.G.A.	High river bench. Deep profile. 6 inches black top.

TABLE XIII.—Soil Areas of Shallow Black Soil Zone—Continued

Series	Location	Topography	Acres	Classification	Remarks
Silt Loam					
3.3.2.	17-27 & 28	U.	3,800	G.A.	Edge of large basin. Deep profile.
3.5.0.	24-2*	L.	800	G.A.	Area along old river course. Cultivated.
3.5.2.	17-1, 24-2*	L. & U.	2,000	G.A.	2 areas. River benches; 17-1 has deep profile.
3.5.2/4.	20-2*	L.-U.	1,500	F.G.A.	Stone free; upper river bench; marshy spots.
3.6/2.2.	24-3*	U.-G.R.	10,500	G.-V.G.A.	Slightly basin-like area. Fairly havy subsoil.
3.6.2.	22-1*	L.-U.	400	G.A.	Part of drain.
Silty Clay Loam					
3.7.4.	22-2*	L.	800	F.G.A.	Part of lake basin. Portions slightly alkaline.
Clay Loam					
3.2/0.1.	19 & 20-2 & 3	H.	4,600	G.P.	3 areas. Foothills; mainly grass covered.
3.2/0.2.	19-2*	G.R.-H.	11,000	G.P. & F.G.A.	A high crown containing some glacial ridges.
3.3.2.	18-2*	U.	300	F.G.A.	Slope to base of hills. Slightly washed.
3.5.2.	17 & 18-2*	U.	1,000	F.G.-G.A.	2 areas. Occasional gravel streak. 18-2 area sloping.
3.5.3.	17 & 18-2*	U.	700	F.G.-G.A.	Basin area. Somewhat marshy; 6 inches black top.
3.5.4.	21-28 & 29	L.-U.	500	P. & F.G.A.	Drain with marshes. Some good clay patches.
3.5.2/5.	20 & 21-1*	L.	800	Pr.-F.A.	Marshy drain. Not cultivated.
3.5.6.	19-28 & 29	L.-U.	1,000	P.-Pr.A.	2 areas. 60% surface eroded off. Alkali patches.
3.6.2.	17-29	L.-U.	800	G.A.	7 inches black tpo. Stone free upper crown.
	17 & 18-2*	L.-U.	800	G.A.	5 inches black top. Contains a few small stones. Silty.
Clay					
3.1.2 Lt.	20 & 21-2*	G.R.	4,500	G.A.	Somewhat humpy topography. 4 inches of Si.C.L. top. Heavy subsoil.
3.3.2 Lt.	19 & 20-2*	G.R.	6,500	G.A.	Fairly heavy subsoil. Lime at 12 inches.
3.5.5.	17-29	L.	200	F.G.P.	A marshy flat.
3.7.4.	21-1*	L.	300	Pr.-F.A.	Slightly alkaline basin.

*West of the 5th meridian.

For topography and class abbreviations see page 39.

BLACK SOIL ZONE

The black soil zone in the Calgary sheet lies as a narrow strip along the edge of and including part of the foothills. The mapped area centres in range 3 as far south as township 19. This zone receives an annual precipitation of from 18″ to 20″. The black surface horizon averages over 6″ to 8″ in depth and soils with upwards of 16″ of black top occur on this sheet. The lime concentration horizon averages about 30″ from the surface. In the southern half of the zone black and degraded wooded soils are intermingled. It should be noted here that there is a frost hazard in this zone and that the frost-free period rapidly shortens towards the mountains.

Below is given a description of the major soil groups of this zone. Table XIV gives the main characteristics of each individual soil area.

Silt Loams North of Priddis.

Extending from township 22, range 2, to township 24, range 4, is a fairly large area of sorted medium to heavy textured black soils. These are mapped mainly as heavy loams and silt loams. An area of 4.7.2 clay is outlined in township 24, range 4.

In general the area is undulating to gently rolling and contains very few stones. Except in the Sarcee Indian reserve most of the soils in this group are cultivated. Due, however, to the presence of small drains and marshes, etc., few quarter-sections are completely cultivated. The soil is good to very good arable land.

The following profile taken in section 28, township 22, range 2, is fairly typical of the sorted heavy loams and silt loams of this group.

0″-11″	A—Black. Friable, elongated, cloddy to prismatic.
11″-18″	B_1—Dark brown. Some vertical cleavage lines. Breaks into small angular nuts. Slightly waxy in appearance.
18″-30″	Upper B_{ca}—Friable, elongated clods. Contains some lime carbonate.
30″-36″	Lower B_{ca}—Fairly heavy lime concentration. Friable.

Note: The black surface horizon varies from 6″ to 16″ in depth throughout the area.

The portion of the area lying in the Sarcee Indian reserve is still largely uncultivated. At present it supports a meadow upland grass or a low tree growth. Since most of the surface has some slope there is adequate drainage.

The clay area in township 24, range 4, is a deep deposition and may originate from the nearby Alberta shales. Much of it appears somewhat marshy at present but should be fairly good to good arable land.

As stated earlier, it is all quite fertile land and topography, in general, permits of fairly easy cultivation. There is a frost hazard in portions of the area, making it desirable to grow some coarse grains.

Clays of the Foothills Area.

In the foothill valleys, principally from Highwood river to Priddis creek, occur black, heavy textured soils. These are mapped mainly as 4.1.2, 4.5.2, and 4.7.2 clay loam to clay.

The laking basin extending north and south from Black Diamond is mapped as 4.7.2 clay. The clay deposition here is quite deep. The following profile taken in section 4, township 20, range 2, is typical:

0″- 9″	Black, friable, silty clay.
9″-18″	Waxy, gray-black clay.
30″-40″	Olive brown, heavy clay. Contains some lime carbonate.

It is a level to undulating basin and has very little waste land. It is cultivated and is good arable land.

West and southwest of Turner Valley the valleys, mainly along stream courses, are mapped as 4.5.2 clay loam. In this portion of the area the valleys and bench lands appear to have received some alluvial deposition. They are somewhat variable and contain a few stones and gravel lenses. A patchy cultivation, much seeded to grass, occurs along these valleys.

West and north of Millarville the valley soils have been mapped as 4.1.2 light clay. The profiles throughout these valleys are quite uniform. The following is typical:

0″- 8″	A—Black, friable, elongated clods. Silty clay loam.
8″-18″	B_1—Dark, olive brown, granular and waxy. Contains a little lime.
18″-24″	B_{ca}—Light olive brown. Suggestion of layering. Friable. Fairly high lime concentration.
28″-36″	Upper C—Gray brown. Resembles somewhat the parent Alberta shale.

In this portion of the area the surrounding upland soils are somewhat lighter textured and are degraded. A patchy cultivation occurs in these valleys.

These heavy textured valley soils are all sloping areas cut by tributary streams. The streams in general have no wide, level, alluvial flood plains, but rather does the slope continue practically to the stream bank. Spruce, poplar and willows grow along these valley slopes. The only fairly level areas of any size occur as bench lands considerably above the present river level. They are good arable lands used mainly for the production of fodder crops (see Plate 2, fig. 2).

Included in this area is the 4.1.2 clay area in township 17, range 2. This is a stone-free upper bench between Pekisko and Stimson creeks. Although sorted, it appears to originate from the local Alberta shales. There is an average of 8″-10″ of black top. It is nearly all cultivated and is fairly good to good arable land.

Foothills Glacial-Residual Clay Loams.

North of the Highwood river to Fisher creek the foothills are mapped as 4.2/0.1 clay loam. In general they are heavier textured than the 3.2/0.1 foothills and are tree covered. The trees are principally poplar and willow. Due to the fairly heavy tree growth they are only fair pasture lands.

TABLE XIV.—Soil Areas of Black Soil Zone

Series	Location	Topography	Acres	Classification	Remarks
Light Loam					
4.5.2.	24-4	U.-G.R.	500	G.A.	Upper benches of creek. Somewhat marshy.
Loam					
4.3.2.	24-4 & 5	U.	1,000	F.G.-G.A.	Head water of drain. Not cultivated.
4.4/2.2.	24-4 & 5	G.R.	3,000	F.A.	Upland bench. Burnt over woods. 5 inches black over gravel.
4.4.2 Gv.	24-4	U.	300	F.P.	Gravel bar on upper bench.
4.4.2.	21-3, 24-4	R. & U.	900	F.G.P. & G.P.	Gravelly river benches; 24-4 area somewhat sandy.
4.5.0.	20-3 & 4, 23-2	L.-U.	4,000	P. to G.A.	River flats. 23-2 area gravelly and some marshes.
4.5.2.	23-1 & 2, 24-4	L.-U.	4,500	G.A.	3 areas. Upper river benches. 10 inches black top.
	24-5, 19 & 20-3	U.-G.R.	1,800	F.G.A.	2 areas. River benches; some gravel streaks.
	24-4	U.	1,000	F.G.A.	Upper bench of Elbow. Variable, Lt.L. to Lt.C.
Heavy Loam					
4.2/0.1.	19 & 20, 3 & 4	H.	7,000	G.P.	Foothills; large percentage tree covered.
4.2.2.	22-2	U.-R.	5,000	G.A.	High crown; some stones; marshy spots.
4.3.2.	23-2, 22-3 to 24-4	G.R. & R.	22,000	F.G.-G.A.	Deep profile; silty texture. 8 inches black top; west area scrub tree covered.
4.4.0.	21-3	L.	1,500	P. to F.A.	2 areas. Creek flat; gravelly and marshy. Occasional arable patch.
4.5.0.	23-2 to 22-4	L. & G.R.	6,000	P. to G.A.	2 areas. Creek flats; patches cultivated; marshy spots.
	20 & 21-2 & 3	L.	2,500	F.-G.A.	2 areas. Creek flat; fairly uniform. Deep silty deposition.
4.5.2.	19-4	G.R.	1,000	F.G.-G.A.	Slope to creek. Heavy subsoil.
Silt Loam					
4.3.2.	22-2 & 3	G.R.-R.	8,000	F.G.-V.G.A.	Deep profile; 7 inches black top.
4.5.2.	18 & 20-3	L.-U.	2,500	F.G.-G.A.	2 areas. River benches; cultivated.
4.6/2.2.	22-2 to 24-4	U.-G.R.	30,000	VG.A.	4 areas. Deep profile; 10in. to 12in. black top. Much is hay land or tree covered.
Silty Clay Loam					
4.5.2.	21 & 22-1 & 2	U.-G.R.	4,000	G.A.	Drain and slopes. Deep black; Si.L. to C. texture.
Clay Loam					
4.1.2.	20-1 to 22-3	U.-R.	9,000	G.A.	Slope to drain. Cultivated; very few stones.
4.1.2.	17-2 to 19-3	U. & G.R.	6,500	F.G.-G.A.	2 areas. Slopes to basin. 8 inches black top; west area marshy.
4.2/0.1.	24-4	R.	800	G.P.	A fairly steep escarpment.
4.2/0.1.	20 & 21-2 & 3	H.	15,000	F.G.-G.P.	5 areas. Foothills. Tree covered, mainly poplar and willow.
4.2/0.2.	24-4 & 5	G.R.-R.	4,000	P. & F.G.A.	2 areas. Fairly stony and has bed rock outcrops; arable patches.
4.2.2.	21-2	R.-H.	3,500	G.P. & F.G.A.	Edge of foothills. Knobby, fairly shallow profile.
4.5.2.	19 & 20-3, 22-4	U.-G.R.	3,200	F.G.-G.A	Benches and slopes to river. Heavy subsoil.

Clay					
4.1.2.	17-2	U.-G.R.	4,000	G.A.	Somewhat variable. Subsoil generally quite heavy.
4.1.2 Lt.	20 to 22-3 & 4	G.R.-R.	44,000	F.G.-G.A.	7 areas. Badly cut slopes. Stone free; 8 inches to 10 inches black top.
4.1.2 Lt.	24-4	U.-G.R.	4,000	G.A.	3 areas. Upland, slightly sloping.
4.5.2 Lt.	22-1 & 2	L.-U.	1,000	F.G.-G.A.	Part of lake basin. A few small alkali patches.
4.7.0.	21-3	L.	500	F.A.	Creek flat; some hay meadows.
4.7.2.	19-2 to 21-3	L.-U.	10,000	G.A.	5 areas. Laking basin; heavy waxy subsoil; few marshy spots.
	24-4	U.-G.R.	4,000	F.G.-G.A.	Marshy hay meadows, deep clay deposition.

NOTE: All areas in this zone are west of the 5th meridian.

For topography and class abbreviations see page 39.

WOODED SOIL ZONE

Lying along the forest reserve and centering at Bragg creek is an area of podsolic soils. The main podsolic or wooded soil zone of Alberta lies north and west of Edmonton. This area in the Calgary sheet is the southern tip (at least outside of the Rocky Mountain forest reserve) of that large zone. The soils of this zone have been formed under humid soil moisture conditions; these conditions result from a fairly high rainfall and a dense forest cover. Three sub-zones have been recognized in this area called respectively 5, 6 and 7, representing increasing degrees of degradation. In general on Alberta's podsolic soils the use of legume rotations and the application of fertilizers are both necessary.

Below is given a description of the major group in this area. Table XV gives the main characteristics of each individual soil area. It should be stated here that the classification rating given in this table and appearing on the soil rating map does not take into consideration the cost of clearing away the tree growth prior to cultivation.

Degraded Soils of the Foothills.

The degraded or podsolic soils lie in a strip extending approximately from township 21, range 3, to township 24, range 6. Going from south to north the soil gets slightly lighter in texture. In the south portion it is mainly clay loam; towards the north loams and fine sandy loams occur. The topography ranges from undulating valleys and bench lands to hilly foothills. They are all tree covered, there being a noticeable percentage of conifers. In the foothills of the black soil zone to the south conifers were almost absent.

The following profile taken in section 32, township 22, range 4, is characteristic of the heavier textured more level phase:

0″- 1″ A_0 and A_1—Brown, leaf mold and some mineral matter.
1″- 2″ Upper A_2—Light brown, laminated.
2″- 5″ Lower A_2—Nearly white, ashy. Breaks out into small porous clods.
5″-14″ B_1—Dark gray brown with red flecking. Heavy and waxy. Vertical cleavage lines.
At 20″ Lower B_1—Similar to B_1 excepting more massive.
Note: No lime carbonate accumulation to this depth.

The white ashy horizon varies in this general area from 1″ to 10″ in thickness. The soils that are in sub-zone 5 have an average of 3″ to 4″ of black top over a thin leached A_2 horizon.

In the northwestern corner of the sheet there is considerable peat accumulation. It was not possible, however, in this reconnaissance survey to outline the areas.

Very little of these wooded soils is cultivated; some could be after the timber has been cleaned away. When cultivated some would make fairly good to good arable lands under certain types of farm management. The hilly areas are only fair pasture due to the heavy timber growth.

TABLE XV.—Soil Areas of Wooded Soil Zone

Series	Location	Topography	Acres	Classification	Remarks
Loam					
5.2/0.2.	24-5	G.R.-R.	7,000	F.A.	Wooded area; 4 inches to 6 inches black top.
Heavy Loam					
5.2/0.2.	23 & 24-4 & 5	R.-H.	6,000	P. & F.A.	Heavily wooded, mainly with poplar
Fine Sandy Loam					
6.4.2.	24-5 & 6	G.R.	1,500	F.G.P.	Stony and gravelly benches. Some grass land patches.
6.5.2.	24-5	G.R.	1,500	F.A.	Streaked with gravelly, coarse sand. Red-brown, ash-like subsoil.
Loam					
6.2/0.1.	24-5 & 6	R.-H.	9,000	F.-F.G.P.	Heavily wooded foothills. Peat in the draws.
6.4.2 Gv.	23-4 & 5	L.-U.	2,000	F.-F.G.P.	River flat; tree covered.
6.4.2.	22 & 23-5	U.-R.	1,000	F.A.	River bank and adjacent upland.
Heavy Loam					
6.2/0.1.	22-4 to 24-5	H.	13,000	F.P.	5 areas. Foothills heavily wooded. Some conifers.
6.2/0.2.	23-4	R.	3,000	P. & F.A.	Wooded. Some marshy spots.
Clay Loam					
6.1.2.	23 & 24-5	G.R.-H.	3,800	P. & F.A.	Some muskegs. Variable amount of degradation.
6.2/0.1.	21-3 to 22-5	H.	44,000	F.P.	2 areas. Wooded foothills. Brown practically to surface.
6.2/0.2.	23-4 & 5	R.-H.	2,400	P. & F.A.	Wooded; patches cultivated. Few stones.
Clay					
6.1.2 Lt.	22-3	R.	1,800	Pr.-F.A.	Draw banks. Heavy subsoil; 1in. to 2in. black.
6.1.2.	22-5	G.R.-R.	2,000	F.-F.G.A.	Slope and basin. Gray to gray-black. Partially treed.
Heavy Loam					
7.1.2.	23 & 24-5	G.R.	7,500	P. & F.A.	Low area. Some muskegs. Deep, light colored, ashy subsurface.
Clay Loam					
7.1.2.	22-4	G.R.	2,000	F.A.	Very heavily treed. Few stones. Deep, gray-white A2 horizon almost to surface.

NOTE: All areas in this zone are west of the 5th meridian.

For topography and class abbreviations see page 39.

CHEMICAL COMPOSITION OF SOILS

The nitrogen, phosphorus, calcium and magnesium contents were determined on soil samples taken in the Blackfoot and Calgary sheets. Only a few representative profiles are reported in Table XVI. These profiles were selected to give a fairly complete coverage of the main soil areas as well as coverage for the five color zones. Excluding the podsolic soils, the decrease in the soils organic matter content is fairly uniform from west to east. The average nitrogen content (calculated on the surface foot) of four black soils was 0.54 per cent, for nine shallow black soils was 0.31 per cent, for twenty-one dark brown soils was 0.18 per cent, and for nine brown soils was 0.14 per cent. The one podsolic (wooded) soil analyzed had 0.12 per cent nitrogen in the surface foot.

The variation in nitrogen content in the black zone was from 0.49 to 0.69 and in the brown soil zone was from 0.09 to 0.17. In the dark brown and shallow black, however, the variation is greater than this. In the dark brown zone the variation was from 0.08 (an alkaline light loam flat) to 0.28 (a uniform silt loam area). In the shallow black the variation was from 0.18 (a sorted glacial loam on the edge of the dark brown) to 0.47 (a sorted glacial loam on the Buffalo hills plateau). In the dark brown zone eight medium heavy to heavy textured soils averaged 0.22 per cent nitrogen, ten medium textured soils averaged 0.17 per cent and three light textured soils averaged 0.10 per cent.

In all profiles analyzed there was a decrease in nitrogen content from the surface down, the decrease in most cases being quite large. The nitrogen in the soil occurs principally as organic matter and since most of it is in the A or surface horizon the loss of that surface by erosion means the loss of the most fertile soil. This organic matter on the prairies has been accumulated from the decomposition of vegetative growth over many centuries of time; it cannot be rapidly replaced. Wind has taken its toll for some time and to-day we are beginning to realize that water from spring thaws and heavy downpours also take a toll of that surface soil. The removing of the top soil exposes for crop production the subsoil which is much lower in nitrogen content and which generally does not have as much available plant foods as is found in the surface. In the somewhat degraded profiles found in this area there is often a slight increase in nitrogen content of the B_1 horizon over the A_2. That is, the leaching process has removed some nitrogen from the lower surface horizon and deposited it in the upper portion of the subsoil.

The average phosphorus content, calculated on the surface foot of four black soils, was 0.104 per cent; of eight shallow black soils was 0.085 per cent; of twenty-two dark brown soils was 0.072 per cent; and of nine brown soils was 0.059 per cent. The one podsolic (wooded) profile analyzed had 0.042 per cent. It is noted from these figures that there is a fairly even gradation down from black to brown; the podsolic profile is lowest in total phosphorus. The second lowest profile analyzed was a dark brown sandy loam with 0.048 per cent in the surface foot. The highest profile analyzed was a black lacustrine clay with 0.114 per cent. In the dark brown soil zone seven medium heavy to heavy soils averaged 0.079 per cent and twelve medium textured soils averaged 0.069 per cent. As can be seen from Table XVI the decrease in phosphorus content from the surface down is not nearly so great as is the case with the nitrogen. No analyses were made of the available phosphorus in these samples. In other profiles analyzed, however, the available phosphorus at pH3 varied considerably, but is usually highest in the surface horizon and in the B_{ca} horizon.

TABLE XVI.—Chemical Composition of Representative Soil Profiles

Sample No.	Depth in inches	Horizon	N (Per cent)	N upper 12″	P	P upper 12″	Ca	Mg	pH
		1.1.6—Loam in undulating area (Brooks)—24-18-17-4							
1215	0–2	A_1	0.17		0.050		0.42	0.32	6.4
1216	2–4	A_2	0.12		0.037		0.51	0.26	6.6
1217	4–12	B_1	0.17	0.16	0.059	0.54	1.40	0.99	8.6
1218	12–24	Bca	0.07		0.071		2.00	0.81	8.9
1219	At 30	C	0.06		0.017		2.15	0.81	9.3
		1.6.0—Sandy loam in undulating area (Countess)—18-21-17-4							
1236	0–5	Drift	0.08		0.046		0.55	0.22	7.3
1237	5–13	Surface	0.09		0.054		0.54	0.22	7.4
1238	13–25	Subsurface	0.06	0.08	0.046	0.051	0.53	0.25	7.6
1239	At 36	Subsoil	0.04		0.037		0.44	0.24	6.9
		1.7.2/6—Silty clay loam in level area (Gem)—5-23-16-4							
1245	0–16	A	0.22		0.075		0.72	0.60	6.0
1246	6–11	B_1	0.13		0.075		0.79	0.68	5.6
1247	11–17	Bca	0.09	0.17	0.077	0.075	4.94	1.36	8.1
1248	24–30	Lower Bca	0.06		0.068		3.65	1.46	8.1
		2.3.2—Loam in undulating area (Vulcan)—34-17-25-4							
1296	0–5	A	0.22		0.070		0.63	0.47	6.8
1297	5–16	A	0.07	0.13	0.065	0.067	0.61	0.68	7.2
1298	16–24	B_1	0.08		0.087		1.53	0.87	7.5
1299	24–32	Bca	0.02		0.079		7.76	1.23	8.5
1300	32–40	C			0.072		3.92	1.16	8.2
		2.7.2—Clay in undulating basin (Chancellor)—33-23-20-4							
1264	0–7	Surface	0.12		0.067		2.26	1.59	8.8
1265	7–14	Subsurface	0.11	0.12	0.067	0.067	2.42	1.62	8.7
1266	14–28	Subsoil	0.06		0.069		3.19	1.61	7.7

Sample No.	Depth in inches	Horizon	N	N upper 12″	P	P upper 12″	Ca	Mg	pH
			Per cent						
2.6.2—Loam in undulating basin (Arrowwood)—8-20-22-4									
1371	0–4	A	0.34		0.101		0.68	0.49	7.1
1372	4–10	Upper B_1	0.16		0.068		0.62	0.57	6.5
1373	10–16	Lower B_1	0.15	0.22	0.080	0.081	0.58	0.50	6.8
1374	16–24	Bca	0.10		0.080		10.82	1.62	8.4
3.3.2—Heavy loam in undulating to gently rolling area (Chestermere)—12-24-28-4									
1358	0–4	A	0.62		0.125		0.95	0.41	6.9
1359	4–12	B_1	0.14	0.30	0.043	0.070	0.48	0.48	6.0
1360	12–20	Lower B_1	0.11		0.068		0.53	0.57	6.5
1361	20–28	Bca	0.08		0.073		4.35	0.77	8.1
1362	At 36	C	0.04		0.073		2.81	1.03	8.1
3.5.0—Loam in level river flood plain (Little Bow)—30-18-28-4									
1393	0–6	Surface	0.42		0.099		2.55	0.83	7.7
1394	6–12	Subsurface	0.29	0.35	0.097	0.098	4.26	1.10	7.9
3.3.2—Heavy loam in undulating basin (High River)—11-19-1-5									
1398	0–7	A	0.45		0.114		0.75	0.54	7.4
1399	7–12	Lower A	0.24	0.36	0.086	0.102	0.55	0.59	7.3
1400	12–20	B_1	0.34		0.078		0.61	0.70	7.2
1401	20–26	Bca	0.12		0.075		9.38	1.23	8.0
1402	At 30	C	0.06		0.072		7.76	1.50	8.6
4.7.2—Clay in level to undulating basin (Black Diamond)—4-20-2-5									
1403	0–9	Surface	0.77		0.133		0.81	0.77	5.5
1404	9–18	Subsurface	0.37	0.67	0.056	0.114	0.63	1.14	6.4
1405	30–40	Subsoil	0.13		0.076		4.94	1.52	7.9
4.6.2—Heavy loam (silty) in gently rolling area (Sarcee)—28-22-2-5									
1410	0–11	A	0.52		0.097		0.83	0.66	5.8
1411	11–18	B_1	0.13	0.49	0.047	0.093	0.59	0.87	6.6
1412	18–30	Bca	0.11		0.076		5.91	1.39	7.0
1413	30–36	Lower Bca	0.08		0.077		9.74	1.65	7.8
6.1.2—Clay loam in wooded, gently rolling area (Foothills)—32-22-4-5									
1414	0–1	A_0 & A_1	0.42		0.097		0.94	0.50	5.8
1415	1–2	A_1	012		0.050		0.45	0.48	5.4
1416	2–5	A_2	0.07		0.027		0.38	0.48	5.5
1417	5–14	B_1	0.10	0.12	0.040	0.042	0.46	0.83	5.0
1418	At 20	Lower B_1	0.10		0.052		0.50	0.90	5.3

Many of the soil areas of these two sheets have a high lime carbonate content; particularly is this true of the alluvial soils along the Bow drainage. This lime possibly had its origin in the dolomitic ranges of the Rocky Mountains. The loams of the Arrowwood district, the silt loams of the Queenstown flat, and the sandy soils south of Gleichen all have a high lime subsoil; upwards of 25 per cent calcium carbonate. In these areas soil drifting has in many places exposed this high lime subsoil giving the fields a white patchy appearance (see Plate 6, fig. 2). In general the west half of the area has a higher lime content than the east half. In this west half the average calcium content of the subsoil or B_{ca} horizon is about 7.0 per cent as compared to about 4.0 in the east half. In the soils of normal profile the calcium content of the surface is usually slightly under one per cent. In some of the lacustrine clay soils the surface may have somewhat more than this. This is desirable since the calcium tends to produce a granular structure making for better tilth.

Magnesium analyses show an average of about 0.75 per cent in the surface foot, varying from 0.22 to 2.01 per cent. The C horizon analyses gave a variation from 0.80 to 2.50 per cent. Although there is considerable range in magnesium content, it does not seem possible to see any type or area correlation. However, it is possible to say that the average content is higher than in the surveyed areas on the east side of the province. That is, the soils adjacent to the mountains are in general higher in magnesium than those farther east.

The calcium and magnesium are, as a rule, lowest in the surface horizon and highest in the subsoil. This is accounted for by the fact that being slightly soluble they are carried downward by the penetrating rain water. Some of the surface soils contain twice as much calcium as magnesium and the subsoil samples up to four or five times as much calcium as magnesium. The magnesium of the soil is less soluble than the calcium and the plants demand less magnesium than calcium, thus the ratio is narrower in the surface than in the subsoil. From the figures given it should be noted that none of the soils of this sheet are deficient in either calcium or magnesium.

No potassium analyses were made on samples from the Blackfoot and Calgary sheets. Analyses on nearby areas, however, indicate that most Alberta soils average between 1.00 and 1.75 per cent. Due to the return of the potassium to the surface by way of the plant roots there is usually slightly more potassium in the surface than in the subsurface.

Some other essential elements for plant growth, namely, iron, sulphur and manganese, are generally present in large quantities, particularly in the grassland soils, in relation to crop requirements.

If the total quantities, as reported in Table XVI were converted into crops theoretically producible, it might seem that the supply of essential plant foods other than nitrogen and phosphorus is practically inexhaustible. However, the fact of the matter is that crop growth may be retarded by the lack of a certain element, even though there is enough of that element present to produce hundreds of crops. The explanation for this is that the essential elements dissolve slowly or become available slowly and only in their available form can they be used by the plant. The rate of solution can often be hastened by better methods of tillage and soil management and by rotation of crops. The decomposition of organic matter is more intense in fallow soil than in cropped soil. However, the percentage of organic matter in the brown and dark brown soil zones of these sheets is relatively low and therefore the amount of essential elements coming into solution by such a process might be limited. The black zones of these sheets are more favorably supplied in this respect.

Although soil moisture as a limiting factor in crop production should be emphasized in all soil zones, the importance of soil fertility should not be disregarded. Among other things the efficiency of a unit of soil moisture will vary directly with the concentration of the soil solution. This, in turn, depends on the amount of readily available essential elements so that, although there is an abundance of total plant food elements in the soil, the plant may be starved because there is not enough food readily available. Much of the available food is in the surface soil and the removal of this surface through soil erosion seriously reduces the immediate as well as the potential productive capacity of the soil.

The reactions of the profiles are given in Table XVI. From the figures it is seen that most of the profiles are very close to the neutral point. The surface soils average between 6 and 7 and the subsoils between 7 and 8.5. The higher pH in the subsoil is generally attributable to the presence there of free lime. The podsolic (6.1.2) profile reported in Table XVI is just over pH 5 to the sampled depth, namely 20 inches. The highest pH found was that of a subsoil sample from an alkaline profile in the Strathmore area. This sample had a pH of 10; that is distinctly alkaline.

ALKALI

Soils are formed by the weathering of rock materials and alkali salts come originally from this decomposed rock. Since some of the parent material is of marine formation it contains various salts, and these salts when set free by the decomposition of the rocks tend to accumulate wherever the rainfall is not sufficient to dissolve and carry them off in the drainage water.

Alkali lands usually occur in areas where the annual rainfall is less than twenty inches. Alkali generally appears in the valleys and depressions that receive the drainage from the surrounding soils and from which there is no drainage outlet. However, alkali may occur in level land that is not too well drained even though the land is slightly elevated.

The alkali salts are commonly classed as brown, black or white. Brown alkali consists chiefly of the nitrates. Black alkali consists chiefly of the carbonate and bicarbonate of sodium, and owes its name mainly to the fact that when this alkali salt is present it dissolves organic matter and produces a dark brown to black color. White alkali consists chiefly of the neutral salts, such as sodium sulphate, sodium chloride, magnesium sulphate, magnesium chloride, and the similar salts of calcium, and even at times potassium. The main salts of both the brown and white alkali are neutral in reaction and not alkaline, as is the case with black alkali.

Black alkali is the most toxic, and when present in quantities exceeding 0.1 of one per cent is often detrimental to plant growth. The white alkali is least toxic and seldom causes injury unless present in quantities exceeding 0.5 of one per cent. Black alkali deflocculates fine textured soil and causes it to become tough and impervious. White alkali has a less injurious effect upon the physical condition of soils and sometimes tends rather to produce a granular character which accompanies good tilth. The injurious effect of black alkali is largely caused by its corroding effect upon the plant roots; however, in the case of white alkali it is believed that the high concentration of salt outside the plant roots prevents water absorption. If the concentration of the salt outside the plant roots is sufficiently great the osmotic pressure would cause the water to be drawn from the plant roots into the soil, thus causing the death of the plant.

Many samples of soil, as well as some alkali incrustations, representing various soil types in the Blackfoot and Calgary sheets were analyzed; only a few representative profiles and samples, however, are reported in Table XVII.

Included in this table are four normal soils, viz., a 2.7.2 clay, a 2.3.2 loam, a 3.3.2 loam, and a 4.1.2 silty clay loam. These have very small quantities of water soluble salts, in all cases less than 0.1 per cent in the surface horizons. This is typical of the normal well drained soils of this area. The dark colored soils of the west side of the area were quite low in water soluble salts. Profile, number 1406 to 1409, is typical. No large alkaline collection basins were seen in the area and the draws were generally sufficiently free of salts to permit of normal crop growth. Many productive semi-arid soils contain from 0.25 to 0.50 of one per cent of water soluble salts. Most of the Alberta semi-arid soils contain less than 0.1 per cent total water soluble salts. Soils containing more than 0.50 of one per cent of total water soluble salts, exclusive of calcium sulphate, are justly viewed with suspicion but soils containing large quantities of gypsum (calcium sulphate), as do many of the soils of southern Alberta, will produce crops when they contain quantities of soluble salts which would be decidedly injurious were there no calcium sulphate present, since this salt, partly by its flocculating action, ameliorates the toxic effect of the other alkali salts. Although the percentage of water soluble calcium in these profiles is relatively low, many of the soils are high in total calcium. As stated previously, black alkali may be toxic in concentrations greater than 0.1 per cent. The sodium reported in this table was obtained by difference. That is, the sodium is calculated to make up the difference in positive ions necessary to link with all the anions determined.

Two profiles reported in Table XVII are of solonized soil, namely, the 1.1.6 loam and the 1.7.2/6 silty clay loam. The first profile, samples 1230 to 1235, is relatively low in water soluble salts. The parent material of this profile is mainly upper Bearpaw to lower Edmonton formation. The second profile, samples 1249-1253, is from a solonized laking basin. The parent material for this soil contains a fairly heavy concentration of salt, mainly sodium and calcium sulphate. These are both neutral salts. Under irrigation there has been some tendency for these salts to collect in lower basin areas in sufficient quantity to be detrimental. Adequate drainage facilities should be provided in these areas.

The remainder of the profiles reported in Table XVII are from low, generally poorly drained areas. Samples 1301 to 1305 is a profile from the Vulcan area. Analyses indicate that the principal salt is sodium sulphate (white alkali). Samples 1386 to 1387 is a profile from the Frank lake area. Its salt content is somewhat similar to the Vulcan area. Throughout this general area from Vulcan to High River there are some low salty collection basins. In many of these the concentration is sufficiently great to seriously affect normal plant growth. Salt can frequently be seen on hill slopes and in the road cuts as well as in the collecting basins. In many of these areas deep plowing just before seeding will turn down the alkali that has accumulated on the surface and will enable the seeds to germinate and the young plants to become established.

Samples 1364 and 1365 are surface incrustation from a fresh road cut; salts seeping out along the B_1 horizon line (see Plate 8, fig. 1). In this profile sodium sulphate is the principal salt. In the general area south and east of Calgary there is a considerable acreage of saline soils. These are mapped as profiles "5" and "4". These lower basins and drains vary in salt content from well below the toxic limit to patches devoid of any native vegetation. Samples 1258 to 1262 are from a normal well drained soil profile in this general area. Although extremely low in water soluble salts in the surface horizon the C horizon (parent material) has a fairly high concentration of sodium sulphate. It would appear that under the available rainfall in this district the salts are capable of moving laterally in the soil, possibly through somewhat lighter textured lenses, to lower positions. These alkali spots tend to cut up the fields and cause some unevenness of crop growth.

Samples 1315 to 1317 is a profile from a low basin in the irrigated Strathmore sandy area. Although no other samples have yet been analyzed from this area, this one was sampled as being typical. The total salt content to the sampled depth is not high, but there is an appreciable quantity of sodium carbonate and sodium bicarbonate and practically no calcium sulphate (gypsum). This was the only profile analyzed from the two sheets that had a measurable quantity of water soluble sodium carbonate. The B_{ca} horizon had a pH of 10, the highest determined. The principal vegetation on this, as on similar surrounding areas, was alkali grass. They are inferior soils with little value at present. Although alkali collection basins are found in most of Alberta's irrigation areas the sandy soils usually have the greatest percentage of alkali waste. This is due to the ease of lateral movement of water through the soil to lower positions. Adequate drainage, by keeping the water table down, will tend to keep these areas from increasing in size, thence ruining more land.

In a general way the area from Vulcan to High River and the area from Calgary to Gleichen has naturally a relatively high salt content. These salts tend to move in the soil—movement is accelerated by irrigation—and collect in the lower positions. As a result both these general areas have considerable waste land as well as lands that are productively slightly inferior. Some alkali collection basins are found in the Bassano-Brooks irrigation area, particularly in the lighter textured portion.

TABLE XVII.—Water soluble or alkali salt of the Blackfoot and Calgary sheets

Sample No.	Location	Horizon	Depth in inches	Remarks	Non-volatile solids	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na	pH
1230-1	9-18-16	A	4-7	1.1.6 loam. Typical of much of the	0.03								6.6
1232-3	"	B_1	7-15	solonized soil of the southeast	0.04								8.6
1234	"	Bca	15-20	corner.	0.38	.055		0.13	.246	.010	.002	.109	8.0
1235	"	C	20-30		0.22	.067		.009	.144	trace	.001	.097	8.5
1249	5-23-16	A & drift	0-5	1.7.2/6 Si.C.L. Level irrigated	trace								6.0
1250	"	A	5-9	area at Gem. This profile solon-	0.19								7.0
1251	"	B_1	9-16	ized.	1.34	.037		.119	.996	.117	.013	.389	6.9
1252	"	Bca	16-24		1.05	.028		.034	.808	.101	.009	.282	8.3
1253	"	Lower Bca	24-30		0.90	.024		.020	.624	.057	.007	.243	8.3
1264	33-23-20	Surface	0-7	2.7.2 clay. Undulating basin. All	0.10								8.8
1265	"	Subsurface	7-14	cultivated.	0.10								8.7
1266	"	Subsoil	14-28		1.61	.026		.012	1.156	.208	.006	.472	7.7
1296	34-17-25	A	0-5	2.3.2 loam. Undulating area all	trace								6.8
1297-8	"	B_1	5-24	cultivated. Typical of Vulcan	0.02								7.4
1299	"	Bca	24-32	loams.	0.04								8.5
1301	19-17-25	Surface	0-6	2.5.5 C.L. Typical of many low	0.60	.037		.009	.438	.027	.003	.318	7.9
1302	"	Subsurface	6-12	lying soils of this area.	2.48	.024		.010	1.812	.130	.003	.700	8.4
1303	"	Subsoil	12-24	-	1.94	.020		.012	1.344	.030	.002	.635	8.9
1315	14-23-25	A_2	0-2	2.5.5 Lt. loam. Typical of low	0.06								8.5
1316	"	B_1	2-9	basins in this area.	0.10	.112	.023						9.7
1317	"	Bca	9-16		0.39	.070	.048	.018	.188	trace	.001	.162	10.0
1358	12-24-28	A	0-4	3.3.2 loam. Undulating area all	0.04								6.9
1359-60	"	B_1	4-20	cultivated. Typical of Calgary-	0.03								6.3
1361	"	Bca	20-28	Carsland loams.	0.05								8.1
1362	"	C	At 36		0.89	.037		.012	.680	.016	.010	.435	8.1
1364	3-24-27	Crust	At 12	Crust from exposed B_1 horizons	3.28	.055		.018	2.244	.023	.003	1.074	8.8
1365	19-23-29	Crust	At 12	in 2.5.5 areas.	3.39	0.17		.026	2.370	.093	.008	1.037	8.6
1386	13-19-28	Surface	0-8	3.3.4 loam. Low spot in Blackie	2.71	.009		.036	2.000	.184	.008	.759	7.2
1387	"	Subsoil	10-20	flat.	4.86	.016		.117	3.520	.136	.015	1.584	8.6
1406	34-21-3	A	0-8	4.1.2 Si.C.L. Typical of heavy	0.02								6.6
1407	"	B_1	8-18	textured foothill valleys.	0.02								7.2
1408	"	Bca	18-24		0.04								8.3
1409	"	C	28-36		0.04								8.0

PRESENT UTILIZATION

This section of the report gives a brief description of the farm practices at present used in the area and cites some of the more pertinent problems arising from these practices. A description is also given of the land rating map which accompanies this report.

FARM PRACTICE

The ultimate purpose of the soil survey is principally to locate and map areas of soil according to their agricultural desirability. Each area on the soil map carries a three digit number as well as the soil texture designation (see page 37). Each of these numbers indicates a specific characteristic of the soil profile and each of these affects the soil's adaptability or possible utilization. Included in this report is a possible land utilization map of the Blackfoot and Calgary sheets. There are eight grades of land mapped in this area. Grading from poor pasture, non-arable, to excellent arable land. These grades are calculated from the physical data obtained in the field on the basis used in this survey, namely, traverses one mile apart; the economic and social factors, excepting in so far as they have determined the kind and yield of crops grown, did not enter into this classification. A fuller description of this map is given on page 100 under the heading of Soil Rating Map. Lands vary in their productive capacity and adaptability and it is generally recognized that many of the failures on Alberta farms are attributable to an incorrect utilization of those land areas. In this regard the best utilization of any land area will tend to get the most economical return from the land without causing any unnecessary immediate or permanent deterioration.

It has been stated earlier in this report that the rainfall decreases fairly rapidly from west to east. As a result farm practices that are applicable for one portion of the area are not satisfactory in another portion. Undoubtedly the limited rainfall is an important factor affecting the agricultural practices of the eastern portion of the area. In this area particularly and, to a limited extent in the western portion of the area, how best to utilize the soil's moisture is a major problem of crop production. Since, up to a certain limit, increased available moisture means a greater rainfall efficiency in the crop produced, every effort should be made to efficiently utilize as much of that moisture as possible. This means such things as conservation of moisture by fallow, prevention of run-off as much as possible, the prevention of loss of moisture by transpiration through weeds, and the growing of crops best suited to the soil and moisture conditions.

Experiments at Swift Current Experimental Station show that wheat on fallow only required about two-thirds as much rainfall to produce a bushel of wheat as did a crop of wheat following wheat. This illustrates what was said above, namely, that increased available moisture means a greater rainfall efficiency. In the drier sections it seems that a one-crop wheat fallow system is the most logical one to use.

However, the one-crop farming system tends to reduce the soil's supply of organic matter, and of nitrogen also, since the soil nitrogen is very largely held in the form of organic matter. Organic matter is constantly decomposing in the soil. The stubble and roots of grain crops, together with any residue from weeds that may have grown on the land, are sources of organic matter. When the land is fallowed the increased air and moisture favor a more rapid decomposition of the organic matter and at the same time no new organic matter is added to replace that which is decomposed. Experiments conducted at the University of Alberta show that the accumulation of avaiable plant foods, particularly nitrate nitrogen, is much greater at the end of the season on land under fallow than on land that has been cropped. It is, therefore, not difficult to understand why this system of farming tends to exhaust the soil's supply of readily decomposable organic matter.

Analyses conducted at the University of Alberta indicate that there is a drop in the nitrogen and carbon content of cropped land as compared with the native sod. Most of the fields sampled for these analyses have been cultivated for over twenty years and have been on a grain fallow rotation.

Normally a rotation that would maintain the percentage of organic matter in the soil and therefore its nitrogen content is to be recommended over the one-crop grain rotation. Organic matter also increases a soil's water-holding capacity. An average soil may hold from 15 to 40 per cent water when saturated, whereas organic matter may hold from 50 to 200 per cent at saturation. These rotations include grass and clover crops, and such rotations must be used if the fertility of these soils is to be maintained. The incorporation of fibrous organic matter into the lighter textured soils of this area will not only tend to increase its fertility but will materially aid in preventing soil drifting. The light to medium textured soils, particularly of the more arid sections, are naturally low in initial fertility. Continuously removing plant food from these soils without an adequate return may soon become apparent in the yield produced.

The wheat fallow rotation, if properly conducted—and this means, as stated above, the periodic inclusion of a hay crop—will give a relatively high rainfall utilization factor. The fallow cannot be expected to conserve moisture, however, unless weed growth is controlled throughout the entire season. Since each cultivation tends to pulverize the soil and encourage soil drifting, tends to dry the soil out and tends to increase the cost of production, each extra cultivation needed to control the weeds must be considered as having some detrimental effects.

The one crop rotation has another objection, and that is it aggravates the problem of soil drifting. Practically all Alberta soils will drift after ten or fifteen years of the one-crop grain farming system, which destroys the soil fibre unless adequate provision is made for its replacement. This is particularly true in years of low rainfall and high winds. Soil drifting has not appeared to be a serious problem over the entire area, although some individual areas have been seriously affected. Of these might be mentioned the Milo-Majorville area of sorted loams, some loams west of Lake McGregor, some of the loams around Arrowwood, the sandy area east of High River, and some of the dry land sands in the Strathmore district. Light sandy soils and heavy clays are generally the most subject to drifting. Most of the clay mapped in this area lies in the foothill valleys where soil drifting is generally not a problem, and a large portion of the sandy soils around Strathmore is under irrigation, which reduces considerably their tendency to drift. A small area of sandy soil just east of High River has drifted rather severely; upwards of two feet of surface soil has been lost in some places. Sweet clover has been included in the rotation on much of this area to very noticeable advantage.

Possibly the worst drifting in the area has occurred in the Milo-Majorville district. Drifting has been so serious that the white subsoil is exposed in many places. The loss of this surface soil is of serious consequences, for in the surface is found a large percentage of available plant foods. The cost in dollars to replace this plant food would reach surprising amounts. This area, being on the eastern edge of the dark brown soil zone, has a shallow surface so that, relatively speaking, the loss of two or three inches of surface soil from this area is more serious than a similar loss from the deeper black soil zone. Such deterioration cannot be allowed to continue if we are to have soil to cultivate for more than one generation.

A discussion of the methods of controlling soil drifting has occurred elsewhere in printed form, but it is not out of place to outline here a few methods that are applicable to this area. Two are outstanding in their application, namely, the practice of strip farming, and the use of the plowless fallow. Strip farming alone cannot be expected to completely control soil drifting. It does prevent the accumulated effect of drifting soil. It has certain objections such as being a little more difficult to farm than the larger fields and increasing insect damage. At least one field in the Arrowwood district was seen that was using the double or insect trap strip. This may tend to eliminate the insect damage objection to strip farming. The plowless fallow seems to be attracting more attention each year. It not only has proved effective in aiding in the control of soil drifting, but it is generally a more economical operation than plowing. Some farmers, particularly in the western half of the sheet feel, however, that periodic plowing of the fields is desirable. It not only gives a deeper mixing of the surface materials, but also tends to return the soil to the more desirable lumpy structure. The use of the plowless fallow depends on the fact that there is some stubble or trash on the surface. If, due to extreme drought, the land is practically bare, the plowless fallow may leave the land surface more vulnerable to the winds than the plowed fallow. In such cases listing may have to be resorted to. Experiments indicate that wheat yields on plowless fallow are at least as great as on the plowed fallow. The trash cover, particularly if fairly heavy, also aids in holding the winter snows, adding to the spring reserve of moisture.

Windbreaks of trees have a definite place in the control of soil drifting. These windbreaks have a distinctly protective effect on the leeward side, but care must be taken to see that they do not become merely a trap for drifting sand and weeds. Cover crops on fallow are being used to a considerable extent, particularly in the west half of the area. The field so covered may or may not be cultivated in the spring before seeding. Fall sown crops can be quite an effective protection against fall and early spring winds as well as winter winds when the fields are bared of snow. In the west half of the area where the rainfall averages from 15 to 20 inches annually, the loss of moisture by this cover crop is not as serious as it would be in the drier eastern portion of the area.

A few cases of water erosion were seen in this area, particularly in the medium to heavy textured soils where some small gullys have started to form. It should be remembered that heavy downpours as well as spring run-off water annually takes a toll of surface soil from cultivated fields, particularly if these fields are on a slope. Leaving the land in the fall in such a condition that it will hold snow and water will cut down the spring run-off considerably and lessen the annual loss of soil. Contour farming may yet be considered as an extreme measure but, for example, if the land were cultivated across the slope rather than with it, each furrow would act as a check dam rather than a water course.

The accumulation of alkali salt is a problem in some portions of the area. This, however, is discussed under the section on alkali. Soil types vary in their productivity as well as in their response to cultural and other treatments. These differences are discussed in the section on soils which describes the various soil areas.

Since it is considered out of the realm of this report, no attempt will be made to designate the type of crop best suited to the area. In determining the crop, however, such things as the rainfall, evaporation, frost-free period, and the soil type must all receive consideration. For more detail on cropping practices representatives of the Dominion and the Provincial Departments of Agriculture may be consulted.

This discussion under farm practice for the Blackfoot and Calgary sheets has, up to the present, been confined principally to the growing of crops. Although ranching in this area, as in most of southern Alberta, has gradually given way to crop production, there still is a fairly large stock production. Some ranches still operate in the area, but the greater percentage of the stock is to be found as small herds on the individual farms. During the last few years upwards of 20,000 head of cattle and 2,000 head of horses have been shipped from this area annually.

In the description of the various soil types and on the utilization map certain areas are designated as useful only as grazing lands. The hilly areas, between Majorville and Bassano, east of Hussar, and south of Arrowwood in the Buffalo hills, have been designated as pasture lands. Much of the foothills area is pasture. In the south half of the Calgary sheet the foothills are mainly grass covered. However, the northern half is mainly wooded and therefore also has value for other than pasture use. This foothills area is well supplied with water and produces a fairly luxuriant growth. At the present time many of the valleys are cultivated and grow hay crops as well as cereals. Since there is a definite frost hazard, it lends itself to mixed farming and ranching. The pasture lands adjacent to Majorville and east of Hussar are on the eastern edge of the dark brown soil zone and in places carry over to the brown soil zone. Dams and wells supply stock water in this area. The grass in this area, although short, is quite nutritious. Caution must be taken at all times to prevent overgrazing which reduces the carrying capacity and induces soil erosion. Very little of the brown soils east of Bassano is cultivated for dry land farming; that is, the areas not irrigated are used as pasture. This area, being immediately adjacent to irrigated land, is able to use the irrigated crops as a source of winter feed. A large portion of the Blackfoot Indian reserve is used as pasture land, particularly the area south of Gleichen. Much of this area is of a light sandy nature and should not be cultivated. Overgrazing on sandy soils may bring serious consequences. Once the surface soil loses its vegetative protection, moving sand dunes may result. The amount of land left as pasture in the Buffalo hills is now quite small; since this area receives a fairly high rainfall these hills produce a good stand of grass. On the larger pasture areas described above are found mainly the stock of the rancher and rancher farmer, that is, the larger herds. A few of these herds, particularly in the foothills area, have been established for a long time.

Scattered throughout the cultivated area are small patches of non-arable land; these patches together with seeded pastures are used by the farmers for their small herds. Nearer to the city of Calgary there are many herds of dairy cows used to supply the city's milk requirements. These small herds of cattle maintained by the farmer are usually profitable, using up feed that might otherwise be waste. Small flocks of sheep are found on some of these farms. The only large flocks of sheep seen in any of this area were in the solonized brown soils of the southeast corner.

It was stated earlier in this section that the most desirable utilization of any land area means getting the most economical return from that area without causing any unnecessary deterioration. This applies equally well to pasture lands. Overgrazed lands mean greater spring run-off, greater erosion and evaporation, as well as proportionately less growth. Pasture land should be grazed on a long term carrying capacity basis. This might actually mean undergrazing during a wet cycle of years. Economically there is little profit in increasing a herd during good years and then having to sacrifice that herd during the dry years. This principal applies equally well to the supply of winter feed; a carryover in a wet year may alleviate an otherwise shortage during a dry year. The stockman who works in co-operation with the irrigationist eliminates to a great extent the seasonal fluctuation in winter feed supply.

The size of farm unit that would provide adequate returns under such practices as have been briefly considered above would vary with the soil type and with the zone. The arable unit would naturally be larger in the eastern portion of the area. In the drier eastern section land should be fallowed every second year and should periodically be seeded to grass. To pursue such a practice, essential for any permanent form of agriculture in this area, a farm unit of considerable size is necessary to make an economic unit.

Irrigation in this area is discussed under a separate heading.

IRRIGATION

In 1878 a rancher by the name of J. Glenn constructed a ditch in section 3, township 23, range 1, W. 5th, to take water out of Fish creek to irrigate a small parcel of land. This parcel was close to the present site of the village of Midnapore, some 10 or 12 miles south of the city of Calgary. As far as is known, this was the first attempt to irrigate land in the province of Alberta. At the present time in Alberta there are nearly 1,000,000 acres of irrigable land under the ditch. Of this total about 275,000 acres lie in the Blackfoot sheet. What is known as the Canadian Pacific Railway irrigation projects make up most of this total. These projects were established in 1903 by the C.P.R. The eastern section, which extends from Bassano to Tilley, started operating in 1914 and the western section, which extends from Strathmore to Cluny, started operating in 1907.

The western project takes water from the Bow river at Calgary, uses Chestermere lake as a reservoir, and irrigates an area from north of Carseland to Cluny. This area has a surveyed irrigable acreage of nearly 220,000 acres, although much less than that is actually irrigated. The eastern project takes water out of the Bow river just south of Bassano. A dam built across the river at this point—section 1, township 21, range 19—backs the water up to a point just west of Crowfoot. Water from this dam is carried to areas between Bassano and Rosemary, to Gem, southeast to an area between Lathom and Brooks, southeast via Coyote coulee to Rainier, and to Lake Newell south of Brooks, to be used to irrigate the area between Brooks and Tilley. The greater portion of this project, in all about 275,000 surveyed irrigable acres, lies east of the Blackfoot sheet. This survey has calculated that about 40,000 acres are at present irrigated in that portion of the Eastern Irrigation project lying inside the Blackfoot sheet.

Some irrigation is at present practiced in the Blackfoot Indian reserve south of Bow river. This project uses water from the main canal that feeds Lake McGregor. This project is in the process of development. A little irrigation is also carried on in the Bow river flat southwest of Gleichen, using spill water from the western section. Water from the Lake McGregor reservoir is used to irrigate lands to the south and east of the Blackfoot sheet, principally around Vauxhaul.

Irrigation ditches, now dry, were seen leading from the Highwood river just west of High River and leading from Quirk creek at the forest reserve boundary. Flood irrigation has been practiced in the Bar U ranch in township 17, range 2, W. 5th.

The construction of irrigation projects in southern Alberta has, in many cases, turned a treeless semi-arid plain subject to great climatic fluctuations into areas producing a luxuriant growth and dotted with groves of trees (see Plate 4, fig. 3).

In the arlier days of irrigation cereals, mainly wheat, formed the principal crop. However, the picture is gradually changing and, although wheat still is a major crop on most of the projects, more and more acreage is devoted to such crops as alfalfa, sugar beets and vegetables for seed and canning purposes.

It is fairly generally recognized that the high capital cost of irrigated lands, plus the cost of applying water, makes such land too costly to grow wheat in competition with the dry land farm, that is, to grow wheat to the complete exclusion of all other crops. Alfalfa, sugar beets, potatoes, peas, fruits and vegetables for canning, etc., are generally recognized as irrigation crops. In the past the markets for these crops have been limited and in many respects are still limited. That is, the production of these more specialized crops can only be expanded as the market warrants. It should be pointed out here that since some of these intertilled crops have a relatively long growing season, the variety of crops grown on the more northerly irrigation projects of Alberta may not be as great as on those in the extreme south.

Much of the alfalfa grown on the irrigation projects of this area is used to feed stock maintained on the irrigation farm. Some, however, find an outside market and some is used to feed the range stock from surrounding ranches. The maintaining of some live stock by the irrigationist is valuable, not alone for the additional source of revenue obtained, but also for maintaining the fertility of the irrigated land. Barnyard manure adds fibre as well as minerals to the soil and the inclusion of alfalfa in the rotation is not only considered advantageous but imperative. It is believed that the irrigationist and the rancher can work in close co-operation to material advantage. The irrigation farmer needs a steady outlet for his surplus hay and the rancher needs the insurance of a reliable source of winter feed. Wintering range cattle on the irrigation farm provides winter employment on the farm as well as valuable fertilizer for this farm. At this point it might be well to again point out that, since irrigated land is valuable land, maintaining or increasing the productive ability of that land is of prime importance. The addition of fertilizers and maintaining adequate rotations are both essential in the maintaining of that fertility. The Dominion Experimental Farm at Lethbridge or the local district agriculturist can supply information on adequate rotations for the irrigation farm.

Earlier in this report it was intimated that any change in the amount or kind of crops grown was governed in a large measure by the market for these crops. Apart from markets, there are other major irrigation problems in southern Alberta; two of these are—alkali, and the supply of water. The first is an immediate problem; the second, although felt to some degree at present, is more concerned with the long-time future development of irrigation.

All arid and semi-arid soils contain some water-soluble alkali salts. The parent rocks from which they are formed determine largely the kind and amount of these salts. Under dry land conditions in Alberta these salts, being below the toxic limit, generally do not cause an alkali problem. However, under irrigation, the concentration of seepage water with its load of salt in the lower areas renders some of these areas non-productive (see Alkali, page 86). Where such areas exist provision for adequate drainage should be made, otherwise the seepage spots may grow in size, ruining more land each year. Before new projects are constructed the possibility of an alkali problem in the area should be considered and precautionary steps taken to prevent the ruination of productive land. Over-irrigation and flooding may cause an alkali problem on land that normally has adequate drainage. The excess water if it returns to the surface will bring with it the salts dissolved from the lower soil horizons.

As stated previously, the problem of a sufficient supply of irrigation water is beginning to be manifest, and as larger acreages are brought under the ditch this problem may become an acute one. The solution of this problem lies in two directions. The first is the maintaining of a sufficiently dense vegetative mantle in the mountains to hold the winter snow and to prevent the too rapid melting of that snow during the spring and summer months. To do this means the prevention of forest fires and the controlled cutting of the forested areas. The loss of the protective covering on the mountain slopes increases the flood hazards in the spring as well as greatly lessening the later summer river flow. The other phase of the solution lies in the construction of reservoirs to impound some of the excess spring waters for use in the later summer.

Another factor in the successful operation of an irrigation farm should be considered and that is the soil type. All soils do not respond equally to the application of irrigation water, nor is the same management applicable to all soil types. In general, three soil types are found in the irrigated areas of the Blackfoot sheet; they are (1) medium to coarse sandy deposits, (2) medium textured deposition soils over glacial till, and (3) some medium to heavy textured soils with a solonized profile. Light textured sandy soils are irrigated in the Strathmore district and between Countess and Rosemary. Sandy soils do not satisfactorily hold the irrigation water and, partly due to the ease of movement of water through soils of this type, alkali problems may arise. Seepage water travelling laterally through the sandy subsoil, dissolving salts as it goes and bringing these salts to the surface in lower areas, may cause alkali or seepage spots so formed to grow in size. The land so saturated is rendered practically useless for crop production. Such loss of land under the ditch can be ill afforded. Adequate drainage, if practicable, is at least a partial solution. Avoiding the application of any excess water during irrigation is very desirable in sandy areas. Where the main canal or large ditches pass through a sandy area, seepage water tends to collect in the lower areas. At the present time, particularly in the Strathmore district, there are some low spots that have a fairly heavy concentration of alkali salt due to this lateral seepage. It should also be added that sandy soils are generally low in initial fertility and may require building up, by the addition of organic material, by the use of legumes, and by the addition of fertilizers. Most Alberta soils will respond to the application of phosphatic fertilizer after ten or more years of irrigation. The medium textured loams lying east of the Strathmore sandy area are fairly good irrigation soils. To date these soils have not presented any serious alkali problem. The areas around Gem and around Southesk are medium to heavy textured and have a high percentage of solonized soils, that is, soils characterized by a very heavy textured, waxy B_1 horizon. This soil is definitely inferior under dry land conditions. However, under irrigation it tends to loosen and often after three or four years the waxy impervious nature of the B_1 horizon disappears. Deep cultivation and the inclusion of organic materials in this soil will add to its general desirability for crop production.

Irrigation, particularly in the brown soil zone, is recognized as a valuable asset to the general prosperity of the area. More lands of a selected character are capable of being irrigated and will be as economic conditions warrant. It seems logical to suggest that since their installation represents a large capital outlay, all information pertinent to their successful operation should be obtained and adequate measures should be taken to insure a sufficient and uniform supply of water to these projects.

SOIL RATING MAP

Accompanying this report is a suggested soil rating map of the Blackfoot and Calgary sheets on the scale of six miles to the inch. This map divides the area into 8 land classes: three pasture and five arable. No attempt has been made to state the type of crop that should be produced on the arable land. The map is applicable only under dry land conditions.

The data on this map are based mainly on the physical characteristics of the area. In making the map, such physical data as soil texture, soil color, mode of deposition, the type of soil profile, degree of stoniness, topography, relief, alkali, rainfall, and rainfall variability were all taken into consideration. Each of these factors was given a number value for each soil area, and the multiplying together of these values gave the final index rating of the soil area. With the aid of pasture carrying capacity data and with wheat yield data obtained from government statistics and the Alberta Economic Survey, P.F.R.A., a suggested productivity grouping of these rated areas was obtained. These groups carry a number and a legend on the map: Group 1 is poor to fair pasture, group 2 is fair to good pasture, group 3 is good to excellent pasture, group 4 is poor to fair arable land, group 5 is fair to fairly good arable land, group 6 is fairly good to good arable land, group 7 is good to very good arable land, and group 8 is very good to excellent arable land. It is realized that this grouping is based on past performance under existing farm practices.

The introduction of more drought resistant varieties of farm crops, the introduction of improved farming methods as well as a change in economic requirements might, for example, shift the dividing line between pasture and arable land. It must also be noted that the number of quarter sections of land necessary to constitute a self-sustaining unit varies from class to class.

It is practically impossible to set any definite productivity limits for these groups. The following tentative limits, however, are suggested to give an approximate idea of the productive capacity of the various groups. Group 1 areas would take over 40 acres to pasture one head of cattle and group 2 areas would require between 20 and 40 acres per head. Group 3 soils would take under 20 acres per head. Group 5 soils over a long term of years have produced from 12 to 15 bushels of wheat per seeded acre, and group 6 soils have produced from 15 to 20 bushels of wheat per seeded acre. Group 7 soils have produced from 20 to 25 bushels per seeded acre and group 8 soils have produced over 25 bushels. Group 4 soils in general have produced less than 10 to 12 bushels. Some farmers in this area have exceeded these yields.

APPENDIX

THE RELATION OF THE GEOLOGY TO THE SOILS IN THE BLACKFOOT AND CALGARY SHEETS

By JOHN A. ALLAN

INTRODUCTION

The distinction between rock and soil is a physical one. No sharp line of demarcation can be drawn between materials that are classed as rock and materials that are classed as soil.

Geologically, soils may be regarded as young deposits of Pleistocene or Recent ages and are unconsolidated rock. The inorganic part of soil consists of mineral and rock particles which vary in size and shape, but these particles have been derived at some time and in some way from solid rock formations. This unconsolidated mantle of weathered rock material when acted upon by organic agencies and mixed with organic matter may contain the required conditions to support vegetable growth. When rocks are exposed at the surface, various chemical and mechanical agents of erosion act upon the rock surfaces and slowly transform the solid rock into soil. The more soluble constituents in the rock are first affected and the structure of the rock is weakened. The less soluble portions of the rock remain to form the regolith or unconsolidated mantle which may be further broken up by mechanical agents of erosion to produce gravel, sand, clay or silt. If the rock debris produced by weathering is not removed by other agents then the product is residual soil; that is, soil that has been formed *in situ* from the underlying rock. Soils formed in this way will have some of the physical and mineral characteristics of the underlying rock.

Mineral soils are formed from the decomposition and disintegration of rocks, but all soils are not formed from the rock immediately underlying the soil. There are four major processes in the development of soil; namely, decomposition, disintegration, transportation and deposition.

Most soils have been transported from their original source and become mixed during the process of transportation. The three principal transporting agents are wind, running water and ice in the form of glaciers. However, transported material must eventually come to rest and here the fourth process in the development of soil, namely, deposition, results. The material transported by wind or by glaciers may be deposited

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on a land surface. Such deposits transported by wind are known as dune, eolian, or some loess deposits. Moraines are deposits left from the melting of glaciers. Water transported material is usually deposited in bodies of water, such as lakes, giving rise to lacustrine deposits, swamps as palustrine deposits, and along the margin of river courses as alluvial soils. In water transported deposits there is greater sorting action and the finer particles will be carried farther than the coarser particles. Such deposits might vary from the finest clays and silts, and even colloidal particles, up to the coarsest of gravel. This fact often explains why the texture of a soil may change materially even within the same section of land. During the process of transportation many kinds of rocks become mixed and the soils produced from these transported deposits may be heterogeneous mixtures and of complex mineral composition as, for example, a soil produced from the weathering of an interbedded-sandstone-shale formation will be different from a soil derived from a shale formation, or from slate and granite rock debris, and so on.

There is still another kind of unconsolidated material influenced by water transportation. Rain falling upon any kind of surface deposit such a glacial moraines, residual soils or wind deposits may wash out the finer rock particles and deposit them further down the hillside or on the flats at the bottom of the slopes. These are known as alluvial fans or outwash plains. The character of the soil in these outwash areas might be quite different physically and even chemically from the soil on which the outwash has become deposited.

These introductory notes on the origin of soils are given to make it clear that there is frequently an obvious and close relationship between the kind of soil and even the depth of soil in an area and the geology of the district. There is obviously no sharp line of demarcation in surficial unconsolidated deposits between what may be called soil and what may be called gravel, sand, till, or boulder clay. In some parts of Alberta, particularly in the mountains, or in the Precambrian rock area in northeastern Alberta, certain types of vegetation grow on gravel deposits and even in fractures on rock surfaces void of soil. In the latter case the plants derive their food from the decomposed products of minerals in the solid rock. If the rock contains potash-bearing minerals, the rock decay will produce potassium carbonate which is favorable to plant growth. Other rocks with a phosphate content or a gypsum content will support a luxuriant plant growth even though the soil is scarce.

There are phosphatic rocks within the Rocky Mountains in the vicinity of Banff, in the western part of the Calgary sheet, from which some of the soils east of the mountains have been derived. There is also a small potash content in some of the rocks within the mountains, but these chemical constituents have influenced only to a very slight extent the soil composition east of the mountains. Potassium minerals also occur in the glacial debris that has been transported into this map-area by ice from the Precambrian shield west of Hudson Bay, but no concentration of potash-bearing minerals occurs in the Blackfoot and Calgary sheets. There are very limited areas of solid rock exposed in this area, except along the sides of the Bow valley and some of its larger tributaries, such as the Jumpingpound, Elbow, Fish, Sheep, Tongue, Highwood and Little Bow rivers, and smaller tributaries such as West and East Arrowwood creeks, Lake McGregor, Crawling valley and Crowfoot creek. However, the conditions of soil origin, as suggested above, occur throughout the Blackfoot and the Calgary sheets.

The map-area discussed in this report includes the whole of the Blackfoot sheet and that part of the Calgary sheet east of the Rocky Mountain Forest Reserve boundary, principally within ranges 1 to 4 west of the fifth meridian, and townships 17 to 24 inclusive. In addition, it includes range 5, north of Elbow river in townships 23 and 24.

The entire map-area has been traversed to obtain geological data but only about three weeks were spent in the field examining the unconsolidated surficial deposits in relation to soil distribution. On this account the following notes must not be regarded as a complete geological report on the surficial deposits in the Blackfoot and Calgary sheets. The geological map (Plate 9) shows the distribution of the geological formations within the Blackfoot sheet, and within the eastern six ranges in the Calgary sheet, which includes parts of Moose Mountain and the Highwood range within the inner foothills belt and eastern side of the Rocky Mountains.

Some of the more prominent geological features responsible for the distribution of several of the soil types shown on the accompanying soil survey map are recorded. More extensive and more detailed observations would have to be carried out in the field before all soil types in every part of the area mapped could be interpreted more accurately. A correct interpretation of the soil occurrences requires not only a knowledge of the sub-surface geology and the structure of the rocks underlying any area, but also the source of the transported soil and the sorting or mixing processes which have occurred since the transported material has been deposited by these various agents. It would also require a detailed knowledge of the history of the glacial deposits and the way in which these deposits were formed. These precise data are not yet available in some parts of the Blackfoot and Calgary sheets.

PHYSICAL FEATURES

The major physical features and the general character of the surface of this map-area have been adequately described in the earlier part of this report under the heading "Description of Area" in those sections dealing with topography and drainage, and will not be repeated except where the geology and the physical features are quite closely related.

The surface relief in any map-area may be shown by means of contour lines, that is, lines drawn through points of equal elevation at definite intervals. The contour lines have been omitted from the soil map accompanying this report to avoid confusion in reading the map. The Blackfoot and Calgary sectional sheets have been published by the Topographical Survey of Canada on a scale of one inch to three miles, on which are shown contour lines with 50-foot contour intervals. Precise level lines have been made by the Geodetic Survey of Canada along the main line of the Canadian Pacific Railway and along the north-south branch line from Calgary south to Nanton. Levels have also been determined along other railway branch lines. Bench marks have been established and altitudes determined along the Fifth Base Line, which is between townships 16 and 17, and which defines the south boundary of this map-area; along the Seventh Base Line between townships 24 and 25 which defines the north boundary of the map-area; and along the Fifth Meridian between the Blackfoot and the Calgary sheets.

The surface of the Blackfoot sheet lies entirely within the plains area with elevations ranging from about 2,400 feet above sea-level at the east side of the Blackfoot sheet, to above 3,650 feet at the west boundary of this sheet along the Fifth Meridian. There are two higher points in the Blackfoot sheet, these are Buffalo Hill (3,860 feet) in the south-east of section 17, township 19, range 23; West Arrowwood Hills (3,760 feet) in the southeast section of 20, township 19, range 24; and Sitook-Spagkway (3,860 feet) in sections 4 and 5, township 20, range 29.

The surface of that portion of the Calgary sheet included in this map-area consists of the western edge of the plains area and the eastern part of the foothills belt. No sharp line separates the plains from the foothills, but the western edge of the plains is approximately along a line drawn from the junction of Pekisko creek and Highwood river, northwest through Black Diamond east of Turner Valley, along Calling valley to Priddis, and to the vicinity of Jumpingpound postoffice about the centre of range 4, in township 24. The lowest elevation along the east side of the Calgary sheet is about 3,400 feet above sea-level, except in the Bow valley where the elevation is 3,300 feet on the Fifth Meridian. In the foothills belt within this map-area and along the boundary of the Forest Reserve the elevation varies from 4,700 feet in Bragg creek and the Elbow river, to 5,600 feet above sea-level north of Sullivan creek.

The drainage pattern in the Blackfoot and Calgary sheets is quite definitely shown on the accompanying soil map by the distribution of the eroded area. The drainage is fully discussed in the earlier part of this report and so will not be repeated. Many most interesting drainage features are indicated when the soil types are mapped. Attention is drawn to the soil map to a few of these ancient pre-glacial, glacial and post-glacial drainage courses, many of which are today represented by deserted valleys.

The Bow river has not always occupied its present position. This drainage started at some time long before the Glacial Age and soon after the uplight began which formed the Rocky Mountains. It is apparent that much of the Bow drainage, before the advance of the ice sheets, was in the vicinity of the pre-glacial Bow valley which in places included much more than the present valley. One of the most prominent old drainage courses extended from the Bow south of Cochrane, through Glenbow flats, along the Elbow to Turner Station, 3 miles south of Calgary, south to Midnapore, DeWinton, and Wilson coulee to Sheep river two miles west of Okotoks. South of Sheep river this abandoned channel extends close to the Fifth Meridian passing west of Sitook-Spagkway to Tongue creek, and then to the position of the town of High River. The main channel south of High River was along the Little Bow where it passes from the map-area in range 26. There are two other smaller drainage channels south of Highwood river, one follows through range 29, two miles west of Cayley into Mosquito creek, and the other extends from the Little Bow two miles south of High River, south to Silver lake flat east of the railway at Connemara. The town of High River is situated on the old buried channel where at one time most of the water from the Highwood river flowed south by the Little Bow. This point is of considerable importance because there is a grave chance that the Highwood when in flood might again follow this old course to the Little Bow, unless this danger is averted by artificial means. The record flood of May, 1942, showed that the change of course of the Highwood into the Little Bow is possible, without a properly constructed dike to keep the water in the present course of the Highwood north from the town. Crawling valley in the northeast of the map-area, north of Bassano, and the valley of Crowfoot creek were at one time much larger drainage courses than at present. Snake creek draining into Lake McGregor was formerly much larger than at present. Frank lake basin, seven miles east of

High River, is an obliterated lake which about Glacial time covered at least twelve sections. This lake drained originally into the Little Bow between sections 32 and 33, township 17, range 27, but, during the last century at least has had no surface outlet. Three miles north of Ensign there was once a lake covering about six sections in post-glacial time drained by the West Arrowwood creek, but this is another example of an obliterated lake. The Southesk flat in township 19, and the north part of township 17, range 16, at one time was occupied by a lake which drained southwards into the Bow valley east of Eyremore. There has been a marked change in drainage along the east side of the map-area, north of Rosemary in the Gem flat and in the vicinity of Matzhiwin creek. Lake McGregor is now an artificial lake as it is used as a reservoir, but formerly there was a large lake extending north to the Queenstown flat. It is quite probable that there was an old drainage course extending from Lake McGregor in a northeasterly direction to Bow valley, southwest from Cluny. There have been marked changes in the drainage in the vicinity of Lloyd lake in township 22, range 2. At one time there were drainage ways from Lloyd lake northwest to Pirmez flat and Jumpingpound flat.

Eagle, Namaka and Stobart lakes, southwest from Strathmore are only remnants of a much larger pro-glacial lake, that is a lake that was formed at the front of the ice sheet when it occurred in this position., Chestermere lake is in a former drainage way that extended south to the Bow valley. Many other evidences of early drainage might be cited from this map-area but those cited will be sufficient to emphasize the fact that the present drainage is only a passing phase of the drainage history of the map-area.

Some of the former lakes have disappeared through a number of factors of which three may be mentioned. (1) Since the appearance of settlement, artificial draining has removed the surface water. (2) Cultivation, causing increased evaporation, has possibly removd a part of the water in some cases. (3) Climatic changes are of major importance. Cyclic variations in the annual precipitation have changed the water table and have caused lakes to disappear and reappear. Several cases might be cited of lakes in Alberta that were at lower levels about the beginning of the century than at present. Unfortunately meteorological data over a period of years are sadly lacking in Alberta. If this interpretation is correct then it is reasonable to anticipate a rise in the water table and ultimately the reappearance of lakes in some areas as the cycle progresses with increased precipitation.

SUB-SURFACE GEOLOGY

The areal geology of the Blackfoot and Calgary sheets is shown on the small scale map (Plate 9) accompanying this report. This information is taken from the geological map of Alberta prepared by the writer and published in 1937.

The geological formations which occur at the surface or immediately below the unconsolidated deposits in the plains and foothills belt in the Blackfoot and the eastern part of the Calgary sheet east of the Forest Reserve boundary are Cretaceous and Tertiary in age. Older Mesozoic and Palaeozoic rocks outcrop within the inner foothills belt, and in the east side of the Rocky Mountains. The positions of these rocks are included on the geological map (Plate 9) in the south-western part of the map, but these are not included in the soil map-area.

On the geological map (Plate 9), nine geological units are shown. It is not necessary to discuss each of these units in detail but mention will be made of some of the chief lithological characteristics of each group. The outcrops of these various rocks are limited in area on the Blackfoot and east part of the Calgary sheets, and are confined largely to the eroded areas shown on the soil map. In other areas the information on the rock formation has been obtained from the records of dug or drilled wells.

The rocks in this map-area, in order of age from the youngest to the oldest, are as follows:

Tertiary	Paskapoo (Willow Creek and Porcupine Hills)	Sandstones, soft gray, clayey, and calcareous, and clay shales.
Upper Cretaceous	Edmonton (St. Mary River)	Sandstone, shale and coal.
	Bearpaw	Shale, dark coloured with sandy beds, some bentonite, marine.
	Belly River	Sandstone and shales interbedded, coal seams in upper part, fresh and brackish water deposition.
	Alberta (Benton)	Shales, dark, with ironstone concretions, marine.
Lower Cretaceous	Blairmore-Kootenay	Sandstones, gray, greenish, and dark coloured. Shales, gray, green and maroon. Coal seams occur near the top of the Kootenay. Non-marine.

The oldest rocks shown on the geological map (Plate 9) are grouped as the Palaeozoic and early Mesozoic. Several formations are grouped and these outcrop in Highwood range and in Moose mountain, both within the Forest Reserve and therefore outside of this soil map-area. It is known that several of these formations occur under the plains at depth, but they do not affect the soil types in this map-area.

The Lower Cretaceous (*Blairmore-Kootenay*) formations are composed essentially of hard gray, greenish and dark coloured sandstones. In the Kootenay formation, which is the lower, there are several coal seams. There is no coal being mined from the Kootenay in this map-area, but a very large reserve tonnage has been proven by prospecting in the Highwood valley west of the Highwood Range in range 6, and in the valley of Sheep river in range 7, west of the 5th meridian.

The strata in the lower part of the Upper Cretaceous are represented by the *Alberta* shale formation, which includes what was formerly known as the *Benton* shale. This formation consists chiefly of dark gray shale of marine deposition. The shale is interbeded with thin beds of sandstone and several thin beds of bentonite, which is also known under the name of *gumbo*. These shales occur as a narrow band in Turner Valley between Tongue creek and Millarville. Another narrow band occurs at the north boundary of the map west of Jumpingpound, and extends southeast into the north side of Sarcee Indian Reserve. The largest belt of these rocks occurs from Pekisko creek in the east half of range 3, on the west side of range 2, across the entire width of the Calgary sheet, and across Jumpingpound creek, to the west side of township 24, range 5. Where these rocks form residual clays, the soil type is a heavy clay or clay loam.

The *Belly River* strata are of fresh-water deposition and consist chiefly of gray, greenish and buff sandstones interbedded with gray, greenish and carbonaceous shales. Crossbedding caused by deposition in shallow water is common in the sandstone. The *Belly River* strata are exposed in a small area in the southeast corner of the Blackfoot sheet on the Bow river in the vicinity of Eyremore. Strata of this age extend under the entire Blackfoot sheet below the younger formations.

Within the foothills it has not always been possible to differentiate between the Upper Cretaceous formations for mapping purposes, so the bands of such strata are mapped in a single unit. Where it has been found possible the *Alberta* shale and the *Edmonton* have been mapped separately, but elsewhere in the foothills the Upper Cretaceous is shown in one unit.

The *Bearpaw* formation consists chiefly of dark gray clay shales and sandy shales of marine deposition. In some areas there are numerous limestone concretions and some of the shale beds contain marine fossils of which the cephalopods as *Baculites* and *Placenticeras* are quite common. These fossils are usually coated with an iridescent layer of lime carbonate known as "mother-of-pearl". These fossils are segmented and are frequently considered to be fish vertebrae, but they are not fish.

There is one large belt of *Bearpaw* along the east side of the Blackfoot sheet. It extends across the south boundary of the map from ranges 16 to 20. The upper contact crosses Bow river near Crowfoot, and at the north boundary of the map it extends to the west side of Range 16. These shales form heavy soils and are frequently salty. Good well water has not been found in the *Bearpaw* shales in any part of Alberta. Water from these shales is usually highly alkaline, and not suitable for domestic use. This formation is over 300 feet thick in the vicinity of Bassano, but it thins to the west and does not occur as a separate formation in the foothills. There is an exposure of dark shaly rocks at the crossing of Highwood river south of Turner Valley that are correlated with the *Bearpaw* formation.

The *Edmonton* formation corresponds in time age to the *St. Mary River* formation in southern Alberta and represents the uppermost Cretaceous strata. It consists of non-marine highly calcareous sandstone, light gray sandstone and sandy shales. Crossbedding and irregular bedding are common structural features. Soils which have been influenced by these strata have a high lime content. Fresh-water oyster shells and other fresh-water fossils are common in this formation. A broad band of *Edmonton* strata occurs across the Blackfoot sheet from township 17, ranges 20, 21, 22 and includes Lake McGregor and extends north to township 24, ranges 17 to 22. The upper contact of this formation crosses Bow river in range 24, 8 miles northwest of Arrowwood. There is a narrow band of *Edmonton* strata extending along the east side of the foothills belt across the Calgary sheet from Pekisko, through Black Diamond, Priddis, and to the north boundary of the map in the west side of range 4. Plate 8, figure 2, shows a typical outcrop in the *Edmonton* southwest of Bassano. It also shows the irregular weathering in the hard and soft beds. The position of this formation indicates in general the line between the plains and the foothills in this map-area.

The youngest rocks in the Blackfoot and Calgary sheets belong to the *Paskapoo* formation which is Tertiary in age. This formation corresponds to the *Porcupine Hills* formation and the *Willow Creek* formation in the McLeod and Pincher Creek sheets. The formation consists of soft, gray, clayey sandstone and clay shale of fresh-water deposition. The lower *Willow Creek* beds have mauve, red and gray hues.

The *Paskapoo* strata have the widest distribution in the map-area, and occur as the surface formation in the western half of the Blackfoot sheet, and the eastern one and a half to three and a half ranges in the Calgary sheet. These Tertiary rocks occupy the trough-like depression known as the *Alberta syncline,* so the older rock formations come to the surface both to the east and to the west of the *Paskapoo* band. These rocks have had a marked influence on many of the soils east of the foothills in Alberta.

ORIGIN OF SURFICIAL DEPOSITS IN THE BLACKFOOT AND CALGARY SHEETS

The mineral composition of a soil and the source from which the mineral grains have been derived are geological problems. Frequently the origin of the material making up the unconsolidated deposits can be determined.

It is not always possible to determine the origin of the surface deposits in certain areas, because frequently the unconsolidated material is of mixed origin. This is particularly true in the case of reworked deposits such as outwash plains, alluvial and marginal deposits.

The soil differs from underlying deposits upon which it is developed in that weathering agents have changed its original texture, color and composition. In some soils the accumulation of organic material, both vegetable and animal, has caused the soils, particularly the surface soils, to assume a dark color. In most cases the surface leaching has deprived the soils of certain original minerals, and often the mineral content of the subsoils has been changed.

The general character of the surface of the Blackfoot and Calgary sheets indicates to some degree the origin and distribution of the unconsolidated deposits. This is shown in the accompanying soil map and in Table 3. In the plains area, rock outcrops are confined chiefly to the eroded areas on the soil map representing about three per cent of the total map-area of about three and a third million acres. There are more rock exposures along the flanks of the ridges in the foothills belt than are represented by the eroded areas, but these cannot be shown on a soil map of this kind. Almost three quarters of the map-area has a level to gently rolling surface in which the unconsolidated deposits consist largely of more or less well sorted glacial moraine and alluvial material, and a very small part of residual soil. More rolling topography, representing about 10 per cent of the map-area, occurs along the outer foothills and the western edge of the area underlain by the *Paskapoo formation,* chiefly on the eastern edge of the Calgary sheet. Similar surface conditions usually occur marginal to the principal morainal areas. The real hilly areas, representing about 12 per cent, occur within the foothills where the ridges consist largely of rock formations, and also in the undisturbed morainal ridges, such as, east of Hussar, east of Lake McGregor, and in the Buffalo Hill moraine.

The unconsolidated surface deposits in the Blackfoot and Calgary sheets can be classified under four major types:

(1) Residual and sorted residual deposits.
(2) Glacial deposits—moraine, till, boulder clay.
(3) Resorted glacial deposits.
(4) Transported deposits of alluvial, lacustrine and dune or eolian origin.

The first type includes the *residual soils* formed by erosion processes from the underlying rock formation. Soils formed in this way will have a composition somewhat similar to the compositin of the underlying rock from which the soil has been formed, except in cases where solutions have removed a part of the more soluble constituents. More frequently the residual soils have been resorted or affected in some way by various transporting agents of erosion and in such cases the composition of the soil is not similar to that of the underlying strata.

Residual soils formed from dark marine shales are more readily recognized in the field than those from sandstone and shale of fresh-water deposition. Only a few narrow belts of residual soil were observed in the map-area and these are associated with underlying *Bearpaw* and *Alberta* shale formations of marine origin. Residual soils, more or less sorted, on the underlying *Bearpaw* formation, occur on the east side of the Bow valley between Eyremore and Lothian. The largest area of residual soil was observed in Turner Valley, Kew Valley, and in the depressions west to the Forest Reserve boundary between ridges of harder sandstone formations. These soils are produced from the underlying bands of *Alberta* shale. In the valley which extends from Sheep river at Black Diamond, northwest to Priddis and about two miles north of Priddis creek, residual soils have been formed on shales that correspond to the *Bearpaw* formation.

The second major type includes those deposits of glacial origin which occur in the form of terminal moraine as irregular hills or undulating ridges, often quite thick, or as ground moraine, usually thin or represented by scattered glacial boulders and pebbles.

The glacial deposits have been derived from one of two sources. The *mountain* or *alpine* glaciers originated within the Rocky Mountains and proceeded eastward over the foothills and plains, carrying rock debris from the rock formations within or possibly west of the front ranges of the Rocky Mountans; and the *Keewatin* or *Continental* glaciers that originated in the vicinity of Hudson Bay, bringing with them a very different kind of rock debris derived from the Precambrian rocks in the Canadian Shield and also the rock material from the plains over which the glaciers passed. No attempt will be made to discuss in detail the glacial history or the deposits of glacial origin which were left in this part of Alberta.

The morainal material transported from the mountains consists largely of limestone, dolomite, shale, slate, quartzitic sandstone some of which is phosphatic, and dark chert pebbles.

The detrital material transported from the northeast by the *Keewatin* glaciers consists largely of igneous and metamorphic rocks such as granite, gabbro, gneiss, schist, argillite, greenstone, etc., etc., and locally of harder sandstone from the younger rock formations under the plains over which the ice moved.

The glaciers from the Rocky Mountains extended down the valleys and spread out over the intervening ridges in the foothills belt. Boulders and gravels carried by the glacier were left when the ice melted. The mountain glaciers extended eastwards until the ice met the Keewatin glaciers from the Hudson Bay area. The most easterly extension of the mountain glaciers in this map-area was about the position of the Fifth Meridian.

On the top of Sitook-Spagkway (Middle Heights) four miles west of Aldersyde in the northwest quarter section 32, township 19, range 29, three Keewatin boulders were observed and many smaller boulders from the mountain glaciers. Two Rocky Mountain boulders and at least one Keewatin boulder were observed in the east slope of this hill in section 3, township 20, range 29. East of this point the boulders are from the Keewatin glaciers, while west of the hill the boulders are from the mountains.

The large boulder known as the "Big rock", on the north side of the highway, eight miles west of Okotoks in section 21, township 20, range 1, has been deposited there by the mountain glaciers. It consists of quartzitic sandstone. Other smaller boulders of the same kind occur to the south in range 1 and farther west around Longview. South of the Highwood river many Keewatin boulders were observed in the vicinity of the Fifth Meridian. The farthest west Keewatin boulder observed is on the side of the highway in section 5, township 18, range 1. This indicates that the soil types west of the Fifth Meridian in this map-area do not contain much of the Keewatin glacial debris. But on the other hand considerable mountain debris has been carried eastward by streams into the Blackfoot sheet.

It is probable that the glaciers from the west and from the east covered the whole of the area included on the soil map, even the highest points. Glacial debris was observed on the top of Buffalo Hill and other high points in the Arrowwood district. Over one-half of the surface of the Blackfoot sheet consists of glacial material either as unsorted glacial moraine or as sorted glacial debris.

There are several prominent morainal ridges and lower areas in the Blackfoot sheet. There is a large morainal area extending across the eastern side of the Blackfoot sheet from north to south. At the north boundary of the map this *Hussar moraine*, either terminal or lateral, extends from Hussar east to Crawling valley, a distance of about fifteen miles. It occurs around Granta in township 22, range 19, and extends west into range 20. From the Bow river valley south to the boundary of the map-area, the moraine covers almost all of range 19 and the west side of range 18. To the west, the hills on the east side of Lake McGregor are glacial moraine, which also extends to the west of the lake as a narrow band in township 17, widening to about five miles in township 18, and reaching a maximum width of about eight miles in Buffalo Hill and the ridge to the northeast. Another belt of moraine extends from the Little Bow river south of Frankburg, northeast between Blackie and Brant in range 26, and east of Dinton and Glenview to the centre of township 21, range 25. On the west side of the Blackfoot sheet there is glacial moraine from the edge of the Bow valley at the city of Calgary, eastward for about six miles, with a small area northwest of Chestermere lake. A morainal ridge occurs between DeWinton and Okotoks in the area between the Bow and Sheep rivers. In the southwest corner of the Blackfoot sheet between the Highwood river and Mosquito creek, there are several isolated morainal islands at Azure and Cayley and west of the meridian.

In the Calgary sheet glacial moraine covers most of the area south of the Tongue creek in range 1, between Tongue creek and Sheep river, and in ranges 1 and 2 between Sheep creek and the Bow river.

The sorted or reworked glacial deposits in the third type have a wide distribution within and around the moraine. The largest area occurs in the Blackfoot sheet in ranges 26, 27, 28 and 29, or west of a line drawn from Ensign, north to Carseland and Cheadle. The unconsolidated deposits are all sorted glacial from Carseland to Shepard, and from Dinton west to the Highwood river. In the Calgary sheet numerous small irregular areas occur within and about the glacial moraine. Gravelly outwash from the glacial deposits occur in a few small areas, chiefly where there is low land adjoining high land capped with glacial moraine, as along drainage courses. Part of the city of Calgary is situated on the gravel outwash from the high banks along the Bow valley.

The fourth type of surface material includes the *transported deposits*. The transporting agents are wind and running water, either along stream courses or as run-off. The former gives rise to dunes or eolian plains, the latter to alluvial flood plain and lacustrine deposits. Transported soils are bedded in character due to the sorting action of the transporting agents. The sand and clay may occur in separate layers or lenses, forming a sandy soil or a clay soil. These deposits may be a mixture of sand and clay with varying proportions of each, giving rise to a sandy clay or a clay loam or a sandy loam soil. It is not always possible to distinguish the fourth type, that is the transported deposits of recent origin, from the resorted or transported glacial deposits.

Transported deposits may be derived from two main sources. There are the gravel, sand and clay that are carried down the slope along major river courses for considerable distances. These are alluvial and fluviatile deposits that are directly associated with river transportation.

In the Blackfoot and Calgary sheets the river-carried alluvial and fluviatile deposits are distributed along the valleys of the Bow, Highwood and Sheep rivers, Priddis creek and other small creeks, and along some of the old abandoned drainage courses such as Crawling valley. Plate 1, figures 1 and 3 are examples of this type.

The second type of transported deposits includes the deposits that have been washed down from higher levels to lower levels possibly in a lake basin. These form alluvial and lacustrine plains. In this type the finer particles will be carried farther than the coarser material. Fine clays and silt will grade into sand, and the sand will grade into gravel. This class of material is widely distributed in the Blackfoot sheet. One large area of alluvial and eolian deposits occurs at the east side of the sheet, east of the Bow from township 19 to the top of the map-area. Much of the surface east of Bassano and Gem contains this type of deposit. The alluvial plain between Gem and Crawling valley, and the east side of the *Hussar moraine,* consists of a mixture of alluvial and glacial material which is known as glacio-alluvial deposits. A much larger area of transported deposits occurs in the central part of the Blackfoot sheet between the Hussar moraine on the east and the glacial plain west of Carseland.

In general the surface deposits are coarser on the west and become finer to the east indicating a sorting due to transportation. Sand and coarser sediments predominate on the west of the map, north of the Bow from about range 25, but silts and clays predominate in range 21 in the Cluny and Ouelletteville areas. The finest particles of transported material occur as heavy clay in the Parflesh plain south of Chancellor.

There is another large area of transported material south of the Bow. Extending north from about the centre of township 17 in the Lake McGregor area there is a narrow band of mixed alluvial and glacial material derived from the adjoining unsorted moraine. Between Queenstown and Milo the transported deposits broaden rapidly towards the Bow and include all the area westward from the Majorville district in range 20, and flanking the north slope of Buffalo hills to West Arrowwood creek in range 25. A narrow band of alluvial material has been deposited along the West Arrowwood drainage southward to the Ensign district and towards Vulcan. There are several small irregular areas of alluvial material on the west side of the Blackfoot sheet such as the Frank lake basin that fingers out to the northwest, and the High River-Aldersyde basin that extends from the centre of section 3, township 19, range 28, west to about the centre of range 29. From DeWinton east to the mouth of Highwood river there is another alluvial area flanking the ridge north of Okotoks. In the Calgary sheet the largest alluvial area occurs in the Sarcee Indian Reserve extending from Lloyd lake and Fish creek in range 2, northwest to the Elbow river and includes the Pirmez silt loam flats. A similar type of soil occurs in range 3, north of Elbow river. These silt loams have been derived largely from the adjoining glacial deposits and from the underlying clay shale and sandstone in the *Paskapoo* formation.

There are several flats in this map-area that are of glacio-lacustrine and post-glacial origins. These old lake basins represent areas where the earlier drainage was dammed by ice or by glacial moraine and lakes were formed, then later the basins were filled in with clays, silts and sands. *Chancellor Flat* (Plate 3, figure 3) is the largest of such pro-glacial lake basins, that is a lake formed at the front of the ice. This basin extends from Hussar westward for about 10 miles, and from Ouelletteville north beyond the boundary of the Blackfoot sheet, which is township 24. This lake was formed against the ice sheet that left the *Hussar moraine*. Much of the clay and silt was washed into this basin from the west during the Glacial Age. The *Cluny Flat* represents a lake basin formed on the side of the Bow river, when the valley was filled with glacial ice. Deadhorse lake occupies a kettle hole, which is a depression formed in the moraine when the glacier melted. There is another small lake basin about two miles wide and six miles long east of Crowfoot creek between townships 22 and 23. Drainage courses sometimes become obstructed and lakes are formed. One small lake was formed in this way between Queenstown and Milo along the drainage from Lake McGregor. Eagle, Namaka and Stobart lakes were at one time connected, but alluvial material washed into this drainage basin has caused the present three lakes. This basin may have at one time extended northwest to the vicinity of Strathmore. Lloyd lake, five miles southwest of Midnapore, is the remnant of a much larger lake basin. There is evidence of considerable laking represented by the *Jumpingpound Flat* north of Elbow river in range 4. This old lake basin at one time extended north at least as far as Jumpingpound creek in township 25, and possibly was connected with *Glenbow Flat,* the south end of which occurs north of Elbow river in range 3.

In almost every case old lake basins can be recognized by the flatness of the surface, and by the fineness and uniformity of the clay or silt, unless the fine soil has been piled up by wind action to form dunes, such as occurs south of Cluny. Eolian deposits in the form of dunes, or as narrow ridges (Plate 3, figure 1) may be found on any surface material that is fine enough to be transported by the wind. There are several small dune areas but in no place are the areas large.

WATER SUPPLY

The term *water-supply,* according to common usage, refers to the water that occurs on or beneath the surface and available for domestic, industrial or irrigation uses. But this term has a broader meaning as it includes the water or moisture in the soils and so necessary for all plant life. Rivers, creeks and lakes form the *surface water* supply, and this water may have been carried long distances from the melting of glaciers, or the run-off from higher lands. A part of the surface water may be supplied from local precipitation.

Underground water includes water that occurs in the rock formations beneath the surface or in the unconsolidated deposits that occur over the bedrock. It is most important to realize that all the underground water supply has been derived from surface precipitation and therefore comes from the surface. The grave mistake has been made in many parts of Alberta by draining off the surface water and by cutting off the brush and forest in order to add a few acres for agricultural purposes. So often by so doing the water supply has been depleted, and in many instances the well water supply has become inadequate for domestic purposes. If man does not allow the surface water to enter the surface deposits then the underground water supply in that district will be reduced just that amount.

The best advice that can be given on the problem of water supply is to retain all possible precipitation on the surface. Do not drain lakes and sloughs, and do not remove brush and woods from the plains area or even from the foothills. By removing water from the surface, some water wells in that district will have a depleted supply. This water problem is so important that it deserves a separate report, but this subject will not be discussed here.

Artesian water differs from the ordinary underground water in that the water has entered the rocks many miles distant from where the artesian water is encountered by deep drilling. All flowing wells are not artesian wells. Most shallow flowing wells are man-made springs where the water is flowing from an orifice on the side of a hill or on or at a point where the water is under a head because of higher ground in the vicinity. Flowing wells were observed in several localities including those in section 5, township 20, range 27, also in 33-19-27, in 24-19-28 and in 5-18-29. Several springs were observed around Buffalo hill, the Arrowwood hills, Sitook-Spagkway, and along the Highwood valley especially west of the town of High River, both on the south and on the north sides of the river.

There is no serious water problem in this map-area. There are many wells with a large supply of good water and there are many flowing wells, some of which were encountered within fifty to two hundred feet from the surface. With the exception of the more compact clay soils, water can be expected in most of the unconsolidated deposits especially where there are lenses or beds of sand or gravel. There are also good chances of water horizons occurring within the bedrock. Sandstone and sandy shale are sufficiently permeable to form good water horizons. The *Paskapoo* formation contains many beds suitable for water reservoirs. The *Edmonton* or *St. Mary River* formation also contains many feet of strata suitable for the accumulation of water. The geological map (Plate 9) indicates that these formations have a wide distribution in this map-area.

It has been pointed out that the *Bearpaw* shales are of marine deposition. Attention is drawn to the important fact that good water or a good water supply cannot be expected from the *Bearpaw* strata. There is no use drilling or digging a well into the Bearpaw shales for good water as it does not exist. Any water from the Bearpaw shales will be unsuitable for domestic or for stock use because of the high content of dissolved salts from the marine shales. In that area where the Bearpaw formation underlies the unconsolidated deposits, it is necessary to obtain well water from the surface unconsolidated deposits, or else to drill through the *Bearpaw* shales that are about 300 feet thick, into the underlying *Belly River* formation which contains strata suitable for water horizons.

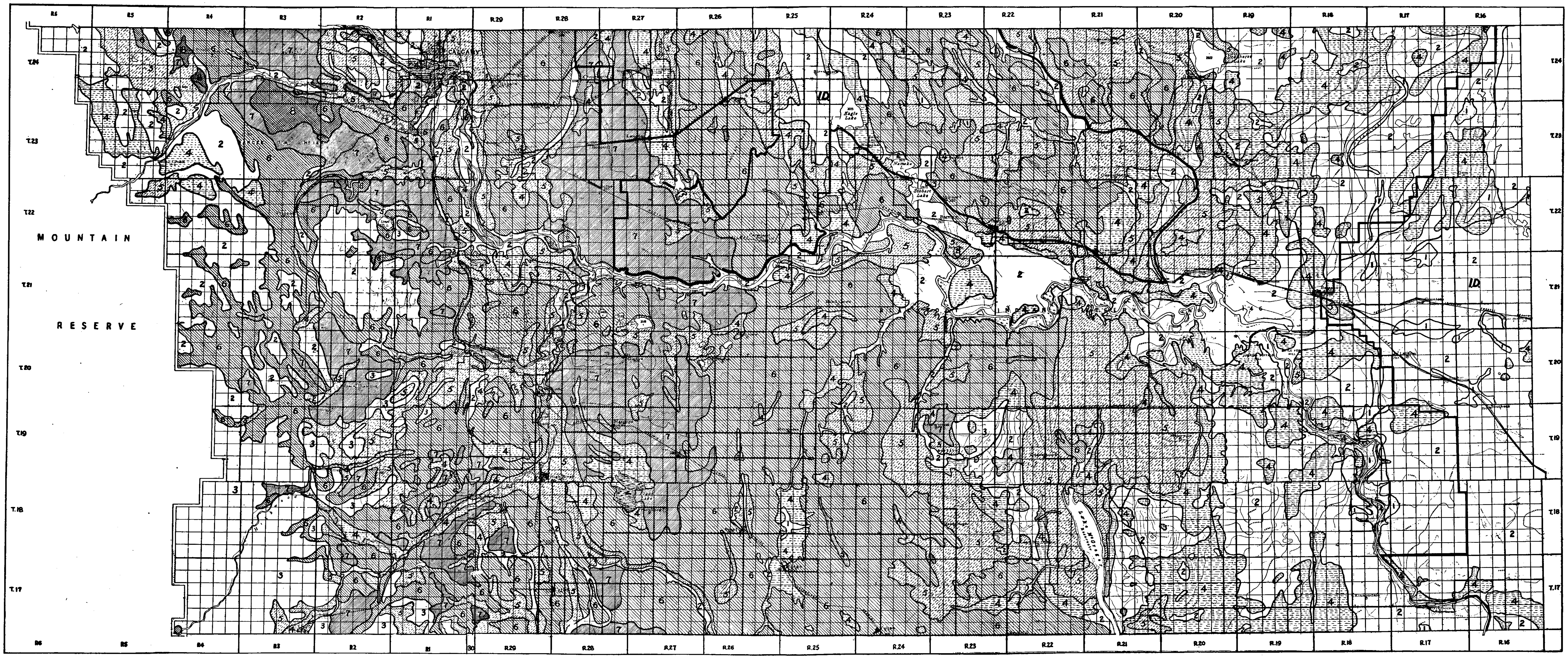
The composition of well water varies widely, depending upon the percentage of soluble salts dissolved in the water.

Some water is soft, and some water is hard because of the dissolved lime in the water, but both hard and soft water can be used for domestic or industrial purposes. Other water may contain alkalies, or alum or iron depending upon the amount of these soluble minerals in the surface soil or underground rock formations through which the water passes. A small quantity of highly saline water with alkalies and the like can spoil a good water by mixing with it. This is why it is most important in digging or drilling a well to shut off all impure water from entering the well in which good water is encountered at a lower level.

SOIL RATING MAP OF BLACKFOOT AND PORTION OF CALGARY SHEETS

PROVINCE OF ALBERTA

Scale: 6 miles to 1 inch



Rating based on Soil and other Physical Features as determined by Soil Survey, 1940. This map to be used in conjunction with Soil Map and Report.

Prepared by Department of Soils, University of Alberta, in co-operation with the Experimental Farms Service, Dominion Department of Agriculture (P.F.R.A.).

LEGEND

Poor to Fair Pasture	1	Fair to Fairly Good Arable	5
Fair to Good Pasture	2	Fairly Good to Good Arable	6
Good to Excellent Pasture	3	Good to Very Good Arable	7
Poor to Fair Arable	4	Very Good to Excellent Arable	8

Irrigation District .... I.D.