

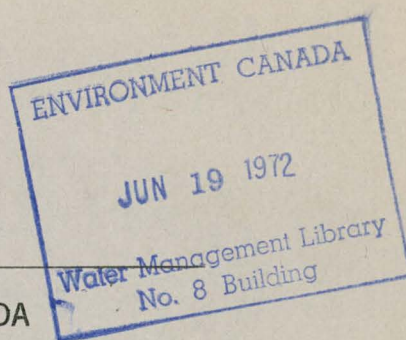
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CANADA
DEPARTMENT OF MINES
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WATER SUPPLY PAPER No. 111



PRELIMINARY REPORT
GROUND-WATER RESOURCES
OF THE
RURAL MUNICIPALITY OF
NO. 50
SASKATCHEWAN

By

B. R. MacKay, H. H. Beach and D. P. Goodall



OTTAWA

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GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY

OF

NO. 50

SASKATCHEWAN

INTRODUCTION

Lack of rainfall during the years 1930 to 1934 over a large part of the Prairie Provinces brought about an acute shortage both in the larger supplies of surface water used for irrigation and the smaller supplies of ground water required for domestic purposes and for stock. In an effort to relieve the serious situation the Geological Survey began an extensive study of the problem from the standpoint of domestic uses and stock raising. During the field season of 1935 an area of 80,000 square miles, comprising all that part of Saskatchewan south of the north boundary of township 32, was systematically examined, records of approximately 60,000 wells were obtained, and 720 samples of water were collected for analyses. The facts obtained have been classified and the information pertaining to any well is readily accessible. The examination of so large an area and the interpretation of the data collected were possible because the bedrock geology and the Pleistocene deposits had been studied previously by McLearn, Warren, Rose, Stansfield, Wickenden, Russell, and others of the Geological Survey. The Department of Natural Resources of Saskatchewan and local well drillers assisted considerably in supplying several hundred well records. The base maps used were supplied by the Topographical Surveys Branch of the Department of the Interior.

Publication of Results

The essential information pertaining to the ground water conditions is being published in reports, one being issued for each municipality. Copies of these reports are being sent to the secretary treasurers of the municipalities and to certain Provincial and Federal Departments, where they can be consulted by residents of the municipalities or by other persons, or they may be obtained by writing direct to the Director, Bureau of Economic Geology, Department of Mines, Ottawa. Should anyone require more detailed information than that contained in the reports such additional information as the Geological Survey possesses can be obtained on application to the director. In making such request the applicant should indicate the exact location of the area by giving the quarter section, township, range, and meridian concerning which further information is desired.

The reports are written principally for farm residents, municipal bodies, and well drillers who are either planning to sink new wells or to deepen existing wells. Technical terms used in the reports are defined in the glossary,

How to Use the Report

Anyone desiring information about ground water in any particular locality should read first the part dealing with the municipality as a whole in order to understand more fully the part of the report that deals with the place in which he is interested. At the same time he should study the two figures accompanying the report. Figure 1 shows the surface and bedrock geology as related to the ground water supply, and Figure 2 shows the relief and the location and type of water wells. Relief is shown by lines of equal elevation called "contours". The elevation above sea-level

is given on some or all of the contour lines on the figure.

If one intends to sink a well and wishes to find the approximate depth to a water-bearing horizon, he must learn: (1) the elevation of the site, and (2) the probable elevation of the water-bearing bed. The elevation of the well site is obtained by marking its position on the map, Figure 2, and estimating its elevation with respect to the two contour lines between which it lies and whose elevations are given on the figure. Where contour lines are not shown on the figure, the elevations of adjacent wells as indicated in the Table of Well Records accompanying each report can be used. The approximate elevation of the water-bearing horizon at the well-site can be obtained from the Table of Well Records by noting the elevation of the water-bearing horizon in surrounding wells and by estimating from these known elevations its elevation at the well-site.¹ If the water-bearing horizon is in bedrock the depth to water can be estimated fairly accurately in this way. If the water-bearing horizon is in unconsolidated deposits such as gravel, sand, clay, or glacial debris, however, the estimated elevation is less reliable, because the water-bearing horizon may be inclined, or may be in lenses or in sand beds which may lie at various horizons and may be of small lateral extent. In calculating the depth to water, care should be taken that the water-bearing horizons selected from the Table of Well Records be all in the same geological horizon either in the glacial drift or in the bedrock. From the data in the Table

¹ If the well-site is near the edge of the municipality, the map and report dealing with the adjoining municipality should be consulted in order to obtain the needed information about nearby wells.

of Well Records it is also possible to form some idea of the quality and quantity of the water likely to be found in the proposed well.

GLOSSARY OF TERMS USED

Alkaline. The term "alkaline" has been applied rather loosely to some ground-waters. In the Prairie Provinces, a water is usually described as "alkaline" when it contains a large amount of salts, chiefly sodium sulphate and magnesium sulphate in solution. Water that tastes strongly of common salt is described as "salty". Many "alkaline" waters may be used for stock. Most of the so-called "alkaline" waters are more correctly termed "sulphate waters".

Alluvium. Deposits of earth, clay, silt, sand, gravel, and other material on the flood-plains of modern streams and in lake beds.

Aquifer or Water-bearing Horizon. A water-bearing bed, lens, or pocket in unconsolidated deposits or in bedrock.

Buried pre-Glacial Stream Channels. A channel carved into the bedrock by a stream before the advance of the continental ice-sheet, and subsequently either partly or wholly filled in by sands, gravels, and boulder clay deposited by the ice-sheet or later agencies.

Bedrock. Bedrock, as here used, refers to partly or wholly consolidated deposits of gravel, sand, silt, clay, and marl that are older than the glacial drift.

Coal Seam. The same as a coal bed. A deposit of carbonaceous material formed from the remains of plants by partial decomposition and burial.

Contour. A line on a map joining points that have the same elevation above sea-level.

Continental Ice-sheet. The great ice-sheet that covered most of the surface of Canada many thousands of years ago.

Escarpment. A cliff or a relatively steep slope separating level or gently sloping areas.

Flood-plain. A flat part in a river valley ordinarily above water but covered by water when the river is in flood.

Glacial Drift. The loose, unconsolidated surface deposits of sand, gravel, and clay, or a mixture of these, that were deposited by the continental ice-sheet. Clay containing boulders forms part of the drift and is referred to as glacial till or boulder clay. The glacial drift occurs in several forms:

(1) Ground Moraine. A boulder clay or till plain (includes areas where the glacial drift is very thin and the surface uneven).

(2) Terminal Moraine or Moraine. A hilly tract of country formed by glacial drift that was laid down at the margin of the continental ice-sheet during its retreat. The surface is characterized by irregular hills and undrained basins.

(3) Glacial Outwash. Sand and gravel plains or deltas formed by streams that issued from the continental ice-sheet.

(4) Glacial Lake Deposits. Sand and clay plains formed in glacial lakes during the retreat of the ice-sheet.

Ground Water. Sub-surface water, or water that occurs below the surface of the land.

Hydrostatic Pressure. The pressure that causes water in a well to rise above the point at which it is struck.

Impervious or Impermeable. Beds, such as fine clays or shale, are considered to be impervious or impermeable when they do not permit of the perceptible passage or movement of the ground water.

Pervious or Permeable. Beds are pervious when they permit of the perceptible passage or movement of ground water, as for example porous sands, gravel, and sandstone.

Pre-Glacial Land Surface. The surface of the land before it was covered by the continental ice-sheet.

Recent Deposits. Deposits that have been laid down by the agencies of water and wind since the disappearance of the continental ice-sheet.

Unconsolidated Deposits. The mantle or covering of alluvium and glacial drift consisting of loose sand, gravel, clay, and boulders that overlies the bedrock.

Water Table. The upper limit of the part of the ground wholly saturated with water. This may be very near the surface or many feet below it.

Wells. Holes sunk into the earth so as to reach a supply of water. When no water is obtained they are referred to as dry holes. Wells in which water is encountered are of three classes.

(1) Wells in which the water is under sufficient pressure to flow above the surface of the ground. These are called Flowing Artesian Wells.

(2) Wells in which the water is under pressure but does not rise to the surface. These wells are called Non-Flowing Artesian Wells.

(3) Wells in which the water does not rise above the water table. These wells are called Non-Artesian Wells.

NAMES AND DESCRIPTIONS OF GEOLOGICAL FORMATIONS, REFERRED
TO IN THESE REPORTS

Wood Mountain Formation. The name given to a series of gravel and sand beds which have a maximum thickness of 50 feet, and which occur as isolated patches on the higher parts of Wood Mountain. This is the youngest bedrock formation and, where present, overlies the Ravenscrag formation.

Cypress Hills Formation. The name given to a series of conglomerates and sand beds which occur in the southwest corner of Saskatchewan, and rests upon the Ravenscrag or older formations. The formation is 30 to 125 feet thick.

Ravenscrag Formation. The name given to a thick series of light-coloured sandstones and shales containing one or more thick lignite coal seams. This formation is 500 to 1,000 feet thick, and covers a large part of southern Saskatchewan. The principal coal deposits of the province occur in this formation.

Whitemud Formation. The name given to a series of white, grey, and buff coloured clays and sands. The formation is 10 to 75 feet thick. At its base this formation grades in places into coarse, limy sand beds having a maximum thickness of 40 feet.

Eastend Formation. The name given to a series of fine-grained sands and silts. It has been recognized at various localities over the southern part of the province, from the Alberta boundary east to the escarpment of Missouri coteau. The thickness of the formation seldom exceeds 40 feet.

Bearpaw Formation. The Bearpaw consists mostly of incoherent dark grey to dark brownish grey, partly bentonitic shales, weathering light grey, or, in places where much iron

is present, buff. Beds of sand occur in places in the lower part of the formation. It forms the uppermost bedrock formation over much of western and southwestern Saskatchewan and has a maximum thickness of 700 feet or somewhat more.

Belly River Formation. The Belly River consists mostly of non-marine sand, shale, and coal, and underlies the Bearpaw in the western part of the area. It passes eastward and northeastward into marine shale. The principal area of transition is in the western half of the area where the Belly River is mostly thinner than it is to the west and includes marine zones. In the southwestern corner of the area it has a thickness of several hundred feet.

Marine Shale Series. This series of beds consists of dark grey to dark brownish grey, plastic shales, and underlies the central and northeastern parts of Saskatchewan. It includes beds equivalent to the Bearpaw, Belly River, and older formations that underlie the western part of the area.

WATER-BEARING HORIZONS OF THE MUNICIPALITY

Rural Municipality No. 50 comprises an area of 324 square miles situated on the southern flank of the Cypress Hills uplands in the southwestern part of Saskatchewan. The municipality consists of nine townships, described as tps. 4, 5, and 6, ranges 22, 23, and 24, W. 3rd mer. The centre of the area lies approximately 44 miles east of the Alberta-Saskatchewan boundary and 27 miles north of the International Boundary.

The land surface, although irregular and deeply eroded in some places, rises in a general northerly direction from an average elevation of about 3,100 feet above sea-level, along the southern border, to elevations as great as 3,700 feet on the lower slopes of the Cypress hills in the northern townships. Frenchman river, formerly known as the Whitemud, flows in an easterly direction across the northern part of the municipality. The river is deeply entrenched in a wide, steep-banked valley, the bottom of which lies at an elevation of about 3,125 feet above sea-level where it enters the area on the western side, and at an elevation of about 175 feet lower where it crosses the eastern border of the municipality. The valley floor varies from a quarter of a mile to a mile in width, and is farmed in some places. A wide, flat-bottomed coulée extends from Frenchman River valley southward on the western side of the area, and opens out to form a lowlands flat in the southwestern part, in the vicinity of sec. 18, tp. 5, range 24.

The northern six townships of the municipality have been mapped topographically in detail and the variations in the land surface are indicated by means of 100-foot contour lines, on Figure 2 of the accompanying map. Unfortunately, no topographic map exists for the three southern townships. Elevations cited for this part of the area were ascertained by means of aneroid barometers during the course of the investigation, and as appreciable errors

are bound to occur such elevations can be regarded as only approximate.

The Lethbridge-Weyburn line of the Canadian Pacific railway follows Frenchman River valley, from the northeast corner of the municipality to sec. 16, tp. 6, range 24, and thence extends south and southwest along the broad tributary coulee referred to above to cross the western border of the municipality, in sec. 18, tp. 5, range 24. The village of Ravenscrag, situated in Frenchman River valley, in sec. 19, tp. 6, range 23, is the only trading centre in the area, although railway sidings also occur at Palisade, about 6 miles southwest, and at Knollys, 8 miles east of Ravenscrag.

Although water supplies of the township are obtained chiefly from wells sunk in the unconsolidated Recent and glacial drift deposits and the underlying bedrock formations, Frenchman river and several, small, spring-fed, northern tributaries also serve as a major source of water supply for stock, in the northern townships. Small sloughs are quite plentiful in some parts of the southern two-thirds of the municipality, but these generally dry up in midsummer, and cannot be depended upon for a permanent stock water supply. The presence of numerous small draws and coulees in this part of the area, however, provides excellent sites for the construction of dams and reservoirs in which part of the surface run-off may be conserved for use through the dry seasons.

Water-bearing Horizons in the Unconsolidated Deposits

The unconsolidated deposits overlie the bedrock and consist of Recent stream deposits and glacial drift. The stream deposits were laid down in the stream channels during flood periods, and consist chiefly of silts and fine sands interbedded in places by coarser sands and gravels. The stream deposits are best developed in the bottom of Frenchman River valley, where they attain a thickness of 30 to 40 feet, or possibly more in some places. As the river has a relatively low gradient its flood-plain deposits consist mostly of

fine sediments, such as would be carried away by a swifter flowing stream.

Wells sunk to depths of 15 or 20 feet in the valley bottom yield adequate supplies of hard and generally "alkaline" water. The mineral salt content, however, is rarely so great as to render the water unfit for drinking. These water supplies are being used by the residents of the village of Ravenscrag for both domestic and stock use. A better quality of water is obtained at some places along the northern edge of the river flats, where deposits of coarser sands and gravels have been washed down from the uplands by tributary streams. Recent deposits also occur in the small coulées and draws in other parts of the municipality, remote from the river valley. Some of these stream channels have steep gradients and their deposits are not sufficiently thick to hold any large ground water supplies. Wells sunk to depths of 15 to 20 feet, at several places, however, yield moderately large supplies of water. The aquifer is generally a bed of sand or gravel, buried under 5 to 10 feet of clay. Such waters are, as a rule, hard, and are quite suitable for the household drinking supply.

The glacial drift forming the unconsolidated deposits throughout the remainder of the municipality was distributed unevenly over the surface of the bedrock by a great continental ice-sheet that advanced in a general southwesterly direction over the province of Saskatchewan many thousands of years ago. The surface of the glacial deposits in those places where the front of the ice-sheet remained stationary for a considerable period is characterized by numerous, small, irregularly shaped hills and undrained depressions. This type of glacial drift topography is known as moraine, as distinguished from the more gently rolling to level till plains.

In this municipality moraine covers a large area of more or less circular outline in the central part, extending southwestward

to the southern border of the municipality. The remaining area of the township, including the deeply eroded northern townships, and a narrow belt of plain extending along the east, west, and part of the southern borders, are covered by a less irregularly rolling deposit of glacial till. Small, isolated, moraine-covered areas also occur on the borders of the municipality west of Palisade, and north and southeast of Knollys.

The glacial drift consists largely of dark grey boulder clay becoming lighter grey to brownish grey in the weathered zone near the surface. Small, irregular pockets of sand and more rarely gravel occur sparsely interspersed through the upper 20 feet of the drift. These porous beds are usually most plentiful in hilly moraine-covered areas and in the eroded part of the till plains. Such pockets are generally concentrated in the depressions between the hills and at the bases of steep slopes, and are formed from materials washed down from areas of higher elevation. In the absence of many wells penetrating into the bedrock in this municipality it is difficult to estimate the lateral variations in the thickness of the drift. It is approximately 75 feet thick along the southern boundary and probably somewhat thicker in the moraine-covered central parts. Along the northern rolling slopes, however, erosion has removed much of the drift and in many places it is entirely absent, allowing the bedrock to outcrop at the surface. Wells encountering these porous beds usually yield small to moderate supplies of water. Most of the waters are hard, and are rarely too highly mineralized for domestic use. These wells are affected by seasonal changes and may fail in dry years or during the winter months. Residents in search of these water supplies are advised to prospect with a small test auger, otherwise it may be necessary to sink several wells before a suitable water supply is located. As the cost of sinking a shallow well is relatively small many residents have increased their water supply by digging several wells in different parts of their property.

More extensive beds of sand and gravel lying at, or near, the contact of the glacial drift with the underlying bedrock formations also form a water-bearing horizon in some parts of the municipality. This horizon is encountered by wells in the midwestern part of the area, at depths ranging from 40 to 75 feet from the surface. An attempt is made to outline the eastern limits of this horizon, by means of the "A" line, shown on Figure 1 of the map accompanying this report. The horizon is known to form the aquifer of an extensive artesian basin in the municipality bordering on the west. The water pressure decreases toward the east, so that in this municipality wells situated in secs. 4, 5, 6, and 19, tp. 5, range 24, encounter water under little or no hydrostatic pressure, suggesting that these wells lie at the northeastern edge of the basin in this part of the area. This supposition is strengthened by the reported occurrence of dry gravels at the base of the drift in two bedrock wells sunk in sections 16 and 17 of the same township. The southern and eastern limits of this horizon are not well defined in township 4, range 24, owing to the scarcity of deep wells in this part of the municipality. Wells located in sections 30 and 32 show a slightly increased hydrostatic pressure on the water as compared with the wells farther north. This horizon can normally be expected to extend through the lowland area in the mid-western part of this township. The mineral salt content of the water from this horizon varies widely from place to place, so that no prediction can be made as to the quality of the water to be expected in any locality. Water from two of the wells now producing from this horizon is reported to be so highly mineralized as to be unsuited for domestic use, but it is being used for watering stock. At other places the water is less highly charged with dissolved mineral salts, and is being used for the household drinking supply.

Similar water-bearing beds are encountered by two wells, sunk to the base of the glacial drift in the southern part of township

4, range 22. For a description of these water supplies the reader is referred to a later section, dealing with the ground water conditions of this township.

Although ground water supplies throughout the greater part of the municipality are obtained from the glacial drift, it must not be inferred that these deposits are everywhere water bearing. Many of the residents have been unable to locate any water in the drift, and have been obliged to sink deep wells into the underlying bedrock, or have constructed dams or dugouts to conserve surface water. Surface water may be used for drinking if it is allowed to seep through porous clay or sand to a shallow well dug beside the reservoir, provided, of course, that the water in the reservoir is not highly mineralized, or is not contaminated by sewage or other decaying organic matter.

Water-bearing Horizons in the Bedrock

Five bedrock formations, known as the Cypress Hills, Ravenscrag, Whitemud, Eastend, and Bearpaw, are present in different parts of the municipality, and are listed in their descending order of occurrence. Thus the Cypress Hills, the uppermost formation, is underlain by the Ravenscrag and it in turn by the Whitemud, then the Eastend, with the Bearpaw forming the lowest of these formations throughout the municipality. All of these formations at one time, presumably, extended over the entire area. Erosion, both prior to and after the deposition of the glacial drift, has removed much of the bedrock, so that at the present time only the Bearpaw extends throughout the entire area. The Cypress Hills formation is now confined to the highest hill tops, in the central and northern townships, with its base lying at elevations ranging from about 3,500 feet to 3,400 feet above sea-level. It consists of alternating layers of silts, fine- to coarse-grained sands and sandstones, and beds of partly cemented gravels forming conglomerates.

The underlying Ravenscrag formation extends beyond the borders of the Cypress Hills beds over the greater part of the west-central and northern uplands, down to elevations ranging from about 3,400 feet above sea-level on the western side of the area, to 3,300 feet above sea-level on the eastern side. The sediments comprising the Ravenscrag formation consist mainly of soft clay shales and silts, interspersed with more porous sands and sandy clays, and an occasional thin seam of lignite coal. Where exposed in outcrops, the Ravenscrag ranges in colour from dark grey and drab to yellow, brown, and dark green.

The Whitemud formation below the Ravenscrag may attain a maximum thickness of about 60 feet in the northeastern part of the area, but owing to erosion that occurred before the Ravenscrag beds were laid down, it is probably absent in some parts and the Ravenscrag there rests immediately upon the Eastend formation. The Whitemud consists of light grey to white clays and sandy clays, outcrops of which form a conspicuous white band along both sides of Frenchman River valley, east of Ravenscrag village.

The Eastend formation underlying the Ravenscrag or Whitemud extends beneath the drift cover for a considerable distance beyond these formations in the south and western townships. This formation is composed chiefly of dark grey shales, interbedded in places by sandy shales, and fine sandstone beds. The lower beds are of marine origin and composed largely of dark, sandy shales that grade without an apparent break into the underlying Bearpaw formation, at an approximate elevation of 3,250 feet above sea-level on the western, and 3,150 feet above sea-level on the eastern, side of the area.

It is to be noted that Frenchman river has cut its valley sufficiently deep so that formations younger than the Bearpaw have been removed, and the river silts may rest immediately on the Bearpaw formation. This formation is also believed to underlie the drift, in the absence of the Eastend along the southern border,

and in the southwestern part of the area. The Bearpaw formation has a thickness of 700 to 800 feet. The upper beds, although probably more shaly than the Eastend, contain a few beds of fine sandstone and sandy shales. The middle and lower parts of the formation, however, are composed almost entirely of dark grey, impervious shales.

Since only a few wells in the municipality have been put down to the bedrock the water-bearing horizons existing in the different formations are not well defined.

The Cypress Hills formation is composed chiefly of porous sediments that should be capable of retaining large water supplies. In this area, however, the formation is restricted in most places to small, isolated uplands, in which the aquifers have little opportunity of either obtaining or retaining any large supplies of ground water. Such waters as do occur in these beds are mostly of excellent quality, and are quite suitable for domestic use.

The Ravenscrag formation has proved to be non-water bearing in many parts of the area, where wells have been sunk through it. As this formation forms an extensive water-bearing horizon in the municipality bordering on the east, and as outcrops on the river bank in this area show the presence of porous sands and coal seams, it seems probable that water may be obtained in some of the unprospected localities. Ravenscrag waters are usually more highly mineralized than water from the Cypress Hills formation, but are mostly drinkable.

Most of the bedrock wells in the municipality are obtaining water from the Eastend, or the upper sandy beds of the Bearpaw formation. Owing to the widely scattered locations of these wells, individual aquifers are seldom traceable over any large areas. A group of wells situated in secs. 27, 33, and 34, tp. 5, range 22, and in sec. 3, tp. 6, range 22, are apparently obtaining water from a sandstone horizon in the Eastend formation,

at elevations ranging from 3,235 to 3,175 feet above sea-level, or at depths of 132 to 260 feet from the surface. The water from the shallowest of the wells is "alkaline" and is being used for stock-watering only. Water from deeper wells is reported to be soft to moderately hard, and is suitable for the domestic requirements.

A 600-foot well, drilled in sec. 9, tp. 6, range 22, about a mile north of the wells referred to above, obtained an abundant yield of soft, brownish coloured water in sand at an elevation of about 2,900 feet above sea-level. This aquifer is undoubtedly in the Bearpaw formation. The water has a slight soda taste, and is being used for the domestic drinking supply. The water is under hydrostatic pressure, and rises in the well about 150 feet above the aquifer, suggesting that this horizon has a fairly wide lateral extent. Water containing a greater concentration of mineral salts is also obtained from the Bearpaw, in the southeastern part of the municipality, at slightly higher elevations.

Drilling wells to elevations below 2,900 feet above sea-level is not recommended, particularly on the western side of the municipality, as at greater depths the Bearpaw can be expected to yield little if any water that is suitable for farm requirements.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 4, Range 22

From an average elevation of about 3,075 feet above sea-level, in the southern part of this township, the general land surface rises toward the north, to attain a maximum elevation of about 3,450 feet in the north-central part of the area. Several, small, intermittent streams flow southward through the western half of the township, to cross the southern border in sections 4 and 5. Surface run-off from several sections in the north-eastern corner may flow to the northwest, through a small tributary of Frenchman river.

Water supplies are obtained from wells sunk to various depths in the glacial drift, and into the underlying bedrock formations. A few small sloughs and dams provide water for range stock, throughout part of the grazing season. The surface deposits in the township consist of glacial drift, with the exception of a thin blanket of Recent sands and silts, that may overlies the drift in some of the depressions, and in the coulée bottoms. The drift deposits occurring over slightly more than the northwestern half of the area consist of an irregularly rolling moraine. The rest of the township is overlain by a more evenly surfaced till plain. The morainic deposits are probably the best potential source of water supplies at shallow depths. Several wells sunk to depths of 10 to 20 feet in this area encountered moderately large supplies of hard, drinkable water in sand or sandy clays. The wells are situated in surface depressions, between the hills where porous beds are most likely to occur. These water supplies have decreased during the dry seasons, but at most places they furnish sufficient water for household use, and for several head of stock.

Shallow water-bearing beds are apparently scarce in the till-covered part of the areas, as here most of the residents are

obliged to sink wells to the base of the glacial drift, or into the underlying bedrock, before striking water. Water-bearing gravels that occur at the base of the drift form an extensive horizon throughout the township to the south, but these gravels probably do not extend into this township for more than a mile. It has been encountered, however, in two wells in section 3, at depths of 50 and 75 feet. The water is hard, and contains large quantities of mineral salts in solution rendering it unsuitable for household use. It may be used, however, for stock. Should productive beds occur at this horizon, elsewhere in the township, they will probably be confined to small, isolated areas.

The Ravenscrag, Eastend, and Bearpaw formations form the bedrock immediately underlying the drift in different parts of the township. The Ravenscrag formation is thought to occur only in the northern third of the area, where surface elevations are above 3,300 feet above sea-level. As the Ravenscrag was deposited on the unevenly eroded surface of the underlying Eastend formation, its base may not occur everywhere at the same elevation throughout the township. Although no wells are known to obtain water from the Ravenscrag it seems probable that water-bearing sands or coal seams may occur in some parts of the area, at depths of 50 to 100 feet from the surface.

The Eastend formation underlies the Ravenscrag where it occurs, and may extend below the drift cover southward to within $1\frac{1}{2}$ miles of the southern border of the township as outlined in Figure 1 of the accompanying geological map. As the lower beds of this formation apparently merge without a break into the underlying Bearpaw formation, the position of its base cannot be accurately determined. Its thickness is not expected to exceed 150 feet, however, and, therefore, its base may occur at an elevation of about 3,150 feet above sea-level. Two wells situated in the W. $\frac{1}{2}$, section 24, encountered an adequate supply of hard, drinkable water in sand

at depths of 118 and 130 feet, or at elevations of 3,143 and 3,195 feet respectively. These sands may be in the lower part of the Eastond formation, or in the upper part of the Bearpaw formation. Water was also encountered in the NE. $\frac{1}{4}$, section 9, at a depth of 130 feet, or at an elevation of about 3,134 feet. This water is reported to occur in blue clay or shale, and is so highly mineralized as to be unfit even for watering stock.

Water-bearing horizons are also known to occur at greater depths and are probably in the Bearpaw formation. A 303-foot well situated in the SW. $\frac{1}{4}$, section 27, struck soft water in a bed of sand, at an elevation of 3,110 feet. This water is under hydrostatic pressure and rises in the well to within about 75 feet of the surface. A still lower aquifer was encountered in section 17, at a depth of 305 feet, or at an elevation of about 2,970 feet. This water is also under pressure and rises in the well to within 80 feet of the surface. The water is reported to be moderately soft and has a salty taste, rendering it unsuitable as a domestic drinking supply, but it is being used for watering stock. These or similar water-bearing horizons are expected to occur at depths of 200 to 350 feet in other parts of the township.

Township 4, Range 23

With the exception of a narrow belt of till plain, extending over the southern half of sections 1 and 2, this entire township is overlain by moraine. In general, the land surface rises toward the northeast from an average elevation of about 3,100 feet above sea-level in the southern part to a maximum elevation of 3,400 feet in the northeastern corner of the area.

The surface drainage is poorly developed, as most of the small draws and coulées terminate in sloughs occupying undrained depressions. These surface supplies provide some water for range stock. As a large part of the area consists of range-land only, a few wells have been put down for ground water supplies. These

wells are confined to the northern part of the area.

The best potential source of ground water supply in the unconsolidated deposits probably occurs in the upper 20 feet of the glacial drift. These supplies are usually found in the depressions and at the bases of steep slopes, where material washed down from the hills collects and forms beds sufficiently porous for ground water accumulation. Although water may not be everywhere present in these deposits, such supplies as occur can be readily located by the use of a small test auger. Three wells situated in sections 27, 32, and 33 yield small to moderate supplies of water from these shallow deposits. These waters are drinkable, although in section 33 they are reported to be noticeably mineralized.

The Ravenscrag formation is believed to immediately underlie the glacial drift, in parts of sections 35 and 36, in the northeastern corner of the area. The Eastend formation may extend for about 3 miles farther south and west. Most of the southeastern half of the township, however, is underlain by the Bearpaw formation. The Ravenscrag formation is probably thin, and may not contain any large ground water supplies. The thickness of the Eastend probably does not exceed 150 feet. A 200-foot well drilled in the SW. $\frac{1}{4}$, section 26, encountered a moderately large supply of highly mineralized water, at a depth of about 130 feet, or at an elevation of about 3,240 feet. This water is being used for stock, but it is reported to be unsuitable for household use. The exact geological position of this horizon is not known, but it probably occurs in the lower Eastend or in the upper part of the Bearpaw formation. The water-bearing bed is apparently of small extent as two dry holes have also been put down in this quarter, to depths of 264 feet and 346 feet. Although no water was obtained from the Eastend or upper Bearpaw in the deep holes drilled in section 26, these formations may be water bearing in other parts of the area. Little if any water can be expected, however, at elevations lower than about 2,900 feet above sea-level,

as the Bearpaw at greater depths consists almost entirely of impervious shales.

Township 4, Range 24

The land surface on the western side of this township consists of a moderately rolling to undulating plain, with surface elevations ranging from about 3,075 feet to 3,175 feet above sea-level. The surface rises generally toward the northeast to reach a maximum elevation of about 3,200 feet in the northeastern corner of the area. The surface in the eastern part, particularly in the northeast, is characterized by steep-sided, irregular hills, with intervening, undrained depressions typical of morainic deposits. The moraine extends westward to section 21 in the central part, to section 32 in the north, and to section 6 in the southern parts of the area. The rest of the western half and a small area in sections 11 and 12 are underlain by glacial till. Most of the township consists of range-land, although a few sections in the northwestern part are farmed. Wells are known to have been put down only in the farming settlement. Stock in the range-land obtain water from sloughs and possibly from a few small dams, constructed in draws or coulées.

In the moraine-covered area, small to moderately large supplies of water may be obtainable from shallow wells, sunk to sand or gravel pockets in the upper 20 feet of the drift deposits. Residents in search of these water supplies are advised to prospect the lower slopes and depressions in preference to the points of higher elevations.

In the till-covered area on the western side of the township the shallow water-bearing beds may be relatively scarce. There abundant supplies of water may be obtained from extensive beds of gravel that occur at the base of the glacial drift, at depths of 60 to 80 feet from the surface. The southern and eastern limits of this horizon are unknown, but it probably extends southward as

far as section 7, and east to the central part of the area, as indicated by the "A" boundary in Figure 1 of the map accompanying this report. Wells sunk to depths of 60 and 73 feet in sections 30 and 32 yield abundant supplies of hard, drinkable water from this horizon. The water is under pressure and rises in the wells 40 and 20 feet above the aquifer. A third well, in section 31, obtained a smaller yield of highly mineralized water from this horizon, at a depth of 60 feet. The water has a laxative effect on humans, if drunk in large quantities, but it is being used for watering stock. Although appreciable amounts of mineral salts may be present in the water at other places, most of these waters are not expected to be so highly mineralized as to render them undrinkable.

No wells in the township are known to be obtaining water from the bedrock formation. The Eastend formation is thought to immediately underlie the glacial drift only in section 36, in the northeastern part of the area. It is probably thin, however, and can not be expected to form an extensive water-bearing horizon.

The Bearpaw formation underlies the Eastend, where it occurs, and is thought to immediately underlie the glacial drift throughout the remainder of the township. This formation is composed mostly of shales, although a few thin beds of fine-grained sand and sandy shales may occur, particularly in the upper part of the formation. The sandy beds may be water-bearing in some places, in the uplands of the south and eastern parts of the area, although no prediction can be made as to the quality or the quantity of water to be expected from this potential horizon. The shale beds that occur below the drift in the central and the northwestern part of the township may be non-water bearing. The bedrock in this part of the area, however, is thought to be overlain by water-bearing gravels of the drift, and prospecting at shallow depths is advisable to deeper drilling into the shales.

Township 5, Range 22

Moraine covers most of the western two-thirds of this township. The surface throughout this part of the area is steeply rolling, particularly in the west, where the presence of numerous, steep-sided hills and undrained depressions renders most of the land unsuitable for farming. Toward the western side of the moraine the general land surface is moderately rolling and in the central to mid-southern part of the township rises from an average elevation of 3,400 feet to over 3,500 feet above sea-level. On the western side of these uplands the surface slopes rather abruptly to an elevation of about 3,200 feet along the western border of the township. This part of the area is overlain by glacial till.

Although numerous small sloughs occur in the western part of the moraine-covered area in years of normal precipitation, they were nearly all dry in 1935. Surface waters may be conserved for stock use in some parts of this township, however, by constructing dams or reservoirs.

Ground water supplies are obtained as a rule by sinking wells in the unconsolidated deposits. Two water-bearing horizons occur in these deposits. The upper horizons consist of small, discontinuous beds of water-bearing sands and sandy clays, which occur interspersed through the upper 10 to 15 feet of the boulder clay. These water supplies are confined mostly to the coulée bottoms, and to the depressions in the moraine-covered area. These waters are usually hard, but are rarely so highly mineralized as to be unsuitable for drinking. The wells are affected by drought conditions, and most of the residents depending upon these water supplies have been obliged to sink several wells in order to obtain sufficient water for stock.

The second water-bearing horizon consists of isolated pockets of sand and gravel that occur sparsely interspersed through

the boulder clays at depths ranging from 30 to 65 feet. Two wells situated in section 9, yield from this horizon small supplies of highly mineralized water that is used only for stock. Larger supplies of hard, drinkable water are also obtained from wells situated in section 4 and 7. A small seepage of water was also obtained from gravel in section 1, but this well was deepened to the bedrock, where an adequate yield was encountered. At various other places in the township, particularly in this eastern half, these drift waters have not been encountered and wells have been put down to the underlying bedrock.

The Ravenscrag formation immediately underlies the glacial drift in this township, with the exception of a narrow belt along the eastern side, where surface elevations lie below 3,300 feet above sea-level. This formation consists mainly of soft clays and shales, through which are interspersed a few thin beds of fine sand and coal seams. Only one well, situated in section 23, is known to yield drinkable water from this formation. In this well a moderate supply is obtained from a sand bed, at a depth of 98 feet or at an elevation of about 3,309 feet. This water is hard and tastes of iron, but is reported to be suitable for domestic use. A dry hole sunk to a depth of 127 feet in section 15 is possibly not sufficiently deep to encounter this horizon. A small yield of "sulphur" water that is unfit for use was also obtained from a coal seam at a depth of 70 feet in section 1.

The underlying Eastend formation is known to be water-bearing in the northern part of the township. Three wells, situated in sections 27, 33, and 34, produce an abundant supply of water from a bed of sandstone at depths of 232, 260, and 132 feet, respectively. This horizon occurs at elevations ranging from about 3,237 feet to 3,175 feet above sea-level. The shallowest of these wells may obtain its water from a higher aquifer as its water is highly mineralized and is used only for stock. The water obtained from the deeper

wells is reported to be soft, and is suitable for the domestic drinking supply. An adequate supply of hard, drinkable water is also obtained from a similar aquifer in section 1, at a depth of 160 feet or at an elevation of about 3,218 feet. Although no wells are known to have been put down to this elevation in other parts of the township, the possibility of obtaining water at this horizon over large areas is considered favourable.

The upper beds of the Bearpaw formation lying immediately below the Eastend may also be water-bearing in some parts of the township. This potential horizon may occur at elevations as low as 2,900 feet above sea-level. No prediction can be made, however, regarding the quality of the water to be expected, as it may vary considerably in different localities. Deep drilling into the shales is not advisable.

Township 5, Range 23

Surface relief in the southeastern part of this township varies irregularly and is typical of morainic topography. On the western side the surface is deeply dissected by a wide coulée that extends northward from section 7 to cross the western border in section 30. The rest of the township is characterized by gentle slopes and extensive areas of fairly low relief. The lowest part of the area occurs in the southwest, at an average elevation of about 3,250 feet above sea-level. Toward the east and north the surface rises to elevations ranging from about 3,400 feet on the eastern border, to a maximum of 3,600 feet in section 34, on the northern border.

With the exception of the deeply eroded area on the western side the entire township is overlain by moraine. As there are no permanent streams in the area, surface water supplies are confined to artificially constructed dams and dugouts, and to a few shallow sloughs in the southeastern parts. Ground water is obtained chiefly from shallow wells sunk in the unconsolidated Recent and

glacial drift deposits.

The Recent stream deposits consist of discontinuous beds of sand and gravel, interspersed through the less porous silts and clays in the coulée bottoms. Wells encountering sand or gravel usually yield small supplies of soft to moderately hard water that is suitable for domestic use. These wells are rarely over 20 feet in depth. At most places where these waters are utilized dams have been constructed to provide water for stock.

The glacial drift consists mainly of boulder clay, yellowish to light brown at the surface, but grading into darker coloured, blue-grey clay at a depth of 15 to 20 feet. Isolated pockets of sand, sandy clay, and more rarely gravel occur interspersed at irregular intervals, through the boulder clay. These porous deposits are usually more numerous in the depressions in the land surface or at the bases of steep slopes at depths of 10 to 20 feet from the surface. Many of them are encountered in wells sunk in the irregular, moraine-covered area, in the southern part of the township. Water obtained from these wells is generally hard, but it is rarely so highly mineralized as to be unsuitable for household drinking supplies. The yield varies but at most places it is sufficient only for household use and for a few head of stock. The supply may be increased, however, by sinking several wells in the same locality. Although numerous dry holes have also been put down in the drift deposits, some of which have encountered the underlying bedrock, a water-bearing horizon may occur at the base of the drift in some parts of the area, particularly in the southwestern sections. A 100-foot well in section 4 encountered water at a depth of about 27 feet. This horizon may extend westward through sections 5, 6, and 7, as water was also encountered at a depth of 67 feet in a well situated in section 12, in the township to the west. Water from both these wells is highly mineralized and is unsuitable for drinking, although the well in section 12 is used for watering stock.

The Cypress Hills formation is known to form the bedrock at the base of the drift in an upland area in section 20. The areal distribution of this formation has not been determined, although it probably has not extended for more than half a mile north of this section. The Ravenscrag formation underlies the Cypress Hills formation where it occurs and is believed to immediately underlie the glacial drift throughout most of the eastern two-thirds of the township at elevations greater than 3,350 feet above sea-level. The rest of the township is underlain by Eastend formation. As the Cypress Hills beds overlie only a small area of upland they are not expected to contain any large ground water supplies, but such water as is obtainable from these beds is generally of excellent quality.

The Ravenscrag formation has proved to be non-water bearing where wells have been sunk into it in sections 1, 20, and 33. It may be water bearing, however, in the northeastern part where it has a greater thickness.

The Eastend formation and the upper more porous beds of the underlying Bearpaw formation, down to an elevation of about 2,900 feet, are possibly the best potential source of water supply in the bedrock. A well, situated in the SE. $\frac{1}{4}$, section 1, was drilled to a depth of 224 feet or to an elevation of about 3,167 feet. The base of this well may be in the Eastend or in the upper part of the Bearpaw formation. The water obtained contains a relatively large amount of the laxative acting salts in solution, but it is being used for domestic use and for watering stock. Two dry holes were also put down in this quarter-section, but the depths were not recorded. A dry hole sunk to a depth of 155 feet or to an elevation of about 3,120 feet in the NW. $\frac{1}{4}$, section 3, failed to encounter water at this horizon. The most satisfactory water supply is obtained from a 130-foot well put down in the Eastend formation in section 33. The water here is reported to be

quite suitable for drinking, although it tastes slightly of iron. The supply is adequate for the farm requirements. Similar water-bearing beds may occur elsewhere, particularly in the northeastern part of the township where the upper and more sandy beds of the Eastend occur.

Township 5, Range 24

Surface relief in the southwestern part of this township is relatively low. Throughout the rest of the area the land is steeply rolling to hilly, and the general surface rises in a northerly direction from elevations of 3,150 feet to 3,200 feet in the south, to elevations of 3,300 to 3,400 feet above sea-level in the northern part. The railway traverses the northwest corner of the township through a wide, flat-bottomed coulee that crosses the northern border in sections 33 and 34, at an elevation of about 3,150 feet. An eastern branch of this stream channel extends from the northern border through the eastern half of the township. Both valleys have a very low gradient and little if any water flows through them.

Surface water supplies of the township are confined to artificially constructed dams and dugouts and to a few shallow sloughs. Ground waters are obtained chiefly from wells sunk in the glacial drift, although Recent stream deposits and the bedrock formations may also yield water in some parts of the area.

Stream deposits that occur in the bottoms of the large coulees consist essentially of clays and silts, interbedded in some places by porous sands and gravels. Wells penetrating sand or gravel beds may be expected to yield moderate supplies of water at depths not exceeding 20 feet. Careful prospecting may be required to locate these aquifers, however, and some of the waters may be charged with relatively large amounts of salts in solution.

The thickness of the glacial drift varies considerably in different parts of the area. Well records show a thickness of

50 to 75 feet for these deposits in the southern parts, but in the north much of the drift has been removed by stream erosion and the underlying bedrock is exposed at some places on the steep slopes. With the exception of the eroded stream channels, and a narrow strip of till plain on the western side of the township, the surface deposits consist of moraine.

Two water-bearing horizons occur in the glacial drift. The upper horizon is confined to scattered pockets of sands and sandy clays interspersed through the weathered zone of the boulder clay within 20 feet of the surface. Many of the wells encountering these water supplies are situated in the low depressions beside sloughs. The yield is affected by drought conditions, but sufficient water may be obtained for domestic use in some parts of the township. This horizon is usually more productive in the moraine-covered areas than on the less rolling till plains.

The second water-bearing horizon occurs in extensive gravel beds at or near the base of the glacial drift. The exact areal distribution of these gravels is not known, but it is probably confined chiefly to the southern part of the township. The "A" line in Figure 2 of the map accompanying this report shows the approximate eastern limit of the horizon. It may, however, extend farther east through the southern sections, as similar gravels occur in a well on section 12, at a depth of 70 feet. Where encountered, these gravels yield water that is generally hard and highly mineralized. In sections 5 and 12 the water is reported to be suitable only for stock use. Other wells produce water that is drinkable, although at most places it has the bitter taste caused by dissolved sulphate salts. Throughout the central and northern uplands the base of the glacial drift is not expected to be water-bearing in more than a few isolated localities. Residents in this part of the area are advised to confine their search for ground water supplies to the shallow Recent deposits and the upper weathered

zone of the glacial drift, unless they are prepared to extend wells to greater depths into the underlying bedrock.

The Ravenscrag formation immediately underlies the glacial drift in only a small area in the northwestern uplands part of the township at elevations greater than about 3,400 feet above sea-level. The Eastend formation underlies the Ravenscrag, and immediately underlies the glacial drift in the central and eastern parts of the township where surface elevations range above 3,250 feet above sea-level.

As only two wells are reported to have been put down to bedrock in the township, little is known regarding the water conditions existing in these formations. The Ravenscrag formation consists chiefly of soft clay shales, from which little or no water can be expected. The Eastend formation is also composed essentially of shales interbedded at wide intervals with thin bands of fine sands and sandy shales. As the lower beds of the Eastend gradually merge into the underlying Bearpaw formation at depth, the position of its base is indefinite, but it probably occurs at an elevation of about 3,250 feet.

The upper part of the Bearpaw also contains an occasional bed of fine sand, but it is known to consist almost ~~entirely~~ of shale at greater depths. These upper sandy beds and those of the overlying Eastend formation are probably the best potential source of ground water supply in the bedrock formations. Drilling wells to elevations lower than about 2,950 feet above sea-level is not recommended.

A 160-foot well bored in section 16 struck an adequate supply of water in what is probably a sandy shale, in the upper beds of the Bearpaw formation at an elevation of about 3,095 feet. The water is hard, and contains appreciable quantities of the mineral salts in solution, but is being used for the household drinking supply with no reported ill effects. A dry hole was also

put down to a depth of 123 feet in this section and another in section 17 to a depth of 170 feet or to an elevation of about 3,020 feet. Although the results from these wells are not very encouraging, it is probable that water may be obtained from the bedrock at other places in the township.

Township 6, Range 22

The variation in surface relief approximates 700 feet in this township. The lowest part occurs at an elevation of 3,000 feet above sea-level in the valley of Frenchman river. Elevations on the uplands south of the valley range from 3,300 feet in the southeastern part to 3,700 feet in section 7 and 18, on the western border of the area. Elevations ranging from about 3,400 feet to 3,550 feet occur north of the valley. Owing to the generally uneven land surface on the uplands, and to the rugged topography existing on the river banks most of the township is given over to ranching. Stock ranging in the vicinity of Frenchman valley may obtain water from the river, although these supplies are not everywhere conveniently located owing to the presence of the railway and farm fences along the valley bottom. Surface waters are relatively scarce on the uplands as most of the sloughs are shallow and retain water only during a part of the grazing season. The presence of numerous small draws and coulées, however, offers splendid opportunities for the construction of dams and dugouts should they be required.

Ground water supplies are obtained by sinking shallow wells in the unconsolidated Recent and glacial drift deposits, and by putting down deep wells in the bedrock formations.

Stream deposits are probably the best potential source of ground water at shallow depths. These sediments are not expected to exceed thicknesses of 20 feet in the small coulées and draws in the upland areas. A well situated in section 12 encountered an abundant supply of soft water in this type of deposit. The water occurs in a bed of gravel buried under about 10 feet of yellow clay.

Similar aquifers are expected to occur at other places in the uplands, although most of these beds are probably of too limited areal extent to produce much more than sufficient water for domestic use.

Stream deposits that occur in the bottom of Frenchman valley may attain a thickness of 30 to 40 feet. They are composed chiefly of clays, silts, and fine sands. Discontinuous beds of coarser sands and gravels are expected to occur interbedded with the finer sediments along the edges of the valley flats, particularly at the confluence of tributary stream channels. Wells sunk to these marginal deposits can be expected to yield water containing relatively small amounts of salts in solution. Water from wells sunk in the fine sands and silts in the lower river flats is in many places quite highly mineralized, and at some places may not be very suitable as a household drinking supply.

The glacial drift overlying the upland areas consists chiefly of till. Small, moraine-covered areas occur in the southeastern and southwestern parts of the township, and in a narrow belt extending along the northern border in section 31, 32, and 33. Drift deposits in the river valley consist mostly of reworked materials, washed down from the upper river banks. The thickness of the drift deposits no doubt varies considerably from place to place. The drift is not expected to attain a thickness greater than 60 feet over most of the uplands and it is relatively thin or absent on the steep slopes of Frenchman valley. Extensive water-bearing horizons are not known to occur in these deposits. Small supplies of drinkable water may be obtainable, however, by sinking shallow wells at the bases of steep slopes or in depressions in the land surface. Such supplies are usually concentrated in small pockets of sandy clays, sands, and gravels, interspersed through the upper 20 feet of the boulder clay, particularly in the more hilly moraine-covered areas.

Although five bedrock formations are known to underlie the unconsolidated deposits in different parts of the township little is known as to the ground-water conditions existing in them.

The Cypress Hills formation caps the small areas of highlands in sections 7 and 30, on the western border of the township. Although this formation undoubtedly contains beds of porous sands, owing to its isolated position on the hill tops, it may have little opportunity of retaining any large water supplies. Any water found in these beds should be quite suitable for domestic use.

The Ravenscrag formation immediately underlies the Cypress Hills beds and the drift deposits throughout the rest of the area, with the exception of the river valley and a narrow belt extending along the eastern side of the township, where surface elevations range lower than about 3,300 feet above sea-level. Two wells, situated south of the river in sections 4 and 9, were drilled through this formation. Soft clay shales and a thin seam of lignite coal were encountered in both wells, but these were not water-bearing. Findings at these locations may not be indicative of water conditions in the Ravenscrag in all parts of the area, however, as some outcrop on the river banks show the presence of beds sufficiently porous for ground water accumulation.

The Whitemud formation, consisting of about 30 feet of white to light grey clays and sandy clays, occurs between the Ravenscrag and the underlying Eastend formations. Outcrops of these clays are fairly continuous across the township on both sides of the river valley. Little more than mere seepages of probably highly mineralized water can be expected from this formation.

The Eastend formation and the upper sandy beds of the underlying Bearpaw formation are considered to be the best potential source of ground water supply in the bedrock of this township. The

above-mentioned well, in section 4, tapped a water-bearing sand in the Eastond formation at a depth of 215 feet at an elevation of about 3,235 feet above sea-level. This horizon is also encountered by three wells located in the northern part of the township to the south. The water is hard, and it is being used for the domestic drinking supply and also for garden irrigation, from which satisfactory results are reported. Although this horizon was not encountered in a deep well drilled in section 9, it or other water-bearing sands may occur elsewhere in the township, particularly in the southern part.

In section 9 an abundant supply of soft water was encountered in sand at a depth of 600 feet or at an elevation of about 2,900 feet in what is undoubtedly the Bearpaw formation. The water has a light brown colour and tastes slightly of soda, but is reported to be suitable for domestic use. The soda or "black alkali" content may, however, be injurious to vegetation if the water is used for irrigation. The water is under hydrostatic pressure and stands at a constant level in the well about 250 feet above the aquifer. This horizon may have a fairly wide areal distribution throughout the township and the horizon would be reached at moderate depths of 100 to 150 feet in the river valley. Its water may be more highly charged with mineral salts at some places, and may not be suitable for domestic use.

Township 6, Range 23

The land surface of this township rises gradually in a northeasterly direction from an elevation of about 3,325 feet above sea-level in the southwestern corner to elevations as great as 3,700 feet at several points on the eastern side of the area. Frenchman River valley and its northern tributaries occupy most of the northern half of the township. The valley sides are steeply dissected, leaving only two small areas of upland in the northern part of the area and some parts of the valley bottom sufficiently

level for farming. The land surface in the southern half of the township is for the most part moderately rolling and much of it is suitable for agriculture.

The unconsolidated deposits overlying the bedrock in the township vary greatly in thickness. In the bottom of the river valley, Recent flood-plain deposits occur to depths of 30 to 40 feet. The valley sides are partly overlain by glacial and Recent deposits, most of which have been washed down from the higher land. The bedrock formations are exposed at intervals along the steep slopes. The uplands north and immediately south of the valley are covered by a mantle of glacial till of an undetermined thickness, but probably nowhere exceeding 40 feet in depth. Farther south, over most of the southern third of the township, the surface deposits consist of moraine.

Frenchman river is the chief source of surface water supplies in the area. Artificially constructed dams and dugouts provide water for stock at several farms in the southern uplands. This method of water conservation could be further developed owing to the presence of numerous small coulées offering suitable sites for the construction of small dams. Such sloughs as occur in the moraine-covered area are usually too shallow to retain a permanent water supply. The present ground water supply is obtained chiefly from shallow wells sunk in the unconsolidated Recent and glacial drift deposits.

Wells dug to depths of 15 to 25 feet in the stream deposits that floor the bottom of Frenchman valley yield ample supplies of hard and generally drinkable water. These deposits provide water for the residents in the village of Ravenscrag, and for several farms situated on the river flats. Water from wells sunk in the fine sands and silts in the lower flats near the river generally contain appreciable amounts of mineral salts in solution. Wells sunk at higher elevations on the edges of the flat, particularly

those situated at the confluence of tributary stream channels, usually encounter coarser sands and gravels and the contained waters are as a rule less highly mineralized. A well situated in the SW. $\frac{1}{4}$, section 30, yields from a deposit of this type soft water of excellent quality.

On the uplands remote from the river valley the shallow water supplies are concentrated in small, irregular pockets of sand or gravel, interspersed through the upper weathered zone of the boulder clay. Such pockets are most readily located in the small draws or coulées, and in depressions, and are formed in part by surface materials washed down from points of higher elevations. As the water-bearing beds are usually buried under 10 to 15 feet of clay their presence is not indicated at the surface, making it necessary at some places to sink several test holes before a water supply is located.

The waters are hard and are reported to be suitable for the domestic drinking supply, although the yield obtainable is not everywhere sufficient for stock use.

Wells sunk in the ridges and on the more gentle slopes of the till-covered areas encounter only compact boulder clay from which little or no water is obtainable.

As only one well in this township is definitely known to have penetrated through the unconsolidated deposits, little is known as to the water conditions existing in the underlying bedrock formations.

The Cypress Hills formation is known to underlie the drift deposits in two small upland areas north and south of Frenchman river on the eastern side of the township. Although this formation undoubtedly contains sand beds sufficiently porous for water accumulation, owing to its small areal extent and high position relative to the surrounding area it may have little opportunity of gathering and retaining any large amounts of water.

Such water as it may contain, however, is expected to be of good quality.

The Ravenscrag formation occurs below the Cypress Hills beds and immediately underlies the unconsolidated deposits throughout most of the uplands, to elevations as low as 3,350 feet above sea-level. Water conditions in the Ravenscrag formation have proved unsatisfactory in most parts of the municipality where wells have been sunk to a sufficient depth to penetrate these beds. Since this formation is known to contain sand beds and coal seams that are sufficiently porous to form reservoirs for ground water accumulation, it seems reasonable to suppose that at least small yields may be obtained in some localities.

Water conditions of the underlying Whitemud formation are also regarded as unsatisfactory in this township. Outcrops of these clays are exposed at intervals along both sides of Frenchman River valley, at an elevation of about 3,300 feet above sea-level. Whitemud beds were also encountered in a 200-foot drilled well in section 9, but they proved to be non-water bearing. At this location an abundant yield was obtained, however, in the Eastend formation below the Whitemud at an elevation of about 3,265 feet. This water is hard and is reported to be suitable for the domestic drinking supply. The areal extent of this horizon remains undetermined, but it or deeper aquifers can be expected elsewhere in the Eastend and upper part of the underlying Bearpaw formation, down to elevations as low as 2,900 feet above sea-level. No prediction can be made regarding the quality of the water to be expected from these potential horizons. It will no doubt vary considerably in different parts of the area, but should be satisfactory at least for watering stock. Still deeper drilling into the compact shales that predominate in the lower part of the Bearpaw formation is not advisable.

Township 6, Range 24

Frenchman River valley and a large southern tributary, together with their steeply eroded banks, occupy approximately one-half the land surface of this township. Relief of the area approximates 600 feet, with surface elevations ranging from about 3,100 feet above sea-level in the valley bottom to elevations of 3,400 feet on the southwestern and southeastern uplands. These surface elevations reach a maximum of about 3,700 feet on the southern slopes of the Cypress hills, along the northern border of the area.

The township consists largely of range-land as a relatively small part of the area is suitable for farming.

Surface water supplies are confined to Frenchman river, and to several, small, spring-fed tributaries from the north. The large coulée, through which the railway enters Frenchman River valley from the south, is devoid of a permanently flowing stream.

As information was obtained of only three wells in this township little is known of its ground water resources. The Recent flood-plain deposits that occur in Frenchman River valley and its tributaries are considered to be the best potential source of water supply in the unconsolidated deposits and are not expected to differ essentially from the river deposits encountered at Ravenscrag and other points farther down stream, as described in previous sections dealing with the townships to the west.

Owing to the extensive stream erosion that has taken place in this area, the thickness of the glacial drift varies greatly within short distances. On the steep slopes it is quite thin, and in many places it is absent, allowing the underlying bedrock formations to be exposed. The drift probably attains its greatest thickness in the moraine-covered areas in the southwestern and in the southeastern parts of the township. A well situated in section 1, in the southeastern morainic area, encountered gravel at a depth of

45 feet, at what is probably the contact of the drift with the underlying bedrock. No water was obtained at this horizon, and drilling was continued to a water-bearing horizon in the bedrock. Unproductive gravels at the base of the drift have also been encountered in other wells situated on the upland areas south of the river in the bordering townships and suggest a prevalence of these conditions through this township.

Shallow wells sunk to sand and gravel pockets that occur sparsely interspersed through the upper 20 feet of the drift deposits may produce small supplies of drinkable water at some places in the uplands. Such pockets are usually more plentiful in the moraine-covered areas than in the less irregular deposits of the till plains. Residents in search of these water supplies are advised to prospect the lower slopes and depressions between the hills, in preference to the ridges and steep hill-sides.

The bedrock formations also yield water or remain as a potential source of water supply in this township. The Cypress Hills formation underlies the glacial drift on the uplands north of Frenchman river, and caps the highest parts of the southern uplands at elevations greater than about 3,370 feet above sea-level. A 70-foot well situated in section 17 obtained an adequate supply of soft water from a bed of sandstone in this formation after penetrating alternating layers of sand, sandstone, and gravel. This water is reported to be of excellent quality, and is being used for the domestic drinking supply. Similar aquifers probably occur in this vicinity and in the uplands north of the river valley and would be found at depths not exceeding 100 feet.

The Ravenscrag formation occurs below the Cypress hills, but does not extend more than half a mile beyond the borders of this formation. Although the Ravenscrag formation is less porous than the Cypress Hills beds, it may yield water in some parts of the area, but throughout the municipality, the yields obtained from

this formation are far from satisfactory. Such water as may be found is expected to be more highly mineralized than that from the Cypress Hills aquifers.

The Whitemud formation is known to underlie the Ravenscrag in the central part of the township and was reported to occur in a well on section 1, but it may not be everywhere present on the uplands. This formation is not known to be water bearing in the municipality.

The Eastend formation occurs below the Ravenscrag, and the Whitemud where it is present, and immediately underlies the drift throughout the remainder of the uplands down to elevations as low as about 3,250 feet above sea-level. A well situated in section 1, after being drilled through about 45 feet of drift and through the Whitemud formation, encountered a small yield of water at a depth of 90 feet in the upper part of the Eastend formation. Drilling was continued and at a depth of 120 feet or at an elevation of about 3,255 feet above sea-level an adequate yield of hard "alkali" water was obtained. This water is being used for household purposes and for watering stock, although it is of poor quality. This aquifer is probably of small areal extent, although others may occur at greater depths at this location and at various elevations in the Eastend or other parts of the township. As no definite contact is recognized between the Eastend and the underlying Bearpaw formation, the exact position of the base of the Eastend is unknown. The upper beds of the Bearpaw formation, however, may also be sufficiently porous at some places to be water bearing. This formation is known to become more shaly at depths and is expected to contain little or no water at elevations lower than about 2,900 feet above sea-level.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL
MUNICIPALITY OF NO. 50, SASKATCHEWAN

	Township		4	4	4	5	5	5	6	6	6	Total No. in muni- cipality
West of 3rd meridian	Range		22	23	24	22	23	24	22	23	24	
<u>Total No. of Wells in Township</u>			15	6	3	35	56	14	5	26	3	163
No. of wells in bedrock			5	3	0	7	4	3	2	1	2	27
No. of wells in glacial drift			10	3	3	26	45	10	1	13	0	111
No. of wells in alluvium			0	0	0	2	7	1	2	12	1	25
<u>Permanency of Water Supply</u>												
No. with permanent supply			15	3	3	32	22	11	5	18	3	112
No. with intermittent supply			0	1	0	1	8	1	0	3	0	14
No. dry holes			0	2	0	2	26	2	0	5	0	37
<u>Types of Wells</u>												
No. of flowing artesian wells			0	0	0	0	0	0	0	0	0	0
No. of non-flowing artesian wells			4	0	2	5	1	1	2	1	0	16
No. of non-artesian wells			11	4	1	28	29	11	3	20	3	110
<u>Quality of Water</u>												
No. with hard water			13	3	3	30	22	11	3	17	1	103
No. with soft water			2	1	0	3	8	1	2	4	2	23
No. with salty water			1	0	0	0	0	0	0	0	0	1
No. with "alkaline" water			2	2	1	1	1	9	0	4	1	21
<u>Depths of Wells</u>												
No. from 0 to 50 feet deep			9	3	0	25	50	6	3	23	1	120
No. from 51 to 100 feet deep			1	0	3	5	2	5	0	2	1	19
No. from 101 to 150 feet deep			3	0	0	2	2	1	0	0	1	9
No. from 151 to 200 feet deep			0	1	0	1	1	2	0	1	0	6
No. from 201 to 500 feet deep			2	2	0	2	1	0	1	0	0	8
No. from 501 to 1,000 feet deep			0	0	0	0	0	0	1	0	0	1
No. over 1,000 feet deep			0	0	0	0	0	0	0	0	0	0
<u>How the Water is Used</u>												
No. usable for domestic purposes			12	3	3	27	26	9	5	18	3	106
No. not usable for domestic purposes			3	1	0	6	4	3	0	3	0	20
No. usable for stock			14	4	3	32	29	12	5	18	3	120
No. not usable for stock			1	0	0	1	1	0	0	3	0	6
<u>Sufficiency of Water Supply</u>												
No. sufficient for domestic needs			14	3	3	25	17	11	5	18	3	99
No. insufficient for domestic needs			1	1	0	8	13	1	0	3	0	27
No. sufficient for stock needs			11	2	3	13	11	10	4	16	3	73
No. insufficient for stock needs			4	2	0	20	19	2	1	5	0	53

ANALYSES AND QUALITY OF WATER

General Statement

Samples of water from representative wells in surface deposits and bedrock were taken for analyses. Except as otherwise stated in the table of analyses the samples were analysed in the laboratory of the Borings Division of the Geological Survey by the usual standard methods. The quantities of the following constituents were determined; total dissolved mineral solids, calcium oxido, magnesium oxide, sodium oxide by difference, sulphate, chloride, and alkalinity. The alkalinity referred to here is the calcium carbonate equivalent of all acid used in neutralizing the carbonates of sodium, calcium, and magnesium. The results of the analyses are given in parts per million--that is, parts by weight of the constituents in 1,000,000 parts of water; for example, 1 ounce of material dissolved in 10 gallons of water is equal to 625 parts per million. The samples were not examined for bacteria, and thus a water that may be termed suitable for use on the basis of its mineral salt content might be condemned on account of its bacteria content. Waters that are high in bacteria content have usually been polluted by surface waters.

Total Dissolved Mineral Solids

The term "total dissolved mineral solids" as here used refers to the residue remaining when a sample of water is evaporated to dryness. It is generally considered that waters that have less than 1,000 parts per million of dissolved solids are suitable for ordinary uses, but in the Prairie Provinces this figure is often exceeded. Nearly all waters that contain more than 1,000 parts per million of total solids have a taste due to the dissolved mineral matter. Residents

accustomed to the waters may use those that have much more than 1,000 parts per million of dissolved solids without any marked inconvenience, although most persons not used to highly mineralized water would find such waters highly objectionable.

Mineral Substances Present

Calcium and Magnesium

The calcium (Ca) and magnesium (Mg) content of water is dissolved from rocks and soils, but mostly from limestone, dolomite, and gypsum. The calcium and magnesium salts impart hardness to water. The magnesium salts are laxative, especially magnesium sulphate (Epsom salts, MgSO_4), and they are more detrimental to health than the lime or calcium salts. The calcium salts have no laxative or other deleterious effects. The scale found on the inside of steam boilers and tea-kettles is formed from these mineral salts.

Sodium

The salts of sodium are next in importance to those of calcium and magnesium. Of these, sodium sulphate (Glauber's salt, Na_2SO_4) is usually in excess of sodium chloride (common salt, NaCl). These sodium salts are dissolved from rocks and soils. When there is a large amount of sodium sulphate present the water is laxative and unfit for domestic use. Sodium carbonate (Na_2CO_3) "black alkali", sodium sulphate "white alkali", and sodium chloride are injurious to vegetation.

Sulphates

Sulphates (SO_4) are one of the common constituents of natural water. The sulphate salts most commonly found are sodium sulphate, magnesium sulphate, and calcium sulphate (CaSO_4). When the water contains large quantities of the sulphate of sodium it is injurious to vegetation.

Chlorides

Chlorides are common constituents of all natural water and are dissolved in small quantities from rocks. They usually occur as sodium chloride and if the quantity of salt is much over 400 parts per million the water has a brackish taste.

Iron

Iron (Fe) is dissolved from many rocks and the surface deposits derived from them, and also from well casings, water pipes, and other fixtures. More than 0.1 part per million of iron in solution will settle as a red precipitate upon exposure to the air. A water that contains a considerable amount of iron will stain porcelain, enamelled ware, and clothing that is washed in it, and when used for drinking purposes has a tendency to cause constipation, but the iron can be almost completely removed by aeration and filtration of the water.

Hardness

Calcium and magnesium salts impart hardness to water. Hardness of water is commonly recognized by its soap-destroying powers as shown by the difficulty of obtaining lather with soap. The total hardness of a water is the hardness of the water in its original state. Total hardness is divided into "permanent hardness" and "temporary hardness". Permanent hardness is the hardness of the water remaining after the sample has been boiled and it represents the amount of mineral salts that cannot be removed by boiling. Temporary hardness is the difference between the total hardness and the permanent hardness and represents the amount of mineral salts that can be removed by boiling. Temporary hardness is due mainly to the bicarbonates of calcium and magnesium and iron, and permanent hardness to the sulphates and chlorides of calcium and magnesium. The permanent hardness

can be partly eliminated by adding simple chemical softeners such as ammonia or sodium carbonate, or many prepared softeners. Water that contains a large amount of sodium carbonate and small amounts of calcium and magnesium salts is soft, but if the calcium and magnesium salts are present in large amounts the water is hard. Water that has a total hardness of 300 parts per million or more is usually classed as excessively hard. Many of the Saskatchewan water samples have a total hardness greatly in excess of 300 parts per million; when the total hardness exceeded 3,000 parts per million no exact hardness determination was made. Also no determination for temporary hardness was made on waters having a total hardness less than 50 parts per million. As the determinations of the soap hardness in some cases were made after the samples had been stored for some time, the temporary hardness of some of the waters as they come from the wells probably is higher than that given in the table of analyses.

Analyses of Water Samples from the Municipality of No. 50, Saskatchewan

LOCATION						Depth of well, Ft. solids	Total dis'vd solids	HARDNESS			CONSTITUENTS AS ANALYSED					CONSTITUENTS AS CALCULATED IN ASSUMED COMBINATIONS							Source of water	
No.	Qtr.	Sec.	Tr.	Rge.	Mer.			Total	Perm.	Temp.	Cl.	Alka- linity	CaO	MgO	SO ₄	Na ₂ O	Solids	CaCO ₃	CaSO ₄	MgCO ₃	MgSO ₄	Na ₂ CO ₃		Na ₂ SO ₄
1	NE	21	6	22	3		25											(2)		(3)	(4)	(1)	(5)	#1
2	NW	21	6	23	3		12										(3)	(2)				(1)		#1
3	NW	20	6	23	3		60									2,185	360	19		805		866	35	#1 or #2

Water samples indicated thus, № 1, are from glacial drift or other unconsolidated deposits.

Water samples indicated thus, № 2, are from bedrock Bearpaw formation.

Analyses are reported in parts per million; where numbers (1), (2), (3), (4), and (5) are used instead of parts per million, they represent the relative amounts in which the five main constituents are present in the water.

Hardness is the soap hardness expressed as calcium carbonate (CaCO₃).

Analyses Nos. 1 and 2 by Provincial Analyst, Regina.

For interpretation of this table read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

Only one sample of water was taken from this municipality for analysis by the Geological Survey. This water, represented by analysis No. 3 in the table of water analyses, was taken from a 60-foot well situated in the bottom of Frenchman River valley. Although the base of the well may be in the Bearpaw formation it is believed that the greater part of the water supply is derived from the overlying Recent alluvium. This analysis probably is fairly representative of waters obtained from the fine sands and silts that occur in the bottom of this stream channel. As these sediments are largely derived by erosion of the Eastend and Bearpaw shales that form the lower banks of the river they contain relatively large amounts of the readily soluble salts. The fine texture of the sediments also tends to retard the underground circulation of the water, thus allowing greater opportunity for the salts to be taken into solution. Such waters usually contain sodium sulphate (Na_2SO_4), magnesium sulphate (MgSO_4), calcium carbonate (CaCO_3), and calcium sulphate (CaSO_4), with minor amounts of sodium carbonate (Na_2CO_3) and common salt (NaCl). These salts are listed in decreasing order of their relative abundance. The sulphates of sodium and magnesium are the most harmful salts present. Waters containing an excess of 1,000 parts per million of both these salts tend to have a laxative effect when drunk by persons unaccustomed to highly mineralized waters, but waters containing concentrations of nearly twice this amount are commonly used for drinking in different parts of the province without causing any apparent ill effects. Stock are less affected by the sulphate salts and have been reported to thrive on waters containing these salts in excess of 2,500 parts per million.

Water obtained from the coarser sediments that occur in the small stream channels and on the edges of Frenchman River flats

are, as a rule, not so highly mineralized as to be unfit for use in the household. The first analysis given in the accompanying table, made by the Provincial Analyst, is of water from a well sunk in sand near the edge of the river flats and shows the total dissolved solids and the relative amounts of the salts present.

Waters obtained from the glacial drift do not differ essentially from those from the stream deposits in respect to the individual salts present and the relative order of their abundance. Although the total concentration of salts varies from place to place, waters contained in the shallow sand and gravel pockets in the upper part of the drift are, as a rule, not highly mineralized, and form the chief source of drinking water supply in the municipality. The second incomplete analysis in the table is of water from this type of deposit. Some of the shallow wells are situated beside sloughs or artificially constructed reservoirs and derive their water by seepage from this source. The sediments through which the water seeps act as a filter and if the water in the reservoir or slough is not highly mineralized or if it is not contaminated by sewage or other decaying organic matter the water in the well will be suitable for drinking. In general, waters obtained from the shallow drift deposits are hard to excessively hard, although a few soft waters are reported, particularly from seepage wells. Most of the waters from the deeper drift deposits are also hard. The hardness is permanent in most of the waters and not removable by boiling. Greater concentrations of the laxative-acting mineral salts are also present in most of these waters, rendering them, in some places, unsuitable for domestic use, although few are reported to be too highly mineralized for stock use.

Water from the Bedrock

The Cypress Hills formation is composed chiefly of quartzite sands and gravels, consolidated in places by a calcareous cement. Calcium carbonate is usually the chief constituent in waters from this

source and is not considered detrimental to health. Calcium carbonate forms temporary hardness and may be almost entirely removed from solution by boiling the water. As the other mineral salts present in solution occur in very minor amounts the water from this source is of particularly good quality for domestic use.

A greater variation is noted as a rule in waters from the Ravenscrag formation than in those from the Cypress Hills beds. Although little water is obtained from the Ravenscrag in this municipality analyses of water samples from this formation in the municipalities to the east and northeast show that the total dissolved solids range from 360 to 1,860 parts per million. In general waters obtained from the coal seams and from the fine sands or sandy shales are more highly mineralized than water from the thick sand beds. Sulphate salts are present in solution, although they are usually not in sufficient quantity to render the water unfit for household use.

Waters obtained from the Eastend and Bearpaw formations vary greatly as to character in different localities and at different horizons. The sulphate salts are usually present in sufficient quantities to impart a bitter taste to the water and have a laxative effect when drunk by persons unaccustomed to waters of this type. At no place, however, is the water reported to be too highly mineralized for stock use. Soft water is obtained from both the Eastend and the Bearpaw formations by several wells located in the east-central part of the municipality. These waters are reported to be suitable for the domestic drinking supply, although the water from the Bearpaw formation has a slight soda taste. This water would probably kill vegetation if it were used for irrigation owing to the presence of sodium carbonate or "black alkali". At greater depths in the shales of the Bearpaw formation the quantity of dissolved sodium sulphate and sodium chloride (common salt) will undoubtedly be found to increase to such an extent that the water will not be suitable for any farm use.

WELL RECORDS—Rural Municipality of NO. 50, SASKATCHEWAN.

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (-) Surface	Elev.	Depth	Elev.	Geological Horizon				
1	NW.	3	4	22	3	Dug	50	3,060	- 36	3,042	36	3,042	Glacial sand	Hard, "alkaline"		S	
2	SW.	3	"	"	"	Dug	75	3,060	- 36	3,042	36	3,042	Glacial sand	Hard		S	Was an insufficient supply; now abandoned and filled in.
3	NW	7	"	"	"	Dug	14	3,221	- 6	3,215	6	3,215	Glacial gravel	Hard, clear		D, S	Sufficient for local needs.
4	NE.	9	"	"	"	Bored	130	3,264	- 55	3,209	130	3,134	Bearpaw	Hard, clear, "alkaline"		N	Unfit for use.
5	SW.	16	"	"	"	Dug	16	3,274	- 11	3,263	11	3,263	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
6	SE.	16	"	"	"	Dug	20	3,274	- 10	3,264	20	3,254	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
7	SE.	17	"	"	"	Drilled	305	3,274	- 60	3,194	305	2,969	Bearpaw sandstone	Soft, clear, salty		D, S	Sufficient for local needs.
8	NE.	23	"	"	"	Dug	16	3,308	- 10	3,298	13	3,295	Glacial gravel	Hard, clear		D, S	Sufficient for local needs.
9	SE.	24	"	"	"	Bored	116	3,243	-100	3,143	100	3,143	Bearpaw sand	Hard, clear		D, S	Sufficient for local needs.
10	N. ½	24	"	"	"	Bored	130	3,250	-105	3,145	105	3,145	Bearpaw sand	Hard		D, S	Sufficient for local needs.
11	NE.	27	"	"	"	Dug	14	3,402	- 6	3,396	6	3,396	Glacial sandy clay	Hard, clear		D	Insufficient for local needs.
12	SW.	27	"	"	"	Dug	14	3,413	0	3,413	0	3,413	Glacial clay	Hard, clear		D	Sufficient for domestic needs.
13	SW.	27	"	"	"	Drilled	303	3,413	- 75	3,338	303	3,110	Bearpaw sand	Soft, clear		D, S	Sufficient for local needs.
14	SW.	28	"	"	"	Dug	14	3,352	- 11	3,341	11	3,341	Glacial sandy clay	Hard, clear		D	Sufficient for domestic needs.
15	SW.	35	"	"	"	Dug	15	3,397	- 7	3,390	10	3,387	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
1	SW.	26	4	23	3	Drilled	200	3,370	-130	3,240	130	3,240	Eastend or Bearpaw	Hard, clear, "alkaline"		S	Sufficient for local needs; also 2 dry holes 345 and 264 feet deep.
2	SE.	27	"	"	"	Dug	16	3,370	0	3,370			Glacial clay	Soft, clear		D	Sufficient for domestic needs.
3	NE.	32	"	"	"	Dug	18	3,250	- 15	3,235	17	3,233	Glacial sand	Hard, clear		D	Intermittent supply.
4	SW.	33	"	"	"	Dug	8	3,268	- 4	3,264	4	3,264	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
1	NE.	30	4	24	3	Dug	60	3,125	- 20	3,105	60	3,065	Glacial gravel	Hard, clear		D, S	Sufficient for local needs.
2	NW.	31	"	"	"	Bored	60	3,134	- 56	3,078	56	3,078	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
3	NW.	32	"	"	"	Bored	73	3,137	- 55	3,082	73	3,064	Glacial gravel	Hard, clear, iron		D, S	Sufficient for local needs.
1	NW.	1	5	22	3	Drilled	160	3,378	-118	3,260	160	3,218	Eastend sandstone	Hard, clear		S	Sufficient for local needs.
2	NW.	1	"	"	"	Dug	70	3,376	- 67	3,309	67	3,309	Ravenscrag sand	Hard, brown, sulphur		N	Unfit for use; intermittent supply.
3	NW.	4	"	"	"	Bored	30	3,525	- 10	3,515	30	3,495	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
4	NE.	5	"	"	"	Bored	85	3,524									Dry hole; base in glacial drift.
5	NE.	7	"	"	"	Bored	50	3,450	- 15	3,435	40	3,410	Glacial gravel	Hard, clear		D, S	Sufficient for local needs.

NOTE—All depths, altitudes, heights and elevations given above are in feet.

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of

NO. 50, SASKATCHEWAN.

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (-) Surface	Elev.	Depth	Elev.	Geological Horizon				
6	SE.	9	5	22	3	Bored	30	3,525	- 28	3,497	28	3,497	Glacial sand	Hard, clear, "alkaline"		S	Insufficient for local needs; a seepage well is used for domestic needs.
7	SE.	9	"	"	"	Bored	50	3,525					Glacial drift	Hard, clear		N	Unfit for use.
8	NE.	9	"	"	"	Bored	81	3,493	- 50	3,443	75	3,418	Glacial sand	Hard, green		S	Insufficient for local needs; also 4 seepage wells.
9	SW.	15	"	"	"	Dug	15	3,465	0	3,465			Glacial clay	Hard, clear		D	Insufficient for local needs; two other similar wells; also a 127-foot dry hole.
10	SW.	17	"	"	"	Dug	15	3,432	- 9	3,423	9	3,423	Recent sand	Soft, clear		D	Insufficient for local needs; 2 other wells 10 and 20 feet deep.
11	SE.	20	"	"	"	Dug	14	3,387	- 3	3,384	13	3,374	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
12	SW.	22	"	"	"	Dug	16	3,500	- 2	3,498	2	3,498	Glacial sandy clay	Hard, clear		D, S	Insufficient for local needs.
13	NW.	22	"	"	"	Dug	13	3,449	- 11	3,438	11	3,438	Glacial clay	Hard, clear		D	Sufficient for domestic needs; a similar well is used for stock.
14	SE.	23	"	"	"	Bored	98	3,407	- 96	3,311	96	3,311	Ravenscrag sand	Hard, clear, iron		D, S	Sufficient for local needs; also a spring on farm.
15	NW.	24	"	"	"	Dug	18	3,316	- 4	3,312			Recent silt	Hard, clear		D	Sufficient for domestic needs; stock is watered at a dam.
16	NW.	27	"	"	"	Drilled	232	3,450	-132	3,318	232	3,218	Eastend sand	Soft, clear		D, S	Sufficient for local needs.
17	NW.	28	"	"	"	Dug	16	3,435	- 11	3,424	11	3,424	Glacial gravel	Hard, clear		D, S, I	Insufficient for local needs; also another well on farm.
18	SE.	33	"	"	"	Drilled	260	3,435	- 80	3,355	260	3,175	Eastend sand	Soft, clear		D, S	Sufficient for local needs.
19	NE.	34	"	"	"	Bored	132	3,369	- 92	3,277	132	3,237	Eastend sand	Hard, clear		S	Sufficient for local needs.
20	S.	35	"	"	"	Bored	82	3,360	- 54	3,306			Glacial drift	Hard		D, S	Water-level constant.
1	NE.	1	5	23	3	Dug	10	3,350	- 4	3,346	4	3,346	Glacial gravel	Soft, clear		S	Intermittent supply; also a dry hole 18 feet deep.
2	SE.	1	"	"	"	Drilled	224	3,400	- 24	3,376			Eastend	Hard, cloudy		D, S	Sufficient for local needs; also 2 dry holes.
3	NE.	3	"	"	"	Bored	36	3,275	- 9	3,266	16	3,259	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
4	NW.	3	"	"	"	Bored	155	3,300									Dry hole; base in Bearpaw.
5	SE.	3	"	"	"	Dug	18	3,280	- 14	3,266			Glacial drift	Hard, clear		D	Sufficient for domestic needs.
6	SE.	4	"	"	"	Dug	18	3,250	- 14	3,236	16	3,234	Glacial sand	Soft, clear		D, S	Sufficient for local needs.
7	NE.	4	"	"	"	Bored	100	3,275	- 88	3,187			Glacial drift	Hard, blue		N	Unfit for use.
8	SW.	4	"	"	"	Dug	16	3,230	- 12	3,218			Glacial drift	Hard, clear, iron		S	Sufficient for stock needs; haul water for domestic needs.
9	SW.	10	"	"	"	Dug	8	3,300	- 3	3,297	4	3,296	Recent sand	Hard, clear		D, S	Sufficient for local needs.
10	SE.	10	"	"	"	Dug	12	3,300	- 4	3,296	4	3,296	Glacial sand	Soft, clear		D, S	Sufficient for local needs.
11	NE.	10	"	"	"	Dug	8	3,325	- 6	3,319	6	3,319	Glacial sand and gravel	Hard, clear		D, S	Sufficient for local needs.
12	NW.	12	"	"	"	Dug	14	3,390	- 7	3,383	7	3,383	Glacial grey sand	Hard, clear		D, S	Sufficient for local needs; also two dry holes.

NOTE—All depths, altitudes, heights and elevations given above are in feet.

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of NO. 50, SASKATCHEWAN.

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (-) Surface	Elev.	Depth	Elev.	Geological Horizon				
13	SW.	13	5	23	3	Bored	50	3,400	- 10	3,390			Glacial drift	Hard, clear		D, S	Intermittent supply; also a number of dry holes to a depth of 25 feet.
14	SW.	13	"	"	"	Bored	20	3,400	- 10	3,390			Glacial sand	Hard, clear		D, S	Intermittent supply.
15	SW.	15	"	"	"	Dug		3,300									Dry hole; base in glacial drift; this hole is in the process of being dug.
16	NW.	15	"	"	"	Dug	18	3,325	0	3,325			Recent gravelly clay	Soft, clear		D	Intermittent supply; also 12 dry holes; stock watered at a dam.
17	SE.	16	"	"	"	Dug	16	3,325	- 11	3,314			Recent sand and gravel	Soft, clear		D, S	Intermittent supply.
18	NW.	16	"	"	"	Dug	16	3,350	- 10	3,340	10	3,340	Recent sand	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
19	NE.	17	"	"	"	Dug	12	3,350	- 11	3,339	11	3,339	Recent sand	Soft, clear		D, S	Insufficient for local needs.
20	SE.	17	"	"	"	Dug	16	3,375	- 1	3,374			Recent silt	Hard, clear		D, S	Intermittent supply.
21	SE.	17	"	"	"	Dug	16	3,370	- 12	3,358			Recent sand	Soft, clear		D, S	Intermittent supply.
22	SE.	20	"	"	"	Bored	150	3,375									Dry hole; base in Ravenscrag.
23	SE.	20	"	"	"	Bored	50	3,375									Dry hole; base in glacial drift.
24	SW.	21	"	"	"	Dug	16	3,375	- 14	3,361	14	3,361	Glacial sandy clay	Soft, clear		D	Insufficient for local needs.
25	SW.	33	"	"	"	Bored	130	3,400	-105	3,295	105	3,295	Eastend sand	Hard, clear, iron		D, S	Sufficient for local needs.
26	NE.	36	"	"	"	Dug	13	3,475					Glacial drift	Hard, clear		S	Intermittent supply.
27	NE.	36	"	"	"	Dug	14	3,475	- 13	3,462			Glacial clay	Hard, clear		D	Insufficient supply; there are 9 similar wells on this quarter-section varying in depth from 14 to 48 feet.
1	SW.	4	5	24	3	Bored	53	3,140	- 56	3,084	56	3,084	Glacial sand and gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
2	NW.	4	"	"	"	Dug	75	3,160	- 73	3,087	73	3,087	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
3	NW.	5	"	"	"	Dug	50	3,175	- 48	3,127	48	3,127	Glacial gravel	Hard, clear, "alkaline"		S	Intermittent supply.
4	SW.	6	"	"	"	Dug	50	3,140	- 46	3,094	46	3,094	Glacial sand and gravel	Hard, "alkaline", grey sediment		D, S	Sufficient for local needs.
5	NW.	6	"	"	"	Dug	65	3,160	- 63	3,097	63	3,097	Glacial gravel	Soft, clear		D, S, I	Sufficient for local needs.
6	NW.	12	"	"	"	Dug	70	3,250	- 67	3,183	67	3,183	Glacial sand	Hard, clear, "alkaline"		S	Sufficient for local needs.
7	NW.	12	"	"	"	Dug	14	3,250	- 11	3,239			Glacial clay	Hard, clear		D	Sufficient for domestic needs.
8	NW.	14	"	"	"	Bored	11	3,200	- 9	3,191	9	3,191	Recent gravel	Hard, clear, "alkaline"		S	Sufficient for local needs.
9	SE.	16	"	"	"	Dug and Bored	160	3,250	-125	3,125	155	3,095	Bearpaw shale	Hard, clear, "alkaline"		D, S	Sufficient for local needs; also a dry hole 123 feet deep.
10	NE.	17	"	"	"	Dug and Bored	170	3,190									Dry hole; base in Bearpaw shale.
11	NE.	17	"	"	"	Dug	28	3,190	- 8	3,182	8	3,182	Glacial sand	Hard, clear		D, S	Sufficient for local needs.

NOTE—All depths, altitudes, heights and elevations given above are in feet.

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.

4
WELL RECORDS—Rural Municipality of NO. 50, SASKATCHEWAN.

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (-) Surface	Elev.	Depth	Elev.	Geological Horizon				
12	SW.	19	5	24	3	Dug	58	3,185	- 66	3,119	66	3,119	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
13	NE.	19	"	"	"	Dug	40	3,200	- 36	3,164	36	3,164	Glacial sand and gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
-1	SE.	4	6	22	3	Drilled	215	3,450	-200	3,250	215	3,235	Eastend sand-stone	Hard, clear		D, S, I	Sufficient for local needs.
-2	SE.	9	"	"	"	Drilled	500	3,500	-350	3,150	600	2,900	Bearpaw sand	Soft, brown		D, S	Sufficient for local needs.
3	SW.	12	"	"	"	Dug	15	3,270	- 2	3,268	8	3,262	Recent gravel	Soft, clear		D, S	Sufficient for local needs.
4	NE.	21	"	"	"	Dug	25	2,998	- 22	2,976	22	2,976	Recent sand	Hard, clear		I	Sufficient for domestic needs; #.
5	NW.	33	"	"	"	Dug	20	3,400	- 8	3,392	8	3,392	Glacial drift	Hard, clear		D, S	Sufficient for local needs.
1	SW.	2	6	23	3	Dug	20	3,500	- 6	3,494	6	3,494	Glacial sand	Hard, clear		D, S	Intermittent supply.
2	NW.	2	"	"	"	Dug	12	3,525	- 3	3,522			Glacial gravel	Hard, clear		D, S	Intermittent supply; #.
3	NW.	2	"	"	"	Dug	16	3,525	- 4	3,521	4	3,521	Glacial sand and gravel	Soft, clear		D, S	Sufficient for local needs; also several dry holes.
-4	NE.	9	"	"	"	Drilled	200	3,465	-165	3,300	200	3,265	Eastend sand	Hard, clear, brown sediment		D, S	Sufficient for local needs.
5	NW.	10	"	"	"	Bored	31	3,465	- 12	3,453	12	3,453	Glacial drift	Hard, clear		D, S	Sufficient for local needs.
6	SE.	12	"	"	"	Dug	15	3,580	- 3	3,577			Glacial drift	Hard, clear, "alkaline"		D	Intermittent supply.
7	SE.	14	"	"	"	Dug	22	3,590	- 8	3,582	8	3,582	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
8	ST.	15	"	"	"	Bored	40	3,465	- 12	3,453	12	3,453	Glacial drift	Hard, clear, brown sediment		D, S	Sufficient for local needs.
9	NW.	16	"	"	"	Dug	16	3,550	- 12	3,538	12	3,538	Recent sand	Soft, clear		D, S	Sufficient for local needs.
10	NW.	19	"	"	"	Bored	24	3,150	- 12	3,138	12	3,138	Recent silt	Hard, clear		D, S, I	
11	NW.	19	"	"	"	Bored	22	3,150	- 12	3,138	12	3,138	Recent silt	Hard, clear, "alkaline"		D	Sufficient for local needs.
12	NW.	19	"	"	"	Dug	9	3,150	- 6	3,144	6	3,144	Recent gravel	Hard, clear		N	Sufficient supply; but not used.
13	NW.	19	"	"	"	Dug	22	3,125	- 14	3,111	14	3,111	Recent gravel	Hard, iron, cloudy		D, S	Sufficient for local needs.
14	NW.	19	"	"	"	Dug	20	3,150	- 19	3,131	19	3,131	Recent gravel	Hard, clear		D	Sufficient for domestic needs.
15	NW.	19	"	"	"	Dug	14	3,125	- 7	3,118	7	3,118	Recent gravel	Hard, clear, iron		I	Sufficient for local needs.
16	NW.	19	"	"	"	Dug	12	3,125	- 9	3,116	9	3,116	Recent gravel	Hard, clear		D, S	Sufficient for local needs.
17	NW.	20	"	"	"	Bored	50	3,100	- 36	3,064	36	3,064	Recent silt	Hard, clear, "alkaline", iron		D, S	Sufficient for local needs; #.
18	NE.	22	"	"	"	Bored	24	3,100	- 20	3,080	20	3,080	Recent gravel	Hard, clear, iron		D, S	Sufficient for local needs.

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(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.

5
WELL RECORDS—Rural Municipality of

NO. 50, SASKATCHEWAN.

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (-) Surface	Elev.	Depth	Elev.	Geological Horizon				
19	SW	23	6	23	3	Bored	55	3,200	- 62	3,138	62	3,138	Glacial gravel	Hard, clear, "alkaline"		N	Sufficient supply; but not used.
20	NE	23	"	"	"	Dug	15	3,100	- 13	3,087	13	3,087	Recent silt	Soft, clear		D, S	Sufficient for local needs.
21	ST	30	"	"	"	Dug	20	3,155	- 14	3,141	14	3,141	Recent gravel	Soft, clear		D, S	Sufficient for local needs.
1	NE	1	6	24	3	Drilled	150	3,375	-120	3,255	120	3,255	Eastend sand	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
2	NE	17	"	"	"	Bored	70	3,440	- 58	3,372	58	3,372	Cypress Hills sand	Soft, clear		D, S	Sufficient for local needs.
3	SE	33	"	"	"	Dug	20	3,550	- 15	3,535	15	3,535	Recent sand	Soft, clear		D, S	Sufficient for local needs.

NOTE—All depths, altitudes, heights and elevations
given above are in feet.

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.