CANADA
DEPARTMENT OF MINES

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BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF FRONTIER No. 19 SASKATCHEWAN

BY

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

Water Supply Paper No. 69

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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 give 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

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[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 overlie 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 rest 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

The rural municipality of Frontier occupies an area of 324 square miles in southwestern Saskatchewan. It consists of nine townships, described as tps. 1, 2, and 3, ranges 19, 20, and 21, W. 3rd mer. The International Boundary forms the southern border of the municipality. The Valmarie branch of the Canadian Pacific railway on which are situated the villages of Frontier and Loomis crosses the municipality in an east-west direction approximately 4 miles south of its northern border.

The central part of the municipality is a lowland area. The ground surface rises to the southwest to form the Boundary plateau and to the northeast to form an upland area that extends to the south bank of Frenchman river, in the municipality to the north. The land surface is gently rolling throughout the greater part of the municipality. The central part of the area has an approximate elevation of 2,800 feet above sea-level and the highlands near the borders of the area have elevations that nowhere greatly exceed 3,050 feet above sea-level. As the area has not been topographically mapped the relief is not shown on Figure 2 of the accompanying map. The elevations quoted in the report were determined as accurately as possible by aneroid barometer during the course of this investigation, but must be regarded only as approximately correct.

The drainage system in this municipality is very poorly developed and most of the sloughs and depressions have no outlets.

The ground water supply is derived from the Recent deposits along the bottoms of coulées and other depressions, from the glacial drift that covers the greater part of the municipality, and to a more limited extent from the underlying bedrock formations.

Water-bearing Horizons in the Unconsolidated Deposits

The Recent deposits consist of fine silts, sands, and occasionally gravels laid down by streams in undrained depressions and in the coulées. Most of these streams flow only for a short time in the spring months. The porous beds in the deposits lie within 15 feet of the surface. Shallow wells dug into them can be expected to yield small supplies of water suitable for domestic use. The permanence of the water supplies depends largely upon the areal extent and depth of the porous beds, the extent of the catchment area, and the amount of surface run-off available to replenish the ground water supply.

Conservation of the surface run-off by the construction of dams at suitable places in the coulées provides a much more dependable water supply for stock. This method of conserving water is widely used by the farmers and ranchers of this municipality.

Glacial drift, deposited many thousands of years ago by a great continental ice-sheet which moved in a southwesterly direction across the province, covers the entire area. The thickness of the drift varies irregularly over the municipality and ranges from 75 to 200 feet. The drift is composed essentially of a yellowish brown boulder clay grading downwards into a heavy, compact, bluish grey boulder clay. Interspersed through the drift are beds or pockets of fine silts, sands, and gravels. These deposits are generally water-bearing, and appear to occur at two distinct horizons in the drift.

The upper horizon consists of small, isolated pockets of sand and gravel interspersed through the boulder clay within 20 feet of the surface. In the central, northwestern, and extreme southwestern parts of the municipality the surface of the glacial drift is quite flat and consists of boulder clay or a till plain. The gravel deposits that occur in the boulder clay do not as a rule show any distinguishable features at the surface, and productive

beds are relatively scarce in the upper part of the drift. Careful prospecting is usually necessary before any adequate supplies are obtained. The ground surface of the remaining parts of the municipality is rolling; undrained depressions are common, and low gravel knolls and ridges occur in many places. This type of glacial drift is known as "moraine". The areal extent of these two types of drift is indicated on Figure 1 of the accompanying map. In the moraine covered areas, the gravel pockets are more numerous and of greater areal extent, and consequently less difficulty is generally experienced in obtaining water at shallow depths. Wells located on or near the low knolls and ridges form in many places sources of good water for domestic use. During the dry seasons, however, most of the shallow wells in the municipality do not yield sufficient supplies for local stock requirements, thus necessitating the construction of dams or the drilling of wells to greater depths. The quality of the waters from the upper part of the drift varies widely from place to place. Water from the boulder clay itself is often so highly mineralized as to be unsuitable for domestic use. Supplies from the sand, and particularly the gravels, are of much better quality. Mineral salts, mainly sulphates, are almost invariably present in solution, but not generally in sufficient quantities to render the water unsuitable for drinking.

The second zone of water-bearing sands and gravels occurs at or near the base of the glacial drift. The distribution of these deposits is not indicated in any way by the surface features of the glacial drift. As the thickness of the drift varies from place to place and since the aquifers occur at various elevations in the lower part of the drift, no definite depth from the surface can be predicted at which the water-bearing beds are likely to be encountered. The drift is known to thin perceptibly toward the northern and northwestern part of the municipality. The gravel deposits are considered to have been washed down from the northern highlands before the deposition of the drift, and underlie the greater part of the central

lowlands area. The gravels are encountered at lower elevations in passing from the northern to the central and southern townships.

In the townships along the north and western borders, water is encountered in the lower water-bearing zone at depths of 40 to 90 feet. Deeper wells are required toward the southeastern part, and some wells in township 1, range 19, are as much as 200 feet deep. The area in which the lower aquifers occur at depths greater than 90 feet from the surface is outlined by the "C" line of the accompanying map (Figure 1).

No information was obtained as to ground water conditions in the range land bordering the Boundary plateau in the southwestern corner of the municipality, but it is quite probable that the greater part of this area is also underlain by these water-bearing beds. Wells sunk to the lower part of the drift usually yield large supplies of water. The water is invariably hard and unfortunately in many instances is too highly mineralized to be suitable for human consumption. Wells sunk to this horizon in many parts of the municipality yield ample supplies of water for farms with large herds of stock.

Water-bearing Horizons in the Bedrock

Ground water in the bedrock formations underlying the glacial drift of the municipality seems to be confined to comparatively limited areas. Fine grey to bluish grey sands, known as the Eastend formation, are water-bearing in the municipality to the north. These beds extend into the northern parts of township 3, ranges 19 and 20, of this municipality where they are also water-bearing. The beds become shaly at greater depths and grade downward into a series of bluish grey, compact shales interbedded with thin layers of fine grey sands. This latter series is known as the Bearpaw formation. It extends beneath the Eastend formation in the small area referred to above and immediately underlies the glacial drift throughout the remainder of the municipality. The upper part of the Bearpaw in the northeastern part of the area where the sandy

layers occur is water-bearing. These beds of sand appear to be confined to the northeastern part of the municipality; in the central, western and southern areas the formation is composed almost entirely of compact shale which yields little or no water.

Of the many wells producing from bedrock aquifers in the northern parts, the shallower ones are undoubtedly deriving their supply from the Eastend beds, and the deeper wells in the northeast corner from sandy beds in the Bearpaw shale. The depths to these horizons range from 75 to 200 feet from the surface. With a few exceptions the depth necessary to drill before production is obtained increases in an easterly direction from the north-central part of the municipality. Hydrostatic pressure causes the water to rise over 50 feet above the aquifer in some of these wells. In others it does not rise above the sand. The supply from most wells is sufficient for farm requirements. The waters vary in quality from soft, drinkable waters to those that are highly mineralized and unsatisfactory for either domestic or stock use.

Throughout the remainder of the municipality the majority of the wells that have been sunk into the shale are dry. Others yield small supplies of water in which the large quantity of dissolved mineral salts render them unfit for drinking and usually unfit for stock. It seems advisable throughout the greater part of the municipality to confine the search for ground water to the drift rather than to prospect by deep drilling.

The total thickness of the Bearpaw formation in this area probably exceeds 800 feet. No wells have been sunk in this municipality through the formation into the sandstones of the underlying Belly River formation, but in the villages of Climax and Bracken, in the municipality to the east, fairly large supplies of soft, "soda-bearing" water are obtained from sandstone beds at the base of the Bearpaw or in the upper part of the underlying Belly River formation at depths of 1,005 and 608 feet. This water is not very suitable for drinking and is used principally for watering stock. Similar water conditions probably exist at depths of 800 to 1,200 feet throughout Frontier municipality.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 1, Range 19

The irregularly rolling surface of the area is formed by a layer of moraine overlying till throughout the entire township. Isolated pockets or beds of sand and gravel occur in the glacial drift in the coulee bottoms, and interspersed through the boulder clay of the uplands within 20 feet of the surface. Shallow wells sunk into these deposits provide small supplies of hard water for household use and for a few head of stock. The largest supply of water from the shallow deposits is being derived from a gravel bed at the base of a dugout excavated in the drift on the NW.¼, section 13. Fairly soft waters seep into this dugout, and a constant level is maintained.

In areas where the shallow water-bearing beds have not been located or are not conveniently situated to farm buildings, deep wells have been sunk to tap a lower sand and gravel aquifer at the base of the glacial drift. These beds form what is believed to be a fairly continuous horizon. It is encountered at elevations of 2,875 to 2,830 in wells sunk to depths of 145 to 160 feet in the southern part of the township. In a northerly direction the horizon is encountered at slightly lower elevations, and hence at greater depths. It is found at depths of 200 feet in the central sections at an approximate elevation of 2,800 to 2,775 feet above sea-level, and one well in section 33 reached production at a depth of 230 feet, at an elevation of 2,750 feet above sea-level. In many of these wells the water is under hydrostatic pressure and rises to levels ranging from 50 to 150 feet above the aquifer. The aquifer extends westerly to section 19 where a well located on the NE.¼, yields only a small production. Several holes on the NW.¼ of this section sunk to bedrock failed to encounter water.

The waters from these deep aquifers also vary greatly as to the amounts of dissolved salts they contain. Wells situated on sections 10, 12, and 23 yield waters suitable only for stock.

A well on section 33 produces a large supply of soft water from a depth of 230 feet and a well at about the same depth on section 28 although now dry produced water of similar quality when first drilled. Waters containing intermediate amounts of salts in solution occur at other places in the township.

Water-bearing beds are not known to occur in the Bearpaw formation which underlies the glacial drift throughout this township. In a 600-foot hole in the NW.¼, section 19, the upper part of the Bearpaw was penetrated to a depth of at least 400 feet without locating water.

Township 1, Range 20

A layer of moraine underlain by till covers the greater part of the township. The moraine yields little water in most parts of the area, and no adequate water supplies are known to occur in the upper part of the drift throughout this township. Several shallow wells along the eastern side of the township yield small, generally intermittent, supplies of hard water from gravel beds within 15 feet of the surface. Throughout the rest of the township the shallow wells are located beside sloughs. The clay acts as a filter for the water seeping through from the surface reservoir and if not contaminated by organic material the water is usually suitable for drinking. These water supplies cannot be depended upon during prolonged dry seasons or during the winter months.

Wells bored to depths ranging from 143 to 176 feet on sections 2, 12, and 15 encounter what is believed to be a fairly continuous productive sand bed in the lower part of the drift at an approximate elevation of 2,900 feet above sea-level. The water is hard and fairly highly mineralized, and in one instance unfit for household use. It is regarded, however, as being quite suitable for watering stock. The extent of this aquifer outside of the southeastern part of the township has not been determined. The surface elevations of the north-central part of the township are

below 2,900 feet above sea-level and the aquifer if present is correspondingly lower. A 128-foot well located on the SW.¼, section 22, encountered gravel lying immediately above the Bearpaw shale at an elevation of 2,777 feet. This aquifer may prove to be the same horizon as that just described and be found to underlie much of the lowland area.

No wells are known definitely to be deriving their supplies from the Bearpaw shale. It is possible that the sandy bed forming the water-bearing horizon in the 176-foot bored well on the SE.¼, section 2, is in the upper part of the bedrock. The water contains only small amounts of mineral salts, but the yield is insufficient for local requirements. It is questionable if an adequate ground water supply will be obtained from the shale. The lower productive beds of the drift offer much better possibilities.

Township 1, Range 21

This township lies on the eastern edge of the Boundary plateau. The ground surface is steeply rolling and the area is largely grazing land. A thin layer of moraine covers the greater part of the area, but the less porous till occupies the southwest corner. Although the demand for water for domestic needs is small, a considerable supply is required for range stock. Dams constructed in coulees to conserve the surface run-off form the principal source of supply at the present time. Two wells have been sunk in the northern part of the township. One of these is situated on the NE.¼, section 33, and encountered water-bearing gravels at a depth of about 87 feet. The water is hard and contains sufficient quantities of soluble salts to render it unsuitable for drinking. The presence of sodium chloride (common salt) tends to give the water a brackish taste. It is used for watering stock and the yield is adequate for about 40 head.

The other well, situated on the SE.¼, section 36, is 185 feet deep. The base of this well is in the grey shale of the Bearpaw formation. The water-bearing horizon is reported to be at

a depth of about 135 feet, and may be a sand bed at the base of the glacial drift or in the upper part of the Bearpaw formation. This water is hard and slightly "alkaline". The supply is limited and is used only for domestic purposes.

The uppermost beds of the Bearpaw formation as observed in areas to the west contain thin sand beds interspersed through the dark grey shale. It seems probable that the lower part of the drift and possibly the upper sandy beds of the Bearpaw will yield moderately large supplies of water, suitable for stock at least at depths not greatly exceeding 150 feet in the southwestern part of the township. Testing to such depths is expensive, however. The construction of dams offer a more dependable source of water.

Township 2, Range 19

A layer of moraine, characterized by an irregularly rolling surface, overlies glacial till throughout the entire township. Isolated pockets and thin beds of sand and gravel occur interspersed through the upper part of the drift in depressions between low-lying hills in this township. These deposits usually lie within 20 feet of the surface and, where encountered in wells, yield small supplies of hard, generally drinkable, water. In places where the deposits are not located conveniently close to farm buildings or do not yield sufficient water for the stock, wells have been sunk to the water-bearing sand and gravel beds in the lower part of the glacial drift. These gravel beds are believed to have been deposited fairly continuously over the greater part of the township by streams flowing from the northern uplands before the last continental ice-sheet deposited the great thickness of overlying boulder clay. The beds are encountered at an approximate elevation of 2,900 feet above sea-level in wells ranging from 85 to 100 feet in depth throughout the northwestern half of the township. The beds slope gradually in a southeasterly direction and are tapped at gradually increasing depths toward the southern

and eastern boundaries. The gravels were reached at an elevation of 2,843 feet in a 130-foot well in section 12, and at 2,860 feet in a 150-foot well in the SW.¼, section 5. It is to be noted, however, that two wells sunk to depths of 156 and 176 feet on the SW.¼, section 2, failed to find water at these horizons. These waters are under hydrostatic pressure and usually stand in the wells at a constant level 40 to 60 feet above the aquifer. The water is invariably hard and contains a high concentration of dissolved mineral salts. It is used for drinking only in a few places, where better supplies of water are not available. In no case, however, is the water considered too highly mineralized for stock.

The Bearpaw formation immediately underlies the glacial deposits throughout the entire township. The shale, which comprises the greater part of the formation, was penetrated near the base of the 176-foot dry hole on the SW.¼, section 2, at an approximate elevation of 2,825 feet above sea-level. A few sandy beds probably occur interbedded with the shale. It is improbable, however, that any large supply of water suitable either for domestic or stock use will be found in the formation in this township. Residents are better advised to confine their search for water to the overlying glacial drift.

Township 2, Range 20

Moraine covers a small area along the eastern border of the township. Such deposits are generally more porous than the till covering the rest of the area and may possibly yield moderately large supplies of water at shallow depths. Shallow wells situated near sloughs or in the coulee bottoms form the principal source of water for domestic needs in this township. Thin beds of water-bearing sands or gravels are encountered in a few of the wells, but most of the water is derived by seepage from the surface and the well supplies cannot be depended upon during prolonged dry seasons or for the winter months. The water is usually hard and the yield

from individual wells is seldom adequate for more than 5 to 10 head of stock.

In this township, as in the area to the east, gravel beds occurring near the base of the drift form the best source of ground water for stock. Although individual gravel beds may not be continuous over any large area the evidence from the existing wells seems to indicate two fairly extensive horizons. The upper horizon is confined to the upland parts of the northwest corner. There water is encountered in a bed of gravel at elevations ranging from 2,900 to 2,850 feet above sea-level. The wells tapping this horizon have been sunk to depths of 85, 70, and 140 feet in sections 28, 32, and 33, respectively. The water is of poor quality, being highly charged with mineral salts and is used for watering stock. The yield from each of the wells is reported to be ample for local requirements.

The second horizon is much more extensive, having been tapped by wells in many sections throughout the eastern and south-central parts of the township. The water is found generally in a gravel aquifer that lies at an elevation 2,730 to 2,700 feet above sea-level in the northeastern and central parts of the township, and at approximately 2,650 feet along the southern boundary. Wells tap this horizon at depths of 100 to 110 feet in the northeastern sections, but at 70 to 115 feet in the central lowland parts of the township, the range in depth being due largely to variation in surface elevation. On sections 3 and 9, depths of 185 and 150 feet were necessary before production was obtained. It is possible that had the two dry holes sunk to depths of 120 and 107 feet on sections 14 and 16, respectively, been continued 20 to 40 feet deeper they would have obtained water at this horizon. The water in this aquifer is under hydrostatic pressure and rises in wells to within 60 to 90 feet of the surface. Considerable amounts of mineral salts are present in solution in the waters from wells in the northern and central parts which tap this aquifer, rendering them unsuitable for domestic use. In a southerly direction, however, the character of

the water improves and it is being used for drinking. Iron is present in small amounts in the water from the well on the NW.¼, section 9, but is absent or occurs only in very small amounts in the other wells. The supply from each of the wells is reported to be sufficient for local requirements.

No wells are known to have been sunk through the drift into the underlying Bearpaw shale. Small supplies of water probably occur in the upper parts of the shale, but it is to be expected that the supply will be inferior both in quality and quantity to water from the drift.

Two types of wells seem to be practical in this area, a shallow seepage well for household use and a bored or drilled well to the lower horizon of the drift for stock.

Township 2, Range 21

Slightly better ground water conditions are to be expected at shallow depths in the moraine covered area of the southern and southwestern parts of the township than in the till covering the remainder of the township. Water-bearing beds or pockets of sand or gravel appear to occur only sparingly in the upper part of the glacial drift throughout this township. This area is sparsely settled. The few residents obtain their water supplies either by storing the surface run-off in dugouts and behind dams in the coulees or by sinking wells to the water-bearing beds of sand and gravel that occur in the lower part of the glacial drift. The thickness of the drift varies from about 50 feet in the northwestern parts to 115 feet or more in the southeastern corner of the township. The wells yielding water from the lower part of the glacial drift are confined to the eastern half of the township. The consistency with which many of the existing wells in the eastern part of the township have struck water in gravel beds at elevations between 2,930 and 2,900 feet above sea-level suggests that a fairly continuous aquifer underlies at least this half of the township. Well data obtained

from townships bordering on the north and west suggest that these water-bearing beds may also underlie the western half of the township. The 52-foot well located on the SE.$\frac{1}{4}$, section 19, obtains its supply from an aquifer in blue clay at an elevation of 2,938 feet above sea-level. This well may indicate the western extension of this aquifer. Wells located on sections 14, 23, 27, and 34, strike this gravel bed at depths ranging between 65 and 80 feet from the surface. On the higher land in sections 10 and 12, however, it was necessary to bore to depths of 100 and 118 feet, respectively, before production was obtained. The water at this horizon is under hydrostatic pressure and rises in the wells to heights of 25 to 30 feet above the aquifer. The water from all these wells is reported to be hard and to contain varying amounts of mineral salts in solution. It is nevertheless being used for domestic purposes as well as for stock. The yield from individual wells is amply sufficient for local stock requirements.

The underlying Bearpaw shale has been penetrated for a few feet in several of these wells. Deeper drilling in this formation is not recommended as sand beds sufficiently porous for any large accumulation of ground water probably do not occur in the Bearpaw in this township.

Township 3, Range 19

Shallow seepage wells sunk near sloughs and dugouts, and wells tapping the small pockets of sands and gravels in the upper 30 feet of the glacial drift form the main source of domestic supply in this township. The productive beds are of limited areal extent. As there is little or no indication of their occurrence on the surface several test holes may be necessary before an adequate household supply is obtained. The moraine covering the southwest and northeastern parts of the township is generally more porous than the glacial till or boulder clay that covers the central, northwestern, and southeastern parts. Hence, slightly larger supplies are to be expected at shallow depths in the gently rolling, moraine covered areas than in the flatter, central till plain.

A large amount of ground water is used for stock in this township and is derived from gravel beds occurring at or near the base of the glacial drift. These beds have not been found at sufficiently uniform elevations to justify the assumption that they form one continuous aquifer over any large area. Throughout the southern two-thirds of the township, many wells have obtained fairly large supplies of water suitable for stock, and in most instances suitable for household use, at depths ranging from 70 to 90 feet from the surface. Within the area bounded by the "C" line on Figure 1, it has been necessary to sink wells to depths of 100 to 110 feet before the productive beds were tapped.

Wells sunk in the northern third of the township have failed to encounter more than small seepages of water in the glacial drift. Deeper drilling into the fine grey sands of the underlying Eastend formation has yielded adequate supplies for the stock requirements of several farms in the district. A few of the wells have been continued through the Eastend and derive a part of their supply from the sands interbedded with the shale of the Bearpaw formation. There appears to be little uniformity to the depths or the horizons at which the water is found. Most of the wells are from 125 to 200 feet deep. It was found necessary in section 26 to drill to a depth of 235 feet, however, before any large yield was encountered.

The quality of the water differs in the different wells. Wells tapping the thicker beds of sands in the shale yield a soft to moderately hard, drinkable water. Others encountering less sand and more shale give a hard water generally quite highly charged with dissolved sulphate salts, which is used only for watering stock.

Throughout the southern two-thirds of the township the Eastend is probably absent, and as the Bearpaw formation that immediately underlies the drift is composed almost entirely of shale, little water can be expected from it.

Township 3, Range 20

Shallow wells sunk in coulee bottoms or at the base of slopes provide small supplies of water on some of the farms in the area. This source of supply is generally inadequate, however, and dugouts conserving the spring run-off provide for stock during the dry months. Shallow wells deriving their water by seepage from the dugouts form a satisfactory household supply if the water is uncontaminated by sewage and decaying vegetable matter. Moraine covers the uplands of the northern half of the township, and offers slightly better possibilities of obtaining water at shallow depths than the less porous till exposed over the southern lowlands.

Little deep drilling has been done in the southern half of the township. Only one well has been sunk to a deep horizon. This well, located on the NW.$\frac{1}{4}$, section 5, is reported to be deriving its supply from blue clay at a depth of approximately 150 feet. The geological horizon of this aquifer is uncertain. It is probable that most of the water comes from the base of the drift at a depth of 75 feet although the base of the well has probably penetrated the Eastend formation or even the upper part of the Bear-paw formation. The water level in the well is about 75 feet above its base and the supply is ample. The water is hard and highly charged with mineral salts in solution, and is used only for watering stock.

The northeastern half of the township is more thickly populated, and the settlers derive their main supplies of ground water from the sand and gravel beds of the lower part of the drift or from sands in the underlying bedrock. Water-bearing gravels have not been encountered at depths greater than 90 feet in this part of the township. This figure probably represents the approximate thickness of the glacial drift. Wells obtaining water from these gravel beds are situated in a narrow belt extending through sections 12, 13, 14, 23, and 27. The water rises in most of these wells 30 to 40 feet above the aquifer. The supply is ample for

average farm requirements. "Alkaline" water is reported to occur in wells on sections 12 and 13, but otherwise the water is satisfactory for household use.

Two water-bearing horizons are known to occur in bedrock in the northern part of the township. The shallowest of these is tapped by two wells situated on sections 25 and 36 at approximate depths of 75 feet. The water is reported to occur in blue-grey shale. It is more probable, however, that the water actually occurs in thin layers of fine sand interbedded with the shale. The water does not rise above the aquifer, but the supply is ample for both household and stock requirements. The water is soft and considered to be of good quality for drinking. This soft water horizon may extend through sections 35 and 34, but does not occur in the northwestern corner of the township. Here two wells have been sunk to a lower horizon at depths of 150 feet and 160 feet. This water also occurs in porous beds in the shale. It is under hydrostatic pressure and rises in the wells about 100 feet above the aquifer. The water is highly mineralized, however, and is not considered suitable for watering stock.

Township 3, Range 21

Shallow deposits of sand and gravel occur in the upper part of the glacial drift throughout the moraine covered northern third and in several sections on the western side of this township. Most of the wells in this area are in valleys or depressions in the land surface and yield good water supplies at depths of 10 to 20 feet. The supply from individual wells is generally sufficient for farm requirements. These waters are usually soft and suitable for household use. Some difficulty has been experienced in locating suitable water supplies at shallow depths in the till covered, central part of the township. In sections 27 and 28 it was found necessary to sink wells to water-bearing gravels in the lower part of the glacial drift. These beds are encountered at comparatively shallow depths, not generally exceeding 50 feet from the surface.

These lower gravels may not, however, form extensive aquifers. A dry hole sunk in the SW.¼, section 27, is thought to have penetrated the underlying bedrock shales at a depth of about 60 feet. Several dry holes have also been sunk in the central part of the township without encountering these gravel beds, and a few of them penetrated the underlying shale to depths of over 60 feet without obtaining water. In the vicinity of the village of Loomis, and south and west to the borders of the township, these water-bearing gravels are encountered at depths ranging from 40 to 60 feet. The water rises 10 to 30 feet above the aquifer in most of the wells tapping these gravel horizons. The yield is quite sufficient for the average farm requirements of the district. Although much of the water is reported to be "alkaline", it is used in the households as well as for watering stock.

Despite the limited extent of the aquifers the glacial deposits offer much greater possibilities of obtaining adequate ground water supplies than deep drilling into the underlying bedrock.

Only one well, situated in the SE.¼, section 23, is known to have encountered water in the Bearpaw formation that immediately underlies the glacial drift in this township. The water contains so much sodium carbonate and sulphate salts in solution that it is unsuitable for farm use. Should water be found in these shales in other localities it probably will be highly mineralized and unfit for drinking, and possibly unsuitable for watering stock.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF FRONTIER, NO. 19, SASKATCHEWAN

West of 3rd meridian — Township / Range	1 19	1 20	1 21	2 19	2 20	2 21	3 19	3 20	3 21	Total No. in Municipality
Total No. of Wells in Township	25	20	2	32	26	10	33	24	35	207
No. of wells in bedrock	3	2	1	2	0	0	10	5	3	26
No. of wells in glacial drift	21	17	1	30	23	9	22	18	29	170
No. of wells in alluvium	1	1	0	0	3	1	1	1	3	11
Permanency of Water Supply										
No. with permanent supply	21	13	2	30	20	10	32	24	32	184
No. with intermittent supply	0	3	0	0	3	0	0	0	0	6
No. dry holes	4	4	0	2	3	0	1	0	3	17
Types of Wells										
No. of flowing artesian wells	0	0	0	0	0	0	0	0	0	0
No. of non-flowing artesian wells	7	4	0	14	8	8	13	9	12	75
No. of non-artesian wells	14	12	2	16	15	2	19	15	20	115
Quality of Water										
No. with hard water	16	16	2	29	20	9	29	17	21	159
No. with soft water	5	0	0	1	3	1	3	7	11	31
No. with salty water	0	0	1	0	4	0	0	1	0	6
No. with "alkaline" water	7	5	2	12	9	7	21	11	17	91
Depth of Wells										
No. from 0 to 50 feet deep	11	16	0	16	11	3	9	13	27	106
No. from 51 to 100 feet deep	2	0	1	8	6	6	12	7	6	48
No. from 101 to 150 feet deep	1	3	0	6	6	1	6	2	1	26
No. from 151 to 200 feet deep	7	1	1	2	3	0	4	2	1	21
No. from 201 to 500 feet deep	3	0	0	0	0	0	2	0	0	5
No. from 501 to 1,000 feet deep	1	0	0	0	0	0	0	0	0	1
No. over 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
How the Water is Used										
No. usable for domestic purposes	17	15	1	22	14	9	18	18	26	140
No. not usable for domestic purposes	4	1	1	8	9	1	14	6	6	50
No. usable for stock	21	16	2	30	23	9	31	24	29	185
No. not usable for stock	0	0	0	0	0	1	1	0	3	5
Sufficiency of Water Supply										
No. sufficient for domestic needs	21	13	1	29	20	10	31	23	29	177
No. insufficient for domestic needs	0	3	1	1	3	0	1	1	3	13
No. sufficient for stock needs	13	6	1	26	10	8	21	18	27	130
No. insufficient for stock needs	8	10	1	4	13	2	11	6	5	60

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 oxide, 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 harness 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 Frontier, No. 19, Saskatchewan.

No.	LOCATION					Depth of Well, Ft.	Total dis'vd solids	HARDNESS			CONSTITUENTS AS ANALYSED						CONSTITUENTS AS CALCULATED IN ASSUMED COMBINATIONS								Source of Water
	Qtr.	Sec.	Tp.	Rge.	Mer.			Total	Perm.	Temp.	Cl.	Alkalinity	CaO	MgO	SO_4	Na_2O	Solids	$CaCO_3$	$CaSO_4$	$MgCO_3$	$MgSO_4$	Na_2CO_3	Na_2SO_4	NaCl		
1	NW.	32	2	19	3	83	4,080	850	850	nil	130	220	40	241	2353	1354	3,796	72		125	539		2,845	215		x 1
2	NW.	36	2	20	3	110	7,260	1,900	1,800	100	190	520	550	364	4162	2001	6,762	520	629		1,085		4,214	314		x- 1
3	NW.	3	3	21	3	48	2,040	700	650	50	104	270	20	209	1007	564	1,832	36		196	343		1,085	172		x 1

Water samples indicated thus, x 1, are from glacial drift.
Hardness is the soap hardness expressed as calcium carbonate ($CaCO_3$).
For interpretation of this table read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

Three samples of ground water from the glacial drift of this municipality were collected and analysed. The following generalizations regarding the dominant characteristics of the ground water of the area are based upon these analyses, supplemented by information given by the residents of the area, and upon analyses of water from similar horizons in adjoining municipalities.

Ground water obtained from shallow wells sunk in the pockets of sand and gravel of the upper part of the drift in this municipality show a wide variation as to quality. Most of the waters are hard and contain mineral salts in solution. Sodium sulphate (Glauber's salt) and magnesium sulphate (Epsom salts) are generally present in the largest amounts. The concentration is in many places sufficiently high to give the water a slightly bitter taste. In the absence of better supplies, however, this water is used in the households with no apparent ill effects. As a rule waters obtained from the sand and gravel deposits in the coulées are of better quality than those obtained from the sands in the undrained depressions. Concentration of mineral salts by evaporation in some places has rendered water from this latter source unfit for domestic use. At other points, shallow wells sunk into the boulder clay beside sloughs or dugouts yield a water of better quality. The clay acts as a filter to the water seeping into the wells, and if the water is uncontaminated by sewage or other decaying organic material these wells form excellent sources of domestic supply. Wells sunk into the compact, bluish grey boulder clay remote from surface accumulations, and not encountering sandy beds, yield very little water. The small seepages obtained are generally too highly charged with dissolved mineral salts to be used either for drinking or for stock.

The three analyses given on the accompanying table are from wells sunk into the extensive beds of gravels occurring in the lower part of the glacial drift. The waters show a general

similarity in the constituent minerals comprising the total dissolved solids and in the relative proportions in which these salts are present in any one sample. These waters are very hard. The hardness is largely permanent and hence not materially lessened by boiling. Glauber's salt (Na_2SO_4) is the mineral present in largest amounts in these waters. In the first two analyses given, the Na_2SO_4 forms 2,845 and 4,214 parts per million of the total dissolved solids. This combined with 539 and 1,085 parts per million of Epsom salts ($MgSO_4$) respectively tend to make these waters strongly laxative and quite unfit for human consumption. No permanent ill effects on stock, after continual use, were reported, however. These two salts are present in lesser amounts in the third water analysed. This water would undoubtedly prove to be laxative to persons unaccustomed to its use. It is being used for household purposes, but as its total dissolved content places this water near the upper limit of waters considered drinkable, it should not be used if better supplies are available within reasonable hauling distance. Common salt (Nacl) is present in all three of these wells. In the first two waters the salt is in sufficient concentration to give a distinctly salty taste to the water, which in itself greatly lessens its thirst quenching properties. The salt present in the third water is sufficient to give to the water a "brackish" taste. The other mineral salts present in solution in these waters are not in sufficient concentration to have any ill effects on persons or stock. They contribute largely to the hardness of the water.

Any laxative effect that these waters may have upon stock may not prove injurious, particularly during winter months when the stock are fed on dry fodder.

Water from the Bedrock

Wells deriving their water supply from the bedrock are confined almost entirely to the northern parts of township 3, ranges 19 and 20. Water from the fine grey sands of the Eastend is

reported to be soft or only moderately hard. Small amounts of mineral salts are present in the waters, causing them to be slightly "alkaline". In general, however, these waters are satisfactory for domestic use and for watering stock. Supplies from wells located on secs. 31 and 32, tp. 3, range 19, and secs. 25 and 36, tp. 3, range 20, are characteristic of the sands of the Eastend and the upper sandy beds of the Bearpaw shale. Wells tapping aquifers at lower elevations in the shale yield a much more highly mineralized water. Glauber's salt and Epsom salts are present in solution in large quantities. The water is highly laxative on humans and tends to create scour in stock. Iron and common salt in lesser amounts add to the disagreeable properties of water from the shale. Such water is to be expected in deep drilling, i.e. below a depth of 200 feet, throughout this northern area. It is improbable that wells sunk into the shale in any other part of the township will yield water of appreciably better quality.

WELL RECORDS—Rural Municipality of FRONTIER, NO. 19, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
1	NE.	1	1	19	3	Drilled	92	2,990	- 82	2,908	82	2,908	Glacial gravel	Hard, clear, iron, "alkaline"	46	D, S	Sufficient for local needs.
2	SW.	2	"	"	"	Dug	14	2,988	- 12	2,976	12	2,976	Glacial sand	Soft, cloudy	45	D, S	Sufficient for local needs.
3	NW.	5	"	"	"	Bored	152	2,980	-120	2,860	150	2,830	Glacial coarse sand	Hard, clear, "alkaline"	44	D, S	Sufficient for local needs.
4	SW.	6	"	"	"	Bored	146	3,015	-130	2,885	142	2,873	Glacial coarse sand	Hard, clear,	46	D, S	Sufficient for local needs.
5	NW.	9	"	"	"	Dug	10	2,975	- 8	2,967	8	2,967	Glacial sandy clay	Hard, clear	46	D	Sufficient for household needs.
6	NE.	10	"	"	"	Drilled	160	2,995	-155	2,840	155	2,840	Glacial sand	Hard, cloudy, "alkaline"	44	S	Insufficient supply. Well now abandoned.
7	NE.	10	"	"	"	Dug	16	2,958	- 4	2,954	4	2,954	Glacial blue clay	Hard, clear	46	D	Insufficient supply for local needs.
8	NW.	12	"	"	"	Bored	160	2,990	- 40	2,950	50	2,940	Glacial gravel	Hard, cloudy, "alkaline"	46	S	Sufficient for local needs.
9	NW.	13	"	"	"	Spring		2,980	0	2,980			Glacial gravel	Soft, clear	45	D, S	Sufficient for local needs.
10	NW.	15	"	"	"	Dug	12	3,005	- 10	2,995	10	2,995	Recent alluvium stream sand	Soft, clear	46	D	Insufficient for local needs.
11	NW.	18	"	"	"	Dug	16	3,040	- 10	3,030	10	3,030	Glacial blue clay	Hard, clear	44	D, S	Insufficient for local needs.
12	NW.	19	"	"	"	Bored	30	3,015	- 12	3,003	12	3,003	Glacial sand	Hard, clear	45	D, S	Insufficient for local needs. Dry holes 100, 245, and 630 feet deep.
13	NE.	19	"	"	"	Drilled	200	3,010	- 190	2,820	190	2,820	Glacial gravel	Hard, clear, "alkaline"	46	D, S	Insufficient for local needs.
14	SW.	20	"	"	"	Drilled	200	3,015	- 60	2,955	185	2,830	Glacial gravel	Hard, clear	46	D, S	Sufficient for local needs.
15	SE.	23	"	"	"	Bored	186	2,990	- 15	2,975	170	2,820	Glacial gravel	Hard, cloudy, "alkaline"	44	D, S	Sufficient for local needs.
16	NW.	23	"	"	"	Bored	198	2,985	- 40	2,945	190	2,795	Glacial gravel	Hard, clear, "alkaline"	44	S	Sufficient for local needs.
17	SW.	25	"	"	"	Dug	16	2,965	- 13	2,952	13	2,952	Glacial sandy clay	Hard, clear	45	D, S	Sufficient for local needs.
18	SW.	28	"	"	"	Drilled	220	2,995					Bearpaw "soapstone" at base				Dry hole.
19	SE.	31	"	"	"	Dug	14	2,990	- 1	2,989	1	2,989	Glacial sand	Hard, clear, iron	47	S	Sufficient for local needs.
20	SE.	33	"	"	"	Drilled	230	2,980	- 55	2,925	230	2,750	Glacial gravel	Soft, clear	46	D, S	Sufficient for local needs.
1	SE.	2	1	20	3	Bored	176	3,050	-146	2,904	161	2,889	Bearpaw sandstone	Hard, clear, "alkaline"	46	D, S	Insufficient for local needs.
2	NW.	12	"	"	"	Bored	143	3,040	- 98	2,942	142	2,898	Glacial gravel	Hard, clear, "alkaline"	45	D, S	Sufficient for local needs.
3	NE.	12	"	"	"	Dug	16	3,015	- 4	3,011	16	2,999	Glacial gravel	Hard, clear	46	D, S	Sufficient for local needs.
4	NE.	14	"	"	"	Dug	15	3,050	- 13	3,037	13	3,037	Glacial gravel	Hard, clear	46	D	Insufficient for local needs.
5	SE.	15	"	"	"	Bored	150	3,050	-105	2,945	145	2,905	Glacial gravel	Hard, clear, "alkaline"	46	D, S	Sufficient for local needs.
6	SE.	16	"	"	"	Dug	14	2,870	0	2,870			Glacial clay	Hard, clear		D	Insufficient 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 FRONTIER, NO. 19, SASKATCHEWAN

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
7	SW.	17	1	20	3	Dug	25	3,050	- 5	3,045	20	3,030	Glacial sand, clay	Hard, clear	46	D, S	Insufficient for local needs.
8	NE.	21	"	"	"	Dug	16	2,875	- 12	2,863			Glacial sand , clay	Hard, clear		D	
9	SW.	22	"	"	"	Bored	128	2,905	- 84	2,821	128	2,777	Glacial gravel			D, S	Sufficient for local needs.
10	NW.	24	"	"	"	Dug	10	3,040	- 6	3,034	6	3,034	Glacial gravel	Hard, clear	46	D, S	Sufficient for local needs.
11	NE.	24	"	"	"	Dug	16	3,005	- 2	3,003			Glacial sandy c clay	Hard, clear	45	D, S	Sufficient for local needs.
12	NE.	25	"	"	"	Dug	18	3,005	- 10	2,995	10	2,995	Glacial clay	Hard, clear	46	D, S	Insufficient for local needs.
13	NE.	26	"	"	"	Dug	12	3,040	- 3	3,037	3	3,037	Glacial gravel	Hard, clear, "alkaline"	47	D	Insufficient for local needs. Dry holes to 50 feet deep.
14	NE.	28	"	"	"	Dug	20	2,800	0	2,800			Glacial clay	Hard, clear		D	Insufficient for local needs.
15	NW.	30	"	"	"	Dug	30	2,860	0	2,860			Glacial sand	Hard, clear, "alkaline"		S	Insufficient for local needs.
16	NE.	36	"	"	"	Dug	14	2,980	- 5	2,975	5	2,975	Recent alluvium stream sands	Hard, clear	47	D, S	Insufficient for local needs.
1	NE.	33	1	21	3	Bored	92	3,024	- 87	2,937	87	2,937	Glacial gravel	Hard, clear, salty, "alkaline"	42	S	Sufficient for local needs.
2	SE.	36	"	"	"	Bored	185	3,067	-135	2,932	135	2,932	Bearpaw shale?	Hard, clear, "alkaline"	42	D	Insufficient for local needs.
1	SW.	2	2	19	3	Bored	176	2,980					Bearpaw shale at base				Dry hole.
2	SE.	3	"	"	"	Dug	16	2,980	- 13	2,967	13	2,967	Glacial blue clay	Hard, clear	47	D	Insufficient for local needs.
3	NW.	3	"	"	"	Dug	18	2,980	- 14	2,966	14	2,966	Glacial gravel	Hard, clear	47	D, S	Insufficient for local needs.
4	SW.	5	"	"	"	Bored	150	2,990	- 60	2,930	130	2,860	Glacial gravel	Hard, clear, iron	48	D, S	Sufficient for local needs.
5	NE.	12	"	"	"	Bored	130	2,970	- 30	2,940	127	2,843	Glacial gravel	Hard, clear, "alkaline"	46	S	Sufficient for local needs.
6	NW.	13	"	"	"	Drilled	108	2,945	- 5	2,940	102	2,843	Glacial sand	Hard, clear, "alkaline"	48	D, S	Sufficient for local needs.
7	SW.	14	"	"	"	Dug	18	2,965	0	2,965	6	2,959	Glacial clay	Soft, clear	49	D, S	Insufficient for local needs.
8	NE.	17	"	"	"	Dug	12	2,985	- 10	2,975	10	2,975	Glacial gravel	Hard, clear	46	D, S	Insufficient for local needs.
9	NE.	19	"	"	"	Bored	100	2,980	- 50	2,930	90	2,890	Glacial gravel	Hard, clear, "alkaline"	47	D, S	Sufficient for local needs.
10	NW.	20	"	"	"	Bored	100	2,990	- 50	2,940	90	2,900	Glacial sand	Hard, clear, "alkaline"	46	S	Sufficient for local needs.
11	SE.	21	"	"	"	Bored	88	2,955	- 40	2,915	80	2,875	Glacial sand	Hard, clear, "alkaline"	46	S	Sufficient for local needs.
12	NW.	23	"	"	"	Bored	105	2,930	- 25	2,905	100	2,830	Glacial gravel	Hard, clear, "alkaline"	44	D, S	Sufficient for local needs.
13	SW.	24	"	"	"	Bored	20	2,920	- 10	2,910	10	2,910	Glacial sandy clay	Hard, clear	47	D, S	Sufficient for local needs.
14	NW.	24	"	"	"	Dug	12	2,920	- 6	2,914	6	2,914	Glacial sand	Hard, clear	47	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 FRONTIER, NO. 19, SASK-TCHEWAN

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
15	NW.	25	2	19	3	Bored	82	2,930	- 11	2,919	77	2,853	Glacial gravel	Hard, clear, "alkaline"	46	S	Sufficient for local needs.
16	SW.	28	"	"	"	Bored	110	2,960	- 50	2,910	100	2, 60	Glacial sand	Hard, clear, "alkaline"	45	D, S	Sufficient for local needs.
17	NE.	28	"	"	"	Bored	84	2,960	- 40	2,920	75	2,885	Glacial sand	Hard, clear, "alkaline"	46	S	Sufficient for local needs.
18	SE.	30	"	"	"	Bored	104	2,985	- 50	2,935	95	2,890	Glacial sand	Hard, clear, "alkaline"	46	S	Sufficient for local needs.
19	NE.	31	"	"	"	Dug	16	2,990	- 13	2,977	13	2,977	Glacial sand	Hard, clear	44	D, S	Sufficient for local needs.
20	NW.	32	"	"	"	Bored	83	2,980	- 40	2,940	75	2,905	Glacial sand	Hard, clear	44	S	Sufficient for local needs; #.
21	NW.	33	"	"	"	Bored	34	2,985	- 40	2,945	75	2,910	Glacial clay, sand	Hard, clear, "alkaline"	45	D, S	Sufficient for local needs.
22	SE.	35	"	"	"	Bored	90	2,945	- 20	2,925	85	2,860	Glacial sand	Hard, cloudy, "alkaline"	46	S	Sufficient for local needs.
23	SW.	35	"	"	"	Bored	18	2,935	0	2,935	16	2,919	Glacial gravel	Hard, clear	46	D, S	Sufficient for local needs.
1	SW.	1	2	20	3	Dug	24	2,775	- 12	2,763			Recent alluvium stream sands	Hard		D, S	Insufficient for local needs.
2	SE.	2	"	"	"	Dug	20	2,750	- 2	2,748			Recent alluvium stream sands	Hard		D, S	Insufficient for local needs.
3	SW.	2	"	"	"	Dug	20	2,870	- 16	2,854			Glacial sand	Soft, clear		D	Insufficient for local needs.
4	SW.	3	"	"	"	Bored	185	2,830	- 85	2,745	180	2,650	Glacial gravel	Hard, clear		D, S	Sufficient for local needs.
5	NW.	9	"	"	""	Bored	154	2,800	- 48	2,752	150	2,650	Glacial gravel	Hard, clear, iron		D, S	Sufficient for local needs.
6	SW.	12	"	"	"	Dug	15	2,810	- 5	2,805			Glacial clay	Hard, clear		D, S	Insufficient for local needs.
7	NE.	12	"	"	"	Dug	12	2,765	- 6	2,759	4	2,761	Recent alluvium stream gravels	Soft, clear		D, S	Sufficient for local needs.
8	SW.	14	"	"	"	Bored	120	2,815					Glacial clay at base				Dry hole.
9	SE.	16	"	"	"	Dug	107	2,810					Glacial clay				Dry hole.
10	SE.	20	"	"	"	Bored	75	2,800	- 45	2,755			Glacial sand	Hard, clear, "alkaline"		S	Insufficient for local needs.
11	SW.	22	"	"	"	Bored	115	2,825	- 90	2,735	115	2,710	Glacial gravel	Hard, clear, "alkaline"		S	Sufficient for local needs.
12	NW.	22	"	"	"	Bored	104	2,830	- 29	2,801	100	2,730	Glacial sand	Hard, clear, "alkaline"		S	Sufficient for local needs.
13	NE.	23	"	"	"	Dug	15	2,790	0	2,790			Glacial clay	Hard, clear		D	Insufficient for local needs.
14	SE.	24	"	"	"	Bored	63	2,795	- 58	2,737			Glacial clay	Hard, clear		D, S	Insufficient for local needs.
15	NE.	25	"	"	"	Bored	100	2,815	- 55	2,760	55	2,760	Glacial sand	Hard, salty, "alkaline"		S	Insufficient for local needs.
16	SW.	28	"	"	"	Bored	85	2,975	- 55	2,920	80	2,895	Glacial gravel	Hard, clear, "alkaline"	46	S	Sufficient for local needs.
17	SW.	32	"	"	"	Bored	70	2,970	- 55	2,915	65	2,905	Glacial gravel	Hard, clear, "alkaline"	46	S	Sufficient for local needs.
18	SE.	33	"	"	"	Bored	140	2,980	- 50	2,930	130	2,850	Glacial gravel	Hard, clear, salty, "alkaline"	45	S	Sufficient for local needs.

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

WELL RECORDS—Rural Municipality of.....

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (—) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
19	NE.	35	2	20	3	Bored	100	2,800	- 40	2,760			Glacial drift	Salty clear, "alkaline"		S	Sufficient for local needs.
20	NW.	36	"	"	"	Bored	110	2,815	- 55	2,760	83	2,732	Glacial sand	Salty, "alkaline"		S	Sufficient for local needs; #.
1	SW.	3	2	21	3	Bored	38	3,059	- 30	3,029	30	3,029	Glacial sand	Hard, cloudy	42	N	
2	SE.	9	"	"	"	Dug	20	2,986	- 0	2,986	0	2,986	Recent alluvium stream silt	Hard, clear	42	D, S	Insufficient for local needs.
3	SE.	10	"	"	"	Bored	100	3,004	- 75	2,929	100	2,904	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
4	SW.	12	"	"	"	Bored	118	3,004	- 53	2,951	118	2,886	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
5	SW.	14	"	"	"	Bored	80	2,973	- 50	2,923	80	2,893	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
6	SE.	19	"	"	"	Dug	52	2,990	- 20	2,970	52	2,938	Glacial clay	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
7	NE.	23	"	"	"	Dug	28	3,002	- 12	2,990	28	2,974	Glacial sand	Soft, clear	42	D	Sufficient for domestic needs.
8	NE.	23	"	"	"	Bored	76	3,005	- 45	2,960	76	2,929	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
9	NE.	27	"	"	"	Bored	65	3,001	- 45	2,956	65	2,936	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
10	NE.	34	"	"	"	Bored	75	2,998	- 45	2,953	75	2,923	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
1	SE.	1	3	19	3	Dug	8	2,955	0	2,955	0	2,955	Recent alluvium stream sands	Hard, clear, "alkaline"	46	S	Sufficient for local needs.
2	NW.	3	"	"	"	Bored	108	2,980	- 40	2,940	106	2,874	Glacial sands	Hard, clear, "alkaline"		S	Sufficient for local needs.
3	NE.	4	"	"	"	Bored	107	3,035	- 47	2,988	104	2,931	Glacial sands	Hard, clear, "alkaline"	44	D, S	Sufficient for local needs.
4	SW.	5	"	"	"	Bored	70	3,010	- 40	2,970			Glacial sands	Hard, iron, "alkaline"		S	Insufficient for local needs.
5	NE.	5	"	"	"	Bored	80	3,045	- 30	3,015	80	2,965	Glacial gravel	Hard, "alkaline"		S	Sufficient for local needs.
6	SE.	7	"	"	"	Bored	82	3,040	- 30	3,010	80	2,960	Glacial gravel	Hard, "alkaline"		S	Sufficient for local needs.
7	NE.	7	"	"	"	Bored	80	3,000	- 60	2,940			Glacial clay	Hard, "alkaline"		S	Insufficient for local needs.
8	SW.	9	"	"	"	Bored	75	2,985	- 25	2,960	74	2,911	Glacial gravel	Hard, clear, "alkaline"		N	
9	NE.	10	"	"	"	Bored	72	2,970	- 32	2,938	72	2,898	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
10	SW.	12	"	"	"	Dug	21	2,970	- 13	2,957	13	2,957	Glacial clay	Soft, clear	44	D, S	Sufficient for local needs.
11	NE.	12	"	"	"	Bored	92	2,970	- 64	2,906	64	2,906	Bearpaw sand	Hard, clear, "alkaline"	46	D, S	Sufficient for local needs.
12	NW.	13	"	"	"	Bored	105	3,075	- 98	2,977	98	2,977	Glacial clay	Hard, clear, "alkaline"	46	D, S	Sufficient for local needs.
13	SE.	16	"	"	"	Dug	18	3,015	0	3,015			Glacial clay	Hard, clear		D, S	Insufficient for local needs.
14	NE.	17	"	"	"	Dug	30	3,055	- 20	3,035			Glacial sand	Hard, clear		D, S	Sufficient for local needs.
15	NE.	18	"	"	"	Dug	27	3,040	- 23	3,017			Glacial clay	Hard, "alkaline"		S	Insufficient 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.....

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				
16	NW.	19	3	19	3	Bored	100	3,045	- 60	2,985	80	2,965	Bearpaw shale	Hard, clear, "alkaline"		S	Sufficient for local needs.
17	SW.	20	"	"	"	Bored	90	2,990	- 40	2,950	90	2,900	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
18	NW.	20	"	"	"	Bored	132	3,085	- 80	3,005	80	3,005	Eastend shale	Hard, clear, "alkaline"		S	Sufficient for local needs.
19	SW.	21	"	"	"	Bored	90	3,045	- 40	3,005	90	2,955	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
20	SW.	22	"	"	"	Bored	84	3,015	- 54	2,961	80	2,935	Glacial blue sand	Hard, clear		D, S	Sufficient for local needs.
21	NW.	22	"	"	"	Bored	80	3,005	- 20	2,985	80	2,925	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
22	SE.	23	"	"	"	Bored	42	3,095	- 40	3,055	40	3,055	Glacial sand, gravel	Hard, clear	45	D, S	Sufficient for local needs.
23	NE.	26	"	"	"	Drilled	232	3,190	-214	2,976	214	2,976	Bearpaw sand-stone	Hard, clear	42	S	Sufficient for local needs.
24	NE.	28	"	"	"	Bored	129	3,160	-114	3,046			Eastend clay?	Hard, "alk-aline"		S	
25	NE.	30	"	"	"	Bored	135	3,075	-130	2,945			Bearpaw shale	Hard, "alk-aline"		S	Insufficient for local needs.
26	SW.	31	"	"	"	Bored	180	3,090	- 68	3,022	68	3,022	Eastend shale	Soft, clear		D, S	Sufficient for local needs.
27	SW.	32	"	"	"	Bored	171	3,100	-141	2,959	171	2,929	Bearpaw fine sand	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
28	NW.	34	"	"	"	Drilled	162	3,010	-144	2,866	162	2,848	Bearpaw shale	Hard, clear		D, S	Sufficient for local needs.
29	SE.	35	"	"	"	Bored	205	3,170					Bearpaw sand at base				Dry hole.
30	SW.	35	"	"	"	Bored	195	3,160	-183	2,977			Bearpaw clay?	Hard, "alk-aline"		S	Sufficient for local needs.
1	NW.	5	3	20	3	Bored	156	2,990	- 76	2,914	151	2,839	Glacial blue clay	Hard, clear, "alkaline"	45	S	Sufficient for local needs.
2	NW.	7	"	"	"	Bored	32	2,990	- 26	2,964	26	2,964	Glacial blue clay	Hard, clear, "alkaline"	47	D	Insufficient for local needs.
3	SW.	8	"	"	"	Dug	15	2,990	0	2,990	0	2,990	Glacial sandy clay	Soft, clear	48	D, S	Sufficient for local needs.
4	NE.	10	"	"	"	Dug	8	2,790	- 4	2,786			Glacial gravel	Hard, clear		D, S	
5	NW.	12	"	"	"	Bored	90	2,830	- 30	2,800			Glacial sand	Hard, clear, salty, "alk-aline"		S	Sufficient for local needs.
6	SE.	13	"	"	"	Bored	40	3,020	- 20	3,000	35	2,985	Glacial blue sand	Hard, clear, "alkaline"		S	Sufficient for local needs.
7	SE.	13	"	"	"	Bored	41	3,020	- 16	3,004	40	2,980	Glacial gravel	Hard, clear, "alkaline"		S	Sufficient for local needs.
8	SW.	13	"	"	"	Bored	63	3,000	- 59	2,941	59	2,941	Glacial clay	Hard, clear, "alkaline"		D, S	Insufficient for local needs.
9	NE.	14	"	"	"	Bored	68	3,000			68	2,932	Glacial gravel	Hard, clear, iron		D, S	Insufficient for local needs.
10	NE.	15	"	"	"	Dug	11	3,010	0	3,010			Recent alluvium stream sands	Soft, clear		D, S	Sufficient for local needs.
11	NW.	20	"	"	"	Dug	16	2,970	- 12	2,958	12	2,958	Glacial gravel	Soft, clear	46	D, S	Sufficient for local needs.
12	NE.	20	"	"	"	Dug	24	2,975	- 22	2,953	22	2,953	Glacial gravel	Hard, clear	46	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 FRONTIER, NO. 19, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
13	SE.	23	3	20	3	Dug	12	3,005	- 5	3,000	5	3,000	Glacial gravel	Soft, clear	46	D, S	Sufficient for local needs.
14	NW.	23	"	"	"	Dug	75	3,010	- 25	2,985	70	2,940	Bearpaw blue sand	Hard, clear, "alkaline"	46	D, S	Sufficient for local needs.
15	NE.	25	"	"	"	Bored	115	3,060	- 75	2,985	70	2,990	Bearpaw shale	Soft, clear		D, S	Sufficient for local needs.
16	SW.	27	"	"	"	Dug	75	3,015	- 40	2,975	70	2,945	Glacial sand	Hard, clear, "alkaline"	46	D, S	Sufficient for local needs.
17	NE.	27	"	"	"	Bored	60	3,025	- 30	2,995	58	2,967	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
18	SW.	30	"	"	"	Dug	7	3,010	- 3	3,007	3	3,007	Glacial gravel	Soft, clear	47	D, S	Sufficient for local needs.
19	SE.	31	"	"	"	Bored	165	3,025	- 65	2,960	160	2,865	Bearpaw blue clay	Hard, clear, "alkaline"	46	S	Sufficient for stock needs.
20	SE.	32	"	"	"	Bored	150	3,015	- 75	2,940	140	2,875	Bearpaw blue sand	Hard, clear, "alkaline"		S	Sufficient for stock needs.
21	SW.	36	"	"	"	Bored	86	3,045	- 60	2,985	40	3,005	Eastend shale	Soft, clear		D, S	Sufficient for local needs.
1	NW.	2	3	21	3	Bored	52	2,968	- 20	2,948	52	2,916	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
2	NW.	3	"	"	"	Bored	48	2,968	- 28	2,940	28	2,940	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs‡ #.
3	SW.	4	"	"	"	Dug	42	2,963	- 17	2,946	42	2,921	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
4	NE.	4	"	"	"	Dug	42	2,986	- 31	2,955	42	2,944	Glacial sand, gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
5	SW.	7	"	"	"	Dug	50	2,981	- 44	2,937	50	2,931	Glacial sand	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
6	NE.	7	"	"	"	Dug	56	2,993	- 42	2,951	56	2,937	Glacial sand, gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
7	NW.	9	"	"	"	Bored	80	3,012	- 65	2,947	80	2,932	Glacial gravel	Hard, clear, "alkaline"	42	S	Sufficient for local needs.
8	NE.	10	"	"	"	Dug	47	2,993	- 38	2,955	38	2,955	Glacial gravel	Hard, clear	42	D, S	Sufficient for local needs.
9	NE.	10	"	"	"	Dug	42	2,973	- 12	2,961	42	2,931	Glacial sand, gravel	Soft, clear	42	D, S, I	Sufficient for local needs.
10	SW.	14	"	"	"	Bored	48	2,979	- 25	2,954	48	2,931	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
11	SW.	14	"	"	"	Bored	45	2,985	- 34	2,951	45	2,940	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
12	SE.	15	"	"	"	Dug	100	3,015					Bearpaw shale at base				Dry hole.
13	SE.	16	"	"	"	Dug	37	2,996	- 25	2,971	25	2,971	Glacial sand	Hard, clear, "alkaline"	42	S	Sufficient for local needs.
14	NW.	16	"	"	"	Dug	14	2,957	- 6	2,951	6	2,951	Glacial clay	Soft		D, S	Sufficient for local needs.
15	NW.	16	"	"	"	Dug	18	2,957	- 8	2,949	8	2,949	Glacial sand	Hard		D, S	Sufficient for local needs.
16	NW.	16	"	"	"	Bored	120	3,018					Bearpaw shale at base				Dry hole.
17	SW.	18	"	"	"	Spring	0	3,140	+ 6	3,146	0	3,140	Glacial black sand	Hard, clear, "alkaline"	41	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 FRONTIER, NO. 19, SASKATCHEWAN

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE: Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED: Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
18	NE.	18	3	21	3	Dug	30	2,976	- 20	2,956	30	2,946	Glacial gravel	Soft, clear, "alkaline"	42	D, S	Sufficient for local needs.
19	SW.	20	"	"	"	Dug	12	2,980	- 8	2,972	8	2,972	Glacial sand	Soft, clear, iron, "alkaline"	42	D, S	Sufficient for local needs.
20	S½.	21	"	"	"	Bored	46	2,960	- 38	2,922	38	2,922	Glacial sand	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
21	SE.	22	"	"	"	Dug	10	2,960	- 6	2,954	6	2,954	Glacial sand, gravel			N	Abandoned and filled in.
22	NW.	23	"	"	"	Dug	25	3,018	- 18	3,000	18	3,000	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
23	SE.	23	"	"	"	Bored	176	2,957	- 50	2,907	50	2,907	Bearpaw blue clay	Hard, soda, bluish colour		N	Filled in soon after dug.
24	NE.	25	"	"	"	Dug	10	3,019	- 8	3,011	5	3,014	Recent alluvium stream sands	Soft, clear	42	D, S	Sufficient for local needs.
25	SW.	27	"	"	"	Dug	16	3,021	0	3,021	8	3,013	Glacial sand	Soft, clear	42	D, S	Insufficient for local needs.
26	SW.	27	"	"	"	Bored	60	3,021					Glacial clay at base				Dry hole.
27	NW.	27	"	"	"	Bored	52	3,033	- 42	2,991	42	2,991	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
28	SW.	28	"	"	"	Bored	42	3,013	- 33	2,980	33	2,980	Glacial gravel	Soft, clear	42	D, S	Sufficient for local needs.
29	SW.	32	"	"	"	Dug	10	3,010	- 6	3,004	6	3,004	Glacial gravel			N	Abandoned and filled in.
30	NW.	33	"	"	"	Dug	20	3,011	- 11	3,000	11	3,000	Glacial sand	Soft, clear	42	D, S	Sufficient for local needs.
31	SE.	33	"	"	"	Dug	20	3,000	- 5	2,995	5	2,995	Glacial clay	Hard		D, S	Sufficient for local needs.
32	NW.	34	"	"	"	Dug	14	3,006	- 7	2,999	7	2,999	Glacial gravel	Hard, clear, "alkaline"	42	S	Sufficient for local needs.
33	NE.	35	"	"	"	Dug	14	3,023	- 11	3,012	11	3,012	Recent stream sand, gravel	Soft, clear	42	D, S	Sufficient for local needs.
34	NW.	36	"	"	"	Dug	15	3,001	- 12	2,989	12	2,989	Glacial sand	Soft, clear	42	D, S	Sufficient for local needs.

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

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(#) Sample taken for analysis.