CANADA
DEPARTMENT OF MINES

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BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF .... No. 170 SASKATCHEWAN

BY

B. R. MacKay, H. H. Beach & R. Johnson

Water Supply Paper No. 146

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CONTENTS

Illustrations

GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY
OF NO. 170
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 fine the approximate depth to a water-bearing horizon, be 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

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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 côteau. 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 unnamed rural municipality No. 170 covers an area of 324 square miles, in the western part of southern Saskatchewan. The municipality consists of nine townships described as tps. 16, 17, and 18, ranges 22, 23, and 24, W. 3rd mer. It is situated centrally between the main line of the Canadian Pacific railway to the south, and the Empress branch of the same railway, to the north. The village of Fox Valley, located at the terminus of the Fox Valley branch of the Canadian Pacific railway, is approximately 8 miles west of the western boundary of the municipality. The villages of Verlo and Hazlet, on the Verlo branch of the same railway, are situated 13 miles from its eastern boundary. There are no centres of population within this municipality. The greater part of the municipality is situated in the Great Sand hills, which extend over the northeastern half of the area and much of the area covered by the southern three townships. This sand dune area is the main topographic feature of the municipality. It is gently to irregularly rolling with low sand hills, covered in places by sparse growths of trees and bushes. As the area is not suited to farming, the number of residents is few. The west-central part of the municipality consists of a rolling plain. The land slopes slightly to the south, from an elevation of 2,300 feet in the northern sections, to a maximum elevation of nearly 2,450 feet in the southwest corner. To date only the three southern townships of this municipality have been mapped topographically. The variations in elevation of the surface over this part of the area are indicated on Figure 2 of the map accompanying this report, by means of 50-foot contour lines.

Surface drainage collects in depressions to form sloughs and small lakes. The waters from most of these sloughs and lakes are too highly mineralized to be used even for watering stock, and water supplies in the municipality are largely obtained from wells and a few springs in township 16, range 24. Throughout the sand dune area adequate supplies of water for range stock and for domestic requirements are generally obtainable at depths of 45 feet or less. In the west-central part of the municipality, more difficulty has been experienced in obtaining water supplies, but no serious shortage exists.

All the ground water being used is obtained from Recent and glacial deposits. The Bearpaw formation, forming the bedrock that underlies the surface deposits of this area, will probably prove unproductive, but deep drilled wells, in at least the northern part of the municipality, might penetrate productive sands in the Belly River formation that underlies the Bearpaw. In places where the water table is close to the surface in the sand hills area, dugouts excavated in the sand became filled by seepage from the sides and bottom and provide a readily accessible supply of water for stock.

Water-bearing Horizons in the Unconsolidated Deposits

The unconsolidated deposits consist of the dune sands that form the Great Sand hills, and of glacial deposits of various types that cover the remainder of the area. The dune sands are of comparatively recent origin and have been formed entirely by wind action. The glacial deposits were laid down by a great continental ice-sheet that many thousands of years ago advanced and retreated over Saskatchewan, and by the waters that issued from the melting ice. The glacial deposits, collectively referred to as drift, are of three types, differentiated by their method of deposition, the character of the material composing each, and by their difference in topographic relief. As the ice-sheet advanced and retreated, it laid down a deposit of till composed essentially of compact, bluish grey boulder clay or till in which are interspersed irregular beds and pockets of sands and gravels that are generally water bearing. The till presents a flat or gently rolling land surface. In this area the till is largely concealed by a mantle of glacial lake sand and Recent dune sands. However, small areas of till are exposed in township 17, range 24. In areas where the retreating ice front remained stationary for any considerable length of time, a more porous type of drift, known as moraine, was deposited. The moraine is also largely composed of sandy boulder clay, interspersed with beds of sands and gravels. The surface of the moraine is irregularly rolling, with many low knolls and intervening, undrained depressions. A large area of moraine covers the northwestern corner of township 16, range 23, the northeastern corner of township 16, range 24, and extends diagonally across township 17, range 24, to its northwestern corner. Four small areas of moraine, each approximately a square mile in extent, occur in township 16, range 22, township 16, range 23, and township 18, range 24.

As the waters from the melting ice accumulated in depressions large lakes were formed in which were deposited coarser sands around the lake margin and fine silts in the areas of deeper water. The site of one of these lakes is marked by an extensive deposit of lake clays, in the municipalities adjoining on the east and north. The lake extended westward to include the western and southern parts of this municipality as lake sands underlie the Great Sand hills and are exposed in a belt several miles in width farther west bordering the higher areas mantled by till and moraine. Subsequent wind action upon these lake deposits has formed the Great Sand hills, which cover the greater part of the municipality. The areal distribution of these various types of deposits is indicated on Figure 1, of the map accompanying this report.

In the Sand Hills area and in the surrounding area covered by lake sands, surface waters percolate downward through the porous sediments and collect in a lower and more compacted part of the deposits or immediately above the underlying impervious boulder clay. In most places water can readily be obtained by sinking shallow wells or sand-points down to the lower part of the sand deposit. In some places in the southern part of the municipality these supplies are available at depths of less than 10 feet, and shallow dugouts are used to provide water for stock. Throughout the northern and central parts, however, the layer of sand is thicker and sand-points are generally sunk to depths of 20 to 45 feet. The wells are equipped with windmills and water is pumped continuously, furnishing a constant supply for range stock. The supplies available from the sands are large in most places, but near the western edge of the sand-covered area, in townships 17 and 18, range 24, the sands become thinner and the supplies are less plentiful. Difficulty has also been experienced in obtaining sufficient water for stock requirements in the eastern part of township 17, range 22, where the water-bearing sands are too fine to yield large supplies of water. The water obtained from the sand is usually only moderately hard and well adapted to domestic use, where required for this purpose. In a few places in townships 17 and 18, range 24, where the lake sand deposits are thin, the waters are more highly mineralized and have a laxative effect when used for drinking.

Where the sands are unproductive or absent, it becomes necessary to sink wells into the underlying glacial drift. The morainic deposits that cover the several areas indicated on Figure 1 are of a porous nature, and water can generally be obtained from them at shallow depths. Wells sunk in depressions and near sloughs are mostly productive. Several residents obtain adequate supplies of soft or only moderately hard water from wells not exceeding 30 feet in depth in the moraine-covered areas.

In some places, however, the supplies are small and two or more wells are necessary to ensure adequate stock supplies.

In the till-covered areas it becomes more difficult to locate productive pockets of sand and gravel, at shallow depths. Nevertheless, supplies of hard, drinkable water, sufficient for household requirements and 5 to 10 head of stock, can generally be obtained from shallow wells in these areas. Similar supplies may be expected in areas where the sands overlying the glacial drift are so thin as to be unproductive.

In this municipality residents are well advised to do considerable prospecting at depths not exceeding 30 or 40 feet before sinking wells to greater depths, as the waters from the deeper wells are as a rule highly mineralized and there is no certainty of obtaining satisfactory supplies. Wells sunk to depths between 50 and 257 feet in this municipality, indicate that water-bearing beds of sand and gravel will probably be encountered in the lower part of the glacial drift in most localities and will yield adequate supplies of water. However, in some places fine sands are penetrated which plug wells and reduce the yield to very small amounts. The sinking of two or more deep test holes within a small area is not advisable, as the beds encountered below depths of 50 feet are usually of sufficient areal extent that one hole will indicate their presence or absence. In the western three townships of the municipality most of the wells between 50 and 120 feet deep have proved productive, and similar conditions might be expected in other areas. The most probable source of supply, where wells of these depths fail, is at the contact of the glacial drift and the underlying bedrock shales. This contact is believed to occur at depths of 150 to 200 feet in most parts of the municipality. The 190-foot well in sec. 24, tp. 17, range 22, yields from this source sufficient water for 500 head of sheep. However, a 257-foot well in section 23, of the same township, and a 185-foot well in sec. 19, tp. 18, range 24, proved unproductive. Information available on the 257-foot well does not indicate whether sands or gravels were penetrated at the contact, but in the 185-foot well silts were penetrated that were too fine and compacted to yield water.

Water-bearing Horizons in the Bedrock

The glacial drift of the entire municipality is underlain by the Bearpaw formation. This formation is composed mostly of compact, dark marine shales, and yields only small seepages of highly mineralized water. The thickness of this formation is not known, but from wells in township 17, range 22, and in township 18, range 24, drilled to the drift-Bearpaw contact, and a deep well near the southern boundary of the municipality to the north that penetrates the Bearpaw-Belly River contact, it is believed to be less than 150 feet throughout the municipality.

The Belly River formation, which underlies the Bearpaw shales throughout the area, is composed mostly of beds of sand and soft sandstone that may be water-bearing. The 425-foot well near the southern boundary of township 19, range 22, in the municipality to the north, yields a fairly large supply of soft, "alkaline", iron-bearing water from a sand bed in this formation at an approximate elevation of 1,885 feet. The water-bearing beds in the Belly River formation are not generally of large areal extent, but wells between 300 and 500 feet deep in the northern part of this municipality will probably tap productive beds in the formation. In the southern part of the municipality the surface elevations are 50 to 100 feet higher, and wells would have to be drilled to correspondingly greater depths. The thicker covering of impervious Bearpaw shales in the southern part of the municipality may have prevented the seepage of water into the Belly River beds and they may prove unproductive. Despite the possibility of obtaining moderately large supplies of water from these Belly River beds prospecting at shallow depths in the Recent or glacial deposits is strongly advised. The financial outlay and labour required to sink a deep well to a Belly River horizon that may or may not yield adequate supplies of water, could be more profitably expended in careful prospecting for water-bearing deposits at shallow depths.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 16, Range 22

A belt of low sand hills occupies most of the northern half of the township and a small area along the southern half of its western boundary. With the exception of a small moraine-covered area in sections 1 and 2 the remainder of the township is a rolling plain covered by glacial lake sands.

The dune and lake sands are between 10 and 35 feet thick, and are underlain by boulder clay. In most places, adequate supplies of hard, drinkable ground water can be obtained at shallow depths in the sand. In some places in the sand hills area these supplies are available at depths of 5 to 10 feet, and shallow dugouts provide ample supplies of water for range stock. Wells sunk in depressions and valleys will usually be more productive than those sunk in the higher lands.

Where sufficient water cannot be obtained from the sand deposits it becomes necessary to deepen the wells into the underlying glacial drift. Localized pockets of sand and gravel occur interspersed in the upper part of the boulder clay, which when tapped by wells will generally yield enough water for the households and for 20 or more head of stock.

Water supplies have also been obtained at shallow depths in the area of glacial moraine, in section 1. Fine sands were encountered, which made it necessary to sink several test holes before satisfactory supplies were obtained. In section 2 fine sands were again found at shallow depths which plugged the shallow wells and made it necessary to continue them to greater depths.

Generally, in this township, adequate supplies of water will be available at depths less than 40 feet. However, should careful prospecting within this range prove unproductive, water will probably be obtained at greater depth in the glacial drift. The drift consists mostly of compact, bluish boulder clay that is too impervious to yield water. However, in most places, porous water-bearing beds of sand and gravel occur interspersed in the clay, from which adequate supplies of hard, but usually highly mineralized water can be obtained. The 60-foot well in section 2 yields an ample supply of hard, drinkable water from such a gravel bed.

In prospecting for water at depths of more than 40 feet the sinking of several holes on sites a short distance apart is not advisable, as the water-bearing beds, if present, will generally be fairly extensive. In the adjoining municipality to the east, the most consistent water-bearing horizon in the glacial drift is at or near the contact with the underlying Bearpaw shales. In this township the contact will probably occur at depths not exceeding 200 feet. Despite the possibilities of obtaining water at the drift bedrock contact, careful prospecting of the upper sandy beds will undoubtedly yield better results with less capital expenditure than will deeper drilling.

Drilling wells much below the contact is not believed advisable, as the Bearpaw formation is composed mostly of compact, dark marine shales, from which only small seepages of very highly mineralized water can be expected.

Township 16, Range 23

This township is used for grazing, and the water necessary for range stock is being obtained from shallow wells. With the exception of three small areas of moraine in the extreme northwestern, central, and southeastern parts of this township, the area is entirely mantled by 10 to 40 feet of glacial lake and Recent dune sands. Glacial lake sands cover the greater part of the northern and southeastern sections and sand dunes mantle a large area extending from the southwestern to the east-central part of the township.

All ground water supplies used in the township are being obtained from wells between 10 and 40 feet deep, sunk into the sand. These wells provide adequate supplies of water for range stock. Due to the fine texture of the sand at many points, sand-points are generally used to obtain the water. Except in the vicinity of "alkali" flats and sloughs, the water is only moderately hard and could be used for drinking or domestic use.

In most places little difficulty will be experienced in obtaining ample supplies of water from the surface sands. However should these sands be unproductive, drilling may be continued to tap water-bearing pockets of sand and gravel that occur interspersed in the upper part of the underlying boulder clay. Several test holes not exceeding 40 feet in depth might be necessary to locate one of these productive pockets. Supplies obtained from this source will generally be smaller and the water more highly mineralized than that obtained from the lake and dune sand. In the small, moraine-covered areas, shallow wells of this type are a very probable source of supply.

More extensive beds of sand and gravel may occur at greater depth in the glacial drift, and if penetrated may be expected to yield fairly large supplies of hard, generally highly mineralized water. The glacial drift, is believed to be between 150 and 200 feet in thickness and to rest upon the Bearpaw formation.

The Bearpaw formation is composed mainly of compact marine shales that will yield only small seepages of highly mineralized water, and it is not considered advisable to drill wells below the base of the glacial drift.

Township 16, Range 24

Water supplies in this township are obtained from a few springs in the sand hills area and from wells. Several "alkali" sloughs occur along a valley in the southwestern part of the township, but the waters from these sloughs are too highly charged with dissolved mineral salts to be used, even for stock.

Glacial lake sands and sand dunes mantle approximately the southern three-quarters of the area. The sand dunes occupy an area of approximately 10 square miles, in the southeastern part of the township. These sands are underlain by glacial lake sands, the combined thickness of both rarely exceeding 30 feet. The lake sands are in turn underlain by glacial drift. The drift is composed mostly of bluish boulder clay. This drift is exposed at the surface in the form of moraine, in the north-eastern and north-central parts, and as till in a small area in the northwestern corner of the township.

In the southern part of the township, the springs, and a few shallow wells and dugouts in the sand, provide adequate supplies of water for range stock. The wells and dugouts being used are only 4 to 6 feet deep, but furnish fairly large supplies of water. The water is soft and suitable for drinking. Supplies of this type will be available in most places at depths of less than 20 feet in the sands of this area. Supplies obtained in the close vicinity of "alkali" sloughs, and flats, will undoubtedly be more highly mineralized than those obtained remote from the sloughs.

The moraine deposits occurring in the northern part of the township are of a porous nature and residents of this area obtain ample supplies of soft water from wells varying between 6 and 22 feet in depth.

Only three wells in this township have been sunk to depths greater than 25 feet. Residents are well advised to thoroughly prospect the lake and dune sands and the upper part of the glacial drift at depths less than 30 feet before sinking deeper wells. Should the supplies available from such shallow wells prove inadequate sand and gravel beds or pockets will probably be encountered in the lower part of the glacial drift, from which it will be possible to obtain adequate supplies of hard, generally highly mineralized, water. A 50-foot well in section 30 yields an adequate supply of hard, drinkable water from a sand aquifer. In section 32 a 120-foot well yields, from a sand bed near the base of the glacial drift, a fairly large supply of hard, highly mineralized water that is being used for stock.

It is not considered advisable to sink wells into the Bearpaw formation that underlies the glacial drift at depths probably nowhere exceeding 200 feet. This formation is composed mostly of compact, dark marine shales that can be expected to yield only small seepages of highly mineralized water.

Township 17, Range 22

This township is entirely covered by sand hills, and is used mostly for sheep ranching. All water supplies required are being obtained from wells.

The surface sands are rarely more than 30 feet thick, and are underlain by glacial till or boulder clay. Water occurs generally at shallow depths in the sand, but in the eastern part of the township the supplies available are very small due to the fineness of the water-bearing sand. Farther west in section 9 a 12-foot well yields a fairly large supply. The waters obtained from the sands are usually only moderately hard and can be used for drinking or other domestic requirements.

Localized pockets of sand and gravel probably occur interspersed in the upper part of the underlying glacial boulder clay. Where the sands are unproductive, wells not exceeding 40 feet in depth tap these pockets and can be expected to yield small supplies of hard, drinkable water.

In sections 23 and 24 the supplies obtained at shallow depths in the sand were found to be inadequate, and wells were drilled to depths of 257 and 190 feet. The 190-foot well in section 24 yields a supply of fairly soft water, sufficient for approximately 500 head of sheep, from a sand bed near the base of the glacial drift. The 257-foot well in section 23 passed through the glacial drift and penetrated the shales of the Bearpaw formation without encountering water. In most places water would probably be obtained at depths of less than 200 feet in the glacial drift. However, the supplies likely to be obtained do not warrant the sinking of deep wells, unless the supplies from the surface sands prove altogether inadequate.

Drilling to depths exceeding 200 feet is not advisable, as the marine shales of the Bearpaw formation will probably be encountered before this depth is reached, and they will yield only small seepages of highly mineralized water.

The Belly River formation that underlies the Bearpaw at elevations probably between 2,000 and 2,050 feet above sea-level, is composed mostly of sand beds that might contain water. However, it would be necessary to drill to depths of 500 feet or more to test this source, and there can be no definite assurance that the horizon will prove to be productive.

Township 17, Range 23

This township is used altogether for stock grazing. The greater part of the township lies within the western part of the Great Sand hills. These hills are of recent origin and have been formed by wind action on the glacial lake sands that formerly covered the area. The southwestern part of the township, as shown on Figure 1, is covered by these undisturbed lake sands, except in a small area in section 6 where the glacial drift is exposed at the surface as moraine.

The dune and lake sands extend down to depths of 30 to 40 feet in most parts of this township, and water supplies for range stock are easily obtained by sinking sand-points down to the lower part of the sand deposit. Fairly large supplies of moderately hard water are obtained from these wells. The water is of good quality and if necessary could be used for domestic purposes.

The sands are underlain by glacial drift, composed mostly of bluish boulder clay. In most parts of the area, however, due to the productive nature of the overlying sands, no necessity to sink wells into the boulder clay is likely to occur.

The possibilities of obtaining water at greater depths in the glacial drift or in the underlying bedrock are discussed in the section of this report dealing with the water-bearing horizons of the municipality.

Township 17, Range 24

With the exception of water from a spring in section 2, and a few sloughs that provide water for stock in wet seasons, all water supplies used in this township are obtained from wells.

Most of the wells are less than 35 feet in depth, and draw their supplies from the glacial lake sands in the northeastern part of the township, and from sand pockets in the moraine and till deposits in the remainder of the area. The lake sands cover most of the northeastern half of the township, and extend to the western edge of the Great Sand hills in section 36. The glacial drift occurring at the surface over the remainder of the township consists of a belt of irregularly rolling moraine that extends diagonally from the southeastern to the northwestern corner of the township. The moraine is flanked by more level areas of till, that on the southwest covering much of the southwestern part of the township and that on the northeast forming a narrow strip that extends from section 14 to the northwestern corner of the township.

Water can be obtained from the lake sands in the northeastern part of the township in most places at depths not exceeding 35 feet. In the northeastern part fairly large supplies of moderately hard, drinkable water are available from this source. Near the southwestern edge of the sand-covered area, however, the supplies obtained are generally small and some residents use two or more wells to supply stock requirements. The water in some places is highly mineralized, and in a 20-foot well in section 23 it is reported to have a laxative effect on humans.

The upper 20 to 30 feet of the moraine and till deposits are of a sandy nature in this township, and it is usually possible to obtain small supplies of hard, drinkable water from wells, 10 to 30 feet in depth, dug in depressions and near sloughs. Wells of this type provide most of the water supplies used in this part of the township. The supplies obtained are, in several places, inadequate for stock requirements, although two or more such wells generally satisfy the present needs.

A few residents have sunk wells to greater depths in the glacial drift, in hope of obtaining more abundant supplies. In sections 5, 28, 31, and 33, sands and gravels were penetrated at depths of 60 to 90 feet and yield adequate supplies for local requirements. The 88-foot well in section 33 yields a relatively soft water, but the other three wells give highly mineralized waters that have a slightly laxative effect on humans. However, in the absence of supplies of better quality, the waters from two of the wells are being used for domestic purposes. Wells 65 and 60 feet deep, in sections 6 and 18, yield only small supplies of highly mineralized water. These wells indicate that water occurs in porous beds in the glacial drift, at depths between 50 and 100 feet, but that the supplies obtained will vary in quantity and quality in different places. The water may in some places be too highly mineralized for drinking, but will be satisfactory for stock.

Should the supplies from shallow wells and wells between 50 and 100 feet deep prove inadequate, the most probable source of supply at greater depths is at the contact of the glacial drift and the underlying Bearpaw formation, where water-bearing sands or gravels commonly occur. The contact will probably be reached at depths between 150 and 200 feet in this township, although no definite information has been obtained to date. Since the contact is not a certain source of supply deep drilling to this horizon is not advisable unless supplies at shallower depths prove altogether inadequate.

Little or no water can be expected from the dark marine shales, which comprise the greater part of the Bearpaw formation that underlies the drift throughout the township. The Bearpaw formation is probably not more than 100 feet thick in this township, and is underlain by the Belly River formation. This latter formation is composed to a large extent of beds of soft sandstone that might yield water. However, it would be necessary to drill to depths of 200 to 400 feet to test the productivity of this source. The uncertainty of obtaining adequate supplies of water suitable even for stock use at the deeper horizons makes it advisable to thoroughly prospect at shallow depths throughout the area.

Township 18, Range 22

This township is situated entirely within the Great Sand hills, and is used as range-land for stock.

All water supplies are obtained by sinking sand-points to depths of 30 to 45 feet in the sand. The supplies available from these wells are fairly large and ample for all local stock requirements. The water is as a rule only moderately hard and could be used for all domestic purposes.

No wells have reached the glacial drift that underlies the dune and lake sands, but it is probable that the overlying sand is between 35 and 50 feet thick in most parts of the township. As there will probably be no necessity to sink wells below the sands in this township it is not necessary to discuss here the possibility of obtaining water in either the glacial drift or the underlying bedrock. The horizons at which water may occur in these deposits are discussed in that part of the report dealing with the water-bearing horizons of the municipality as a whole.

Township 18, Range 23

This township is situated in the western part of the Great Sand hills and is entirely range land.

The sand hills or dunes are of recent origin and have been formed by wind action on glacial lake sands that formerly covered the area. These lake sands occur at the surface in a small area in the western part of the township, as shown on Figure 1. The dune and lake sands probably extend down to depths of 30 to 50 feet in most parts of the township, where they are underlain by glacial boulder clay.

All water supplies are obtained by sinking sand-points to depths between 20 and 35 feet in the surface sands. These wells are provided with windmills that pump continuously and yield fairly large supplies of water that are adequate for the range stock requirements. The water is only moderately hard and well adapted to domestic purposes, as well as for stock use.

Since the supplies available from the sands are much better than any that might be obtained at greater depths in either the underlying glacial drift, or the bedrock, no discussion of these latter deposits will be given here. The possibilities are discussed in that part of the report dealing with the municipality as a whole.

Township 18, Range 24

This township is almost entirely covered by glacial lake and Recent dune sands. The northeastern and southeastern corners of the township lie within the western edge of Great Sand hills. Lake sands cover most of the remainder of the township, with the exception of a small area of glacial till in the southwestern corner, and one of moraine in the west-central part of the township.

Water occurs in the lake and dune sands at depths between 10 and 35 feet. The sands are probably 40 or more feet thick, in places near the eastern boundary of the township, but become thinner toward the western boundary where they do not exceed 25 feet in thickness. Water supplies can be obtained in most places from the sands at depths of 10 to 35 feet. In the eastern part of the township the supplies from this source are fairly large, and easily provide range stock requirements. However, in the western sections, the supplies are smaller, and in some places fine sands are encountered that retard the flow into wells, so that the supplies are inadequate for local requirements. The water from the sand is generally only moderately hard, and of good quality for drinking, but in a few places in this township it contains high concentrations of mineral salts. The water from a 10-foot well in section 21 is reported to have a laxative effect on humans.

The glacial drift underlying the sands and exposed at the surface in the two small areas of moraine and till is composed largely of boulder clay. Isolated pockets of sand and gravel occur interspersed in the upper part of the boulder clay, which if tapped by wells will probably yield small supplies of hard, drinkable water. In areas in the western part of the township, where the lake and dune sands are absent, or too thin to be productive, residents are well advised to test for pockets of this type at depths of 30 feet or less. In places, where supplies from the sands are small due to the tendency for the fine sands to plug wells, difficulty might be experienced in sinking wells through the fine sand into the glacial drift.

A few residents in prospecting for larger supplies of water have sunk wells down to the lower part of the glacial drift. In sections 3 and 5, wells 80 and 100 feet deep, penetrated sands and gravels at elevations of approximately 2,235 feet and 2,225 feet above sea-level. The water rises in these wells to points 20 and 6 feet below the surface, and the supplies are fairly large. The water from the well on section 3 is hard and highly mineralized, and is used only for stock. The water from the well in section 5 is reported to be soft, iron-bearing, and "alkaline", but is being used for drinking. These wells may be drawing their supplies from a continuous water-bearing bed in the lower part of the glacial drift, and other wells sunk in this part of the township might yield similar supplies. In section 19 a well was drilled to a depth of 185 feet, and penetrated water-bearing sands that were too fine to yield water. A 100-foot well in section 20 yields a small supply of hard, iron-bearing water from sand in the glacial drift. The flow in this well is also retarded by the fineness of sand. The above four wells indicate that water-bearing sands and gravels will probably be encountered in the lower part of the glacial drift in practically all parts of this township, but that no certainty exists of obtaining suitable supplies of water from them. In some places the aquifers are thin and at others the fineness of the sand will greatly retard the flow of water into the well. The 185-foot well in section 19 is down to an elevation of approximately 2,215 feet, and probably reaches almost to the base of the glacial drift. The marine shales of the Bearpaw formation are believed to underlie the glacial drift of this area, but probably do not exceed 75 feet in thickness. No water can be expected from this formation, but the Belly River formation underlying it is composed mostly of beds of sand and soft sandstone, that may be water-bearing. It would be necessary to sink wells to depths probably not less than 350 feet, to reach this latter horizon. As no evidence of its productivity in this area has been obtained to date it is advisable to restrict prospecting at the present time for ground water to shallower depths.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL
MUNICIPALITY OF No. 170, SASKATCHEWAN

West of 3rd meridian — Township / Range	16 / 22	16 / 23	16 / 24	17 / 22	17 / 23	17 / 24	18 / 22	18 / 23	18 / 24	Total No. in municipality
Total No. of Wells in Township	17	13	21	6	5	30	7	9	19	127
No. of wells in bedrock	0	0	0	1	0	0	0	0	0	1
No. of wells in glacial drift	15	13	17	1	4	30	7	5	19	111
No. of wells in alluvium	2	0	4	4	1	0	0	4	0	15
Permanency of Water Supply										
No. with permanent supply	11	13	21	5	5	28	7	9	19	118
No. with intermittent supply	0	0	0	0	0	1	0	0	0	1
No. dry holes	6	0	0	1	0	1	0	0	0	8
Types of Wells										
No. of flowing artesian wells	0	0	0	0	0	0	0	0	0	0
No. of non-flowing artesian wells	0	0	2	1	0	1	0	0	2	6
No. of non-artesian wells	11	13	19	4	5	28	7	9	17	113
Quality of Water										
No. with hard water	10	13	3	4	5	25	6	9	18	93
No. with soft water	1	0	18	1	0	4	1	0	1	26
No. with salty water	0	0	0	0	0	0	0	0	0	0
No. with "alkaline" water	0	0	2	3	0	7	0	1	7	20
Depths of Wells										
No. from 0 to 50 feet deep	16	13	20	4	5	24	7	9	12	110
No. from 51 to 100 feet deep	1	0	0	0	0	6	0	0	3	10
No. from 101 to 150 feet deep	0	0	1	0	0	0	0	0	2	3
No. from 151 to 200 feet deep	0	0	0	1	0	0	0	0	2	3
No. from 201 to 500 feet deep	0	0	0	1	0	0	0	0	0	1
No. from 501 to 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
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	11	13	20	5	5	26	7	9	19	115
No. not usable for domestic purposes	0	0	1	0	0	3	0	0	0	4
No. usable for stock	11	13	20	3	5	29	7	9	19	116
No. not usable for stock	0	0	1	2	0	0	0	0	0	3
Sufficiency of Water Supply										
No. sufficient for domestic needs	8	13	21	5	5	26	7	9	15	109
No. insufficient for domestic needs	3	0	0	0	0	3	0	0	4	10
No. sufficient for stock needs	8	13	20	1	5	16	6	9	11	89
No. insufficient for stock needs	3	0	1	4	0	13	1	0	8	30

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. Resident 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.

Water from the Unconsolidated Deposits

No analyses are available of waters obtained from the unconsolidated deposits in this municipality. The following generalizations are based upon analyses of waters from similar sources in adjoining municipalities, observations made at the wells, and reports of residents using the water.

The waters obtained from the Recent dune and glacial lake sands are generally low in mineral salt content, as compared with waters obtained from sand and gravel beds in the glacial till. Analyses of waters from shallow wells in the Recent and glacial lake sands in adjoining municipalities indicate that the total solid contents of these waters are in many places less than 500 parts per million, and rarely exceed 750 parts per million. The salts present in the greatest concentration are usually calcium carbonate, magnesium carbonate, and sodium sulphate, with minor amounts of sodium carbonate and possibly magnesium sulphate. In only a few places have the magnesium sulphate or sodium sulphate been reported to be present in sufficient amounts to render the water so laxative as to be unsatisfactory for drinking. The total hardness seldom exceeds 300 parts per million and in many places the water could be classed as soft. Waters obtained from the sands in the close vicinity of "alkali" flats and sloughs contain much higher concentrations of sulphate salts, and may be distinctly laxative. In a few places in townships 17 and 18, range 24, waters of this type have been obtained from the lake sands.

The character of the glacial drift encountered within 40 feet of the surface varies considerably within small areas. Similar variations commonly occur in the quality of water from shallow wells spaced only short distances apart. The boulder clay is generally regarded as being the source of the objectionable sulphate salts present in varying amounts in waters from the drift. Hence, beds of sands and gravels that are not covered by an appreciable thickness of boulder clay yield water that is usually soft or only moderately hard, whereas waters from porous beds under 30 feet or more of boulder clay are hard and highly mineralized. Waters obtained at shallow depths in the porous moraine of this municipality, are, in most places, reported to be soft or only moderately hard. These waters probably do not contain over 1,000 parts per million of dissolved mineral salts. The sulphates of sodium and magnesium are usually present in the greatest amounts, but not in sufficient concentration to give the water a bitter taste or render it laxative. The few supplies obtained at shallow depths in the till-covered areas seem to be similar in quality to waters from the morainic deposits. At greater depths in the boulder clay the amounts of sulphate salts present in solution increase appreciably, so that from some wells the water is unfit for domestic use. The total solid contents of most of the waters from porous beds in the lower part of the drift or at the contact of the drift with the bedrock, exceed 1,500 parts per million. Sulphate salts tend to give the water a bitter taste. No waters from the drift in this municipality are, however, reported to be unfit for stock use.

Iron salts, which form red stains on kitchen utensils and containers, are commonly present in waters from the lower part of the glacial drift, but these are not present in sufficient quantities to affect the quality of the water for drinking.

Water from the Bedrock

No water is being obtained from either the Bearpaw or Belly River formations that underlie this municipality. Any seepages of water obtained from the marine shales of the Bearpaw formation would probably contain large quantities of sodium sulphate (Na_2SO_4, Glauber's salt) and sodium chloride (NaCl, common salt), and would be unfit even for stock use.

Water from the sand beds of the Belly River formation varies considerably in quality, from hard and highly mineralized to soft, and soda-bearing. In adjoining municipalities analyses have been made of waters from this formation having a total hardness of 1,500 parts per million, and containing nearly 2,000 parts per million of dissolved solids made up largely of sulphate salts of sodium, magnesium, and calcium. Other water from the same formation has a total hardness of only 300 parts per million, and a total dissolved solid content of 900 parts per million made up chiefly of sodium carbonate (Na_2CO_3), calcium carbonate ($CaCO_3$), sodium chloride ($NaCl$), and magnesium carbonate ($MgCO_3$).

The quality of the water obtained appears to vary within this range more from one locality to another than from any specific horizons in the formation. It is, therefore, impossible to predict the type of water that will be obtained from the Belly River formation, until wells are put down sufficiently deep to reach the productive horizon, and the waters are analysed.

WELL RECORDS—Rural Municipality of NO. 170, 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	NW.	1	16	22	3	Dug	41	2,400	- 39	2,361	39	2,361	Glacial sand	Medium hard	43	D, S	Sufficient supply; several other wells in quicksand--unsatisfactory.
2	NE.	1	"	"	"	Dug	23	2,400	- 18	2,382	20	2,380	Glacial sand	Slightly hard, clear		D, S	Three other wells in quicksand--abandoned.
3	SE.	2	"	"	"	Dug	60	2,400	- 39	2,361			Glacial sand	Hard, clear	48	D, S	Sufficient supply; also 6 dry holes to 25 feet in depth.
4	NE.	4	"	"	"	Bored	42	2,400	- 38	2,362	38	2,362	Glacial sand	Hard	46	S	
5	NE.	4	"	"	"	Bored	31	2,425	- 25	2,400	28	2,397	Recent sand	Fairly hard, clear	44	D, S	
6	NW.	6	"	"	"	Bored	35	2,400	- 8	2,392			Glacial sand	Hard, clear	42	S	Sufficient for local needs.
7	NE.	15	"	"	"	Bored	32	2,400	- 21	2,379			Glacial sand	Soft, clear	43	D, S	Sufficient supply.
8	NE.	35	"	"	"	Dug	13	2,400	- 9	2,391	9	2,391	Recent sand	Hard, brown colour	43	S	Sufficient this year; dugouts of similar nature used only for stock.
1	NE.	4	16	23	3	Drilled	14	2,400	- 10	2,390	10	2,390	Glacial sand	Hard, mineral, brown sediment		S	Sufficient for local needs; also similar wells on this community pasture.
2	SW.	29	"	"	"	Dug	10	2,375	- 7	2,368	7	2,368	Glacial sand	Fairly hard, clear		S	Sufficient for local needs; other similar wells.
3	NE.	34	"	"	"	Dug	15	2,350	- 8	2,342	8	2,342	Glacial sand	Fairly hard, clear	42	D, S	Sufficient supply; 4 similar sand-point wells.
4	NE.	34	"	"	"	Dug	40	2,350	- 36	2,314	36	2,314	Glacial sand	Fairly hard, clear		S	Sufficient for local needs.
1	SE.	2	16	24	3	Spring	0	2,400	0	2,400	0	2,400	Recent sand	Soft, clear		D, S	Sufficient supply.
2		10	"	"	"	Dug	5	2,370	- 1	2,369	1	2,369	Recent sand	Soft, clear		S	Sufficient for local needs; located on community pasture.
3	NE.	20	"	"	"	Dug	4	2,325	- 1	2,324	1	2,324	Glacial sand	Soft, clear	46	D, S	Sufficient supply; spring in same locality with ample water.
4	SW.	23	"	"	"	Dug	4	2,400	- 1	2,399	1	2,399	Recent sand	Soft, clear		D, S	Community pasture; springs in this locality with good supply.
5	SW.	24	"	"	"	Dug	5	2,425	- 1	2,424	1	2,424	Recent sand	Soft, clear	48	D, S	Community pasture.
6	NE.	26	"	"	"	Dug	44	2,400	- 43	2,357	43	2,357	Glacial sand	Hard, odorous, "alkaline"		D, S	Laxative; also several dry test-holes to 18 feet in depth.
7	NE.	26	"	"	"	Dug	22	2,400	- 12	2,388	12	2,388	Glacial sand	Soft, clear	45	D, S	Sufficient supply.
8	SE.	27	"	"	"	Dug	12	2,400	- 9	2,391	9	2,391	Glacial sand	Soft, clear		D, S	Sufficient supply.
9	NE.	27	"	"	"	Dug	12	2,400	- 9	2,391	9	2,391	Glacial sand	Soft, clear		D, S	Sufficient supply.
10	SW.	30	"	"	"	Bored	50	2,320	- 18	2,302	50	2,270	Glacial sand	Hard, clear		D	
11	NW.	32	"	"	"	Drilled	120	2,350	- 70	2,280	120	2,230	Glacial sand	Hard, "alkaline"	44	S	Laxative.
12	NE.	32	"	"	"	Dug	15	2,350	- 13	2,337	13	2,337	Glacial sand	Soft, clear	45	D, S	Sufficient supply.
13	NW.	34	"	"	"	Dug	15	2,400	- 11	2,389	11	2,389	Glacial sand	Soft, clear	47	D, S	Sufficient supply.
14	NE.	34	"	"	"	Dug	12	2,400	- 8	2,392	12	2,388	Glacial sand	Soft, clear	46	D	Sufficient supply.

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. 170, 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				
15	SW.	35	16	24	3	Dug	6	2,400	- 3	2,397	3	2,397	Glacial sand	Soft, clear, amber colour	44	D, S	Sufficient supply.
16	NW.	36	"	"	"	Dug	13	2,400	- 6	2,394	6	2,394	Glacial sand	Soft, clear		D, S	Insufficient supply; second similar well.
17	NE.	36	"	"	"	Dug	20	2,390	- 14	2,376	14	2,376	Glacial sand	Soft, clear	46	D, S	Just sufficient.
1	NW.	9	17	22	3		12	2,420	- 8	2,412	8	2,412	Recent sand	Fairly hard, clear		S	Sufficient for local needs; excellent supply.
2	SW.	23	"	"	"	Dug	12	2,410	- 10	2,400	10	2,400	Recent sand	Hard, clear, "alkaline"		S	Insufficient supply due to quicksand.
3	SW.	23	"	"	"	Drilled	257	2,415									Dry hole base in Bearpaw.
4	NW.	23	"	"	"	Dug	13	2,405	- 10	2,395	10	2,395	Recent sand	Hard, clear, "alkaline"		S	Insufficient supply due to quicksand.
5	SW.	24	"	"	"	Drilled	190	2,410			190	2,220	Glacial sand	Fairly soft, clear			Limited supply; can be pumped dry; waters approximately 500 sheep.
6	SE.	36	"	"	"	Dug	8	2,410	- 6	2,404	6	2,404	Recent sand	Hard, slightly "alkaline"		D, S	Limited supply due to quicksand.
1	NE.	14	17	23	3	Sand-point	17	2,345	- 9	2,336	9	2,336	Recent sand	Hard, clear		S	Sufficient for local needs.
2	NE.	16	"	"	"	Sand-point	36	2,340	- 14	2,326	14	2,326	Glacial sand	Hard, clear		S	Sufficient for local needs.
3	NE.	18	"	"	"	Sand-point	20	2,340	- 8	2,332	8	2,332	Glacial sand	Hard, clear		S	Sufficient for local needs.
4	SW.	32	"	"	"		30	2,345	- 10	2,335	10	2,335	Glacial sand	Hard, clear		S	Abundant supply.
5	SW.	34	"	"	"		38	2,340	- 15	2,325	15	2,325	Glacial sand	Hard, clear		S	Sufficient for local needs.
1	NE.	3	17	24	3	Spring							Glacial sand	Hard, "alkaline"			
2	NE.	4	"	"	"	Dug	16	2,375	- 4	2,371	4	2,371	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
3	NW.	5	"	"	"	Bored	90	2,375	- 80	2,295	80	2,295	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient supply.
4	SE.	6	"	"	"	Dug	20	2,385	- 16	2,369	16	2,369	Glacial sand	Soft, clear		D, S	Sufficient supply.
5	NW.	6	"	"	"	Bored	65	2,390	- 50	2,340	50	2,340	Glacial sand	Hard, clear, "alkaline"		D, S	Insufficient supply.
6	SE.	8	"	"	"												Dry hole in glacial drift.
7	SW.	9	"	"	"	Dug	12	2,360	- 7	2,353	7	2,353	Glacial sand	Hard, clear		D, S	Just sufficient.
8	NW.	9	"	"	"	Dug	30	2,365	- 21	2,344	21	2,344	Glacial sand	Hard, clear		D, S	Insufficient supply.
9	SE.	10	"	"	"	Dug	20	2,385	- 16	2,369	16	2,369	Glacial sand	Hard, clear		D, S	Sufficient supply.
10	NW.	10	"	"	"	Dug	12	2,395	- 7	2,388	7	2,388	Glacial sand	Hard, clear		D, S	Sufficient supply.
11	NW.	15	"	"	"	Dug	12	2,345	- 0	2,345	0	2,345	Glacial alluvium	Soft, clear		D, S	Intermittent, insufficient supply; varies from full to dry.
12	SW.	18	"	"	"	Dug	17	2,380	- 12	2,368	12	2,368	Glacial sand	Hard, clear		S	Sufficient for local needs; laxative; has bored 60-foot well--insufficient.

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. 170, 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	NE.	19	17	24	3	Bored	40	2,340	- 20	2,320	20	2,320	Glacial sand	Fairly hard, clear		D, S	Sufficient supply; another shallow seepage well of soft water.
14	NE.	20	"	"	"	Dug	22	2,420	- 17	2,403	17	2,403	Glacial sand	Hard, clear		D, S	Insufficient supply; also a 13-foot seepage well.
15	SW.	23	"	"	"	Dug	20	2,385	- 17	2,368	17	2,368	Glacial sand	Hard, clear, "alkaline"		D, S	Insufficient supply; laxative.
16	NE.	26	"	"	"		18	2,310	- 9	2,301	9	2,301	Glacial sand	Hard, clear		S	Sufficient supply.
17	NW.	27	"	"	"	Bored	28	2,315	- 15	2,300	15	2,300	Glacial sand	Hard, clear		S	Insufficient supply; also 2 shallow wells in quicksand--very slow flow.
18	NE.	28	"	"	"	Bored	60	2,345	- 40	2,305	60	2,285	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient supply; laxative.
19	NE.	30	"	"	"	Dug	15	2,305	- 13	2,292	13	2,292	Glacial sand	Hard, clear, "alkaline"	48	D, S	Slow yield; a second similar well.
20	NW.	31	"	"	"	Bored	80	2,300	- 20	2,280	20	2,280	Glacial sand	Hard, clear, iron		S	Sufficient for stock needs; another 20-foot well used for house purposes.
21	SE.	33	"	"	"	Bored	35	2,320	- 20	2,300	20	2,300	Glacial sand	Hard, clear, iron		S	Sufficient for local needs; another 12-foot well for house use.
22	NW.	33	"	"	"	Bored	88	2,300	- 60	2,240	60	2,240	Glacial sand	Fairly soft, clear		D, S	Sufficient supply.
23	NE.	34	"	"	"		15	2,315	- 5	2,310	5	2,310	Glacial sand	Soft, clear		S	Sufficient supply.
1	NW.	2	18	22	3		40	2,295					Glacial sand	Hard, clear		S	Sufficient supply.
2	SW.	7	"	"	"	Drilled	35	2,285					Glacial sand and gravel	Slightly hard, clear		S	Sufficient supply.
3	SW.	10	"	"	"	Drilled	30	2,200					Glacial sand	Hard, "alkaline"		S	Sufficient supply for local needs; but a poor yield.
4	NW.	14	"	"	"		45	2,290					Glacial sand	Hard, clear		S	Sufficient for needs.
5	SW.	19	"	"	"	Drilled	30	2,293					Glacial sand	Fairly soft, clear		S	Sufficient for local needs.
6	SW.	31	"	"	"		35	2,297					Glacial sand	Hard, clear		D, S	Sufficient for local needs.
7	SW.	32	"	"	"		35	2,303					Glacial sand	Hard, iron, reddish		S	Sufficient for local needs.
1	NW.	2	18	23	3	Sand-point	20	2,345	- 8	2,337	8	2,337	Recent sand	Hard, clear		S	Sufficient supply.
2	NE.	9	"	"	"		25	2,340	- 10	2,330	10	2,330	Recent sand	Fairly hard, slightly "alkaline", clear		S	Sufficient supply.
3	NE.	10	"	"	"	Dug	20	2,350	- 10	2,340	10	2,340	Recent sand	Hard, clear		S	Sufficient supply.
4	SE.	18	"	"	"		35	2,350	- 15	2,335	15	2,335	Glacial sand	Fairly hard, clear		D, S	Sufficient supply; also second similar well.
5	NE.	21	"	"	"	Dug	24	2,345	- 10	2,335	10	2,335	Recent sand	Hard, clear		S	
6	NE.	23	"	"	"	Dug	32	2,340	- 12	2,328	12	2,328	Glacial sand	Hard, clear		S	Sufficient supply.
7	SE.	26	"	"	"	Dug	20	2,340	- 8	2,332	8	2,332	Glacial sand	Hard, clear		S	Sufficient supply.
8	SW.	29	"	"	"		35	2,335	- 15	2,320	15	2,320	Glacial sand	Hard, clear		S	Sufficient supply.

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. 170, 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
9	SW.	35	18	23	3	Dug	32	2,350	- 10	2,340	10	2,340	Glacial sand	Hard, clear		S	Sufficient supply.
1	SW.	3	18	24	3	Bored	80	2,315	- 20	2,295	80	2,235	Glacial sand	Hard, clear, "alkaline"		S	Sufficient supply.
2	SE.	4	"	"	"	Dug	12	2,300	- 8	2,292	8	2,292	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient supply.
3	SW.	5	"	"	"	Dug	24	2,310	- 22	2,288	22	2,288	Glacial sand	Hard, clear		D, S	Insufficient supply.
4	NE.	5	"	"	"	Drilled	100	2,325	- 6	2,319	100	2,225	Glacial gravel	Soft, iron, "alkaline"		D, S	Sufficient supply.
5	NE.	9	"	"	"	Dug	20	2,325	- 16	2,309	16	2,309	Glacial sand	Fairly hard, clear		D, S	Sufficient supply.
6	NW.	10	"	"	"		12	2,320	- 8	2,312	8	2,312	Glacial sand	Hard, slightly "alkaline"		S	Sufficient supply.
7	NE.	10	"	"	"		12	2,325	- 8	2,317	8	2,317	Glacial sand	Hard, slightly "alkaline"		S	Sufficient supply.
8	SE.	12	"	"	"		30	2,348	- 10	2,338	10	2,338	Glacial sand	Fairly hard, clear		S	Sufficient supply.
9	SE.	19	"	"	"	Dug	16	2,260	- 13	2,247	13	2,247	Glacial sand	Hard, clear, slightly "alkaline"		S	Insufficient supply; second well similar characteristics for house use.
10	NW.	19	"	"	"	Drilled	185	2,310					Glacial sand				Very little water due to fine sand plugging; 3 other wells with similar conditions.
11	SE.	20	"	"	"	Bored	100	2,320	- 50	2,270	50	2,270	Glacial sand	Hard, clear, iron		S	Barely sufficient; second shallow household well.
12	SW.	21	"	"	"	Dug	10	2,320	- 7	2,313	7	2,313	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient supply; laxative.
13	NW.	30	"	"	"	Dug	12	2,350	- 10	2,340	10	2,340	Glacial sand	Hard, clear		D, S	Barely sufficient.
14	SE.	34	"	"	"		32	2,350	- 10	2,340	10	2,340	Glacial sand	Fairly hard, clear		S	Abundant supply.

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.