CANADA
DEPARTMENT OF MINES

HON. T. A. CRERAR, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF BROKENSHELL No. 68 SASKATCHEWAN

BY

B. R. MacKay, H. H. Beach & J. M. Cameron

Water Supply Paper No. 53

OTTAWA

1936

CANADA

DEPARTMENT OF MINES

BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY OF BROKENSHELL NO. 68 SASKATCHEWAN

BY

B.R. MacKAY, H.H. BEACH, and J.M CAMERON

WATER SUPPLY PAPER NO. 53

CONTENTS

Illustrations

GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY OF BROKENSHELL, NO. 68 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 analysis. 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

---

[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 Brokenshell covers an area of 324 square miles in the central part of southern Saskatchewan. The municipality consists of nine townships, described as tps. 7, 8, and 9, ranges 16, 17, and 18, W. 2nd mer. The village of Trossachs, situated near the centre of the municipality, is approximately 55 miles south and 17 miles east of Regina, and 17 miles west of Weyburn. Several railway branches traverse the area. The Lethbridge-Weyburn branch of the Canadian Pacific railway, along which are situated the villages of Yeoman, Trossachs, and Axford, passes in an east-west direction across the central part of the area. The Canadian Pacific "Soo Line" from Moose Jaw, and the Weyburn-Radville and Moose Jaw-Radville branches of the Canadian National railways extend across the northeast, southeast, and southwest corners of the area, respectively. The municipality is a plains area lying to the east of Missouri coteau. The ground surface is flat or gently rolling and is broken only by the shallow valleys of the few creeks that cross the area. The north-central part of the municipality is particularly flat and lies in the southern part of the basin of an extinct lake that many thousands of years ago occupied a large area in southeastern Saskatchewan. From an approximate elevation of 1,900 feet above sea-level in the lake basin the ground surface rises almost imperceptibly in a southwesterly direction to an elevation of 2,000 feet along the northwest-southeast diagonal of the municipality. From thence it rises slightly more rapidly to reach elevations exceeding 2,100 feet above sea- level along the western border. Brokenshell creek and a few, small, intermittently flowing tributaries drain the northern and central parts and form a swamp in the low areas in township 9, range 17.

Long creek flows in a southerly direction across the southwest corner of the area.

Sloughs and ponds fill shallow depressions in the north-central lowlands. The drought of 1930-1934 dried up many of these, and rendered the mineral salt concentration in the waters of others so high that the water was unfit even for watering stock. The streams cannot generally be depended upon as a source of stock water throughout the year. Several of the valleys, however, in the areas west of Trossachs, are sufficiently narrow and deep to form sites for the construction of shallow dams, capable of storing sufficient quantities of the spring run-off to satisfy local stock requirements for considerable periods of time. The Canadian Pacific Railway Company have constructed such a dam immediately west of Trossachs. The supply of water thus stored is sufficient for the company's requirements and for the village of Trossachs.

Ground water supplies in the municipality are derived from three sources. These are: (1) the Recent deposits of sands, silts, and gravel lying along the bottoms of Long, Brokenshell, and other smaller stream valleys; (2) the glacial drift that mantles the area; (3) water-bearing horizons in the underlying bedrock formations.

Throughout many parts of the municipality considerable difficulty has been experienced in obtaining adequate water supplies. An attempt is made in this report to direct the attention of those contemplating sinking wells to the water-bearing possibilities of the various types of deposits in the area. The areal extents and porosity of aquifers, and the nature of the supply of water to be expected are discussed. So marked has been the effect of the drought on near surface sources of supply that residents of areas in which deep drilling is not advisable must seriously consider the conservation of the surface run-off by dams and dugouts, and the collection of rainfall by eavestroughs and cisterns.

Water-bearing Horizons in the Unconsolidated Deposits

The Recent deposits occurring along the larger stream channels are thin and composed largely of fine silts and sands. Pockets of gravel occur sparingly and are usually encountered only after careful testing. Since the water is in most places drinkable, very shallow wells sunk into these deposits form an inexpensive source of water for household use. The supply, however, is not as a rule sufficient for more than a few head of stock. Three distinct types of glacial deposits are found in the area, namely, till, lake clay, and outwash sands and gravels. These deposits were laid down by a great continental ice-sheet that many thousands of years ago passed over the province of Saskatchewan, and by the waters formed from the melting ice.

The glacial outwash sands and gravels occurring in the municipality are confined to a small area extending on both sides of Long creek in the vicinity of the point where the creek leaves the municipality in sec. 2, tp. 7, range 18. Due to their porosity these deposits form excellent reservoirs for ground water. A 10-foot well sunk in this area produces a large supply of hard, drinkable water and further prospecting in the area should find similar supplies.

When the continental ice-sheet retreated from this region water resulting from the melting ice formed a large lake known as Lake Regina in the broad valley lying between Missouri coteau and the Moose Mountain highlands. Fine silts and clays were laid down in this lake, the southern tip of which extended into the north-central part of the municipality. Throughout the area a layer of 15 to 35 feet of compact, blue-grey, lake clays overlies the glacial till. The lake clays themselves are generally too compact to form aquifers for ground water accumulation. Sand beds lying between the lake clay and the underlying till are, however, generally fairly

productive. Many wells in this area have penetrated the sands at depths less than 25 feet, but in a few, isolated places it has been found necessary to sink wells to depths of 30 and even 60 feet before water was obtained. The water is invariably hard and varies in the amounts of mineral salts it contains in different parts of the area. Water from wells encountering the sands at depths less than 20 feet is suitable for domestic use, but that from the deeper wells is generally so highly mineralized as to be fit only for stock. The yields from individual wells are, on nearly all farms, sufficient for the stock requirements, but in only a few of the wells would the yield supply more than 20 to 25 head of stock.

Glacial till or boulder clay underlies the Recent deposits, the outwash gravels, and the lake clays, and covers the bedrock throughout the entire municipality. The upper part of the boulder clay weathers light yellowish brown and the lower part is bluish grey. Through it are interspersed irregular pockets and more rarely extensive beds of sands and gravels, which are generally water-bearing. The thickness of the mantle of till is believed to vary greatly over the municipality. A lack of detailed information in the logs of many of the deeper wells has made it difficult to estimate the thickness in many parts with any degree of accuracy. Over much of the southeastern corner of the municipality the till is less than 25 feet thick and probably nowhere greatly exceeds 40 feet over the southwestern half of the area. It has been penetrated to depths of 50 feet in the central part of township 8, range 16, and is believed to thicken toward the northeast corner. In the extreme northeast corner the drift is considered to have filled a valley carved into the bedrock before the advance of the ice. This pre-glacial stream channel is now completely filled and no evidence of its existence is to be found on the present ground surface. It

has been traced over a considerable distance in municipalities to the north and northwest and several deep wells give evidence, of its occurrence in this area. The "A" lines drawn on Figure 1 of the accompanying map are considered to mark the approximate northeast and southwestern edges of the channel. The drift is probably not more than 35 to 40 feet thick along the edges of the channel, but it increases in thickness as the centre of the buried valley is approached. Sand beds occurring at the contact of the bedrock shales forming the valley floor and the overlying drift are penetrated at depths between 100 and 160 feet in sec. 26, tp. 9, range 16. As in the municipalities to the north, the sand beds at or near the base of the channel produce large supplies of ground water, but the concentration of iron and sulphate salts in solution limits the use of the water to the watering of stock.

The sand and gravel pockets scattered through the boulder clay are the only sources of water supply in these deposits. In those parts of the municipality where the till is not overlain by later deposits, most wells tap pockets within 40 feet of the surface. The supplies from these wells are seriously affected by drought conditions, and generally yield a sufficient supply for the local stock needs only during wet years. The water is hard and in most places suitable for household use, particularly if obtained within 25 feet of the surface. Wells that tap pockets below 40 feet in the till, obtain water that is invariably highly mineralized and suitable only for watering stock.

Productive pockets are by no means numerous in the till and careful systematic prospecting extending over as large an area as possible is necessary in many places before an adequate water supply is obtained. Wells located at or near the bases of slopes, in coulées and even on gravel ridges, have proved to be productive

in many parts of Saskatchewan, and locations of this nature deserve the first consideration. In an area comprising most of township 7, range 17, the eastern part of township 7, range 18, and the southern part of township 7, range 16, conditions for obtaining sufficient water supplies are particularly poor and in some places it has been necessary to haul additional supplies. The boundaries of this area are shown by the "B" line on Figure 1 of the accompanying map.

Serious shortages in the ground water supplies available from the water-bearing beds in both the lake clays and the till resulted from the years of drought. It was necessary to supplement the supplies obtainable from the wells by conserving surface run-off. This is done by constructing dams in coulées and by excavating dugouts. Similar means of obtaining a supply may be used in the areas in which it is difficult to obtain well water. Such reservoirs provide a supply of water for stock requirements, and household supplies may be derived from shallow seepage wells sunk beside the reservoirs. Water from this source is generally of good quality, but care must be exercised that it does not become contaminated by sewage or decaying organic material.

Water-bearing Horizons in the Bedrock

Two bedrock formations, known as the Ravenscrag formation and the Marine Shale series, underlie the glacial drift in this municipality. The geological boundary as shown on Figure 1 of the accompanying map divides the municipality into two areas. South of this line the Ravenscrag formation immediately underlies the glacial drift and it in turn is underlain by the Marine Shale series below an approximate elevation of 1,950 feet above sea-level. North of the line the Marine Shale series is encountered immediately below the glacial drift. Due to a lack of bedrock outcrops and a paucity of deep wells in the area the position of this

line can, at best, be regarded only as approximate. It is to be noted that no evidence either for or against the occurrence of the fine sands and silts of the Eastend formation which lies between the Ravenscrag and the Marine Shale in the municipalities to the northwest has been found in this area.

The Ravenscrag formation consists of light yellowish brown clay and shales, interbedded with blue-grey sands and thin seams of lignite coal. The sands and coal seams generally contain water. This formation is a reliable source of ground water of fairly good quality in many parts of southern Saskatchewan. In this area, however, the quality of the water is poor. Sulphate salts render the water from most of the wells tapping the formation unfit for domestic use. It is nevertheless being used for watering stock on several farms with no reported ill effects. All wells struck water at an approximate elevation of 1,960 feet above sea-level. This would suggest that a fairly continuous productive horizon extends at this elevation throughout the three southern townships of the municipality. In the southeast corner several wells have tapped coal seam aquifers at depths of 10 to 20 feet, but in a westerly direction the increased elevation of the land surface necessitate deeper wells. One well, 480 feet deep, located on the NE.$\frac{1}{4}$, sec. 8, tp. 7, range 16, encountered water in coal at a depth of 140 feet at an approximate elevation of 1,900 feet above sea-level. This bed is probably at or near the base of the Ravenscrag and marks a lower productive horizon than encountered in the shallower wells. No other wells have been sunk sufficiently deep in this area to determine the areal extent of the deeper horizon. Although soft, highly mineralized water was encountered at a depth of 6 feet in a coal seam in a ravine on the SE.$\frac{1}{4}$, sec. 3, tp. 8, range 17, it is probable that throughout township 7, range 17, it will be necessary to sink wells to depths of 100 to 200 feet, depending upon the surface elevation, before water-bearing beds are found in the Ravenscrag. A well bored on the NE.$\frac{1}{4}$,

sec. 24, tp. 7, range 17, to a depth of 98 feet or an elevation of 1,960 feet, yields water suitable only for watering stock, and it is probable that water found in the Ravenscrag in other parts of this township will not be of essentially better quality. Wells must be sunk 150 to 200 feet below the surface before water can be expected from the Ravenscrag in township 7, range 18. At present, only one well, 160 feet deep, on the NE.$\frac{1}{4}$, section 9, obtains a supply from the formation. The good quality of the water from this well, however, should encourage the sinking of other wells to this horizon in the southwestern part of the municipality.

No wells have penetrated the bedrock at Axford, so that the water-bearing properties of the Ravenscrag formation can only be surmised from the conditions in the well referred to above. At Trossachs, however, the Ravenscrag formation is probably thin and any water found at depth in this area probably will resemble supplies found generally in the Marine Shale and will be highly mineralized.

The Marine Shale series is composed almost entirely of dark grey, compact shales. It is readily recognized in drilling by its almost black appearance when wet, its soapy feel to the touch, and by the small, roughly cubical, buff-coloured fragments into which it breaks upon drying. A few thin beds of sand that may be water-bearing are interspersed in the upper part of the formation. The shale itself is too compact to form a reservoir for more than very small amounts of water. The shales contain readily dissolvable mineral salts and water derived from them is generally so highly mineralized as to be unsatisfactory even for stock use. However in the area north of the geological boundary line, except in the part underlain by the buried stream channel small supplies of water suitable for stock watering may be obtained within 50 feet of the surface at the contact of the drift and the shale or in the upper part of the shale itself. At greater depths in the shales very little water will be found and it will be so highly charged with dissolved sulphate salts and common salt as to be unfit for any farm use. For this

reason extensive prospecting of the glacial drift and the conservation of surface run-off are stressed as the best possible means of satisfying the water supply requirements of the central and northern parts of the municipality.

The presence of the Marine Shale series beneath the Ravenscrag in the southern parts of the area limits the search for water in this area to the drift and to the Ravenscrag formation. It is improbable that an adequate supply of ground water will be found much below an elevation of 1,900 feet above sea-level throughout the southern townships.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 7, Range 16

Ground water in this township is derived from three sources, namely: the thin beds of Recent sands, silts, and gravels lying along the bottoms of the small stream valleys, the glacial till that covers the entire area remote from the streams, and water-bearing horizons in the underlying bedrock formations.

Small supplies of drinkable water are obtainable from wells dug to shallow depths in the silts lying along the stream channels. These wells form a constant source of household supply and may be used for watering a few head of stock for a period of time after the creek itself has ceased to flow in summer. Such a source cannot generally be depended upon, however, for watering stock throughout extended periods of drought.

The mantle of glacial till covering the township probably nowhere exceeds 40 feet in thickness. Isolated pockets of gravel and sand, generally of limited areal extent, found in the uppermost 20 feet of the till, are water-bearing. No difficulty has been experienced in this township in locating such beds, but during the drought of 1930-1934 supplies from this source seriously decreased, particularly in the southern sections. Most of the residents have been obliged to supplement their supplies, either by sinking additional wells or by constructing dugouts to conserve the rainfall. The water from the glacial till is hard, "alkaline", and in many places unfit for drinking. Shallow wells dug beside dugouts, from which they derive small supplies of water by seepage, yield on some farms a satisfactory supply for the household. In other places the irregularity with which the productive pockets occur in the drift has apparently made it immpossible to obtain an adequate supply of stock water at shallow depths, and water must be hauled from areas where water-bearing beds have been encountered.

The Ravenscrag formation underlies the drift throughout all but the northeast corner of the township. Several wells located in the centre of the area obtain sufficient water for stock from the coal seams and sand beds of the formation at depths less than 20 feet below the surface. It is probable that this formation will be found to be productive in the southern and western parts, but deeper wells will be necessary. Although water should be obtained at depths less than 60 feet in the southern sections, it will probably be necessary in the western and southwestern sections, where surface elevations are greater to sink wells 75 to 100 feet deep. One well located in the NE.$\frac{1}{4}$, section 8, derives soft water from an horizon at or near the base of the Ravenscrag at a depth of 112 feet or at an approximate elevation of 1,900 feet above sea-level. The areal extent of this horizon is not known, but the horizon is worth prospecting in the southwestern parts of the township. Water from the Ravenscrag contains large amounts of sulphate salts in solution and is unfit for domestic use but can be used for watering stock. Although prospecting in the bedrock is recommended to obtain a stock water supply, residents will be obliged to depend upon surface and near surface sources for the water for household requirements. Drilling below an elevation of 1,900 feet above sea-level in this area will encounter the Marine Shale series, from which an adequate supply of water suitable for either domestic or stock use cannot be expected. In the northeastern corner water may occur at the contact of the drift and the underlying dark shales, but it is inadvisable in this part of the area to sink wells deeper than 50 feet.

Township 7, Range 17

Ground water is derived from two sources in this township. These are: (1) the glacial till, which mantles the area to a depth of approximately 70 feet; (2) a water-bearing

horizon in the underlying Ravenscrag formation. A third possible source exists in the thin beds of Recent sands, silts, and gravels lying along the bottoms of the small stream valleys. These deposits contain small amounts of water that can be tapped by shallow wells and they form a source of household supply to farmers resident along these valleys.

The small rainfall during the past few years reduced the supplies of water obtainable from the scattered pockets of sand and gravel occurring in the glacial till. In many of the wells in the glacial drift in this township the yield is insufficient and in nearly all of them the water is so highly mineralized as to be unfit for domestic use. Consequently, few satisfactory wells exist in this township and the residents have supplemented their supplies or obtained better supplies by conservation of the rainfall either by means of dugouts or by damming the small water courses. From holes sunk beside these catchment basins, they obtain small amounts of water that can be used for the household.

The Ravenscrag formation, which underlies the glacial deposits, is usually a reliable source of ground water. However, in this township the two wells that have been sunk into it do not yield satisfactory supplies. The 98-foot well on the NE.$\frac{1}{4}$, section 24, penetrates a water-bearing coal seam in the formation at an approximate elevation of 1,960 feet above sea-level. Although unsuitable for drinking the water was reported to have been used for stock watering. This well has now caved in.

The other bedrock well located on the higher land in section 30 was bored 125 feet to tap a sand bed in the Ravenscrag at an elevation of 2,015 feet above sea-level. This well yields only a very limited supply of highly mineralized water that is

unfit for any farm use. It is very probable that had this well been drilled 45 feet deeper it would have encountered a lower coal horizon and there obtained larger supplies of better water.

Deep wells in the township to the west and in other areas in which water is derived from the Ravenscrag formation at depths greater than 100 to 150 feet show that the water from the deeper horizons is commonly of better quality than that from horizons nearer the surface. In the water from the deeper wells sodium carbonate is the chief salt present in solution. This salt may give the water a flat taste and make it unsuitable for watering plants, but the soft nature of the water makes it of excellent quality for laundry purposes, and it is more suitable for stock than the sulphate waters.

It would appear that the Ravenscrag is well worth prospecting in this area. Water is to be expected within 125 feet in the northeastern half of the township and at depths of 150 to 200 feet in the southwestern parts. Drilling much below these depths will encounter the dark shales of the Marine Shale series, from which it is improbable that water suitable for any farm use will be obtained.

Township 7, Range 18

The ground water supply of this township is derived from Recent stream deposits, the glacial till that covers the entire area remote from the stream courses, and from the underlying Ravenscrag bedrock formation.

The Recent deposits of sands, silts, and more rarely gravels are generally thin and do not form sources of large quantities of ground water. They do, however, constitute a source of household supply for farmers living along the creeks, and in years of ample rainfall shallow dug wells in the deposits would water a few head of stock.

The southern parts of sections 2 and 3 are overlain by beds of glacial outwash sands and gravels. Only one well has been

sunk in these beds, a 10-foot well dug on the SW.$\frac{1}{4}$, section 3. This well derives an adequate supply of drinkable water for all local requirements from a sand horizon. Further prospecting at shallow depths in this porous type of deposit is strongly recommended.

No great difficulty seems to have been experienced in locating productive sand and gravel beds in the glacial till in the western part of the township. Unfortunately, the successive dry years have rendered many of these beds insufficiently productive for stock needs and the rainfall must be conserved by dugouts or by damming the small water-courses. In the eastern sections the beds are harder to locate, and since their occurrence in the unsorted till follows no definite pattern, the only solution is systematic prospecting directed to cover as wide an area as possible. Water from these glacial beds is in all places highly mineralized, and in some wells the dissolved mineral salt content is so high as to make the water unfit for domestic use. Such wells are being used for watering stock, but seepage wells located beside dugouts or very shallow wells in coulées encountering gravel beds, must be depended upon for household requirements.

The Ravenscrag formation underlies the glacial till throughout the township. Two wells derive water from horizons at different elevations in this formation. A 35-foot well located on the SE.$\frac{1}{4}$, section 6, draws a large supply of water, suitable for stock watering, from the upper of these two horizons at an elevation of 2,105 feet above sea-level. The other well bored to a depth of 160 feet on the NE.$\frac{1}{4}$, section 9, derives an ample supply of drinkable water from the lower horizon at an elevation of 1,970 feet above sea-level. The water is soft and contains an

appreciable amount of sodium carbonate in solution, which gives the water a slightly flat taste. The horizon is believed to underlie the whole township, and the sinking of wells to it is recommended as a source of ground water supplies in this township. Wells should reach a productive horizon in the lower part of the Ravenscrag formation at most points in the township, within 250 feet from the surface. Drilling at any point in the township, however, should not exceed this depth as the Marine Shale series will be penetrated and from it water sufficiently low in dissolved mineral salts for farm use is not to be expected.

Township 8, Range 16

Ground water supplies in this township are derived entirely from the glacial till although another possible source exists in the beds of Recent deposits occurring along the stream valleys.

These Recent deposits of sands, silts, and gravel possibly do not greatly exceed 10 feet in thickness and contain only limited supplies of water. To residents along these valleys, however, shallow wells sunk into these deposits might yield sufficient supplies of water for their household requirements, even for a considerable time after the creeks themselves have ceased to flow. The dry years of 1930-34 made this source uncertain for a continuous household supply.

The glacial drift covering the area is largely till except in the northwest corner where the till is overlain by 10 to 25 feet of compact, blue-grey, lake clay. Due to its almost impervious nature, little water can be expected from the lake clay itself. Beds of sand, and in some places gravel, occur generally between the lake clay and the underlying boulder clay. These deposits are almost invariably water-bearing and are generally penetrated at depths not exceeding 25 feet. The water is soft to moderately hard

and in all places visited was reported to be satisfactory for drinking and in sufficient quantities for local farm requirements.

The mantle of 50 to 75 feet of till covering the remainder of the township is by no means as productive as the sands referred to above. Little difficulty has been experienced, however, in finding water-bearing sand and gravel pockets that are irregularly interspersed through the upper 25 feet of the drift. The few wells that have failed to encounter the porous beds yield small seepages of highly mineralized water. Otherwise the supplies from the drift, although "alkaline", are usable for household purposes. These shallow sources were materially affected by the drought years of 1930 to 1934 and it has been found necessary on the majority of farms to supplement the supply by digging other shallow wells and by constructing dams in coulées and excavating dugouts to conserve surface run-off.

Small supplies of ground water may be found at the contact between the glacial drift and the Marine Shale that underlies the glacial deposits throughout the entire township, except possibly the extreme southwest corner. This water will, however, probably be highly mineralized and may be unfit for drinking or even for watering stock. The 60-foot hole bored on the SE.$\frac{1}{4}$, section 21, encountered only blue clay and produced no water.

The Ravenscrag formation may extend immediately beneath the drift in the southwest corner, but it is believed to be too thin to be water-bearing. The Marine Shale bedrock in this area is almost entirely lacking in sandy beds capable of acting as reservoirs for any large supply of ground water. Residents are advised to confine their prospecting for ground water to shallow depths in the Recent and glacial deposits rather than to undertake deep drilling.

Township 8, Range 17

The Recent stream deposits, the glacial till, and to a limited extent the Ravenscrag bedrock formation, form sources of ground water in this township.

The Recent stream deposits are confined to the valley of Brokenshell creek and to the many tributary coulées occurring in the western part of the area. Shallow wells dug in these deposits form a permanent source of household supply for farms bordering the larger creeks, and some of the wells yield sufficient water for 30 head of stock or more.

Most residents of this township derive their ground water supplies from the glacial drift. The drift is composed of till or boulder clay; in the northeast corner it is overlain by glacial lake clay. In the glacial till the water is derived usually from gravel and sand pockets irregularly scattered through the uppermost 25 feet of the drift. Unfortunately the years of drought dried up the supplies of water available from these pockets, and in 1935 many of the wells yielded insufficient supplies for farm requirements. On some farms where the well supply is inadequate the surface run-off is conserved by dugouts or by damming small watercourses as a means of increasing the available water supplies. Holes sunk beside these catchment basins and obtaining from them a small amount of seepage water supply in many places the needs of the household. In the area of glacial lake clay in the northeast corner supplies of ground water are derived mainly from a sand bed 10 to 20 feet from the surface and lying between the light blue-grey lake clay and the lower boulder clay. The water from this source is usually quite suitable for drinking, but here, also, shortages of supply caused by the extended drought have necessitated conservation by dams and dugouts.

The Ravenscrag bedrock formation is believed to immediately underlie the drift throughout the southern half of the area. It is probable, however, that in the central part of the township, this formation is too thin to form a reservoir for any large supply of ground water.

A 6-foot well dug on the SE.$\frac{1}{4}$, section 3, obtains a small supply of highly mineralized, undrinkable water from a 2-inch seam of coal. This coal horizon lies in the Ravenscrag formation and possibly this or a slightly lower horizon will be encountered at depths less than 120 feet below the highest ground in the southern sections. Drilling below this depth will probably penetrate the unproductive Marine Shale series. It is improbable thatwater of satisfactory quality for domestic use will be found by deep drilling at Trossachs and little if any water can be expected by sinking wells through the drift into the shale throughout the northern half of the township. Small supplies of water may exist at the contact between the boulder clay and the shale bedrock at depths between 50 and 75 feet, in the area north of Brokenshell creek, but it will probably be too highly charged with sulphate salts in solution to be used in the household or for watering stock.

Township 8, Range 18

The entire ground water supply in this township is derived from glacial till that covers the area. Other possible sources exist in the Recent deposits along the bottoms of the stream valleys and the water-bearing horizons in the underlying Ravenscrag formation, but these have not been tested.

The Recent deposits of sands, silts, and gravels along the stream valleys contain small amounts of water which possibly would serve for the residents along the valleys as a household supply. Only shallow wells, less than 15 feet deep, would be necessary to tap this source. It is questionable, however, if such supplies would last long after the creeks had ceased to flow in summer.

In this sparsely settled township the ground water possibilities of the glacial till have been little prospected. Although most residents have been successful in locating water-bearing sand or gravel pockets in the upper 35 feet of the drift, the dry years decreased the available supplies and in 1935 few of these wells yielded adequate quantities of water for local requirements. It was necessary to resort to the excavation of dugouts or to the construction of dams on the small water courses to conserve the rainfall and obtain a water supply adequate for stock requirements. Holes sunk beside these catchment basins form the chief source of household supply on many farms. With increased precipitation these sand and gravel pockets near the surface undoubtedly would again prove to be adequate sources of water for farm use.

It is improbable, however, that deeper wells in the glacial drift would produce water sufficiently low in mineral salt content to be satisfactory for domestic purposes.

The Ravenscrag formation is believed to underlie all but the northern sections of the township. It is probable that wells sunk to depths of 150 to 200 feet in the southern third of the township will encounter a productive horizon in this formation at an approximate elevation of 1,950 feet above sea-level. The water would probably be soft and contain appreciable amounts of sodium carbonate, but should be drinkable. Should drought conditions continue, a well sunk in the southern part of this township to determine the actual condition at the horizon mentioned would be a worth-while venture. Drilling much below an elevation of 1,920 feet above sea-level would encounter the Marine Shale series from which water suitable for farm use cannot be expected. It is improbable that wells penetrating the shales beneath the 50 to 100 feet of drift that covers the northern sections will yield water fit for human or stock use.

Township 9, Range 16

The present ground water supply of this township is derived from two general horizons in the glacial till that covers the bedrock throughout the township. Another possible source of small supplies of water in wet years exists in the thin beds of Recent sands, silts, and gravels lying along the sides of the small watercourses. It is improbable, however, that these shallow deposits will yield more than enough water for household requirements during periods of the summer and autumn when the creek ceases to flow. With the exception of the area underlain by the buried stream channel in the extreme northeast corner, the covering of till throughout the township does not greatly exceed a thickness of 40 feet at any place. Only by encountering sand or gravel pockets in the upper 20 feet of the drift is a supply of water likely to be found that would be sufficiently low in dissolved mineral salts to be suitable for domestic use. Water suitable only for stock has been found at depths of 40 to 50 feet in sections 16 and 32. The supply from the well on the latter section is sufficient for 40 head of stock.

The shallow wells are readily affected by drought conditions and on many farms it has been found necessary to reserve the supply from the shallow well for drinking purposes and construct dams in coulées or excavate dugouts on the plains to conserve surface water for stock use. At other places shallow wells dug beside these reservoirs and deriving their supply by seepage, serve the households. A thin layer of lake clay overlies the till in the south-central parts and along the western boundary of the township. Wells situated in sections 5 and 9, have encountered sandy beds immediately beneath the lake clay at depths less than 20 feet. At other points in sections 16 and 19 efforts to obtain water in the underlying till have yielded only small supplies of highly "alkaline"

water that is being used only for stock. Although little water can be expected from the lake clay itself, extensive prospecting to encounter sand beds lying immediately beneath it is advisable rather than deep drilling in this part of the area. Studies in the area to the north have indicated the presence of a buried pre-glacial stream channel cut into the bedrock in the northeast corner of the area. This channel is completely filled with glacial drift so that no evidence of its existence is manifest on the present ground surface. Water-bearing beds of sand occur on the lower slopes and along the bottom of this channel between the overlying drift and the dark, grey shales comprising the underlying bedrock. The approximate boundaries of this buried channel are indicated by the "A" lines on Figure 1 of the accompanying map.

Three wells, 67, 80, and 160 feet deep, have been sunk to tap the water-bearing sand and gravel beds extending along the sides and bottom of this old stream channel. The 67- foot and 160-foot wells obtain water which, though highly mineralized and undrinkable, is in sufficient quantities in each well to water 100 head of stock. The 80-foot well obtains only a small supply of a water that has a high content of common salt. This salt content in the water is typical of supplies from the Marine Shale series and it is, therefore, possible that this well has encountered Marine Shale bedrock projecting into the stream channel. Water suitable for drinking cannot be expected at depth in the channel area, but prospecting at depths between 80 and 200 feet in this area is recommended if water for stock is required. It is improbable that this channel extends appreciably farther west than indicated, as a well was drilled to a depth of 550 feet on the SE.$\frac{1}{4}$, section 31, without obtaining water or striking more than boulder clay underlain by the Marine Shale.

The Marine Shale series underlies the entire township. It probably occurs within 40 feet of the surface over the greater part of the township and it is possible that the wells on sections 16 and 32 may have entered the shale. The surface of the bedrock lies below a depth of 160 feet in the lower part of the buried channel, but presumably rises again to within 50 feet of the surface in the extreme northeast corner of the township. The very compact nature of the shale and the large amounts of readily dissolvable mineral salts inherent in it excludes it as a source of water for any farm use in this township. Search for water in this area, except for the part underlain by the channel, should be confined to the systematic prospecting of the upper 30 feet of the drift, rather than attempting deep drilling.

Township 9, Range 17

This township lies almost entirely within the basin of the extinct glacial lake Regina. The surface water forming Buttermilk lakes and surrounding marshes was used for watering stock in years of normal precipitation. With continued drought, however, the mineral salts in solution in the water became so concentrated as to render this source of supply unfit for any farm use.

Bluish grey lake clays cover the entire township with the exception of the southwest corner which lies beyond the margin of the basin and there boulder clay is exposed at the surface. The lake clay itself is nearly impervious to the passage of ground water and cannot be regarded as a source of supply.

The lake clay probably does not exceed 25 feet in thickness at any point. It is underlain by thin beds of sands and more occasionally gravels that are water-bearing. These porous beds are in turn underlain by boulder clay, down to depths of 40 or 50 feet. The boulder clay rests upon the Marine Shale series

throughout the township. Shallow wells penetrating sand and gravel horizons yield sufficient water for 25 to 35 head of stock. The water may be slightly "alkaline", but is generally suitable for household use.

Two wells, 75 and 60 feet deep, located on the NW.$\frac{1}{4}$, and NE.$\frac{1}{4}$, section 36, respectively, obtain their supplies of water either from porous beds lying at the contact between the blue boulder clay and Marine Shale series, or from the upper part of the Marine Shale series itself. The supplies from these wells are large, but the water is so highly mineralized as to be unfit for human consumption. It is possible that supplies could be obtained in other parts of the township from a similar source, but it is advisable to prospect with test holes for productive beds under the lake clays before attempting drilling to greater depths.

Should careful testing not reveal productive beds beneath the lake clays residents are well advised to excavate dugouts or construct dams where possible. Such reservoirs if carefully made will provide a year round stock supply under conditions of normal precipitation.

Township 9, Range 18

Ground water in this township is derived from the Recent deposits lying along the bottoms of the small stream valleys and from the glacial drift that mantles the area to depths probably nowhere exceeding 60 feet.

The Recent deposits of sand, silts, and occasionally gravels in the stream valleys are generally not over 20 feet in thickness. Shallow wells sunk into these deposits can be expected to yield supplies of water in sufficient quantity for at least the household and perhaps a few head of stock. The water from this source is as a rule sufficiently low in dissolved mineral salts to be suitable for all domestic purposes.

The glacial drift is composed mainly of till, but in a small area in the northeast corner the till is overlain by 10 to 20 feet of bluish grey lake clay. The lake clay is generally too compact to yield more than very small seepages of water. Wells have tapped sand and gravel beds that occur between the lake clays and the underlying boulder clay at depths not exceeding 25 feet from the surface in the township to the east. These wells yield moderately large supplies of water.

The water derived from the glacial till comes from scattered sand and gravel pockets encountered within 20 feet of the surface. The wells have all penetrated such pockets, but since the years of drought many of the well supplies are insufficient and additional supplies for stock must be taken from the creeks. To residents at a distance from the creeks the excavation of dugouts to conserve the rainfall is recommended as a means of increasing the available water supplies. The water from both the lake clay and the glacial till is hard and highly mineralized, but only in a few places is it unfit for domestic use.

Prospecting for water in this township should be limited to the glacial drift, as the underlying dark grey bedrock shales are not considered a likely source of water supplies suitable for farm use. It is possible that a supply of water might be obtained from sand beds that occur at the contact of the boulder clay and the shale, but the quantity of mineral salts in solution would undoubtedly make the water suitable only for stock. Sinking wells deeper than 75 feet in the northeastern half of the township, or 200 feet at the highest point in the southwest corner, to obtain a supply of water for farm use, is not recommended in this township.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF BROKENSHELL, NO. 68, SASKATCHEWAN

West of 2nd meridian — Township	7	7	7	8	8	8	9	9	9	Total No. in municipality
Range	16	17	18	16	17	18	16	17	18	
Total No. of Wells in Township	31	23	48	31	47	15	38	26	15	274
No. of wells in bedrock	4	2	2	0	0	0	1	5	0	14
No. of wells in glacial drift	25	21	46	31	43	15	37	21	13	252
No. of wells in alluvium	2	0	0	0	4	0	0	0	2	8
Permanency of Water Supply										
No. with permanent supply	27	17	36	28	43	8	37	22	15	233
No. with intermittent supply	0	0	3	0	0	1	0	1	0	5
No. dry holes	4	6	9	3	4	6	1	3	0	36
Types of Wells										
No. of flowing artesian wells	0	0	0	0	0	0	0	0	0	0
No. of non-flowing artesian wells	4	1	4	0	1	1	15	10	3	39
No. of non-artesian wells	23	16	35	28	42	8	22	13	12	199
Quality of Water										
No. with hard water	17	16	32	28	33	9	37	23	15	210
No. with soft water	10	1	7	0	10	0	0	0	0	28
No. with salty water	1	0	0	0	0	0	1	0	0	2
No. with "alkaline" water	6	8	12	16	24	3	24	9	8	110
Depths of Wells										
No. from 0 to 50 feet deep	30	21	44	27	47	15	34	21	15	254
No. from 51 to 100 feet deep	0	1	2	4	0	0	2	4	0	13
No. from 101 to 150 feet deep	0	1	1	0	0	0	0	0	0	2
No. from 151 to 200 feet deep	0	0	1	0	0	0	1	1	0	3
No. from 201 to 500 feet deep	1	0	0	0	0	0	0	0	0	1
No. from 501 to 1,000 feet deep	0	0	0	0	0	0	1	0	0	1
No. over 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
How the Water is Used										
No. usable for domestic purposes	20	9	31	20	23	8	18	16	13	158
No. not usable for domestic purposes	7	8	8	8	20	1	19	7	2	80
No. usable for stock	24	12	37	24	33	8	35	20	15	208
No. not usable for stock	3	5	2	4	10	1	2	3	0	30
Sufficiency of Water Supply										
No. sufficient for domestic needs	27	17	37	28	41	9	36	22	15	232
No. insufficient for domestic needs	0	0	2	0	2	0	1	1	0	6
No. sufficient for stock needs	17	9	26	22	37	5	26	17	12	171
No. insufficient for stock needs	10	8	13	6	6	4	11	6	3	67

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 Brokenshell, No. 68, Saskatchewan

LOCATION						Depth of well, Ft.	Total dis'vd solids	HARDNESS			CONSTITUENTS AS ANALYSED						CONSTITUENTS AS CALCULATED IN ASSUMED COMBINATIONS								Source of water
No.	Qtr.	Sec.	Tp.	Rge.	Mer.			Total	Perm.	Temp.	Cl.	Alkalinity	CaO	MgO	SO_4	Na_2	Solids	$CaCO_3$	$CaSO_4$	$MgCO_3$	$MgSO_4$	Na_2CO_3	Na_2SO_4	NaCl	
1	NW.	5	7	17	2	16	1,071																		* 1
2	SE.	30	7	17	2	125	7,809												(3)		(5)	(2)	(1)	(4)	* 2

Water samples indicated thus, * 1, are from glacial drift.
Water samples indicated thus, * 2, are from bedrock, Ravenscrag formation.
Analyses are reported in parts per million; where numbers (1), (2), (3), (4), and (5), are used instead of parts per million, they represent the relative amounts in which the five main constituents are present in the water.
Hardness is the soap hardness expressed as calcium carbonate ($CaCO_3$).
Analyses Nos. 1 and 2, by Provincial Analyst, Regina.
For interpretation of this table read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

No samples of ground water were collected for analysis in this municipality. The following generalizations regarding the quality of waters from the various types of Recent and glacial deposits and from the bedrock formations are based upon two analyses made by the Provincial Analyst, Regina, upon the reports of residents, upon observations at the well sites, and upon analyses of waters from adjoining municipalities in which the character of the water-bearing deposits are similar.

Because of the generally poor quality of the ground water found in this municipality the problem of obtaining supplies suitable for household use is a very real one on many farms and to an even greater extent in the villages of the area.

The surface water in swamps and small lakes was used for a number of years for watering stock. During the recent drought period these sources greatly diminished in size and the mineral salts present in the waters became concentrated to such an extent that thewater could no longer be used. The salts present in solution are largely sulphates of sodium and magnesium. Water stored in dugouts and derived directly from precipitation is not highly mineralized. Shallow wells sunk beside dams and dugouts hence yield water suitable for drinking. Such sources, however, are easily contaminated by sewage and decaying organic matter and care must be exercised in keeping the water free from pollution.

The shallow deposits of sands, silts, and gravels lying along the stream courses yield a moderately hard water that is reported to be slightly "alkaline", but suitable for drinking. Here, again, the danger of contamination by refuse accumulating in stream courses should be guarded against.

Large variations in the character of ground waters from the glacial drift are noted throughout the region and often within small areas. One well may yield a moderately soft drinkable water, whereas another well sunk to a similar depth only a few hundred feet away may give a supply too highly charged with sulphate salts to be fit even for watering stock. It is not to be inferred, therefore, that if water of poor quality is found in one well such conditions must of necessity exist over an extensive area.

Water derived from the compact, blue-grey, lake clays is not generally suitable for drinking. Shallow wells tapping the sands and gravels lying between the lake clays and the boulder clay, is, however, of much better quality. The water is hard and in nearly all places is reported to contain sulphate salts in solution, but to be suitable for domestic use.

Much of the water found at shallow depths in the till-covered areas is of poorer quality than the supplies from the sands beneath the lake clays. The boulder clay is considered to be the main source of the mineral salts of which sodium sulphate (Glauber's salt) and magnesium sulphate (Epsom salts) are the most objectionable. In wells tapping gravel pockets at shallow depths, the water is derived by seepage from the surface and does not pass through any great thickness of boulder clay. Hence it is only slightly mineralized and in a few places is of excellent quality for domestic use. Wells deriving their supplies from pockets, and particularly small pockets, lying beneath any considerable thickness of boulder clay yield a much more highly mineralized water. Seepages from wells sunk entirely in boulder clay may have a dissolved mineral salt content so high as to prohibit the water being used even for stock.

The first analysis given on the accompanying table is of water from a 16-foot well located on the NW.$\frac{1}{4}$, sec. 5, tp. 7, range 17, and shows this water to have a total dissolved solid content of 1,071 parts per million. This water is reported to be suitable for all farm requirements. Such a total solid content may be typical of waters obtained at very shallow depths in the till-covered areas, but is much lower than that of the waters from greater depths in the boulder clay.

Water from the Bedrock

In many parts of southern Saskatchewan ground water from the Ravenscrag formation is being used for all farm requirements. In this area, however, the large amount of dissolved mineral salts in the water from this source renders it unfit generally for domestic use and in some places unsuitable for stock. Two types of water are found in the Ravenscrag formation. The wells encountering the productive beds at shallow depths in the southeastern part of the township yield a water that owes its poor taste and laxative effect to large concentrations of Glauber's salt (sodium sulphate). With increasing depth of wells, as is necessary to reach the water-bearing horizons in the southwestern part, sodium carbonate is the chief salt in solution. The second analysis given on the accompanying table is of water from a 125-foot well on the SE.$\frac{1}{4}$, sec. 30. tp. 7, range 17. This water is intermediate in composition between the sulphate and the "soda" types of water. It will be noted that sodium sulphate is dominant, with sodium carbonate ranking next in concentration of the mineral salts present in solution. The presence of calcium sulphate ($CaSO_4$) in the water contributes only to the hardness and in itself causes no distinct taste. This water has the very high total solid content of 7,809 parts per million and it is quite unfit for any farm use. It is

improbable, however, that the water found at all places in the upper part of the Ravenscrag of this area is so highly mineralized. If this well had been sunk deeper and upper flows cased off it is possible that the "soda"-bearing type of water characteristic of the lower beds of the Ravenscrag would have been found. The 160-foot well located on the NE.$\frac{1}{4}$, sec. 9, tp. 7, range 18, encountered the lower horizon in the Ravenscrag and yields a soft water containing large amounts of sodium carbonate in solution. This salt gives the water a flat taste and makes it unsuitable for watering house or garden plants, but it can be used for drinking when better supplies are not available.

Waters from the Marine Shale series are all characterized by large concentrations of sodium and magnesium sulphate and common salt. They have a decided laxative effect and a bitter, salty taste. Supplies derived from the upper few feet of the shale are being used for watering stock in some places, but with greater depths the total solid content increases greatly. Water suitable for any farm use cannot be expected at greater depths from the shale in this area.

WELL RECORDS—Rural Municipality of BROKENSHELL, NO. 68, 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.	3	7	16	2		35	2,035	- 19	2,016	20	2,015	Glacial sand	Hard, "alkaline"		D, S	Sufficient for 20 head stock.
2	NE.	8	"	"	"	Drilled	480	2,030	- 40	1,990	140	1,890	Ravenscrag sand	Hard, clear, iron, soda		S	Insufficient for local needs; several dry holes from 20 feet to 80 feet deep.
3	NE.	9	"	"	"		10	2,030					Glacial drift	Salty		N	Farm deserted.
4	NE.	9	"	"	"		20	2,000									Dry hole; 4 dry holes from 16 feet to 20 feet deep; glacial drift at base.
5	NW.	10	"	"	"	Dug	27	2,010	- 11	1,999	10	2,000	Glacial sand	Hard, clear		D, S	Sufficient for 30 head stock.
6	SE.	11	"	"	"	Dug	12	1,950	0	1,950	0	1,950	Glacial gravel	Soft, clear		D, S	Insufficient for local needs.
7	NW.	12	"	"	"	Spring		1,940	0	1,940	0	1,940	Glacial boulders	Soft, clear		S	Sufficient for 60 head stock.
8	NE.	12	"	"	"	Dug	14	1,950					Glacial clay	Soft, clear		S	Insufficient for local needs; 6 other similar wells.
9	SE.	14	"	"	"	Dug	14	1,950			5	1,945	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient only for 3 head stock.
10	SW.	15	"	"	"	Dug	11	1,960	- 5	1,955	11	1,949	Ravenscrag coal	Hard, "alkaline"		N	Not used; filled in; also a spring unfit for use.
11	NE.	16	"	"	"	Dug	19	1,960	- 13	1,947	17	1,943	Recent gravel and sand	Hard, clear		D, S	Sufficient for 30 head stock.
12	NW.	18	"	"	"	Dug	20	2,030	- 6	2,024	18	2,012	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient for local needs; not sufficient in 1931.
13	SW.	21	"	"	"	Dug	12	1,965	- 8	1,957	12	1,953	Ravenscrag coal	Hard, brown, iron, "alkaline"		S	Sufficient for local needs. Also a 50-foot seepage well for house use.
14	SE.	25	"	"	"	Dug	20	1,950					Recent sand	Hard, clear		D	Sufficient for household needs.
15	NW.	35	"	"	"	Dug	16	1,920	- 12	1,908	10	1,910	Glacial sand	Hard, clear		D, S	Sufficient for local needs; other similar wells.
16	SW.	36	"	"	"	Dug	15	1,920	- 9	1,911	5	1,915	Glacial sand and gravel	Hard, clear		D, S	Sufficient for 100 head stock; another similar well.
17	NW.	36	"	"	"	Dug	18	1,910	- 15	1,895	15	1,895	Glacial sand	Hard, clear		D, S	Sufficient for local needs; another well 14-foot deep.
18	NE.	36	"	"	"	Dug	16	1,930	- 13	1,917	13	1,917	Glacial gravel	Hard, clear		D, S	Sufficient for local needs; not sufficient in 1933.
1	NW.	5	"	"	"	Dug	16	2,100	- 12	2,088	12	2,088	Glacial gravel	Hard, clear		D, S	Insufficient for local needs. #.
2	SW.	14	"	"	"	Test-auger	40	2,100									Dry hole; several dry holes 30 feet to 40 feet ; glacial drift at base.
3	SE.	22	"	"	"	Dug	30	2,120	- 29	2,091	27	2,093	Glacial sand	Hard, clear, "alkaline"		N	Not used; nearly dry.
4	NW.	23	"	"	"	Dug	40	2,125	- 31	2,094			Glacial sand	Hard, clear, "alkaline"		S	Water is too "alkaline" and is only used for stock in dry years.
5	SW.	23	"	"	"	Dug	9	2,120	- 7	2,113			Glacial clay	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
6	NE.	24	"	"	"	Bored	98	2,040	- 48	1,992	80	1,960	Ravenscrag coal	Hard, clear, "alkaline"		S	Was sufficient but caved in; a shallow seepage well used for house.
7	SW.	24	"	"	"	Dug	32	2,100	- 28	2,072			Glacial sand	Hard, clear, "alkaline"		S	Sufficient for local needs; 2 other wells 16 feet deep.
8	NE.	26	"	"	"	Dug	15	2,040	- 13	2,027	15	2,025	Glacial sand	Hard, clear		D	Sufficient for household needs; another well 20 feet deep used for stock.

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 BROKENSHELL, NO. 68, 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.	28	7	17	2	Dug	6	2,135					Glacial drift				Farm deserted.
10	SE.	30	"	"	"	Bored	125	2,140					Ravenscrag sand	Hard, clear, "alkaline"		N	Unfit for use; also a seepage well near dugout-#.
11	NE.	31	"	"	"	Dug	40	2,135	− 25	2,110			Glacial clay	Hard, clear		S	Insufficient for local needs.
12	SE.	34	"	"	"	Dug	22	2,055	− 2	2,053	14	2,041	Glacial drift	Soft, clear		D	Sufficient only in wet years.
13	NE.	35	"	"	"	Spring		2,025	0	2,025	0	2,025	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
1	SE.	1	7	18	2	Dug	35	2,135	− 30	2,105			Glacial drift	Hard, clear, "alkaline"		D, S	Was sufficient, but filled in now.
2	NE.	1	"	"	"	Bored	110	2,140									Dry hole; another 80-foot dry hole; glacial drift at base.
3	NE.	2	"	"	"	Dug	30	2,100	− 28	2,072	28	2,072	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient, but not in dry years.
4	SW.	3	"	"	"	Dug	10	2,090	− 4	2,086	4	2,086	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
5	SW.	4	"	"	"	Dug	42	2,110	− 16	2,094			Glacial drift	Hard, clear, "alkaline"		S	Sufficient for local needs; also another well 22 feet deep.
6	SE.	6	"	"	"	Bored	35	2,140	− 25	2,115	35	2,105	Ravenscrag coal	Hard, rusty, iron, "alkaline"		S	Sufficient, but unfit for use. Also 3 other wells with intermittent supply.
7	NE.	6	"	"	"	Dug	30	2,140					Glacial drift	Hard, clear, soda		S	Sufficient for local needs; another well 20 feet deep.
8	NW.	6	"	"	"	Dug	20	2,190					Glacial gravel	Hard, clear		D	Insufficient for local needs; several other wells, but unfit for use.
9	NW.	8	"	"	"	Dug	10	2,125	− 7	2,118	4	2,121	Glacial sand and gravel	Hard, clear		D, S	Sufficient for local needs.
10	NE.	8	"	"	"	Dug	16	2,135	− 10	2,125	16	2,119	Glacial sand	Hard, clear		D, S	Sufficient for local needs; also another similar well.
11	SW.	9	"	"	"	Dug	30	2,090	− 27	2,063			Glacial clay	Soft, clear		D, S	Insufficient for local needs.
12	NE.	9	"	"	"	Drilled	160	2,120	− 30	2,090	150	1,970	Ravenscrag sand	Soft, clear, soda		D, S	Sufficient for local needs.
13	SE.	10	"	"	"	Dug	15	2,080	− 8	2,072	8	2,072	Glacial gravel	Hard, clear		D	Sufficient for local needs.
14	NE.	12	"	"	"	Dug	20	2,095	− 16	2,079	16	2,079	Glacial gravel	Hard, clear		D, S	Sufficient for local needs.
15	NE.	16	"	"	"	Dug	24	2,090	− 2	2,088	24	2,066	Glacial sand and gravel	Hard, clear, "alkaline"		S	Sufficient for local needs.
16	SE.	17	"	"	"	Dug	20	2,140	− 16	2,124	16	2,124	Glacial sand	Soft, clear		D, S	Sufficient for local needs; 2 other similar wells.
17	NE.	17	"	"	"	Dug	30	2,110	− 27	2,083	27	2,083	Glacial sand	Hard, clear		D, S	Insufficient; enough for house; another well 12 feet deep used for stock.
18	SE.	18	"	"	"	Dug	14	2,100	− 11	2,089	11	2,089	Glacial sand	Hard, clear		D, S	Sufficient for local needs; another similar well.
19	SW.	18	"	"	"	Dug	25	2,150					Glacial drift	Hard, clear, "alkaline"		N	Unfit for use.
20	SW.	20	"	"	"	Dug	30	2,110	− 26	2,084	26	2,084	Glacial sand	Hard, clear		D, S	Sufficient for local needs; another well 18 feet deep used for household needs.
21	NW.	20	"	"	"	Dug	25	2,100	− 23	2,077	23	2,077	Glacial sand	Soft, clear		D	Sufficient for household needs only.

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 BROKENSHELL, NO. 68, 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
22	NE.	20	7	18	2	Dug	20	2,120	- 17	2,103	17	2,103	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
23	SW.	21	"	"	"	Dug	20	2,110									Several dry holes 15 to 20 feet deep; glacial drift to base.
24	SW.	22	"	"	"	Dug	43	2,090	- 38	2,052	38	2,052	Glacial sand	Hard, clear, iron		D, S	Sufficient for local needs.
25	SW.	28	"	"	"	Dug	40	2,090	- 32	2,058	32	2,058	Glacial sand	Hard, clear		D, S	Insufficient for local needs.
26	NW.	32	"	"	"	Bored	30	2,125	- 18	2,107	18	2,107	Glacial sand	Hard, iron, reddish, "alkaline"		D, S	Sufficient for local needs.
27	SE.	33	"	"	"	Dug	20	2,125	- 6	2,119			Glacial fine sand	Hard, clear		D	Sufficient for household needs.
28	NW.	34	"	"	"	Dug	20	2,130					Glacial sand	Hard, clear		D	Sufficient for household needs.
29	NE.	34	"	"	"	Bored	55	2,120									Dry hole; glacial drift at base.
30	NW.	36	"	"	"	Dug	20	2,130	- 5	2,125	5	2,125	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
1	SE.	2	8	16	2	Dug	16	1,910	- 13	1,897	13	1,897	Glacial sand	Hard, clear		D	Sufficient for household needs; also another well 18 feet deep used for stock.
2	NW	2	"	"	"	Dug	25	1,910					Glacial drift	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
3	SW.	3	"	"	"	Dug	16	1,930	- 14	1,916	14	1,916	Glacial gravel	Hard, clear		D, S	Sufficient for local needs; another similar well.
4	NW.	5	"	"	"	Dug	17	1,960	- 5	1,955	11	1,949	Glacial sand	Hard, clear		D, S	Sufficient for 120 head stock.
5	SW.	9	"	"	"	Dug	12	1,920	- 9	1,911	9	1,911	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient for local needs; 2 other similar wells.
6	NW.	11	"	"	"	Dug	18	1,915	- 12	1,903	12	1,903	Glacial sand	Hard, clear		D, S	Insufficient for local needs; 3 other similar wells.
7	SW.	16	"	"	"	Dug	18	1,940	- 15	1,925	15	1,925	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient for 30 head stock.
8	NE.	18	"	"	"	Dug	25	1,912	- 10	1,902			Glacial clay	Hard, milky, "alkaline"		N	Too "alkaline" for use; 3 other similar wells.
9	SE.	20	"	"	"	Dug	20	1,905	- 12	1,893	12	1,893	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient for local needs; two other similar wells.
10	NW.	20	"	"	"	Dug	20	1,970	- 18	1,952	19	1,951	Glacial sand	Hard, clear, "alkaline"		S	Sufficient for local needs.
11	SE.	21	"	"	"	Bored	60	1,925									3 dry holes; glacial blue clay at base.
12	SE.	28	"	"	"	Dug	22	1,910	- 18	1,892	18	1,892	Glacial sand and gravel	Hard, clear		D, S	Sufficient for 8 head stock.
13	NE.	31	"	"	"	Dug	22	1,910	- 16	1,894	16	1,894	Glacial sand and gravel	Hard, clear		D, S	Sufficient for local needs.
14	NW.	34	"	"	"	Bored	60	1,910	- 50	1,860	50	1,860	Glacial sand	Hard, clear, "alkaline"		S	Sufficient for local needs; another well 16 feet deep used for household needs.
15	NW.	35	"	"	"	Dug	30	1,910					Glacial sand	Hard, clear, "alkaline"		S	Sufficient for local needs.
16	SW.	36	"	"	"	Bored	40	1,885					Glacial sand	Hard, clear, "alkaline"		D, S	
1	SW.	2	8	17	2	Dug	25	1,920	- 15	1,905			Glacial clay	Soft, clear		D, S	Sufficient for local needs; another well 10 feet deep used for stock needs.
2	SE.	3	"	"	"	Dug	16	1,920	- 8	1,912	8	1,912	Glacial gravel	Hard, clear		D, S	Sufficient for local needs. Another 12-foot well

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 BROKENSHELL, NO. 68, 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
3	SW.	4	8	17	2	Dug	12	2,070	− 9	2,061			Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
4	NE.	5	"	"	"	Dug	10	2,080	− 7	2,073	7	2,073	Recent sand	Hard, clear		D, S	Sufficient for 30 head stock.
5	NE.	6	"	"	"	Dug	12	2,110	− 4	2,106	4	2,106	Recent sand	Hard, clear		D, S	Sufficient for local needs.
6	SE.	8	"	"	"	Dug	12	2,020					Recent sand	Hard, clear		D	Sufficient for local needs.
7	NE.	10	"	"	"	Dug	25	1,995					Glacial clay	Hard, clear, "alkaline"		N	Too "alkaline" for use; several similar well.
8	SW.	12	"	"	"	Dug	16	1,925					Glacial clay	Hard, "alkaline"		N	Too "alkaline" for use; several similar wells from 14 feet to 1[illegible] feet deep.
9	SW.	14	"	"	"	Dug	30	2,000	0	2,000			Glacial clay	Soft, clear		S	Insufficient for local needs; also 3 dry holes 30 feet deep.
10	NW.	14	"	"	"	Dug	16	1,960	− 13	1,947	13	1,947	Glacial gravel	Soft, clear		D, S	Sufficient for local needs; 3 other similar wells; also a 13-foot dry hole.
11	SE.	15	"	"	"	Dug	13	1,990	− 8	1,[illegible]32	8	1,982	Glacial drift	Hard, "alkaline"		N	Strong supply.
12	NE.	15	"	"	"	Dug	16	1,985					Recent sand	Soft, clear		I	Sufficient for household needs.
13	SE.	22	"	"	"	Dug	24	1,975	− 10	1,965			Glacial clay	Soft, clear		D, S	Sufficient for local needs.
14	SE.	24	"	"	"	Dug	16	1,960	− 13	1,947			Glacial clay	Soft, clear		D, S	Sufficient for local needs in wet years.
15	SE.	25	"	"	"	Dug	18	1,960	− 12	1,948	12	1,948	Glacial sand and gravel	Hard, clear		D, S	Insufficient for local needs; also an 18-foot well used for stock; several dry holes 16 feet to 18 feet deep.
16	NW.	26	"	"	"	Dug	12	1,940	− 9	1,931	11	1,929	Glacial sand	Hard, clear		D	Sufficient for house needs in wet years.
17	SE.	27	"	"	"	Dug	16	1,940	− 12	1,928	12	1,928	Glacial sand	Hard, clear, "alkaline"		D, S	Insufficient for local needs.
18	SW.	30	"	"	"	Dug	13	2,005	− 9	1,996	12	1,993	Glacial sand and gravel	Hard, clear, "alkaline"		D, S	Sufficient for 20 head stock.
19	SW.	32	"	"	"	Dug	14	1,970					Glacial clay	Hard, clear, "alkaline"		D, S	
20	NE.	33	"	"	"	Dug	11	1,970	− 6	1,964	6	1,964	Glacial red sand	Hard, clear, "alkaline"		D, S	Was sufficient; but filled in now.
21	NW.	34	"	"	"	Dug	20	1,940	− 8	1,932	10	1,930	Glacial gravel	Hard, clear		D, S	Sufficient for local needs; also another similar well.
22	NE.	34	"	"	"	Bored	12	1,920	− 6	1,914	10	1,910	Glacial sand	Hard, clear		D	Sufficient forhousehold needs in wet seasons; another well 12 feet deep used for stock.
23	SW.	36	"	"	"	Dug	16	1,930	− 11	1,919	11	1,919	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient for local needs; another similar well.
1	NE.	2	8	18	2	Dug	20	2,130	− 10	2,120	10	2,120	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
2	SE.	4	"	"	"	Dug	15	2,130	− 10	2,120			Glacial clay	Hard, clear		D	Sufficient for household needs only.
3	SW.	7	"	"	"	Dug	32	2,110	− 20	2,090	20	2,090	Glacial gravel	Hard, clear, "alkaline"		N	Too "alkaline" for use.
4	SW.	12	"	"	"	Dug	18	2,130					Glacial sandy clay	Hard, clear		D	Sufficient for household needs only.
5	SE.	14	"	"	"	Dug	18	2,115	− 6	2,109	6	2,109	Glacial sand	Hard, clear		D, S	Sufficient for local needs.

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

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

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
6	SW.	17	8	18	2	Dug	12	2,120					Glacial clay	Hard, clear, "alkaline"		D	Sufficient for household needs only.
7	SE.	19	"	"	"	Bored	35	2,150									Dry hole; glacial blue clay at base; also 5 wells with a poor supply of highly mineralized water.
8	SE.	30	"	"	"	Dug	22	2,130	− 18	2,112	18	2,112	Glacial sand	Hard, clear		D, S	Insufficient for needs in dry years.
9	NW.	30	"	"	"	Dug	20	2,135	− 8	2,127	8	2,127	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient for household needs.
10	NE.	34	"	"	"	Dug	14	2,065	− 6	2,059	10	2,055	Glacial sand and gravel	Hard, clear		D, S	Sufficient for 10 head stockin winter.
1	SW.	2	9	16	2	Dug	20	1,900	− 12	1,888	12	1,888	Glacial clay	Hard, clear, "alkaline"	42	D, S	Sufficient for 8 head stock.
2	NE.	3	"	"	"	Bored	34	1,900	− 18	1,882	34	1,866	Glacial sand and gravel	Hard, clear, "alkaline"		S	Sufficient for local needs.
3	SE.	5	"	"	"	Dug	14	1,900	− 7	1,893	7	1,893	Glacial clay	Hard, clear, "alkaline"	45	D	Another similar well used for stock.
4	NE.	9	"	"	"	Dug	20	1,900	− 10	1,890	10	1,890	Glacial clay	Hard, clear, "alkaline"	48	D, S	Sufficient for 12 head stock.
5	S½.	11	"	"	"	Dug	20	1,900	− 14	1,886	20	1,880	Glacial sand	Hard, "alkaline"		D, S	Sufficient for local needs.
6	SE.	12	"	"	"	Dug	20	1,900	− 16	1,884	20	1,880	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for 10 head stock.
7	NE.	12	"	"	"	Dug	30	1,900	− 10	1,890	26	1,874	Glacial gravel	Hard, clear, sulphur	42	D, S	Sufficient for 10 head stock.
8	SW.	13	"	"	"	Dug	18	1,900	− 8	1,892			Glacial sand	Hard, clear, "alkaline"	43	S	Sufficient for local needs.
9	NE.	13	"	"	"	Dug	28	1,900					Glacial clay	Hard, clear	40	D	Insufficient for local needs.
10	SE.	14	"	"	"	Bored	30	1,900	− 12	1,888	30	1,870	Glacial sand and gravel	Hard, clear	42	D, S	Oversufficient for 10 head stock.
11	NW.	14	"	"	"	Dug	14	1,900	− 10	1,890			Glacial clay	Hard, clear	45	D, S	Sufficient for household needs; another similar well 16 feet deep.
12	NE.	14	"	"	"	Dug	14	1,900	− 9	1,891			Glacial yellow clay	Hard, clear		D	Sufficient for household needs; another well 22 feet deep used for stock.
13	NW.	16	"	"	"	Dug	39	1,900	− 8	1,892	39	1,861	Glacial sand	Hard, "alkaline"		D, S	Sufficient for 50 head stock.
14	SW.	16	"	"	"		27	1,900					Glacial drift	Hard, clear, "alkaline"		D, S	Also another well 23 feet deep.
15	NW.	19	"	"	"	Dug	30	1,900	− 26	1,874	26	1,874	Glacial sand	Hard, clear, "alkaline"		S	Insufficient for local needs; another similar well.
16	NE.	20	"	"	"	Dug	20	1,900	− 7	1,893	19	1,881	Glacial gravel	Hard, clear	42	D, S	Sufficient for 10 head stock; also a 14-foot well used for stock.
17	NW.	21	"	"	"	Dug	26	1,900	− 12	1,888	26	1,874	Glacial gravel	Hard, clear, "alkaline"		S	Sufficient for local needs; another similar well.
18	SE.	24	"	"	"	Bored	28	1,900	− 16	1,884			Glacial sand	Hard, clear,	45	S	Sufficient for local needs.
19	SW.	24	"	"	"	Dug	14	1,900	− 11	1,889	11	1,889	Glacial sand	Hard, clear, "alkaline"	43	D, S	Sufficient for local needs.
20	SW.	26	"	"	"	Bored	160	1,900	− 80	1,820	160	1,740	Glacial blue clay	Hard, rusty, iron, "alkaline"		S	Sufficient for 100 head stock.
21	SW.	28	"	"	"	Dug	32	1,900	− 18	1,882			Glacial yellow clay	Hard, "alkaline"		N	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

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
22	NE.	29	9	16	2	Dug	35	1,900	− 20	1,880	35	1,865	Glacial sand	Hard, clear, "alkaline"	45	D, S	Sufficient for10 head stock.
23	SW.	31	"	"	"	Drilled	550	1,900									Dry hole; Marine Shale at base.
24	SW.	31	"	"	"	Dug	28	1,900	− 12	1,888	28	1,872	Glacial gravel	Hard, clear, "alkaline"	42	N	Insufficient and unfit for use.
25	NW.	32	"	"	"	Bored	47	1,900	− 21	1,879	47	1,853	Glacial sand	Hard, clear, iron	45	S	Sufficient for 40 head stock.
26	SE.	34	"	"	"	Bored	80	1,900	− 77	1,823	77	1,823	Glacial clay	Salty, clear, "alkaline"		S	Insufficient for local needs.
27	SW.	35	"	"	"	Dug	18	1,900	− 10	1,890	17	1,883	Glacial sand	Hard, "alkaline"	42	D, S	Sufficient for local needs.
28	NE.	36	"	"	"	Dug	26	1,900	− 19	1,881	26	1,874	Glacial gravel	Hard, "alkaline"		D, S	Sufficient for 30 head stock.
29	NW.	36	"	"	"	Bored	67	1,900	− 30	1,870	67	1,833	Glacial grey sand	Hard, iron		S	Sufficient for local needs.
1	SE.	1	9	17	2	Dug	13	1,900	− 14	1,886	14	1,886	Glacial sand	Hard, "alkaline"		D, S	Sufficient for local needs.
2	SW.	2	"	"	"	Dug	16	1,900	− 10	1,890	16	1,884	Glacial sand	Hard		D, S	Sufficient for local needs.
3	SE.	3	"	"	"	Dug	18	1,925	− 16	1,909	16	1,909	Glacial sand	Hard, clear, iron, "alkaline"		D, S	Insufficient for local needs; also another well 12 feet deep.
4	SW.	4	"	"	"	Dug	10	1,935	− 8	1,927	8	1,927	Glacial clay and sand	Hard, clear, "alkaline"		D	Sufficient for house needs.
5	E½.	9	"	"	"	Dug	7	1,940	− 2	1,938	2	1,940	Glacial sand and gravel	Hard, clear		D, S	Sufficient for local needs.
6	SE.	10	"	"	"	Dug	20	1,900	− 2	1,898	2	1,898	Glacial sand and clay	Hard		D, S	Sufficient for 37 head stock in dry years.
7	NE.	12	"	"	"	Dug	12	1,900	− 7	1,893	7	1,893	Glacial clay	Hard, clear	45	D	Sufficient for house needs only; 2 other wells 20 feet deep.
8	S½.	14	"	"	"	Dug	20	1,900	− 16	1,884	20	1,880	Glacial gravel	Hard, clear, "alkaline"	45	S	Sufficient for local needs; also a 12-foot well used for household needs.
9	SE.	15	"	"	"	Dug	15	1,900	− 9	1,891	15	1,885	Glacial red, sandy clay	Hard, clear, "alkaline"	42	D, S	Sufficient for 25 head stock.
10	NW.	16	"	"	"	Dug	16	1,900	− 12	1,888	16	1,884	Glacial sand	Hard, clear, "alkaline"		S	Sufficient for local needs; another well with intermittent supply.
11	NW.	18	"	"	"	Dug	14	1,950	− 6	1,944	6	1,944	Glacial sand and clay	Hard		D	Sufficient for household needs.
12	SW.	19	"	"	"	Dug	20	1,925	− 12	1,913	12	1,913	Glacial clay	Hard, clear, "alkaline"	42	D, S	Sufficient for 25 head stock.
13	NE.	25	"	"	"	Dug	25	1,900	− 20	1,880	20	1,880	Glacial sand	Hard, clear, "alkaline"	42	N	Water is never used.
14	NE.	31	"	"	"	Dug	27	1,900	− 19	1,881	27	1,873	Glacial clay and sand	Hard, clear	45	D, S	Sufficient for local needs.
15	SE.	32	"	"	"	Bored	30	1,900	− 26	1,874	30	1,870	Glacial sand	Hard, clear	43	D, S	Sufficient for local needs.
16	SE.	36	"	"	"	Dug	18	1,900	− 15	1,885	18	1,882	Glacial sand and gravel	Hard, clear	44	D, S	Sufficient for 20 head stock.
17	NE.	36	"	"	"	Bored	60	1,900	− 35	1,865	60	1,840	Marine Shale blue clay	Hard, iron, soda		N	Good supply; not used.
18	NW.	36	"	"	"	Drilled	75	1,900	− 35	1,865	55	1,845	Marine Shale sand	Hard, iron, "alkaline", clear		S	Sufficient for local needs; also 3 dry holes to a depth of 200 feet.

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 BROKENSHELL, NO. 68, 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	SW.	2	9	18	2	Dug	16	2,000	− 11	1,989	11	1,989	Glacial sand	Hard, clear		D, S	Sufficient for local needs.
2	SW.	5	"	"	"	Dug	16	2,100	− 10	2,090	10	2,090	Glacial sand	Hard, clear	45	D, S	Sufficient for local needs.
3	NE.	14	"	"	"	Dug	12	1,900	− 10	1,890	10	1,890	Glacial sand	Hard, clear, iron	45	D, S	Sufficient for 5 head stock.
4	SE.	18	"	"	"	Dug	16	2,075	− 8	2,067	8	2,067	Glacial sand	Hard, clear, "alkaline"	45	S	Sufficient for 25 head stock; another well 10 feet deep used for domestic needs.
5	SW.	20	"	"	"	Dug	13	2,000	− 6	1,994	10	1,990	Glacial sand	Hard, clear, "alkaline"		D, S	
6	SE.	22	"	"	"	Dug	13	1,950	− 8	1,942	13	1,937	Glacial sand	Hard, "alkaline"		D, S	Sufficient for 250 head stock; 3 other similar wells.
7	NW.	27	"	"	"	Dug	9	1,940					Recent stream gravels	Hard, clear		D, S	Sufficient for local needs.
8	NE.	35	"	"	"	Dug	16	1,925	− 10	1,915	16	1,909	Glacial sand	Hard, clear, "alkaline"	44	S	Sufficient for 100 head stock winter 1934-5; another well 28 feet deep.
9	NW.	36	"	"	"	Dug	22	1,900	− 10	1,890	22	1,878	Glacial sand	Hard, clear, iron	42	D, S	Sufficient for 30 head stock.

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.