MC 82 + 8C21x

This document was produced by scanning the original publication.

Ce document est le produit d'une numérisation par balayage de la publication originale.

CANADA
DEPARTMENT OF MINES
AND
TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 196

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF BEAVER NO. 276 SASKATCHEWAN

By

B. R. MacKay, H. N. Hainstock & G. L. Scott

DISCARD
ELIMINER

LIBRARY
NATIONAL MUSEUM
OF CANADA

OTTAWA
1936

CANADA

DEPARTMENT OF MINES

BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY OF BEAVER NO. 276 SASKATCHEWAN

BY

B.R. MacKAY, H.N. HAINSTOCK, G.L. SCOTT

WATER SUPPLY PAPER NO. 196

CONTENTS

	Page
Introduction	1
Glossary of terms used	5
Names and descriptions of geological formations referred to	8
Water-bearing horizons of the municipality	10
Water-bearing horizons in the unconsolidated deposits	11
Water-bearing horizons in the bedrock	14
Ground water conditions by townships:	
Township 28, Range 10, west of 2nd meridian	15
Township 28, Range 11, " " " "	16
Township 28, Range 12, " " " "	18
Township 29, Range 10, " " " "	19
Township 29, Range 11, " " " "	21
Township 29, Range 12, " " " "	23
Township 30, Range 10, " " " "	25
Township 30, Range 11, " " " "	27
Township 30, Range 12, " " " "	30
Statistical summary of well information	33
Analyses and quality of water	34
General statement	34
Table of analyses of water samples	38
Water from the unconsolidated deposits	39
Water from the bedrock	40
Well records	41

Illustrations

Map of the municipality.

Figure 1. Map showing surface and bedrock geology that affect the ground water supply.

Figure 2. Map showing relief and the location and types of wells.

GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY OF BEAVER, NO. 276, SASKATCHEWAN

INTRODUCTION

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

Publication of Results

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

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

How to Use the Report

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

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

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

---

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

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

GLOSSARY OF TERMS USED

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

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

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

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

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

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

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

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

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 rests upon the Ravenscrag or older formations. The formation is 30 to 125 feet thick.

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

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

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

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

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

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

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

WATER-BEARING HORIZONS OF THE MUNICIPALITY

The rural municipality of Beaver, No. 276, comprises an area of 324 square miles in eastern Saskatchewan. It consists of tps. 28, 29, and 30, ranges 10, 11, and 12, W. 2nd mer. The Winnipeg-Edmonton line of the Canadian Pacific railway traverses part of the northern 2 miles of the municipality, and on it are located the town of Foam Lake, the hamlet of Tuffnell, and the sidings of Goudie and Herrick. A branch line of the Canadian Pacific railway runs north from Goudie to Nipawin, and another branch line runs south-west from Herrick to Wishart. On this latter line are located the hamlets of Edmore and West Bend. The centre of the municipality is 48 miles northwest of Yorkton.

The greater part of the southern half of the municipality is covered by moraine. An area to the west of Milligan creek and another to the south of Ebel creek, both approximately 9 miles long and 2 miles wide, are also covered with moraine. The remainder of the municipality is mantled by glacial till. The elevation decreases gradually from 2,200 feet above sea-level at the southwestern corner of the municipality to 1,800 feet at the northeastern corner. The ground surface of the moraine-covered areas is rough and rolling, and is characterized by low hills and large, undrained depressions. Sloughs and long, shallow draws are very common. The land surface of the till plain is slightly undulating and in some districts is quite flat. Except for township 30, range 12, and other smaller areas, the municipality is wooded with poplar and willow.

The eastern 8 miles of the municipality are drained by several, small, intermittent streams, the largest of which is Ebel creek which flows eastward into Whitesand river. The remainder of the municipality is drained by Milligan creek, Beevar brook, Beckett brook, and several, small tributary streams. These streams flow in a general northerly direction and empty into Foam lake in

the rural municipality of Foam Lake. All of the creeks in the municipality are intermittent and they are usually dry by midsummer. A few small lakes, the largest of which is Horse lake, are scattered throughout the municipality.

Water-bearing Horizons in the Unconsolidated Deposits

The supply of water from wells in the southern 6 miles of the municipality, and in the southern 2 miles of township 29, range 10, is poor. In the remainder of the municipality water supplies are very good. Approximately 140 farms in the municipality have a shortage of water and 66 of these are located in townships 28, ranges 11 and 12. Many farmers in the southern part of the municipality depend entirely on surface water from seepage wells and sloughs. Snow is melted in winter by some farmers and others haul water. Horse lake, in the southern part of townships 28, ranges 11 and 12, is one of the main sources from which water is tanked. Surface water from creeks and sloughs is also used for stock in the northern townships, not because of a shortage of water from wells but because it is convenient. Flowing springs are quite numerous in the ravines that contain Milligan creek and its tributaries and along Beevar brook and Beckett brook. Some springs, such as one in the SE. $\frac{1}{4}$, sec. 12, tp. 30, range 12, yield abundant supplies of water, whereas others yield small and occasionally intermittent supplies. The water from the springs is hard and much of it contains iron, but it is drinkable.

The producing wells in the municipality range from 4 to 130 feet deep and tap aquifers in the glacial drift. Some wells have been bored and drilled to a maximum depth of 282 feet, but they are either dry holes, or obtain only small supplies of water from aquifers at depths less than 130 feet. As an example, a 180-foot well in the NW. $\frac{1}{4}$, sec. 35, tp. 28, range 12, obtains a paltry supply of water from an aquifer 20 feet below the surface.

Most of the wells in the municipality have been dug by hand to depths less than 35 feet. Water-bearing pockets of sand and gravel are very difficult to locate in the upper 125 feet of the glacial drift in the three southern townships, and many dry holes have been made in this district. Nearly all the wells that have struck water-bearing pockets of sand and gravel in these three townships are less than 35 feet deep. Very few of these wells yield abundant supplies of water. One well dug for a school in the NE. $\frac{1}{4}$, sec. 18, tp. 28, range 10, struck a large lens of sand 20 feet below the surface. The supply of water obtained is abundant, and many farmers in the district haul water from this well. Only five wells in the three southern townships and the southern 2 miles of township 29, range 10, have struck pockets of sand and gravel, in the glacial drift, that yield water under pressure. These wells are 38 to 82 feet deep and they are all located in township 28, range 12. The deepest well in the municipality was drilled in the SE. $\frac{1}{4}$, sec. 22, tp. 28, range 12. This well is 282 feet deep and the material penetrated was almost entirely blue boulder clay. No water was obtained.

In the remainder of the municipality very little difficulty is experienced in obtaining adequate, and in many places over-sufficient, supplies of water at depths of 4 to 130 feet in the glacial drift. Abundant supplies of water are assured by digging to depths less than 15 feet in the ravines, and in several quarter-sections, particularly in the northwestern part of the municipality, water can be easily found by digging to depths less than 10 feet in thick deposits of sand and gravel that outcrop at the surface. In the shallow wells, less than 35 feet deep, the sand and gravel beds are usually found beneath a layer of yellow or brown clay. Many of these wells yield very abundant supplies of water, the water-level has remained constant over a long period of years, and the wells cannot be pumped dry. Two shallow wells, 6 and 15 feet deep, in the NW. $\frac{1}{4}$, sec. 30, tp. 29, range 12, and the SW. $\frac{1}{4}$, sec. 4, tp. 30,

range 10, are flowing artesian wells. The shallow wells that tap sand and gravel above the blue clay generally yield slightly mineralized water that is usually hard but rarely "alkaline", and which is suitable for drinking.

Abundant supplies of water under pressure are easily obtained from deposits of sand and gravel in the glacial drift at depths of 40 to 130 feet, in townships 29 and 30, ranges 11 and 12. Definite water-bearing horizons of sand and gravel are only detected in township 29, range 12, where two separate horizons are located at elevations of 1,996 to 2,053 feet and 1,905 to 1,935 feet above sea-level. In the other three townships the sand and gravel deposits within the blue clay, although of numerous occurrence, do not occur at any definite level or horizon. Nevertheless, very few dry holes have been made in any of the six northern townships, and those farmers who have been unable to strike water in wells are able to obtain water within reasonable hauling distance. The water from the 40- to 130-foot wells is more highly mineralized than that from the shallow wells. It is invariably hard, much of it contains iron, and is "alkaline". The water from a small proportion of these wells cannot be used for drinking, either because of its high iron content or laxative effect.

Farmers in the three southern townships and the southern part of township 29, range 10, are advised to excavate dugouts to collect and conserve surface water for stock use during the late summer months and winter. The area referred to is covered by moraine, and sloughs that are good locations for dugouts are numerous. Sloughs are used extensively by the farmers in this district and they could be deepened so as to collect a maximum amount of water in the freshet season. It is important that dugouts be at least 12 feet deep. Boring and drilling operations are not advised in this district. If deep drilling is contemplated anywhere in the municipality it should be confined to the drift above an elevation of 1,760 feet. The base

of the glacial drift is estimated to be near this elevation, and the underlying Marine Shale series rarely contains water-bearing sand and gravel deposits.

Water-bearing Horizons in the Bedrock

The Marine Shale series underlies the glacial drift throughout the municipality. Two wells in the NE. $\frac{1}{4}$, sec. 35, and the SW. $\frac{1}{4}$, sec. 36, tp. 30, range 11, struck the Marine Shale or "soapstone" as it is locally termed. The well in the SW. $\frac{1}{4}$, section 36, was bored 105 feet deep and water was struck in glacial sand 85 feet below the surface. The contact of the glacial drift and the Marine Shale series at this location is, therefore, between 90 and 105 feet below the surface or at an approximate elevation of 1,770 feet. The well in the NE. $\frac{1}{4}$, section 35, was drilled 212 feet deep. Shale bedrock, "soapstone", was reported near the base of this well, but it is possible that the lower 100 to 125 feet of the well was drilled in bedrock. Small quantities of water were obtained in each well, but the source of the water is believed to be sand and gravel in the glacial drift. Water-bearing sand and gravel are seldom found in the Marine Shale series in this part of Saskatchewan and well drillers are advised to discontinue drilling when the shale is encountered.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 28, Range 10

The elevation of the ground surface decreases gradually from 2,165 feet at the southwestern corner of the township to 2,030 feet at the northeastern corner of the township. Parts of sections 13, 14, 23, and 24, and the northern parts of sections 34, 35, and 36, are mantled by glacial till, whereas the remainder of the township is covered by moraine. The land surface is rolling and is characterized by low hills, shallow undrained depressions, and long narrow draws. Approximately 75 per cent of the township is covered by poplar and willow.

Two flowing springs were reported in the NE. $\frac{1}{4}$, and the NW. $\frac{1}{4}$, sections 2. Both springs are in sand that outcrops at the surface in slight depressions, and the farmers on the respective quarter-sections use the springs for watering stock.

The producing wells in the township have all been dug by hand to depths less than 45 feet; most of the wells being from 5 to 25 feet deep. Those wells that yield a permanent supply of water have tapped pockets of sand and gravel that either outcrop at the surface or underlie yellow or brown boulder clay. Blue or black clay is generally struck at a depth of 30 feet. Since the sand and gravel occur as pockets in the upper 30 feet of the glacial drift, some farmers experience little difficulty in obtaining a producing well, whereas others make numerous unsuccessful attempts. At least thirteen farmers in the township have been unable to locate a satisfactory water supply from wells. The supply of water from the wells that have encountered sand or gravel is variable and depends to a large extent on the size of the gravel pocket and the amount of annual precipitation. One of the best wells in the township was dug for a school in the NE. $\frac{1}{4}$, section 18. The well was dug through 20 feet of stony clay and struck a 5-foot bed of sand beneath the clay.

The water-level varies between points 15 and 20 feet below the surface, depending on the season, and the supply is abundant. Several farmers who are short of water tank from this well. Other wells that yield a good supply of water are located in the NW. $\frac{1}{4}$, and the NE. $\frac{1}{4}$, section 14, and the SW. $\frac{1}{4}$, section 28. The wells are 8, 10, and 8 feet deep, respectively, and were dug entirely in sand. One farmer in the NE. $\frac{1}{4}$, section 16, has dug twenty-five dry holes to a maximum depth of 25 feet without striking any sand. Some farmers obtain a sufficient supply of water in summer from shallow wells dug beside sloughs, but in winter when the sloughs freeze water must be hauled.

Three attempts to obtain water in the glacial drift at depths greater than 45 feet were made in the SW. $\frac{1}{4}$, section 14. The wells were 48, 72, and 92 feet deep and the main material penetrated was black clay. No water was obtained in any of these three wells. The farmer waters his stock at a small dam that is constructed across a ravine in the quarter-section. A dry hole, 65 feet deep, was also bored in the NW. $\frac{1}{4}$, section 32.

Those farmers who are short of water are advised to excavate deep dugouts as a means of catching and conserving surface water, rather than to bore or drill to depth in the glacial drift. Slough basins are numerous and they are favourable locations for dugouts. The dugout must be at least 12 feet deep to be satisfactory. The sub-soil in most places is impervious, but test holes with a small auger should be made prior to excavation to make certain that no permeable bed of sand and gravel exists that would allow the water to escape.

Township 28, Range 11

Moraine covers the entire township and the land surface is rolling and rough, and is thickly wooded with clumps of poplar. Sloughs are very common. A portion of Horse lake, at an elevation of 2,188 feet, extends through parts of sections 6 and 7. The

elevation decreases gradually from approximately 2,200 feet at the southern boundary of the township to 2,190 feet at the northern boundary.

Adequate supplies of water are difficult to locate in the upper 110 feet of the glacial drift in this township. All wells that yield a satisfactory supply of water are less than 36 feet deep. The water-bearing beds of sand and gravel in these wells occur generally beneath yellow boulder clay. These pockets of sand and gravel are small, and consequently the supply of water from wells tapping them is not large. Several farmers are obliged to use more than one well in order to obtain sufficient water for their local needs. The water is hard, in many places "alkaline", and some contains iron, but it is used for drinking as water of better quality is so difficult to obtain. Approximately one-half of the farmers in the township are able to obtain sufficient water for local needs from wells on their own land. Numerous dry holes have been made to a maximum depth of 110 feet in all parts of the township. Many farmers rely on shallow seepage wells dug near sloughs, and during the summer months sufficient water is obtained from the wells and sloughs to meet all farm requirements. During the winters, however, and in years of drought, these farmers must haul water. A few farmers in the township haul water throughout the year for all farm needs. Horse lake, in sections 6 and 7, and the school well in the NE. $\frac{1}{4}$, sec. 18, tp. 28, range 10, are two of the main sources from which water is hauled. No well in the township yields an abundant supply of water under pressure.

It appears useless to employ the boring method of obtaining water in this township, since many dry holes 40 to 110 feet have encountered no sand or gravel in the impervious blue clay that forms the greater bulk of the glacial drift. Drilling to depths greater than 110 feet may be successful, but it is not recommended as the risk of obtaining water does not warrant the expense of drilling.

Farmers are advised to excavate deep dugouts to alleviate the acute shortage of well water in this township. These dugouts will prove satisfactory if the site is carefully chosen and if they are at least 12 feet deep. Undrained depressions are numerous in this township and they are excellent locations for dugouts. Test augers should be used on the proposed site to ascertain the type of material that will be struck during excavation.

Township 28, Range 12

The elevation in this township decreases from 2,200 feet in the southern part to 2,100 feet above sea-level in the northern part. The entire area is mantled by moraine. The ground surface is very undulating, and low hills and undrained depressions are common. Beckett brook, a small, intermittent stream, has its source in the NE. $\frac{1}{4}$, section 5, and flows in a northwesterly direction through sections 8, 7, 18, and 19. Parts of Horse lake are located in sections 1, 2, and 12.

The well water conditions of this township are similar to those in township 28, range 11. Pockets of water-bearing sand and gravel are very difficult to locate in the upper 120 feet of the glacial drift. Most of the wells that yield a small, permanent supply of water have struck the aquifer at depths less than 35 feet beneath yellow or brown boulder clay. Many dry holes, however, usually were dug before a pocket was located. As a rule more than one shallow well must be used in order to obtain sufficient water for local requirements.

Many farmers in the township depend on shallow seepage wells that are dug in clay near sloughs. During the summer months, except in periods of drought, sufficient water for local needs is obtained from the wells and sloughs. Some farmers have been unable to locate water. In winters and years of drought, over one-half the farmers in the township haul water, some hauling a distance of 5 miles.

Horse lake is the main source from which water is hauled by farmers in the southern sections, and wells in township 29, range 12, are the source from which water is generally hauled by farmers in the northern sections.

Five wells, 46, 38, 82, 60, and 55 feet deep, bored in the NW. $\frac{1}{4}$, section 18, the NW. $\frac{1}{4}$, and the NE. $\frac{1}{4}$, section 25, the NW. $\frac{1}{4}$, section 33, and the SE. $\frac{1}{4}$, section 35, strike pockets of sand and gravel in the glacial drift and yield water under pressure. The water rises from the aquifers to points 10, 18, 22, 45, and 15 feet below the surface and these levels remain constant. The water is hard, usually more highly mineralized than the water from the shallow wells, and contains iron. The farmers use it for drinking as well as for stock. Although these five wells obtain abundant supplies of water at depths greater than 35 feet, numerous dry holes, 35 to 120 feet deep, have been dug and bored in other parts of the township, many in the quarter sections adjoining those wherein water is located. One well, in the NW. $\frac{1}{4}$, section 35, was bored 80 feet and drilled another 100 feet. A 1-foot layer of sand was struck 20 feet below the surface, but the lower 160 feet of the well was in clay. A dry hole 282 feet deep, the deepest in the municipality, was drilled in the SE. $\frac{1}{4}$, section 22.

In view of the numerous failures by boring and drilling, these methods are not advised, even though five wells did strike pockets of sand and gravel in the impervious, blue clay that largely composes the glacial drift. Farmers are advised to excavate dugouts to collect and retain surface water for stock use.

Township 29, Range 10

The topographic relief decreases approximately 150 feet from the southwestern corner of the township to the northeastern corner. A moraine, about 2 miles wide, covers most of the northern $2\frac{1}{2}$ miles of the township. Section 6 and parts of sections 5 and 4 are also covered by moraine. The remainder of the township is

mantled by glacial till. The ground surface is undulating, undrained depressions are common, and tree growth is quite dense. Several small ravines carry the surface water towards Whitesand river. A small, unnamed lake, $\frac{1}{2}$ mile wide and $1\frac{1}{4}$ miles long, occurs in sections 20 and 21.

A dry hole, 150 feet deep, was bored in the NE. $\frac{1}{4}$, section 26, but all the other wells in the township were dug by hand to depths of 4 to 50 feet, most of them being less than 20 feet deep. In some quarter-sections much difficulty is experienced in striking a pocket of water-bearing sand and gravel in the upper 50 feet of the glacial drift, whereas in others, and often in adjoining quarter-sections, a well will be dug in a deposit of sand or gravel that extends from the surface to the base of the well, 4 to 20 feet below the surface. In a few wells the water-bearing sands and gravels are overlain by yellow boulder clay. Those wells dug entirely in sand and gravel usually yield good supplies of water. One 4-foot well dug in gravel in the SE. $\frac{1}{4}$, section 32, waters 60 head of stock. The water from shallow wells is invariably hard, but rarely "alkaline", and is usable for drinking.

A well in the NE. $\frac{1}{4}$, section 22, struck petrified wood beneath blue clay 50 feet below the surface. Water under pressure was encountered at this depth and it rises to a point 30 feet below the surface. The water is hard, suitable for drinking, and the supply remains constant regardless of seasonal precipitation. This is the only well in the township that yields water under pressure.

Of the forty-nine farms visited, sixteen have an inadequate supply of well water. Dugouts to collect and retain surface water for stock use are recommended in those sections where the supply is inadequate for local needs. Drilling to depths greater than 50 feet may strike pockets of water-bearing sand and gravel in the glacial drift, but the uncertainty of obtaining water does not warrant the expense of drilling.

Township 29, Range 11

The elevation of the ground surface decreases gradually from 2,100 feet above sea-level in the southern part of that township to 1,950 feet at the northern boundary. The northwestern, northeastern, and southern parts of the township are covered by moraine, whereas the remainder of the area is mantled by glacial till. The land surface is gently undulating to hilly, and in some sections is densely wooded with poplar and willow. Milligan creek flows intermittently in an easterly direction through sections 19, 18, 20, and 21, then turns sharply in section 22, and flows in a northerly direction through sections 27, 28, and 33. A tributary stream joins Milligan creek in the NE. $\frac{1}{4}$, section 28.

Satisfactory supplies of water are readily obtained from the glacial drift in this township at depths less than 125 feet. Three springs were reported in the SE. $\frac{1}{4}$, section 25, the SE. $\frac{1}{4}$, section 28, and the SW. $\frac{1}{4}$, section 36. Most of the farmers rely on hand-dug wells less than 30 feet deep. These wells usually tap beds of water-bearing sand and gravel beneath yellow or brown clay, but some wells are dug in deposits of sand and gravel that extend from the ground surface to the base of the well, 8 to 20 feet below the surface. Very little difficulty is experienced in striking beds of water-bearing sand and gravel at depths less than 30 feet. Water is almost assured by digging to depths of 4 to 15 feet in the ravine that contains Milligan creek. The supply of water obtained from most of the shallow wells is moderate to abundant, and it is not uncommon for a shallow well to water 35 to 60 head of stock. Wells in the SW. $\frac{1}{4}$, section 3, the NW. $\frac{1}{4}$, section 4, the NE. $\frac{1}{4}$, section 6, the SE. $\frac{1}{4}$, section 9, the SE. $\frac{1}{4}$, section 16, and the NW. $\frac{1}{4}$, section 33, all less than 21 feet deep, have never been pumped dry, and wells in the SE. $\frac{1}{4}$, section 8, and the SW. $\frac{1}{4}$, section 12, both 8 feet deep, have never been bailed dry. Other wells less than 30 feet deep are

pumped or bailed dry with difficulty. The quality of the water from the shallow wells in this township is very good; it is generally soft or moderately hard and is suitable for drinking.

Sixteen wells, 32 to 113 feet deep, were bored or drilled to sand and gravel aquifers within the blue boulder clay and yield water under pressure. In some of these wells a thin layer of hard-pan was struck immediately above the sand and gravel, and when this was penetrated the water rushed into the well and ascended to points 10 to 30 feet below the surface. The supply of water from these wells is abundant, and in many of them the water-level cannot be lowered by continuous pumping. The water is invariably hard, often contains iron, but only infrequently is it "alkaline". The water from these wells is used for drinking.

The only quarter-sections wherein difficulty has been experienced in obtaining water are the NW. $\frac{1}{4}$, section 7, the NE. $\frac{1}{4}$, section 10, the NW. $\frac{1}{4}$, section 15, and the NE. $\frac{1}{4}$, section 22. Several dry holes, 9 to 105 feet deep, were dug and bored in the NW. $\frac{1}{4}$, section 7, and the farmer hauls water. A 75-foot well in the NE. $\frac{1}{4}$, section 10, yields sufficient water for household needs, but the stock are watered at a shallow well in the SE. $\frac{1}{4}$, section 10. No adequate supplies of water could be obtained from wells dug to a maximum depth of 40 feet in the NW. $\frac{1}{4}$, section 15. A 6-foot well yields sufficient water in summer for the farmer in the NE. $\frac{1}{4}$, section 22, but in the winter the water freezes and some water must be hauled. In any of these four instances, although water is tanked, it does not have to be hauled a great distance.

Water conservation schemes are unnecessary in this township. Abundant supplies of water are obtained with little or no difficulty from beds of sand and gravel at depths less than 125 feet in the glacial drift. The boring method of making a well is recommended.

Township 29, Range 12

An area of approximately 4 square miles in the north-eastern corner of the township is covered by glacial till, whereas the remainder of the township is overlain by moraine. The elevation decreases towards the north, and the ground surface is rolling and largely covered by poplar trees. The source of Milligan creek is in the SE. $\frac{1}{4}$, section 21, and the stream flows intermittently in an easterly direction through sections 22, 23, and 24. A small, tributary creek flows through sections 2, 11, and 13. The headwaters of Becvar brook, a tributary of Beckett brook, occur in the NW. $\frac{1}{4}$, section 17, and the stream flows intermittently in a northerly direction through sections 19, 30, and 31.

Most of the wells in the township are dug by hand to depths less than 30 feet. Generally, little difficuly is experienced in striking beds of water-bearing sand and gravel in the upper 30 feet of the glacial drift. Abundant supplies of water are easily obtained from wells dug less than 15 feet deep in the floors of the ravines. In several localities, particularly in the northern sections, thick deposits of sand and gravel are struck directly beneath the top soil. Water in abundance can be obtained from sand at depths of 7 to 10 feet below the surface anywhere in the SW. $\frac{1}{4}$, section 29. A 4-foot well dug in sand and gravel in the SW. $\frac{1}{4}$, section 12, yields a supply of soft water that is sufficient for 75 to 100 head of stock, and the water-level, 2 feet below the surface, cannot be lowered by bailing. An 8-foot well dug in sand beneath red clay in the NE. $\frac{1}{4}$, section 24, has delivered a constant and abundant supply of water since 1905, and this well has never been bailed dry. A 6-foot well dug in the bottom of Becvar Brook valley in the NW. $\frac{1}{4}$, section 30, obtains water from sand that underlies yellow clay, and the water rises to a point 6 inches above the ground. The water from this well is soft and the supply has remained constant since the well-

was dug. Many other shallow wells in the township that are less than 30 feet deep yield an oversufficient supply of water for farm requirements. The quality of the water from the shallow wells is very good, nearly always hard, but rarely "alkaline", and a few wells yield soft water.

At least sixteen wells in the township have established the presence of two water-bearing horizons of sand and gravel, in the glacial drift, that yield water under hydrostatic pressure. Thirteen of the sixteen wells have tapped the upper water-bearing horizon at elevations of 1,996 to 2,053 feet above sea-level, or at depths of 16 to 107 feet, depending on the surface elevation. A 29-foot well in the SE. $\frac{1}{4}$, section 19, penetrated 2 feet black loam, 6 feet yellow clay, 1 foot brown clay, and 20 feet blue clay. The gravel aquifer underlies the blue clay at an elevation of 2,021 feet and the water rises under pressure to a point 9 feet below the surface. The well has never been pumped dry since it was dug in 1927. The water, like most of the water from the upper water-bearing horizon, is hard and contains iron, but is suitable for drinking. In several wells in the township the yellow or brown clay is absent and red clay overlies the blue clay. In the deeper wells a greater thickness of blue clay overlies the gravel aquifer.

The lower water-bearing horizon was tapped by three wells 160, 80, and 55 feet deep in the SE. $\frac{1}{4}$, section 2, the NW. $\frac{1}{4}$, section 24 and the SW. $\frac{1}{4}$, section 35. The aquifers are fine sand located at elevations of 1,935, 1,920, and 1,905 feet above sea-level. The existence of the two separate water-bearing horizons is clearly indicated in section 2, where a 65-foot well in the SW. $\frac{1}{4}$ taps the upper water-bearing horizon at an elevation of 2,035 feet, and the 160-foot well in the SE. $\frac{1}{4}$ taps the lower water-bearing horizon at an elevation of 1,935 feet. The water rises from the fine sand of the lower water-bearing horizon to points 60, 25, and 30 feet below the surface in the three wells, and the supply is

abundant. When first drilled, the 160-foot well was a flowing artesian well, but the water-level has gradually lowered, probably due to sand plugging the casing, to the present level, 60 feet below the surface. The water from the lower water-bearing horizon is hard, contains iron, and is slightly "alkaline", but it is usable for drinking. It is probable that the two horizons mentioned above are not continuous, but are formed by individual pockets of sand and gravel.

Wells 65, 56, 110, and 50 feet deep, in the SW. $\frac{1}{4}$, section 3, the SW. $\frac{1}{4}$, section 9, the NE. $\frac{1}{4}$, section 9, and the NE. $\frac{1}{4}$, section 12, failed to encounter water, and a 60-foot well in the SW. $\frac{1}{4}$, section 18, obtains only a very small supply. Only eleven of the seventy-two farmers interviewed in the township are unable to obtain a sufficient supply of well water. Although these farmers must tank water, the distance of haul is not far, as so many wells in the township yield an abundant supply of water. These farmers are advised to prospect the upper 30 feet of the glacial drift with small hand augers, as in this manner a bed of water-bearing sand and gravel may be located. If water cannot be located by wells, dugouts could be excavated to collect and store surface water for stock use.

Township 30, Range 10

The elevation of the ground surface decreases gradually from 1,950 feet above sea-level in the southeastern corner, to less than 1,800 feet in the northeastern corner of the township. The township, with the exception of the southern portion of section 6 which is covered by moraine, is mantled by glacial till. The ground surface is slightly undulating and quite densely wooded with poplar. Ebel creek flows intermittently in an easterly direction through sections 7, 8, 9, 10, 11, and 12. This creek empties into Sheko lake in township 30, range 9, and forms a part of the Whitesand River drainage system. The ravine through which the creek flows is approximately 30 feet deep.

The wells in the township range in depth from 6 to 70 feet, but most of them are less than 25 feet deep. The wells less than 25 feet deep tap pockets of sand and gravel that generally underlie a layer of yellow or brown, weathered clay. Ten wells, most of which are dug in depressions or ravines, encounter sand and gravel that extend from the surface to the base of the well 6 to 20 feet below the surface. Three wells 26, 24, and 24 feet deep, in the NW. $\frac{1}{4}$, section 15, and the NE. $\frac{1}{4}$, and SW. $\frac{1}{4}$, section 16, respectively, apparently tap a common aquifer. The three wells were dug through yellow clay to a grey-coloured quicksand. The water in the wells that tap sand and gravel beneath the weathered clay does not rise under hydrostatic pressure, but the yield from most of them is sufficient for local needs. An 11-foot well in the NW. $\frac{1}{4}$, section 24, waters 75 head of stock, and an 8-foot well in the NE. $\frac{1}{4}$, section 6, waters 50 head of stock. A 15-foot well in the SW. $\frac{1}{4}$, section 4, was dug through yellow clay and blue clay, and the sand aquifer beneath the blue clay yields water under pressure sufficient to raise it to a point 4 feet above the surface.

Three bored wells 60, 55, and 70 feet deep, in section 36, tap a common sand aquifer. The water rises under pressure to points 45, 40, and 15 feet below the surface and the supply is abundant. The water, unlike that from most of the shallow wells, is highly mineralized and only that from the 70-foot well is used for drinking. A 40-foot well in the NW. $\frac{1}{4}$, section 19, taps a pocket of grey sand beneath black clay and blue clay. The water rises to a point 20 feet below the surface and the supply is abundant and constant. The water is too "alkaline" and bitter for drinking, but is suitable for stock.

Seven farmers located in the SW. $\frac{1}{4}$, section 2, the SW. $\frac{1}{4}$, section 7, the SE. $\frac{1}{4}$, section 14, the SE. $\frac{1}{4}$, section 15, the SW. $\frac{1}{4}$, and SE. $\frac{1}{4}$, section 18, and the SW. $\frac{1}{4}$, section 32, do not obtain an adequate supply of well water at all seasons of the year. During the summer months sufficient water is obtained from sloughs and wells

for stock, but during the winter water must be hauled. Two dry holes were reported; one 42-feet deep in the SE. $\frac{1}{4}$, section 14, and the other 110-feet deep in the SE. $\frac{1}{4}$, section 24.

The excavation of dugouts in depressions is a satisfactory method of collecting and retaining surface water, provided that they are at least 12 feet deep. These dugouts will prove valuable sources of water in the autumn and winter months when some of the shallow wells become intermittent due to lack of precipitation.

Township 30, Range 11

Moraine covers the western $\frac{1}{2}$ to $1\frac{1}{2}$ miles of this township, and the southern parts of sections, 1, 2, and 3, and glacial till mantles the remainder of the township. The ground surface slopes to the north and is rolling in the moraine-covered areas, but is only slightly undulating or flat in the glacial till plain. Ebel creek has its source in the NE. $\frac{1}{4}$, section 11, and flows eastward through section 12. Milligan creek flows due north through the western part of the township, passing to the west of the town of Foam Lake. Three, small, tributary streams join Milligan creek in the vicinity of section 20. The township is wooded with clumps of poplar trees.

Several flowing springs occur in the shallow ravine in the southern half of section 7. Springs were also reported along Milligan creek in the SW. $\frac{1}{4}$, section 4, and the NE. $\frac{1}{4}$, section 20.

Approximately 50 per cent of the farmers in the township rely on shallow wells less than 30 feet deep for their supplies of water. In some sections, particularly those in the eastern half of township, water-bearing beds of sand and gravel are difficult to locate in the upper 30 feet of the glacial drift. Most of the shallow producing wells are located in the western sections and several of them were dug in ravines where in many places sand and gravel deposits are struck beneath the top soil. Some of the shallow wells yield abundant supplies of water, showing that the lenses of sand and gravel

tapped must be of large areal extent. Three such wells are located in the NE. $\frac{1}{4}$, section 30, and the NW. $\frac{1}{4}$, and NE. $\frac{1}{4}$, section 32. They are 29, 13, and 12 feet deep and tap gravel aquifers beneath a thin covering of yellow clay. The supply of water has never altered, although the 13-foot well has been used since 1912. The 29-foot well and the 13-foot well cannot be pumped dry and the former well waters 100 head of stock. Water can be located in thick sand beds at depths less than 10 feet at almost any place on the western half of section 8.

Although most of the shallow wells tap water-bearing sand beneath yellow clay at depths less than 30 feet, two wells 26 and 12 feet deep, in the NW. $\frac{1}{4}$, section 27, and the SW. $\frac{1}{4}$, section 34, struck sand beneath blue clay. The 12-foot well was dug through 2 feet black loam, 7 feet yellow clay, and 3 feet blue clay. The water rises from the sand to a point 4 feet below the surface, and this level has been maintained since 1924. The well has never been pumped dry and 40 barrels of water have been taken from the well during one day. The 26-foot well was also dug through yellow and blue clay, and the water rises from the sand to a point 15 feet below the surface. This level has remained constant since 1914, although 50 head of stock are watered at the well. The water from both wells is hard and contains iron, and is suitable for drinking.

As in township 29, range 11, beds of water-bearing sand and gravel are easily struck at depths of 40 to 125 feet in the glacial drift. At least twenty farmers own wells that tap pockets of sand and gravel within the blue clay and which yield water under pressure. In many places a thin layer of hardpan overlies the aquifer, and when this is punctured the water rises under pressure to points usually 20 to 40 feet below the surface. In a 125-foot drilled well in the NW. $\frac{1}{4}$, section 36, the water rises to a point 3 feet below the surface. The aquifer in this well is sand that underlies hardpan. The supply of water from most of these wells is

very abundant and in several wells, such as the 60-foot well in the SE. $\frac{1}{4}$, section 9, the water-level cannot be lowered by continuous pumping. The water from the 40 to 125-foot wells is more highly mineralized than that from shallow wells. It commonly contains iron and is "alkaline", but the water from many wells is used for drinking. One or two wells yield water that contains "sulphur". Wells sunk to depths of 45 to 212 feet, in the NW. $\frac{1}{4}$, section 14, the SE. $\frac{1}{4}$, section 22, the SE. $\frac{1}{4}$, section 26, the NE. $\frac{1}{4}$, section 35, and the SW. $\frac{1}{4}$, section 36, either failed to encounter water or obtained only small supplies. Only eight farms in the township have an unsatisfactory supply of well water. In these locations dugouts could be economically excavated to retain surface water for stock use.

The Marine Shale series underlies the glacial drift throughout the municipality and it is probable that two wells have encountered the shale in this township. Soapstone, as the Marine Shale series is locally known, was reported in two wells in the NE. $\frac{1}{4}$, section 35, and the SW. $\frac{1}{4}$, section 36. The well in the [illegible] $\frac{1}{4}$, section 35, was drilled 212 feet deep, but the point of contact between the glacial drift and the Marine Shale was not obtained. It is possible that the lower 100 to 125 feet of the well may be in bedrock. The base of the well is at an elevation of 1,638 feet above sea-level and very little water was obtained. The well is not used. The well in the SW. $\frac{1}{4}$, section 36, is bored to a depth of 105 feet or to an elevation of 1,765 feet. Water was struck in a thin layer of glacial sand 85 feet below the surface, so that the contact of the glacial drift and the Marine Shale must be between 90 and 105 feet below the surface. It is thought, however, that the bedrock occurs at an approximate elevation of 1,765 feet. The Marine Shale series in this part of Saskatchewan seldom contains water-bearing horizons of silt, sand, or gravel, and drilling into it in a search for water is not recommended; all prospecting for water should be

confined to the glacial drift.

Township 30, Range 12

The elevation in this township decreases gradually from 2,000 feet at the southwestern corner to 1,825 feet at the northeastern corner. The ground surface is rolling, but is not densely wooded. The eastern 1 to 1½ miles of the township and the southwestern corner are covered by moraine, whereas the remainder of the township is mantled by glacial till. Beaver brook flows diagonally across the township in a northeasterly direction and Beckett brook flows northwesterly through sections 30, 31, 32, 29, and 33. Both creeks flow through shallow ravines approximately 30 feet deep, and the streams flow only in the freshet season. A small tributary of Milligan creek has its source in a small lake in the SW. ¼, section 1, and flows in a northeasterly direction across sections 1 and 12.

A flowing spring in the creek bed in the SE. ¼, section 12, yields an abundant supply of hard water that is suitable for drinking. Two small springs are also located in the SE. ¼, section 22, and springs occur along the course of Beckett brook in the NW. ¼, section 28, the NW. ¼, section 30, and the SW. ¼, section 33. The spring in the NW. ¼, section 28, yields a large supply of hard water that contains iron. The spring in the SW. ¼, section 33, flows during the cold autumn months, but ceases in the warm spring weather. The water from this spring will rise 4 feet above the ground surface in winter when ice forms around the outlet.

Most of the hand-dug wells in the township are less than 35 feet deep. In some quarter-sections water-bearing beds of sand and gravel are very difficult to locate in the upper 35 feet of the glacial drift, whereas in others, as in the NE. ¼, section 19, water in abundance can be found easily by driving a sand-point 8 to 15 feet into the thick beds of sand that underlie the top soil. Water is easily found at depths less than 15 feet in the ravines, such as in the NE. ¼, section 21, where a 16-foot well is bored in the ravine

that contains Beevar brook. The well was bored through 2 feet black loam, 1 foot yellow clay, 5 feet sand, and 8 feet of blue clay. The water-level has remained constant for twenty years at a point 8 feet below the surface, and the well has never been bailed dry. Another good well was dug on the plain in the SE. ¼, section 26. This well is 10 feet deep and is dug entirely in gravel. The water-level stands at a point 5 feet below the surface and this level cannot be lowered by continuous pumping. The water from this well is soft. Two wells less than 35 feet deep in the NW. ¼, section 10, and the NE. ¼, section 13, yield water under hydrostatic pressure. The 18-foot well on the NE. ¼, section 13, was bored through 2 feet black loam, 9 feet grey clay, 3 feet quicksand, and 4 feet blue clay. The water rises from the quicksand to a point 1 foot below the surface and the supply is abundant and constant. Several other wells in the township less than 35 feet deep yield very abundant supplies of water.

Twenty wells, 40 to 130 feet deep, have tapped large pockets of sand and gravel, in the glacial drift, that usually yield abundant quantities of water under high hydrostatic pressure. One well, bored 40 feet deep, in the NE. ¼, section 1, yields water that rises from a sand and gravel aquifer beneath blue clay to a point 6 inches above the ground surface. In some wells, 80 to 120 feet deep, the water rises to points 10 to 25 feet below the surface. A 103-foot bored well in the SW. ¼, section 31, yields water that rose to a point 10 feet below the surface when the well was made, but since then the water-level has gradually lowered until it now stands at a point 100 feet below the surface. The base of this well has probably been gradually plugged with sand, thus shutting off the supply of water. The water from the wells 40 to 130 feet deep is hard, in many cases "alkaline", and usually contains large quantities of iron. A 130-foot well in the NW. ¼, section 28, yields water with such a high iron content that it is not even being used for

stock, although the supply of water is very abundant. The water from other wells imparts a laxative effect to humans and cannot be used for drinking.

The only districts wherein it has been impossible to obtain adequate supplies of water by boring or drilling to depths over 40 feet, are in the NW. $\frac{1}{4}$, section 2, the SW. $\frac{1}{4}$, section 18, the SE. $\frac{1}{4}$, section 19, the SW. $\frac{1}{4}$, and the SE. $\frac{1}{4}$, section 23, and the SW. $\frac{1}{4}$, section 24. Wells bored in the SW. $\frac{1}{4}$, section 23, strike a 20-foot bed of dry sand, 60 feet below the surface. Dry holes have been bored to a maximum depth of 132 feet in this quarter-section. The 132-foot well penetrated the following materials; 12 feet yellow clay, 48 feet blue clay, 20 feet dry black sand, 20 feet blue clay, dry sand at a point 100 feet below the surface, and blue clay.

Fourteen farmers in the township either have not been able to obtain any water in wells, or obtain an inadequate supply for stock requirements. Some water is often hauled in the winter months but sloughs and seepage wells provide sufficient water during the summer months. Water is not hauled for a greater distance than 2 miles.

The Marine Shale series underlies the glacial drift, the contact occurring at an approximate elevation of 1,750 feet above sea-level. Drilling or boring into the bedrock for water is not advised.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF BEAVER, NO. 276, SASKATCHEWAN

West of 2nd meridian — Township	28	28	28	29	29	29	30	30	30	Total No. in municipality
Range	10	11	12	10	11	12	10	11	12	
Total No. of Wells in Township	81	166	240	52	82	106	57	72	82	938
No. of wells in bedrock	0	0	0	0	0	0	0	2	0	2
No. of wells in glacial drift	81	166	240	52	82	106	57	70	82	936
No. of wells in alluvium	0	0	0	0	0	0	0	0	0	0
Permanency of Water Supply										
No. with permanent supply	34	56	67	43	69	87	49	66	60	531
No. with intermittent supply	5	10	9	5	2	3	5	1	7	47
No. dry holes	42	100	164	4	11	16	3	5	15	360
Types of Wells										
No. of flowing artesian wells	0	0	0	0	0	2	1	0	1	4
No. of non-flowing artesian wells	0	0	5	1	17	17	4	23	21	88
No. of non-artesian wells	39	66	71	47	54	71	49	44	45	486
Quality of Water										
No. with hard water	30	61	73	48	60	70	49	63	62	516
No. with soft water	9	5	3	0	11	20	5	4	5	62
No. with salty water	0	0	1	0	0	0	0	0	0	1
No. with "alkaline" water	2	27	26	2	6	7	8	9	14	101
Depths of Wells										
No. from 0 to 50 feet deep	78	144	187	51	63	86	52	47	56	764
No. from 51 to 100 feet deep	3	20	48	0	15	17	4	19	18	144
No. from 101 to 150 feet deep	0	2	3	1	4	2	1	5	7	25
No. from 151 to 200 feet deep	0	0	1	0	0	1	0	0	0	2
No. from 201 to 500 feet deep	0	0	1	0	0	0	0	1	1	3
No. from 501 to 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
No. over 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
How the Water is Used										
No. usable for domestic purposes	36	62	67	48	61	75	48	56	49	502
No. not usable for domestic purposes	3	4	9	0	10	15	6	11	18	76
No. usable for stock	39	66	76	48	67	89	54	63	65	567
No. not usable for stock	0	0	0	0	4	1	0	4	2	11
Sufficiency of Water Supply										
No. sufficient for domestic needs	34	56	67	43	69	87	48	66	60	530
No. insufficient for domestic needs	5	10	9	5	2	3	6	1	7	48
No. sufficient for stock needs	27	44	40	36	57	72	43	50	44	413
No. insufficient for stock needs	12	22	36	12	14	18	11	17	23	165

ANALYSES AT 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 boilders and tea-kettles is formed from these mineral salts.

Sodium

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

Sulphates

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

Chlorides

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

Iron

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

Hardness

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

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

Analyses of Water Samples from the Municipality of Beaver, No. 276, 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	SO4	Na_2O	Solids	$CaCO_3$	$CaSO_4$	$MgCO_3$	$MgSO_4$	Na_2CO_3	Na_2SO_4	NaCl	$CaCl_2$	
1	SW.	32	30	11	2	10	885	100	Bacteria in 1 c.c. of water								885	(3)	(1)		(2)		(4)		(5)	* 1
2	NW.	22	30	12	2	32	8,320	3,000+	3,000+	N.D.	80	490	940	1,577	4,920	78	6,958	490	1,619		4,699		18	132		* 1

Water samples indicated thus, * 1, are from glacial drift.
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 ($CaCO_3$).
Analysis No. 1 by Provincial Analyst, Regina.
For interpretation of this table read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

The results of analysis of two samples of water from wells tapping aquifers in the glacial drift are shown on the accompanying table. The first analysis is from a shallow well dug in the town of Foam Lake. The water has a total dissolved content of 885 parts per million which is not considered large for water from the glacial drift in Saskatchewan. The main constituent salts in solution are calcium sulphate, magnesium sulphate, and calcium carbonate. Magnesium sulphate (Epsom salts) is one of the most undesirable salts in drinking water, but there would not be a sufficient amount of it in this water to impart a laxative effect to humans. Sodium sulphate (Glauber's salt), and calcium chloride are not of sufficient magnitude to impart any injurious effects. The water from this well is quite suitable for drinking purposes. Most of the shallow wells in the municipality do not yield highly mineralized water and are used for drinking.

The second analysis is from a 32-foot well, the water from which was known to be very highly mineralized, and it is not representative of the water from the wells in the glacial drift of the municipality. Stock refuse this water if any other is available. The water has a total dissolved solid content of 8,320 parts per million, which is excessive. The total dissolved mineral salt content is largely composed of magnesium sulphate (Epsom salts) which causes the water to have a purgative effect on humans and also causes it to be bitter. The fact that the water is bitter would account for the stock refusing it. The water is very hard, due to the high proportion of magnesium and calcium. The water from this well should not be used for stock.

No analyses of water from the wells 40 to 130 feet deep, that yield water under pressure, are available. Generally those wells yield water that is used for drinking, although it is hard,

contains iron, and some of it is termed "alkaline". It is suitable for stock.

Water from the Bedrock

Only on rare occasions has water been obtained from the Marine Shale series in this part of Saskatchewan. No wells in the municipality are deriving water from the bedrock, although two wells in township 30, range 11, have penetrated it. Where water was obtained from the Marine Shale series it was too highly mineralized for either domestic or stock use.

NOTE:

Because of difficulties involved in reproduction, the tables of well records referred to are not included with this report. Information regarding individual wells may be obtained by writing to the Director, Geological Survey of Canada, Ottawa.