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 KUTAWA NO. 278 SASKATCHEWAN

By

B. R. MacKay, H. N. Hainstock and P. D. Bugg

WATER SUPPLY PAPER No. 77



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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.

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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 | 10 |
| Water-bearing horizons in the bedrock | 11 |
| Ground water conditions by townships: | |
| Township 28, Range 16, west of 2nd meridian | 13 |
| Township 28, Range 17, " " " " | 13 |
| Township 28, Range 18, " " " " | 14 |
| Township 29, Range 16, " " " " | 15 |
| Township 29, Range 17, " " " " | 15 |
| Township 29, Range 18, " " " " | 16 |
| Statistical summary of well information | 18 |
| Analyses and quality of water | 19 |
| General statement | 19 |
| Water from the unconsolidated deposits | 23 |
| Water from the bedrock | 23 |
| Well records | 24 |

Illustrations

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 KUTAWA, NO. 278, 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 shews 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

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

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

## GLOSSARY OF TERMS USED

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

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

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

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

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

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

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

Continental Ice-sheet. The great ice-sheet that covered most of the surface of Canada many thousands of years 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 Kutawa, No. 278, consists of six townships described as townships 28 and 29, ranges 16, 17, and 18, W. 2nd mer., and comprises an area of approximately 165 square miles. The centre of the municipality is approximately 68 miles north of the city of Regina and 21 miles east of the village of Tate. The reduced area of the municipality is due to the fact that a considerable part of the district is set aside for the Poor Man and Day Star Indian reserves as shown on the map. The north-central part of the municipality lies within the southern edge of Touchwood hills and the ground surface is rough and irregular, whereas the remainder is slightly irregular and rolling. There are many small lakes throughout the municipality, the largest of which are Kutawa in the southeastern part, and Whitewood in the north-central part. The relief amounts to approximately 300 feet. The lowest point is in the northwestern corner at an elevation of 1,960 feet above sea-level, and the highest point is near the centre of township 29, range 17, at an elevation slightly greater than 2,250 feet above sea-level. The entire municipality is covered by part of a large, terminal moraine. The upper 110 feet of the glacial drift does not appear to contain any definite, or continuous, water-bearing horizons and the paucity of information at greater depths makes it impossible to predict the extent and character of aquifers occurring in the lower part of the drift.

### Water-Bearing Horizons in the Unconsolidated Deposits

Throughout the municipality small quantities of ground water are being obtained from sand and gravel deposits that occur as pockets within the upper 110 feet of the glacial drift. These pockets are of local distribution, as a great number of dry holes have been encountered throughout the municipality. In isolated sections and over very limited areas there is some appearance of continuity in the sand and gravel deposits, but the areas are so limited that no outline of their areal extent can be definitely made. Some of the wells are non-flowing artesian in character, but most of them are non-artesian and the water does not rise above the aquifer. Many of the wells are of the intermittent type and in years when the precipitation is below normal their yield decreases to such an extent that the supply must be augmented by hauling water from wells having a permanent supply. In most of the wells the supply is sufficient for domestic requirements, in the others it is sufficient or more than sufficient for all the needs of the farm. The water is generally hard, but in most cases is suitable for all farm needs.

Information obtained on a well located on sec. 11, tp. 28, range 17, and drilled to a depth of 186 feet below the surface, and on a 180-foot well on sec. 32, tp. 28, range 18, suggests that there may be a general water-bearing horizon present at this approximate depth. However, with so little available information over the intervening area, it cannot be stated definitely that this horizon extends far. The water in the first well mentioned rises to a point 60 feet below the surface and is being used for all farm purposes.

Dugouts appear to be the best method of obtaining water for stock in this area and these, in conjunction with shallow wells that yield a sufficient supply for household requirements, should relieve the acute shortage of water in the greater part of the township.

## Water-bearing Horizons in the Bedrock

The contact of the bedrock and glacial drift was not established in this municipality, and no wells are known to have tapped a water-bearing horizon in the bedrock. The glacial drift is at least 200 feet thick and along the northern boundary it probably attains a thickness of 400 feet. Shales of the Marine series underlie the glacial deposits throughout the municipality. It is probable that bedrock aquifers would be encountered over most of the municipality by drilling to depths of at least 350 feet, but the quality and quantity of the water likely to be obtained cannot be ascertained until such wells have been drilled.

## GROUND WATER CONDITIONS BY TOWNSHIPS

### Township 28, Range 16

The surface of the township is almost flat, the difference in relief being only 35 feet. Many small lakes, the chief of which is Kutawa lake, occur throughout the township. The glacial drift is wholly in the form of a moraine.

Small, scattered deposits of sand and gravel that occur as pockets throughout the glacial clay at depths up to 85 feet below the surface, form the only known water-bearing horizon in this township. The limited extent of these pockets is shown by encountering dry holes in the vicinity of producing wells. Many of the wells become dry in the autumn and winter months, necessitating the hauling of water. Most of the wells in this township are affected by the amount of precipitation. The water in two wells located on the SW.$\frac{1}{4}$, sec. 12, and NE.$\frac{1}{4}$, sec. 14, however, is under sufficient hydrostatic pressure to rise to a point a few feet below the surface and the yield is more than sufficient for local needs. The water is moderately hard and in only a few cases is it too highly mineralized to be used for drinking. The use of dugouts for stock is highly recommended in this township.

### Township 28, Range 17

There are many small lakes throughout the township and although the difference in surface relief is only 75 feet, the surface is somewhat rolling and irregular. The entire township is mantled by part of a large, terminal moraine. Ground water conditions in this township are only fair, the main supply being obtained from scattered sand and gravel pockets occurring within 85 feet of the surface. In the southeastern corner of the township the pockets appear to be fairly continuous and the water supply is better than over the remainder of the area. Dry holes 100 feet deep show the limited extent and local distribution of the sand and gravel lenses. Only a few of the wells become completely dry in the winter, but in a good many the supply is insufficient for local needs. The water is generally hard and in some cases slightly "alkaline", but most of it is used for drinking.

One well located on the NW.¼, sec. 11, has tapped an aquifer at a depth of 186 feet below the surface at an elevation of 1,964 feet above sea-level. The water is under pressure and rises to a point 60 feet below the surface. The areal extent of this horizon is undefined. The yield is more than sufficient for local needs and the water is used for all purposes. Dugouts are recommended for securing a supply of water for stock use in this township, especially in the northwestern half.

Township 28, Range 18

The surface of this township rises gently from the west to the east, the difference in elevation being less than 100 feet. Small lakes are not so common as in the townships to the east, although the surface is also mantled by part of a glacial moraine. Widely scattered pockets of sand and gravel located throughout the blue clay at depths up to 70 feet below the surface form the main source of ground water supply in this township. Dry holes to a depth of 160 feet have been reported. If a supply of water is not obtained within 80 feet of the surface, it will probably not be encountered before a depth of 160 feet is reached. The water varies from comparatively soft in the shallow wells to hard in the deeper wells, but in most cases it is being used for all farm purposes.

One well located on the SW.¼, sec. 32, encountered an aquifer at a depth of 180 feet below the surface or at an elevation of 1,885 feet above sea-level, but drilling was continued and the supply shut off. The well was sunk to a depth of 280 feet without encountering another water-bearing horizon. It is not known if the aquifer that occurs at a depth of 180 feet is of limited extent, or if it continues over a considerable area. No data are available concerning the type of water or the supply that might be expected at depth. Dugouts are recommended as a means of storing run-off water for stock use.

### Township 29, Range 16

The surface of this township is slightly rolling and somewhat irregular and it is mantled by part of a large moraine. Eleven square miles of area within the borders of this township are occupied by Day Star Indian reserve, and remain unsubdivided.

Small supplies of water are being obtained from scattered sand and gravel pockets that occur in the drift down to a depth of 107 feet. These pockets are of very limited extent and distribution as many dry holes have been sunk, some attaining a depth of 120 feet.

In a few of the wells the water is under hydrostatic pressure and rises to a point 20 feet below the surface, but the large majority of the wells are non-artesian. Some of the wells become almost dry in the early autumn months and the supply must be augmented by hauling. In about one-half the wells the supply is sufficient for local needs, but all of the wells are directly dependent upon annual precipitation for their yield. All of the water from the wells in this township can be used for drinking as well as for stock. By using shallow wells for domestic supplies and dugouts for the storage of run-off waters for stock, sufficient supplies of water for local needs should be obtained in this township.

### Township 29, Range 17

Only 15 square miles of this township are discussed in this report, the remainder being part of the Poor Man and Day Star Indian reserves. Many lakes, the largest of which is Whitewood, occur in the township. A part of a large terminal moraine covers the entire township.

With few exceptions most of the wells in this township have tapped shallow sand and gravel aquifers within 30 feet of the surface. The pockets that form these aquifers are widely scattered in the glacial clay and give no appearance of continuity throughout the area. Some of these wells dry up during the autumn months, whereas others yield a supply that is often more than sufficient for local needs the year through. Generally speaking, the water is suitable for all farm needs. One well located on the NE.$\frac{1}{4}$, sec. 14, is obtaining more than an adequate supply of hard, usable water, from a depth of 90 feet. The areal extent of this horizon is unknown; it may be in the form of a single pocket. However, there should be no acute water shortage in this township as the many small lakes that exist can be used for watering stock and a sufficient supply of water for domestic use can be usually obtained at shallow depth.

Township 29, Range 18

The eastern 2 miles of this township is part of the Poor Man Indian reserve. The surface of the township is slightly rolling and the general rise is from west to east, the lowest point, 1,960 feet above sea-level, being in the northwestern corner. Terminal moraine covers the township, but small lakes are less numerous than in the area to the east.

The main water-bearing horizon in this township appears to be formed by scattered sand and gravel deposits that occur as pockets or lenses at the base of the upper weathered zone of the glacial clay. On sections 15, 16, 21, and 22 these pockets appear to be fairly continuous, but over the remainder of the township they are of local distribution. Most of the producing wells in the township are less than 40 feet in depth. Dry holes have been encountered in almost all sections of the township, some of them attaining a depth of 200 feet. Many of the wells are intermittent in character, others yield supplies that are only sufficient for domestic needs, and a very few yield a supply that is more than sufficient for farm requirements. However, a few shallow wells located near the central part of the township yield an abundant supply, and many of the other residents haul from these wells. The water in almost all cases is hard, but there is not a high concentration of mineral salts present and in most cases it is being used for drinking. From the evidence on hand it would not appear logical to go deeper than 50 feet in search of water, unless a well to a depth in excess of 150 feet or more was contemplated. If the existing shallow wells do not yield a sufficient supply for stock use, the supply can be augmented by the use of dugouts.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF KUTAWA, NO. 278, SASKATCHEWAN

| | Township | 28 | 28 | 28 | 29 | 29 | 29 | Total No. in municipality |
|---|---|---|---|---|---|---|---|---|
| West of 2nd meridian | Range | 16 | 17 | 18 | 16 | 17 | 18 | |
| Total No. of Wells in Township | | 37 | 50 | 34 | 65 | 16 | 77 | 279 |
| No. of wells in bedrock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| No. of wells in glacial drift | | 37 | 50 | 34 | 65 | 16 | 77 | 279 |
| No.oof wells in alluvium | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Permanency of Water Supply | | | | | | | | |
| No. with permanent supply | | 29 | 44 | 23 | 32 | 11 | 25 | 164 |
| No. with intermittent supply | | 6 | 0 | 1 | 8 | 4 | 13 | 32 |
| No. of dry holes | | 2 | 6 | 10 | 25 | 1 | 39 | 83 |
| Types of Wells | | | | | | | | |
| No. of flowing artesian wells | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| No. of non-flowing artesian wells | | 7 | 5 | 1 | 13 | 0 | 6 | 32 |
| No. of non-artesian wells | | 28 | 39 | 23 | 27 | 15 | 32 | 164 |
| Quality of Water | | | | | | | | |
| No. with hard water | | 34 | 41 | 20 | 38 | 13 | 35 | 181 |
| No. with soft water | | 1 | 3 | 4 | 2 | 2 | 3 | 15 |
| No. with salty water | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| No. with "alkaline" water | | 14 | 22 | 0 | 5 | 0 | 2 | 43 |
| Depths of Wells | | | | | | | | |
| No. from 0 to 50 feet deep | | 25 | 40 | 22 | 34 | 14 | 58 | 193 |
| No. from 51 to 100 feet deep | | 12 | 9 | 6 | 14 | 2 | 18 | 61 |
| No. from 101 to 150 feet deep. | | 0 | 0 | 5 | 17 | 0 | 0 | 22 |
| No. from 151 to 200 feet deep | | 0 | 1 | 1 | 0 | 0 | 1 | 3 |
| No. from 201 to 500 feet deep | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| No. from 501 to 1,000 feet deep | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| No. over 1,000 feet deep | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| How the Water is Used | | | | | | | | |
| No. usable for domestic purposes | | 28 | 31 | 22 | 40 | 14 | 34 | 169 |
| No. not usable for domestic purposes | | 7 | 13 | 2 | 0 | 1 | 4 | 27 |
| No. usable for stock | | 33 | 36 | 22 | 40 | 15 | 37 | 183 |
| No. not usable for stock | | 2 | 8 | 2 | 0 | 0 | 1 | 13 |
| Sufficiency of Water Supply | | | | | | | | |
| No. sufficient for domestic needs | | 28 | 42 | 23 | 32 | 11 | 24 | 160 |
| No. insufficient for domestic needs | | 7 | 2 | 1 | 8 | 4 | 14 | 36 |
| No. sufficient for stock needs | | 19 | 28 | 16 | 25 | 10 | 21 | 119 |
| No. insufficient for stock needs | | 16 | 16 | 8 | 15 | 5 | 17 | 77 |

# 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 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.

## Water from the Unconsolidated Deposits

No samples of water from the wells in this municipality were taken for analyses. The following discussion is based on the physical examination of the waters made in the field, and upon the character of water samples analysed from the surrounding municipalities. The waters obtained from wells sunk in the glacial drift vary from comparatively soft to very hard, but they can generally be used for drinking without any noticeable ill effects. In the water from the shallow wells the "total dissolved mineral content" is not as high as in that from the deeper drift wells. The harmful salts are the sulphates of magnesium and sodium. As deeper aquifers are encountered the salts mentioned above are usually found in greater concentration. Many of the waters from the drift are termed "alkaline", but in the majority of cases these waters are used for domestic needs as well as stock. None of the waters in this municipality was reported as having a laxative effect, so it is probable that $Na_2SO_4$ (Glauber's salt) and $MgSO_4$ (Epsom salts) are not present in any great concentration. The waters do not appear to contain noticeable amounts of iron in solution. The quality of most of the drift water of the municipality is such that if the supply were sufficient it could be used for irrigation.

## Water from the Bedrock

To date no wells are obtaining water from the bedrock in this municipality but if an aquifer be encountered the water from it will probably be moderately hard. The predominant salts will probably be $Na_2SO_4$, $Na_2CO_3$, $NaCl$, $CaSO_4$, and $MgSO_4$. If the calcium and magnesium salts are absent the water will be soft, whereas if the calcium and magnesium salts are present in considerable amounts the water will be hard. From the meagre information furnished by the surrounding municipalities it is probable that bedrock waters would probably prove to be salty and fit only for stock use.