CANADA
DEPARTMENT OF MINES
AND
TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 236

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF TRAMPING LAKE, NO. 380 SASKATCHEWAN

Records collected by C. O. Hage
Compilation by G. S. Hume and C. O. Hage

OTTAWA
1947

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INTRODUCTION

Information on the ground-water resources of east-central Alberta and western Saskatchewan was collected, mostly in 1935, during the progress of geological investigations for oil and gas. The region studied extends from Edmonton in the west to Battleford in the east, and from township 32 on the south to township 59 in western Alberta, township 63 in eastern Alberta, and in part as far north as township 56 in western Saskatchewan.

This region is crossed by North Saskatchewan and Battle Rivers, and includes other more or less permanent streams. Most of the lakes within the area, however, are alkaline, and water is obtained in wells from two sources, namely, from water-bearing sands in surface or glacial deposits, and from sands in the underlying bedrock.

A division has been made in the well records, in so far as possible, between glacial and bedrock water-bearing sands. In investigations for oil and gas, however, the bedrock wells were used to trace the lateral extent of geological formations, with the result that the records deal more particularly with this type of well. No detailed studies were made of the glacial materials in relation to the water-supply, nor were the glacial deposits mapped adequately for this purpose. In almost all of the region investigated in Alberta, and in all but the northeast part of the region studied in Saskatchewan, water can be obtained from bedrock. In a few places, however, the water from the shallower bedrock sands is unsatisfactory, and deeper drilling may be necessary.

The water records were obtained mostly from the well owners, some of whom had acquired the land after the water supply had been found, and hence had no personal knowledge of the water-bearing beds that had been encountered in their wells. Also the elevations of the wells were taken by aneroid barometer and are, consequently, only approximate. In spite of these defects, however, it is hoped that the publication of these water records may prove of value to farmers, town authorities, and drillers in their efforts to obtain water supplies adequate for their needs.

In collecting this information several field parties were employed. These were under the direction of Professors R. L. Rutherford and P. S. Warren of the University of Alberta, C. H. Crickmay of Vancouver, and C. O. Hage, until recently a member of the Geological Survey. The oil and gas investigations of which these water records are a part were undertaken under the general supervision of G. S. Hume.

Publication of Results

The essential information pertaining to ground-water conditions is being issued in reports that in Saskatchewan cover each municipality, and in Alberta cover each square block of sixteen townships beginning at the 4th meridian and lying between the correction lines. The secretary-treasurer of each municipality in Saskatchewan and Alberta will be supplied with the information covering that municipality. Copies of the reports will also be available for study at offices of the Provincial and Federal Government Departments. Further assistance in the interpretation of the reports may be obtained by applying to the Chief Geologist, Geological Survey, Ottawa. Technical terms used in the reports are defined in the glossary.

How to Use the Report

Anyone desiring information concering ground water in any particular locality will find the available data listed in the well records. These should be consulted to see if a supply of water is likely to be found in shallow wells sunk in the glacial drift, or whether a better supply may be obtained at greater depth in the underlying bedrock formations. The wells in glacial drift commonly show no regional level, as the sands or gravels in which the water occurs are irregularly distributed and of limited extent. As the surface of the ground is uneven, the best means of comparing water wells is by the elevations of their water-bearing beds. For any particular well this elevation is obtained by subtracting the figure for the depth of the well to the water-bearing bed from that for the surface elevation at the well. For convenience both the elevation of the wells and the elevation of the water-bearing bed or beds in each well are given in the well record tables. Where water is obtained from bedrock, the name of the formation in which the water-bearing sand occurs is also listed in these tables, and this information should be used in conjunction with that provided on bedrock formations, pages 4 to 8, which describes these formations and gives their thickness and sequence. Where the level of the water-bearing sand is known, its depth at any point can easily be calculated by substracting its elevation, as given in the well record tables, from the elevation of the surface at that point.

With each report is a map consisting of two figures. Figure 1 shows the bedrock formations that will be encountered beneath the unconsolidated surface deposits. Figure 2 shows the position of all wells for which records are available, the class of well at each location, and the contour line or lines of equal surface elevation. The elevation at any location can thus be roughly judged from the nearest contour line, and the records of the wells show at what levels water is likely to be encountered. The depth of the well can then be calculated, and some information on the character and quantity of water can be obtained from a study of the records of surrounding wells.

GLOSSARY OF TERMS USED

Alkaline. The term "alkaline" has been applied rather loosely to some ground waters that have a peculiar and disagreeable taste. In the Prairie Provinces, water that is commonly described as alkaline usually contains a large amount of sodium sulphate and magnesium sulphate, the principal constituents of Glauber's salt and Epsom salts respectively. Most of the so called alkaline waters are more correctly termed sulphate waters, many of which may be used for stock without ill effect. Water that tastes strongly of common salt is described as salty.

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 porous bed, lens, or pocket in unconsolidated deposits or in bedrock that carries water.

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

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

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

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

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

Escarpment. A cliff or a relatively steep slope separating level or gently sloping areas.

Flood Plain. A flat part in a river valley ordinarily above water but covered by water when the river is in flood.

Glacial Drift. The loose, unconsolidated surface deposits of sand, gravel, and clay, or a mixture of these, that were deposited by the continental ice-sheet. Clay containing boulders forms part of the drift and is referred to as glacial till or boulder clay. The glacial drift occurs in several forms:

(1) Ground Moraine. A boulder clay or till plain (includes areas where the glacial drift is very thin and the surface uneven).

(2) Terminal Moraine or Moraine. A hilly tract of country formed by glacial drift that was laid down at the margin of the continental ice-sheet during its retreat. The surface is characterized by irregular hills and undrained basins.

(3) Glacial Outwash. Sand and gravel plains or deltas formed by streams that issued from the continental ice-sheet.

(4) Glacial Lake Deposits. Sand and clay plains formed in glacial lakes during the retreat of the ice-sheet.

Ground Water. Sub-surface water, or water that occurs below the surface of the land.

Hydrostatic Pressure. The pressure that causes water in a well to rise above the point at which it is first encountered.

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 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.

(2) Wells in which the water is under pressure but does not rise to the surface.

(3) Wells in which the water does not rise above the water table.

BEDROCK FORMATIONS OF WEST-CENTRAL SASKATCHEWAN AND EAST-CENTRAL ALBERTA

The formations that outcrop in west-central Saskatchewan are an extension of similar formations that occur in east-central Alberta. They are of Upper Cretaceious age, and consist entirely of relatively soft shales and sands, with some bands of hard sandstone and layers of ironstone nodules. The succession, character, and estimated thickness of the formations are shown in the following table:

Formation	Character	Thickness Feet
Edmonton	Grey to white, bentonitic sands and sandstones with grey and greenish shales; coal seams prominent in some areas, as at Castor, Alberta.	1,000 to 1,150
Bearpaw	Dark shales, green sands with smooth black chert pebbles; partly non-marine, with white bentonitic sands, carbonaceous shales or thin coal seams similar to those in Pale Beds; shales at certain horizons contain lobster claw nodules and marine fossils; at other horizons are abundant selenite crystals.	300 to 600 thins rapidly to the northwest
Pale and Variegated Beds	Light grey sands with bentonite; soft, dark grey and light grey shales with selenite and ironstone; carbonaceous shales and coal seams; abundant selenite crystals in certain layers.	950 to 1,000 in Czar-Tit Hills area; may be thinner elsewhere
Birch Lake	Grey sand and sandstone in upper part; middle part of shales and sandy shales, thinly laminated; lower part with grey and yellow weathering sands; oyster bed commonly at base.	100 in west, but less to east and south
Grizzly Bear	Mostly dark grey shale of marine origin, with a few minor sand horizons; selenite crystals and nodules up to 6 or 8 inches in diameter	Maximum, 100
Ribstone Creek	Grey sands and sandstones at the top and bottom, with intermediate sands and shales; thin coal seam in the vicinity of Wainwright; mostly non-marine, but middle shale in some areas is marine.	Maximum, 325 at Viking; thins eastward
Lea Park	Dark grey shales and sandy shales with nodules of ironstone; a sand 70 feet thick 110 feet below the top of the formation in the Ribstone area, Alberta.	950 to 1,100

Edmonton Formation

The name Edmonton formation was first applied to the beds containing coal in the Edmonton area, and later to the same beds in adjoining areas. The formation has a total thickness of 1,000 to 1,150 feet, but is bevelled off eastward and the east edge of the formation follows a northwest line from Coronation through Tofield to a point on North Saskatchewan River about midway between Edmonton and Fort Saskatchewan. No Edmonton beds occur northeast of this line, but the formation becomes progressively thicker to the southwest due to the fact that the beds incline in that direction and the surface bevels across them.

The Edmonton formation consists of poorly bedded grey and greenish clay shales, coal seams, and sands and sandstones that contain clay and a white material known as bentonite. This material when wet is very sticky and swells greatly in volume, and when dry tends to give a white appearance to the beds containing it. Such beds are relatively impervious to water, and at the surface produce the "burns" of barren ground where vegetation is scanty or absent.

Water is relatively abundant in the Edmonton formation, which contains much sand, commonly in the form of isolated lenses distributed irregularly through the formation. Consequently, there is little uniformity in the depth of wells even within a small area. Water also occurs commonly with coal seams and, unlike the sand lenses, these beds are much more regular and persistent. In contrast with the water from the bentonitic sands, which is generally "soft", water from the coal seams, as the water from the shallow surface deposits, may be "hard". The basal beds of the Edmonton formation usually contain fresh water, but this may become brackish locally where the underlying Bearpaw beds contain highly alkaline or salty water.

Bearpaw Formation

In southern Alberta, where the Bearpaw formation is thickest, the beds composing it are mainly shales that have been deposited in sea water. In the area north of township 32 the formation thins to the northwest and becomes a shoreline deposit composed of shales containing bentonite, impure sands, and thin coal seams. In some areas, as at Ryley and near Monitor, and in the Neutral Hills, the Bearpaw contains pebble beds. At Ryley these are consolidated into a conglomerate, but mostly the pebbles are loosely distributed in shale or sandy beds.

In the area immediately north of township 32 the Bearpaw occupies a widespread belt beneath the glacial drift, but farther northwest the belt narrows, and at Ryley and northwestward it is only a few miles wide. This belt crosses North Saskatchewan River about midway between Edmonton and Fort Saskatchewan. Bearpaw beds form the main bedrock deposits of the Neutral Hills. Farther south, where they have an exposed thickness of at least 400 feet, they contain green sands, and beds of marine shale interfinger with the bentonitic shales and sands of the underlying formation. To the north, on the banks of North Saskatchewan River, the division between the Bearpaw and the overlying and underlying formations is indefinite, and the thickness of beds of Bearpaw age is relatively small.

The water in the Ryley area is from the Bearpaw formation, and is salty. In other areas to the south the marine Bearpaw formation carries green sand beds that yield fresh water, but commonly a much better supply is found by drilling through the Bearpaw into the underlying Pale Beds.

In Saskatchewan, Bearpaw beds occur southeast of Maclin and south of Luseland and Kerrobert. Only the basal beds are present, and these contain green sands that are commonly water-bearing.

Pale and Variegated Beds

Underlying the Bearpaw formation is a succession of bentonitic sands, shales, and sandy shales containing a few coal seams. The upper part of this succession, due to the bentonitic content, is commonly light coloured and has been described as the Pale Beds, whereas the lower part is darker, and is known as Variegated Beds. In part, dark shales are present in both Pale and Variegated Beds; others are greenish, grey, brown, and dark chocolate, carbonaceous types. The sands may also be yellow, but where bentonite is present it imparts a light colour to the beds. Both Pale and Variegated Beds are characterized by the presence of thin seams of ironstone, commonly dark reddish, but in part purplish, Selenite (gypsum) crystals are, in places, abundant in the shales.

The best sections of Pale Beds exposed in the region are in the Tit Hills, southwest of Czar. These hills carry a thin capping of Bearpaw shales, beneath which, and around Bruce Lake, more than 200 feet of Pale Beds are exposed. The total thickness of Pale and Variegated Beds in the Tit Hills area is about 970 feet. Variegated Beds outcrop near Hawkins on the Canadian National Railway west of Wainwright, but no area exposes the complete succession, which is considered to comprise about 200 feet of beds.

Records of wells drilled into the Pale and Variegated Beds do not, in general, indicate lateral persistence of sands for long distances, nor any uniform average depth to water-bearing sands in a local area. This points to the conclusion that the sands are mainly local lenses, but as such lenses are numerous, few wells fail to obtain water. In the Cadogan area many flowing wells have been obtained from sands about midway in the succession. In western Saskatchewan Paleland Variegated Beds occur over a wide area from Maclin and Kerrobert northeast through Wilkie to the Eagle Hills, south of Battleford. Numerous outcrops occur in the area south of Unity at Muddy Lake, but south and east around Biggar these beds are almost wholly concealed by glacial drift.

The water from the sands of the Pale and Variegated Beds is generally soft. The supply, apparently, is dependent in part on the size of the sand body that contains the water and in part on the ease with which water may be replenished in the sand. Small sand lenses surrounded by shales may be filled with water that has infiltrated into them, but when tapped by a well the supply may be very slowly replenished. In many instances such wells yield only a small supply, although this is commonly persistent and regular.

Birch Lake Formation

The Birch Lake formation underlies the Variegated Beds, but in many areas the division is not sharp. The type area of the formation is along the north shore of Birch Lake south of Innisfree, where a section 65 feet thick, composed mostly of sand, is exposed. The total thickness of the formation in this area is about 100 feet, and although this is dominantly sand a central part is composed of alternating thin sand and shale beds. At the base of the formation, in a number of places, is an oyster bed, and this is exposed in a road cut in a section 73 feet thick on the east side of Buffalo Coulée in sec. 3, tp. 47, rge. 7, W. 4th mer. In both upper and lower parts of the formation the sand is commonly massive and outcrops tend to consolidate into hard, nodular masses from a foot to a few feet in diameter. Apparently these are formed through the deposition of salts from the water that finds an outlet at the outcrops. In fact, in some areas the sand may be traced along the side of a hill by the presence of small springs or nodular masses of sandstone.

The Birch Lake formation occurs under the drift and in outcrops in a large area south of North Saskatchewan River and northeast of a line from Willingdon to Innisfree and Minburn. East of this area the southwest boundary is more irregular, but outcrops are persistent on the banks of Battle River from a few miles north of Hardisty to and beyond the mouth of Grizzly Bear Coulée in tp. 47, rge. 5. It is believed, too, that a large area near Edgerton and Chauvin is underlain by the Birch Lake formation and that it extends southeastward into Saskatchewan around Manitou Lake and southeast to Vera.

It is thought that the Birch Lake formation thins eastward from its type section at Birch Lake, and that it loses its identity in western Saskatchewan. Deep wells drilled at Czar, Castor, and elsewhere no longer show the Birch Lake as a clearly recognizable sand formation, so that its southern limit beneath younger formations is unknown. Wherever it occurs as a sand, however, it is water-bearing, although in some areas the sand is apparently too fine to yield any considerable volume of water. In other areas, however, it persistently yields good wells. There is no apparent uniformity in the character of the water, which is either hard or soft in different wells in the same general area. Direct contact with surface waters that contain calcium sulphates may in time change a "soft" water well to a "hard" water well, and many wells are not sufficiently cased to prevent the percolation of water from surface sands into the well, and hence into the deeper, soft water producing sands. In part this accounts for the change in character of the water in a well, a feature that has been noticed by many well owners.

Grizzly Bear Formation

The type locality for the Grizzly Bear formation, which underlies the Birch Lake beds, is near the mouth of Grizzly Bear Coulée, a tributary of Battle River with outlet in tp. 47, rge. 5. The formation is mainly composed of dark shales that were deposited in sea water. At the mouth of Grizzly Bear Coulée two shale sections, each about 100 feet thick, are separated by a zone of thin sand beds. It is now recognized that the upper section is the Grizzly Bear shale, and that the lower one, very similar in character and also deposited in sea water, occurs in the next lower formation, the Ribstone Creek. The Grizzly Bear shale contains a thin nodular zone about 50 feet above the base, that is, at about the centre of the formation. This zone is sandy, and is believed to yield water in various wells. Other thin sands, in places water-bearing, are also present. The impervious nature of the Grizzly Bear shales makes the overlying Birch Lake sand a strong acquifer, as water collects in the sand above the shale. The contact of the Birch Lake and Grizzly Bear formations can be traced in some places by the occurrence of springs issuing from the base of the Birch Lake sand even where this is not exposed.

Grizzly Bear shales occur in a road cut on the south side of Battle River near the highway bridge at Fabyan. The shales in this area are about 100 feet thick. It is thought they extend as far west as the Viking gas field, where they have been recognized in samples from deep wells. It is probable, however, that the shales thin westwardrand thicken eastward so that their general form is a wedge between both higher and lower sand beds. The position of the thin edge of the wedge to the west is unknown, but evidently the Grizzly Bear marine shale underlies a large area in east-central Alberta extending into Saskatchewan mainly in the area south of Battle River.

Ribstone Creek Formation

The type area of the Ribstone Creek formation is on Ribstone Creek near its junction with Battle River in tp. 45, rge. 1, W. 4th mer. At this place the lower sand beds of the formation are well exposed. The upper part of the lower sand member of this formation outcrops on the north side of Battle River, in the northeast part of sec. 26, tp. 47, rge. 5, near the mouth of Grizzly Bear Coulée, Above it, higher on the bank and at a short distance from the river, there is a 12 foot zone of carbonaceous and coaly beds in two layers, each about 2 feet thick, separated by 8 feet of shale. Above this are 90 feet of dark shales that are thought to have been deposited in sea water, that is, they are marine shales. These marine shales in turn are overlain by a sandy zone about 20 feet thick containing oysters in the basal part. This sandy zone is the upper sand member of the Ribstone Creek formation.

It thickens to the east and west from the Grizzly Bear area but is probably at no place much more than 50 feet thick.

The lower sand member of the Ribstone Creek formation also varies in thickness from a minimum of about 25 feet. On the banks of Vermilion Creek, north of Mannville, the basal sand is at least 60, and may be 75,feet thick. It is overlain by shaly sand and sandy shale beds, which replace the shale beds in the central part of the formation as exposed at the mouth of Grizzly Bear Coulée. In the Wainwright area, where the formation has been drilled in deep wells, the basal sand is 60 feet thick, with the central part composed of shale containing sand streaks. The upper sand member is about 20 feet thick in this area. The total thickness of the formation in the Wainwright area is 100 to 200 feet, but this increases to the west and in the Viking area exceeds 300 feet.

The Ribstone Creek formation is widely exposed in a northwest-trending belt in east-central Alberta. The southwest boundary of this northwest-trending belt passes through the mouth of Grizzly Bear Coulée in tp. 47, rge. 5, and beyond to the Two Hills area in tp. 54, rge. 12, whereas the northeast boundary crosses North Saskatchewan River southwest of Elk Point and extends northwest to include an area slightly north of St. Paul des Metis and Vilna to tp. 60, rge. 14. Within this belt water wells are common in the Ribstone Creek sands, which are almost without exception water-bearing in some part of the formation. The limits of the belt to the northeast determine the limits of water from this source, but to the southwest of the belt, as here outlined, water may be obtained in this formation by drilling through the younger beds that overlie it. The Ribstone Creek sands are a prolific source of water in many places and hence the distribution of this formation is of considerable economic importance. Where the formation consists of upper and lower sands with a central shale zone only the sands are water-bearing, although thin sand members may occur in the shale. Where the formation is largely sand the distribution of water may be in any part of the formation, although the upper and lower sands are perhaps the better aquifers. To the east of Alberta, along Battle River and Big Coulée in Saskatchewan, the Ribstone Creek sands are marine. Marine conditions apparently become more prevalent to the southeast and it is believed that in this direction the sands are gradually replaced by marine shales. Thus at some distance southeast of Battleford the Ribstone Creek formation loses its identity and its equivalents are shales in a marine succession.

Lea Park Formation

The Lea Park formation is largely a marine shale, and only in the upper 180 feet is there any water. In the Dina area south of Lloydminster the upper beds of the Lea Park consist of silty shales about 110 feet thick underlain by silty sands 70 feet thick. Below these sands are marine shales only, and these yield no fresh water either in east-central Alberta or west-central Saskatchewan. The sand in the upper Lea Park formation is thus the lowest freshwater aquifer within a very large area. The extent of this sand in the Lea Park, particularly to the northeast, is not known, but as the strata in east-central Alberta have a southwest inclination, progressively lower beds occur at the surface to the northeast. Thus at a short distance beyond the northeast boundary of the Ribstone Creek formation, as previously outlined, the sand in the upper Lea Park reaches the surface, and represents the last bedrock aquifer in that direction. Farther northeast water must be obtained from glacial or surface deposits only. In Alberta this area without fresh water in the bedrock includes the country north of North Saskatchewan River in the vicinity of Frog Lake and a large area extending to and beyond Beaver River. In this area, however, more fresh water streams are present than farther south, and bush lands help to retain the surface waters. The area northeast of North Saskatchewan River in Saskatchewan is almost wholly within the Lea Park formation, where water can be found only in surface deposits.

WATER ANALYSES

Introduction

Analyses were made of water samples collected from a large number of wells in west-central Saskatchewan. Their purpose was to determine the chemical characteristics of the waters from different geological horizons, and thereby assist in making correlations of the strata in which the waters occur. Although this was the main objective of the analyses, it was also realized that a knowledge of the mineral content of the water is of interest and value to the consumer. The analyses were all made in the laboratory of the Water Supply and Borings Section of the Geological Survey, Ottawa.

Discussion of Chemical Determinations

The dissolved mineral constituents vary with the material encountered by the water in its migration to the reservoir bed. The mineral salts present are referred to as the total dissolved solids, and they represent the residue when the water is completely evaporated. This is expressed quantitatively as "parts per million", which refers to the proportion by weight in 1,000,000 parts of water. A salt when dissolved in water separates into two chemical units called "radicals", and these are expressed as such in the chemical analyses. In the one group is included the metallic elements of calcium (Ca), magnesium (Mg), and sodium (Na), and in the other group are the sulphate (SO4), chloride (Cl), and carbonate (CO_3) radicals.

The analyses indicate only the amounts of the previously mentioned radicals, thus neglecting any silica, alumina, potash, or iron that may be present. It will be noticed that in most instances the total solids are accounted for by the sum total of the radicals as shown by the analyses. Actually, the residue when the water is completely evaporated still retains some combined water of crystallization, so that the figures for the "total solids" are higher than the sum total of the radicals as determined. These radicals are also "calculated in assumed combinations" to indicate the theoretical amounts of different salts present in the water. The same method was followed in each analysis, so that the table presents a consistent record of the different compounds present.

Mineral Constituents Present

Calcium. Calcium (Ca) in the water comes from mineral particles present in the surface deposits, the chief source being limestone, gypsum, and dolomite. Fossil shells provide a source of calcium, as does also the decomposition of igneous rocks. The common compounds of calcium are calcium carbonate ($CaCO_3$) and calcium sulphate ($CaSO_4$).

Magnesium. Magnesium (Mg) is a common constituent of many igneous rocks and, therefore, very prevalent in ground water. Dolomite, a carbonate of calcium and magnesium, is also a source of the mineral. The sulphate of magnesia ($MgSO_4$) combines with water to form "Epsom salts" and renders the water unwholesome if present in large amounts.

Sodium. Sodium (Na) is derived from a number of the important rock-forming minerals, so that sodium sulphate and carbonate are very common in ground waters. Sodium sulphate (Na_2SO_4) combines with water to form "Glauber's salt" and excessive amounts make the water unsuitable for drinking purposes. Sodium carbonate (Na_2CO_3) or "black alkali" waters are mostly soft, the degree of softness depending upon the ratio of sodium carbonate to the calcium and magnesium salts. Waters containing sodium carbonate in excess of 200 parts per million are unsuitable for irrigation purposes[1]. Sodium sulphate is less harmful.

Sulphates. The sulphate (SO_4) salts referred to in these analyses are calcium sulphate ($CaSO_4$), magnesium sulphate ($MgSO_4$), and sodium sulphate (Na_2SO_4).

Chloride. Chlorine (Cl) is with a few exceptions, expressed as sodium chloride (NaCl), that is, common table salt. It is found in all of the analyses, most of the waters containing less than 200 parts per million, but some as much as 2,000 or 3 ,000 parts. These waters have a brackish taste.

Alkalinity. The alkalinity determined in these water analyses is based on the assumption that the only salts present in the samples that will neutralize acids are carbonates, and that, consequently, the degree of alkalinity is proportional to the amount of the carbonate radical (CO_3) present.

Hardness. The hardness of water is the total hardness, and has been determined by the amount of a standard soap solution required to form a lather that will stand up (persist) for 2 minutes. Hardness is of two kinds, temporary and permanent. Temporary hardness is caused by calcium and magnesium bicarbonates, which are soluble in water but are precipitated as insoluble normal carbonates by boiling, as shown by the scale that forms in teakettles. Permanent hardness is caused by the presence of calcium and magnesium sulphates, and is not removed by boiling. The two forms of hardness are not distinguished in the water analyses. Waters grade from very soft to very hard, and can be classified according to the following system[2]:

A water under 50 degrees (that is, parts per million) of hardness may be said to be very soft.
A water with 50 to 100 degrees of hardness may be said to be moderately soft.
A water with 100 to 150 degrees of hardness may be said to be moderately hard.
A water with more than 200 and less than 300 degrees of hardness may be said to be hard.
A water with more than 300 degrees of hardness may be said to be very hard.

Hard waters are usually high in calcium carbonate. Almost all of the waters from the glacial drift are of this type, especially those not associated with sand and gravel deposits that come close to the surface.

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[1] "The extreme limit of salts for irrigation is taken to be 70 parts per 100,000, but plants will not tolerate more than 10 to 20 parts per 100,000 of black alkali (alkaline carbonates and bicarbonates)" Frank Dixey in "A Practical Handbook of Water Supply", Thos. Murby & Co., 1931, p. 254.

[2] The "Examination of Waters and Water Supplies", Thresh & Beale, page 21, Fourth Ed. 1933 .

In soft water the calcium carbonate has been replaced by sodium carbonate, due to natural reagents present in the sand and clays. Bentonite and glauconite are two such reagents known to be present. Montmorillinite, one of the clay-forming minerals, has the same property of softening water, owing to the absorbed sodium that is available for chemical reaction[1].

If surface water reaches the lower sands by percolating through the higher beds it may be highly charged with calcium salts before reaching the bedrock formations containing bentonite or glauconite. The completeness of the exchange of calcium carbonate for sodium carbonate will, therefore, depend upon the length of time that the water is in contact with the softening reagent, and also upon the amount of this material present. The rate of movement of underground water will, consequently, be a factor in determining the extent of the reaction.

The amount of iron present in the water was not determined, owing to the possibilities of contamination from the iron casings in the wells. Iron is present in most waters, but the amount may be small. Upon exposure to air a red precipitate forms, the water becomes acid, and, hence, has a corrosive action. When iron is present in large amounts the water has an inky taste.

WATER ANALYSES IN RELATION TO GEOLOGY

Glacial Drift

The quality of the water from glacial drift depends largely on the nature of the deposit from which it comes and on the depth of the aquifer below the surface. Glacial deposits may be divided roughly into three types.

(1). Sand and gravel beds that form the surface deposit, such as outwash material and glacial lake sands.

(2). Buried outwash and interglacial deposits between two tills of boulder clay.

(3). Pockets or lenses of sand and gravel irregularly distributed through the till.

Water from surface sand deposits is normally low in dissolved salts, the total being generally less than 1,000 parts per million. Where large amounts of limestone occur in the glacial sand and gravel beds a characteristic constituent of the glacial water is calcium carbonate, the amount present varying from 300 to 700 parts per million.

Water from buried outwash deposits contains more dissolved salts than the surface sands, as the water in order to reach them has to percolate through overlying till. Rain water contains carbonic acid, which acts as a solvent and dissolves a great deal of calcium, magnesium, and sodium from the rock-forming minerals. Sulphate salts are commonly present, though their proportions vary greatly in the different waters. The shales that are incorporated in the drift are high in calcium sulphate, so that the amount of shale present will modify the quality of the water. The oxidized upper part of the drift contains less sulphate than the deeper, less oxidized boulder clay. The character of the water in the buried outwash deposits will, therefore, depend largely on the composition and amount of till that overlies it.

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[1] Piper, A. M. "Ground Water in Southwestern Pennsylvania", Penn. Geol. Surv., 4th series.

Water from irregularly distributed sand and gravel beds will vary in its content of dissolved salts depending upon the character of the material surrounding the reservoir beds. As the water in this type of deposit does not flow to any marked extent, it is apt to be more highly impregnated with soluble salts than where the underground movement is more rapid. Soft water in the drift is mostly confined to shallow wells in sands low in calcium carbonate. Waters from glacial lake clays are sometimes high in soluble salts. The sample from a well in glacial lake clay on N.W. ¼ sec. 27, tp. 42, rge. 17, has 11,040 parts per million of soluble salts, largely magnesium sulphate and sodium sulphate. The sample from SE. ¼ sec. 13, tp. 42, rge. 16, which is believed to come from glacial lake silts, has a very different composition. The total solids in it are only 440 parts per million, of which 250 are calcium carbonate. The great difference in these waters is due to the high soluble salt content that is associated with the lake clays but absent in the silts. Average drift water contains between 1,000 and 3,000 parts per million of dissolved mineral salts.

Bearpaw Formation

The Bearpaw formation consists of dark marine shales and beds of green sand. Water from these sands has a total solid count ranging from 300 to 1,600 parts per million and a hardness of more than 300 degrees. Calcium carbonate is very marked in all samples, due, perhaps, to the proximity of the water sands to the glacial drift. Sodium sulphate is the chief salt present, followed by calcium carbonate, magnesium sulphate, magnesium carbonate, and sodium chloride in decreasing amounts. These waters are distinguished from the overlying drift waters by being relatively low in total dissolved solids, and in containing no calcium sulphate and only moderate amounts of sodium sulphate, magnesium sulphate, and magnesium carbonate.

Pale Beds

Pale Beds underlie the Bearpaw formation. Total solids in waters from these beds vary from 700 to 1,300 parts per million. The water is, in most instances, soft, as it contains sodium carbonate in excess of calcium and magnesium carbonates, but when mixed with surface water high in calcium carbonate, it will become hard. The high concentration of sodium salts, especially sodium carbonate, in contrast with the calcium and magnesium salts distinguishes this water from that in Bearpaw sands. The Pale Beds include much bentonite, and it is this mineral that acts as a water softener within the formation. The following analyses are typical of waters from the Pale Beds:

Salts	SE. sec. 16, tp.38, rge. 21	NE. sec. 3, tp.39, rge. 25,	SW. sec. 7, tp.37, rge.24,	SE. sec. 21 tp. 38, rge.23
$CaCO_3$	73	18	53	35
$CaSO_4$	-	-	-	-
$MgCO_3$	52	14	45	38
$MgSO_4$	-	-	-	-
Na_2CO_3	297	679	464	562
Na_2SO_4	297	158	266	437

NaCl	31	45	46	130
Total solids	760	1,020	940	1,260
Hardness	100	20	30	75

Variegated Beds

In Senlac Rural Municipality, Saskatchewan, are a number of wells that have water very similar in character to that found in the Bearpaw formation. These wells tap an horizon that corresponds with the Variegated Beds in Alberta, although they have not been separated from the Pale Beds. They are less bentonitic than the Pale Beds and darker in colour. The water is hard and has a low dissolved solid content. The three analyses given below show a great deal of similarity and suggest a common horizon.

Salts	NW. sec. 21, tp.41,rge.26	NW. sec. 3, tp.41,rge.28	SE. sec. 28, tp.40,rge.28
$CaCO_3$	250	305	125
$CaSO_4$	–	–	–
$MgCO_3$	1109	80	155
$MgSO_4$	149	104	69
Na_2CO_3	–	–	–
Na_2SO_4	98	132	386
NaCl	12	12	18
Total solids	640	640	780
Hardness	600	600	500

Ribstone Creek Formation

Chemical analyses of water from the Ribstone Creek formation vary more than in the Pale Beds, the reason being that at several different horizons the sediments show considerable lateral variation. The formation includes both marine and non-marine beds, thin coal seams being present in the basal part of the formation around Paynton, whereas south of Lashburn, on Battle River, marine fossils were found in strata considered to be at approximately the same horizon. The water analyses show similarities within limited areas, but long distance correlations cannot be made safely except for the saline waters that occur in the flowing wells at Vera, Muddy Lake, and at the south end of Tramping Lake. Analyses of these waters are given in the following table:

Salts	SE.sec.25, tp.41,rge. 24	SE.sec.22, tp.41,rge. 24,	NE.sec.36, tp.41,rge. 24,	SW.sec.7 tp.41,rge. 24,	SE.sec.30, tp.38, rge. 22,	SW.sec10, tp.35, rge.20,
$CaCO_3$	73	73	73	198	108	90
$CaSO_4$	–	–	–	–	–	–
$MgCO_3$	38	38	38	52	69	52
$MgSO_4$	–	–	–	–	–	–

Na_2CO_3	129	119	129	11	106	125
Na_2SO_4	55	55	61	61	49	43
NaCl	2,929	3,036	2,690	2,863	3,531	3,861
Total solids	3,840	3, 460	3,120	3,200	3,860	4,460
Hardness	135	90	110	100	130	130

The similarity in these anlayses suggests a common source bed. The distance between the Tramping Lake well and the Vera wells is about 40 miles. This water, which is thought to come from the basal sand of the Ribstone Creek formation, is not typical of water from the same stratigraphical horizon in the vicinity of Battle River, one reason being, possibly, that at Battle River the stream has cut through the Ribstone Creek formation exposing the sand members along its banks. This may cause a more rapid movement of the underground water in this area than farther south, and it is known that the rate of flow is a controlling factor that governs the change of calcium carbonate to sodium carbonate when the softening reagents of bentonite or glauconite are present in the sand.

Some of the soft waters from the Ribstone Creek formation cannot be distinguished from those of the Pale Beds, whereas others are quite different. The following analyses illustratetsome of the different types of water from this formation:

Salts	Se.sec. 11, tp. 46, rge. 28	Ind.Agent Little Pine I.R.	SW.sec. 24, tp. 46, rge. 21	NE.sec. 36, tp. 43, rge. 18	Se.sec. 26. tp. 43, rge. 18	NE.sec. 36. tp. 41, rge. 24	NW.sec. 22. tp. 42. rge. 23
$CaCO_3$	90	90	410	73	35	73	125
$CaSO_4$	-	-	-	-	-	-	-
$MgCO_3$	97	59	168	38	31	38	97
$MgSO_4$	-	-	64	-	-	-	-
Na_2CO_3	217	392	-	283	592	129	196
Na_2SO_4	1,644	777	2,518	225	522	61	1,541
NaCl	249	63	76	12	83	2,690	71
Total solids	2,220	1,340	3,000	620	1,260	3,120	1,900
Hardness	280	160	750	110	35	110	600

The above chemical analyses show such a wide range in the dissolved salts present in the different waters in the Ribstone Creek formation that they cannot be used for correlation purposes over a large area.

Conclusions

(1) In most instances water from glacial drift is quite different from water from bedrock.

(2) Some of the bedrock horizons carry waters that show definite chemical characteristics.

(3) Most waters from glacial till carry total solids amounting to between 1,000 andn3,000 parts per million.

(4) Bedrock waters are commonly low in dissolved salts. Exceptions to this are to be found in water from the Ribstone Creek formation.

(5) Water from the Bearpaw formation is hard. An average of ten wells gave a total solid content of 1,100 parts per million.

(6) Water from the Variegated Beds resembles that from the Bearpaw formation.

(7) Waters from the Pale Beds is mostly soft. An average of ten wells gave a total solid of 1,000 parts per million.

(8) All soft waters contain sodium carbonate (Na_2CO_3), which is present in water from the Pale Beds and Ribstone Creek formations but absent from the Bearpaw formation and Variegated Beds.

RURAL MUNICIPALITY OF TRAMPING LAKE, NO. 380, SASKATCHEWAN

Physical Features

The most striking feature of this municipality is the depressed basin of Muddy Lake, which has an elevation of 1,866 feet and no apparent outlet below 2,000 feet. The origin of the basin is unknown. Presumably, it had a drainage outlet in pre-Glacial time, but this has been completely obliterated. As Tramping Lake has an elevation of 2,018 feet, and as bedrock is exposed on both sides of it, it is improbable that the narrow trench occupied by the lake was ever much deeper than it is at present. The drainage from Muddy Lake, therefore, could hardly have been by Eaglehill Creek. A valley enters Muddy Lake from End Lake, which in turn is connected with a valley past Unity to Akerlund Lake. The drainage, however, suggested by the present valley would be southward rather than northward. Muddy Lake is now dry and the bottom is, in part, grassed over. Grill Lake is another depressed, dry basin, with exposures of Pale Beds on the east side. It has an elevation of 2,069 feet, more than 200 feet higher than Muddy Lake basin, but likewise has no outlet. To the east and north of Grill Lake is a stony moraine, but the drift immediately south of Muddy Lake is thin. Eaglehill Lake and Creek draining into Tramping Lake occupy the only prominent creek valley in the municipality. The west side of Tramping Lake has steep banks that in places are almost 100 feet high.

Geology

The municipality is covered by a mantle of drift through which, on the north side of Muddy Lake and the east side of Grill Lake, project outcrops of Pale Beds. The highest outcrops have an elevation of more than 2,000 feet, and coal streaks have been reported from wells as high as 2,066 feet. In the well drilled by Northwest Company, Limited, on sec. 7, tp. 39, rge. 22, at the northwest end of Muddy Lake, the base of the Pale and Variegated Beds is believed to lie at an elevation of about 1,730 feet, or 130 feet below the level of Muddy Lake, and, presumably, the entire municipality is underlain by these beds.

Water Supply

Sand, and to a less extent gravel, beds in the drift provide the reservoirs for water in many wells. In the northeast corner of the municipality there is some evidence of a buried outwash deposit in the drift, which thins out and disappears westward and does not mark a continuous or dependable horizon. In other places sand and gravel beds are grouped at certain elevations in the drift and are encountered in many wells. In still other places the drift is thin and carries little water, so that wells have been drilled to the underlying bedrock sands. Several of these wells have obtained water in the Pale Beds at elevations above the level of Muddy Lake. It is, therefore, probable that in order to retain the water these sands are lenticular and, if so, must derive their water wholly from downward percolating rain-water. In addition, one prominent, widespread aquifer occurs, presumably, in the Variegated Beds, and another, still deeper, in the Ribstone Creek formation. The latter yields slightly salty water with gas.

Township 37, Ranges 20 and 21, West of Tramping Lake. Most of the wells in this township obtain their supply of water from sand and gravel beds in the glacial drift. Apparently these water-bearing beds are grouped in a zone mainly between elevations of 2,070 and 2,980 feet, but with other wells at both lower and higher elevations. The water-bearing sands above this zone are very irregularly distributed and rather widely scattered, and, as a result, have been encountered in only a few wells, whereas the sand and gravel beds at greater depth are rather numerous and some of them probably have considerable lateral extent. The depth of the glacial drift is not known with any degree of certainty. In the Canadian Pacific Railway well at Revenue gravel was reported at a depth of 144 feet, or an elevation of 2,030 feet. Below this the log of the well shows clay down to the water-bearing sand at a depth of 334 feet, or an elevation of 1,830 feet. It is thought that the 2,030-foot level must represent the approximate base of the drift below which Pale and Variegated Beds occur. Another well, 350 feet deep, on SE. section 34, reached the same horizon in the Variegated Beds at an elevation of 1,844 feet. This is apparently the same sand as was encountered in a well on SW. sec. 36, tp. 36, rge. 21, also at 1,844 feet. Thus it seems safe to infer a widespread water horizon in what is presumed to be Variegated Beds.

Township 37, Range 22. Several wells in this township obtain water in glacial sand and gravel deposits. One well, on SE. section 24, is reported to have encountered gravel at a depth of 80 feet, elevation 2,010 feet. If this is so, the gravel is probably at the base of the drift, as a well on SW. section 12 is reported to have encountered coal, presumably in the Pale Beds, at a depth of 112 feet and elevation of 2,027 feet. Similarly, a well 103 feet deep on SE. section 12 struck coal at an elevation of 2,005 feet. This places the contact of the drift and the underlying Pale Beds just slightly above an elevation of 2,000 feet. A well, 90 feet deep, on SW. section 30 obtained water at an elevation of 2,001 feet, and another, 85 feet deep, on NE. section 35 obtained water at 2,000 feet. It is not known whether these are in sands at the base of the drift or in sands in the Pale Beds, as apparently from the records a water-bearing sand in the Pale Beds at about the 2,000-foot level immediately underlies the drift. A deeper horizon of the Pale Beds, at an elevation of 1,869 feet, was reached by a well 345 feet deep on SE. section 4, and a still deeper horizon yielded a flowing well from what is considered to be Ribstone Creek sands at a depth of 500 feet and an elevation of 1,604 feet. The water from this well is slightly salty, and is considered to be from the same horizon that yields flowing wells at Vera in the wells drilled for gas and oil, on SE. sec. 30, tp. 38, rge. 22, south of Muddy Lake, at a depth of 300 feet and, perhaps, by the well at Tramping Lake Park on SW. sec. 10, tp. 35, rge. 20, although the depth of this well, 640 feet, appears to be excessive to reach this horizon. In most of the wells that obtain water from this horizon a little gas was encountered. It is apparent, however, that from Vera to the south end of Tramping Lake, a distance of about 50 miles, flowing wells can be obtained, though water is mostly too salty for human consumption.

Township 38, Ranges 20 and 21, West of Tramping Lake. A widespread but not uniformly persistent water horizon occurs in the glacial drift at an elevation of 2,020 and 2,035 feet, and probably the base of the drift is only slightly deeper. In the drift also are a few higher, irregularly distributed sands, but most of the wells in this area have been drilled into Pale and Variegated Beds underlying the drift. Apparently several clearly defined horizons are indicated. In wells on NE. sec. 18, tp. 38, rge. 21, at a depth of 185 feet, on NW. section 22 at a depth of 230 feet, and on SE. section 24 at 240 feet, a sand occurs in the Pale Beds at an elevation of 1,960 to 1,965 feet. In the well on NE. section 18 this horizon did not yield sufficient water, and the well was deepened to 225 feet, or to an elevation of 1,923 feet, where a further yield was obtained. This lower horizon seems to lie within a group of water-bearing sands between elevations of 1,920 and 1,940 feet, and is providing water in wells on SE. sec. 16, SW. sec. 20, SE. sec. 23, SE. sec. 29, and NW. sec. 33 of tp. 38, rge. 21. In the well on SE. section 16 the sand at elevation 1,933 feet did not yield a sufficient amount of water, and the well was deepened 50 feet to reach another sand at an elevation of 1,883 feet, passing through a sand that in two wells yields water at 1,908 to 1,909 feet. Two other wells appear to have tapped this same group of lower sands, although the elevations of both are slightly lower than the bottom sand in the well on SE. section 16. Of these two wells, one, 310 feet deep on NE. section 27, and the other, 300 feet deep on NE. section 36, reached water-bearing sands in either Pale or Variegated Beds at elevations of 1,867 and 1,865 feet respectively. A still lower horizon was tapped by two other wells, one, 374 feet deep on NE. sec. 30, tp. 38, rge. 20, which reached the aquifer at an elevation of 1,798 feet, and another, 405 feet deep on SW. sec. 27, tp. 38, rge. 21, which obtained a supply of water obviously from the same horizon at an elevation of 1,789 feet. This horizon is probably within the Variegated Beds, although it is impossible to distinguish between Pale and Variegated Beds in well logs. In the well drilled for oil and gas at Muddy Lake, in tp. 39, rge. 22, the base of the Variegated Beds occurred at an elevation of 1,729 feet. Thus, although relatively deep wells are the rule in this area a sufficient water supply is available. An interesting fact is that the upper, water-bearing horizons in the Pale Beds are all above the level of Muddy Lake at 1,866 feet. The horizon at 1,865 to 1,867 feet is at the level of the lake, and the lowest horizon, at approximately 1,790 feet, is below lake level. As the lake is now completely dry, it is doubtful if the former lake level has any bearing on the horizon from which water is now obtained at the same elevation. It is probable that the water obtained at levels above that of the lake is contained in lenticular sand deposits, occurring at various elevations, and hence it can be understood why the same sand does not produce water at the same level in every well. But if the water-bearing horizons are limited in lateral extent the migration of water will be limited in the same way. Thus it would appear that the water in these sands is replenished from downward percolation of rain or melting snow.

Township 38, Range 22. The conditions under which water is produced in this area are almost identical with those in the range to the east. A few wells obtain water in the drift, but most of them reach sands in the Pale or Variegated Beds or in the much deeper Ribstone Creek formation. Of the two wells that reach the Ribstone Creek sands, one flows and water rises quite high in the other. Both contain some gas.

Township 39, West Half Range 20. In this area a buried outwash plain of gravel and sand occurs in the drift at an elevation of about 2,150 to 2,165 feet, and this supplies the water in several wells. It is probable that the well on the Experimental Farm at Scott reached a sand in the Pale Beds at a depth of 216 feet and an elevation of 1,962 feet. Such a sand corresponds to the horizon in secs. 18, 22, and 24, tp. 38, rge. 21, at a depth of 1,960 to 1,965 feet, which in the well on section 18 yielded only a poor supply of water, presumably because of the character of the sand. The wells on sections 5 and 6 for which records are available in this township probably obtain their water from local sand lenses in the drift.

Township 39, Range 21. Most of the wells in this township obtain their water supply from a group of sand and gravel beds in the drift between elevations of 2,040 and 2,090 feet. The depth to the base of the drift is unknown, but water is encountered at several horizons in the underlying Pale Beds. The highest of these definitely known to be in the Pale Beds is on NE. section 5 at a depth of 215 feet and an elevation of 1,966 feet, and on NW. section 18 at a depth of 137 feet and an elevation of 1,963 feet. This sand horizon is the same as that encountered in the well on the Experimental Farm at Scott and in the wells already enumerated in tp. 38, rge. 21, and is, apparently, fairly persistent. Below it, in a well 227 feet deep on SE. section 3, water was encountered in another sand at an elevation of 1,921 feet. This is the lowest elevation reached in the township, although other, deeper, water-bearing beds are probably present.

Township 39, Range 22. In this township exposures of Pale Beds occur on the north bank of Muddy Lake above an elevation of 2,000 feet. Coal is reported to have been encountered in sections 31 and 32 at elevations of 2,057 and 2,066 feet, and in section 10 at 2,000 feet, and is undoubtedly in the Pale Beds. Above this level several wells obtain water in glacial sands, and in one well on NW. section 9 gravel was reported at a depth of 130 feet or an elevation of 1,960 feet. This gravel deposit must represent a channel in the Pale Beds filled with glacial materials. On SW. section 9 is a large spring at an elevation of 1,985 feet, and apparently this horizon is productive of water in a number of wells. The deepest well in the township, drilled to 310 feet or to an elevation of 1,785 feet, probably reached a sand in the Variegated Beds corresponding to the horizon reached in wells on sec. 30, tp. 38, rge. 20, and on sec. 27, tp. 38, rge. 21, at an approximate elevation of 1,790 feet, and is fairly conclusive evidence of the widespread nature of this aquifer. The only other lower water-bearing horizon likely to be encountered is that in the Ribstone Creek formation at an elevation of about 1,600 feet.

ANALYSES OF WATER SAMPLES FROM RURAL MUNICIPALITY OF TRAMPING LAKE, NO. 380, SASKATCHEWAN

							Constituents as Analysed							Constituents as Calculated in assumed Combinations							
No.	¼ Sec.	Tp.	Rge.	Depth in feet	Elev. of Aquifer	Total dissolved solids	Ca	Mg	Na	SO_4	Cl.	Alk.	Total Hardness	$CaCO_3$	$CaSO_4$	$MgCO_3$	$MgSO_4$	Na_2CO_3	Na_2SO_4	NaCl.	Source of Water
39	S[illegible] 34	37	21	350	1844	920	57	26	242	226	31	495	280	143		90		260	335	51	Pale Beds
40	SE 6	37	22	210	2002	1040	21	31	344	320	19	570	170	53		108		411	474	31	Pale Beds
36	NE.30	38	20	374	1798	1860	14	7	648	689	155	535	40	35		24		499	1079	256	Pale Beds
38	SE 16	38	21	330	1933	760	29	15	237	201	19	415	100	73		52		297	297	31	Pale Beds
37	SE 23	38	21	300	1939	1260	21	9	431	463	13	525	40	53		31		461	685	21	Pale Beds
43	SW 14	38	22	125	1901	1380	21	13	470	533	30	530	85	53		45		448	788	50	Pale Beds
42	SE 30	38	22	300	1600	3860	43	20	1453	33	2140	290	130	108		69		106	49	3531	Ribstone Creek
44	NE 5	39	21	215	1966	2240	43	13	778	1046	25	725	140	108		45		597	1548	41	Pale Beds
45	NW 18	39	21	137	1963	2360	143	76	539	1189	30	560	900	358		170	134		1601	50	
46	SE 18	39	22	105	1990	1120	43	26	313	508	22	335	260	108		90		127	752	36	Pale Beds.
47	SW 33	39	22	83	1980	1540	90	52	505	685	30	490	190	90		52		358	1014	50	Pale Beds

RECORD OF WELLS IN RURAL MUNICIPALITY OF TRAMPING LAKE, NO. 380, SASKATCHEWAN

Well No.	LOCATION				Type of Well	Depth of Well	Altitude of Well	WATER LEVEL		PRINCIPAL WATER-BEARING BED			Character of Water	Use to Which Water is Put^x	Yield and Remarks
	¼ Sec.	Tp.	Rge.	Mer.				Above (-) or Below Surface	Elev. above Sea Level	Depth Ft.	Elev.	Geol. Horizon			
1	S.E. 5	37	20	3	Bored	105	2120		Low	105	2015	Glacial	Hard	D.S.	Poor supply
2	S.W. 7	"	"	"	"	57	2131	-13	2118	57	2074	" gravel	"	"	Sufficient
3	S.W.19	"	"	"	Dug	9	2118	- 6	2112	9	2109	Glacial	Soft	"	
1	S.W. 1	37	21	3	Bored	50	2149	-25	2124	50	2099		Hard	D.S.	Sufficient
2	S.W. 2	"	"	"	"	54	2165	-20	2145	54	2111	Blue sand	"	"	"
3	N.E. 4	"	"	"	"	35	2167	-15	2152	35	2132		"	"	Good supply
4	S.E. 8	"	"	"	"	80	2181	-50	2131	80	2101		"	"	Sufficient
5	S.W.14	"	"	"	"	88	2171	-81	2090	88	2083	White "	"	"	Limited
6	S.E.16	"	"	"	"	35	2160	-24	2136	35	2125			"	Poor supply
7	N.E.16	"	"	"	"	90	2164	-20	2144	90	2074	Glacial	"	S.	" "
8	S.W.16	"	"	"	"	93	2156	-80	2076	93	2063		"	D.S.	" "
9	S.E.17	"	"	"	"	90	2160	-52	2108	90	2070	Hard pan	" "	"	Good supply
10	N.W.19	"	"	"	"	80	2096	-70	2026	80	2016	Glacial gravel		"	Sufficient
11	S.E.20	"	"	"	"	60	2192	-40	2152	60	2132		"	S.	Poor supply
12	N.W.22	"	"	"	"	65	2182	-43	2139	65	2117		"	"	Sufficient
13	S.W.26	"	"	"	Drilled	207	2154	-52	2102	170	1984		"	"	"
										207	1947	Red sand	Soft	D.S.	"
14	S.W.31	"	"	"	Bored	87	2101			87	2014		Hard	D.	"
15	S.W.32	"	"	"	Bored	45	2176	-32	2144	45	2131	Glacial sand & gravel	"	S.	Poor supply
16	S.E.34	"	"	"	Drilled	350	2194	-110	2084	350	1844	Pale or Var. Beds	Soft	D.S.	Sufficient
17	N.W.35	"	"	"	"	338	2174	-12	2162	98	2076	Sand			
										144	2030	Gravel			C.P.R. Revenue Well
										334	1840	Pale or Var. Beds			
18	S.W.36	"	"	"	Bored	92	2166	-72	2094	92	2074	Sand	Hard	S.	Sufficient
1	S.E 2	37	22	3	Bored	98	2148	-68	2080	98	2050		Hard	D.S.	Poor supply
2	S.E. 3	"	"	"	"	107	2146			107	2039		"	"	Good "
3	S.E. 4	"	"	"	Drilled	345	2204	-70	2134	335	1869	Pale Beds	Soft	"	Sufficient
4	N.E. 5	"	"	"	Dug	40	2152	-33	2119	40	2112	Sand	"	"	"

x. P. - Domestic, S.- Stock, Fe.- Iron, Alk.- Alkaline, Var.- Variegated.

Well No.															
5	S.E. 6	37	22	3	Drilled	210	2212	-195	2017	210	2002	Pale Beds	Soft	D.S.	Sufficient
6	N.W. 7	"	"	"	Bored	140	2161	-70	2091	140	2021		Hard	"	"
7	N.E. 8	"	"	"	"	115	2128	-40	2088	115	2013	Sand	Soft	"	Good supply
8	S.W.12	"	"	"	"	112	2139	- 5	2134	112	2027	Pale Beds	Hard	"	" " Coal at 112'.
9	S.E.12	"	"	"	"	103	2108	-18	2090	103	2005	" "	Soft	"	Sufficient " " 103'.
10	N.E.22	"	"	"	"	125	2150					Dry Hole			Water supply from 14' well.
11	S.E.24	"	"	"	"	80	2090	-75	2015	80	2010	Gravel	Hard	"	Limited
12	N.W.28	"	"	"	"	59	2147	-35	2112	59	2088	Glacial sand	"	"	Sufficient
13	S.W.30	"	"	"	"	90	2091	-50	2041	90	2001	Sand	"	"	"
14	N.E.33	"	"	"	Drilled	500	2104	- 0	2104	500	1604	Ribstone Ck.	Soft salty	S.	Abundant
15	N.E.35	"	"	"	Bored	85	2085	-50	2035	85	2000		Soft	D.S.	Dry Hole 125'.
16	S.E.36	"	"	"	"	80	2093	-62	2031	80	2013	Gravel	Hard	"	Sufficient
17	N.E.36	"	"	"	"	85	2114	-81	2033	85	2029	Sand	"	"	"
1	S.W.19	38	20	3	Bored	109	2195	-104	2091	109	2086	Sand	Hard	D.S.	Sufficient
2	N.W.20	"	"	"	"	140	2171			140	2031		"	"	"
3	N.E.30	"	"	"	Drilled	374	2172	-100	2072	374	1798	Variegated?	Soft	"	"
4	S.E.31	"	"	"	Bored	132	2163	-119	2044	130	2033	Sand	Hard	"	"
5	N.E.32	"	"	"	Dug	24	2145			24	2121		"	"	"
1	N.W. 2	38	21	3	Bored	70	2200	-66	2134	70	2130	Glacial gravel	Soft	D.S.	Sufficient
2	N.W. 2		"	"	Drilled	300	2200			208	1992				Tools lost in hole and well abandoned.
3	N.W. 5	"	"	"	Bored	65	2165	-63	2102	65	2100	Gl. sand	Hard	"	Sufficient. Dry Hole 150', Gl.
4	N.E. 7	"	"	"	Bored	121	2157	-85	2072	121	2036	Blue "	Soft	"	Abundant
5	S.W.12	"	"	"	"	76	2182	- 7	2175	76	2106	Glacial gravel			Limited. Dry Hole 140'.
6	N.W.13	"	"	"	"	145	2193	-142	2051	145	2048	Sand	Hard	"	" .
7	S.W.14	"	"	"	Drilled	306	2215	-200	2015	306	1909	Pale . Beds	"	"	Sufficient
8	S.E.16	"	"	"	"	330	2213	-230	1983	280	1933	" sand	Soft		
										330	1883	" ?	"	"	Sufficient
9	N.E.18	"	"	"	Drilled	225	2148	-121	2027	185	1963	" sand			
										225	1923	" "	Soft	"	Abundant
10	N.W.18	"	"	"	Bored	140	2139			140	1999	Sand	Hard	"	Sufficient
11	N.E.19	"	"	"	"	80	2165			80	2085	Glacial sand	"	"	
12	S.W.20	"	"	"	Drilled	222	2147			222	1925	Pale Beds			
13	N.W.20	"	"	"	"	162	2179	-136	2043	162	2017	Hardpan	Hard	"	Sufficient
14	N.E.20	"	"	"	Bored	160	2180	-140	2040	160	2020	Hard sand	"	"	"
15	N.W.22	"	"	"	Drilled	230	2191	-100	2091	230	1961	Pale Beds	Soft	"	"
16	S.E.23	"	"	"	"	300	2199	-150	2049	260	1939	Pale Beds	"	"	" Dry Hole 400'.
										300	1899	" "	"		

Well No.															
17	N.W.24	38	21	3	Bored	152	2182			152	2030		Hard	D.S.	Limited
18	S.E.24	"	"	"	Drilled	240	2205			240	1965	Pale Beds sand	Soft	"	" sand trouble
19	N.E.25	"	"	"	Bored	59	2176	-55	2121	59	2117	Glacial gravel	Hard	"	Limited
20	S.W.27	"	"	"	Drilled	405	2194	-200	1994	200	1994				
										405	1789	Var. sand	Soft	"	Abundant
21	N.E.27	"	"	"	Drilled	310	2177			310	1867	Pale or Variegated Beds	Hard	"	Sufficient
22	S.E.28	"	"	"	"	210	2194	-180	2014	200	1994	Hardpan	"	"	"
23	S.E.29	"	"	"	"	253	2180	-150	2030	170	2010	Sand			
										253	1927	Pale Beds Sand	Soft	"	Good supply
24	N.E.30	"	"	"	"	180	2160	-140	2020	180	1980	Hardpan	Hard	"	Sufficient
25	N.E.31	"	"	"	"	258	2166	-158	2008	258	1908	Pale Beds Sand	Soft	"	Good supply
26	N.W.33	"	"	"	"	235	2171	-170	2001	235	1936	" "	Hard	S.	Sufficient
27	S.W.34	"	"	"	"	150	2176	-100	2076	150	2026	Sand	"	D.S.	Good supply
28	N.E.34	"	"	"	"	170	2162	-110	2052	170	1992	"	"	"	Sufficient
29	N.E.36	"	"	"	"	300	2165	-98	2067	300	1865	Pale or Variegated Beds (Other Water Horizons)	Soft	"	Abundant
1	N.E. 1	38	22	3	Bored	100	2119	-97	2022	100	2019	Glacial gravel	Soft	D.S.	Good supply
2	N.W. 5	"	"	"	"	70	2133			70	2063	Glacial			Poor supply. Dry Hole over 100'.
3	N.E.10	"	"	"	"	97	2024	-90	1934	97	1927	Pale Beds?	Hard	D.S.	Sufficient
4	N.E.12	"	"	"	"	60	2136	-57	2079	60	2076	Sand	"	"	Limited
5	S.W.14	"	"	"	Drilled	125	2026	-70	1956	125	1901	Pale Beds?	Soft	"	Sufficient
6	N.W.16	"	"	"	Bored	90	1900	-10	1890	90	1810	" "	Hard	S.	" Gas in Well
7	N.W 19	"	"	"	Drilled	310	1906		High	310	1596	Ribstone Creek	Soft	"	Good supply
8	S.W 23	"	"	"	Bored	56	1892	-2	1890	56	1836	Variegated Beds	"	D.S.	Sufficient
9	N.W.24	"	"	"	Dug	15	1981	-13	1968	15	1966	Glacial Sand	Hard	"	"
10	N.E.25	"	"	"	Bored	110	2096	-90	2006	110	1986	" "	"	"	"
11	S.E.30	"	"	"	Drilled	300	1900	+40	1940	300	1600	Ribstone Creek	Soft	S.	" Gas. Used.
1	S.W 5	39	20	3	Bored	120	2147	-100	2047	120	2027	Sand	Hard	D.S.	Sufficient
2	S.W. 6	"	"	"	"	150	2155	-140	2015	150	2005		"	"	"
3	N.E 17	"	"	"	Drilled	216	2178	-115	2063	216	1962			Experimental Farm	Sand trouble well abandoned.
4	N.W.20	"	"	"	Bored	65	2190	-46	2144	65	2125		Hard	D.S.	Sufficient
5	S.W.21	"	"	"	Dug	12	2163	-7	2156	12	2151	Glacial Gravel	Soft	"	Good supply
6	N.W.28	"	"	"	"	25	2179	-15	2164	25	2154		Hard	"	Sufficient
7	N.E.30	"	"	"	Bored	43	2204	-36	2168	43	2161	Glacial Sand	"	"	Limited
8	S.W.30	"	"	"	"	33	2196		Low	33	2163	" Gravel	"	"	"

Well No.															
1	S.E. 3	39	21	3	Drilled	227	2148	-180	1968	227	1921	Pale Beds	Soft	D.S.	Sufficient
2	S.E. 4	"	"	"	Dug	40	2165	-32	2133	40	2125	Gravel	Hard	"	Limited
3	N.E. 5	"	"	"	Drilled	215	2181	-100	2081	215	1966	Pale Beds	Soft	"	Sufficient
4	N.W. 8	"	"	"	Bored	70	2129			70	2059	Sand	"	"	Limited
5	S.W.16	"	"	"	"	108	2147	-100	2047	108	2039	"	"	"	Poor supply
6	S.W.17	"	"	"	Drilled	90	2133		Low	90	2043	"	"	"	Limited
7	N.W.18	"	"	"	Bored	137	2100	-62	2038	137	1963	Pale Beds	"	"	"
8	S.E.18	"	"	"	Dug	46	2125		Low	46	2079		Hard	D.	Poor supply
9	S.W.20	"	"	"	Bored	70	2058	-65	1993	70	1988		" Poor	S.	
10	S.W.24	"	"	"	"	70	2182	-60	2122	70	2112	Sand	" "	D.S.	Sufficient
11	N.E.25	"	"	"	"	100	2191	-60	2131	100	2091	"	"	"	"
12	S.W.26	"	"	"	Drilled	150	2172	-80	2092	150	2022	"	Soft	D.	" School
13	N.W.26	"	"	"	Bored	90	2176	-60	2116	90	2086	"	Hard	D.S.	Sufficient
14	S.E.27	"	"	"	Dug	50	2168	-47	2121	50	2118	Gravel	"	"	Limited
15	N.W.27	"	"	"	Bored	70	2181	-40	2141	70	2111		"	"	Good supply
16	N.E.28	"	"	"	Dug	29	2180	-25	2155	29	2151	Sand	"	"	Poor "
17	N.E.31	"	"	"	"	30	2106	-21	2085	30	2076	Clay	"	"	Sufficient
18	S.W.32	"	"	"	"	14	2101			14	2087		"	"	"

1	S.W. 7	39	22	3	Dug	18	1866	-16	1850	18	1848	Clay	Hard	D.S.	Limited
2	N.W. 7	"	"	"	Drilled	2900	1894								Deep well drilled for oil & gas
3	N.W. 9	"	"	"	Bored	130	2094			130	1964	Gravel	Hard	D.S..	Sufficient
4	N.W.10	"	"	"	Drilled	190	2121	-70	2051	190	1931	Pale Beds sands	Soft	"	" Coal at 120'
5	N.E.10	"	"	"	Bored	120	2102	-90	2012	120	1982	" "	"	"	"
6	N.E.12	"	"	"	Drilled	145	2099	-90	2009	145	1954	" "	"	"	"
7	S.W.13	"	"	"	Bored	110	2113	-10	2103	110	2003	Sand	"	"	Limited
8	S.E.14	"	"	"	"	94	2093	-44	2049	94	1999	Clay	Hard	"	Sufficient
9	S.E.15	"	"	"	"	67	2137	-60	2077	67	2070	Hard pan	"	"	
10	S.E.16	"	"	"	"	120	2105	-100	2005	120	1985	Clay	"	"	Poor supply
11	S.E.18	"	"	"	"	105	2095	-100	1995	105	1990	Pale Beds	"	"	Sufficient
					Drilled	310	2095			310	1785	Variegated Beds	" Alk.		Good supply (not used)
12	S.E.20	"	"	"	Bored	50	2070	-30	2040	50	2020	Sand	"	"	Poor supply
13	N.W.20	"	"	"	"	36	2072	-22	2050	36	2036	"	"	"	Sufficient
14	S.W.20	"	"	"	"	70	2079			70	2009	"	"	"	Limited
15	N.W.21	"	"	"	"	30	2091		Low	30	2061	Glacial sand	"	"	Sufficient
16	N.E.22	"	"	"	Dug	30	2103			30	2073	" "	"	"	Limited

Well No.															
17	S.W.23	39	22	3	Bored	85	2110	-35	2075	85	2025	Glacial sand	Soft	D.S.	Sufficient
18	N.E.23	"	"	"	"	80	2084	-74	2010	80	2004	Pale Beds	"	"	Limited
19	N.E.26	"	"	"	"	85	2076	-35	2041	80	1996	" "	Hard	S.	Sufficient
20	N.W.28	"	"	"	"	52	2087	-25	2062	52	2035	" "		D.S.	"
21	S.W.31	"	"	"	"	79	2136	-72	2064	79	2057	" "	"	"	Limited. Coal at 79'.
22	N.W.32	"	"	"	"	36	2102		High	36	2066	" "	"	"	Sufficient " " 36'.
23	S.W.33	"	"	"	"	83	2063			83	1980	" "	Soft	"	"
24	N.E.36	"	"	"	Drilled	95	2098	-86	2012	95	2003	Clay	"	"	Waters 50 head of stock.