CANADA
DEPARTMENT OF MINES
AND
TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 251

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF PAYNTON NO. 470 SASKATCHEWAN

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

OTTAWA
1947
Reprinted 1953

CANADA
DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH
BUREAU OF GEOLOGY AND TOPOGRAPHY

GEOLOGICAL SURVEY

WATER SUPPLY PAPER NO. 251

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF PAYNTON, NO. 470, SASKATCHEWAN

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

OTTAWA
1947

CONTENTS

Illustrations

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 north-west
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 westward and 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 180 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 (SO_4), 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

---

[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.

---

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]:

---

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

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 associated with sand and gravel deposits that come close to the surface.

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].

---

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

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.

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.23
$CaCO_3$	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	1,280	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 and 3,000 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 PAYNTON, NO. 470, SASKATCHEWAN

Physical Features

Paynton municipality is bounded on the south by Battle River, which has rather gently sloping north banks higher in the west than in the east but relatively low throughout. Saskatchewan River forms the eastern boundary and lies in a valley about 200 feet deep that trends southeasterly in a straight course. The most prominent topographic feature is Maskwa Hill, a rounded knob covering about 3 square miles and rising 250 to 300 feet above the flat prairie level. Apparently it is an erosion remnant, and may owe its preservation to a cap of harder rock than occurs elsewhere. A deposit of sand, evidently derived from a glacial lake, covers the south and west part of this municipality. In part this sand has been blown into dunes, and toward the margin of the sand are two lakes at elevations of 1,798 and 1,775 feet respectively.

A large part of the northwest part of the municipality is covered with a sand deposit of glacial lake origin. These sands, which were laid down under water in beds that were nearly horizontal, have since been modified by wind action and blown into dunes. Bordering the sand-dune areas are flat stretches of light loam that make good farming land. Such an area is found north of the town of Paynton.

Geology

The boulder till that overlies the bedrock is covered in part by a sand deposit of glacial lake origin, the thickness of the drift varying from less than 50 to more than 100 feet. Along Saskatchewan River the surface has been modified by the eroding action of the river during its early stages. The Ribstone Creek formation is believed to underlie part of the area, as outcrops of sandstone thought to be of this age were found on sec. 24, tp. 47, rge. 21. On NE. sec. 32, tp. 47, rge. 21, a deep, dry hole was drilled into the Lea Park shale without striking water or a bed of sand. This indicates an area where the Ribstone Creek sand is absent and where the drift rests directly on the impervious marine shale.

In the higher land of Maskwa Hill, Grizzly Bear and Birch Lake formations are undoubtedly present, and sandstones thought to be Birch Lake outcrop. The top of the hill may be capped by Variegated Beds, as it is above the elevation at which Birch Lake sandstones would be expected from the elevations of known outcrops.

Water Supply

The water supply is obtained from wells in the glacial drift or in the underlying bedrock sand wherever it is present. On the whole the wells are shallow, only one being more than 100 feet deep. The only deep dry holes were drilled on sec. 32, tp. 47, rge. 21.

In the areas of sand and sandy soil the water-table is close to the surface. The sand deposit lies on top of the boulder till, which is sufficiently impervious to prevent a downward movement of water. The lower part of the sand, therefore, becomes saturated and serves as a good aquifer at a shallow depth. The source of this water, as well as that in the other aquifers in the drift, is the annual precipitation.

In the boulder till the sand bodies are not as regular, and the depths are not as uniform, but the upper part contains a considerable amount of sorted material at various places, which serves as local aquifers. In the area of boulder till and sandy loam that parallels Saskatchewan River such an aquifer occurs within the drift at an elevation between 1,780 and 1,800 feet.

The Ribstone Creek formation yields a good supply of water wherever it has been encountered. The sand outcropping along the road on the east side of sec. 24, tp. 47, rge. 21, is fairly coarse and thus makes a very good water sand. It has an exposed thickness of 15 feet. So far as known this is the only sand member present within the formation. On the basis of coal seams encountered in wells on sec. 19, tp. 47, rge. 20, it is thought that the strata rise towards the south. Likewise, several wells south of Paynton have indicated a dip to the south on a small coal seam, and if it is the same seam in each case it denotes a small fold with very gentle dips. The well on NE. sec. 6, tp. 47, rge. 20, struck water at an elevation of 1,668 feet. If this is the same aquifer as the one previously referred to there must be a depression between the two areas where the coal occurs. So far as known no coal was encountered in the well on section 6, and its relationship to the other wells referred to and the outcrop on section 19 was not fully established. Dark grey marine shales of the Lea Park formation underlie the Ribstone Creek basal sand member where present, or the drift where the sand member is absent. No known aquifers occur in the Lea Park shales and drilling into them for water is not considered advisable.

<u>Township 45, Ranges 20 and 21.</u> The records of only three wells are available from this area, and of these one on SW. sec. 36, tp. 45, rge. 21, obtains water at a depth of 28 feet at the base of the sandy soil. The other two, at an elevation of 1,750 feet, found a water-bearing bed in the drift. The thickness of the drift here is unknown, but below it the Ribstone Creek formation contains water-bearing sands.

<u>Township 46, Ranges 20 and 21.</u> In this area one hole drilled to a depth of 600 feet on SE. sec. 28, tp. 46, rge. 20, failed to yield water. This confirms the fact, previously mentioned, that no water-bearing sands are to be expected in the Lea Park formation. The base of the Ribstone Creek formation in this hole is not known, but at a depth of about 40 feet the well passed through a sand in the Ribstone Creek formation that elsewhere is presumed to yield water. Also, at a depth of about 100 feet, another Ribstone Creek water-bearing sand probably was encountered, although no water was reported at this depth. It is possible in this area that the Ribstone Creek sands are slightly silty, and for this reason may not everywhere contain water. A well on SW. sec. 26, tp. 46, rge. 20, obtained only a poor supply in the higher of the known Ribstone Creek sands at an elevation of 1,783 feet. Other wells in tp. 46, rge. 21, encountered coal in the Ribstone Creek formation, and in one well, on NW. section 25, water occurred with the coal, an association that has been noted in many places.

Many shallow wells have been dug on the edge of the sand area previously referred to. As already stated, these wells obtain their water supply at the base of the sandy soil where it rests on more impervious clay. As in all glacial wells in this and other areas the source of this water is rain.

Township 47, Range 20. The part of this township lying in Paynton municipality is a triangular area bounded on the east by Saskatchewan River. The surface deposit of boulder till is very flat, with a gentle slope towards the river. It is more than 80 feet thick on section 6, 50 feet or less thick on section 19, and even less than this along the river.

The Ribstone Creek sand, which outcrops along the ravine in section 19, is believed to underlie the whole area except for a narrow strip along Saskatchewan River that is underlain by impervious Lea Park shale.

The water supply is obtained from shallow wells in the drift and deeper ones that tap the bedrock sand at greater depth. On section 19 the sand exposed in the roadcut on the west side of the section is fairly coarse and has all the appearance of a very good water sand. The elevations of the wells in this section are 1,697, 1,713, and 1,744 feet, rising towards the south. A thin coal seam was struck in each of these wells. The relation of these wells to the one on NE. section 6, at an elevation of 1,668 feet, is difficult to determine. Two possible explanations may be made, both of which seem equally reasonable. One is that the strata rise to the south from section 19 and then reverse their dip to the south, leaving the well on section 6 in a low part of the structure. This interpretation is supported by the fact that the water in the aquifer is under great pressure, having a water level only 20 feet from the surface. So far as could be determined, no coal was struck in this well, which supports a second interpretation that this is a lower aquifer and may have a limited lateral extent. Whatever interpretation is accepted the sand bed should serve as a good water horizon within a radius of several miles, but the drilling depth will depend on the surface elevation and the dip of the strata.

Several shallow wells in the upper part of the drift yield a good supply of water. Because of the large number of gravel deposits found on the surface it would appear that an equal or greater amount should be present within the drift. On SW. section 17 a very large spring occurs at an elevation of about 1,800 feet, and must come from a gravel deposit underlain by an impervious layer of either glacial clay or shale. Smaller springs are found along the banks and gullies adjoining Saskatchewan River. One of the larger of these, on SW. section 3, is believed to emerge from the top of the bedrock shale.

Township 47, Range 21. The surface of this township is very flat, the relief, excluding the gullies, being not more than 50 feet. This is accounted for by the nature of the deposits that form the surface. The sand and sandy loam that covers the largest part of the area is of glacial lake origin. The sandy loam was a marginal deposit and affords excellent farming land, whereas the sand, which is now blown into dunes, is only suitable for grazing purposes. These sand and sandy deposits are underlain by boulder till, which forms the only surface deposit along the north side of the township in a strip from 1 to 2 miles wide.

Ribstone Creek sand underlies the glacial drift within most of the township and outcrops of sandstone occur on sections 35 and 24 at elevations of 1,748 and 1,750 feet respectively. On section 32 a hole was drilled to more than 200 feet without striking water or sand below the drift, and shale was reported at a depth of 145 feet at an elevation close to 1,700 feet. As this is much lower than the sandstone outcrops, the absence of the sand may be due to deeper pre-glacial erosion and subsequent replacement of the sandstone by drift. The area in which this occurs must extend to the north and west, but except for this corner, Ribstone Creek sandstone is thought to underlie the whole township.

Surface deposits supply most of the water in this township. In the sandy areas water is found towards the base of the sand, the underlying boulder till preventing the downward movement of water that has entered the sand as rain. The lower sands, consequently, become saturated and yield a good supply of water. Along the east and north sides of the township, where boulder till forms the surface deposit, extensive sand beds are not so common in the drift. These sorted deposits are smaller and irregular in shape and it is, therefore, very difficult to predict the depth necessary to reach a good supply of water. The elevation of the aquifers on sections 34 and 26 are 1,786, 1,793, and 1,788 feet respectively, the similarity in level suggesting a common water-bearing bed. According to information obtained from the owners, the thickness of the drift varies from less than 50 feet on sections 22 and 24 to about 145 feet on section 32. This shows an increase of about 100 feet towards the northwest.

The bedrock sand of the Ribstone Creek formation, which underlies almost all of the township, yields a good supply of water wherever it has been encountered, and the sand that outcrops in sections 35 and 24 is considered to be the basal sand of that formation. Water should be encountered at the level of these outcrops, that is, very close to 1,750 feet where the stratum is flat lying. However, there is some evidence, as indicated by the positions of thin coal seams in wells in section 19 in the township to the east, to suggest that a small fold may be present. The wells on sections 11 and 12 are thought to be in the same aquifer as the well on NE. section 24, and this should be encountered in wells at intermediate points. To the west no wells have penetrated the surface deposit into the bedrock, so the exact elevation at which it occurs is not known, but is probably between 1,750 and 1,780 feet. Below the bedrock sand is the impervious marine shale of the Lea Park formation, which failed to yield water on section 32.

Township 47, Range 22. This township lay at one time well within the boundaries of the glacial lake that once covered a large area to the north and south. The sand that was deposited in this lake has now been blown into dunes, and on the whole very little of the area is suitable for farming, except for a strip on the west side.

No well records are available, as the water requirements are obtained from the surface deposit of sand and the wells range in depth from 5 to 15 feet. The boulder till that underlies the sand acts as an impervious bed and the overlying sand becomes saturated and serves as a good aquifer. The annual rainfall largely determines the depth to the water-table, which will fluctuate in elevation with abnormally high or low precipitation. These surface sands have hitherto yielded a good supply of water.

The drift that underlies the sand probably contains a certain amount of sand and gravel that would serve as water horizons were it necessary to tap them. Due, however, to the heterogeneous nature of the boulder till it would be difficult to predict the location or extent of such deposits without at least some well logs as a guide.

The character of the bedrock strata below the glacial till is also unknown, though information from areas to the west and east indicates that no Ribstone Creek sand is present. Thus the impervious Lea Park shale may underlie the area, and it contains no known water horizons. Isolated small patches of sand may be present, but on the whole the bedrock cannot be expected to contain deposits that would yield a good supply of water.

Township 48, Range 21. The part of this township in Paynton municipality is bounded on the east by Saskatchewan River. The surface deposit of sand of glacial lake origin covers the area except for a strip from 1 to 1½ miles wide along the south side, where the boulder till that underlies the sand is exposed.

The boulder till is at least 77 feet thick on section 7, as water was encountered in gravel at that depth. This is the deepest well in the township, but in section 32 of the township to the south a hole was drilled through a reported thickness of about 150 feet.

The bedrock strata below the drift has not been encountered in any of the wells. In the drilled well on sec. 32, tp. 47, rge. 21, shale of the Lea Park formation underlies the drift at an elevation of 1,700 feet. However, on section 35 in the same township, an outcrop of sandstone presumably of the Ribstone Creek formation occurs at an elevation of 1,748 feet. If this sandstone has a considerable lateral extent, it may reach into this township. Shale outcrops were observed along the west bank of Saskatchewan River in section 22 at elevations close to 1,700 feet.

Well records indicate an horizon within the drift that appears to be fairly extensive. This aquifer is in gravel and is located on section 4, 7, and 9 at elevations of 1,798, 1,780, and 1,793 feet respectively. This seems to be good evidence for a fairly wide distribution of this aquifer to the south and west, yet it was not encountered in the deep dry hole, referred to above, on section 32.

Most of the wells of which no records were taken are shallow. Their water supply comes from sand and gravel in the upper part of the drift in the south and in the surface sands north of the boulder till area. In the sandy area water is easily obtained at no great depth in the sand overlying the boulder till. Water should be available in sand or gravel deposits in the glacial drift if sufficient quantities cannot be obtained in the surface sands.

Water in the bedrock depends upon the presence of Ribstone Creek sand beneath the drift. No wells, however, have encountered this sand in the township, and a hole was drilled to the southwest without encountering the sand.

ANALYSES OF WATER SAMPLES FROM RURAL MUNICIPALITY OF **PAYNTON NO. 470, SASKATCHEWAN.**

						Constituents as Analysed							Constituents as Calculated in assumed Combinations							
No.	¼ Sec.	Tp.	Rge.	Depth in feet	Total dis-solved 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
47	SW 16	46	20	165	2040	322	116	283	1234	91	485	1700	485	435		574		692	150	Similar to drift water.
48	SW 24	46	21	112	3000	164	61	845	1751	46	610	750	410		168	64		2518	76	Very high in Na_2SO_4
1	NE 6	47	20	156	1860	50	22	629	828	131	535	230	125		76		339	1225	216	Ribstone Creek
2	SW 19	47	20	58	660	64	31	151	164	10	430	330	160		108		149	243	17	Ribstone Creek

RECORD OF WELLS OF RURAL MUNICIPALITY OF PAYNTON, NO. 470, SASKATCHEWAN.

Well No.	LOCATION ¼ Sec.	Tp.	Rge.	Mer.	Type of Well	Depth of Well	Altitude of Well	WATER LEVEL Above (+) or Below (-) Surface	Elev. Above Sea Level	PRINCIPAL WATER-BEARING BED Depth Ft.	Elev.	Geol. Horizon	Character of Water	Use to Which Water is Put^x	Yield and Remarks
1	S.E.32	45	20	3	Bored	50	1800	-36	1764	50	1750	Blue Clay	Hard Alk.	D.S.	Sufficient
2	S.E.33	"	"	"	"	35	1780	-28	1752	30	1750	Black sand	" "	"	
1	S.W.36	45	21	3	Dug	28	1859	-26	1833	26	1833	Gray sand		D.S.	Top of Shale ?
1	N.W. 2	46	20	3	Bored	20	1740			18	1722	Gray sand	Hard	D.S.	Sufficient
2	N.E. 4	"	"	"	"	50	1770	-35	1735	44	1726	" "	" Alk.	"	"
3	N.W. 4	"	"	"	Dug	45	1810			45	1765	Blue clay	" "	"	"
4	N.E. 5	"	"	"	Bored	73	1810	-50	1760	60	1750	" "	" "	"	"
5	N.E. 8	"	"	"	"	60	1847	-45	1802	60	1787	Gray sand	" "	"	Poor supply
6	S.E. 9	"	"	"	"	60	1780	-35	1745	52	1728	" "	" "	"	Sufficient
7	N.E.14	"	"	"	"	50	1819	-35	1784	45	1774	Blue "	" "	S.	"
8	S.W.14	"	"	"	"	25	1799	-18	1781	25	1774	" clay	" "	D.S.	Limited supply
9	N.W.16	"	"	"	Drilled	180	1897	-10	1887	180	1717	Ribstone Ck.	" "	"	Good " "
10	S.W.16	"	"	"	Bored	165	1872	-80	1792	158	1714	" " "	" Fe.	"	" "
11	N.W.17	"	"	"	"	45	1913	-25	1888	45	1868	Blue sand	" Alk.	"	Sufficient
12	N.E.19	"	"	"	"	50	1903	-30	1873	50	1853	" clay	" "	S.	
13	S.E.20	"	"	"	"	108	1902	-98	1804	108	1794		" "	D.S.	Sufficient
14	N.E.20	"	"	"	"	98	1862	-30	1832	98	1764	Blue clay	" "	"	Good supply
15	N.W.21	"	"	"	"	75	1842	-30	1812	65	1777		Soft	"	Sufficient
16	N.E.21	"	"	"	"	96	1842	-66	1776	96	1746	Blue clay	"	"	"
17	N.W.24	"	"	"	"	50	1830	-38	1792	49	1781	" sand	Hard Alk.	"	"
18	N.E.24	"	"	"	"	40	1800			38	1762	Fine sand	" "	S.	
19	S.W.24	"	"	"	Dug	25	1810	-15	1795	25	1785	" "	Hard	D.S.	Sufficient
20	S.W.26	"	"	"	Bored	64	1834	-51	1783	51	1783	Ribstone Ck. ?	" Alk.	S.	Poor supply
21	S.E.27	"	"	"	Drilled	700	1820			600	1220				Oil Showings Reported
22	S.[illegible]28	"	"	"	Bored	76	1825	-60	1765	76	1749	Blue clay	Soft	D.S.	Sufficient
23	S.W.28	46	20	3	Bored	40	1827	-25	1802	40	1787	Gray sand	Hard Alk.	S.	Sufficient
24	S.W.29	"	"	"	"	42	1882	-12	1870	40	1842	Gl. gravel	" "	D.S.	"
25	N.W.30	"	"	"	"	50	1853	-25	1828	50	1803	White sand	" "	"	Godd supply

WELL RECORDS—Rural Municipality of PAYNTON NO. 470, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE: Above (+) Below (−) Surface	HEIGHT TO WHICH WATER WILL RISE: Elev.	PRINCIPAL WATER-BEARING BED: Depth	PRINCIPAL WATER-BEARING BED: Elev.	PRINCIPAL WATER-BEARING BED: Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
26	SW	31	46	20	3	bored	47	1863	- 17	1846	47	1816	Glacial	hard		D.S.	Good supply in white sand
27	SW	32	46	20	3	bored	80	1832									Dry hole in shale.
28	NW	33				bored	36	1779	- 10	1769	36	1745	Ribstone Creek	hard		D.S.	Limited supply in sandstone
1	NW	13	46	21	3	bored	85	1834	- 45	1789	85	1749	Blue sand	hard Alk.		D.S.	Good supply
2	NE	22	46	21	3	bored	70	1829	- 50	1779	65	1764	Gray sand	hard Alk.		S.	Good supply
3	NW	23	46	21	3	bored	82	1829	- 50	1779	82	1747	Blue sand	hard Fe.		D.S.	Sufficient
4	SW	24	46	21	3	bored	112	1846	- 35	1811	112	1734	Ribstone Creek	hard Fe.		S.	Good supply. Coal at 98'.
5	NW	25	46	21	3	bored	135	1899			135	1764	Ribstone Creek				Coal with water
6	NE	27	46	21	3	bored	90	1869	- 30	1839	90	1779		hard Fe.			Not in use at present
	NE	34	46	21	3	bored	60	1839	- 10	1829	60	1779	Ribstone Creek	Med. soft		D.S.	Good supply
	NE	35				bored	100	1854			100	1754	Glacial	hard Alk.		D.S.	Good supply in blue clay.
	NW	4	47	20	3	bored	16	1789	- 8	1781	15	1774	Glacial	hard		S.	Good supply in gravel.
	SE	6				bored	86	1814	- 76	1738	80	1734	glacial	hard alk.		S.	Good supply in yellow sand. Dry hole 120 feet deep.
	NE	6				bored	156	1824	- 20	1804	156	1668	Ribstone Creek?	Med. soft		D.S.	Abundant supply
	SW	17				spring		1800									Very large continuous flow.
	NE	19				bored	80	1767	- 70	1697	70	1697	Ribstone Creek	Med. soft		D.S.	Good supply in black sand
	SE	19				bored	73	1786	- 61	1725	73	1713	Ribstone Creek	Med. soft		D.S.	Good supply in sand
	SW	19				bored	58	1794	- 50	1744	50	1744	Ribstone Creek	hard		D.S.	Good supply in black sand
	NE	2	47	21	3	dug	31	1834	- 19	1815	31	1803	glacial	hard alk.		D.S.	Good supply
	SE	11				dug	44	1829	- 24	1805	44	1785	Ribstone Creek	Med. soft		D.S.	Good supply in fine grey sand
	SW	12				bored	42	1834	-14	1820	42	1792	Ribstone Creek	Med. soft		D.S.	Good supply in sand
	SW	21				bored	42	1819	- 22	1797	42	1777	Ribstone Creek?	hard alk.		S.	Good supply - another well 40 feet, good water.
	SE	22				bored	26	1824	-20	1804	26	1798	glacial	soft		D.S.	Limited supply,-
	NW	22				bored	54	1804	- 23	1781	54	1750	Ribstone Creek	soft		D.S.	Good supply in green sand.
	NE	24				bored	55	1799	- 45	1754	45	1754	Ribstone Creek	Med. soft		D.S.	Good supply in green sand.
	SW	24				dug	18	1819	- 17	1802	18	1801	glacial	hard		D.S.	Limited supply on top of gravel
	NW	26				dug	6	1794	- 0	1794	6	1788	glacial	hard		D.S.	Well dug beside spring for winter supp=
	SE	29				bored	60	1824	- 12	1812	60	1764	glacial	hard alk.		S.	Good supply
	NE	32				drilled	200	1847									Dry hole. Top of shale at 145 feet
	SE	34				bored	50	1836			50	1786	glacial	hard alk.		D.S.	Limited supply in fine sand
	NE	34				bored	49	1841	- 40	1801	48	1793	glacial	hard alk.		S.	Good supply
	SE	3	48	21	3	bored	22	1810	- 12	1798	22	1788	glacial	hard		D.S.	Good supply in fine sand.
	NE	4				bored	43	1841	-21	1820	43	1798	glacial	hard		D.S.	Good supply in gravel
	SE	4				bored	64	1841	- 25	1816	64	1777	glacial	hard		D.S.	Good supply in yellow sand
	NE	7				bored	77	1857			77	1780	glacial	med. soft		D.S.	Good supply in gravel
	SW	9				bored	64	1857	- 25	1832	64	1793	glacial	hard		D.S.	Limited supply in gravel
	NW	14				bored	16	1718	- 12	1706	12	1706	glacial	hard		D.S.	Good supply

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

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