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CANADA

DEPARTMENT OF MINES

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GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 231

GROUND-WATER RESOURCES
OF THE
RURAL MUNICIPALITY OF PROGRESS
NO. 351
SASKATCHEWAN

Records Collected by C. O. Hage.

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

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DEPARTMENT OF MINES AND RESOURCES

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GEOLOGICAL SURVEY

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Figure 1. Map showing bedrock geology;

" 2. Map showing topography and location and types of wells.

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 5, 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 (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 (MgSO4) 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 degress 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.

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].

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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.28
$CaCO_3$	250	305	125
$CaSO_4$	-	-	-
$MgCO_3$	1109	60	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	-	233	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 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 PROGRESS, No. 351, SASKATCHEWAN

Physical Features

The municipality is a gently rolling plain of prairie lands with broad northwest- and southwest-trending valleys and ridges. A few basins are occupied by shallow lakes, some of which dry up during the summer. Mostly the soil is good agricultural land, but to the south of Shallow Lake, in the vicinity of Onward, is an area of sandy soil and sand deposited in a former glacial lake. On the high land around Kerrobert the soil is quite bentonitic, and the drift is probably thin.

Geology

Soft bedrock is exposed in a few places in this municipality. A shale outcrop, in Buffalo Coulée, west of Onward, is known to be of marine origin from its content of microscopic fossils. This outcrop is probably of Bearpaw age, although the division between Pale Beds and the overlying Bearpaw is indefinite, and represents a transition from non-marine to marine deposition. An exposure beside the road a short distance west of Kerrobert may also be Bearpaw, but the outcrops along the railway west of Elemer Lake have the lithology of Pale Beds.

Water Supply

The wells in the sand area around Onward are mostly shallow. Rain water collects in the sand where it rests on relatively much less pervious clays and can thus be obtained at no great depth. In other parts, however, the supply comes mainly from sands and gravels in a zone near the base of the drift. Several wells penetrate the drift to the rock formations underlying it and obtain hard water in the lower part of what is thought to be Bearpaw or the upper part of the Pale Beds. Deeper wells in the Pale Beds encounter sands that yield soft water. There are no flowing wells in this municipality, although in a few wells the water rises to an elevation above some of the lower land. It is uncertain, however, to what degree, if any, flowing wells could be obtained, as the sand beds of the Pale Beds may be too lenticular to afford a continuous head for a flowing well.

Township 34, Range 23. The surface deposits in this township are very thin, and the ridge trending northwest in the vicinity of Kerrobert is evidently underlain by Pale Beds and perhaps by a little Bearpaw. The surface between the drift and the underlying bedrock is evidently quite uneven, and water tends to accumulate in sand and gravel deposits near the base of the drift. This is especially the case where the underlying formation is less pervious than the glacial materials. In prospecting for shallow wells in the drift, therefore, the search for gravel and sand beds is apt to be more successful in the lower areas than on the higher land. In this township, however, it may be difficult to distinguish wells in glacial sand from those that have entered sandy beds of the formation below the drift. On Buffalo Coulée, in the next range west, green marine shale that is considered to be Bearpaw outcrops at an elevation of about 2,250 feet, and the outcrop on the highway west from Kerrobert is still higher. Thus the well on SE. section 5 may be in the Bearpaw or Pale Beds at an elevation for the aquifer of 2,259 feet. Other wells in which water is encountered at a lower elevation may also be in the Pale Beds, although the thickness of the drift is apparently quite variable. The deepest well on NW. section 9, drilled to a depth of 450 feet, or an elevation of 1,906 feet, obtained soft water that rose to an elevation of 2,206 feet, or considerably above the level of most of the range immediately east of Kerrobert.

Township 34, Range 24. In the vicinity of some small lakes north of Street Lake in township 33 several springs issue at an elevation slightly above 2,200 feet. These may be connected with sand beds within the bedrock, as an outcrop of green marine shale occurs on Buffalo Coulée west of Onward at an elevation of about 2,250 feet. In this township it is difficult to state which wells are in sands of the drift and which are in sands of the underlying formations. The drift is variable in thickness, and the contact between it and the bedrock is believed to be very uneven. In SE. section 34 glacial gravel is known to occur at a depth of 66 feet, or at an elevation of 2,144 feet, which is 100 feet below the level of the outcrop of marine shale on Buffalo Coulée. Under these circumstances, therefore, it is probable that water occurs most abundantly at the base of the drift in the depressions on the surface of the bedrock, and thus that the elevations of the aquifers will show a wide variation from place to place. No doubt further water supplies exist at greater depths within the bedrock formations, so that where neither sufficient nor good water has been obtained from shallow wells it can be reached by deeper drilling.

Township 34, Range 25. Most of the wells in this township are relatively deep, several being sunk to more than 100 feet. The drift is presumed to be underlain by a little Bearpaw, which, in turn, overlies the Pale Beds. It is impossible, however, to distinguish sands in the drift from sands high up in the bedrock formations, and as the thickness of drift is unknown it is not at all certain that most of the wells reached the Bearpaw, although the occurrence of sand without gravel suggests that this is so. It is highly probable that both the wells on SE. section 13 and SW. section 21 reached a sand in the Pale Beds at an elevation of between 2,180 and 2,190 feet, and there obtained water. The fact that the water in one well is reported as soft and the other as hard has no significance, because of the opportunities for downward percolation of hard water from the drift.

Township 35, Range 23. In this township a few wells are less than 50 feet deep, but most of them reach a depth of from 50 to 90 feet. One, on SE. section 36, reached a gravel bed at a depth of 65 feet, or an elevation of 2,092 feet. It may be that this bed is in a pre-glacial valley deposit that trends southeast to the Kerrobert town well on NE. sec. 18, tp. 34, rge. 22. In the Kerrobert well the water horizon is at a depth of 220 feet, or an elevation of 1,945 feet, and the well flows. Farther northwest, in tp. 36, rge. 23, a well on SE. section 22 was bored to a depth of 144 feet, and another, on SE. section 28, to 130 feet, in glacial materials without obtaining water. Both of these wells are apparently also in this pre-glacial valley. The edges of the valley cannot be accurately defined, but, on NE. sec. 22, tp. 35, rge. 23, a well 90 feet deep encountered coal in the Pale Beds at an elevation of 2,169 feet, or 77 feet above the bottom of the glacial well on SE. section 36. Also, another well, on SE. section 27, encountered coal in the Pale Beds at a depth of 48 feet, or an elevation of 2,206 feet. This well is 114 feet above the glacial gravel in the bottom of the well on section 36. This evidence clearly points to a bedrock ridge beneath the drift. The eastern edge of this ridge passes through Kerrobert and extends northwest through tp. 35, rge. 23. East of this ridge the glacial deposits are thick, and all wells in this part of the township are in drift, whereas to the west certain of the wells reach bedrock.

Two wells, one on SW. section 14 and the other on SE. section 15 obtain water at 2,250 to 2,255 feet in clay. It is not known whether this is glacial clay or Bearpaw shale. Deeper wells at both these locations would encounter water in the Pale Beds. Apparently the bedrock ridge is relatively narrow, and the thickness of glacial materials increases again to the west. Thus most of the wells in the western part of this township obtain water in glacial sands at no great depth. The supply, however, could be increased by drilling to sands in the underlying formations.

Township 35, Range 24. In section 23 two wells obtain water at elevations of 2,129 and 2,139 feet respectively. One of these wells, 83 feet deep, encountered coal in the Pale Beds so that both wells are considered to have tapped a sand within this formation. The thickness of drift in this township has not been determined. In a few wells the water occurs in a green sand suggestive of sand in the upper part of the Pale Beds. As already stated the passage from non-marine Pale Beds to overlying marine Bearpaw shale is transitional, and this transitional zone includes considerable marine sand, above which may lie typical, non-marine Pale Beds. The wells in sections 9, 14, and 16 may, consequently, be in green sand of this transition zone, and if so most of the other wells may also be in sands within this zone rather than in glacial materials. In the entire township there is reason to believe that a still greater supply of water can be obtained by sinking deeper wells into the Pale Beds.

Township 35, Range 25. In a well on NW. section 12 glacial gravel occurs at a depth of 84 feet, or an elevation of 2,204 feet, whereas on NW. section 30 coal is reported at a depth of 60 feet, or an elevation of 2,301 feet. Coal is known to occur in certain areas in the basal part of the Bearpaw formation and the probability is that this well reached a coal horizon within this formation. The ridge in which the coal was encountered is apparent at the surface. It trends northwest through the western part of the township, and is believed to have a core of bedrock. Hence the glacial materials thicken to the northeast, occupying a depressed area in the bedrock surface between this ridge and the one previously described that extends northwest from Kerrobert. The wells to the northeast of the ridge are, consequently, mostly in glacial sand and gravel, whereas to the southwest most of them are in the bedrock, that on NW. section 30 being an exception. Two of the wells that reach bedrock evidently tap a sand in the Pale Beds at an elevation of approximately 2,175 to 2,180 feet on opposite sides of the surface ridge. It is thus inferred that this sand is probably a fairly continuous aquifer. It would also probably be present to the northeast of the ridge provided it has not been removed by pre-glacial erosion.

Township 36, Range 23. As already noted, a pre-glacial valley cuts across this township in a northwest direction from the southeast corner. In it, on SE. section 22, a hole 144 feet deep failed to reach the bottom of the drift at an elevation of 2,150 feet, and another, 130 feet deep, on SE. section 28, reached an elevation of 2,190 feet without penetrating the drift. It is probable, in view of the information provided by the Kerrobert town well in this same pre-glacial valley, that the drift is upwards of 100 feet thick below the lowest point reached in the hole on section 22. Both of these dry holes should encounter flowing wells at the base of the drift, as in the Kerrobert town well. The edge of the pre-glacial valley to the northeast seems clearly defined by a well on SE. section 13, which encountered coal, presumably in the Pale Beds, at a depth of 80 feet, or an elevation of 2,160 feet. This is probably the same coal horizon as that encountered in the well on SW. sec. 6, tp. 35, rge. 25, at an elevation of 2,175 feet, and in the well on NE. sec. 17, tp. 35, rge. 25, at an elevation of 2,180 feet, further confirming the fact that this is a widespread horizon in the Pale Beds, and probably also indicating a very slight easterly dip to this formation in this area. With the exception of the well on SE. section 13 and another on NE. section 14 drilled to a depth of 412 feet and obtaining water in the Pale Beds at an elevation of 1,855 feet, all other wells in this township, so far as can be judged from the records, are in glacial materials. A sand zone at an elevation between 2,150 and 2,175 feet, has supplied water for several wells, and another, higher zone, between elevations of 2,220 and 2,240 feet is also quite widespread. It is almost certain, however, that in both of these zones the individual, water-bearing sand beds have a very limited extent laterally, though, due to the number of them, they have been encountered in many wells.

Township 36, Range 24. In one well on SE. section 9, drilled to a depth of 288 feet, coal, believed to be in the Pale Beds, was reported at 80 feet, or an elevation of about 2,200 feet. This indicates that the ridge of bedrock that extends northwest from Kerrobert is still persisting but is becoming much less pronounced northward. On NW. section 9, however, a well 127 feet deep, the bottom of which is at an elevation of 2,203 feet, is thought to derive its water from glacial sand, and another well, 125 feet deep, on SW. section 16, also obtains water from glacial sand. These are probably the deepest glacial wells in this area. There is no uniformity of level of the water-bearing sands in the drift, and gravel has not been reported from a single well of which records are available. The prospects for finding water in the drift are, therefore, entirely dependent on encountering one of these irregularly distributed glacial sands, and these must derive all their water from downward percolation of rain through the drift. Below the drift several wells in this township have reached sands in the Pale Beds, the deepest well, on SW. section 21, having a depth of 500 feet and reaching an elevation of 1,889 feet. A decided lack of uniformity of elevation of the aquifers in the Pale Beds is shown by the well records, and indicates that probably several are represented.

Township 36, Range 25. In the centre of this township a gently sloping hill rises above an elevation of 2,400 feet. A well on NE. section 21, bored to a depth of 123 feet, obtained alkaline water at an elevation of 2,268 feet in what is considered to be glacial sand, indicating that the hill is a glacial feature. On NE. section 23 a well 160 feet deep obtained water in the Pale Beds at an elevation of 2,196 feet. The depth of the drift is not known, but is presumably above 2,200 feet, which was the level of a coal horizon in Pale Beds in a well in range 24. It is possible, therefore, that the drift composing the hill in this township reaches a thickness of nearly 200 feet. Many of the wells in the township are in drift, but none of the sands is extensive and their depths at any location cannot be predicted except within the limits of present information gained from the available records Below the drift several wells obtain water from sands in the Pale Beds. On SW. section 16, NE. section 18, and NE. section 25 water was encountered at an elevation of 2,150 to 2,155 feet, and in each well coal was reported. These coal seams may not represent very continuous horizons within the Pale Beds, but their presence is proof that the wells are in that formation. A well, 175 feet deep on NW. section 31, reported brown water at an elevation of 2,073 feet, and another, on NE. section 31, apparently encountered the same horizon at a depth of 176 feet, or an elevation of 2,066 feet. The difference in elevation as shown by the two wells is unimportant in that the elevations at the surface were not the result of a precise instrument survey, and the depths of the wells may also be slightly inaccurate. A third, Pale Beds sand intermediate between the two referred to above was encountered in a well 95 feet deep on NW. section 19 at an elevation of 2,197 feet, and also in a well 160 feet deep on NE. section 23 at an elevation of 2,196 feet. Thus, three water-bearing horizons are indicated in the Pale Beds of this township, and there is no reason why these should not be productive over the whole area, though sufficient supplies of water may not be available in shallower wells.

ANALYSES OF WATER SAMPLES FROM **Progress Rural Municipality No. 351, Saskatchewan.**

No.	¼ Sec.	Tp.	Rge.	Depth in feet	Elev. of Aquifer	Total dissolved solids	Constituents as Analysed: Ca	Mg	Na	SO_4	Cl.	Alk.	Total Hardness	Constituents as Calculated in assumed Combinations: $CaCO_3$	$CaSO_4$	$MgCO_3$	$MgSO_4$	Na_2CO_3	Na_2SO_4	NaCl.	Source of Water
1	SE 13	34	25	165	2180	2060	300	120	92	1230	12	145	1500	145	822		594		259	20	Similar to water from drift.
2	NE 17	35	25	168	2180	1140	50	22	324	406	11	480	240	125		76		281	601	18	Pale Beds
3	NE 30	35	25	80	2301	700	114	50	66	185	10	425	600	285		118	79		181	17	Bearpaw-
4	NE 24	35	25	67	2175	1100	114	61	175	390	13	490	700	285		172	54		514	21	Very similar to No. 3.
5	NE 23	35	24	90	2139	980	122	59	110	295	18	455	700	305		126	114		302	30	do.
6	NE 14	36	23	412	1855	1280	14	13	411	324	26	605	35	35		45		547	480	43	Pale Beds --
7	SE 9	36	24	288	1996	1080	7	9	368	37	53	740	35	18		31		726	55	87	Pale Beds --
8	SE 31	36	24	175	2143	1040	36	11	308	209	16	565	90	90		38		456	309	26	Pale Beds --
9	SW 16	36	24	136	2151	760	64	24	165	70	15	520	280	160		83		277	104	25	Pale Beds --

RECORD OF WELLS IN RURAL MUNICIPALITY OF PROGRESS, NO. 351, SASKATCHEWAN.

[redacted]	A T I O N	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 the Water.	Use to Which Water Is Put[x]	Yield & Remarks
1	N.E. 2	34	23	3	Dug	23	2266	-20	2246	23	2243	Glacial sand	Hard	D.S.	Waters 10 head.
2	S.E. 5	"	"	"	Bored	60	2319	-50	2269	60	2259	Pale Beds ?	"	"	" 10 "
3	S.W. 6	"	"	"	"	62	2284			62	2222	Sand	"	"	" 12 "
4	S.W. 7	"	"	"	"	65	2257	-45	2212	65	2192		"	"	" 40 "
5	N.W. 7	"	"	"	"	40	2256	-35	2221	40	2216	Glacial clay	"	"	Sufficient
6	N.W. 9	"	"	"	Drilled	450	2356	-150	2206	450	1906	Pale Beds	Soft	"	
7	N.W.10	"	"	"	Bored	60	2340	-50	2290	60	2280	Sand	Hard	"	Sufficient
8	S.E.12	"	"	"	"	60	2281		Low	60	2221	"	"	"	Waters 12 head.
9	S.W.14	"	"	"	Dug	20	2299	-12	2287	20	2279	Glacial gravel	"	"	Limited
10	N.E.16	"	"	"	Bored	36	2245		Low	36	2209		" Bad	S.	10 bbl. per day.
11	S.W.16	"	"	"	"	58	2334	-50	2284	58	2276	Sand	"	D.S.	Poor supply
12	S.W.16	"	"	"	"	140	2334	-120	2214	140	2194	" Pale beds?			
13	S.W.18	"	"	"	"	60	2281	-50	2231	60	2221	Glacial sand	"	"	Sufficient
14	S.E.20	"	"	"	Dug	45	2194	-25	2169	45	2149	Sand F.	"	"	Waters 15 head.
15	N.W.20	"	"	"	"	35	2216	-23	2193	35	2181	Clay	"	"	" 30 "
16	S.W.21	"	"	"	Bored	104	2198	-64	2134	104	2094	Sand Pale beds?	"	S.	" 50 "
17	N.W.22	"	"	"	"	70	2238	-47	2191	70	2168	Sand	Soft	D.S.	" 100 "
18	S.W.22	"	"	"	Dug	24	2234			24	2210		"	"	Abundant
19	S.W.23	"	"	"	Bored	82	2240	-42	2198	82	2158	Glacial gravel		S.	Sufficient
20	S.W.26	"	"	"	Dug	10	2210	- 7	2203	10	2200	" sand	Hard	D.S.	Waters 30 head.
21	S.W.28	"	"	"	Bored	90	2243	-86	2157	90	2153		"	"	Poor supply
22	S.E.35	"	"	"	"	65	2245			65	2180	Sand	"	"	Fair "
23	S.W.36	"	"	"	"	110	2230	-40	2190	110	2120		Salty Hard	S.	Sufficient
	S.W.36	"	"	"		36	2230			36	2194	Glacial gravel	Soft	D.	
1	S.W. 1	34	24	3	Bored	40	2285	-30	2255	40	2245	Glacial sand	Hard	D.S.	Sufficient
2	S.E. 2	"	"	"	"	36	2326	-30	2296	36	2290		"	"	Poor supply
3	S.W. 4	"	"	"	"	90	2302	-50	2252	90	2212	Sand	"	"	Sufficient
4	N.W. 4	"	"	"	"	90	2308	-75	2233	90	2218	"	"	"	"
5	N.E. 8	"	"	"	"	64	2280		Low	64	2216	"	" Fe.	"	Limited
6	N.E.10	"	"	"	"	80	2275	-40	2235	80	2195	"	" "	"	Sufficient

x. D.- Domestic, S.- Stock, Alk.- Alkaline, M.- Municipal, Fe.- Iron, Br.- Brown.

Well No.															
7	N.W.10	34	24	3	Bored	60	2303	-45	2258	60	2243	Sand	Hard	D.S.	Sufficient
8	S.E.13	"	"	"	"	82	2246	-30	2216	82	2164	**Blue sand**	Hard & S.	"	Waters 70 head of stock
9	N;W.14	"	"	"	"	33	2231	-28	2203	33	2198	Sand & grav	Hard	"	" 10 " " "
10	S.W.16	"	"	"	Dug	30	2282	-25	2257	30	2252		"	S.	Abundant, bad odour.
11	N.W.16	"	"	"	"	32	2255		Low	32	2223	Sandy shale	"	D.S.	Limited
12	N.E.16	"	"	"	Bored	36	2254	-20	2234	36	2218	Shale sand	"	S.	
13	S.E.18	"	"	"	"	87	2295	-62	2233	87	2208	Sand	"	D.S.	Sufficient supply
14	S.E.19	"	"	"	"	45	2275	-40	2235	45	2230	**Glacial sand**	Soft	"	Good supply
15	S.W.21	"	"	"	"	40	2235	-13	2222	40	2195	" "	"	"	Sufficient
16	S.E.25	"	"	"	"	16	2218	-12	2206	16	2202	" "	Hard	"	Limited
17	S.E.28	"	"	"	"	30	2241	- 8	2233	30	2211	" gravel	" Alk.	"	Good supply
18	S.E.30	"	"	"	"	52	2284	-50	2234	52	2232	" sand	"	"	Poor "
19	S.E.34	"	"	"	"	66	2210	-10	2200	66	2144	" gravel	"	"	Abundant supply
20	N.W.35	"	"	"	"	38	2200	-15	2185	38	2162	Sandy clay	" Alk.	S.	Sufficient
21	N.E.36	"	"	"	Dug	42	2221	-36	2185	42	2179	**Blue sand**	"	D.S.	6 bbl. per day.
22	S.E.36	"	"	"	"	32	2214	-20	2194	32	2182	Gray clay	"	"	Sufficient
1	S.E. 2	34	25	3	Bored	114	2356	-100	2256	114	2242	Sand	Hard Fe.	D.S.	Sufficient supply
2	N.W. 2	"	"	"	"	146	2375	-140	2235	146	2229	"	" "	"	" "
3	S.W. 4	"	"	"	"	80	2354	-65	2289	80	2274	"	"	"	Good
4	N.W. 6	"	"	"	"	60	2390	-40	2350	50	2340	"	"	"	" "
5	S.E. 9	"	"	"	"	160	2367			160	2207	"	Soft	"	" "
6	N.E.10	"	"	"	"	140	2375			140	2235	"	Hard	"	" "
7	S.W.12	"	"	"	"	90	2332	-80	2252	90	2242	"	Soft	"	Poor "
8	S.E.13	"	"	"	Drilled	165	2345	-150	2195	160	2180	Pale Beds	Hard	"	Good "
9	N.W.14	"	"	"	Bored	110	2361	-100	2261	110	2251	Sand	"	"	Sufficient
10	S.W.15	"	"	"	"	130	2379	-124	2255	130	2249	Sandy clay	"	"	"
11	S.W.17	"	"	"	"	60	2376	- 40	2336	60	2316	Sand	"	"	"
12	N.W.18	"	"	"	"	80	2381	- 50	2331	80	2301	"	"	"	"
13	N.E.20	"	"	"	"	95	2383	-83	2300	95	2288	Clay	"	"	Poor supply
14	S.W.21	"	"	"	Drilled	192	2380	-132	2248	192	2188	Pale Beds	Soft	"	Abundant supply
15	S.E.22	"	"	"	Bored	85	2314			85	2229	Clay	Hard	"	Fair supply
16	N.W.22	"	"	"	"	125	2348			125	2223	Sand	"	S.	Good "
17	N.E.24	"	"	"	"	60	2300	-35	2265	60	2240	**Blue sand**	"	D.S.	" "
18	N.E.33	"	"	"	"	75	2296	-69	2227	75	2221	Sand	"	"	Poor "
19	N.E.36	"	"	"	"	83	2283	-70	2213	83	2200	"	"	"	Good "

Well No.															
1	S.W. 1	35	23	3	Dug	20	2193	-15	2178	20	2173		Hard	D.S.	Sufficient
2	N.E.13	"	"	"	Bored	90	2232	-40	2192	90	2142	Glacial sand	"	"	"
3	S.W.14	"	"	"	"	50	2300			50	2250		"	"	"
4	S.E.15	"	"	"	"	50	2305			50	2255	Clay	"	"	Limited supply
5	N.E.16	W	"	"	"	50	2255			50	2205	"	"	"	Sufficient
6	N.W.16	"	"	"	"	60	2260	-30	2230	60	2200	Glacial gravel	"	"	"
7	N.E.17	"	"	"	Dug	40	2265			40	2225	" clay	"	"	Limited supply
8	S.E.18	"	"	"	Bored	50	2223	-20	2203	50	2173	Clay	"	"	Sufficient
9	N.E.19	"	"	"	"	65	2267			65	2202	Sand	"	"	"
10	N.W.21	"	"	"	"	60	2240			60	2180	Clay	"	"	"
11	N.E.22	"	"	"	"	90	2259	-50	2209	90	2169	Pale Beds sand	"	"	Limited. Coal at 65'
12	N.E.23	"	"	"	"	53	2235	-47	2188	53	2182		"	"	Sufficient
13	N.E.24	"	"	"	"	70	2171	-40	2131	70	2101	Sandy soil	"	"	Waters 25 head stock
14	N.W.24	"	"	"	"	62	2220	-40	2180	62	2158	Sand	"	"	Sufficient supply
15	N.W.25	"	"	"	"	47	2176	- 7	2169	47	2129	Glacial red sand	"	"	" "
16	N.E.26	"	"	"	Dug	36	2186	-16	2170	36	2150	Sand	Soft	"	" "
17	S.E.27	"	"	"	Bored	54	2254	-20	2234	48	2206	Pale beds	Hard Br.	"	Coal at 48'.
18	S.W.29	"	"	"	"	65	2272			65	2207	Sand	"	"	Sufficient "
19	N.W.32	"	"	"	"	70	2230			70	2160	"	"	"	" "
20	N.W.35	"	"	"	"	36	2177	-16	2161	36	2141	Glacial sand & clay		S.	" "
21	S.E.36	"	"	"	"	65	2157	-15	2142	65	2092	Glacial gravel	"	"	" "

1	S.W. 4	35	24	3	Dug	35	2262	-20	2242	35	2227	Sand	Hard	D.S.	Abundant supply
2	N.E. 4	"	"	"	Bored	75	2224			75	2149		"	"	Waters 200 Head Stock
3	N.W. 5	"	"	"	"	60	2259	-30	2229	60	2199	Sand	Soft	"	Sufficient
4	S.W. 9	"	"	"	"	34	2253	-30	2223	34	2219	Green sand	Hard	"	Limited
5	S.E.14	"	"	"	Bored	51	2204	-16	2188	51	2153	" "	Soft	"	Waters 50 head "
6	N.E.16	"	"	"	Dug	20	2195	-10	2185	20	2175	" "	" salty	"	Sufficient
7	S.W.17	"	"	"	Bored	100	2264		Low	100	2164	Sand	Hard	S.	Poor
8	N.W.23	"	"	"	"	88	2217	-40	2177	88	2129	Pale Beds sand	"	D.S.	Coal at 88'.
9	N.E.23	"	"	"	"	90	2227	-30	2197	88	2139	" " "	"	"	Sufficient
10	N.W.25	"	"	"	"	40	2232			40	2192	Sand	"	"	"
11	N.E.30	"	"	"	"	40	2266	-14	2252	40	2226	"	"	"	Good supply
12	S.E.31	"	"	"	"	42	2229	-25	2204	42	2187	"	"	"	" "
13	S.E.32	"	"	"	"	40	2210	-10	2200	40	2170		Soft	"	Sufficient
14	N.E.32	"	"	"	"	40	2240	-20	2220	40	2200	"	Hard	"	Good supply
15	S.W.33	"	"	"			2202						Soft		Flowing Spring.

Well No.															
16	N.E.34	35	24	3	Bored	65	2208	-40	2168	65	2143	Sand	Hard	D.S.	Sufficient
17	S.W.36	"	"	"	Dug	30	2247		Low	30	2217		"	"	Limited
1	S.W. 6	35	25	3	Drilled	260	2435	-90	2345	260	2175	Pale Beds	Soft	D.S.	Abundant. Coal 1'.
2	S.W. 7	"	"	"	Bored	114	2410			114	2296	Sand	Hard	"	Good supply
3	S.W.10	"	"	"	"	80	2330	-50	2280	80	2250	Sand	"	"	" "
4	N.W.12	"	"	"	"	84	2288	-40	2248	84	2204	Glacial gravel	"	"	" "
5	N.E.12	"	"	"	"	65	2269	-55	2214	65	2204	Sand	"	"	Limited
6	S.E.13	"	"	"	"	94	2263			94	2169	"	"	"	Good supply
7	S.E.14	"	"	"	"	54	2285	-16	2269	54	2231	Glacial gravel	"	"	Limited "
8	S.E.16	"	"	"	"	85	2319	-75	2244	85	2234	Sand	"	"	Poor "
9	N.E.17	"	"	"	"	168	2348	-78	2270	168	2180	Pale Beds	Soft	"	Sufficiant. Coal4 168'.
10	S.W.20	"	"	"	"	56	2352	-36	2316	56	2296	Glacial sand	Hard	"	Limited
11	N.E.21	"	"	"	"	70	2280			70	2210	" "	"	"	Good supply
12	S.W.22	"	"	"	"	60	2297			60	2237	" gravel	"	"	" "
13	N.E.22	"	"	"	"	45	2286			45	2241	Sand	"	"	" "
14	S.E.23	"	"	"	"	73	2259	-30	2229	73	2186	Clay	"	"	" "
15	S.W.23	"	"	"	"	52	2294	-32	2262	52	2242	Glacial	"	"	Limited
16	S.E.24	"	"	"	"	55	2245	-44	2201	55	2290	" sand	"	"	" "
17	N.E.24	"	"	"	"	67	2242	-62	2180	67	2175	[illegible] sand	"	"	" "
18	N.W.28	"	"	"	"	60	2274			60	2214	Gl. sand	"	"	Good supply
19	N.E.30	"	"	"	"	80	2361	-45	2316	60	2301	Bearpaw?	Soft	"	" " Coal at 60'.
20	N.W.30	"	"	"	"	60	2382	-50	2332	60	2322	Glacial gravel	Hard	"	Poor "
21	N.E.35	"	"	"	"	65	2279	-35	2244	65	2214	" sand	"	"	Sufficient
22	N.E.36	"	"	"	"	50	2243			50	2193	" "	"	"	"
1	N.W. 4	36	23	3	Bored	50	2219			50	2169		Hard	D.S.	Sufficient supply
2	S.W. 4	"	"	"	"	60	2213			60	2153	Sand	"	"	" "
3	S.E. 9	"	"	"	Dug	20	2211			20	2191	" F.	"	"	Limited "
4	N.W. 9	"	"	"	Bored	65	2210	-35	2175	36	2174	Glacial sand	" Fe.	"	Sufficient "
5	S.E.10	"	"	"	"	50	2208			50	2158	" "	"	"	" "
6	N.W.10	"	"	"	"	35	2238	-32	2206	35	2203	" "	"	"	Limited "
7	N.E.12	"	"	"	"	40	2250	-28	2222	40	2210	" "	"	"	" "
8	S.E.13	"	"	"	Drilled	211	2241	-65	2176	211	2030	Pale Beds	Soft	"	Sufficient. Coal 80'.
9	N.E.14	"	"	"	"	412	2267	-45	2222	367	1900	" "	Hard		
										412	1855	Pale Beds	Soft	D.S.	Abundant supply

Well No.															
10	S.E.14	36	23	3	Bored	100	2246	-13	2233	100	2146	Glacial	Hard	D.S.	Sufficient
11	S.E.16	"	"	"	"	50	2240			35	2205	Sand	"	"	"
12	N.E.17	"	"	"	"	55	2255			35	2220		"	"	"
13	S.W.17	"	"	"	"	68	2239	-38	2201	68	2171	Sand	"	"	"
14	N.E.18	"	"	"	"	80	2246			80	2166		"	"	Limited
15	N.E.19	"	"	"	"	70	2300	-40	2260	70	2230	Sand	"	"	Sufficient
16	S.W.19	"	"	"	"	64	2336	-34	2302	64	2272	Blue sand	Soft	"	"
17	S.E.21	"	"	"	"	52	2285	-48	2237	52	2233	Glacial sand	Hard	"	Waters 6 head stock
18	S.E.22	"	"	"	"	57	2293	-40	2253	57	2236	" sand	"	S.	Dry Hole 144' deep
19	S.W.24	"	"	"	"	90	2255	-40	2215	90	2165	Glacial	"	D.S.	Waters 75 head.
20	S.W.26	"	"	"	"	82	2244	-55	2189	70	2174	" sand	Soft	"	" 60 "
21	S.E.28	"	"	"	"	54	2318			54	2264		Hard	"	" 15 " Dry Hole 130' Deep.
22	S.E.30	"	"	"	Dug	30	2346			30	2316	Sand	Hard	D.S.	Limited supply
23	N.E.30	"	"	"	Bored	120	2340			120	2220		Hard Alk.	S.	Sufficient
24	N.E.31	"	"	"	"	62	2329	-30	2299	62	2267	Glacial sand	"	D.S.	"
25	S.W.34	"	"	"	"	100	2291	-20	2271	100	2191		"	"	"
26	S.W.36	"	"	"	"	75	2223	-45	2178	75	2148		"	S.	"

1	N.E. 3	36	24	3	Bored	100	2278			100	2178	Sand	Hard	D.S.	Limited
2	S.E. 5	"	"	"	"	88	2255			88	2167	"	Hard Alk.	"	Good supply
3	N.W. 5	"	"	"	"	52	2266			52	2214	"	Soft	"	" "
4	S.W. 5	"	"	"	"	65	2279			65	2214	"	Hard	"	" "
5	N.W. 8	"	"	"	Drilled	350	2288	-20	2268	350	1938	Pale Beds Fine Sand	Soft	"	Sand trouble Luse-land Swimming Pool.
6	N.W. 9	"	"	"	Bored	127	2330	-95	2235	127	2203	Sand	Hard	"	Good supply
7	S.E. 9	"	"	"	Drilled	288	2284	-70	2214	288	1996	Pale Beds	Soft	"	" " Coal at 80
8	N.W.12	"	"	"	Bored	100	2289			100	2189		Hard	"	Sufficient
9	S.W.14	"	"	"	Drilled	180	2289	-100	2189	180	2109	" " sand	"	"	Sand trouble
10	N.W.16	"	"	"	Dug	40	2334			40	2294	Glacial	"	"	Sufficient
11	S.W.16	"	"	"	Bored	125	2368	-60	2308	125	2243	" sand	Soft	"	Good supply
12	S.W.20	"	"	"	Dug	25	2303			25	2278	" "	Hard	"	Sufficient
13	S.W.21	"	"	"	Drilled	500	2389	-35	2354	300	2089	Pale Beds	Soft	"	
										500	1889	" "	"	"	
14	S.W.22	"	"	"	Bored	60	2340			60	2280	Glacial	Hard	"	Sufficient
15	N.E.23	"	"	"	"	40	2249	-20	2229	40	2209	" sand	"	"	Limited
16	S.E.24	"	"	"	"	35	2342			35	2307	" "	"	"	Sufficient

Well No.															
17	S.W.24	36	24	3	Bored	60	2256	-30	2226	60	2196		Hard	Bad	
18	N.W.24	"	"	"	Dug	20	2340			20	2320	**Glacial sand**	"	D.S.	Limited
19	N.W.27	"	"	"	Bored	30	2341			30	2311	" "	"	"	Sufficient
20	S.W.28	"	"	"	Dug	30	2370			30	2340	" "	"	"	"
21	S.E.31	"	"	"	Drilled	175	2318	-70	2248	175	2143	Pale Beds	Soft	"	"
22	S.W.32	"	"	"	Dug	15	2329			15	2314	Sand Cl.	Hard	"	"
23	S.W.35	"	"	"	"	38	2334			38	2296	**Glacial sand**	"	"	"
24	N.E.36	"	"	"	"	36	2301	-20	2281	36	2265	Glacial	"	"	"
1	N.E. 2	36	25	3	Bored	54	2296	-29	2267	54	2242	Sand	Hard	D.S.	Limited
2	S.W. 3	"	"	"	"	69	2280	-30	2250	69	2211	"	"	"	Sufficient
3	N.E. 4	"	"	"	"	75	2321			75	2246	"	"	"	Good supply
4	N.E. 5	"	"	"	"	70	2297	-20	2277	70	2227	**Glacial gravel**	"	"	" "
5	S.E. 6	"	"	"	"	90	2281	-10	2271	90	2191		"	"	Sufficient
6	N.W. 6	"	"	"	"	90	2272			90	2182		"	"	Good supply
7	S.W. 8	"	"	"	Dug	45	2267	-35	2232	45	2222	**Glacial sand**	"	"	Sufficient
8	N.E. 9	"	"	"	Bored	100	2334	-50	2284	100	2234		Soft	"	Good supply
9	S.E.10	"	"	"	"	60	2321		Low	60	2261	**Glacial sand**	Hard	"	Poor "
10	N.E.11	"	"	"	"	105	2306		Low	105	2201	" "	"	"	" "
11	S.E.14	"	"	"	"	45	2312	-20	2292	45	2267	Blue "	"	"	Sufficient
12	S.E.15	"	"	"	"	55	2329	-30	2299	55	2274	**Glacial sand**	" Alk.	"	Good water supply
13	S.W.16	"	"	"	"	136	2287	-20	2267	136	2151	Pale Beds Coal	Soft	"	" " "
14	N.E.18	"	"	"	"	80	2232			80	2152	" " "	Hard	"	Poor supply
15	N.W.19	"	"	"	"	95	2234			37	2197	" " sand	Soft	S.	Sufficient
16	N.W.20	"	"	"	"	55	2239			55	2184	Sand	Hard	D.S.	Abundant
17	S.E.21	"	"	"	"	80	2380			80	2300	**Glacial sand**	"	"	Sufficient
18	N.E.21	"	"	"	"	123	2391			123	2268	Sand	" Alk.	"	Abundant
19	S.E.22	"	"	"	"	75	2389			70	2319		"	"	Sufficient
20	N.E.23	"	"	"	"	160	2356	-100	2256	160	2196	Pale Beds sand	Soft	"	"
21	S.E.24	"	"	"	"	70	2323	-40	2283	70	2253	Sand	"	"	"
22	N.E.25	"	"	"	Drilled	150	2304	-25	2279	150	2154	Pale Beds Coal	"	"	Good supply Coal 138-
23	S.E.27	"	"	"	Bored	60	2413	-20	2393	60	2353	Sand	"	"	Abundant
24	S.W.27	"	"	"	"	65	2413			65	2348	**Glacial sand**	Hard	"	Sufficient
25	N.E.28	"	"	"	"	75	2380								Dry hole.
26	N.W.28	"	"	"	"	50	2330			50	2280	Sand	Hard	"	Sufficient
27	N.W.30	"	"	"	"	35	2238			35	2203	"	Soft	"	"
28	S.W.30	"	"	"	"	37	2240			37	2203	**Glacial sand**	Hard	"	"
29	[illegible].W.31	"	"	"	Drilled	175	2248	-35	2213	175	2073	Pale Beds Coal	Soft Br.	"	Good supply

Well No.															
30	N.E.31	26	25	3	Drilled	176	2242			176	2066	Pale Beds Coal	Soft Br.	D.S.	Good supply
31	S.E.32	"	"	"	Bored	90	2312			90	2222	Glacial	Hard	"	Poor "
32	N.E.32	"	"	"	Dug	30	2294			30	2264	**Glacial sand**	"	"	" "
33	N.E.34	"	"	"	Bored	65	2319			65	2254	**Sand**	"	"	Sufficient
34	S.W.36	"	"	"	Dug	16	2324	-13	2311	16	2308	**Glacial gravel**	"	"	"