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CANADA
DEPARTMENT OF MINES
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GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 255

GROUND-WATER RESOURCES
OF THE
RURAL MUNICIPALITY OF PARKDALE
NO. 498
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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CONTENTS

	Page
Introduction	1
Publication of results	1
How to use report	2
Glossary of terms used	2
Bedrock formations of west-central Saskatchewan and east-central Alberta,	4
Water analyses	9
Introduction	9
Discussion of chemical determinations	9
Mineral constituents present	9
Water analyses in relation to geology	11
Glacial drift	11
Bearpaw formation	12
Pale Beds	12
Variegated Beds	13
Ribstone Creek formation	13
Rural Municipality of Parkdale, No. 498, Saskatchewan	16
Physical features	16
Geology	16
Water supply	16
Township 49, range 16, west 3rd meridian	17
" 49, " 17, " " "	18
" 49, " 18, " " "	18
" 50, " 16, " " "	19
" 50, " 17, " " "	20
" 50, " 18, " " "	21
" 51, " 16, " " "	21
" 51, " 17, " " "	22
" 51, " 18, " " "	22
Analyses of water samples	24
Records of wells in Rural Municipality of Parkdale, No. 498, Saskatchewan	25

Illustrations

Map - Rural Municipality of Parkdale, No. 498, Saskatchewan:

Figure 1. Map showing bedrock geology;

2. Map showing topography and the 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 concerning 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 subtracting 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 overlies 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 Cretaceous 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:

<u>Formation</u>	<u>Character</u>	<u>Thickness</u> 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 Pale and 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 Coulee 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 Coulee 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 Coulee, 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 Coulee 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 aquifer, 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 Coulee. 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 3 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 Coulee. In the Wainwright area, where the formation has been drilled in deep wells, the basal sand is 60 feet thick, with the central part composed of shale containing sand streaks. The upper sand member is about 20 feet thick in this area. The total thickness of the formation in the Wainwright area is 100 to 200 feet, but this increases to the west and in the Viking area exceeds 300 feet.

The Ribstone Creek formation is widely exposed in a northwest-trending belt in east-central Alberta. The southwest boundary of this northwest-trending belt passes through the mouth of Grizzly Bear Coulee 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 Coulee 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 purposes¹. 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 soft² to very hard, and can be classified according to the following system :

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 ~~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

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. $\frac{1}{4}$ 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. $\frac{1}{4}$ 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:

	SE. sec. 16, NE. sec. 3, SW. sec. 7, SE. sec. 21	tp.38, rge. 21	tp.39, rge. 25,	tp.37, rge.24,	tp. 38,rge.23
Salts					
CaCO ₃	73	18	53	35	
CaSO ₄	-	-	-	-	
MgCO ₃	52	14	45	38	
MgSO ₄	-	-	-	-	
Na ₂ CO ₃	297	679	464	562	
Na ₂ SO 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	325	125
CaSO ₄	-	-	-
MgCO ₃	1109	80	155
MgSO ₄	149	104	69
Na ₂ CO ₃	-	-	-
Na ₂ SO 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. sec. 10, tp.35, rge. 20,
CaCO ₃	73	73	73	198	108	90
CaSO ₄	-	-	-	-	m-	-
MgCO ₃	38	38	38	52	69	52
MgSO ₄	-	-	-	-	-	-

Na ₂ CO ₃	129	119	129	11	106	125
Na ₂ SO 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 analyses 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 Deds, whereas others are quite different. The following analyses illustrate some of the different types of water from this formation:

	Se.sec. 11, tp. 46, rge.	Ind.Agent Little Pine I.R.	SW.sec. 24, tp. 46, rge.	NE.sec. 36, tp. 43, rge.	Se.sec. 26, tp. 43, rge.	NE.sec. 36, tp. 41, rge.	NW.sec. 22, tp. 42, rge.
Salts	28		21	18	18	24	23
CaCO ₃	90	90	410	73	35	73	125
CaSO ₄	-	-	-	-	-	-	-
MgCO ₃	97	59	160	38	31	38	97
MgSO ₄	-	-	64	-	-	-	-
Na ₂ CO ₃	217	392	-	283	592	129	196
Na ₂ SO 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	1,200	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 PARKDALE, NO. 498,
SASKATCHEWAN

Physical Features

The main topographical feature in this municipality is the abrupt rise in the land to the east of Jackfish Creek, a stream that, in township 49, marks the division between areas of thin and thick drift. The numerous stream channels that enter the main valley from the northeast extend back about 6 miles. The abrupt rise is caused by a morainal deposit of boulder till several hundred feet thick, which, unlike most deposits of this type, is comparatively flat on top, resembling a plateau, and is fairly well drained. The boulder till that forms the surface deposit is very rocky in certain localities, indicating that considerable erosion has taken place. On the lower land of tp. 49, rge. 18, west of Jackfish Creek, the surface deposits of sand and boulder till rarely exceed 25 feet in thickness.

Geology

No outcrops of bedrock are exposed in the municipality, and only wells that have drilled through the drift are in tp. 49, rge. 18. These encountered a shale, presumably the Lea Park formation. On section 4, in this township, the top of the shale was reached at an elevation of 1,849 feet, and no noticeable change was noted in the formation to a further depth of 300 feet. On the high, plateau-like country east of Jackfish Creek no tests have been made to bedrock, so it is impossible to place the elevation of the bedrock surface in the remaining part of the municipality. As the general level of the plateau in tp. 49, rge. 16, is more than 2,300 feet, or about 500 feet above the lower land west of Jackfish Creek, it is possible that part of this rise is due to the presence of higher beds, stratigraphically.

Water Supply

So far as known all wells in the municipality obtain their water from sand and gravel bodies within the glacial drift. In tp. 49, rge. 18, where the drift is comparatively thin, some wells obtain a seepage supply on top of the underlying shale; elsewhere, however, the water obtained is within the drift.

As in all glacial drift deposits the elevations at which the water horizons occur vary greatly from place to place, any uniformity over a large area depending on the presence of outwash or interglacial deposits. The latter were not detected, but outwash deposits of gravel and sand are common. Most of these are small, and are buried beneath boulder till, and those that reach the surface are mostly small, isolated pockets or lenses. One of these buried outwash deposits is found on the east side of tp. 51, rge. 18, another, around the town of Glaslyn, may be associated with the upper part of Jackfish Creek drainage channel, and several other smaller deposits yield a good supply of water.

There are areas, however, where no definite water-bearing horizons are known, the sand and gravel occurring as pockets or lenses of very limited size. The upper 50 feet of the drift contains a large number of such deposits. Fortunately, there are very few areas where no sand or gravel has been found in the upper 100 feet of drift, the dry holes being usually confined to a single farm rather than to a district.

Light precipitation will lower the water level in the wells and lakes, and as rainfall is the source of all ground water a serious problem arises when this supply shows signs of depletion. The amount of water present in an aquifer will depend on its size and porosity. The latter is generally very good in this municipality, but the size of the sand or gravel body cannot be estimated without sinking several test holes.

It is possible that aquifers exist below those already tapped.

Township 49, Range 16. The topography of this township is typical of most of the land in the municipality. It is part of a plateau, as the country on the whole is quite flat and marked by occasional small ridges of boulder till trending northwest and southeast. Several parallel streams and deep gullies enter Jackfish Creek and provide drainage to the southwest. These gullies were formed by the large volume of water that flowed from the melting ice-mass that once covered this country. Many of them dry up after the snow waters have been carried away in the spring of each year, and others are occupied by small streams.

The deposit left by the glacier is largely boulder till. Its thickness is not definitely known, as no wells have been drilled through it, but is probably as much as several hundred feet. Sand and gravel pockets and lenses in the drift are water-bearing. The possibilities of water in the bedrock beneath the drift will depend on whether sand is present in beds higher ~~stratigraphically than those~~ on the lower land to the south and west. If the drift is less than 400 feet thick such possibilities are good.

The upper part of the drift provides by far the greatest amount of water. Wells deeper than 50 feet are the exception, and most of them are about 30 feet deep or less. The amount of sand and gravel in the drift depends upon the degree of sorting that took place during periods of fluctuation in the ice-front. Deposits of limited lateral extent centre around sections 27 and 28, along the upper part of the ravine that leads to the southwest. These deposits occur at elevations between 2,290 and 2,312 feet. Within this area, in section 21, is a large spring that has an elevation of 2,225 feet. The difference in these two levels seems too great to suggest that the spring is from the upper horizon, but it is quite possible that it may come from one about 50 feet lower.

Another spring, on section 18, has an elevation of 2,122 feet, much lower than that of any aquifer encountered in any of the wells, and also lower than that of the dry hole on SE. section 8. As springs are commonly indicative of either gravel deposits or the tops of impervious beds of shale or clay, it seems probable an aquifer is present at the low level of this spring, and that deep drilling, about 200 feet on the higher land, will be required to reach it. The possibility of the water rising to any great height in the wells seems rather remote.

The upper horizon in the drift is not represented on SE. section 8, several wells having been sunk to a depth of as much as 101 feet without encountering either sand or gravel. Deeper horizons may be present, as indicated by springs along the gullies, and the low aquifer represented by the spring on section 18, if it extends this far, would be reached at a depth of about 200 feet. It is possible, too, that other water horizons may lie between these two levels, but owing to the extremely variable nature of the boulder till, it is impossible to predict their occurrence.

Township 49, Range 17. Jackfish Creek cuts across the southwest corner of the township along the western edge of a large moraine. The land rises rather abruptly to a comparatively flat plain dissected by numerous parallel streams and stream channels that drain into Jackfish Creek. These gullies are typical of the western face of the moraine, and at one time carried a large amount of water from the melting ice as it retreated to the northeast.

All wells in this township are in glacial drift and most of them are less than 30 feet deep. The water supply varies from good to poor, but none of the wells is dry. The water horizons represented have a vertical range of 500 feet between the southwest and northeast corners of the township, a range about equal to the difference in relief. The upper 30 feet of the drift contains a fairly large amount of sand and gravel, but owing to the limited supply of water obtained by some of the wells, the deposits are probably in the form of pockets or lenses rather than continuous beds. The elevations of the aquifers follow the surface contours fairly closely, but the wells on sections 14 and 15 at a lower elevation than those to the northeast carry only a small supply of water, whereas if they were in the same aquifer the pressure and supply would be greater.

A spring on section 18 has an elevation of 1,862 feet, and may represent the base of the drift at this place.

Township 49, Range 18. Jackfish Creek cuts across the northeast corner of this township, and marks the boundary between two different types of surface deposits. To the northeast of the creek the deposit is a rocky boulder moraine, whereas to the southwest the drift is much thinner and the surface deposits more varied. A large area of sand and sandy soil borders Russell Lake and extends east and north to Jackfish Creek. These sands were deposited by glacial waters before the outlet through Jackfish Creek was established.

No bedrock outcrops are exposed in the township, but several wells have struck shale at shallow depths. A deep hole drilled on section 4 encountered Lea Park shale at a depth of 19 feet, or an elevation of 1,894 feet, and continued in similar rock to a depth of 415 feet. In a well on section 31 shale was encountered at an elevation of 1,892 feet. Therefore, Lea Park shale underlies the drift at least in the western part of this township.

The water supply, with two exceptions, is obtained from wells less than 25 feet deep. The two deeper wells are on sections 2 and 14 and are 70 and 100 feet deep respectively. Available information indicates that both are in glacial materials and if so the shale surface, which occurs at a higher elevation to the west, must slope to the east, with Jackfish Creek either occupying a depression or lying within a pre-glacial drainage channel.

The main water horizon south of Russell Lake has an elevation of about 1,860 feet, and wells in it are all less than 20 feet deep and yield a good supply of hard water. The drift here is considered to be thin, with the water-bearing sand near its base. Where this aquifer is missing a fair supply of water may collect as seepage at the base of the drift or at the top of the shale. This seepage supply is best in wells located in a basin or depression on the shale surface, where water collects from a fairly large drainage area.

In the area of sand, north of Russell Lake, water is obtained at very shallow depths at the base of the surface sand deposit. The drift that underlies this sand may also contain sand or gravel lenses or pockets that yield a fair amount of water. In section 31 the thickness of the drift is only 24 feet. Unless water is obtained in a sand or gravel pocket within the drift a seepage supply must be looked for on top of the shale.

The well on NW, section 14 struck a good supply of water at a depth of 100 feet and elevation of 1,759 feet. As this is much lower than the shale surface to the west, it is possible that this well is in bedrock. On the other hand, the shale surface in the township to the south showed a marked slope to the east into the basin of Jackfish Lake, indicating that the well on section 14 may be in glacial materials. This is probably the better interpretation, as no water was encountered in the shale on section 4 below 19 feet, at an elevation of 1,849 feet. Bedrock sands generally have a wider extent than the pockets and lenses typical of deposits in the glacial drift.

Township 50, Range 16. The glacial material that forms the surface deposit in this township has the appearance of a ground moraine in that it is relatively flat, but there is some evidence to indicate that it has been modified since first deposited. The large concentration of boulders along the west side of the township suggests considerable stream erosion. Other morainal characteristics are several, deep, narrow lakes and small morainal ridges. The evidence available indicates that the drift is extremely thick, although the exact thickness has not been determined. The surface is about 500 feet above the nearest outcrops of bedrock strata, and much of this difference in elevation may represent the thickness of glacial materials, although the bedrock surface may rise in this direction or be represented by higher beds stratigraphically. A deep test well is the only means by which the exact character of the deposit can become known.

During the past 2 years the water-table in this township has lowered appreciably. This is shown by the lower levels of the lakes and a decrease in the water supply from pockets, lenses, or beds of sand and gravel within the glacial material. Most of these wells are less than 50 feet deep, with a few approaching 100 feet. Owing to the extreme variability of the deposits it is difficult to group the aquifers of these wells into definite horizons that might be useful in locating new wells. The large number of gravel aquifers indicates that considerable sorting has taken place within certain limited areas. Such an area lies in the northwest corner of the township. It is evident from the map that Jackfish Creek had its origin in this area, and that the gravel deposits there may have been deposited by the waters that formed the creek channel. The elevations of the aquifers indicate

a small slope to the northwest. The gravel deposits may represent a series of pockets rather than a single bed, but the possibilities of striking water in the upper part of the deposit are everywhere very good, and this applies to the land adjoining Curry Lake as well. On the slightly higher land to the south most of the wells have an aquifer between elevations of 2,275 and 2,311 feet, but this horizon is not continuous and does not afford an adequate supply. Deeper digging at widely separate points has indicated another horizon between elevations of 2,225 feet and 2,240 feet. This horizon has been encountered on sections 2, 10, 18, and 25, and has yielded a very good supply in each case. It appears, therefore, that this can be considered a fairly extensive deposit of sand and gravel in the drift, and that water should be encountered at this level at intermediate points. Nothing definite is known about lower horizons that may be reached by still deeper drilling.

Township 50, Range 17. The thick deposit of boulder till in this township has a fairly flat surface. The highest part, along the east side, slopes gradually to the west, where Jackfish Creek and some of its tributaries provide good drainage. The drift covers all trace of the underlying bedrock, which was not even encountered in any of the deeper wells.

Sand and gravel pockets, lenses, and beds within the glacial drift act as reservoirs for the required water supply. The source of this water is the annual rainfall, part of which finds its way into these porous beds. During years when the rainfall has been below normal the water-table has been lowered in many of the wells. These wells are mostly less than 25 feet deep. On the higher land in the east-central part of this township the elevation of the aquifer lies between 2,250 and 2,262 feet, but as the surface slopes to the west the elevation of the water horizon will be lower in that direction. There are possibilities of a buried gravel deposit along the northern part of Jackfish Creek. Gravel was struck in wells on sections 28 and 35 at elevations of 2,222 and 2,213 feet respectively. As gravel wells are fairly numerous in the township to the east it appears that this is a small buried outwash deposit at the headwaters of Jackfish Creek.

A lower aquifer has been tapped in at least three wells on sections 6, 12, and 22, at depths of 85, 77, and 110 feet, or at elevations of 2,166, 2,250, and 2,162 feet respectively. The two deeper wells are in a fine sand and yield only a moderate supply of water. The other, on section 12, yields a limited supply in a blue clay. The fact that the two deeper wells encountered water at almost the same elevation does not necessarily imply that the sand bed is continuous between them, though from a study of the glacial deposits it is evident that pockets or lenses of sand or gravel are in many places confined to a zone, and in this respect simulate a single sand bed.

The water possibilities at depth, especially in bedrock strata, can only be determined by making a test. Shale underlies the drift in the township to the southwest at an elevation of 1,892 feet, but it is possible that higher beds stratigraphically are present in this township, and in the event that they include sand members they should make good aquifers.

Township 50, Range 18. The deposit of glacial drift that forms the surface covering in this township increases in thickness from the southwest corner to the northeast. On section 31 in the township to the south bedrock shale was reached in a well at a depth of 24 feet. Deeper wells to the northeast did not, however, penetrate the drift. The deepest of these is on section 24, where a good supply of water was encountered at a depth of 110 feet. Here the elevation of the aquifer is more than 2,250 feet as compared with less than 1,900 feet on section 6. The difference may be due to thicker glacial material, provided that the bedrock surface does not rise to the northeast.

The elevations of the water horizons show a gradual rise to the northeast from 1,864 to 2,220 feet. This rise is very uniform, and many of the wells report a gravel aquifer. The aquifer, however, does not seem to be a continuous deposit, as flowing wells do not occur on the lower land. It is, therefore, concluded that the gravel and sand in the wells are represented by a series of pockets and lenses rather than a single bed, and that the upper part of the drift contains considerable sorted material, which, as a whole, forms a good water horizon. The source of the water is from the annual precipitation.

Lower aquifers will undoubtedly be found in the areas of thicker drift, but no definite information will be available until tests are made. Should these deposits be continuous to the lower land, flowing wells should result where they are tapped.

If the underlying bedrock strata below the drift is a shale, possibilities of obtaining water in it are poor, but should an overlying bedrock sand be present, water would probably be found in it.

Township 51, Range 16. Boulder till, in places very rocky, forms the surface deposit in this township. The area is comparatively flat, and typical morainal deposits are few. McLeod Lake partly fills a gently sloping depression bordered by very rocky land, and the country west of Birch Lake, in the northeast part of the township, is likewise flat and stony.

The water supply is obtained from wells at various depths that tap sand and gravel deposits in the glacial drift. The thickness of the drift is not known and can only be determined when deep wells have penetrated it. The deepest well, on NE, section 30, is in glacial material at 78 feet, and the drift may be more than twice that thickness.

The wells fall into two groups, which seem to indicate two distinct water horizons. The upper horizon yields a good supply at an average depth of 30 feet, and at elevations that vary somewhat within the limits of the township. South of McLeod Lake the elevation is between 2,258 and 2,224 feet. Water occurs in gravel in most of these wells, and it is possible that the gravel beds are part of the buried outwash deposit to the south at the head of Jackfish Creek. North of McLeod Lake the elevation of the aquifer is between 2,209 and 2,227 feet, with one well, on SE, section 30, at an elevation of 2,257 feet. The general uniformity of these levels suggests a continuous sand horizon. West of McLeod Lake this upper horizon is either absent or does not yield the required amount of water. A lower water horizon, between elevations of 2,177 and 2,199 feet, is reached at depths between 60 and 80 feet. It is also encountered farther

north, on sections 30 and 35, and is apparently sufficiently continuous to serve as a good aquifer for the greater part of the township, if it becomes necessary to tap it. The water in the drift comes from rainfall, and the height of the water-table has a direct relationship to the annual precipitation. A succession of dry seasons might, therefore, seriously imperil the water supply.

Township 51, Range 17. The surface deposit in this township is a thick boulder till that is relatively flat on top. Its thickness has not been determined, as the deepest well is in glacial material at a depth of 93 feet. So far as known no wells have penetrated the drift on this plateau, and it is, consequently, impossible to estimate either its approximate thickness or the nature of the underlying bedrock.

Several water horizons are represented by wells of various depths. Most of the wells are in the upper 40 feet of the glacial deposits, and have encountered sand and gravel deposits that are believed to represent a series of separate pockets or lenses rather than a single bed. The elevation of this zone is between 2,200 and 2,250 feet. Some of these deposits of sorted material may be several miles in lateral extent, and the direction of drainage of the buried material is believed to be towards the west.

A lower aquifer occurs at an elevation of 2,155 feet on section 4 and at 2,159 feet on section 10, and wells at about the same elevation encountered water in gravel in sections 17, 24, and 32. The similarity in the elevations of this lower aquifer is suggestive of a continuous horizon or a zone in which sand and gravel is quite abundant. These zones mark a retreat of the ice front followed by an advance, and the magnitude of this fluctuation controls the amount and extent of the gravel and sand present. Evidence to suggest that in this instance it was comparatively small is the dry hole 100 feet deep on NW. section 18, which reached an elevation of 2,162 feet. This is lower than the elevation of the aquifer on section 19, but the well may not have reached that aquifer as a slight slope to the southwest would account for the difference in altitude. On the other hand, this aquifer may be composed of isolated gravel and sand deposits, and dry holes may result where one of these is not encountered in digging.

Township 51, Range 18. The eastern half of this township is typical of the high, flat, plateau-like plain that extends to the east and south, its surface broken only by a few small morainal ridges that trend east and west. The western part slopes gently to the lower land in the township to the west. The surface deposit is a boulder till that varies considerably in composition from place to place. Small areas of marshy ground are found on sections 17 and 20, and numerous springs occur on this slope.

The water supply is obtained from these springs and from wells that vary in depth from 8 to 115 feet. These wells are all in the glacial drift, but at least two horizons are represented. The lower horizon is much the more important as it supplies the greatest amount of water. The springs on sections 30, 20, and 17 are believed to represent the level of this

horizon. From the large number of springs that occur at approximately the same elevations for a considerable distance, it is concluded that a sand or gravel bed sloping gently to the west must come close to the surface. The elevations of the springs are 2,129 feet in section 30 and 2,112 feet in section 20, and this horizon can be traced to the east and south by the well records. The elevation rises slightly to the east: on sections 24 and 25 it is 2,145 and 2,168 feet respectively; on section 17 it has an elevation of 2,057 feet; and on section 10 its elevation is 2,130 feet. Farther east the rise is very small; in fact the well on section 12, at an elevation of 2,123 feet, may be on the same horizon. It would appear from this evidence that an outwash deposit dipping slightly to the west is buried by boulder till that increases in thickness to the east. This outwash deposit can be expected to yield a good supply of water wherever it is encountered. A dry hole was sunk on section 15 to a depth of 135 feet without striking sand or gravel. The elevation at the bottom is 2,106 feet, and is lower than the level of the outwash deposit in the immediate vicinity. A similar dry hole was dug 2 miles east, and may indicate a narrow strip running east and west where the sand and gravel are absent.

The higher aquifer is found in very shallow wells in limited areas in the eastern half of the township. One of these wells is on NE. section 3 at an elevation of 2,193 feet, and the well on SE. section 23, at an elevation of 2,221 feet, is believed also to be in this upper aquifer. As the wells are few and widely distributed, it is believed that they occur in isolated pockets and lenses within the drift, and in this respect are quite different from those that tap the lower horizon just described.

ANALYSES OF WATER SAMPLES FROM RURAL MUNICIPALITY OF PARKDALE, NO. 498, SASKATCHEWAN

No.	Sect.	Tp. R.	Depth of well in ft.	<u>CONSTITUENTS AS ANALYSED</u>					Total diss'd solids	Alka- linity	Total hard- ness	<u>CONSTITUENTS AS CALCULATED IN ASSUMED COMBINATIONS</u>					Remarks	
				Ca	Mg	Na	SO ₄	Cl				CaCO ₃	CaSO ₄	MgCO ₃	MgSO ₄	Na ₂ CO ₃		Na ₂ SO ₄ NaCl
1	SE 18	49	16	Spring	720	179	65	15	226	4	505	700	448	48	252	36	7	Iron Spring

WELL RECORDS—Rural Municipality of Parkdale No. 498, Saskatchewan

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (—) Surface	Elev.	Depth	Elev.	Geological Horizon				
1	NE	1	49	16	3	dug	40	2260			11	2249	Glacial	hard		D	Poor supply in sand
2	SE	8	49			bored	101	2353					glacial clay				Dry hole in blue clay
3	NE	8				dug	26	2351	- 18	2333	26	2325	glacial	hard		D.S.	Good supply
4	NE	8				bored	75	2345	- 35	2310	75	2270	glacial	hard		N.	Good supply, poor water.
5	SE	9				dug	45	2332	- 25	2307	45	2287	glacial	hard		D.S.	Good supply
6	NE	9				dug	21	2339	- 19	2320	21	2318	glacial	hard		D.S.	Limited supply in fine sand
7	SE	10				dug	33	2323			33	2290	glacial lake clay	hard		D.S.	Good supply
8	SE	12				dug	90	2271	- 80	2191	90	2181	glacial	hard		D.S.	Poor supply
9	SW	13				dug	33	2329									Dry hole in yellow clay
10	SW	14				dug	50	2347	- 44	2303	50	2297	glacial			D.S.	Good supply in sand and gravel
11	NW	14				dug	40	2345	- 37	2308	40	2305	glacial			D.S.	Good supply in gravel
12	SW	15				dug	22	2333	- 20	2313	22	2311	glacial	hard		D.S.	Limited supply in fine sand
13	SE	18				spring		2122									Large continuous flow. Gas seepage
14	NW	18				"	12	2254			12	2242	glacial	hard		D.S.	Poor supply in sand
15	NE	19				"	14	2285			14	2271	glacial	hard		D.S.	Good supply in sand
16	NW	19				"	14	2267			14	2253	glacial	hard		D.S.	Limited supply
17	NE	20				"	22	2299	- 20	2279	22	2277	glacial	hard		D.S.	Limited supply
18	NW	20				"	34	2325			34	2291	glacial	hard		D.S.	Good supply in sand
19	SE	21				"		2225						hard		D.S.	Continuous flow
20	NW	24				"	30	2342	- 15	2327	30	2312	glacial	hard		D.S.	Good supply
21	SE	27				"	30	2327	- 20	2307	25	2302	glacial	hard		D.S.	Limited supply
22	NE	28				"	30	2325	- 25	2300	25	2300	glacial	hard		D.S.	Good supply in sand
23	SE	30				"	24	2282	- 22	2260	24	2258	glacial	hard		D.S.	Good supply in sand and gravel
24	NE	31				"	10	2291	- 8	2283	10	2281	glacial	hard		D.S.	Limited seepage supply
25	SE	32				"	14	2317	- 11	2306	14	2303	glacial	hard		D.S.	Good supply in sand
26	NE	32				"	73	2332	- 62	2270	62	2270	glacial	hard		D.S.	Good supply in sand
	SW	34				dug	7	2299	- 5	2294	7	2292	glacial	hard		D.S.	Good supply in fine sand.
	NW	34				"	27	2298	- 12	2286	15	2283	glacial	hard		D.S.	Limited supply in gravel
27	NE	35				bored	93	2337	- 88	2249	93	2244	glacial	hard		D.S.	Good supply in fine sand
28	SE	35				dug	50	2347	- 47	2300	50	2297	glacial	hard		D.S.	Good supply in fine sand
29	NW	35				"	17	2319			17	2302	glacial	hard		D.S.	Limited supply of seepage water.
1	SW	7	49	17	3	dug	15	1746			15	1731	glacial	hard		D.S.	Good supply in gravel
2	SE	10				"	3	1967			3	1964	"	s5ft		D.S.	Good supply
3	NE	10				"	7	2051			7	2044	"	hard		D.S.	Good supply in gravel
4	NE	11				"	25	2119			25	2094	"	"		D.S.	Good supply in clay
5	SE	12				"	40	2190			40	2150	"	"		D.S.	Limited supply
6	NE	14				"	30	2165			30	2135	"	"		D.	Limited supply in clay
7	SW	15				"	40	2142			40	2102	"	"		D.	Limited supply in clay
8	SE	15				"	35	2113			35	2078	"	"		D.S.	Good supply in clay
9	NE	18				spring						1862					
10	NW	24				dug	10	2241			10	2231	"	"		D.	Not sufficient
11	SW	28				dug	10	2091			10	2081	"	"		D.S.	Limited supply in clay
12	NW	34				dug	20	2235			20	2215	"	"		D.S.	Limited supply in clay and sand
13	NE	35				dug	20	2255			20	2235	"	"		D.S.	Good supply in gravel
14	SW	36					70	2264			70	2194	"	"		D.S.	Good supply in sand and gravel

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.

WELL RECORDS—Rural Municipality of Parkdale No. 498, Saskatchewan

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (-) Surface	Elev.	Depth	Elev.	Geological Horizon				
1	NE	2	49	18	3		70	1896	- 25	1871	70	1826	glacial	hard alk.		N.	Poor quality
2	SW	3					20	1863	- 3	1860	20	1843	"			D.S.	Good supply
	SE	4				drilled	415	1868									Dry hole. Shale below 19 feet
3	SW	5					17	1877			17	1860	"	hard		D.S.	Good supply in gravel
	SW	6				bored	40	1860			19	1841	"	hard alk.		S.	Limited seepage supply
4	NE	6					13	1878			13	1865	"	hard		D.S.	Good supply in sand
5	SE	9				dug	14	1881			14	1867	"	hard		D.S.	Limited supply in gravel
6	SW	10				"	6	1826			6	1820	"	hard		D.S.	Good supply in gravel
7	NW	10				"	19	1877	- 16	1861	19	1858	"	hard		D.	Limited supply in sand
8	NW	12					12	1833			12	1821	"	hard		D.	Limited supply in clay
9	NW	14					100	1859			100	1759	"	hard alk.		S.	Good supply
10	NE	15					12	1857			12	1845	"	hard		D.S.	Good supply
11	NE	20				"	11	1923	- 2	1921	11	1912	"	hard		D.S.	Good supply in fine sand
12	NE	21				"	11	1921			4	1917	"	hard		D.S.	Good supply in sand
13	NW	22					14	1884			14	1870	"	hard		D.S.	Good supply in clay
14	SW	31					24	1916			24	1892	Lea Park	hard		D.	Limited supply on top of shale
15	NW	32				bored	25	1965			25	1940	glacial	soft		D.	Limited supply
1	NE	1	50	16	3	bored	80	2334	- 20	2314	80	2254	glacial	hard		D.S.	Good supply in gravel
2	SE	1				dug	55	2346	- 52	2294	55	2291	glacial	hard		D.S.	Good supply in gravel
3	SW	2				"	20	2331	- 18	2313	20	2311	"	"		D.S.	Limited supply in gravel
4	NE	2				bored	80	2311	- 76	2235	80	2231	"	"		D.S.	Good supply in gravel
5	SE	3				bored	50	2313	- 35	2278	35	2278	"	"		D.S.	Good supply in gravel
6	SE	7				dug	33	2335					"			D.S.	Good supply in gravel
7	SE	8				"	25	2310	- 23	2287	25	2285	"	"			Dry hole in blue clay
8	NE	10				bored	60	2300	- 51	2249	60	2240	"	"		D.S.	Good supply in gravel
9	SE	12				dug	51	2301	- 47	2254	51	2250	"	"		D.S.	Good supply in gravel
10	NW	13				dug	16	2292	- 14	2278	16	2276	"	"		D.	Limited supply in sand and gravel
11	SW	17				dug	37	2300			37	2263	"	"		D.S.	Limited supply in clay
12	SW	18				bored	94	2319	- 59	2260	94	2225	"				Water in gravel
13	NE	19				dug	30	2256	- 28	2228	30	2226	"	hard		D.S.	Good supply in sand
14	SE	20				"	26	2272	- 23	2249	26	2246	"	"		D.S.	Limited seepage supply
15	NW	21				bored	26	2269	- 24	2245	26	2243	"	"		D.S.	Good supply
16	NE	22				dug	25	2268	- 20	2248	25	2243	"	"		D.S.	Limited supply in gravel
17	NE	24				"	20	2296			20	2276	"	"		D.S.	Limited seepage supply
18	SE	25				bored	75	2311	- 65	2246	75	2236	"	"		D.S.	Good supply
19	SE	27				dug	30	2258	- 14	2244	30	2228	"	"		D.S.	Good supply in sand
20	SW	28				bored	36	2273	- 34	2239	36	2237	"	"		D.S.	Good supply
21	NW	28				dug	22	2280	- 20	2260	22	2258	"	"		D.S.	Limited supply in gravel
22	SE	31				"	40	2259	- 30	2229	40	2219	"	"		D.S.	Good supply in gravel
23	SW	32				"	40	2282	- 25	2257	40	2242	"	"		D.S.	Limited supply in gravel
24	NW	35				bored	60	2281	- 45	2236	60	2221	"	"		D.S.	Good supply in gravel
25	SE	35				dug	17	2260	- 14	2246	17	2243	"	"		D.S.	Good supply in sand
26	NE	36				bored	66	2281	- 36	2245	66	2215	"	"		D.S.	Good supply in gravel

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WELL RECORDS—Rural Municipality of Parkdale No. 498, Saskatchewan

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rgt.	Mer.				Above (+) Below (-) Surface	Elev.	Depth	Elev.	Geological Horizon				
1	NE	2	50	17	3	dug	11	2294			11	2283	glacial	hard		D.S.	Poor supply
3	SW	5					14	2191			14	2177	"	"		D.	Limited supply in gravel
4	SE	6				bored	85	2251	- 81	2170	85	2166	"	"		D.S.	Limited supply in sand
5	NE	7					20	2228			20	2208	"	"		D.S.	Good supply in sand and gravel
6	SE	8					20	2263			20	2243	"	"		D.S.	Good supply in gravel
7	SW	10					11	2282			11	2271	"	soft		D.S.	Good supply in clay
8	NE	10				dug	36	2282			36	2246	"	"		D.S.	Good supply in fine sand
9	NE	12				bored	77	2327	- 73	2254	77	2250	"	hard		D.S.	Limited supply in blue clay
10	SE	14				dug	16	2280			16	2264	"	"		D.S.	Limited supply in blue clay
11	NW	15					25	2276			25	2251	"	"		D.S.	Good supply in clay
12	NW	16					27	2262			27	2235	"	"		D.S.	Limited supply in clay
13	SE	17					18	2259			18	2241	"	soft		D.S.	Limited supply in sand and gravel
14	SE	18					22	2229			22	2207	"	hard		D.S.	Good supply
15	NE	21					15	2269			15	2254	"	soft		D.S.	Good supply in gravel
16	SW	22					110	2272			110	2162	"	hard		D.S.	Limited supply in sand
17	NE	24				dug	14	2265			14	2251	"	soft		D.S.	Good supply in fine sand
18	SE	25				"	32	2275			32	2243	"	hard		D.S.	Good supply in fine sand
19	SE	26				"	6	2272	- 1	2271	6	2262	"	soft		D.	Limited supply in fine sand
20	SE	27				"	5	2265	- 3	2262	5	2260	"	"		D.S.	Good supply in fine sand
21	SW	28				"	15	2237			15	2222	"	"		D.S.	Good supply in sand and gravel
22	SW	35				"	10	2223	- 8	2215	10	2213	"	hard		D.S.	Good supply in gravel
23	SE	36				bored	25	2262			25	2237	"	"		D.S.	Limited supply in fine sand
1	SW	2	50	18	3	dug	14	1935	- 10	1984	14	1921	glacial	hard		D.S.	Good supply in sand and gravel
2	SE	4				bored	22	1994			22	1972	"	soft		D.S.	Good supply in sand and gravel
3	NW	5				dug	15	1935			15	1920	"	hard		S.	Limited supply in fine sand
4	SW	6					23	1876	- 8	1868	23	1853	"	"		D.S.	Good supply in clay and gravel
5	NW	7				bored	17	1944	- 10	1934	17	1927	"	"		D.S.	Good supply in sand
6	NE	8				dug	2	2006			2	2004	"	soft		D.S.	Abundant supply in gravel
7	NE	9				"	75	2101			75	2026	"	hard		D.	Limited supply in gravel
8	SW	10					50	2051			50	2001	"	"		D.S.	Good supply in fine sand
9	NW	20				bored	60	2044			60	1984	"	soft		D.S.	Good supply in fine sand
10	SE	21				dug	35	2156			35	2121	"	hard		S.	Limited supply in fine sand
11	NE	21					14	2164			14	2150	"	"		D.S.	Good supply in gravel
12	NW	24				dug	14	2234			14	2220	"	soft		D.S.	Good supply in sand and gravel
13	SW	24				bored	110	2259			110	2149	"	"		D.S.	Good supply in sand
14	SW	30				dug	10	2013			10	2003	"	hard		D.S.	Good supply in clay
15	NE	30					10	2109			10	2099	"	"		D.S.	Good supply in gravel
16	NE	32				dug	16	2103			16	2087	"	soft		S.	Limited supply in fine sand
17	SW	34				bored	30	2147			30	2117	"	hard		D.S.	Limited supply in fine sand
18	NE	35				dug	25	2241	- 19	2222	25	2216	"	"		D.S.	Good supply in gravel
19	SW	36					18	2187			18	2169	"	soft		D.	Limited supply in gravel
20	NE	36					18	2193			18	2175	"	hard		D.S.	Good supply in sand

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WELL RECORDS—Rural Municipality of Parkdale No. 498, Saskatchewan

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (−) Surface	Elev.	Depth	Elev.	Geological Horizon				
1	SE	2	51	16	3	dug	50	2279	- 38	2241	50	2229	glacial	hard		D.S.	Good supply in sand and gravel
2	NW	2				"	34	2258	- 24	2234	34	2224	"	"		D.S.	Good supply in sand
3	NW	2				"	40	2284			40	2244	"	"		D.S.	Good supply
4	NW	3				"	42	2260			15	2245	"	soft		D.S.	Limited supply in gravel
5	NE	6				bored	64	2242	- 34	2208	64	2178	"	hard		D.S.	Good supply in sand
6	NE	8				bored	70	2269	- 47	2222	70	2199	"	"		D.S.	Good supply in gravel
7	SW	9				dug	25	2283	- 22	2261	25	2258	"	"		D.S.	Poor supply
8	SW	12				"	23	2281	- 27	2254	23	2258	"	"		D.S.	Good supply in sand
9	NW	13				"	12	2257	- 8	2249	12	2245	"	"		D.S.	Good supply in sand
10	SW	17				bored	63	2244	- 58	2186	63	2181	"	"		D.S.	Good supply in sand
11	SW	18				"	40	2230			40	2190	"	"		D.S.	Good supply in sand
12	NE	18				"	63	2248	- 58	2190	63	2185	"	"		D.S.	Good supply in sand
13	SW	19				"	23	2245	- 21	2224	23	2222	"	"		D.S.	Good supply in gravel
14	NE	20				dug	25	2245	- 23	2222	25	2220	"	"		D.S.	Seepage supply in sandy clay
15	NW	20				bored	48	2264	- 33	2231	48	2216	"	"		D.S.	Good supply
16	SW	21				dug	37	2246			37	2209	"	"		D.S.	Limited supply in sand
17	NE	22				"	28	2255			28	2227	"	"		D.S.	Good supply in fine sand
18	NW	22				bored	33	2246	- 23	2223	33	2213	"	"		D.S.	Good supply in sandy clay
19	NE	26				"	37	2240	- 34	2206	37	2203	"	"		D.S.	Good supply in sand
20	SW	26				dug	35	2258	- 30	2228	35	2223	"	"		D.S.	Good supply in fine sand
21	SW	27				"	26	2252	- 20	2232	26	2226	"	"		D.S.	Good supply in sand
22	SE	27				"	36	2250	- 22	2228	36	2214	"	"		D.	Limited seepage supply
23	NE	27				"	40	2252	- 36	2216	40	2212	"	"		D.S.	Good supply in sandy clay
24	NW	30				"	20	2242			20	2222	"	"		D.S.	Good supply in black sand
25	NE	30				bored	78	2255	- 50	2205	78	2177	"	"		D.S.	Good supply in sandy clay
26	SE	30				dug	18	2275			18	2257	"	"		D.S.	Good supply in sandy clay
27	SE	32				"	24	2265	- 17	2248	24	2241	"	"		D.S.	Good supply in gravel
28	SE	35				"	51	2235	- 18	2217	51	2184	"	"		D.S.	Good supply in gravel
29	NW	36				"	30	2254	- 25	2229	30	2224	"	"		D.S.	Limited seepage supply in clay
1	NE	2	51	17	3		7	2245			7	2238	glacial	hard		D.S.	Limited supply in sand
2	NE	4					80	2235			80	2155	"	"		D.S.	Good supply in clay
3	SE	4					25	2228			25	2203	"	"		D.S.	Good supply in sand
4	SW	10					93	2252	- 30	2222	93	2159	"	"		D.S.	Good supply in sand
5	NE	12					22	2237			22	2215	"	"		D.S.	Limited supply in sand
6	SE	13					10	2200			10	2190	"	soft		D.S.	Good supply
7	SE	14					12	2255			12	2243	"	"		D.S.	Good supply in gravel
8	SW	15					80	2290			80	2210	"	hard		D.S.	Good supply in gravel
9	SW	16					30	2259			30	2229	"	"		D.S.	Good supply in gravel
10	SE	17					72	2269			72	2197	"	"		D.S.	Limited supply in gravel
11	NW	18					100	2262					"	"		D.S.	Dry hole
12	SW	19					80	2257			80	2177	"	"		D.S.	Good supply in sand
13	NE	20					37	2254			37	2217	"	"		D.S.	Limited supply in clay
14	NW	21					44	2241			44	2197	"	"		D.S.	Good supply in sand
15	SW	22					47	2267			47	2220	"	"		D.S.	Good supply in fine sand
16	NW	23					16	2229			16	2213	"	"		D.S.	Good supply in sand
17	NE	24					60	2233			60	2173	"	"		D.S.	Good supply in gravel
18	SE	25				bored	40	2281			40	2241	"	"		D.S.	Good supply in gravel
19	NW	26					20	2243			20	2225	"	"		D.S.	Good supply in sand
20	SE	30					15	2262			15	2247	"	soft		D.S.	Good supply in clay

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.

WELL RECORDS—Rural Municipality of Parkdale No. 498, Saskatchewan

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	1/4	Sec.	Tp.	Rgt.	Mer.				Above (+) Below (-) Surface	Elev.	Depth	Elev.	Geological Horizon				
21	SW	31	51	17	3		27	2254			27	2227	glacial	soft		D.S.	Good supply in sand
22	NW	32					60	2233			60	2173	"	"		D.S.	Good supply
23	SW	32					42	2261			42	2219	"	"		D.S.	Good supply in gravel
24	NW	35					18	2228			18	2210	"	"		D.S.	Good supply in clay
25	NW	36					14	2265			14	2251	"	"		D.S.	Good supply in sand
1	NE	1	51	18	3	dug	8	2221			8	2213	glacial	hard		D.S.	Good supply in fine sand
2	SW	2	51	18	3	bored	100	2252	- 92	2160	100	2152	"	"		D.S.	Good supply in fine sand
3	NE	2				"	100	2179			100	2079	"	"		D.S.	Good supply in gravel
4	NE	3				dug	8	2201			8	2193	"	soft		D.S.	Good supply in gravel
5	SE	4				"	33	2103	- 30	2073	33	2070	"	"		D.S.	Limited supply in fine sand
6	NW	5					17	2077			17	2060	"	hard		D.S.	Good supply in clay
7	NE	6					33	2075			33	2042	"	soft		D.S.	Limited supply in dark clay
8	SE	6					40	2081			40	2041	"	"		D.S.	Good supply in clay
9	SW	8					10	2069			10	2059	"	hard		D.S.	Good supply in fine sand
10	SE	10				bored	90	2220	- 8	2212	90	2130	"	soft		D.S.	Good supply in gravel
11	NE	12				"	115	2238	- 85	2153	115	2123	"	hard		D.S.	Good supply
12	SE	13				"	89	2263			89	2174	"	"		D.	Limited supply
13	SE	14				"	100	2266			100	2166	"	"		D.	Limited supply in glacial sand
14	NW	14					100	2231	- 80	2151	100	2131	"	"		D.S.	Good supply in sand
15	SE	15				bored	135	2241					"	"			Dry hole in blue clay
16	SW	17				"	30	2087			30	2057	"	"		D.S.	Good supply in silt
17	NW	20				spring		2112					"	"		D.S.	Large continuous flow
18	NE	20				"	75	2213			75	2138	"	soft		D.S.	Good supply
20	SE	23				dug	20	2241			20	2221	"	hard		D.S.	Limited supply in gravel
21	NW	24				"	78	2223	- 76	2147	76	2145	"	"		D.S.	Sufficient
22	SW	25				bored	73	2241	- 69	2172	73	2168	"	"		D.S.	Good supply in clay
23	SE	26				dug	55	2242			55	2187	"	"		D.S.	Good supply in fine sand
	SE	30				spring		2129					"	"			Continuous flow
24	NW	33				"	12	2194			12	2182	"	soft		D.S.	Good supply in clay
25	SE	34				"	30	2200			30	2170	"	hard		D.S.	Good supply in boulder till
26	NE	35				"	30	2222			30	2192	"	"			Supply exhausted. Gravel aquifer
27	NW	36				"	45	2238	- 43	2195	45	2193	"	hard		D.S.	Good supply in gravel

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