CANADA

DEPARTMENT OF MINES

AND

TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 273

GROUND-WATER RESOURCES

OF

TOWNSHIPS 43 TO 46, RANGES 9 TO 12,

WEST OF 4TH. MERIDIAN

ALBERTA

Records collected by P. S. Warren and
G. S. Hume; compiled by G. S. Hume

OTTAWA
1947

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DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH
BUREAU OF GEOLOGY AND TOPOGRAPHY

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CONTENTS

Illustrations

GROUND-WATER RESOURCES OF TOWNSHIPS 35 TO 38, RANGES 1 TO 4, WEST 4TH MERIDIAN, ALBERTA

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 central 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 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 11, 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 lines 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 salts 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 IN EAST-CENTRAL ALBERTA

The formations that outcrop in east-central Alberta are mainly of Upper Cretaceous age, but Tertiary beds occur to the southwest in the Red Deer area. These higher strata are sandstones and shales with thin coaly and carbonaceous beds. Commercial coal beds occur in the Upper Cretaceous Edmonton formation, but other thin coal seams are present, particularly in the Ribstone Creek formation and in the Pale and Variegated Beds. Carbonaceous beds also occur in the Bearpaw formation and are widely scattered through other formations. The Edmonton formation contains some harder sandstones, but almost the whole Upper Cretaceous succession consists of softer sands and sandstones alternating with shales in which ironstone nodules are commonly present. The succession, character, and estimated thickness of the formations are shown in the following table:

Age	Formation	Character	Thickness Feet
Tertiary	Paskapoo	Sandstones and shales with thin coal seams and carbonaceous beds; basal sandstones, massive and crossbedded; some siliceous limestone 150 to 200 feet above the base of the formation.	A few hundred feet thick in Red Deer area. The thickness increases to the south and west.

	Edmonton	Grey to white bentonitic 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 Pale Beds; shales at certain horizons contain lobster claw nodules and marine fossils; at other horizons are abundant selenite crystals.	300 to 600; Thins rapidly to the northwest.
Upper Cretaceous	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 with a few minor sand horizons; marine origin, with 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 seams in the vicinity of Wainwright; mostly non-marine, but intermediate 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.	950 to 1,100

Paskapoo Formation

The Paskapoo formation was first named by Tyrrell from exposures of the lower part of the formation occurring along Blindman

River near its confluence with the Red Deer. It is composed essentially of sandstones and shales of freshwater deposition, and includes some thin coal seams and carbonaceous beds. The basal beds are massive, crossbedded sandstones that weather buff-yellow, and are in striking contrast to the underlying, light-coloured, bentonitic clays of the Edmonton formation. About 150 to 200 feet above the base of the formation are beds of siliceous limestones containing gastropods and pelecypods, but these beds are lenticular rather than continuous, although a zone of them appears widely distributed at about the same stratigraphic level.

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 eastwards, 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 dip in that direction and are bevelled across at the surface.

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 whiten 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. Water occurs in these sands, and, hence, 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, Alberta, 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 Macklin 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 lenticular, 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 Macklin 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 eastwards 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 sulphate 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 noted 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 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 Jasper 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 eastwards 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. On the north side of Battle River, in the north-east part of sec. 26, tp. 47, rge. 5, near the mouth of Grizzly Bear Coulée, the upper part of the lower sand member of this formation outcrops. 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 southern boundary on the Alberta-Saskatchewan meridian is in the south part of township 44, south of Battle River, whereas the northern boundary is in township 51, a few miles north of Lloydminster. 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 Tit 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 only 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. Consequently, 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 freshwater 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.

TOWNSHIPS 43 to 46, RANGES 9 to 12, WEST 4th MERIDIAN,

ALBERTA

Physical Features

Battle River crosses the southeast corner of this area. It has a flat bottom in which the river flows rather sluggishly. In the northeast part Grattan Coulée contains several elongated lakes, evidently remnants of a former drainage channel. A glacial moraine crosses the area in a northwest direction, and gives rise to a hilly topography with a relief of 150 to 200 feet. Numerous alkaline lakes occur in depressions between the hills.

Geology

The area is mainly underlain by Pale and Variegated Beds, but the Bearpaw formation is probably present in the southwest corner although no outcrops of it are known. Birch Lake sands probably occur in the valleys of Grattan Coulée and Battle River. The regional dip is to the southwest. A deep well, Blackleaf No. 1, drilled for oil and gas on lsd. 1, sec. 29, tp. 44, rge. 9, was reported to have reached the base of the Ribstone Creek formation at a depth of 695 feet, and although water-bearing sands were not logged this is probably the lowest level at which fresh water would be present.

Water Supply

Few wells in this area obtain their supply of water from glacial sands and gravels. In the southwest corner water is obtained from the Bearpaw formation, and much of this is hard. Over the remainder of the area water is yielded by sands in the Pale and Variegated Beds. These sands occur at various stratigraphic levels, apparently are not thick, and no single sand appears to extend far. Many of them, however, are sufficiently coarse to carry water.

Township 43, Range 9. Battle River with its steep-sided valley 200 feet deep crosses range 9. Several wells 20 to 45 feet deep obtain water in glacial sands and gravels, but other wells 100 to 275 feet deep find a supply within sands in the Pale and Variegated Beds. A well on SE. section 10, 196 feet deep, obtains water in a sand in the Pale Beds at an elevation of 2,020 feet. This is about the same level as that in a well 145 feet deep on NE. sec. 18, tp. 42, rge. 9. Another well, 215 feet deep, on SE. section 15 yields water from the Pale or Variegated Beds at an elevation of 1,986 feet, which compares with wells on each of NE. sec. 31 and SW. sec. 33, tp. 42, rge. 9. A well, 103 feet deep, drilled in the valley of Battle River on NW. section 9 obtains salty water at an elevation of 1,852 feet, possibly in the Birch Lake formation. So far as known this is the deepest horizon reached in this area.

Township 43, Range 10. An outcrop of Pale Beds in section 4 lies slightly below an elevation of 2,100 feet, and it is probable, therefore, that the bedrock surface in this area is everywhere at about this elevation. Nearly all the wells in the township of which records are available obtain their water from the Pale Beds. Shallow wells in this area get their water from the drift. Near the mouth of Iron Creek there is a sand dune area in which in all probability water occurs at the base of the sand where it lies on more impervious beds below. As the bedrock dips southwest at a rate of 20 to 25 feet a mile, the same beds are higher in the east than in the west. The recorded elevations at which water was struck do not seem to indicate that any single water-bearing sand continues far, and no doubt several sands are present.

Township 43, Range 11. In this township all the wells of which records are available are 80 or more feet deep. It is believed that several wells in the west part of the township obtain water from sands in the Bearpaw formation at elevations of 2,135 to 2,195 feet. Most of the wells, however, are believed to obtain water from several sands in the Pale and Variegated Beds. The strata dip southwesterly and probably the same water-bearing sand occurs in the wells on SE. section 36 at 2,013 feet, on NW. section 27 at 2,000 feet, on NW. section 13 at 2,000 feet, on SW. section 13 at 1,991 feet, on NW. section 15 at 1,983 feet, on NE. section 9 at 1,960 feet, and on SE. section 17 at 1,930 feet. These wells indicate that the bedrock has a slope to the southwest. Several wells near the centre of the township reach a water-bearing bed at 2,080 to 2,085 feet, and other less extensive sands occur at various elevations. On the whole, therefore, it appears that water is obtainable everywhere in the Pale Beds although a poor supply is reported from a few wells. The lowest elevation, namely 1,875 feet, is reached by a well 300 feet deep on SW. section 27. This bed is several hundred feet stratigraphically below the top of the Pale Beds, but is believed to be in that formation.

Township 43, Range 12. This township has a considerable number of comparatively deep wells. One of these, on section 2, obtains water from a bed at a depth of 400 feet or an elevation of 1,923 feet, the lowest level reached in this township. The township, except for a very small northern part, is underlain by Bearpaw beds, but many wells, particularly in the eastern part, have been sunk to sands in the underlying Pale Beds. Most of the water-bearing sands in the Bearpaw lie between elevations of 2,150 and 2,220 feet. It is suspected that in this township the strata dip northeast and that to the west the direction of dip changes to southwest. If this is so, the strata lie in an anticline whose axis is close to the southwest corner of the township. The rate of dip is unknown, but it may be as much as 50 feet a mile. The evidence indicating the presence of an anticlinal fold is not strong, and confirmation by structural test wells or seismograph is needed. If the structure is as is suspected, it would not cause water to rise very high in the wells because the effective hydrostatic head, especially in the Bearpaw formation, would be small. The records of wells believed to be within the Bearpaw seem to indicate that this formation contains a very considerable amount of sand, and hence in most wells it yields sufficient water to meet requirements.

Township 44, Range 9. An anticlinal fold trending southeast probably lies west of Jarrow, and is believed to cross this township. West of it the strata dip at higher angles than to the east, although the rate of dip does not exceed 25 feet a mile. The records of only a few wells are available. One well, on NW. section 21, drilled to a depth of 240 feet is reported to have encountered three water-bearing sands. The highest is at a depth of 150 feet and is said to be in gravel, but this is highly improbable because to the north bedrock is close to the surface or outcrops. The probabilities are that the three water-bearing horizons encountered in the well are all in the Pale or Variegated Beds. The well is close to the axis of the fold crossing this township and, therefore, the water does not rise very high in the well. A well on section 35 is thought to reach the Birch Lake formation at a depth of 280 feet or an elevation of 1,995 feet.

Township 44, Range 10. In this township a well, 75 feet deep on SW. section 13, is reported to have found water in gravel, All of the township is underlain by Pale and Variegated Beds in which water-bearing beds occur between elevations of 1,920 and 2,160 feet. The strata have a southwest dip, and on this account it is suspected that a water sand at an elevation of 1,985 feet in a well 170 feet deep on NE. section 26 is the same as that at an elevation of 1,920 feet in a well 260 feet deep on NE. section 20. This water-bearing bed is in the base of the Variegated Beds or the top of the Birch Lake formation. A well 385 feet deep on SW. section 26 secures water at an elevation of 1,895 feet, probably in the Birch Lake formation. Apparently few of the water-bearing beds are widespread, but they are sufficiently numerous to ensure a water supply almost everywhere.

Township 44, Range 11. In this township the Pale and Variegated Beds outcrop along Iron Creek up to an elevation of more than 2,150 feet. The strata dip southwest and as a result the water in many of the wells is under a considerable hydrostatic pressure. One well, on SW. section 36, flows from a depth of 72 feet, the water rising to an elevation of more than 2,130 feet. In other wells the water rises to a height of 2,200 feet, and in several reaches almost to the surface. The water-bearing sands within the Pale and Variegated Beds appear to be of the nature of discontinuous lenses and, therefore, the hydrostatic pressure varies widely. Some of the lenticular, water-bearing sands are small, and probably will afford only a limited supply of water, but in all probability such sands are underlain by other water-bearing sands from which a further supply of water could be secured. One well, 380 feet deep, on NW. section 22 reaches a water-bearing bed at an elevation of 1,860 feet that may be in the Birch Lake formation. This sand is probably the same as that at an elevation of 1,920 feet in a well on NE. section 20 and at 1,985 feet on NE. sec. 26, tp. 44, rge. 10.

Township 44, Range 12. On section 24 of this township the Pale Beds outcrop on the north bank of Iron Creek at an elevation slightly above 2,150 feet. Several wells 35 feet or less deep and other deeper wells get water at elevations either only slightly below 2,150 feet or considerably above it, and presumably are in the glacial deposits. Deeper wells reach bedrock and most of them are believed to bottom in the Pale or Variegated Beds at elevations of 1,940 to 2,120 feet. One well, 298 feet deep on NW. section 21, reaches an elevation of 1,863 feet and may be in the Birch Lake formation. It is believed that in the southwest part of the township the strata may have a low northeast dip of a few feet to the mile. This, if so, would indicate a syncline on the east side of the township, and the well on NW. sec. 22, tp. 44, rge. 11, which reaches an elevation of 1,860 feet, probably obtains water from the same horizon as the well on NW. sec. 21 in this township. Some of the deeper wells afford only a small supply of water. A further supply could no doubt, be secured by drilling deeper, into more continuous sand beds known to be present in this township.

Township 45, Range 9. All wells in this township of which records have been collected are 60 or more feet deep. In Grattan Coulée, east of Irma, are many outcrops of Variegated Beds above an elevation of 2,150 feet, and, therefore, it is assumed that the bedrock surface is at no great depth anywhere in the township. In this, as in tp. 45, rge. 8, however, many wells have been sunk to the Birch Lake formation, where a good supply of water is obtained.

Township 45, Range 10. In this township the Pale and Variegated Beds afford the main supply of water. Outcrops of Pale Beds occur in the north part of the township on the north side of Vernon Lake up to an elevation of slightly more than 2,150 feet. They also occur north of a couple of dry lakes on the south part of sections 14 and 15 at elevations of nearly 2,200 feet. Very little drift is apparent in other parts of the township, and wells penetrate to the bedrock everywhere at quite shallow depths. On SW. section 32 a well 150 feet deep, and on SE. section 33 a well 75 feet deep, reach the highest known water-bearing sand within the Pale Beds at an elevation of about 2,200 feet. On SW. section 22, on the southeast strike of the strata in this area, another well, at a depth of 85 feet, obtains water from what is thought to be the same sand at an elevation of 2,195 feet. A very small anticline or fold may trend northwest through this township. On the west flank the dip appears to be 15 to 20 feet a mile, and the northeast dip on the east flank is small and continuous only a short distance to where it again changes to a southwest dip. In the southwest part of the township several wells obtain water in a zone at an elevation of 2,060 to 2,070 feet. Of these a well on SW. section 17 is 200 feet deep, one on NE. section 18 is 236 feet deep, one on NW. section 4 is 190 feet deep, and one on SE. section 10 is 170 feet deep. A well 152 feet deep on SE. section 6 obtains water at an elevation of 2,063 feet from an horizon slightly higher than that between 2,060 and 2,070 feet, presumably due to the southwest dip. Coal is reported from a well on NW. section 28 above the water at an elevation of 2,130 feet, from a well on SE. section 21 at a depth of 175 feet or an elevation of 2,105 feet, and from a well on SE. section 13 above the water at an elevation of 2,115 feet. It is assumed that this is the same coal seam in each well, and that differences in elevation may be in part due to inaccurate information. The coal seam is thought to be at the top of the Variegated Beds. A well 357 feet deep on SE. section 30 yields water at an elevation of 1,963 feet. This is the lowest sand reached in the township and may be in the top of the Birch Lake formation, in which case the Variegated Beds in this area are about 150 to 175 feet thick. Apparently this is the same sand that occurs in a well on NE. sec. 20, tp. 44, rge. 10, at an elevation of 1,920 feet, and in a well on NW. sec. 22, tp. 44, rge. 11, at 1,860 feet.

Township 45, Range 11. This township is wholly underlain by Pale and Variegated Beds, and many of the wells are sunk to water-bearing sands in these formations. A few, however, obtain water at depths of 50 feet or less from sands scattered through the drift cover. These are irregularly distributed and unreliable as a source of water, although individual wells may obtain a sufficient supply. One well, 380 feet deep on NE. section 16, may have reached the top of the Birch Lake formation at an elevation of 1,900 feet. In two wells small stringers of coal were encountered at elevations of 2,100 to 2,130 feet, presumably in Variegated Beds. The highest sands of the Pale and Variegated Beds occur at an elevation of 2,175 to 2,200 feet. Another sand at an elevation of about 2,130 feet was encountered in wells on SE. section 17 at a depth of 73 feet, on SE. section 20 at a depth of 150 feet, and on SE. section 22 at a depth of 100 feet. A still deeper sand, at an elevation of about 2,040 feet, occurs in a well 217 feet deep on NE. section 4 and in a well 200 feet deep on SW. section 15. In both of these wells soft water was obtained, as also in a slightly lower sand reported in only one well 255 feet deep on SW. section 10. It is possible that the water in this well comes from the sand at an elevation of 2,040 feet, and that the well was continued slightly below the water-bearing bed. Apparently there are no water-bearing sands in the lower 100 feet of the Variegated Beds, and the next lower horizon is in the Birch Lake formation at an elevation of 1,900 feet.

Township 45, Range 12. This township, like the last, is wholly underlain by Pale and Variegated Beds, and almost all water is obtained from sands within these formations at depths of 150 to 300 feet. The highest water-bearing sand, at an elevation of 2,200 feet, is in a well 133 feet deep on SE. section 12. This sand is the same as that in a well 136 feet deep on SW. sec. 7, tp. 45, rge. 11. Several wells obtain water in a zone between elevations of 2,080 and 2,090 feet. These are as follows: a well 180 feet deep on SW. section 3, a well 200 feet deep on SE. section 7, a well 200 feet deep on NW. section 10, a well 359 feet deep, which obtains water from a depth of 250 feet in SW. section 14, a well 220 feet deep on NE. section 15, a well 217 feet deep on SE. section 16, a well 198 feet deep on SW. section 16, and a well 175 feet deep on NW. section 18. It is considered that these wells are in a gentle syncline between two small folds. The other water-bearing sands reached in this township do not seem to be very continuous, and yield a supply only locally.

Township 46, Range 9. A few very shallow wells in this township yield water from gravel. The drift is apparently very thin, and most wells reach the bedrock, obtaining water either in the Variegated Beds or in Birch Lake sands. One sand in the Variegated Beds, at an elevation of 2,224 to 2,230 feet, has been penetrated by wells in sections 16, 20, and 30. As a result of the northeastward dip from the axis of the Hawkins fold, which crosses this township, it may be the same water-bearing bed that occurs at slightly lower elevations on SE.

section 21 at 2,198 feet, on SE. section 12, at 2,181 feet, and on NE. section 12 at 2,180 feet. These data also suggest a southward plunge to the structure. The eastward dip is suggested by wells on sections 4, 3, and 2, which presumably reach the same water-bearing bed, but elevations decrease eastward from 2,040 feet on section 4 to 2,015 feet on section 3, and to 2,005 feet on section 2. It may be that the water-bearing sand in the Birch Lake formation reached by wells on NE. section 24 and SE. section 25 is slightly higher stratigraphically. It is suspected that the crest of the Hawkins fold lies somewhat west of section 4 and trends northwesterly, but the available data furnished by the wells are not sufficient to permit locating the position of the axis of the fold.

Township 46, Range 10. In this township Pale Beds outcrop along the north edge of Vernon Lake between elevations of 2,215 and 2,265 feet. Several wells less than 100 feet deep appear to get their supply of water from glacial sands and gravels, but many are presumed to have reached sands in the Pale and Variegated Beds. The lowest water in these beds appears to be in a well 200 feet deep on SW. section 16 at an elevation of 2,095 feet. A lower sand encountered in a well 365 feet deep on NW. section 4 at an elevation of 1,985 feet is presumably in the top of the Birch Lake formation. This would again confirm the opinion that in this area the lower 100 feet of the Variegated Beds contain no water-bearing sands.

Township 46, Range 11. In the east part of this township Pale Beds outcrop north of Vernon Lake, but most of the exposures are in tp. 46, rge. 10. At Kinsella a very large gravel pit is evidently an outwash deposit from a moraine that occurs to the north and east. It is probable, however, that most of the wells in this township reach bedrock where they encounter water-bearing sands. The lowest of these has an elevation of 2,060 feet in a well 250 feet deep on NW. section 27, but the most persistent sands occur between elevations of 2,160 and 2,195 feet. It is suspected that a gentle fold extends through the township and that part of the differences in level is probably owing to the local dip.

Township 46, Range 12. This township, like the last, is wholly underlain by Pale and Variegated Beds. The records show that several wells between 260 and 375 feet in depth obtain water in bedrock sands. One of the water-bearing zones occurs at an elevation of 2,015 to 2,025 feet in wells in the southern part of the township. Apparently, however, these water-bearing beds are not widespread. A well 375 feet deep on SW. section 32 yields water at an elevation of 1,960 feet; this is the lowest water-bearing sand recorded in the township, and is probably in the Variegated Beds. All these deep wells obtain soft water.

WELL RECORDS—~~Rural Municipality of~~ TOWNSHIPS 43-46, RANGES 9-12, WEST OF 4th MERIDIAN, ALBERTA.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
1	N W	4	43	9	4	Dug	18	2081	- 12	2069	18	2063	Fine sand	Hard		D.S.	Limited supply
2	N W	7				Drilled	120	2082			120	1962	Pale & Variegated Beds	"		D.	Sufficient
3	N W	9	43	9	4	Drilled	103	1955	- 8	1947	103	1852	Birch Lake	Soft - salty		D.S.	Sufficient
4	S E	10				"	196	2216			196	2020	Pale & Variegated Beds	Hard		"	"
5	S E	15				"	215	2201	-180	2021	215	1986	" "	"		"	"
6	S W	15				Dug	30	2111	- 27	2084	30	2081	Gravel	"		"	"
7	N W	15				"	35	1967			35	1932	"	"		"	"
8	S W					"	45	2084	- 25	2059	45	2039	Glacial	"		"	"
9	N W	20				Drilled	262	2197			262	1935	Pale & Variegated beds	"		"	"
10	N E	31				Bored	60	2241			60	2181	White dry sand				Dry Hole
11	S E	32				Drilled	275	2193			275	1918	Pale & Variegated Beds				Supply exhausted
12	S E	33				Dug	39	2184			39	2145	Glacial			D.	Poor supply
13	S W	33				"	32	2188			32	2156	"				" "
1	S W	3	43	10	4	Dug	16	2053			16	2037	Glacial sand	Hard		D.S.	Sufficient
2	N E	14				"	35	2027	- 7	2020	35	1992	Gravel	"		"	Limited supply
3	S E	18				Drilled	95	2142			95	2047	Pale & Variegated Beds	"		"	Poor supply
4	N W	19				"	287	2193	-140	2053	287	1906	" "	Soft		"	Sufficient
5	N W	23				"	275	2195			275	1920	" "	Hard		"	"
6	S W	27				"	165	2080	- 15	2065	165	1915	" "	Soft		"	"
7	N W	27				"	192	2146			192	1954	" "	"		"	"
8	N W	28				"	76	2119	- 30	2089	76	2043	" "	Hard		"	"
9	S E	33				"	190	2139	- 60	2079	190	1949	" "	Soft		"	"
10	S E	34				"	186	2180			186	1994	" "	Hard		"	
1	S W	5	43	11	4	Bored	80	2187			80	2107	Pale & Variegated Beds	Hard		D.S.	Sufficient
2	N W	6				"	100	2294	- 85	2209	100	2194	Bearpaw	Soft		D.	"
3	S W	7				Drilled	300	2274	- 40	2234	300	1974	Pale & Variegated Beds	Hard		D.S.	"
4	N W	7				"	270	2294	-135	2139	270	2024	" "	Soft		"	"
5	N E	7				"	250	2335			250	2085	" "	Hard		"	Poor supply
6	N E	8				"	220	2315	-200	2115	220	2095	" "	"		"	Sufficient
7	N E	9				"	400	2360			400	1960	" "	"		"	"
8	S E	10				"	275	2320			275	2045	" "	"		"	Poor supply
9	S E	12				Bored	90	2151	- 45	2106	90	2061	" "	"		"	Sufficient
10	N E	12				Drilled	240	2269	-225	2044	240	2029	" "	"		"	"
11	S W	13				"	260	2251	-220	2031	260	1991	" "	"		"	"
12	N W	13				Bored	115	2115	- 30	2085	115	2000	" "	"		"	"
13	N W	14				Drilled	145	2225			145	2080	" "	"		"	"
14	N W	15				"	292	2275	-200	2075	292	1983	" "	"		"	
15	N E	15				"	213	2238			213	2025	" "	"		N.	Poor supply
16	N E	16				"	200	2315			200	2115	" "	"		D.S.	Limited supply
17	S E	17				"	400	2330			400	1930	" "	"		"	Sufficient
19	N E	19				"	196	2345			196	2149	Bearpaw	"		"	"
20	N E	20				"	220	2225			220	2005	Pale & Variegated Beds	"		"	"
21	S E	21				"	175	2255			175	2080	" "	"		"	"

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.
(Alk) Alkaline; (Br) Brown.

WELL RECORDS—Rural Municipality of

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
22	S W	22	43	11	4	Drilled	175	2260			175	2085	Pale & Variegated Beds	Hard		D.S.	Sufficient
23	N E	24				Bored	80	2131	- 74	2057	80	2051	" "	"		"	"
24	N E	25				Drilled	235	2213			235	1978	" "	Soft		"	"
25	N W	26				"	85	2188			85	2103	" "	Hard		"	"
26	S E	27				"	85	2170			85	2085	" "	"		"	"
27	S W	27				"	300	2175			300	1875	" "	Soft		"	"
28	N W	27				"	175	2175			175	2000	Pale & Variegated Beds			"	"
29	S E	28				Bored	90	2165	- 50	2115	90	2075	" "	Hard		"	"
30	N E	28				Drilled	267	2175	- 30	2145	267	1908	" "	Soft		"	"
31	S W	29				"	180	2330	- 16	2314	180	2150	Bearpaw	Hard		"	"
32	N E	30				"	160	2295			160	2135	Bearpaw ?	"		"	"
33	S E	36				"	180	2193			180	2013	Pale & Variegated Beds	Soft		"	Limited supply
1	N W	1	43	12	4	Drilled	250	2295			250	2045	Pale & Variegated Beds	Hard		D.S.	Poor supply
2	N E	1				"	200	2284	- 60	2224	200	2084	" "	Soft		"	Sufficient
3	S W	2				Drilled	400	2323			400	1923	" "	"		"	"
4	S W	3				"	130	2338			130	2208	Bearpaw	Hard		"	Limited supply
5	N E	3				"	200	2328			200	2128	"			N.	Poor supply
6	N W	4				"	125	2329			125	2204	"	Hard		D.S.	Sufficient
7	S W	5				"	140	2324			140	2184	"	"		"	"
8	N W	5				"	110	2324			110	2214	"	"		"	"
9	S W	6				Bored	140	2334			120	2214	"	"		"	"
10	S E	7					100	2324			100	2224	"	"		D.S.	"
11	N E	8				Drilled	128	2319			128	2191	"	"		"	"
12	N W	9				"	300	2331			260	2071	Pale & Variegated Beds				
13	N E	9				"	275	2326			275	2051	" "	Hard		D.S.	Poor supply
14	N E	10				"	150	2333			150	2183	" "	"		"	Sufficient
15	S E	13				"	270	2299			270	2029	" "	"		"	"
16	S W	13				"	250	2295			250	2045	" "	"		"	Poor supply
17	S W	14				"	115	2309			115	2194	Bearpaw	"		"	Sufficient
18	N W	15				"	130	2335			130	2205	"				
19	S W	16				Dug	100	2312			100	2212	"	Hard		D.S.	Sufficient
20	N W	17				"	100	2324			100	2224	"	"		"	"
21	N E	17				Bored	90	2283			90	2193	"	"		"	"
22	N E	18				Drilled	100	2312			100	2212	"	"		"	"
23	N W	20				Dug	93	2307	- 90	2212	93	2209	"	"		"	"
24	S W	21				"	120	2304			120	2184	"	"		"	"
25	N W	21				Drilled	96	2300			96	2204	"	"		"	"
26	S W	22				"	125	2324			125	2199	"	"		"	"
27	N W	22				"	135	2313			135	2178	"	"		"	"
28	S W	23				"	250	2288			250	2038	Pale & Variegated Beds	"		"	"
29	S W	25				"	147	2305			147	2158	Bearpaw	"		"	"
30	N E	26				"	125	2285			125	2160	"	"		"	"
31	S E	30				Dug	87	2302			87	2215	"	"		"	Limited supply
32	N W	30				"	85	2289			85	2204	"	"		"	Sufficient
33	S E	32				"	90	2266			90	2176	"	"		"	"
34	N W	33				Drilled	240	2247			240	2007	Pale & Variegated Beds	Soft		"	"

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

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35	S E	34	43	12	4	Drilled	80	2236			80	2156	Bearpaw	Hard		D.S.	Sufficient
1	N W	5	44	9	4	Bored	60	2250			60	2190	Glacial	Hard		D.	Poor supply
2	N W	21				Drilled	240	2290	-190	2100	150	2140	Gravel ? & Sand	"			
											200	2090	Pale & Varie-	Soft			
													gated Beds				
											240	2050	" "	Hard		D.S.	Sufficient
3	N W	25				Drilled	85	2240			85	2155	Glacial	"		"	"
4	S W	35				"	280	2275	-180	2095	280	1995	Birch Lake	"		"	"
													sandstone				
5	N E	36				Bored	35	2255	- 10	2245	35	2220	Glacial	"		"	"
1	S W	3	44	10	4	Drilled	128	2200	-100	2100	128	2072	Pale & Varie-	Soft		D.S.	Sufficient
													gated Beds				
2	N E	3				"	300	2202	-150	2052	200	2002	" "	"		"	"
3	S W	13				Bored	75	2320			75	2245	Gravel	Hard		"	"
4	N W	13				"	80	2300	- 40	2260	80	2220	Blue clay	"		"	"
5	N W	15				"	120	2260			100	2160	Pale & Varie-	"		"	"
													gated Beds				
6	N E	16				"	125	2250			125	2125	" "	"		"	"
7	S W	17				Drilled	137	2180			137	2043	" "	Soft		"	"
8	N W	20				"	165	2220			165	2055	" "	"		"	"
9	N E	20				"	260	2180			260	1920	" " ?	"		S.	"
10	S E	22				Bored	73	2280			73	2207	Glacial ?	Hard		D.S.	"
11	S W	23				Drilled	210	2285			210	2075	Pale & Varie-	Soft		"	"
													gated Beds				
12	N W	24				"	202	2305			202	2103	" "	"		"	"
13	S W	26				"	385	2280			385	1895	Birch Lake			S.	"
14	N W	26				"	99	2288	- 85	2203	99	2189	Pale & Varie-	Hard		D.S.	"
													gated Beds				
15	N E	26				"	170	2155			170	1985	" " ?	Soft		S.	"
16	S E	28				"	143	2240			143	2097	" "	"		D.S.	"
17	N W	32				"	160	2200			160	2040	" "	Hard		"	Waters 60 head of stock
18	S W	34				"	135	2265			135	2130	Pale & Varie-	Soft		"	Sufficient
													gated Beds				
19	N W	34				Bored	104	2254	- 80	2174	104	2150	" "	Hard		"	"
20	S E	35				Drilled	304	2190			120	2070	" "	Soft		D.	Poor supply
21	S E	36				"	136	2144			136	2008	" "	"		D.S.	" "
22	N W	36				"	71	2150	- 21	2129	71	2079	" "	"		"	Sufficient
1	N W	2	44	11	4	Bored	60	2225			60	2165	Sand	Hard		D.S.	Sufficient
2	S W	3				Drilled	275	2200			275	1925	Pale & Varie-	Soft		"	"
													gated Beds				
3	N E	3				Bored	55	2225			55	2170	Sand	Hard		D.S.	"
4	S W	4				Dug	43	2210			43	2167	Glacial	"		"	"
5	N E	4				Drilled	60	2200			60	2140	Pale & Varie-	Soft		"	"
													gated Beds				
6	N E	5				"	130	2220			130	2090	" "	"		"	"
7	S W	6				Dug	45	2210	- 42	2168	45	2165	Fine sand	Hard		"	"
8	S W	9				Drilled	80	2200			80	2120	Pale & Varie-	"		"	"
													gated Beds				
9	N W	10				"	100	2230			100	2130	" "	Soft		"	"

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10	S E	12	44	11	4	Drilled	110	2185			110	2075	Pale & Variegated Beds	Hard		D.S.	Sufficient
11	N W	12				"	164	2210	-110	2100	164	2046	" "	Soft		"	"
12	S W	13				"	125				125	2100	" "	Hard		"	
13	S W	14				Bored	30	2195			30	2165	Glacial	"		"	Poor supply
14	N W	14				Dug	32	2170	- 15	2155	32	2138	Sand	"		"	Sufficient
15	N E	14				Drilled	120	2190			120	2070	Pale & Variegated Beds	Soft		"	"
16	N W	16				Bored	65	2220			65	2155		"		"	Poor supply
17	S W	18				Dug	36	2180	- 20	2160	36	2144	Sandstone	Hard		D.	Sufficient
18	S E	21				Drilled	105	2150	- 10	2140	105	2045	Pale & Variegated Beds	Soft		"	"
19	N W	22				"	380	2240	- 64	2176	380	1860	Birch Lake ?	"		D.S.	"
20	N E	23				Dug	70	2173			70	2103	Pale & Variegated Beds	Hard		N.	
21	S W	24				Bored	90	2195	- 10	2185	90	2105	" "	"		D.S.	Sufficient
22	S W	27				Drilled	135	2240			135	2105	" "	"		"	"
23	S W	28				"	230	2280			230	2050	" "	Soft		"	"
24	N W	28				"	300	2265			300	1965	" "	"		"	"
25	S W	29				"	84	2240	- 40	2200	84	2156	" "	"		"	"
26	S E	30				Bored	67	2220	- 17	2203	67	2153	" "	"		"	"
27	S E	32				Drilled	112	2305			112	2193	" "	"		"	"
28	S W	32				"	180	2280			180	2100	" "	"		"	"
29	N W	32				"	158	2315			158	2157	" "	"		"	"
30	S W	33				"	200	2300	-160	2140	200	2100	" "	"		"	"
31	N E	34				"	123	2260			123	2137	" "	"		"	"
32	N E	35				"	130	2205			130	2075	" "	Hard		"	"
33	S W	36				"	72	2130	Flows	2130+	72	2058	" "	"		"	"
1	N W	3	44	12	4	Bored	18	2200			18	2182	Sand	Hard		D.S.	Sufficient
2	S W	4					22	2196			22	2174	"	Soft		S.	"
3	S W	6				Dug	30	2184			30	2154	"	Hard		D.S.	"
4	S W	7				"	25	2191			25	2166	Fine sand	Soft		"	"
5	S E	13				"	35	2180	- 20	2160	35	2145	Sand	Hard		"	"
6	S E	17				"	30	2177			30	2147	"	"		"	"
7	N W	21				Drilled	298	2161			298	1863	Birch Lake ?	Soft		"	"
8	S W	23				"	150	2157			150	2007	Pale & Variegated Beds	"		"	"
9	N W	23				"	160	2180			160	2020	" "	Hard		"	Limited supply
10	N W	27				"	130	2230			130	2100	" "	Soft		"	Sufficient
11	S E	28				"	180	2200			180	2020	" "	"		"	"
12	S E	31				"	266	2257	- 16	2241	266	1991	" "	"		"	"
13	S W	32				Dug	50	2232			50	2182	Glacial	Hard		"	"
14	S E	33				Bored	100	2215			100	2115	Pale & Variegated Beds	"		"	
15	N E	34				Drilled	160	2260			160	2100	" "	Soft		"	"
16	S W	35				"	130	2248			130	2118	" "	"		"	Limited supply
17	N W	35				"	258	2200			258	1942	" "	"		"	Sufficient
18	S E	36				Dug	70	2296			70	2226	Glacial ?	"		D.	Poor supply

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1	N E	1	45	9	4	Bored	75	2260			75	2185	Variegated Beds	Hard		D.S.	Limited supply
2	S E	2				Drilled	245	2250			245	2005	Birch Lake	Soft		"	Good supply
3	S W	4				"	325	2285	-100	2185	325	1960	" "	"		"	" "
4	S E	6				"	280	2252			280	1972	" "			"	
5	S E	10				"	250	2270	-100	2170	250	2020	" " sand	Soft		"	Sufficient
6	S W	16				"	152	2220	-112	2108	152	2068	Pale & Varie- gated Beds	Hard		"	"
7	N E	16				Bored	60	2150			60	2090	Yellow sand	"		"	"
8	N W	17				Drilled	160	2160			160	2000	Birch Lake	"		"	"
9	N W	18				"	130	2240	-100	2140	130	2110	Variegated Beds	" Alk.		"	"
10	S W	24				Dug	60	2210	- 52	2158	60	2150	" "	"		"	Limited supply
11	N W	27				Drilled	240	2245			240	2005	Birch Lake sand				Fire Hall, Irma.
12	N E	32				Bored	113	2338			113	2225	Fine sand	Hard		"	Poor supply
13	N E	36				"	60	2292			60	2232	Glacial				
1	N W	4	45	10	4	Drilled	190	2250	-100	2150	190	2060	Pale & Varie- gated sand	Soft		D.S.	Good supply
2	N E	4				"	150	2250	-100	2150	150	2100	Pale & Varie- gated Beds	Hard		"	Poor "
3	S W	6				Bored	23	2170	- 10	2160	23	2147	Glacial sand	"		"	Sufficient
4	S E	6				Drilled	152	2215			152	2063	Pale & Varie- gated Beds	Soft		"	"
5	S E	7				Drilled	223	2270			223	2047	" "	"		"	Good supply
6	S E	10				"	170	2230	-120	2110	170	2060	" "	Hard		"	" "
7	N W	12				"	127	2220	-115	2105	127	2093	" "			"	" "
8	S W	13				"	225	2220			225	1995	" "	Soft		"	Sufficient
9	S E	13				"	120	2235	-105	2130	120	2115	" "	Hard Alk.		"	Good supply
10	S W	14				"	176	2280	- 66	2214	176	2104	" sand	Soft		"	" "
11	N E	16				"	128	2255			128	2127	" "	Hard Alk.		"	" "
12	S E	16				"	90	2250	- 70	2180	90	2160	" "	"		"	" "
13	S W	17				"	200	2270	-100	2170	200	2070	" Beds	Soft		"	" "
14	N E	18				"	236	2305	-110	2195	236	2069	" "	"		"	
15	S W	19				Bored	75	2320	- 60	2260	75	2245	Sand	Hard		"	Limited supply
16	S E	21				Drilled	235	2280	- 60	2220	235	2045	Pale & Varie- gated Beds	Soft		"	Good supply
17	N E	21				"	185	2280	- 70	2210	185	2095	" "	"		"	Sufficient
18	S W	22				Bored	85	2280	- 70	2210	85	2195	" "	Hard Alk.		"	Limited supply
19	N W	23				"	195	2280	-115	2165	125	2155	" "	"		"	" "
20	N W	28				"	50	2280	- 10	2270	50	2230	Glacial sand	"		"	" "
21	N W	28				Drilled	150	2280	- 50	2230	150	2130	Pale & Varie- gated Beds	Soft		"	Good supply
22	S E	30				"	357	2320	-130	2190	357	1963	Birch Lake ?	"		"	Sufficient
23	S E	31				Bored	35	2350	- 30	2320	35	2315	Glacial	Hard		"	Poor supply
24	S W	32				Drilled	150	2350	- 65	2285	150	2200	Pale & Varie- gated Beds	Soft		"	Sufficient
25	S E	33				Bored	75	2280	- 20	2260	75	2205	" "	"		"	Limited supply
26	S W	34				"	25	2240			25	2215	Glacial	Hard		"	
27	N E	34				Drilled	185	2350	- 40	2310	185	2165	Pale & Varie- gated Beds	Soft		"	Good supply
28	N W	34				"	270	2300	- 20	2280	270	2030	" "	"		"	" "
29	S W	36				"	160	2340	-112	2228	160	2180	" sand	Hard		"	Sufficient
30	S E	36				Bored	70	2360	- 50	2310	70	2290	Sand	" Alk.		"	Limited supply

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1	N E	4	45	11	4	Drilled	217	2260	- 60	2200	217	2043	Pale & Variegated Beds	Soft		D.S.	Good supply
2	S W	4				"	230	2300	-100	2200	230	2070	" "	"		"	" "
3	S W	7				"	136	2335	- 40	2295	136	2199	" "	Hard		"	Sufficient
4	S W	10				"	255	2265	-150	2115	255	2010	" "	Soft		"	Good supply
5	S W	12				Bored	50	2170	- 25	2145	50	2120	Glacial sand ?	Hard		"	" "
6	S E	12				Drilled	120	2220	- 20	2200	120	2100	Pale & Variegated Beds	Soft		"	Sufficient
7	S W	15				"	200	2240	-150	2090	200	2040	" "	"		"	Good supply
8	N E	16				"	380	2280	- 40	2240	380	1900	Birch Lake sand	Hard Alk.		"	" "
9	S E	17				"	73	2200			73	2127	Pale & Variegated Beds	"		"	
10	N E	20				"	100	2275	- 10	2265	100	2175	Pale & Variegated Beds	" Alk.		"	Good supply
11	S E	20				"	150	2280	- 35	2245	150	2130	" "	"		"	Sufficient
12	S W	21				"	300	2295	- 60	2235	300	1995	" sand	"		"	Good supply
13	N W	21				"	92	2265			92	2173	" "	"		"	Poor "
14	S E	22				"	100	2230	- 20	2210	100	2130	" Beds	"		"	Good "
15	N E	22				Bored	33	2200	- 20	2180	33	2167	Sand	"		"	Sufficient
16	S E	24				"	90	2285	- 60	2225	90	2195	Pale & Variegated Beds	"		"	Limited supply
17	N W	26				"	60	2280	- 50	2230	60	2220	Sand	"		"	Sufficient
18	N W	30				Drilled	175	2355			175	2180	Pale & Variegated sand	"		"	Good supply
19	N W	32				Bored	54	2290	- 45	2245	54	2236	Sand	"		"	Limited supply
20	S E	32				"	60	2260	- 50	2210	60	2200	Pale & Variegated Beds	"		"	" "
1	S E	1	45	12	4	Drilled	292	2308	- 80	2228	292	2016	Pale & Variegated Beds	Soft		D.S.	Sufficient
2	S W	3				"	180	2266			180	2086	" "	"		"	Good supply
3	S E	5				"	283	2240	-140	2100	283	1957	" "	"		"	Sufficient
4	S W	6				"	150	2280	- 35	2245	150	2130	" "	"		"	"
5	S E	7				"	200	2280			200	2080	" "	"		"	Good supply
6	S E	9				"	225	2291			225	2066	" "	"		"	Sufficient
7	S E	10				"	206	2315			206	2109	" "	"		"	Good supply
8	N W	10				"	200	2292			200	2092	" "	"		"	Sufficient
9	S E	12				"	133	2335	- 40	2295	133	2202	" "	Hard		"	"
10	N W	12				"	168	2340	-108	2232	168	2172	" "	Soft		"	"
11	S E	14				"	220	2335	- 80	2255	220	2115	" "	"		"	"
12	S W	14				"	359	2340	- 90	2250	250	2090	" "	"		"	"
13	N E	14				"	222	2345	- 69	2276	222	2123	" "	"		"	"
14	N W	15				"	220	2302	- 20	2282	220	2082	" "	"		"	"
15	S E	16				"	217	2300	- 60	2240	217	2083	" "	"		"	"
16	S W	16				"	198	2280	- 40	2240	198	2082	" "	"		"	"
17	N W	18				"	175	2260	- 40	2220	175	2085	" "	"		"	"
18	S E	20				"	200	2335	- 60	2275	200	2135	" "	"		"	"
19	S E	22				"	310	2360			310	2050	" "	"		"	"
20	S W	22				"	204	2350	-140	2210	204	2146	" "	"		"	"
21	N W	22				"	295	2360			295	2065	" "	"		"	"
22	S E	28				"	185	2350	- 40	2310	185	2165	" "	"		"	"
23	S W	28				"	245	2350	- 60	2290	245	2105	" "	"		"	"
24	S E	30				"	245	2305	- 45	2260	245	2060	" "	"		"	"

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25	S W	31	45	12	4	Drilled	230	2345			230	2115	Pale & Variegated Beds	Soft		D.S.	Sufficient
26	N E	32				Dug	18	2350	- 14	2336	18	2332	Glacial sand	Hard		"	"
1	S W	2	46	9	4	Drilled	285	2290			285	2005	Birch Lake	Soft		D.S.	Sufficient
2	S E	3				"	280	2295			280	2015	" "	"			
3	S E	4				"	266	2306			266	2040	" "	"			
4	N W	4				Bored	40	2328			40	2288	Glacial	Hard		D.S.	Limited supply
5	S W	10				Drilled	180	2316			180	2136	Variegated Beds	"		"	Sufficient
6	S W	12				Dug	44	2285			17	2268	Gravel			"	
7	S E	12				Bored	106	2287			106	2181	Variegated Beds	Hard		"	Sufficient
8	N E	12				Dug	62	2242			62	2180	" "				"
9	S E	16				Bored	89	2315	- 70	2245	89	2226	" "	Hard		"	"
10	S E	20				"	84	2308	- 72	2236	84	2224	" "	Soft		D.	"
11	N E	20				"	75	2290	- 50	2240	75	2215	" "	Hard		D.S.	"
12	S E	21				"	87	2285			87	2198	" "				
13	S E	24				Drilled	175	2242			175	2067	Birch Lake	Soft		D.S.	"
14	S E	25				"	165	2241			165	2076	" "				
15	N W	26				"	260	2265			100	2165	Variegated Beds				
											260	2005	Birch Lake			D.S.	
16	S W	30				Bored	65	2295			65	2230	Variegated Beds	Hard		"	Sufficient
17	N E	32				"	60	2208	- 15	2193	60	2148	Glacial	Hard Alk.		"	Limited supply
18	N E	35				"	40	2245			40	2205	Fine sand				
19	S E	36				"	60	2231			60	2171	Glacial	Soft			
1	N W	4	46	10	4	Drilled	365	2350	- 39	2311	365	1985	Birch Lake sand	Soft		D.S.	Good supply. Town Well, Jarrow.
2	N W	7				Bored	69	2280	- 65	2215	69	2211	Gravel ?	Hard		"	Limited supply
3	S W	10				Dug	40	2370	- 10	2360	40	2330	Glacial	"		"	Sufficient
4	N E	12				Bored	61	2340	- 58	2282	61	2279	Blue clay	"		"	Limited supply
5	S W	14				"	62	2340	- 55	2285	62	2278	Gravel	"		"	Sufficient
6	S W	16				Drilled	200	2295	-125	2170	200	2095	Pale & Variegated Beds	Soft		"	"
7	N W	16				Bored	86	2330	- 20	2310	86	2244	" sand	Hard		"	"
8	S W	18				"	80	2255	- 64	2191	80	2175	" "	"		"	"
9	N E	18				"	72	2285	- 62	2223	72	2213	Gravel	" Br.		"	Limited supply
10	S E	20				"	75	2300	- 30	2270	75	2225	Pale & Variegated sand	Soft		"	Sufficient
11	S E	22				"	48	2300	- 16	2284	48	2252	" "	Hard		"	"
12	S E	27				"	47	2300	- 18	2282	47	2253	" "	"		S.	Good supply
13	S W	27				"	40	2310	- 20	2290	40	2270	Shale	"		D.S.	Sufficient
14	N W	28				"	64	2310	- 34	2276	64	2246	Gravel ?	"		"	"
15	S W	28				"	68	2300	- 35	2265	68	2232	Pale Beds	Soft		"	"
16	S W	30				"	38	2273	- 24	2249	38	2235	Pale & Variegated sand	Hard		"	"
17	N W	30				"	60	2280	- 20	2260	60	2220	" "	" Alk.		"	"
18	N E	33				"	40	2308	- 20	2288	40	2268	Black sand	" "		"	"
19	S E	34				"	40	2300	-14	2286	40	2260	Glacial	Soft		"	"
20	N W	35				"	44	2310	- 18	2292	44	2266	Shale ?	Hard		"	"

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.

(Alk) Alkaline; (Br) Brown.

WELL RECORDS—~~Rural Municipality of~~ ....

B 4-4
1800—10,000

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE: Above (+) Below (−) Surface	HEIGHT TO WHICH WATER WILL RISE: Elev.	PRINCIPAL WATER-BEARING BED: Depth	PRINCIPAL WATER-BEARING BED: Elev.	PRINCIPAL WATER-BEARING BED: Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
1	N W	4	46	11	4	Drilled	82	2240	- 50	2190	82	2158	Pale & Variegated sand	Hard Alk.		D.S.	Sufficient
2	S E	6				Bored	70	2305	- 40	2265	70	2235	" shale	Soft		"	"
3	S E	6				"	75	2300	- 30	2270	75	2225	" sand	Hard Alk.		S.	"
4	S W	12				Bored	120	2255	- 60	2195	120	2135	" beds	Soft		D.S.	"
5	S E	12				"	50	2255	- 30	2225	50	2205	Pale & Variegated sandstone	"		"	"
6	S E	14				"	70	2255	- 40	2215	70	2185	Pale & Variegated sand	"		"	"
7	N W	22				"	85	2250	- 75	2175	85	2165	Glacial sand	"		"	"
8	N E	22				"	55	2305	- 25	2280	55	2250	"	"		"	"
9	N W	26				"	70	2310	- 50	2260	70	2240	Pale & Variegated sand	Hard		"	"
10	N W	27				"	105	2300	- 85	2215	105	2195	" beds	Soft		"	Limited supply. J.F. Murray, Kinsella
11	N W	27				"	110	2290	- 60	2230	110	2180	" "	"		"	" " " " "
12	N W	27				Drilled	250	2310	- 96	2214	250	2060	" "	" Br.		"	Sufficient
13	S W	34				Bored	100	2320	- 72	2248	100	2220	" "	Hard			"
1	S E	2	46	12	4	Drilled	350	2366	-100	2266	350	2016	Pale & Variegated Beds	Soft		D.S.	Sufficient
2	N E	2				"	345	2365			345	2020	" "	"		"	"
3	N W	2				"	365	2387	-150	2237	365	2022	" "	"		"	"
4	S E	3				"	365	2387			365	2022	" "	"		"	"
5	N E	6				"	280	2360	-160	2200	280	2080	" "	"		"	Limited supply
6	S W	18				"	350	2330	-150	2180	350	1980	" "	"		"	" "
7	S W	30				"	295	2342	-160	2182	295	2047	" "	"		"	Sufficient
8	N E	30				"	260	2333			260	2073	" "	"		"	"
9	S W	32				"	375	2335	-100	2235	375	1960	" "	"		"	"

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.
(Alk) Alkaline; (Br) Brown.