CANADA
DEPARTMENT OF MINES
AND
TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 272

GROUND-WATER RESOURCES OF TOWNSHIPS 43 TO 46, RANGES 5 TO 8, 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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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 northeast 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 5 TO 8, WEST FOURTH MERIDIAN, ALBERTA

Physical Features

Battle River crosses the northwest part of this area. It has a valley 250 to 300 feet deep, and deep gorges are also cut by several subsidiary streams. The area, however, is gently rolling, with sand hills in the Buffalo Park Reserve and around Baxter Lake. Ribstone Creek cuts across the southeast corner of the area, and Ribstone Lake is one of the few freshwater lakes in this part of the Plains.

Geology

Grizzly Bear and Birch Lake strata outcrop in the valley of Battle River, and Variegated Beds are exposed along the edges of Grattan Coulée, which enters Battle River at Hawkins. Variegated and Pale Beds are presumed to underlie the whole of the upland area, except in patches where they have been eroded to expose the underlying Birch Lake formation. Many boreholes have been drilled for gas and oil in this area. Gas for Wainwright is supplied from a few wells to the west of Fabyan, and since its discovery in 1923, oil has been produced from a few wells north of Wainwright. Oil and gas were formerly produced from several wells on the west edge of Wainwright, but these wells have now been abandoned. In 1946 an oil well was drilled on l.s.d. 12, sec. 20, tp. 46, rge. 5. Several low anticlinal folds are believed to cross the area in a northwest direction. One of these occurs east of Baxter Lake; another crosses Battle River at its bow bend north of Wainwright, and a third lies west of Fabyan in the vicinity of the gas-producing wells. Between each of these anticlinal folds is a gentle syncline. The regional dip of the strata is to the southwest, so that the folds to the northeast are structurally higher than those to the southwest.

Water Supply

Several wells obtain water in sand and gravel beds in the drift, and where sand forms the surface material water collects in it and can readily be found in shallow wells. A few wells also obtain water in the Variegated Beds, but the sands of the Birch Lake and Ribstone Creek formations are a much more reliable source. Relatively few wells reach the Ribstone Creek formation, but at the Gold Standard refinery at Wainwright one such well is 320 feet deep and obtained a flow of 400 barrels a day. At the military camp south of Wainwright a well was drilled on sec. 25, tp. 44, rge. 7, to a depth of 347 feet or to an elevation of 1,956 feet (elevation of well 2,303 feet). The water-bearing sand was 33 feet thick, and on initial test the well pumped 35 gallons a minute. Thus in the vicinity of Wainwright the Ribstone Creek is a source of an adequate water supply.

<u>Township 43, Range 5.</u> No well records are available in this township. ~~Most of it is~~ a high plateau covered with scrub brush, and on the north and west edges are sand hills. The area is best suited for grazing. Parts of it were cultivated at one time, but on the plateau these have now been abandoned.

Township 43, Range 6. In this township all the wells for which records are available obtain their water from sands in the glacial drift. From regional information it is known that water-bearing sands occur in the underlying formations, and should the shallower wells not yield a sufficient supply an additional amount may be secured in deeper wells.

Township 43, Range 7. This township is wholly within the Buffalo Park reserve. The land is mainly one of sand hills, and so far as known there are no wells.

Township 43, Range 8. Except for the southwest corner this township also is within the Buffalo Park Reserve. One well on SW. section 4, drilled to a depth of 208 feet, obtains soft water in the Pale and Variegated Beds, and doubtless wells in other parts of the township would find similar water-bearing sands.

Township 44, Range 5. This township is entirely covered with drift and sand, and the depth to bedrock is difficult to determine. Several wells obtain water in comparatively shallow sands and gravel. Wells in sections 14, 15, 16, 23, 24, 25, and 26 indicate the presence of a northwesterly trending water-bearing horizon, partly sand and partly gravel, lying between elevations of 2,070 and 2,095 feet. It may be that this water-bearing bed is at the base of the drift, and that the water accumulates above the underlying, impervious, shaly beds of the bedrock formation. A well in section 32 may tap the same horizon. A few wells obtain water at a higher elevation, between 2,110 and 2,120 feet, also apparently within the drift. A well on NE. section 23 is reported to have obtained water at a depth of 265 feet and elevation of 1,899 feet. It is thought that the water-bearing bed is in the upper part of the Ribstone Creek formation because Birch Lake sandstone outcrops on the west side of Baxter Lake at an elevation of 2,080 feet. It is probable that the Birch Lake is not more than 60 feet thick in this locality, and the underlying Grizzly Bear formation is about 100 feet thick. Thus the top of the Ribstone Creek cannot be lower than an elevation of about 1,920 feet. A well on NE. section 34 is reported to have encountered water at a depth of 440 feet or at an elevation of 1,734 feet, probably in the base of the Ribstone Creek formation, which is thought to be 180 to 200 feet thick in this area.

Township 44, Range 6. In the area west and northwest of the town of Wainwright several deep wells have been drilled for oil. It is thought that at Wainwright the base of the Variegated Beds occurs at an elevation of 2,025 feet, that the Birch Lake occurs between elevations of 2,025 and 1,965 feet, the Grizzly Bear between elevations of 1,965 and 1,900 feet, and the Ribstone Creek between elevations of about 1,900 and 1,715 feet. In Wainwell No. 1 well water was encountered in the Variegated Beds at a depth of 150 feet, or an elevation of 2,070 feet; in the Birch Lake formation at a depth of 230 feet, or an elevation of 2,070 feet; and in the Ribstone Creek formation at a depth of 350 feet, or an elevation of 1,870 feet. A few wells in this township reach the Birch Lake water-bearing beds, and for the most part have found a sufficient supply. In the autumn of 1942 the Department of National Defence drilled a well 342 feet deep on the east edge of the town of Wainwright in sec. 32, rge. 6. This well was pumped on test at the rate of 43,000 gallons a day. It is in the

Ribstone Creek formation. Apparently some of the wells obtain water in the Variegated Beds, but as the drift is deep and also carries water it is difficult in some cases to determine from the available information whether the water-bearing bed of a well is in drift or bedrock. In wells on sections 1 and 12 there is a water-bearing bed at an elevation of 2,135 feet; in wells on sections 3, 4, 6, 10, 13, and 28 water occurs at an elevation of 2,150 to 2,165 feet; and in wells on sections 15, 20, 22, and 23 a still higher water-bearing horizon is present at an elevation of 2,180 to 2,190 feet. It is not certain that the water-bearing beds in all these wells are in drift, although a well on section 12 is reported to be in gravel at a depth of 84 feet. The fact that water-bearing sands occur at the same elevation in two or more wells suggests that the water-bearing beds are not in drift but in bedrock, that is in the Variegated Beds. This is particularly true of the lower bed at 2,135 feet, as water-bearing beds at the same elevation occur in one of the deep wells west of Wainwright.

Township 44, Range 7. Much of the township is covered with sand, and at the base of the sand, which rests on more impervious beds, a supply of water can be obtained. This water is an accumulation from rainfall. In the water wells drilled for the military camp on section 25 the basal Birch Lake water-bearing sand occurs at an elevation of 2,050 feet, and the upper sand of the Ribstone Creek formation at an elevation of 1,950 feet.

Township 44, Range 8. This township is largely sandy land, and it is probable that nearly everywhere water can be obtained in the base of the sand. Only two wells are known to be more than 100 feet deep. One of these obtains water in a sand in the Variegated Beds and the other reaches a water sand in the Birch Lake formation. So far as known no well has been drilled in this area to the Ribstone Creek formation, where a further supply of water is available.

Township 45, Range 5. The outwash deposit occurring in tp. 45, rge. 4, extends into the east side of tp. 45, rge. 5, and is present in sections 12 and 25. West of this the surface is eroded below the level of this water horizon. In this township, as in the township to the east, a water-bearing sand occurs at an elevation of 2,150 to 2,170 feet. It probably is in the Variegated Beds. A few wells reach water-bearing sands in the Birch Lake formation at an elevation of 2,080 to 2,090 feet. Several penetrate to the Ribstone Creek formation, which is at least 200 feet thick and holds sands both in the upper and lower parts. Wells on sections 6 and 18 apparently reach the upper sands, whereas one well 390 feet deep on NW. section 2 reaches the lower sand at an elevation of 1,740 feet.

Township 45, Range 6. A few of the shallower wells in this township find sufficient water in glacial sands and gravels, but most of the wells penetrate the bedrock to water-bearing sands. The higher water-bearing beds are in the Variegated Beds at an elevation of 2,150 to 2,195 feet. Birch Lake sandstone beds outcrop on the west side of Baxter Lake at an elevation slightly above the level of the lake at 2,080 feet. To the west of this the strata rise gently to the crest of the Battle River-Wainwright anticlinal structure, which crosses this township in a southeast direction. Beyond the crest the dip is to the southwest. Because of the presence of this fold the Birch Lake sands vary in elevations between 2,010 and 2,090 feet. Deep wells have been drilled for oil and gas about 4 to 5 miles north of Wainwright, and from the records of these wells it is apparent that there are at least two water-bearing beds in the Birch Lake and two in the Ribstone Creek formation with others in the Variegated Beds and in the glacial and surface materials.

Township 45, Range 7. The Fabyan fold crosses this township. On this fold several wells have been drilled in the vicinity of Fabyan, and reached water-bearing sands in the Birch Lake formation. Some shallow wells found water in drift materials, others are believed to have obtained water from sands in the Variegated Beds, and one well is believed to have reached the top sand of the Ribstone Creek formation. It is thus apparent that a plentiful supply of water is available in this township, although in some places relatively deep water wells are necessary to obtain it.

Township 45, Range 8. Some deep wells were drilled for oil and gas in this township, and in the Maple Leaf wells artesian water was encountered in the Ribstone Creek formation at an elevation of about 1,640 feet. The water is slightly saline. In Maple Leaf No. 1 well the flow was reported as 300 barrels a day. This well is thought to be on the west flank of the Fabyan fold, which may account for part of the hydrostatic head that forces the water to the surface. The source of the water is unknown because nowhere in the area do the Ribstone Creek beds outcrop at elevations higher than the surface at these wells. In Imperial Fabyan No. 1 well the base of the Birch Lake formation was encountered at an elevation of about 2,000 feet. Sands of this formation outcrop close to the well. To the west, in cuts along the railroad, Variegated Beds occur at an elevation above 2,150 feet. These consist of grey and chocolate coloured shales, carbonaceous shales, and yellowish weathering sands. It is possible, therefore, that many of the wells in this township from 35 to 85 feet deep obtain water from sands in the Variegated Beds, whereas some of those that reach lower elevations undoubtedly tap the water-bearing sands of the Birch Lake formation. None, except those drilled for oil and gas, reaches the Ribstone Creek formation.

Township 46, Range 5. The water-bearing outwash glacial deposit that occurs in tp. 45, rge. 4, at elevations between 2,215 and 2,240 feet appears to be present in this township at elevations of 2,220 and 2,250 feet. Many wells 30 to 75 feet deep obtain water from it. The supply is not large although it is mostly sufficient to meet requirements. Relatively few wells have been drilled to water horizons in the bedrock. The Battleview anticline presumably crosses this township, and hence the elevation of any water-bearing sand in the bedrock will vary considerably in elevation at different locations. A well on NW. section 5, 150 feet deep, reaches a water-bearing sand in the Variegated Beds at an elevation of 2,115 feet, but obtains its main supply of water at a depth of 220 feet or an elevation of 2,045 feet in the Birch Lake formation. Another well close by is reported to have reached a water-bearing sand in the Birch Lake at 255 feet or at an elevation of 2,005 feet, but possibly there is some error in the record and it may be that the sand is the same as occurs in the nearby well at an elevation of 2,045 feet.

Township 46, Range 6. In this township Birch Lake sand and sandstones outcrop on the north side of Buffalo Coulée, and Ribstone

Creek sandstones occur north of the bridge over Battle River near the centre of section 33. The elevation of the Ribstone Creek beds here is 1,905 feet, and farther north near the top of Battle River Hill the upper sandstones of the Birch Lake formation occur at an elevation of 2,117 feet. Many of the shallow wells in this township obtain water from sands or gravels in the drift, but especially in the southern part of the township several have been sunk to the water-bearing sands of the Birch Lake formation. In the central part of the township two wells reach sands that are thought to be in the Ribstone Creek. It is certain that on the prairie away from Battle River Valley water can be obtained by drilling to either the Birch Lake or Ribstone Creek formations.

Township 46, Range 7. The Battle River-Wainwright anticline is thought to trend northwest across this township, but away from Battle River little is known about the form of this fold or the course followed by it. Owing to the presence of this fold the various water-bearing beds would be expected to occur at different elevations in different parts of the township, and considerable variation in the height to which the water rises in different wells would be anticipated. From the records it is apparent that several wells obtain water from the Variegated Beds. The Birch Lake formation, however, is the main source, although a few wells in close proximity to Battle River, where the Birch Lake formation outcrops and, therefore, might be drained of water, must go as deep as 350 feet to reach the Ribstone Creek sands.

Township 46, Range 8. In this township it is probable that almost all the water supply comes from bedrock, either the Variegated Beds or the Birch Lake formation. Probably the elevation of each water-bearing sand varies from place to place, as the northwestward continuation of the Fabyan anticline crosses this township. As in tp. 46, rge. 7, the details of the structure are unknown, and it is difficult to interpret the data obtained from the wells. Water-bearing strata within the Birch Lake formation occur at elevations ranging from 2,000 to 2,080 feet, but whether at one or more horizons is not clear. No wells in the township have been sunk to the Ribstone Creek formation, which is a potential source of water in deeper wells.

NOTE: Because of difficulties involved in reproduction, the tables of well records referred to are not included with this report. Information regarding individual wells may be obtained by writing to the Director, Geological Survey of Canada, Ottawa.