CANADA

DEPARTMENT OF MINES

AND

TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 311

GROUND-WATER RESOURCES OF TOWNSHIPS 31 to 34; RANGES 21 to 24; WEST OF 4th MERIDIAN, ALBERTA

(Three Hills Area)

By

A. Mac S. Stalker

OTTAWA

1953

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.

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INTRODUCTION

The survey of the ground-water resources of the Red Deer region, Alberta, was resumed during the field season of 1946, and much information on these resources was obtained by a compilation of records of water wells.

A division has been made in the well records, in so far as possible, between the glacial and bedrock water-bearing sands. The water records themselves 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 the farmers, town authorities, and drillers in their efforts to obtain adequate water supplies.

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 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 report 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 on bedrock formations, provided in the report, 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-records tables, from the elevation of the surface at that point.

With each report is a map consisting of two figures. Figure 1 shows the distribution and type of surface deposits and bedrock formation that occur in the area. Figure 2 shows the locations of all wells for which records are available, the class of well at each location, and the contour lines or lines of equal 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 apt to be encountered. The depth of the well can then be calculated, and some information on the character and quantity of water can be obtained from a study of the records of surrounding wells.

GLOSSARY OF TERMS USED

Alkaline. The term "alkaline" has been applied rather loosely to some ground waters that have a peculiar and disagreeable taste. In the Prairie Provinces, water that is commonly described as alkaline usually contains a large amount of sodium sulphate and magnesium sulphate, the principal constituents of Glauber's salt and Epsom salts respectively. Most of the so-called alkaline waters are more correctly termed sulphate waters, many of which may be used for stock without ill effect. Water that tastes strongly of common salt is described as salty.

Alluvium. Deposits of earth, clay, silt, sand, gravel, and other material on the flood-plains of modern streams and in lake beds.

Aquifer. A porous bed, lens, or pocket in unconsolidated deposits or in bedrock that carries water.

Buried pre-Glacial Stream Channel. 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 pauses in its retreat. The surface is characterized by irregular hills and undrained basins.

(3) Glacial Outwash. Sand and gravel plains or deltas formed by streams that issued from the continental ice-sheet.

(4) Glacial Lake Deposits. Sand and clay plains formed in glacial lakes during the retreat of the ice-sheet.

Ground Water. Sub-surface water, or water that occurs below the surface of the land.

Hydrostatic Pressure. The pressure that causes water in a well to rise above the point at which it is first encountered.

Impervious or Impermeable. Beds, such as fine clays or shale, are considered to be impervious or impermeable when they do not permit of the perceptible passage or movement of ground water.

Pervious or Permeable. Beds are pervious when they permit of the perceptible passage or movement of ground water, as for example porous sands, gravel, and sandstone.

Pre-Glacial Land Surface. The surface of the land before it was covered by the continental ice-sheet.

Recent Deposits. Deposits that have been laid down by the agencies of water and wind since the disappearance of the continental ice-sheet.

Unconsolidated Deposits. The mantle or covering of alluvium and glacial drift consisting of loose sand, gravel, clay and boulders that overlies the bedrock.

Water-table. The upper limit of the part of the ground wholly saturated with water. This may be very near the surface or many feet below it.

Wells. Holes sunk into the earth so as to reach a supply of water. When no water is obtained they are referred to as dry holes. Wells in which water is encountered are of three classes.

(1) Wells in which the water is under sufficient pressure to flow above the surface of the ground.

(2) Wells in which the water is under pressure but does not rise to the surface.

(3) Wells in which the water does not rise above the water-table.

BEDROCK FORMATIONS OF EAST-CENTRAL ALBERTA

The formations that outcrop in east-central Alberta are of Tertiary and Upper Cretaceous age, and consist entirely of relatively soft shales and sandstones, with some bands of hard sandstone and layers of ironstone nodules. The succession, character, and estimated thickness of the formations are shown in the following table:

Age	Formation	Character	Thickness Feet
Tertiary	Paskapoo	Light grey sandstone, in part carbonaceous; shale; small amounts of siliceous limestone and volcanic dust; coal seams.	800 ±
Upper Cretaceous	Edmonton	Grey to white, bentonitic sands and sandstones, with grey and greenish shales; coal seams prominent in some areas, as at Drumheller.	1,000 to 1,150
	Bearpaw	Dark shales, green sands with smooth, black chert pebbles; partly non-marine, with white bentonic sands, carbonaceous shales, or thin coal seams similar to those in Pale Beds; shales at certain horizons contain lobster-claw nodules and marine fossils; at other horizons selenite crystals are abundant.	300 to 600
	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.	600 ±
	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 ±
	Grizzly Bear	Mostly dark grey shale of marine origin, with a few minor sand horizons; selenite crystals and nodules up to 6 or 8 inches in diameter.	100 ±
	Ribstone Creek	Grey sands and sandstones at the top and bottom with intermediate sands and shales; mostly non-marine, but middle shale in some areas is marine.	325 ±

WATER ANALYSES

Introduction

The following discussion of water analyses is included to assist those who wish to know the effect of various mineral constituents in well water, which give the water in some wells certain peculiar qualities.

Discussion of Chemical Determinations

The dissolved mineral constituents vary with the material encountered by the water in its migration to the reservoir bed. The mineral salts present are referred to as the total dissolved solids, and they represent the residue when the water is completely evaporated. This is expressed quantitatively as "parts per million", which refers to the proportion by weight in 1,000,000 parts of water. A salt when dissolved in water separates into two chemical units called "radicals", and these are expressed as such in the chemical analyses. In the one group is included the metallic elements of calcium (Ca), magnesium (Mg), and sodium (Na), and in the other group are the sulphate (SO_4), chloride (Cl), and carbonate (CO_3) radicals.

Mineral Constituents Present

Calcium (Ca) in the water comes from mineral particles present in the surface deposits, the chief source being limestone, gypsum, and dolomite. Fossil shells provide a source of calcium, as does also the decomposition of igneous rocks. The common compounds of calcium are calcium carbonate ($CaCO_3$) and calcium sulphate ($CaSO_4$).

Magnesium (Mg) is a common constituent of many igneous rocks and, therefore, very prevalent in ground water. Dolomite, a carbonate of calcium and magnesium, is also a source of the mineral. The sulphate of magnesium ($MgSO_4$) combines with water to form "Epsom salts", and if present in large amounts imparts a bad taste and is detrimental to the health.

Sodium (Na) is derived from a number of important rock-forming minerals, so that sodium sulphate and carbonate are very common in ground waters. Sodium sulphate (Na_2SO_4) combines with water to form "Glauber's salts", which if present in amounts over 1,200 parts per million makes the water unfit for domestic use or for irrigation. Sodium carbonate (Na_2CO_3) or "black alkali" waters are mostly soft, the degree of softness depending upon the ratio of sodium carbonate to the calcium and magnesium salts. Waters containing sodium carbonate in excess of 200 parts per million are unsuitable for irrigation.

Chlorine (Cl) is, with a few exceptions, expressed as sodium chloride (NaCl), which is common table salt. When found in water in excess of 400 parts per million it renders the water unfit for domestic use.

Iron, when present in more than 0.1 parts per million, will settle out of the water as a red precipitate on exposure to the air. Water that contains not more than 0.5 parts per million is considered the usual upper limit for potable water, but this amount is often exceeded. A water that contains considerable iron will stain porcelain, enamel ware, and clothing that is washed in it, but the iron can be almost completely removed by aeration and filtration of the water.

Hardness. Hardness is of two kinds, temporary and permanent. Temporary hardness is caused by calcium and magnesium bicarbonates, which are soluble in water but are precipitated as insoluble normal carbonates by boiling, as shown by the scale that forms in teakettles. Permanent hardness is caused by the presence of calcium and magnesium sulphates, and is not removed by boiling. Waters grade from very soft to very hard, and can be classified according to the following system[1].

[1] The "Examination of Waters and Water Supplies"; Thresh and Beale, Fourth Ed. 1933, p. 21.

A water under 50 degrees (that is, parts per million) of hardness may be said to be very soft.

A water with 50 to 100 degrees of hardness may be said to be moderately soft.

A water with 100 to 150 degrees of hardness may be said to be moderately hard.

A water with more than 200 and less than 300 degrees of hardness may be said to be hard.

A water with more than 300 degrees of hardness may be said to be very hard.

Hard waters are usually high in calcium carbonate. Almost all of the waters from the glacial drift are of this type, particularly those not associated with sand and gravel deposits that come close to the surface.

In soft water the calcium carbonate has been replaced by sodium carbonate, due to natural reagents present in the sands and clays. Bentonite and glauconite are two such reagents known to be present. Montmorillonite, one of the clay-forming minerals, has the same property of softening water, owing to the absorbed sodium that is available for chemical reaction.[2]

[2] Piper, A.M.: "Ground Water in Southern Pennsylvannia", Penn. Geol. Surv., 4th series.

If surface water reaches the lower sands by percolating through the higher beds it may be highly charged with calcium salts before reaching the bedrock formations containing bentonite or glauconite. The completeness of the exchange of calcium carbonate for sodium carbonate will, therefore, depend upon the length of time that the water is in contact with the softening reagent, and also upon the amount of this material present. The rate of movement of underground water will, consequently, be a factor in determining the extent of the reaction.

TOWNSHIPS 31 TO 34, RANGES 21 TO 24, WEST OF FOURTH MERIDIAN, ALBERTA

Introduction

The investigation of ground-water resources in Alberta was continued during the summer of 1949 by the writer, ably assisted by P. J. S. Byrne. The surface deposits were also mapped, and the relation of both the surface deposits and the underlying bedrock to the ground-water supply studied. The following report is based on information gained at that time.

Physical Features

Red Deer River flows southward through the eastern townships of the area in a valley 450 to 700 feet deep and 1 mile to 2 miles wide, which has the steep walls and canyon-like form of a new drainage channel developed in unresistant material in a semi-arid region. Many deep gullies, as much as 4 miles long, are tributary to it. The land a mile or so back is singularly unaffected by the nearness of the river, with no general slope towards it, and with much the same general topographic features as occur in places remote from the river. Big Valley Creek enters Red Deer River in the northeast corner of the area through a gully-like valley and is the only large tributary. In the area mapped the river drops from about 2,325 to about 2,225 feet above sea-level, and thus has a gradient of 3 or 4 feet to a mile.

Three other large valleys strike southeast through the area, with courses parallel with that of Red Deer River in townships 31, 32, and 33. Threehills Creek crosses the southwest corner of the area with a flat-floored valley as much as 4 or 5 miles wide and generally about 300 feet deep. Ten miles east of this Ghostpine Creek flows in a parallel direction along another flat-floored valley 5 miles wide and 250 feet deep. The third parallel valley, which joins the Red Deer at its bend in township 33, does not now contain any stream, but is about 200 feet deep and 3 or 4 miles wide. Small streams are numerous, and the area, and especially the southern half, is well drained, though in the north a few ponds and sloughs collect water.

Several hills, such as Three Hills in the west, and others in the northwest, reach more than 3,100 feet above sea-level, and others, present in all regions, rise above 3,000 feet. Most of the area is more than 2,700 feet above sea-level, and the lowest point, where Red Deer River leaves the area, is about 2,200 feet. The topography consists of broad, bedrock hills, ridges, and divides, commonly gullied, separated by wide, mostly gently-walled, valleys. Local relief is, in places, 200 to 300 feet. Except in the north and east, drift hills are uncommon, and the surface has a generally smooth appearance.

Geology

Glacial deposits cover almost the entire area. The underlying bedrock is either Edmonton formation or the overlying Paskapoo formation, the latter occupying some three-quarters of the area. Older formations, mentioned in a table earlier in the report, underlie the Edmonton, but at too great a depth, probably not less than 1,000 feet, to affect surface features or water supply.

The prevailing dip of the bedrock is to the west and southwest, and in those directions 300 or 400 feet of Paskapoo formation may cover the Edmonton. This cover thins to the east, where the Edmonton commonly underlies the unconsolidated material. Practically all the exposed bedrock is Edmonton formation, as Red Deer River, Big Valley Creek, and most of the gullies cut into this formation. Bedrock is exposed or very near the surface in about 45 square miles, mostly in Red Deer Valley, but also in several small areas in the southwest.

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 eastern 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 as the formation dips to the southwest it becomes progressively thicker in that direction.

The Edmonton formation consists of poorly bedded, grey and greenish grey clay shale, coal seams, and sand and sandstone that contain clay and a white material known as bentonite. Bentonite 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.

Paskapoo Formation. This formation was first named by Tyrrell from exposures of the lower part of the formation along Blindman River near its confluence with the Red Deer. It is composed essentially of sandstone and shale deposited in fresh water and includes some thin coal seams and carbonaceous beds. The basal beds, which are of importance in this area, are massive, crossbedded sandstone that weathers buff-yellow, and are in striking contrast with the underlying, light-coloured, bentonitic clay of the Edmonton formation. About 150 to 200 feet above the base of the formation are a series of lenses of siliceous limestone containing fossil gastropods and pelecypods. This limestone may be largely the cause of the extreme hardness of some of the ground water in the area.

Unconsolidated Deposits. During Pleistocene or Glacial time, great accumulations of ice formed at various centres in northern Canada. This ice moved out in all directions from these centres and covered large regions with what has been called the continental ice-sheet. As the ice advanced, it picked up great quantities of loose rock debris that was deposited when the ice finally melted. This material is unconsolidated, and is commonly called glacial drift.

The present area was entirely covered by one or more continental ice-sheets during Pleistocene time, and the final retreat of the ice left the bedrock buried to various depths of glacial drift, the unconsolidated deposits of the area. Most of the glacial drift consists of boulders and pebbles of various compositions and sizes embedded in a matrix of clay or sandy clay to form a more or less impervious mass known as boulder clay or till. Irregularly intermingled with this till, and also lying above it, are beds, pockets, and lenses of sand and gravel that form the water-bearing members or aquifers.

The character of the till changes from east to west. In the east most of it is very sticky, grey in colour, and contains much clay but little sand. In the west, however, where there is a greater content of material from the Paskapoo formation, the till, although containing much clay, is brown, more sandy, and slightly less sticky. Stones are nowhere common, and pockets and lenses of gravel are almost entirely absent.

The unconsolidated deposits are rarely more than 30 feet thick and probably average less than 20 feet in thickness. They are thickest in the north and northeast.

Ground Moraine. This type of glacial drift is chiefly till or boulder clay laid down beneath the ice-sheet. It commonly has a flat or gently rolling surface, and covers 368 square miles, or about two-thirds of the area.

End Moraine. Part of the material carried by the ice-sheet is dropped at its front or margin during pauses in the general retreat of the melting glacier. It consists of till, silt, sand, and gravel gathered during the advance of the ice-sheet. Much of the clay, silt, and fine sand may have been carried away by melt-water from the glacier, and the material forming end moraine is mostly coarser than that seen in ground moraine. It is characteristically arranged in hummocks and undrained or poorly drained hollows. About 65 square miles of the area, mostly in the north and northeast, is covered with low, weakly developed, end moraine.

Glacial-lake Deposits. During the melting back of the ice-sheet many lakes were formed where the normal drainage was temporarily blocked by lobes of ice or masses of glacial debris. Sand, silt, and clay were washed into these lakes and there deposited. Draining or lowering of these lakes exposed this material. Such deposits, in this area mostly clay, cover about 95 square miles in the valleys of Threehills and Ghostpine Creeks.

Some small areas of stream and glacial-outwash gravels are present, and will be mentioned in the descriptions of the various townships.

Water Supply

With a few exceptions to be mentioned later, sufficient supplies of water can be obtained anywhere in the area. The quality is generally good, and chemical analysis of representative samples are given later. The average depth of drilled well is about 135 feet, with the deepest wells in the east near Red Deer Valley, where many are more than 250 feet deep. The rise of water in the wells is small or negligible in the east, but is greater in the west.

The average yearly precipitation in the area ranges from about 14 to 18 inches, and the region is semi-arid. One-third to one-quarter of the precipitation is in the form of snow. As the area is generally well drained, trees few, vegetation light, and much of the surface material nearly impermeable, run-off is quick and proportionately large. Also, as humidity is generally low and the summers warm, the rate of evaporation is high. The proportion of the precipitation and the total amount of water that seeps into the unconsolidated deposits and bedrock to become ground water is, therefore, relatively small. However, as the area is rather thinly populated, the amount of ground water is sufficient for present use. Red Deer River is the only large source of surface water, as other streams are nearly dry much of the summer.

Of the surface deposits only the end moraine and lake sand are important in water supply, and even they are seldom of much value and generally yield only a fair supply or one insufficient for local purposes. Any attempt to obtain water from ground moraine or lake clay is inadvisable. Water found in the Pleistocene deposits is mostly hard, as it contains much calcium, and may also contain noticeable amounts of iron.

Of the 337 wells recorded, 318 draw from bedrock aquifers, and about 175 of these, mostly in the east, depend upon aquifers in the Edmonton, whereas about 143, largely in the west, tap aquifers in the Paskapoo. Determination of the formation in which an aquifer lies is commonly difficult as the contact between the two formations is very uneven.

The Edmonton contains many isolated lenses of sand irregularly distributed through the formation. Some zones contain more of these lenses than others and, as the water is in the sand, these zones are the more likely to yield water. Water is also frequently found either above or below coal seams. As the beds dip to the west and the surface of the ground rises to the west, an aquifer becomes more deeply buried in that direction, and others appear above it. Thus few aquifers are traceable very far in an east-west direction but may be traced farther north and south.

Although aquifers in the Paskapoo are more commonly used in the western part of the area, the Edmonton beneath it is everywhere a potential source of water. The upper part of the Edmonton, which is present in this part of the area, contains much water, but only yields it slowly because of its generally small grain size and high bentonitic content. Large supplies are thus seldom obtained from it.

Water entering the Edmonton beds through glacial deposits is commonly charged with calcium carbonate and, consequently, hard. Sodium carbonate from the Edmonton formation, however, replaces the calcium carbonate, softening the water. Generally the longer water is in contact with the Edmonton formation the softer it becomes, and although hard or medium hard water may occur near the surface, deeper down all the water is soft. Sodium carbonate is the principal mineral matter found in water from the Edmonton formation, but small amounts of iron occur in places, and some carbonaceous material from water near coal seams.

The Paskapoo formation generally contains abundant water, mostly in porous sand lenses that are more common in some horizons of the formation than in others. None of these lenses can be traced far, but in most places they overlap to form aquifer zones. The water of each of these zones bears distinguishing characteristics. As with the Edmonton formation, these aquifer zones become deeper to the west, and finally can be traced no farther.

The sand of the Paskapoo formation is commonly coarse, and thus will yield large quantities of water rapidly. This, however, is a drawback where the Paskapoo forms high ground or is cut by valleys, for it also allows easy drainage to lower ground or into the underlying Edmonton formation. For this reason aquifers in the Paskapoo formation supply few wells in the eastern part of the area. Apparently the water drains out of the thin cover of Paskapoo rocks, and the main supplies come from the Edmonton beds.

The water contained in the Paskapoo formation varies greatly in quality, but generally contains much calcium carbonate, particularly if drawn from near the horizon of the siliceous limestone layers where much of the water is too hard for ordinary washing. Both above and below this zone the water may not be as hard and is soft in some cases. Most of the Paskapoo water, and particularly the very hard water, contains a noticeable amount of iron, which commonly gives yellowish or brownish stains.

Over much of the area, especially in the Edmonton formation west of Red Deer River, precautions against gas should be taken if a well is being hand dug. Boring or drilling of wells is generally advisable.

As the soft water of the area contains much soda, aluminium or magnesium casing is inadvisable in wells yielding soft water.

Township 31, Range 21. Red Deer River flows southward through the centre of the township in a valley about 400 feet deep and 1½ miles wide. Many deep gullies, several 3 or 4 miles long, are tributary, and these cut an otherwise flattish surface. The topography is completely a reflexion of bedrock, and is unaffected by the drift.

Except for the river valley and the gullies, in which bedrock is exposed continuously, ground moraine covers the entire surface. In the northeast this has been modified by water, and patches of lake clay are present. The moraine is composed of a clayey, practically stoneless, dark, commonly almost black, till, and probably averages less than 10 feet in thickness. No wells obtain water from the unconsolidated deposits and their thinness and clayey nature would render any attempt to do so very inadvisable.

The bedrock exposures along the river and the gullies are all of the Edmonton formation, and this formation generally underlies the unconsolidated deposits. The Paskapoo formation may be present in the higher parts of the township in the northeast and southwest, but all the water used appears to be drawn from Edmonton beds, and probably no attempt should be made to find water in the Paskapoo.

All the wells recorded are drilled, and they are from 150 to 320 feet deep, with an average depth of 210 feet. They tap aquifers lying between 2,390 and 2,590 feet elevation, and mostly from 2,440 to 2,555 feet. All yield very soft water except for one well which supplies hard water for no known reason. Iron is seldom noticeable. The water is under little pressure and has practically no rise in the wells.

The river has an immense effect on the water supply of the township, and, through its drainage of higher aquifers, is the chief cause for the deepness of the wells. This is also the reason that the supply in most of the wells in only fair, and is, in two cases, insufficient.

Several measures can be taken to ensure larger supplies of water. First, it is best to drill as far from the river valley and the deeper gullies as is possible. Second, larger supplies can be obtained by drilling nearly to river level. This would necessitate very deep drilling and probably much pumping, as the water is unlikely to have much rise. Third, the use of larger diameter holes and drilling to a greater distance below the aquifer should increase the reservoir. However, as all these measures add to expense and may not result in satisfaction, they are hardly advisable unless larger quantities of water are absolutely necessary. Dugouts, or damming of streams and gullies, may aid in watering stock, and Red Deer River is always a potential source of water. However, anyone expecting to move into the township would be well advised to investigate water-supply conditions carefully if they anticipate requiring large quantities of water.

In general, this township is poorly off for water, and the cost of obtaining adequate supplies is high.

Township 31, Range 22. Ghostpine Creek flows southward through the centre of the township in a comparatively flat-floored valley 4 or 5 miles wide and several hundred feet deep. The elevation of the valley floor is about 2,600 feet, and from there the land rises to 2,900 feet in the northeast and 3,000 feet to the southeast. The topography reflects broad, bedrock hills whose shape is little modified by drift.

Dark, sticky, lake clay or silt covers about 20 square miles of the valley. The rest of the township is covered by a mantle of dark, commonly almost black, clayey ground moraine that contains few stones. The average thickness of the unconsolidated deposits is probably less than 15 feet. This thin sheet of drift, most of which is clay, is useless for water supply, and no well is known to draw water from it.

The Paskapoo formation is in the higher parts of the township and contains so much coarse sand that water from it can seep easily into valleys or the underlying Edmonton formation and leave it relatively dry. Thus, although the Paskapoo probably underlies much of the township, all the water used appears to come from Edmonton beds. One well 30 feet deep dug on low ground obtains a good supply of soft water. All the other wells are drilled and range from 80 to 280 feet in depth, with an average of 170 feet. The deeper wells are largely in the high land in the northeast part of the township. Aquifers used range from 2,400 to 2,780 feet in elevation, but are mostly in that zone between 2,540 and 2,605 feet. The supply is satisfactory in all cases, and is usually good. All but four of the wells supply very soft water, but the water from two of these four is unfit for consumption. Iron in noticeable quantity is rarely present. As the water drains readily into Red Deer River it is under little pressure and has practically no rise in the wells and, consequently, requires much pumping.

Water supply is better here than in the township to the east and sufficient water for farm use can be obtained anywhere. However, large supplies, such as for town water systems or large numbers of stock, would be difficult to obtain. The deep drilling, and the large amount of pumping necessary to raise the water from its low level, make water supply here costly.

Township 31, Range 23. The divide between Threehills and Ghostpine Creeks runs through the township. The terrain in many places rises to a height of 3,000 feet above sea-level. Threehills Creek crosses the southwest corner of the township in a valley 200 feet deep and drains that part of the township, but in the east the land slopes towards Ghostpine Creek. The surface near the valleys is relatively flat, but elsewhere are coulées and broad, bedrock hills little modified by drift.

A nearly flat mantle of lake clay covers about 7 square miles along the valleys in the southwest and northeast. Sticky, clayey, grey ground moraine that contains few stones covers the remainder of the area to a depth of several feet. The unconsolidated deposits have an average thickness of less than 15 feet and are too thin and contain too much clay to be of any importance in water supply.

A thin section of Paskapoo formation underlies the unconsolidated deposits in most places, but is not thick enough to contain much water so that important amounts are also obtained from the underlying Edmonton. All wells tap bedrock aquifers and all, except one that is bored, are drilled. About half draw from each formation, but the formation used commonly cannot be determined with accuracy, as no distinct division between the formations is apparent. The wells range from 25 to 265 feet in depth, with an average of 160, and draw from aquifers between 2,600 and 2,950 feet above sea-level, and particularly between 2,600 and 2,840 feet. The lower aquifers, largely in the Edmonton formation, supply chiefly soft water, whereas the others, mainly in the Paskapoo, yield mostly hard to very hard water, which usually contains noticeable iron. Soft and hard water wells are about equal in number. Most yield adequate to good amounts of water, but in several the supply is insufficient. The wells with poor supplies are all on upper parts of gentle slopes 100 to 200 feet or more high, and thus the water tends to be drained away by springs. Deepening should greatly improve the supply in these wells, and in few cases would need to be very great. The water is under small pressure and has little rise in the wells, although its rise is greater than in the townships to the east.

In general, ample water for ordinary farm use can be obtained anywhere in the township, but large supplies might be difficult to get, because much of the water in the Paskapoo drains into valleys and seepage through the Edmonton is slow. As the wells tend to be deep, and the water-level low, drilling and pumping are expensive.

Township 31, Range 24. Threehills Creek flows southeastward across the northeast of the township in a gentle-sided valley several miles wide and as much as 200 feet deep. From the valley the surface rises both to the town of Three Hills, in the northeast, and to the southwest, rising steeply in the very southwest corner. The topography reflects broad, bedrock features that are little modified by drift.

About 11 square miles of the valley of Threehills Creek have a flattish cover of lake clay. The remainder of the area, except for some exposures of Paskapoo formation in the west, is covered by a thin mantle of sticky, grey or black, nearly stoneless till. The unconsolidated deposits average less than 15 feet in thickness, and are too thin and contain too much clay to be a satisfactory source of water, and, indeed, none of the wells recorded draws from aquifers in them.

Paskapoo formation underlies the township, but as it is commonly too thin to contain much water the Edmonton formation is also important in water supply, and about one-third of the wells appear to use Edmonton aquifers. Wells are shallower than in the townships to the east, ranging from 30 to 250 feet in depth with an average of 110, and use aquifers between 2,620 and 2,990 feet above sea-level, with no particularly important zones in this range. Although about 60 per cent of the wells yield hard water, that from the lower, Edmonton, aquifers is generally soft, and the water has enough pressure to rise one-third to two-thirds of the distance to the surface. The quantity of water is generally adequate to good, being insufficient in only one well, which was probably a fault of the well rather than a lack of good aquifers. Iron is seldom noticeable in the water.

In general, sufficient water for farm use can be obtained at depth anywhere in the township, but much pumping is required. Wells with large supplies are not common, partly because the coarse-grained Paskapoo is easily drained to low ground, and also because the Edmonton, although containing large quantities of water, does not permit easy seepage of this water into wells as it is relatively fine grained.

Township 32, Range 21. Red Deer River flows southward, near the western edge of this township, in a valley 1 mile to 2 miles wide and more than 500 feet deep, to which many deep gullies, several as much as 3 miles long, are tributary. Except for the river valley, the gullies, and a broad, 200-foot high bedrock hill in the north, the township has a relatively flat surface.

Patches of gentle end moraine cover high land in the northeast. Elsewhere is a thin mantle of ground moraine, which in the southeast has been modified by water to give local patches of thin lake clay. The till of the ground moraine is usually dark, commonly nearly black. It is largely composed of clay and is sticky and contains few stones. As they probably average less than 15 feet in thickness, and are of a clay composition, the unconsolidated deposits are practically useless for water supply, and no wells draw from them.

Edmonton formation is exposed continuously along the river valley and in many gullies, and underlies the lower parts of the township. Paskapoo formation is probably present in much of the higher land, as in the northeast, but is much less important for water supply, and only two wells that draw from Paskapoo aquifers are recorded. These yield fair quantities of hard water that contains noticeable iron. As the Paskapoo is commonly coarse grained, water seeps quickly through it and escapes to valleys, gullies, and the underlying Edmonton. Thus, most wells must pass through the Paskapoo and tap aquifers in the Edmonton.

The wells are from 70 to 274 feet in depth, with an average of 165 feet, and use aquifers from 2,450 to 2,745 feet above sea-level, mainly from 2,525 to 2,745 feet. Those below 2,700 feet are all in the Edmonton formation, and practically all yield good quantities of very soft water without noticeable iron. Those above 2,735 feet are in the

Paskapoo. As would be expected in a township where drainage into a river valley and into gullies is strong, the water is under little pressure and has practically no rise in the wells, which makes pumping expensive. Drilling, so far as possible, from the river valley and the gullies is advisable.

Although no trouble in obtaining adequate water for farm use is apparent, difficulty may be experienced in obtaining larger quantities. More water could be obtained by drilling to about river level, or by providing larger reservoirs through larger diameter wells and by drilling deeper than the aquifer. As all these methods are expensive, the conservation and use of surface water may prove practicable if much water is required for stock.

Township 32, Range 22. The divide between Red Deer River and Ghostpine Creek strikes north through the centre of the township, and reaches 2,900 feet above sea-level. The 500 foot deep Red Deer Valley crosses the extreme northeast corner, and several of its tributary gullies cut the eastern districts. Ghostpine Creek flows southward near the western edge in a wide, gentle-walled valley 200 feet deep. Broad, bedrock hills and ridges, little modified by smaller, drift features, shape the topography.

Lake clay and silt produce a nearly flat surface in more than 12 square miles of the valley of Ghospine Creek. Elsewhere is a thin mantle of ground moraine, that increases to low end moraine in the extreme northeast, and is composed of a clayey, commonly dark or even black, sticky till that contains few stones. As the drift probably averages less than 20 feet in thickness and has a clayey composition, it is useless for water supply and no wells draw from aquifers in it.

Paskapoo formation commonly underlies the drift, but as it is thin, is in the higher areas, and is coarse grained, water easily seeps cut of it into valleys or the underlying Edmonton. It thus has little importance in water supply, except to necessitate deeper wells where it has to be pierced. All wells recorded enter the Edmonton formation and are deep, half being more than 300 feet deep. They range from 90 to 360 feet in depth with an average of 260 feet, the deepest average of any of the townships. They tap aquifers lying between 2,370 and 2,720 feet, but largely in the zone from 2,560 to 2,625 feet above sea-level. The water in all is very soft, and iron is never noticeable. Because of drainage by springs into coulées and the nearby river valley, the water has little pressure and its rise in the wells is negligible.

Practically all the wells have ample water, but the supply is no more than adequate in four and is insufficient in one. These five wells are in the six eastern sections, near Red Deer Valley, and obviously much of their water is drained into this valley. It is advisable to drill as far as possible from the river valley, and, if large supplies are needed, it will be necessary to drill nearly to river level, although even there the amount of water available may not be as great as desired. Conservation and use of surface water may be practicable in watering many stock, and the quantity of water may be increased by having larger reservoirs in the wells, made by using larger diameter holes and going farther below the aquifers. These methods are expensive, and pumping from the low levels to which the water rises is also expensive. If much water is required conditions should be investigated carefully before moving into this township.

<u>Township 32, Range 23.</u> The Three Hills, which rise to about 3,100 feet above sea-level, are a distinctive feature of the west part of this township. Eastward from them the surface drops with a fairly uniform slope to about 2,700 feet at Ghostpine Creek, which flows southward through the east in its characteristic broad valley. The land near the creek is relatively flat, whereas elsewhere broad bedrock hills, little modified by drift, shape the topography.

Lake clay and silt, commonly not thick enough to smooth out the features of the underlying bedrock, cover about 8 square miles near the creek. A fairly smooth mantle of ground moraine, composed of sticky, usually grey, clayey, nearly stoneless till, covers the remainder of the area. As they have an average thickness of probably less than 15 feet, and are generally clayey, the unconsolidated deposits are of little importance in water supply. In section 4 one hard-water well is thought to obtain its water, an adequate supply, from these deposits.

Edmonton formation underlies the unconsolidated deposits near Ghostpine Creek, but elsewhere it is generally overlain by the Paskapoo. As the contact between the formation is uneven, difficulty arises in determining which wells draw from Paskapoo and which from Edmonton aquifers, but about two-thirds appear to enter Edmonton beds. The drilled wells are from 70 to 330 feet deep, with an average depth of 150, and tap aquifers lying between 2,595 and 2,830 feet above sea-level, and particularly in the zones of 2,595 to 2,690 feet and 2,765 to 2,832 feet. About half the wells yield soft or medium-hard water. The water from the lower aquifers tends to be softer than that from the higher, as it is drawn largely from the Edmonton formation. The water in half the wells contains noticeable iron.

The quantity of water in practically all wells is adequate to good, though in no instance is it large. The deepest well, which draws upon a low aquifer, for unknown reasons has insufficient water for ordinary farm use. The trouble may be with the well, as higher aquifers should be present. Deepening 60 feet should give a sufficient supply of soft water.

The water is under little pressure and its rise in the wells is negligible. On account of the deepness of the wells and the amount of pumping required, water is relatively expensive to obtain in this township, and difficult to obtain in large amount.

Township 32, Range 24. In the western part of this township Threehills Creek flows southward through a gentle-walled, flattish floored valley several miles wide and perhaps 200 feet deep. From there the surface rises to Three Hills, a distinctive feature in the east. Broad bedrock hills, commonly gullied but little modified by drift, shape the topography.

A flattish mantle of lake clay and silt, that is never thick enough to smooth over the relief features of the underlying bedrock, covers about 12 square miles of the floor of Threehills Creek valley. Ground moraine, composed of a grey, sticky, usually clayey till that contains few stones, covers the remainder of the area. As the drift probably does not average much more than 15 feet in thickness, and is of a clayey composition, it is of no importance for water supply, nor, so far as is known, do any wells use aquifers in it.

Paskapoo formation underlies the drift, but is thin enough to permit the deeper wells to reach aquifers in the underlying Edmonton formation. The uneven contact between the two formations makes it difficult in some cases to determine from which formation a well draws its water. Two dug wells, one flowing, obtain good supplies of water from Paskapoo aquifers. The rest of the wells are drilled, and are from 50 to 280 feet deep with an average of 120. They tap aquifers lying between 2,675 and 2,910, but mostly from 2,735 to 2,815, feet above sea-level. All those aquifers below 2,815 feet yield, or else when the wells were new yielded, ample water. In those above 2,815 feet the supply is only fair, and from the highest aquifer insufficient. Only a few lower aquifers are in Edmonton beds, and less than one-fifth yield soft water. The water from half the wells contains a noticeable amount of iron. The water has little pressure and its rise in the wells is in most cases negligible.

In general in this township satisfactory amounts of water, usually hard, can be obtained from aquifers below 2,815 feet. Larger amounts, such as might be needed for town supply, are probably unobtainable at any reasonable depth.

Township 33, Range 21. Red Deer River crosses the southwest corner of the township in a steep-walled valley 500 feet deep and 1½ miles wide, with several deep, tributary gullies as much as 2 miles long. From this valley edge the land rises about 200 feet towards the centre of the township. Broad, bedrock hills, with smaller ones superimposed, produce the rolling surface typical of most of the township. Many hollows in the north contain water all summer, whereas those in the south become dry, and trees, which are lacking in the south, grow in the north.

Except for 8 square miles of ground moraine in the southwest, the township has a cover of end moraine, with gentle-sloped hills that rise perhaps 20 feet above the kettles. The till composing the moraine contains much clay. It is sticky, usually brown or grey in colour, and contains few stones. The average thickness of drift is probably less than 20 feet. The ground moraine is useless for water supply, but some hard water can be obtained from end moraine, particularly from near the hollows. Two dug wells are recorded that draw fair quantities of water from it. This water would be of no importance were it not that obtaining water from the bedrock is expensive, as wells into it are deep and the rise of water negligible.

Although the Paskapoo formation underlies the unconsolidated deposits in the higher districts, it contains no water, and necessitates deep drilling in those wells that must pass through it. The lack of water is due to the formation's relatively coarse grain-size so that, as it occupies the higher areas, the water readily drains away into valleys and the underlying Edmonton formation. All bedrock wells are drilled into the Edmonton, and are from 80 to 300 feet deep, with an average of 195. They tap aquifers between 2,530 and 2,755 feet, but mostly between 2,590 and 2,700 feet, and all yield very soft water, with iron noticeable in the water of only one well. Good quantities of water are the rule, but in several wells the supply is only adequate, and in three is insufficient. One of these latter, in the southwest of section 26, is comparatively shallow and obviously should be deeper. The lack of water in the others is more likely the fault of the wells than a lack of aquifers. Drainage into Red Deer River prevents the water having much pressure, and its rise in the wells is negligible.

In general, sufficient soft water for ordinary farm and domestic use is available in the bedrock, but larger quantities probably are unobtainable, because seepage through the fine-grained Edmonton formation is slow. Water is expensive to obtain in the township.

<u>Township 33, Range 22.</u> Red Deer River flows south in the eastern part of the township through a valley, up to 2 miles wide and 500 to 700 feet deep. This valley has many deep tributary gullies, several as long as 3 miles. It and its gully system occupies one-third of the township. The remaining two-thirds of the township consists of broad, bedrock hills and ridges, with superimposed, smaller hills in the southeast.

Low, knob-and-kettle end moraine covers about 4 square miles in the southeast, lake clay is present in the southwest, and gravel, probably pre-glacial, lies in sections 29 and 32. Otherwise the township, except for the valleys and gullies, which are mainly in bedrock, has a mantle of ground moraine composed of sticky, clayey, usually grey, almost stoneless till. As the drift probably does not average more than 15 feet in thickness and is clayey throughout, finding a good water supply in it is impossible, and no wells draw from aquifers in it.

The Edmonton formation outcrops continuously along Red Deer Valley and in many of the gullies, and also outcrops near Ghostpine Creek in the southwest. The Paskapoo formation underlies the drift in the higher and more populated parts of the township, and supplies most of the water. Probably three-quarters of the wells draw from aquifers in the Paskapoo, but the uneven contact of it with the Edmonton makes it uncertain in which formation many aquifers are.

The water-supply conditions described for township 33, range 22, continue into that part of this township east of the river. West of the river most of the wells recorded are drilled, and range in depth from 60 to 385 feet, with an average of 135; 110 feet for those into Paskapoo and 225 feet for those into Edmonton. Aquifers used are between 2,560 and 2,860 feet above sea-level, with four wells drawing ample soft water from aquifers below 2,700 feet in Edmonton beds, but most tapping aquifers lying between 2,770 and 2,810 feet. No soft water is obtained from the Paskapoo formation, and some is very hard, too hard for washing. Half the Paskapoo wells yield water with noticeable iron, and in a few cases enough to prevent its use.

Practically all the wells in this township have good amounts of water, and the supply is inadequate in only three. One of these three, in the southeast of section 16, probably drains into Ghostpine Creek, and should need only slight deepening for improvement, whereas the other two are near Red Deer Valley and may have difficulty obtaining adequate supplies. Large amounts of water, as for town use, may also be difficult to obtain because of drainage into Red Deer Valley. Also, because of this drainage, the water has little pressure, and generally rises no more than one-third of the distance to the surface. Wells should be drilled as far from the river as possible.

Township 33, Range 23. Ghostpime Creek flows southeastward through the centre of the township in a valley several miles wide and 150 to 250 feet deep. The land rises steadily, but gently, from the stream and, except for several gullies, reflects a generally smooth bedrock surface that has been little modified by drift.

Lake sand, silt, and clay form a flattish cover in about 13 square miles near the creek. Elsewhere a mantle of ground moraine, composed of a grey or brown, sticky, clayey, nearly stoneless till, overlies the bedrock. As the unconsolidated deposits probably do not average much more than 10 feet in thickness and are clayey, they are of no use in water supply, and no wells that draw from aquifers in them are recorded.

The Edmonton formation underlies the drift in about half the township, chiefly in a belt near Ghostpine Creek where it outcrops. The Paskapoo formation underlies the drift in the higher districts, mainly in the west and northeast, but, being comparatively coarse grained, it is easily drained into valleys and the underlying Edmonton, and thus usually is dry. The Edmonton is much more important for water supply, and practically all the wells enter it. However, as the contact of the two formations is very irregular, it is not always possible to determine in which an aquifer lies.

All the wells are drilled, and range from 55 to 300 feet in depth, with an average of 130 feet. The aquifers used lie between 2,620 and 2,830 feet elevation, but mostly between 2,665 and 2,785 feet, the lower ones mostly being in the Edmonton formation. About two-thirds of the wells yield soft water and iron is rarely noticeable.

The quantity of water is generally adequate to ample for farm and domestic use. The only well with insufficient supply went through a good, hard-water aquifer in an attempt to obtain soft water. The water generally has enough pressure to rise about one-half the distance from the aquifer to the surface, and a flowing well is present in the southwest of section 28, near Ghostpine Creek.

Red Deer Valley, although to the east of the township, even here drains the aquifers and prevents the water from rising high in the wells. Although adequate water for ordinary use is available anywhere, this drainage, a heavy run-off, and the slowness with which water seeps from the surface into the bedrock, makes it unlikely that large supplies, such as for town use, can be obtained without difficulty.

Township 33, Range 24. This township includes the divide between Ghostpine Creek and Threehills Creek. From higher than 3,000 feet above sea-level at the divide the surface drops steadily, and in the north comparatively rapidly, towards both creeks. Broad bedrock hills and ridges, in places cut by gullies, are present, but the surface is little modified by minor, drift hills. Several ponds are present, but the area is generally treeless.

Lake clay gives a flattish cover to about 4 square miles of the southwest, and a few end-moraine ridges are present, otherwise the area has a mantle of ground moraine composed of brown or grey, usually clayey but in places sandy, relatively stoneless till. As the unconsolidated deposits probably average only about 15 feet in thickness, and generally have a clayey nature, they are of little use for water supply, and none of the wells examined draws from aquifers in them.

Although the Paskapoo formation underlies the entire township, and is in places as much as 250 feet thick, the underlying Edmonton formation is also important for water supply, especially where the Paskapoo is thin. The wells are nearly equally divided between the two formations. All but one of the wells are drilled, and these range in depth from 20 to 200 feet, with an average of 100; 110 feet into Edmonton and 90 into Paskapoo. They use aquifers between 2,725 and 2,990 feet above sea-level, and particularly in the zones 2,750 to 2,830, 2,850 to 2,870, and 2,805 to 2,945 feet. Those aquifers below 2,830 feet are mostly in Edmonton beds and, except for a few between 2,750 and 2,780 feet that contain hard or very hard water with much iron, yield soft water without noticeable iron. Most aquifers above 2,850 feet yield hard to very hard water that usually contains noticeable to much iron. The thirty-four wells recorded all yield good to very good amounts of water, and supplies suitable for town use can probably be found without trouble.

As water drains away in springs along the valleys of Ghostpine and Threehills Creeks it is under little pressure and in most wells rises only about half-way to the surface. In southwest section 7, near Threehills Creek, one well flows.

<u>Township 34, Range 21.</u> Red Deer River flows southwestward through the northwest part of the township in a valley 2 miles wide and more than 500 feet deep. Its main tributary, Big Valley Creek, flows westward in a deep, gully like valley through the centre of the township. Large, deep gullies, a few 2 miles long, are tributary to river or creek, particularly in the north and west. The land rises southwestward, where broad, bedrock hills are overlain by small, morainal hills. The river valley and the gullies, in which the Edmonton formation is exposed continuously, occupy about 12 square miles.

Low, knob-and-kettle, end moraine, with knolls up to 20 feet high, covers about 9 square miles in the south and 2 or 3 in the north. Gravel is present in the northeast. Elsewhere the township is covered by a mantle of ground moraine, composed of sticky, clayey, brown or grey, relatively stoneless till. As the average thickness of unconsolidated deposits is probably only around 10 feet, and as they are clayey, these deposits are of little use for water supply, and none of the wells examined draws from aquifers in them.

As much as 200 feet of Paskapoo formation underlies the drift in the south and in the extreme northwest, but most of the township is underlain by Edmonton formation and the latter is more important for water supply. Water-supply conditions in township 34, range 22, hold for the small part of this township west of the river and will be described in the next section. East of the river all but one of the wells are drilled, and these range from 24 to 265 feet in depth, with an average of 130; an average of 90 feet for those into Paskapoo and 140 for those into Edmonton. Aquifers used range from 2,535 to 2,750 feet, but mostly from 2,610 to 2,710 feet above sea-level. Two wells recorded draw from Paskapoo aquifers, but the others, including all tapping lower aquifers, use those in Edmonton beds. All but two of the wells yield sufficient or ample water, and one of the two, in the southwest of section 14, had a good supply but is now partly filled with silt. As the other, in the southeast of section 16, is shallow, and is in the easily drained Paskapoo near a coulée, it could not be expected to have enough water. All the wells with only fair supplies are near coulées or the river valley.

Generally aquifers in Edmonton are better than those in Paskapoo. Sufficient water can be obtained anywhere east of the river, although difficulty may be had in obtaining large supplies. Due to the rise of water in the wells, large reservoirs, such as are given by large-diameter wells and by drilling a distance below the aquifer, are of benefit. Although it is inadvisable to drill near deep gullies and the main river valley, it is generally easier to obtain water near this valley on the east side than on the west.

Township 34, Range 22. Red Deer River flows southwestward through the southeast corner of the township in a valley 2 miles wide and as much as 500 feet deep. Several deep gullies, a few as much as 4 miles long, are tributary to it, giving the southeast of the township a very cut-up appearance. In the west a large valley 250 feet deep and 4 miles wide strikes northward through the township. It is occupied by morainal hills and now carries no stream. The surface of the township rises to the west and southwest to more than 700 feet above river level. In the south, except for local gullies, it is smooth and reflects bedrock, whereas in the north it is broken by many morainal hills.

A thin mantle of ground moraine gives a relatively smooth surface to most of the area. Twelve square miles in the north and in the extreme southeast corner have the knolls and depressions of gentle end moraine, with hills about 10 feet high in the south but higher in the north. Small pockets of gravel are present in the west. The drift is thin, particularly in the south and near the river, and its average thickness is probably not much more than 15 feet. The till is usually clayey, grey or brown, and rarely has many stones, but the end moraine has more sand, and thus carries a fair number of trees.

As the southern part is dry and gullied and the hilly end moraine in the north is poor for farming, the township is only thinly populated and little well information is recorded. The unconsolidated deposits are too thin and contain too much clay to yield much water and all the wells examined enter bedrock. Some poor water might, however, be obtained in the end moraine.

The Edmonton formation is continuously exposed in the river valley and in many gullies, and it underlies the large valley leading northward in the west. As much as 200 feet of Paskapoo formation underlies the higher land in the west and in the northeast, and it is a more important source of water than the Edmonton as it is present in the more populated areas. All the wells examined are drilled, and they are from 32 to 215 feet deep. The average depth is 110 feet, and most wells are around that figure. They tap aquifers between 2,540 and 2,885 feet above sea-level, but mostly in the zone from 2,755 to 2,810 feet. The aquifers above 2,660 feet, so far as can be determined, are in Paskapoo beds, and contain hard to very hard water, commonly too hard for washing. Deep wells into the Edmonton could obtain soft water anywhere. Noticeable iron, commonly enough to give a bad taste to the water, is always present. The quantity of water in practically all wells is good, and is always adequate for farm needs. As the relief in the township is considerable, the rise of water varies in different wells from negligible in some to overflowing in others and in the springs along the large valley in the western part of the township. These springs supply water in areas that otherwise would have to use Edmonton aquifers, and are in part the reason so few wells enter that formation.

Generally, good supplies of hard water are obtainable anywhere in this township. Springs are numerous, and the drilled wells are shallower and have a better rise of water than might be expected in an area so near a large river canyon.

Township 34, Range 23. Ghostpine Creek flows southeastward across the southwest corner of the township in a valley 3 miles wide and 300 feet deep. From the creek, the land rises to the southwest and northeast, and in the centre of the township is plateau like. The smooth, wide valleys and broad bedrock hills of the south are in the north covered with smaller, drift hills. Trees are common in the north, but rare in the south.

The south and west parts of the township, except for the recent sand along Ghostpine Creek, are covered by a mantle of ground moraine. The northern part, however, is covered by knob-and-kettle end moraine, with knolls 10 to 20 feet high. The till is generally brown or grey, clayey, and contains few stones, in contrast with some of the end moraine that is more sandy. The average thickness of the unconsolidated deposits is probably less than 20 feet. Two dug wells obtain hard water in the end moraine in the northeast, one obtaining a good, the other a poor, supply. Although water may be obtained in the sand along Ghostpine Creek, and elsewhere in end moraine, bedrock aquifers are more satisfactory.

The Edmonton formation probably underlies the drift near Ghostpine Creek, but elsewhere it is generally overlain by more than 200 feet of Paskapoo. The Edmonton has, therefore, little importance in water supply, although it is everywhere a potential, but deep, source of soft water. Most bedrock wells are drilled, and these are from 60 to 262 feet deep, with an average depth of 130 feet. They tap aquifers between 2,700 and 2,965 feet above sea-level, but mostly between 2,755 and 2,965 feet. The quantity of water in practically all cases is ample, and is never insufficient for ordinary farm use. The quality is mostly hard to too hard for washing and iron is noticeable in the water from two-thirds of the wells, in a few in sufficient amount to give a bad taste to the water. The water in most wells is under insufficient pressure to have much rise, but flowing wells and springs are present.

In general, water supply is no problem in this township. Large supplies are probably most easily obtainable in the west.

Township 34, Range 24. The outstanding topographic feature of this township is the slope with which the plateau-like western half of the township drops eastward 300 feet to the valley of Ghostpine Creek. Except for several valleys tributary to this creek that cut deeply into the high land, the plateau and the creek valley have little local relief, and minor, morainal hills are not common. Several small lakes and sloughs are present, but trees are rare.

Recent sand occurs along Ghostpine Creek and some other streams. Elsewhere the township is covered by some 20 feet of ground moraine, composed of brownish, almost stoneless till, either clayey or sandy in composition. One dug well draws a fair supply of hard water from drift, and more could be found in sandy ground moraine and in sand along the streams. Generally, however, bedrock aquifers are more satisfactory.

The Edmonton formation underlies drift in places near Ghostpine Creek, but is generally overlain by 200 or 300 feet of Paskapoo. Outcrops are rare. The Paskapoo formation is more important for water supply, Edmonton aquifers being used only where the Paskapoo is thin or absent. The Edmonton is everywhere, however, a potential source of soft water for deep drilling. Several springs and some dug or bored wells tap bedrock aquifers, but most wells are drilled. The drilled wells are from 40 to 183 feet deep, with an average depth of 105 feet. Those drilled into Edmonton beds are slightly shallower than those into Paskapoo. Aquifers used lie between 2,655 and 2,950 feet above sea-level, and chiefly between 2,715 and 2,950 feet. Three quarters of the wells yield hard or very hard water, the latter too hard for washing. The water from two-thirds of the wells contains noticeable iron, and in a few instances enough to cause an unpleasant taste. Most wells have good to very good amounts of water, the only one with insufficient supply is relatively shallow and near a valley, and could be improved by deepening. In the northwest the quantity of water, although still sufficient, does not seem as great as elsewhere in the township, probably because of easy drainage into Ghostpine Creek. The rise of water in wells on the high land of the western half is negligible, because of drainage to lower areas, whereas in the east it is very good, especially near Ghostpine Creek where springs and flowing wells occur. One well, which deserves special notice, is a 60 foot, hard-water well drilled on the road allowance in the northeast of section 23 by an oil company survey. The water rises 5 feet above surface and the flow, when examined in August 1949, was more than 75,000 gallons a day. This well drains the Paskapoo of the high land to the west.

Good or very good amounts of water can be obtained anywhere in this township, and no trouble should be encountered in obtaining sufficient for town use or other large requirements, especially from the Paskapoo of the high land in the southwest.

ANALYSES OF WELL WATERS FROM Townships 31-34, ranges 21-24, West of 4th Meridian, Alberta.

									Constituents as Analysed (parts per million)								Hardness as ($CaCO_3$) (pts. per million)		
Sample Number	¼	Section	Township	Range	Meridian	Owner	Depth of well (feet)	Aquifer *	Total dissolved solids (parts per million)	Calcium (Ca)	Magnesium (Mg)	Alkalis (Na) (K)	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Bicarbonate (HCO_3)	Alkalinity (as $CaCO_3$)	Ca hardness	Mg hardness	Total hardness
3957	SW	3	33	23	4	H. Kaisler	185	E	1596	11.0	3.0	433.5	475.3	13.7	3.5	793.0	650.0	142.2	78.2	220.4
4185	NE	19	31	24	4	E.B. Thomson	80	P	1904	133.3	68.0	405.8	883.6	63	1.2	678.9	554.0	332.6	279.8	612.4
4186	NE	20	34	24	4	W.C. Malcolm	160	P	1266	90.7	177.0	61.2	360.9	NIL	1.4	822.3	574.0	226.3	723.4	954.7
4187	NE	26	33	24	4	O. Bartsch	145	E?	1016	15.5	24.0	284.2	335.2	2.2	5.3	375.3	392.8	38.7	98.8	137.5
4188	NE	23	34	24	4	Road Allowance	60	P	1616	115.0	80.8	308.4	703.7	1.4	2.7	675.9	554.0	286.9	332.5	619.4
4206	NE	24	34	23	4	G.V. Kranston	130	P?	1578	58.6	62.1	428.4	639.1	2.3	1.2	700.6	648.0	146.2	255.5	401.7
4207	NE	31	31	21	4	M. Kopjar	165	E	2493	20.6	6.6	953.6	562.1	0.7	TRACE	1878.8	1540.0	51.4	27.2	78.6
4208	NE	24	31	21	4	P. Notland	222	E	1668	22.0	10.3	646.2	117.7	19.5	7.1	1617.8	1332.0	54.9	42.4	97.3
4209	NW	16	31	23	4	L.A. Matus	120	P	2564	349.0	155.5	155.0	1177.4	20.7	30.1	600.2	492.0	870.8	557.6	1428.4
4210	SE	28	32	23	4	J. Hanna	152	E	1592	6.5	3.3	602.2	445.7	2.4	NIL	1002.8	882.0	16.2	13.6	29.8

* Symbols used for aquifers P - Paskapoo, E - Edmonton