CANADA
DEPARTMENT OF MINES
HON. W. A. GORDON, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

BUREAU OF ECONOMIC GEOLOGY
GEOLOGICAL SURVEY

MEMOIR 174

Surface Deposits and Ground-water Supply of Winnipeg Map-area, Manitoba

BY

W. A. Johnston

OTTAWA
J. O. PATENAUDE
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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PREFACE

This report deals with the underground water supply, the character of the soils, and other economic features of the surface deposits overlying the bedrock in Winnipeg map-area. As the ground-water in places comes from the bedrock, some reference is made to the character of the bedrocks in the area. For a description and the areal distribution of these, the reader is referred to Map 303A in course of publication. Map 254A accompanying this report shows the character and distribution of the surface deposits.

Winnipeg map-area embraces nearly all of Manitoba south of Swan River valley and a small part of eastern Saskatchewan. It extends from the International Boundary to latitude 52 degrees north, and from the second meridian (102 degrees) to the Ontario-Manitoba boundary. Parts of the area in the east and northeast have not been mapped because of the rocky or swampy and unsettled character of the region.

One of the most interesting features of the area is the occurrence of extensive deposits of ancient, ice-dammed lakes known as Glacial Lakes Agassiz and Souris. Studies of these lakes over forty years ago, by Warren Upham, formed the subject of an extensive monograph published by the United States Geological Survey in 1896, and investigations at a later time by J. B. Tyrrell[1], D. B. Dowling[2], R. C. Wallace[3], and others have extended Upham's work. More recently, Frank Leverett has re-examined parts of Lake Agassiz basin south of the International Boundary. The results of his work are given in Professional Paper 161 of the United States Geological Survey published in 1932. Antevs has recently studied the Lake Agassiz clays in northern Manitoba[4]. In the field work on which the present report is based, the lake beaches and other features of the surface deposits were mapped over all the map-area. Parts of the area have been described by the present writer[5].

In the present report the surface deposits are referred to only briefly in the description of underground water conditions and other economic features of these deposits. Mapping of the bedrock as shown on Map 303A was done by the late S. R. Kirk, and examinations of well sections on which the stratigraphy of the bedrocks is in part based were made by R. T. D. Wickenden.

In connexion with the description of ground-water conditions, which forms a major part of this report, the author is indebted to the Government of the Province of Manitoba for records of well drilling done under their supervision; and to many well drillers for information supplied by them.

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[1] Tyrrell, J. B.: "Report on Northwestern Manitoba"; Geol. Surv., Canada, Ann. Rept., vol. V, pt. 1, pt. E (1893).

[2] Dowling, D. B.: "Report on the Geology of the West Shore and Islands of Lake Winnipeg"; Geol. Surv., Canada, Ann. Rept., vol. XI, pt. F (1901).

[3] Wallace, R. C., and Maynard, J. E.: "The Clays of Lake Agassiz Basin"; Trans. Roy. Soc., Canada, vol. 18, sec. 4, pp. 9-30 (1924).

[4] Antevs, Ernst: "Late-Glacial Correlations and Ice Recession in Manitoba"; Geol. Surv., Canada, Mem. 168 (1931).

[5] Johnston, W. A.: "Winnipegosis and Upper Whitemouth River Areas, Manitoba, Pleistocene and Recent Deposits"; Geol. Surv., Canada, Mem. 128 (1921).

Surface Deposits and Ground-Water Supply of Winnipeg Map-Area, Manitoba

CHAPTER I

GENERAL CHARACTER OF THE AREA

PHYSICAL FEATURES

The area embraced by the Winnipeg map-area is naturally divided into two main parts of different character by an abrupt rise, known as the Manitoba escarpment, that extends northwest from Morden near the International Boundary, in the central, southern part of the map-area, and forms the northeast faces of Pembina, Riding, and Duck mountains. Another abrupt rise forms the slopes of the relatively small Turtle Mountain area in southwestern Manitoba, the surface of which is a rolling upland about 500 feet above the surrounding country. Much of the region below the Manitoba escarpment is a nearly level plain, particularly a broad belt bordering Red and Assiniboine rivers. The region is known as the Manitoba lowland or first prairie level. It includes a part of the Precambrian area to the east, over which there is a thick covering of surface deposits that almost entirely conceal the irregularities of the bed-rock and render the surface nearly level. The second prairie level lies southwest of the Manitoba escarpment and, in contrast with the lowland, is a rolling country, 500 to over 1,000 feet above the lowland, that has considerable relief, though parts of Souris and Assiniboine valleys have very little relief, being old lake beds. The escarpment bounding the low-land on the southwest is interrupted by broad valleys in which there is a more gradual rise to the southwest. These set apart the "mountains" which in reality are drift-covered uplands having much local relief, but when viewed from the west appear as slightly higher parts of a rolling plain. Their steep northeastern faces and striking appearance when seen from the lowland have led to their being called mountains.

The maximum relief in the area is about 1,800 feet. Lake Winnipeg is the lowest part and has an elevation of 715 feet above sea-level. The highest part of Turtle mountain is about 5 miles from the western end, where the hills rise to a little above 2,500 feet above sea-level. In Duck mountain, which is somewhat higher than Riding mountain to the south, and is the highest part of the map-area, some of the hills have an altitude of 2,600 feet or somewhat more.

The Manitoba lowland consists of four parts that differ somewhat in physical character: (1) Red River Valley plain; (2) a highland area in southeastern Manitoba; (3) Winnipeg River valley and adjacent highland drift areas; and (4) the inter-lake plain extending west from lake Winnipeg to the foot of the Manitoba escarpment (Figure 1).

The term Red River valley is usually applied to the broad plain drained by Red river and its tributaries and not simply to the valley of the river itself which is only a comparatively narrow trench, 20 to 50 feet deep, cut in the central part of the plain. Only a small part of the plain has been formed by erosion and deposition by the present streams; the nearly level surface is due to deposition of clay, silt, and sand in an ancient lake known as Glacial Lake Agassiz, which covered nearly all of Manitoba east of the Manitoba escarpment. The greater part of the plain is prairie and is underlain by thick deposits of clay on which lies a deep black soil that has long been famous for its fertility. In the north a few rock hills, notably Stonewall and Stony mountains, which are erosion remnants of resistant rocks, project through the clay plain.

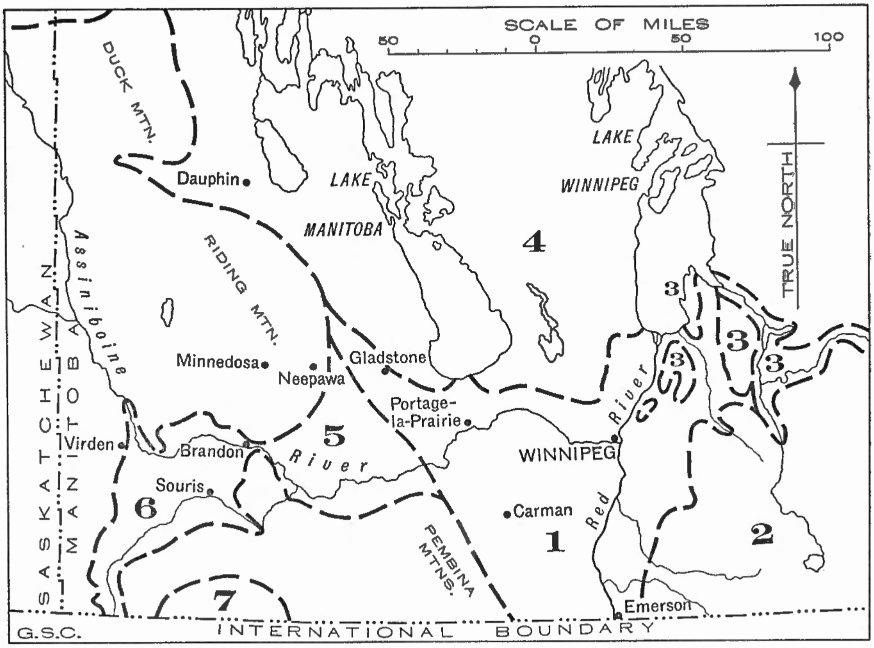

Figure 1. Physiographic divisions of the Winnipeg map-area. Subdivisions of the Manitoba lowland: 1, Red River Valley plain; 2, Highland area of southeastern Manitoba; 3, Winnipeg River valley and highland drift areas; 4, Inter-lake plain. Subdivisions of the second prairie level: 5, Assiniboine delta; 6, Souris basin; 7, Turtle mountain.

The part of southeastern Manitoba east of Red River Valley plain is a highland, the highest part of which is traversed by the Canadian National railway from Bedford to South Junction. It is an irregularly shaped tract or drift plateau occupying about 200 square miles and has a general altitude of 1,150 to 1,250 feet, but rises in places to 1,300 feet. It has a maximum height of 500 feet above Red River valley on the west and 250 feet above Lake of the Woods on the east. For a distance of 15 miles north from Bedford the plateau has a steep front 50 to 100 feet high, overlooking the nearly level plain towards the northwest. The greater and higher part lies northeast of the railway, but spur-like ridges extend south from Bedford for several miles. Much of the surface is undulating and is characterized by numerous, irregularly shaped hills with intervening, undrained hollows. The great thickness of the surface deposits overlying the bedrock in this area, over 300 feet in places as shown by well borings, indicates that the surface features are the result of irregular deposition and erosion of the drift deposits.

The part of eastern Manitoba drained by Winnipeg river and the lower part of Whitemouth river is a marginal part of the Canadian Shield; it is a rocky lake country east and south of Winnipeg river, and a clay plain along Winnipeg river from the mouth of Whitemouth river down to lake Winnipeg and along Whitemouth river south to the crossing of the Canadian National railway. The clay plain is several miles wide in the central and lower parts, but is comparatively narrow along Whitemouth river. It is well drained in a narrow strip along the rivers, but poorly drained in the parts one or more miles away from the rivers and, except in places along Whitemouth river, is not subject to overflow by the streams. There is, however, a belt of well-drained land several miles wide in the vicinity of Lac du Bonnet, that has long been settled and is in large part under cultivation.

The area lying between lakes Winnipeg and Manitoba and extending west to the foot of Riding and Duck mountains differs markedly from the plains of Red and Assiniboine rivers to the south, in that much of it is wooded; much of the surface materials consists of stony clay and gravel, in contrast with the lake and alluvial clay deposits of the southern plains, and the surface as a rule is uneven, though it has only slight local relief. There are, however, within the plain, areas of nearly level land underlain by stoneless, alluvial or lake clay, which are the most important parts for agriculture. One of these areas extends along the west side of lake Winnipeg in the form of a narrow strip from the southern end of the lake north to the valley of Icelandic river where it continues in a wider belt up the river valley to its head. The surface of the clay plain slopes gently towards lake Winnipeg from a height of about 50 to 100 feet above the level of the lake. In the valley of Icelandic river large tracts are swampy because of the inadequate drainage; the banks of the river are low except near the mouth at Riverton and stretches along the river have been built up by overflow of the stream and deposition of sediment. Similar areas occur along the east branch of Fisher river in the vicinity of Fisher Branch and lower down stream in the valley near Hodgson. An area a few square miles in extent lies southwest of Gypsumville. More extensive tracts lie along Ochre and Turtle rivers south of lake Dauphin, along Wilson and Vermilion rivers in the vicinity of Dauphin west of the lake, and along Mossy river north of the lake. Save for these areas and a few others of small extent, the general character of the inter-lake plain is very similar throughout; it is a poorly drained, stony clay plain having slight local relief.

Pembina mountains in the south, Riding mountain north of Assiniboine valley, and Duck mountain, which is a continuation of Riding mountain but is partly set off from it by Valley river, form parts of the second prairie level or steppe. Other parts of somewhat different character are Brandon and Tiger hills south of Assiniboine valley, a rolling plain that extends south of these hills to the International Boundary, the ancient delta of the Assiniboine below Brandon, the Souris basin in which large tracts, being an old lake bed, are nearly level, and a rolling plain occupying the western part of the map-area, west of Souris valley and in part bordering the upper reaches of Assiniboine river.

Tiger hills extend east and west in a belt 5 to 10 miles wide from near the edge of the Manitoba escarpment to where Souris river leaves the continuation of Pembina valley and turns abruptly to the northeast to pass through these hills and join the Assiniboine. A broad spur of the hills extends southeast along the northern side of Pembina River valley and determines the course of this river as far east as Pembina lake where the stream turns to the south. Over much of the area the hills are spaced at intervals of one or two to the square mile, though in places the spacing is very irregular, and there is a local relief of 50 to 300 feet or somewhat more. Undrained basins, in some cases filled with water, lie at irregular intervals between the hills. At other places stream valleys traverse the hills and afford natural drainage for much of it. Some of these are old, abandoned water courses that carry no water except possibly during freshets. One of these issues to the south near Greenway and passes completely through the hills. Most of the hills are composed of glacial drift, but some of those southwest of Treherne show on their slopes jumbled and tilted masses of bedrock, indicating that the solid rock is not far below the surface. A few of the hills southwest of Treherne have elevations of 1,750 feet above the sea and are the highest. Those to the west near Souris river have elevations up to 1,575 feet. In most places the hills are considerably lower and there are stretches of rolling country where the general elevation is 1,300 to 1,400 feet. Many of the hills throughout the area are wooded, chiefly with a young growth of aspen poplar and birch.

Brandon hills are a continuation of Tiger hills, but are set off from them by the deep, narrow valley of Souris river and by a stretch of comparatively low relief to the northwest of the river. They are best developed about 10 miles south of Brandon where the highest points have elevations of nearly 1,600 feet, or 400 feet above the level of the Assiniboine at Brandon. They are formed of glacial drift that irregularly overlies the bedrock. Small ponds and lakes such as lake Clementi, a summer resort south of Brandon, occupy undrained basins in the hills.

The rolling plain that extends south from Tiger hills to the International Boundary and southwest to Turtle mountain and Souris valley is bounded near its north side by the trench-like Pembina valley, which is a striking feature because of its precipitous sides and broad, level bottom, interrupted in places by long, narrow lakes. All these lakes are only a few feet deep in the deepest parts and have been formed by deltas or alluvial fans of tributary streams that act as natural dams. The trench-like character of the valley is due to the fact that it was formerly occupied by a large stream that drained a former glacial lake in Souris valley. Much of the plain to the south is nearly level, but here and there hills such as Pilot mound, a well known landmark in the early days of travel, rise 100 feet or somewhat more above the plain. To the southwest, in a broad belt extending through Holmfield, Killarney, and Boissevain, the surface is hilly and there are a few ponds and small lakes, some of which, for example Killarney lake, overflow into stream valleys and, therefore, have good fresh water in them. On the other hand, Whitewater lake near Deloraine farther west does not overflow, although it is fed by a number of small streams coming from Turtle mountain. Its water is saline and on evaporation in dry seasons leaves behind a white encrustation of salts around the shores; hence the name.

Souris basin is the bed of an ancient lake. It, therefore, has many level tracts, though parts are hilly or rolling owing to the fact that the lake sediments do not entirely mask the irregularities of the old floor which was very uneven. In the south along Souris river the basin is a narrow belt 10 to 15 miles wide. It widens to the north and includes an area along the Assiniboine from near Virden in the west to Brandon, and north along Minnedosa river and other tributaries of the Assiniboine to Rivers.

Riding and Duck mountains form the great part of the upland in the northwest part of the sheet. They are connected by a hilly strip about 15 miles wide that forms a divide between the headwaters of Valley river flowing east into lake Dauphin, and tributaries of Assiniboine river flowing south along the western side of the upland. These " mountains," like Pembina mountains, show no great relief when viewed from the west; the higher parts are 100 to 500 feet above the general level of the plain to the west. But on the northeast side there is an abrupt rise from the lowland amounting in places to over 1,000 feet. The amount of rise increases towards the north. Along Riding mountain, near Kelwood, and Riding Mountain village, there is a rise of 1,000 feet in 4 miles. Farther to the north the broad depression occupied by Valley river and other small streams interrupts the escarpment and forms a gentle slope towards the southwest. Along the northeastern face of Duck mountain there is a rise of about 1,200 feet in 4 miles and the height of the highest parts of the " mountain " above the lowland to the northeast is about 1,800 feet.

Nearly all the surface of Riding and Duck mountains is rolling and is composed of glacial drift. Large parts are forested and are included in forest reserves. Irregular hills a few feet to about 200 feet high are in places closely spaced and in other places scattered and are separated by undrained depressions or by drainage channels. Many of the depressions hold lakes, some of which, for example Clear lake in the southern part of Riding mountain and Madge lake in the northwestern part of Duck mountain, overflow and contain good fresh water.

The plain extending west from Souris basin and northwest along the upper reaches of Assiniboine river has both hilly and nearly level tracts. Low ridges and chains of irregular hills separated by shallow depressions extend southeast and determine the course of the drainage, but form only a small part of the plain. An extensive sand-plain deeply trenched by Assiniboine and Qu'Appelle rivers lies at the junction of these two streams. Bordering the Assiniboine for a few miles above and below Kamsack there is a clay plain, an old lake bed; another clay plain occurs in Swan River valley to the northeast. The general elevation of the plain in the southwestern part of the map-area is 1,600 to 1,800 feet above the sea. There is a gradual rise to the north amounting to about 200 feet. Stream valleys such as the Souris in the southeast and the Assiniboine and Qu'Appelle in the north are on the average about 200 feet below the general level of the plain. Only a few lakes occur, though there are many ponds and small marshes. Shoal lake overflows occasionally and has only slightly saline water. Many of the ponds, particularly in the south, are saline, but some contain fresh water. Most of the nearly level tracts are prairie, whereas many of the hills and ridges, except in the extreme south, are covered with young forest growth.

Turtle mountain extends for about 40 miles along the International Boundary and for 8 to 10 miles north of the boundary. The surface of the upper part of the mountain is very uneven due to the uneven deposition of glacial drift, but there is no great relief except near the western end where the tops of a few hills are 200 to 300 feet above the general level. When seen from a distance the surface appears fairly even and oval-shaped, somewhat resembling the back of a turtle, hence the name. On the summit there are a great many small lakes occupying depressions between hills of various sizes and shapes. Nearly all the mountain is heavily forested. The highest part and steepest slope to the plain below is near the western end where there is a rise of 300 feet in $1\frac{1}{2}$ miles and 800 feet in 6 miles.

Most of the hilly tracts throughout the area are moraines formed at the margin of the last ice-sheet during its retreat. Sand-plains formed by streams issuing from the ice occur in places on the southwest sides of the moraines.

CLIMATE

Climatic conditions in the area are those characteristic of an interior continental region; the winters are cold and the summers warm, and there is a comparatively small rainfall. At Winnipeg the mean temperature for January from 1885 to 1930 ranged from -14·5 to 7·8 degrees (F.) and for July from 61·4 to 72·3 degrees. Precipitation ranged from 13·76 inches (1917) to 27·19 inches (1898) and averaged nearly 20 inches. The average precipitation for the Manitoba lowland is nearly the same as at Winnipeg, but is slightly less in the south near the International Boundary. On the second prairie level the average precipitation ranges from 16 to 18 inches, being least in the southwestern part of the province. About half the precipitation comes in the growing months April to July inclusive. The length of the growing season free from killing frosts ranges from about 100 to 140 days.

CHAPTER II

GROUND-WATER CONDITIONS

GENERAL STATEMENT

The ground-waters in Manitoba that are obtained by digging or drilling wells, or by means of sand points, occur at various depths and in different kinds of materials. Some of the waters are fresh; others are saline. In many places the water is under pressure and rises nearly to the surface, that is, it is artesian; in other places the water found at shallow, or at considerable, depths does not rise in the hole when reached by the drill. In some areas there is not sufficient water to supply a well, or the water is saline.

The waters may be broadly classified into three groups according to the ways in which they occur. One group comprises the shallow waters that commonly lie within 50 or 60 feet from the surface. These shallow waters are fed by the rainfall absorbed through the soil and are abundant only in certain areas where the surface deposits are porous. In the heavy clay areas shallow wells obtain only small supplies as clay does not readily give up its contained water. Wells that draw their supplies from these shallow sources are in the surface deposits immediately overlying the bedrock and in some cases extend a few feet into the bedrock. The height at which the water stands in the wells marks the ground-water level, or water table as it is sometimes called. This water level is found at a nearly uniform depth, being a little lower below the hills than beneath the depressions, so that all the wells find water at about the same depth. Good supplies of water, however, are found only in the low-lying, sandy tracts, as for example in the lowland tract south of lake Dauphin and in Gladstone district. The height of the water table in these areas may be nearly the same as that of adjacent lakes, marshes, and streams or may be somewhat lower, as these basins in many cases have impervious mud-covered bottoms through which there is very little seepage into the ground below.

A second group comprises those waters that lie at various depths up to 200 or 300 feet beneath clay or other only slightly pervious material and do not rise appreciably in the hole when tapped by the drill. They are found in sandy or gravelly beds in the surface deposits and in porous strata of the bedrock. In many places these waters are scanty and in some places absent. As they are not under pressure their upper surface may represent the true ground-water level at the locality or they may lie below a poorly defined water table and may be waters that have gradually seeped down from the surface through beds that are slightly pervious and collected in porous beds. Lack of pressure may be due to friction in the passage of the water through beds that are only slightly pervious. In many places these waters are under slight pressure and thus form an intermediate group that approaches in character the artesian waters of the third group.

The pressure, however, appears to be due to the head of water seeping downwards rather than to any true artesian conditions. Wells of this character, for example, are found at depths of about 300 feet in the surface deposits on the upland area near Reston in southwestern Manitoba, where it is improbable that artesian conditions exist, for there is no known source for the water to enter the water-bearing beds and it is unlikely that these extend laterally in the drift for any great distance. Nor does the weight of the overlying beds appear to have any effect on the water pressure, for the height to which the water rises in the wells has no definite relation to the depth of the wells.

The waters of the third group are the artesian well waters that rise to the surface or part way, depending upon the elevation of the ground at the well site and the amount of pressure. They occur in sandy or gravelly beds below clay in the surface deposits and in porous beds in the bedrock at various depths from 80 or 100 feet to over 1,000 feet. Their source is the rainfall absorbed by porous beds or from streams traversing these beds, through which the waters pass downward and laterally to the water-bearing strata in which the water is held by the impervious rocks above and below, and which may lie at a considerable distance from the intake or source beds. They are under hydrostatic pressure from the head of water in the intake beds, but the water in the well does not rise as high as the source because of friction in the strata through which the water passes. In a few places natural gas occurring along with the water causes an "air" lift for the water, which, therefore, rises higher than it otherwise would. The term artesian well is sometimes restricted to flowing wells, and the term "sub-artesian" used for those that rise towards the surface but do not overflow. Others use the term artesian as referring to well water that is under pressure regardless of whether it overflows or not. In this report "artesian" refers to well water that is under pressure and "artesian flow" to waters that rise to or above the surface.

WATER-BEARING FORMATIONS

Waters of the Surface Deposits

The water-bearing beds of the surface deposits overlying the bedrock are generally sandy or gravelly layers of the glacial drift. These vary greatly in character and extent with locality, and in places are absent. In some places the sand or gravel occurs at the surface and extends to a sufficient depth to hold supplies of water; at other places the sand is buried beneath clay and carries water, or all the drift may consist of silt and clay which are so nearly impervious that little or no well water can be obtained from them.

The glacial drift of Manitoba includes the deposits of two or more glacial stages, the Wisconsin and at least one older stage. It also consists of two classes of material, the boulder clay or till deposited directly by the ice, and the stratified beds of silt, sand, and gravel laid down by the waters of the melting ice. Interglacial beds consisting of peat, sand, gravel, and silt or clay are shown in sections on Roaring river in the northern part of Duck mountain and are known from well sections, but do not appear to be extensive.

Lake clay and silt occupy parts of the basins of the former glacial lakes and are covered along the present river courses by very similar material, which is the alluvium or flood-plain deposits of the streams and was laid down after the disappearance of the lakes. Along the lower part of Assiniboine river, from where it issues from the hills to the west of Portage la Prairie to its junction with Red river, and along Red river from the International Boundary to lake Winnipeg, the alluvium forms a belt several miles wide. Its limits, however, can hardly be defined, as it differs as a rule from the lake clay only in that it contains more organic matter, tending to make a blacker and deeper soil cover than that of the lake clay. Similar deposits occur in the Lake Souris basin along the Assiniboine and other streams west and southwest of Brandon. The clays and silts of the former Lake Souris contain more sand and silt than do the clays of the Lake Agassiz basin, so that they are more porous and form better sources of ground-water. Although wells in the lake clays and silts are very numerous they yield only small quantities of water, as the pore spaces are so small that the water seeps out very slowly. In the heavy clay areas shallow wells may not yield sufficient water for farm use, but the clay forms excellent material in which "dug-outs" for the storage for rain and snow water are excavated. These are usually 8 to 10 feet deep, about 30 feet long, and 20 feet wide. A useful practice is to place a number of posts in the bottom to support the ice in winter. Once the ice has formed sufficiently thick to be supported by the posts some of the water is withdrawn and an air space left which prevents freezing to any great depth.

Lake sands occur around the margins of the former lake basins, and dune sands occupy a large area east of Brandon and smaller areas in other parts of the region. Shallow wells in these areas commonly find an abundance of good water, though in the well-drained areas near stream valleys the ground-water may lie at a considerable depth.

The sands and gravels of ancient beaches form good sources of ground-water at shallow depths. In many places the beaches have been selected as sites for farm homes, not only because the ground is usually a few feet above the plain on either side of the ridge and is well drained, but because of the good well water obtainable for home and stock. The beach deposits contain much coarse sand and fine gravel so that they are very porous; water passes freely down from the surface and laterally down the slope from the marshy ground usually found behind the ridge. Water passes downward to the stony clay underlying most of the ridges at depths of 6 or 8 feet to a maximum depth of about 40 feet and saturates the upper part of the clay and the gravel for a few feet above. The water is of good quality in most places, though hard because of the presence of bicarbonates of lime and magnesia dissolved from the gravel and sand, which contain much limestone and dolomite. Wells in these deposits are rarely over 50 feet deep and are usually dug or bored wells. Drive points are used in a few places and probably are the cheapest and most satisfactory type of well unless large supplies of water are needed, as they can be sunk quickly at slight cost and can be readily moved if necessary. The drive point should carry a screen to exclude the sand, especially if much fine sand is present. In gravel a perforated pipe may be used or a large perforated casing, without screens. By pumping until all the fine sand near the openings in the casing is removed a natural gravel screen is formed. Drive points with or without screens are most successful in the beach sand and gravel where much of the sand is fairly coarse. They are of little or no use in silt or clay or even in very fine sand, for screens sufficiently fine to exclude such materials will not let in the water freely. Water polluted at the surface is filtered and purified to some extent by passing through sand and gravel for even a few feet. In the coarse sand and gravel of the beaches there is less purification by natural filtration than in fine sand. Wells, therefore, on the beaches, and especially if they are shallow, should be placed some distance from barns and other sources of pollution.

A large area referred to by Upham as the Assiniboine delta of Glacial Lake Agassiz extends east from Brandon nearly to Portage la Prairie, north to Neepawa, and south to Treherne. A great part of the surface is dune sand, but along the central part near the valley of the Assiniboine there is a thickness in places of over 100 feet of sand and gravel below the dune sand. Near the river, where these deposits are well drained, the ground-water level lies at a considerable depth. The water in these deposits is of good quality and away from the stream valleys is found at shallow depths. Silt and clay underlie the surface sand over much of the delta area except along the Assiniboine, but the sand in most cases is sufficiently thick to carry water supplies. Springs issue at many places along the stream valleys and come from the base of the sand, at its contact with the underlying clay. A notable example is the series of large springs on the south bank of the Assiniboine a few miles below Brandon. Another area in which there is a considerable thickness of what appears to be delta sand and gravel is at Grand View and Gilbert Plains on Valley river flowing into lake Dauphin. Clay overlies the sand and gravel over much of the area, and flowing wells are obtained from the gravel below.

Boulder clay or till, the unstratified deposit of the ice-sheets, forms the surface material over much of the uplands region and the area between lakes Winnipeg and Manitoba. It ranges in thickness from a few feet to over 100 feet. In places there are two or more till sheets separated by sands and gravels, and the total thickness of the drift may be as much as 400 feet. There is a great thickness in the highland area in southeastern Manitoba along the line of the Canadian National railway from Sandilands to Carrick where wells over 300 feet deep do not reach the bedrock. The drift is 200 to 400 feet thick in the area a few miles west of Souris river and in the lowland along and a few miles east of the foot of the Manitoba escarpment from Gladstone to near Emerson. It is also very thick on Turtle, Riding, and Duck mountains. As much of the boulder clay is very clayey and nearly impervious, wells sunk entirely in it yield very little water. Sandy and gravelly beds forming lenses in the till or lying below it form the chief source of water from the drift and in places yield an abundant supply. In places, however, the boulder clay extends down to bedrock and no water is obtainable from the drift.

Outwash sands and gravels along the soutnwest sides of moraines, for example Tiger Hills moraine, form gently sloping plains in many places and as a rule contain good supplies of water at shallow depths. In places where the plains are deeply trenched by streams, as in the case of the large area near the junction of Assiniboine and Qu'Appelle rivers, the ground-water level in the gravel lies at a considerable depth.

Waters from the Bedrock

The term " bedrock " as used in this report refers to the rock formations that lie beneath and are older than the surface deposits consisting chiefly of glacial drift. Parts of the bedrock are fairly soft; the upper part of shale may be weathered to clay; unconsolidated sands, soft gypsum, and clay commonly occur beneath solid rock. A common expression in some parts of the district is that the drill passed through the bedrock, meaning that hard rock in place was passed through and a soft rock such as gypsum entered. Once the bedrock is reached, however, it continues downward. It is important in drilling for water to determine when the surface deposits have been passed through and the older rocks reached, as there is little chance in some areas of finding good water in the bedrock. It is not always easy to determine when the older rocks are reached as parts of the shale bedrock are clay that does not differ greatly from the boulder clay of the surface deposits. The boulder clay, however, is usually distinguished by the presence in it of small stones or pebbles of rocks that are foreign to the district and were transported by the ice-sheets. These do not occur in the rocks below the surface deposits.

Many wells draw their supplies from the bedrock. Many of the waters are under pressure and rise to the surface when tapped by the drill; others rise part way to the surface, the height depending upon the elevation of the ground and the amount of pressure. All the bedrock formations of the district consist of sedimentary beds, except the Precambrian granitic rocks that outcrop to the northeast and east of Winnipeg and underlie the younger sedimentary beds extending to the southwest. The succession of formations that overlie the Precambrian, from the youngest to the oldest, and their general character and distribution, are shown in the following table, after S. R. Kirk and R. T. D. Wickenden who have recently investigated the bedrock geology of the region.

Formation	*Character and Distribution*
Boissevain sandstone and Turtle Mountain beds (Tertiary)	Sandstone, shale, and thin seams of lignite underlie Turtle mountain. The base of the sandstone is at elevation of about 1,625 feet. The beds extend upward in Turtle mountain for 300 to 400 feet, the upper part being deeply buried beneath glacial drift. A similar sandstone with lignite underlies the Carnduff area at a depth of about 200 feet. It extends east to near Gainsborough, north to Fairlight, and west to the border of the sheet. It is the source of artesian water in the Carnduff area.

Formation	*Character and Distribution*
Pierre shale (Upper Cretaceous)	In part a hard, brittle, non-calcareous shale and in part a soft shale weathering to clay. It ranges in thickness from 400 to 500 feet and underlies the great part of the upland southwest of the Manitoba escarpment.
Pierre or Niobrara? shale (Upper Cretaceous)	Calcareous and carbonaceous shales 250 to 385 feet thick. Exposed in Pembina mountain and at places along the Manitoba escarpment.
Niobrara or Benton? shale and limestone (Upper Cretaceous)	Calcareous shale and limestone 70 feet thick. Exposed at places along the Manitoba escarpment.
Benton shale (Upper Cretaceous)	Dark grey, calcareous, and non-calcareous shale, 180 to 225 feet thick. Exposed in the north along the Manitoba escarpment.
Swan River beds (Dakota sandstone)	Quartz sandstone and fine to coarse sand, clay, and shale. Thickness ranges from a few feet to nearly 200 feet. Exposures occur only in the north in Swan River valley.
Lower Cretaceous and Jurassic shale	Variegated shales with a little sandstone at the top. Known only from well sections. Thickness ranges from 220 to 370 feet.
Upper Devonian?	Limestone, dolomite, gypsum, and red shale, 300 to 370 feet thick. Exposed in Lake Winnipegosis region. Little shale is present in the north. In the south the dolomite is largely replaced by shale.
Winnipegosan dolomite and Elm Point limestone (Devonian)	Dolomite with some limestone, red shale, and sandstone, at the base. Thickness in the north about 300 to 400 feet. Exposed at places in the Manitoba lowland.
Stonewall (Silurian)	Dolomite, gypsum, limestone, and red shale. Sandstone at the base. Thickness 230 to 500 feet. Exposed at places in the Manitoba lowland.
Stony Mountain (Ordovician)	Dolomite, limestone, and red shale with some sandstone in places in the lower part. Exposed in part at Stony mountain. Thickness about 100 to 120 feet.
Red River (Ordovician)	Light and dark mottled limestone with some cavernous and cherty limestone. Exposed on some islands in lake Winnipeg. Thickness about 300 to 475 feet.
Winnipeg sandstone and shale (Ordovician)	Green shale 50 to 100 feet thick and white sandstone 10 to 100 feet thick. Exposed in part on islands in lake Winnipeg.

The Winnipeg sandstone rests on the eroded surface of the Precambrian rocks. All the formations shown in the table dip towards the southwest at the rate of a few feet a mile, except in the southwest part of the sheet in the vicinity of Carnduff where the beds have a slight dip in the opposite direction. The elevation of the surface increases towards the southwest from about 750 feet at Winnipeg to over 2,000 feet in the southwestern and western parts of the sheet. There is an abrupt rise of 500 to 1,000 feet along the Manitoba escarpment, and the top of Turtle mountain is about 500 feet above the surrounding plain. The depth, therefore, to the Dakota sandstone or to any deeper sands is progressively greater towards the southwest. The depth to the Precambrian rocks at Winnipeg is about 600 feet. A boring in Pembina valley south of Manitou showed the depth to be 2,625 feet. At Winnipegosis the Precambrian rocks—outcrops of which occur along the east side of lake Winnipeg and at other places in the eastern part of the map-area—lie at a depth of 1,460 feet. In the western and southwestern parts of the area the depth may be as much as 4,000 feet.

Water horizons in the bedrocks include: the upper part of the Pierre shale where it is hard and brittle and not weathered to clay; the upper part of the limestone and dolomites, where these underlie the surface deposits in the Manitoba lowland; the Dakota sandstone; a sandstone at the base of the Stonewall series; a sandstone in the Stony Mountain formation; and the basal Winnipeg sandstone. Flowing wells from the Dakota sandstone have been obtained at Deloraine and at other places in Manitoba, but the water from the formation—an important source of artesian water in North Dakota and South Dakota—is saline. It is not, therefore, considered in this report. The other sources are described in the following section on artesian water areas.

ARTESIAN WATER AREAS

There are several areas in southern Manitoba and in southeastern Saskatchewan in which flowing water wells may be obtained by drilling. The water in these artesian basins is confined beneath impervious shale or clay and is under pressure from the head of water in the intake beds, which are at a higher elevation than that of the ground at the well sites, so that the water rises to the surface when tapped by the drill.

Carnduff Area

Artesian conditions in Carnduff area (Figure 2), in southeastern Saskatchewan, may be due to the fact that a highland area, Moose mountain, lies to the northwest of the artesian basin. The highland contains numerous lakes, some of which are drained by streams, and forms a good collecting ground for the rainfall, part of which may pass down into sandy lignite-bearing beds that are shown by borings to underlie both the highland and the artesian basin. That the source of the water is in Moose mountain is suggested by the fact that the water rises to higher elevations in the northwestern parts of the artesian basin in the direction of the supposed source than in the southern parts. It rises to 1,740 feet above the sea at Carnduff and about 1,900 feet in the northern part southeast of Redvers. The eastern limits of the basin appear to be determined by the extent of the sandstone in that direction; the sandstone is not found in well sections to the east. In the south the basin extends from a few miles west of Carnduff, east to near Gainsborough, and 3 to 5 miles south of Carnduff and Carievale. It appears to be limited on the south and southwest by distance from the source and the water pressure. On the west, the elevation of the ground is too high for the water to rise to the surface.

The artesian area is about 400 square miles in extent. Probably flowing wells can be obtained at nearly all places within the boundaries of the area as shown on Figure 2, but there may be places where, because of absence of the sand or lack of porosity of the material, little water is present and does not rise to the surface because of the small pressure. Logs of a number of wells in the basin show that the depth to the water sand ranges from 239 to 250 feet in the south near Carnduff and Carievale and from 420 to 485 feet in the north near Storthoaks and Alida. In some wells the water is in sand at the base of the surface deposits. In other wells it is in a soft sandstone or sand below a thin, lignite seam, or in the upper part of shaly beds.

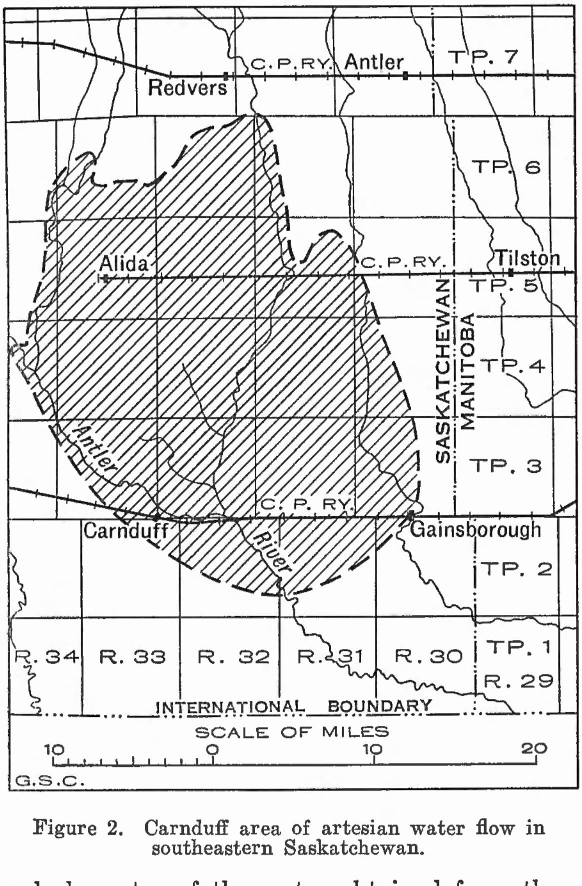

Figure 2. Carnduff area of artesian water flow in southeastern Saskatchewan.

The mineral character of the water obtained from the southern part of the basin is shown by the analysis of the water from the Carnduff Creamery well given in Table 12. The water is soft compared with most wells in the region and is unusual in character in that it is a sodium and magnesium carbonate water with some common salt and only traces of sulphates.

Red River Area

Flowing wells are obtained in an area (Figure 3) extending east of Red river to Bedford and Piney at the base of an abrupt rise to the highland in southeastern Manitoba; west of Red river to near Gretna and Lowe Farm; and north from the International Boundary to near Dufresne and Niverville; the total area being about 1,200 square miles. In the highland to the east of the artesian basin the surface deposits have a thickness in places of over 300 feet and are sandy in their upper parts. The rainfall entering these beds tends to flow underground in the lower part of the surface deposits and in the bedrock below, west and southwest in direction of the dip of the beds. As the water in its travel underground becomes

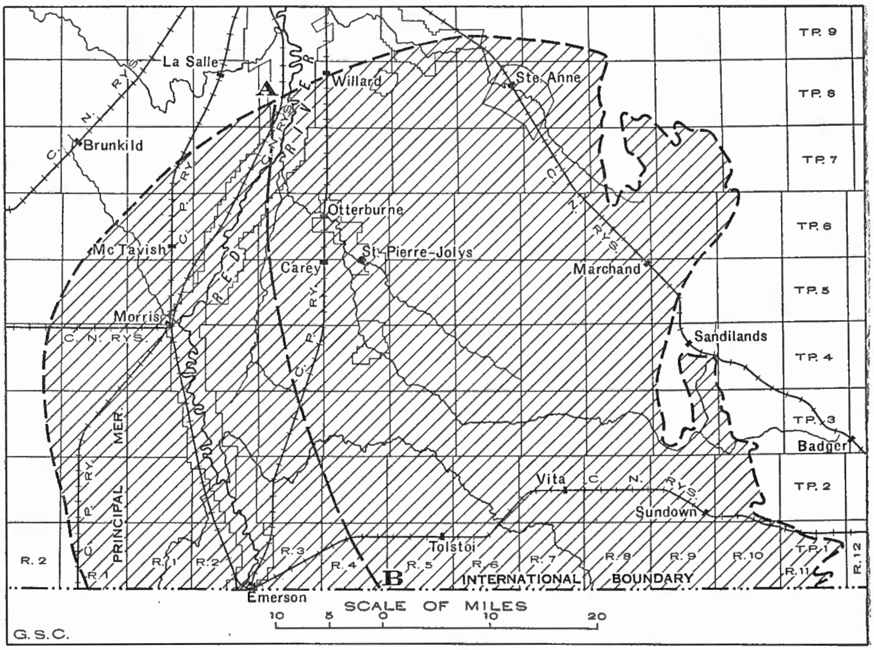

Figure 3. Red River area of artesian water flow in southern Manitoba. In the western part of the area, west of the line A-B, the water is saline; in the eastern part the water is fresh or only slightly saline.

confined beneath the impervious beds, and as the surface of the ground to the west is below the level of the highland area, where the water enters, artesian conditions are produced. Elevations in the highland range from 1,150 to 1,300 feet and from 775 to 800 feet in the plain bordering Red river. Lake clay in Red River valley forms an impervious capping; boulder clay below the lake clay and shale of the bedrock also forms confining beds for the water in various parts of the basin.

Source beds of the artesian water are numerous and lie at various depths. Two, or even more, water horizons may be found at one locality. At St. Pierre water is found in the lower sandy and gravelly part of the surface deposits, at a depth of about 150 feet, and in limestone or sandy beds below shale at a depth of 230 to 344 feet. At St. Malo the depth of the water horizon, which appears to be a sandstone in the Stony Mountain formation, is 455 feet and is the deepest found in any of the wells east of Red river. None of the wells appears to have reached the Winnipeg sandstone except at Arnaud where a sandstone was reached at 710 feet. Artesian water obtained at Piney in the extreme southeastern part of the basin, and at Steinbach in the northeastern part, comes from sandy beds in the surface deposits at depths of 75 to 100 feet. Near Emerson, Dominion City, and Lowe Farm in Red River valley the water also comes from the surface deposits, but at somewhat greater depths ranging from 150 to 200 feet.

Fresh water of good quality is found in the eastern part of the basin, east approximately of a line extending northwest from Ridgeville to Arnaud and Ste. Agathe. Only saline water is obtained in the western part, both in the lower part of the surface deposits and in the bedrock below. A deep well at Rosenfeld in the western part of the basin obtained a strong flow of brine from sandstone at a depth of 925 feet. There probably is an increase in salt content in the artesian water towards the west and southwest, as might be expected considering that the water in the west is progressively farther away from the source or intake beds and has no outlet other than well borings; salts dissolved from the rocks tend to accumulate in the water.

Artesian water at one or other of the several horizons is likely to be found at nearly all places within the basin. In the higher areas east of St. Malo and Ridgeville in the south, the water may not rise quite to the surface. In places only the deeper water in the bedrock is present; sands or gravels occur only locally in the lower part of the surface deposits, so that water is not everywhere found at this horizon. It probably is present in the bedrock throughout the basin, but bigger flows are obtained at some places than at others, possibly because of more favourable conditions, such as permeability of the rock that carries the water. Wells in the area have continued to flow for over twenty years. Casings in some of them, especially the deeper ones, are much corroded, but there has been little difficulty from sand coming in and plugging the wells.

The mineral character of the artesian water obtained at St. Pierre is shown by the analyses (Table 12): one (No. 2) of the water that comes from sand and gravel at the base of the surface deposits at a depth of 153 feet; and the other (No. 1) of the water that comes from the bedrock at a depth of about 300 feet. The latter is remarkably soft water for the general region. It has only one-tenth of the hardness of the shallower water which differs from it in containing a large amount of calcium and magnesium sulphates. Nearly all the wells in the vicinity of St. Pierre, the best known of which, and one of the first to be put down, is the Prefontaine well, are of the soft water type. At St. Malo, where the water comes from a lower horizon than at St. Pierre, some flocculent iron oxide comes with the water and forms a deposit around the well mouth. Shallow water from the surface deposits at Piney, where there is little limestone in these deposits, is fairly soft. In the vicinity of Steinbach where there is considerable limestone in the surface deposits the shallow water is hard.

Over the great part of the basin the water from the surface deposits is likely to be hard and that from the bedrock considerably softer, though it may be somewhat saline, particularly along the borders of the known saline area in the west as shown by wells at Dominion City, Arnaud, and Ste. Agathe.

Winnipeg Area

Water for the city of Winnipeg was formerly obtained from a series of wells in and north of the city. Since 1917 water has been obtained from Shoal lake on the boundary between Manitoba and Ontario by means of a buried concrete pipe-line 97 miles long. The water flows by gravity, the lake being about 300 feet above the ground level at Winnipeg, and is fairly soft owing to the fact that the lake is surrounded by Precambrian rocks that contain little limestone. As the lake region is only sparsely settled, there is little or no danger of pollution of the water and as the lake has a large overflow into Lake of the Woods there is an abundant supply. Analyses of the water show that the salts in solution average only 130 parts in a million and that the water has a temporary hardness of 90 parts in a million with no permanent hardness. The water, therefore, is of very good quality.

Flowing wells were obtained in the early days in the northwestern part of the city of Winnipeg in an area about 1½ miles long from north to south and about ¼ mile wide. In 1894, according to an old plan by the city engineer, there were about a dozen flowing wells in this area. The water rose 1 to 4 feet above the surface of the ground and rose highest in the northern part of the artesian basin. The level at which the water stood declined towards the south and east. In wells along Red river about a mile to the east the water stood 10 to 20 feet below the prairie level. Along the Assiniboine ½ mile to the south of the basin, the water level also stood at about the same depths below the surface. Saline water was found on the south side of the Assiniboine. The height to which the water rose, both in the area of artesian flow and to the south and east, varied somewhat from place to place, but there was a fairly regular rise towards the north. In 1914, after a number of years during which heavy pumping had been resorted to in order to supply the growing city with water, the level of the water was lowered considerably. A series of twenty-nine wells was put down in the northwestern part of the city, at ½-mile intervals along a line extending north for 8¼ miles to a point about 3½ miles east of Stony Mountain. The water level in these wells was nearly at the surface in the north and declined towards the south to about 40 feet below the surface in the most southerly wells near where flowing wells had formerly been obtained. After disuse of the water, except locally for a number of years, the water level gradually rose. In 1929 there were a few flowing wells in the northern part of the basin in the vicinity of Stony Mountain and one well about 4 miles to the south had a slight flow. It is evident that continued use of the water on a large scale would have exhausted the supply and it is probable that, under present conditions of limited use of the water, or even with the addition of a number of wells for local use, the pressure in a few years will be very largely restored. The number of new wells that can be put down without materially reducing the pressure probably can only be determined by observations on the effects of new wells on older producing wells, as there appears to be no way of estimating the volume of the source water.

Water is found in the wells at various depths from 15 or 20 feet to about 150 feet, in gravel at the base of the surface deposits or just above the bedrock, and in the bedrock below. The depth to bedrock in the northern part of the basin east of Stony Mountain is 15 to 20 feet; in the southern part in the city of Winnipeg it is 40 to 60 feet. The rock surface is much more uneven than that of the prairie; within the basin it has a relief of about 50 feet, whereas the ground level varies only about 12 feet in the stretch of 9 miles from north to south and $\frac{1}{4}$ mile from east to west. In the wells stratified clay, a few feet up to about 45 feet thick, is passed through first. This clay and the hardpan (boulder clay) below form the impervious cover that retains the water under pressure. The boulder clay ranges in thickness from a foot or so to about 20 feet and is underlain by a small thickness of gravel and boulders resting on broken or solid bedrock. Water is usually found in this layer, but the largest supply comes from fissures and channels in the bedrock that are probably due to solution of the limestone by circulating ground-waters. Below about 150 feet no water is found until the Winnipeg sandstone is reached at a depth of about 600 feet. It yields saline water but only small supplies are reported in the few wells put down to this horizon. The temperature of the artesian water is close to 40 degrees Fahrenheit. It is of value, therefore, for cooling purposes. Some of the wells yielded much more than others, probably owing to the occurrence of fissures and cavities in the bedrock in which the underground water flow is concentrated; some of the wells find these openings whereas others do not. Some of the best wells, which were 12 inches to 14 inches in diameter, were reported to yield upwards of 800,000 gallons a day, but others yielded only small supplies.

The source of the artesian water probably is the rainfall that descends into the ground on the upland of Stony mountain and other areas to the north and west, such as Stonewall, that rise above the general prairie level. In these areas the bedrock is exposed in places and is well jointed so that the rainfall readily enters. That the source is to the north or northwest towards Stony mountain is suggested by the fact that the height to which the water rises gradually increases towards the north. The extent of the areas over which the rainfall enters the ground to form the source water is not definitely known, so that, even if the proportion of the rainfall that enters the ground could be determined, it would be difficult to estimate the volume of water that enters the artesian basin or the amount that could be withdrawn from the wells in the basin without depleting the supply.

The water from the Winnipeg artesian basin is of good quality, but is very hard owing to the fact that it comes from a limestone reservoir.

Lake Winnipeg Area

Flowing wells are obtained at many places in a narrow strip along the west side of lake Winnipeg from near the southern end to Riverton, a distance of about 45 miles, and in the valley of Icelandic river from Riverton to Arborg. The water in the wells at Arborg rises to an elevation of nearly 745 feet above the sea. It is 727 feet at Riverton, 740 feet at Hnausa, and 725 to 730 feet at places along the lake shore to the south. The elevation of lake Winnipeg at an average stage of water is 715 feet. As the water in wells in the strip along the lake shore rises only 10 to 25 feet above the lake level and the shore rises abruptly in places the strip is only a mile or so wide at the most. It is somewhat wider in the north than in the south. A simple way of determining whether a proposed well in the area is likely to flow is to measure the height of the ground at the well above the lake. If the ground at places in the southern part of the area, say south of Winnipeg beach, is not over 10 or 12 feet above the lake and is not over 25 feet in the vicinity of Hnausa in the north, the well is likely to flow. At intermediate points the height is roughly proportional to the distance from the southern end of the strip. It increases from about 10 feet in the south to 25 feet near Hnausa in the north and decreases again towards the north from Hnausa to Riverton. Up the valley of Icelandic river the height increases from 12 feet at the mouth to about 30 feet at Arborg.

A number of wells at Riverton and at other places in the artesian area are reported to have been flowing for over twenty years. In 1929 six wells at Riverton were flowing at rates of 600 to 3,600 gallons an hour, the largest flow being from the well at the section house. The flow was said to be less than in previous years. There was also a large flow from a well on the lake shore near Hnausa. A well at Arborg is said to have ceased flowing in 1929, the summer having been an exceptionally dry one. It seems probable that in time other wells in the artesian area will cease to flow, especially if many new wells are put down, unless the flow is controlled and limited to a small amount instead of the wells being allowed to flow freely throughout the year. That an artesian area will cease to yield flowing water if there is much waste or if the amount of water used exceeds a certain limit is well established in the case of the well-known Dakota artesian basin[1], one of the largest in North America, and is evident in the case of the small Winnipeg area. To limit the flow in many artesian areas, reducers are commonly used. These permit the uniform flow of a small quantity of water, sufficient to prevent freezing in winter, and are of such character that they can easily be removed with a wrench so as to permit free flow of the water in case clogging of the pipe by sediment occurs. Valves placed below the frost line and operated from the surface by an attachment are also used, but in some cases are less satisfactory than the reducers, as the turning on and off of the water abruptly is likely to cause inflow of sediment along with the water and consequent plugging of the well. There is a popular belief that the wells must be allowed to flow freely in order to prevent "sanding up" of the well, but it seems probable that a controlled small flow would be equally effective.

Most of the wells in the area are shallow. Water is obtained in gravel and sand at the base of the surface deposits or in the upper part of the limestone bedrock below the surface deposits. The wells at Riverton are reported to be 80 to 90 feet deep and to have open casings without screens to the bottom. At Hnausa the wells are 80 to 100 feet deep. Wells in the

[1] Simpson, H. E.: "Geology and Ground-Water Resources of North Dakota"; U.S. Geol. Surv., Water-Supply Paper 598, p. 58 (1929).

area to the south average about 80 feet in depth. One well at Arborg is said to be 226 feet deep, the surface deposits extending to 72 feet. In other wells at Arborg the surface deposits are only about 50 feet thick. In all the wells, clay, in part stratified and in part unstratified and stony, forms the bulk of the surface deposits that are passed through in drilling. It forms the impervious capping that retains the water under pressure and ranges in thickness from a few feet to nearly 100 feet. The source of the water probably is the rainfall that descends into the ground to the west in the central parts of the area between lakes Winnipeg and Manitoba. There the general elevation of the ground is 175 to 200 feet above lake Winnipeg, and well-jointed limestone or dolomite bedrock is at or near the surface in many places so that much of the rainfall readily seeps into the ground. The water that seeps into the ground tends to flow down the slope towards lake Winnipeg. A popular belief is that the water comes from lake Manitoba which is 100 feet above lake Winnipeg. There are no good grounds for this belief, however, as deposits of mud and clay in the basin of lake Manitoba probably make it water-tight. Moreover, the water in many of the wells in the area to the east of lake Manitoba and west of the divide between the two lakes rises above the level of lake Manitoba, indicating that the source of the water is in the highland between the lakes. Only a few of the wells on the western slope actually flow. The inter-lake area that forms the feeding ground for the water of the Lake Winnipeg artesian basin is of large extent and this indicates an abundant source of supply, except possibly during or immediately following a series of exceptionally dry years such as 1929 to 1931. The water has a temperature of 40 to 42 degrees Fahrenheit, is of good quality, and only moderately hard. The mineral character of the water from a flowing well at Hnausa is shown by analysis No. 9 (Table 12). Water from other parts of the artesian basin probably is nearly similar in character.

Other Artesian Areas

Flowing wells may be obtained in a narrow strip along the west side of lake Manitoba from near the southern end to Kinosota in the north. There conditions are much the same as in the area along the west side of lake Winnipeg. The strip is narrow, as in the case of Lake Winnipeg area, and the water rises in the wells to only a few feet above the level of lake Manitoba. Only a few wells have been put down so that the exact height to which the water will rise in wells in different parts of the area is not definitely known. In the south the height is about 5 or 6 feet above the lake level. It is about 10 or 12 feet in the vicinity of Kinosota in the north. The water is found in sand and gravel below clay at depths of 25 to 80 feet, and in the bedrock below at various depths up to about 125 feet.

In the vicinity of Gladstone and Westbourne a few flowing wells have been obtained, but the water is saline and unfit for use. It is found in sand below clay and in the bedrock below at depths of 150 to 230 feet.

Flowing wells are obtained in the vicinity of Ste. Rose du Lac and in the stretch of lower ground extending northwest to lake Dauphin. The area includes the northwestern part of the township in which Ste. Rose du

Lac is situated, and the marshy ground around the southern end of lake Dauphin. The water is found in limestone or dolomite below shale at a depth of about 100 feet and is a little salty.

An area along the west side of lake Dauphin has yielded a few flowing wells. The area is only 1 or 2 miles wide. Water is obtained in sand and gravel below clay at a depth of about 80 feet. Flowing wells are also obtained some 35 miles west of lake Dauphin in the vicinity of Grand View where thick deposits of glacial drift fill the valley of Valley river. Water is found in sand and gravel below clay at depths reported to be 200 to over 300 feet. A few flowing wells have been obtained in the vicinity of Fork River. The water comes from sandy beds below the surface clay and rises to the surface at places where the ground has an elevation only slightly above the high water level of Fork river. In the vicinity of Winnipegosis flowing wells are obtained, but as a rule the water is saline.

DESCRIPTION OF WATER CONDITIONS WITHIN AREAS OF THE SECTIONAL SHEETS

In the following, the underground water resources of the Winnipeg map-area are described separately by areas covered by the Sectional Sheets of the Dominion Lands surveys. Eleven of these sheets, each embracing an area of nearly 4,650 square miles, include practically all parts of the Winnipeg map-area in which the water resources have been investigated. The sheets are numbered from west to east beginning at the south. Each includes eight townships from north to south and fourteen ranges and a fraction from east to west. Townships are numbered north from the International Boundary and ranges east and west from the principal meridian, about 14 miles west from the city of Winnipeg.

Tables accompany the description of ground-water conditions in each sheet and give data regarding the principal wells. They give to the well driller and to those who are desirous of obtaining supplies of well water, information as to the depth at which water is likely to be found and the character of the water. They also show that in some areas no usable water is likely to be found by drilling. Most of the well records were supplied by the Provincial Government who obtained them from the drillers when well drilling was being carried on a number of years ago by the Government. As the records are not complete, there are areas regarding which little or no information is available.

Terms used by the drillers in describing the formations passed through and the character of the water appear in the tables and in the drillers' logs. They are used by the drillers in somewhat different ways. Hardpan usually refers to stony clay or boulder clay, but some of the drillers restrict its use to the lower, older, boulder clay that is much harder and more difficult to drill than is the upper, stony clay. Rubber clay may refer to tough clay layers in shale. These are shown in the shale quarry a few miles north of Deloraine. They are difficult to penetrate with the drill as it bounces off the clay instead of cutting it; hence the name. This difficulty is overcome by putting broken glass or hard rocks in the hole. In many cases the driller is unable to determine when the bedrock is reached as the upper, weathered part is clay that gradually passes down into shale. The term "red clay" may refer to the weathered, upper part of the bedrock, or to parts of the bedrock interbedded with hard layers. White rock and marl in some cases may refer to gypsum. In many cases the limestone bedrock is described by the drillers simply as rock. In their description of the character of the water, good water means that it is usable and contains only small or moderate amounts of salts; alkaline water means that it contains, in fairly large amounts, a variety of common salts; salty water has a salty taste and contains much common salt (sodium chloride) in solution.

TURTLE MOUNTAIN SHEET (NO. 21)

This sheet includes a part of the upland Turtle mountain in the southeast, a more gently sloping upland in the northwest, and a broad plain in the central part drained to the northeast by Souris river and its branches. Souris river flows south in a deep valley in the southwest corner of the sheet, makes a great loop to the south in North Dakota, and then continues northeast through the central lowest part of a broad plain in Manitoba to join the Assiniboine. Its chief tributary, Antler creek, occupies a deep valley for a few miles above where it joins the Souris, and, in the upper part, a broad shallow valley.

Surface deposits consisting of sand, gravel, boulder clay, and stratified lake clay cover the bedrock over nearly all the area and are very thick in places. On Turtle mountain they probably average at least 200 feet in thickness. Well records show that they are 300 to 420 feet thick in the vicinity of Antler and Bellegrade in the northwestern part of the central plain. Dune sands occupy the surface in the central part of the Lake Souris basin over a large area northwest of Hartney and in the vicinity of Oak Lake, and a small thickness overlies stratified clay in other parts of the lake basin, but over most of the basin stratified clay forms the surface materials and has considerable thickness. Outside of the lake basin, boulder clay is at the surface except for an area of stratified, heavy clay surrounding Whitewater lake and a number of small areas of sand and gravel.

Springs occur at many places around the base of Turtle mountain and the streams coming from this upland carry good, fresh water, but the supply is small and the streams may fail entirely in exceptionally dry seasons. Good water, though possibly coloured by organic matter, is obtained in wells drilled into the sandstone and lignite that underlie the surface deposits around the base of Turtle mountain. In the heavy clay area around Whitewater lake and in the vicinity of Deloraine good water is difficult to obtain, but is found at shallow depths in the sand and gravel beach deposits around the margin of the clay basin. A deep well at Deloraine showed only saline water at depth. The water came from the Dakota artesian basin and overflowed at the surface. Most of the wells at Boissevain and in the vicinity are shallow, and the water contains a fairly high percentage of salts; a few wells obtain fairly good water in gravel at depths of 30 to 40 feet. A deep well drilled in the shale bedrock was dry. Better water is obtained in sandstone in the area to the south of Boissevain. To the north, in the vicinity of Minto and Bunclody and in the area north of Whitewater lake, good water is obtained in many places in sand and gravel at the base of the surface deposits or in the upper part of the shale below. In places the boulder clay is tight on the bedrock and little or no water is obtainable.

In the vicinity of Waskada and along Souris valley from the International Boundary north to Melita, water is obtained at the base of the surface deposits and in the upper part of the shale below, and in many places small flows of natural gas come with the water. The gas affects the taste of the water to some extent but has no marked odour. In these areas shallow wells that do not extend down to the natural gas horizon yield better water, but these are obtainable only in places where sand and gravel occur near the surface. At Melita, for example, the town supply is derived from a large, shallow well in sand and gravel.

In the sandy areas northwest of Hartney and extending northwest to Pipestone and Oak Lake, good water is obtained at shallow depths in the sand or at the contact of the sand and stratified clay below.

In the western part of the sheet, flowing wells are obtained in the Carnduff artesian area (page 13). Outside of this area and over most of the western half of the sheet, water under pressure sufficient to cause it to rise part way to the surface, when reached by the drill, occurs in the lower part of the surface deposits or in the bedrock below at depths that vary from place to place, and range from about 200 feet to 450 feet. Shallow wells yielding fair supplies of water are obtained in the sandy and gravelly areas, which, however, are not very extensive.

TABLE 1

Wells of Turtle Mountain Sheet (No. 21), Tps. 1 to 8, Ranges 20 to 34, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
23	3	XX	W.P.M.	Boissevain	262	64	Dry		Shale below 64 feet
24	3	"	"	"	37		16	Good	Water at 37 feet in gravel
24	3	"	"	"	141	56	25		Water at 50 feet in gravel
24	3	"	"	"	50				Abandoned
SE. ¼ 28	3	"	"	"	132	65	Dry		
34	3	"	"	"	52		42	Bad	Water at 52 feet in sand and gravel
34	3	"	"	"	170	67	28	Good	Water in shale
20	4	"	"	Alcester	111		Dry		
20	4	"	"	"	144		34		Water at 144 feet in sand that comes with water
20	4	"	"	"	105		34		
12	5	"	"	Minto	95		15	Good	Water in sand
13	5	"	"	"	96		Dry		
15	5	"	"	"	175	160	25	Good	Water in shale
13	5	"	"	"	146	143	26	Good	Water in shale
15	5	"	"	"	120		Dry		
13	5	"	"	"	129		14	Good	Water in gravel
15	5	"	"	"	149	130	19	Good	Water in shale
SW. ¼ 12	7	"	"	Bunclody	90	At surface	45		
SW. ¼ 23	7	"	"	Beverley	98	85	30		Water at 98 feet in shale
25	7	"	"	"	76		36	Good	Water at 76 feet in sand
NE. ¼ 28	7	"	"	Acorn	190	155	50		Water at 190 feet in shale
SE. ¼ 10	8	"	"	Hebron	90		35	Good	Water at 90 feet in quicksand
SE. ¼ 10	8	"	"	"	155		Dry		Water shut off by quicksand
NW. ¼ 15	8	"	"	"	125	100	35		Water at 10 feet in shale
28	8	"	"	Hayfield	75	65	15	Good	Water in shale
30	6	XXI	"	Souris	154	95	60	Very salty	Water at 154 feet in shale
12	7	"	"	"	76	42	16	Good	Water at 76 feet in shale
14	7	"	"	"	48		12	Good	Water in sand and gravel
33	7	"	"	"	137		5	Good	Water at 137 feet in sand and gravel
33	7	"	"	Plum Creek	10–30				
32	3	XXII	"	Naples	93	62	20	Good	Water at 93 feet in shale
18	4	"	"	Dand	80		45	Good	Water at 80 feet in sand and gravel
NE. ¼ 34	5	"	"	Underhill	420	80	Dry		
NE. ¼ 36	5	"	"	"	570	30	"		
NE. ¼ 36	5	"	"	"	550	25	"		

	5	6	"	"	"	230	95	Dry		
	26	7	"	"	Schwitzer Jct.	116	64	16	Good	Water at 116 feet in shale
	18	1	XXIII	"	Deloraine	43				Coal at 43 feet
	24	2	"	"	"	47				Coal at 47 feet
	10	3	"	"	"	1,943	94	Flows	Saline	Water at 1,835 feet in "Dakota" sand
	14	5	"	"	Argue	77	37	20	Good	Water at 77 feet
	32	5	"	"	"	194	129	Dry		
	12	1	XXIV	"		73½				Coal
	12	1	"	"		73½				Coal at 73 feet
	12	1	"	"	Goodlands	177	114		?	Coal at 179 feet
	13	1	"	"	"	87	82		?	Water; coal at 87 feet
	24	1	"	"	"	54	50		?	? coal at 54 feet lignite at 60 feet
	3	2	"	"	"					
	25	2	"	"	"	94	41	Dry		
	25	2	"	"	"	70	58	Dry		
	25	2	"	"	"	69	38	Dry		
NE. ¼	6	3	"	"	Medora	79			Salty	Water in shale
SE. ¼	19	3	"	"	"	35		12	Good	Water at 26 feet in gravel
NE. ¼	19	3	"	"	"	271	156	Dry		
SW. ¼	19	3	"	"	"	269	145			Gas at 241 feet in shale
NE. ¼	19	3	"	"	"	170	160	Dry		Small supply of water at 30 feet
SW. ¼	28	3	"	"	"	100	45	35	Fairly good	Water at 96 feet in shale
SE. ¼	31	3	"	"	"	229		Dry		
SE. ¼	31	3	"	"	"	182		Dry		
SE. ¼	31	3	"	"	"	231		180	Good	Water at 223 feet in sand and gravel
	32	3	"	"	"	156	124	Dry		
	32	3	"	"	"	302	126	Dry		
SW. ¼	15	1	XXV	"	Waskada	140	85	Dry		
NW. ¼	15	1	"	"	"	231	80	Dry		
NW. ¼	20	1	"	"	"	95		Dry		
NW. ¼	20	1	"	"	"	140	85	30	Good	Water at 90 feet in shale
	29	1	"	"	"	96		57	Good	Water at 96 feet in sand and gravel
	29	1	"	"	"	70		Dry		
NE. ¼	29	1	"	"	"	100		15	Bitter	Water at 28 feet
SW. ¼	31	1	"	"	"	130	80	10	Good	Water at 80 feet, small supply
	31	1	"	"	"	95	64?		Used for stock	
	6	2	"	"	At Waskada	232	78?	Dry		Soft shale 78 to 138 feet and hard shale below
	6	2	"	"	"	300	126?	Dry		
	6	2	"	"	"	127	65?	Dry		
	8	2	"	"	"	180	91			Some gas
NE. ¼	1	3	"	"	"	114	56	12	Good	Water at 90 feet
	4	3	"	"	"	205	78	75	Saline	Water at 205 feet in sandy shale
NW. ¼	11	3	"	"	"	123	98	25	Saline	Water at 115 feet in shale
NW. ¼	11	3	"	"	"	115	100?	30	Good	Water at 112 feet in black sand

TABLE 1 (Cont'd.)

Wells of Turtle Mountain Sheet (No. 21), Tps. 1 to 8, Ranges 20 to 34, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
NW. ¼ 12	3	XXV	W.P.M.	At Waskada	48		7	Good	Water at 45 feet in sand
13	3	"	"	"	113		Dry		
13	3	"	"	"	155	100	Dry		
NE. ¼ 19	3	"	"	"	85	40?	22	Good	Water at 85 feet
NE. ¼ 20	3	"	"	"	60	40?	7	Good	Water at 60 feet
20	3	"	"	"	95		18	Salty	Water at 93 feet in gravel
20	3	"	"	"	16			First class	Water
SW. ¼ 31	3	"	"	"	100	30?	15	Good	Water at 100 feet
24	1	"	"	"	80	75	22		Water at 80 feet
NE. ¼ 29	1	XXVI	"	Dalny	370	95	Dry		
31	1	"	"	"	398	95	Dry		
31	1	"	"	"	135	80	100		A little water at 135 feet
34	1	"	"	"	114	69	Dry		
34	1	"	"	"	70	60	Dry		
34	1	"	"	"	42		33	Mineral	
4	2	"	"	"	325	54			
10	2	"	"	"	72		20	Good	Water at 72 feet in sand rock
24	2	"	"	"	60	50	40	Salty	Water at 60 feet
34	2	"	"	"	77	40	Dry		
34	2	"	"	"	58	44	Dry		
34	2	"	"	"	46	40	Dry		
35	2	"	"	"	215	35	140	Salty	A little salty water at 215 feet
10	3	"	"	"	40	34	18	Good	Water at 40 feet in shale
7	1	XXVII	"	Coulter	340	130?			
7	1	"	"	"	142	125?		Good	Water at 120 feet in gravel
SW. ¼ 10	2	"	"	"	235	60			Gas at 150 and 212 feet in shale
25	3	"	"	Melita	95	95	35	Good	Water at 95 feet in shale
NW. ¼ 36	3	"	"	"	70			Good	Water at 20 feet
1	4	"	"	"	127	114	Dry		
1	4	"	"	"	159	159+	Dry		
1	4	"	"	"	141	135		Good	Water at 141 feet
28	4	"	"	"	103		50	Good	Water at 103 feet in sand
SW. ¼ 18	5	"	"	Broomhill	265	210?	Dry		
SE. ¼ 20	7	"	"	Reston	250		Dry		
NW. ¼ 20	7	"	"	"	300	285	30	Salty	Water at 300 feet in shale
20	7	"	"	"	185				

NE. ¼	23	7	"	"	"	40				
NE. ¼	23	7	"	"	"	200				
NE. ¼	26	7	"	"	"	55		18	Good	Water at 50 feet in sand
NE. ¼	26	7	"	"	"	225		20	Salty	Water at 225 feet
NE. ¼	26	7	"	"	"	210	210	Dry		
SW. ¼	34	7	"	"	"	162		39	A little saline	Water at 162 feet in sand
NW. ¼	36	7	"	"	"	208	208	8	?	Water at 208 feet
	36	7	"	"	"	215	215+			
	1	8	"	"	Manda	278		Dry		
	12	8	"	"	"	252		Dry		
	24	8	"	"	"	27				
	24	8	"	"	"	185		25	Good	Water at 185 feet
	24	8	"	"	"	164		Dry		
	25	8	"	"	"	191		41	Good	Water at 190 feet
SW. ¼	13	5	XXVIII	"	Broomhill	185	185+	20	Very fair	Water at 185 feet in gravel
NW. ¼	3	7	"	"	Reston	265		Dry		
NW. ¼	3	7	"	"	"	320		Dry		
NW. ¼	3	7	"	"	"	200			Good	Water at 165 feet in sand
NE. ¼	23	7	"	"	"	385	290	12		Water
NE. ¼	23	7	"	"	"	100		50	Good	Water at 100 feet in gravel
NE. ¼	9	8	"	"	Ewart	315	305			Water
NE. ¼	9	8	"	"	"	335	290		Salty	Water at 335 feet in shale
	14	8	"	"	"	108		Dry		
	12	1	XXIX	"		73½				Coal
	1	3	"	"	Pierson	65		18	Good	Water at 65 feet in sand
	22	5	"	"	Tilston	220		45		Water at 153 feet in sand
	22	5	"	"	"	164				Water at 164 feet in quicksand, small supply
	13	7	"	"	Sinclair	396		20	Salty	Water, small supply
	28	8	"	"	Ewart	18		10	Good	
	28	8	"	"	"	20		10	Good	
	5	3	XXX	"	Gainsborough	289	289+	Flows	Soft	Water at 285 feet in sand
	5	3	"	"	"	301	300	Flows	Hard	Water at 301 feet in sandy shale
	7	3	"	"	"	312	312+	Flows	Soft	Water at 300 feet in sand and gravel
	16	6	"	"	Bellegarde	212		8	Hard	Water in coarse gravel
	28	6	"	"	"	420	420+			Water in sand and gravel
	28	6	"	"	"	690	410	Dry		
	14	7	"	"	Antler	100		Dry		
	14	7	"	"	"	10				
	17	7	"	"	"	440		Dry		
	20	7	"	"	"	22		17		
	20	7	"	"	"	87		Dry		
	21	7	"	"	"	277		Dry		
		7	"	"	"	235		Dry		
		7	"	"	"	505	290	Dry		
		7	"	"	"	320		Dry		
		7	"	"	"	155		Dry		Water at 155 feet, later failed

TABLE 1 (Cont'd.)

Wells of Turtle Mountain Sheet (No. 21), Tps. 1 to 8, Ranges 20 to 34, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
19	1	XXXI	W.P.M.	Elmore	286	....	....	Soft	
30	2	"	"	Carievale	251	....	Flows	....	Water
27	2	"	"	"	239	....	Flows	Medium hard	Water at 239 feet in fine sand
33	2	"	"	"	463	290	Flows	Salty and soft	Water at 460 feet in shale
32	2	"	"	"	260	260	Flows	Hard	Water at 252 feet in gravel
	2	"	"	"	248	....	Flows	Hard	Water
1	3	"	"	"	420	....	40	Hard	
1	3	"	"	"	520	....	Dry	....	
8	3	"	"	"	270	....	Flows	Hard	Water at 250 feet in sand and gravel
29	3	"	"	Audrey	440	....	Flows	Salty, soft	Water at 420 feet in shale
17	4	"	"	Storthoaks	520	....	Flows	Salty, soft	
9	5	"	"	"	440	....	Flows	Salty, soft	
27	5	"	"	"	490	350	Dry	....	
34	5	"	"	"	464	345	10	Medium hard	Water at 425 feet in sand
16	5	"	"	....	151	....	Dry	....	
14	7	"	"	Frys	10–20	....	....	....	
SW. ¼ 2	2	XXXII	"	Workman	338	225	28	Soft	Water at 325 feet in coarse sand
7	2	"	"	Carnduff	300	....	....	....	
13	2	"	"	"	320	....	....	Soft, salty	
SE. ¼ 25	2	"	"	Carievale	273	190	Flows	Soft	Water at 263 feet in coarse sand
2	3	"	"	Carnduff	344	240	30	Soft	Water at 335 feet in shale
SE. ¼ 7	3	"	"	"	270	210	Flows	Soft	Water at 270 feet in coarse sand, yield 10 gallons a minute
6	3	"	"	"	275	206	Flows	....	
11	3	"	"	"	287	....	Flows	....	Water at 280 feet in sand and gravel
20	6	"	"	Redvers	145	145	25	Hard	Water at 135 feet in gravel
29	6	"	"	"	496	340	Flows	Soft	Water at 480 feet in shale
13	7	"	"	"	475	....	25	Soft	Water at 260 feet in quicksand and 460 feet in shale
3	8	"	"	"	280	....	....	....	
NW. ¼ 8	1	XXXIII	"	Goschen	325	270	60	Soft	Water at 313 feet in sand, yield 3½ gallons a minute
SW. ¼ 36	1	"	"	Workman	438	260	50	Salty	Water at 432 feet in sand, yield 2 gallons
13	3	"	"	Carnduff	275	....	Flows	....	
32	3	"	"	"	376	245	30	Soft	Water at 365 feet in shale

	4	4	"	"	Oakley...	....	382	245	Flows	Soft...........	Water at 370 feet in black sand
	28	4	"	"	" ...	....	....	....	....	....	
	16	5	"	"	Alida.....	....	90	....	Dry	....	
	16	5	"	"	"	....	385	....	Dry	....	
	16	5	"	"	"	....	186	182	Dry	....	
	1	6	"	"	"	....	474	350	Flows	Soft...........	Water at 465 feet in shale
SW. ¼	16	6	"	"	"	....	493	342	Flows	Salty, soft......	Water at 485 feet in shale
SE. ¼	21	7	"	"	Wauchope	....	488	....	Dry	....	
	22	7	"	"	"	....	16	....	6	....	
	26	7	"	"	"	....	210	....	Dry	....	
	26	7	"	"	"	....	80	....	Dry	....	
	26	7	"	"	"	....	85	....	....	....	Small supply
SE. ¼	35	7	"	"	"	....	8	....	....	Hard..........	
		7	"	"	"	....	232	....	....	Salty..........	Water, unfit for stock
	32	8	"	"	Parkman.	....	438	....	Dry	....	
NW. ¼	10	2	XXXIV	"	GlenEwen	....	297	230	....	Soft..........	Water at 297 feet in sand
SW. ¼	15	2	"	"	"	....	311	215	80	Salty..........	Water at 305 to 311 feet in sand
	34	2	"	"	"	....	220	....	....	Good..........	Water

DUFFERIN SHEET (NO. 22)

In the eastern part of the sheet there is an abrupt rise known as Pembina mountains, and extending from Treherne to near Morden. It forms the southwestern boundary of a lowland plain that slopes gently to the northeast and is part of the Manitoba lowland floored with ancient lake sands and clays. North and west of Treherne, in the broad valley of Assiniboine river, there are extensive areas of nearly level land formed from ancient lake clays and sands, and large tracts of sandhills in the Spruce Woods Forest Reserve. Pembina mountains and Tiger hills, extending west along the south side of Assiniboine valley, are hilly tracts formed by irregular deposition of glacial drift on an upland in which the bedrock stands at a higher level than in the lowland to the northeast and in Assiniboine valley. The part of the upland to the southwest has less relief, but is rolling in contrast to the plain-like surface of the lowland in the northeast part of the sheet. In the southwest corner of the sheet a part of Turtle mountain forms a second, higher upland and has a marked, uneven surface due to irregular deposition of glacial drift on the bedrock. Glacial till or boulder clay forms the surface deposit over most of the upland part of the sheet. Sand and gravel areas occur in places along the southwest sides of the hilly belts, and alluvium fills the bottom of Pembina valley and some of its tributaries, in some places to a considerable depth. Sandstone and shale underlie the surface deposits on Turtle mountain, and shale forms the bedrock over the great part of the rest of the sheet.

Usable well water, though generally slightly saline, is obtained in most places at shallow depths in the lowland plain in the northeastern part of the sheet and is most abundant in the sandy areas. Numerous deep borings have shown the presence of saline water at depth, though at some places water is found in gravel at the base of the surface deposits at various depths up to about 200 feet. In areas where there is a small thickness of sand overlying the lake clay water is found at the contact of the sand and clay. The clay itself is nearly impervious and in places where it extends downwards from the surface only small amounts of water are obtainable in wells.

In the hilly tracts on the upland areas, where there are a great number of small lakes and ponds containing fresh or slightly saline water, well water is obtained at most places in the surface deposits at depths of less than 100 feet. It occurs in sandy layers in the boulder clay and in sand and gravel below the clay or between two clays. In some places where only clay is present it may be difficult to secure water, though it is generally found in the upper part of the shale below. In the upland plain bordering Pembina valley, where the shale bedrock over large areas is near the surface, good water is usually found at shallow depths in the upper part of the shale. Good water is also generally obtained in the southwestern part of the sheet at depths not exceeding 100 feet, either in sandy beds in the surface deposits or in the upper part of the shale below.

TABLE 2

Wells of Dufferin Sheet (No. 22), Tps. 1 to 8, Ranges 5 to 19, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
3	2	V	W.P.M.	Glencross	22				Water at 22 feet in gravel
5	3	"	"	Morden	600	31—shale		Salty	Water
5	3	"	"	"	12		6	Alkaline	Water at 11 feet in gravel
	3	"	"	"	12		6	Alkaline	Water at 6 feet in gravel
5	3	"	"	"	18		9	Alkaline	Water at 16 feet in gravel
5	3	"	"	"	12		13	Alkaline	Water at 9 feet in gravel
33	3	"	"	Rosebank	10–25			Alkaline	Water at 10 to 25 feet in till
NE. ¼ 5	4	"	"	"	120	30—white rock	Dry		
NE. ¼ 5	4	"	"	Dunstan	94		18?	Salty	Water at 94 feet in gravel
25	4	"	"	Rosebank	127		Dry		Water
32	4	"	"	"	249		24	Used for stock	Water at 249 feet in gravel
36	4	"	"	"	131		22	Good	Water at 131 feet in sand
8	4	"	"	"	200		Dry		Clay and hardpan to 200 feet
8	5	"	"	"	116		21	Good	Water at 116 feet in gravel
SW. ¼ 18	5	"	"	"	136		19	Good	Water at 136 feet in gravel
8	5	"	"	"	207		19	Used for stock	Water at 207 feet in gravel
NW. ¼ 7	6	"	"	Carman	150		28	Good	Water at 150 feet in gravel, also at 105 feet in hardpan
5	7	"	"	Graysville	87		Dry		Clay and sand to bottom
13	8	"	"	Elm Creek	167		12	Good	Water at 167 feet in gravel
SE. ¼ 25	8	"	"	"	123		23	Good	Water at 123 feet in gravel
NE. ¼ 25	8	"	"	"	130		30	Good	Water at 130 feet in gravel
24	4	VI	"	Miami	225	15—weathered shale	Dry		All shale
SE. ¼ 6	3	"	"	Thornhill	30				Water at bottom in quicksand
8	3	"	"	"	8–25			Fair	Water from sandy streak in till
35	3	"	"	"					Water
NW. ¼ 12	6	"	"	Graysville	225		35	Good	Water at 225 feet in gravel
SE. ¼ 23	6	"	"	"	272				No water. Quicksand at bottom
NW. ¼ 24	6	"	"	"	180		140	Good	Water at 180 feet in sand
SE. ¼ 22	2	VII	"	Darlingford	87	50—shale	29	Good	Water at 87 feet in hard shale
SE. ¼ 22	2	"	"	"	76	70?—shale	13	Good	Water at 76 feet in shale
SW. ¼ 23	2	"	"	"	168	?160—shale	15	Good	Water at 168 feet in shale
SW. ¼ 23	2	"	"	"	150	?145—shale	Dry		Started at 43 feet
NE. ¼ 24	2	"	"	"	290	?265—shale	Dry		Soft shale at base

TABLE 2 (Cont'd.)

Wells of Dufferin Sheet (No. 22), Tps. 1 to 8, Ranges 5 to 19, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
SW. ¼ 24	2	VII	W.P.M.	Darlingford	110	95—shale	10	Salty	Water at 100 feet in shale below hardpan
24	2	"	"	"	76		64	Good	Water at 76 feet in blue clay?
SW. ¼ 24	2	"	"	"	110			Salty	Water at 100 feet in black shale
NE. ¼ 24	2	"	"	"	76	30—hard shale	34	Good	Water at 76 feet in shale
SW. ¼ 24	2	"	"	"	80	60—hard shale	?	Good	Water at 75 feet in shale
SE. ¼ 24	2	"	"	"	70	65—shale	15	Good	Water at 65 feet in shale
SE. ¼ 24	2	"	"	"	116	55—hard shale	?	Good	Water at 116 feet in shale
SW. ¼ 28	2	"	"	"	89½	Shale at surface	?	Good	Water 15 feet shale, 40 feet limestone, 34½ feet shale
SW. ¼ 28	2	"	"	"	124	35—shale	16	Slightly salty	Water at 120 feet in hard blue rock
NW. ¼ 8	3	"	"	"	140	Slate at 45 feet in old well	40	Good	Water at 135 feet below shale above quicksand
SE. ¼ 14	3	"	"	"	62	35—shale	4	Good	Water at 58 feet in shale
NE. ¼ 14	3	"	"	"	52		14	Very good	Water at 52 feet in gravel
NE. ¼ 15	3	"	"	"	85	60—hard shale	30	Good	Water at 84 feet in shale
NE. ¼ 17	3	"	"	"	45		13	Good	Water at 45 feet in gravel
NW. ¼ 17	3	"	"	"	72	62—shale	45	Good	Water at 60 feet in boulder clay
SE. ¼ 25	3	"	"	"	148	140—shale	25	Good	Water at 138 feet in hardpan
SE. ¼ 25	3	"	"	"	118	24—hard shale	? 8	Good	Water at 118 feet in hard shale
NW. ¼ 27	3	"	"	"	85	80—shale?	20	Good	Water at 80 feet
NW. ¼ 30	3	"	"	"	117	85—hard shale	27	Good	Water at 103 feet in hard shale
NE. ¼ 30	3	"	"	"	82	25—hard shale	Dry		
4	1	VIII	"	Manitou	15-30	Few feet to shale		Good	Water at 30 feet in shale
SE. ¼ 1	3	"	"	"	65		17	Good	Water at 65 feet in gravel
NE. ¼ 1	3	"	"	"	70	60—shale	12	Good	Water at 68 feet in shale
SE. ¼ 1	3	"	"	"	42		12	Good	Water at 42 feet in gravel
SW. ¼ 2	3	"	"	"	60	40—shale	22	Good	Water at 60 feet in shale
5	3	"	"	"	95	65—shale	Dry		
NE. ¼ 8	3	"	"	"	60	15—shale	25	Good	Water at 60 feet in shale
11	3	"	"	"	35		12	Very good	Water at 32 feet in gravel
NW. ¼ 11	3	"	"	"	80	20—shale	Dry		
NE. ¼ 19	3	"	"	"	137	20—shale	17?	Good	Water at 137 feet in hard shale
SW. ¼ 29	3	"	"	"	35		8	Very good	Water at 30 feet in sand
30	3	"	"	"	175	5—shale			Water. C.P.R. well—all shale save 5 feet at surface

	30	3	"	"	"	20–30	5–12—shale		Good	Water at 20–30 feet in shale
SE. ¼	35	3	"	"	"	150		50	Good	Water at 140 feet
NE. ¼	6	4	"	"	"	38	15—shale	8	Good	Water at 38 feet in shale
	6	4	"	"	"	86		Flows	Good	Water at 86 feet in sand
NW. ¼	6	4	"	"	"	85	Hard shale at surface	?	Good	Water at 85 feet in hard shale
	27	4	"	"	"	117	88—shale	87	Good	Water at 117 feet in shale
	10	4	"	"	"	221	Shale at surface	Dry		Dry
	13	6	"	"	"	88		Dry		Dry
	13	6	"	"	Leary	101	77—soapstone	Dry		
NW. ¼	28	7	"	"	Rathwell	135			Good	Water at 120 feet in clay; note says height to which water rises, 125 feet
SW. ¼	21	7	"	"	"	215		Dry		Gas at 172 feet in grey rock—three layers 1 to 2 feet of grey rock in blue clay?
	7	8	"	"	"	1,885	283—shale	?	Salty	Water? No note of water
	7	8	"	"	"	88		18	Good	Water at 65 feet in quicksand
	7	8	"	"	"	225		70	Good	Water? (at bottom?) in ?
	7	8	"	"	"	95		3	Fair	Water at 95 feet in sand
	7	8	"	"	"	40		3	Fair	Water at 40 feet in clay
	7	8	"	"	"	464			Bad	Water—a little at 300 and 450 feet, both bad—log not given
	19	8	"	"	"	204		Dry		
	2	1	IX	"	Snow Flake	82				No remarks *re* water
	4	1	"	"	"	227	108—shale	20	Good	Water at 207 feet in shale
	12	1	"	"	"	71	7—shaly clay	31	Good	Water at 71 feet in shale
	16	1	"	"	"	102	36—shale	19	Good	Water at 102 feet in shale?
	16	1	"	"	"	150	99—shaly clay	15	Fair	Water at 150 feet in shale (hard shale at 132 feet)
	18	1	"	"	"	79		15	Good	Water at 79 feet in hardpan
SW. ¼	19	1	"	"	"	120	75—blue clay shale 110—hard shale	34	Good	Water at 119 feet in hard shale
SE. ¼	19	1	"	"	"	87	?70—hard shale	20	Good	Water at 85 feet in sand and gravel (15 feet of hard shale above)
	19	1	"	"	"	65		5	Good	Water at 65 feet in gravel
	19	1	IX	W.P.M.	"	74		14	Good	Water at 74 feet in sand and gravel
	19	1	"	"	"	110	?	12	Good	Water at 110 feet in sand
	19	1	"	"	"	127	64—shale	27	Good	Water at 127 feet in shale and limestone
	28	1	"	"	"	15–30	15–30—shale		Good	Water 15-30 feet in till, sometimes a few feet deeper in shale
	28	1	"	"	"	100		15		Hard water at 82 feet in soft clay and shale
	35	1	"	"	"	323	62—shale		Bad	Water ?
	28	1	"	"	Town of Snow Flake	78		13	Good	Water at 78 feet; records incomplete
	14	1	"	"	"	90	76—shale	18	Good	Water at 90 feet in shale

TABLE 2 (Cont'd.)

Wells of Dufferin Sheet (No. 22), Tps. 1 to 8, Ranges 5 to 19, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
14	1	IX	W.P.M.	Town of Snow Flake	99	Shale at surface		Dry	
25	1	"	"	"	116	24—soft shale and clay; 102—hard shale	6	Good	Water at 116 feet in hard shale
5	2	"	"	McKenzie	144	15—shale	16	Good, soft	Water at 144 feet in shale
14	2	"	"	"	140	Shale at surface	Dry		
14	2	"	"	"	78		Dry		
SW. ¼ 23	2	"	"	Manitou	925	112			Gas at 737 feet in Dakota sandstone
SW. ¼ 23	2	"	"	"	1,215	75—shale			Fresh water at 12 feet; gas and salt water at 740 feet in Dakota sandstone
SE. ¼ 26	2	"	"	"	2,500	140—shale			Salt water at 695 feet in Dakota sandstone
26	2	"	"	"	670	140—dark grey shale	?		Drift to 100 feet
23	2	"	"	"	225				
23	2	"	"	"	120				
23	2	"	"	"	635				
SE. ¼ 15	3	"	"	Larivière	112		?	Good	Water at 112 feet in hardpan
NE. ¼ 10	3	"	"	"	140	?	?	Good	Water at 140 feet in blue shale
NE. ¼ 10	4	"	"	"	128	Hard shale at surface	?	Good	Water at 128 feet in hard shale
NE. ¼ 10	4	"	"	"	120		?	Good	Water at 120 feet in hardpan
SW. ¼ 11	4	"	"	"	192	41—hard shale	?	Good	Water at 192 feet in hard shale
SE. ¼ 15	4	"	"	"	135		?23	Good	Water at 135 feet in hardpan
SE. ¼ 16	4	"	"	"	65	44—hard shale	?	Good	Water at 60 feet in hard shale
NE. ¼ 22	4	"	"	"	186	25—hard shale	?	Good	Water at 186 feet in hard shale
35	4	"	"	Somerset	10–15	Shale 6–12		Good	Water at 10–15 feet in shale
35	4	"	"	"	10–30	15—shale		Good	Water at 10–30 feet mostly in shale
NW. ¼ 25	7	"	"	Rathwell	50		30	Good	Water at 50 feet in boulder clay
SW. ¼ 25	7	"	"	"	60				? all clay and stones
SW. ¼ 25	7	"	"	"	50		30	Good	Water at 50 feet in boulder clay
1	8	"	"	"	105	10—shale			Shale to bottom
SW. ¼ 1	8	"	"	"	100	35—shale			
SW. ¼ 1	8	"	"	"	65		30	Good	Water at 45 feet in shale (?)
4	8	"	"	"	260	10—shale	Dry		Shale to bottom
4	8	"	"	"	25	15—shale	Dry		
SW. ¼ 14	8	"	"	"	75		50	Good	Water at 75 feet in quicksand

NW. ¼	14	8	"	"	"	55		16	Good	Water at 52 feet in quicksand
NW. ¼	13	8	"	"	"	120		30	Good	Water at 50 feet in quicksand
		......	"	"	Snow Flake	97		32	Good	Water at 97 feet in shale
	13	1	X	"	"	28		....		Much of these reported as stone
	13	1	"	"	"	102		....		Much of these reported as stone
	13	1	"	"	"	89		....		Much of these reported as stone
	13	1	"	"	"	48	32—shale	28	Good	Water at 48 feet in hard shale
	22	1	"	"	"	15–30	12—shale	....		Water at 15–30 feet in till and shale
	12	1	"	"	"	46	?	8	Good, soft	Water at 46 feet in shale
	10	1	"	"	"	180		90	Good, soft	Water at 180 feet in soft clay, also at 106 feet
	13	1	"	"	"	175	?	20	Good, soft	Water at 91 feet in clay and shale and 175 feet in shale and gravel
	13	1	"	"	"	122	?	11	Good	Water at 122 feet in clay, stone, and shale
	22	1	"	"	"	98	38—shale	28	Good	Water at 98 feet in shale
	35	1	"	"	"	97	38—shale	27	Good	Water at 97 feet in shale
	25	2	"	"	Purves	108		11	Hard	Water at 108 feet in quicksand
	26	2	"	"	"	118	Shale at surface	15	Clear, soft	Water at 118 feet in hard shale
	27	2	"	"	"	102	72—shale	16	Good	Water at 102 feet in shale
	23	3	"	"	Larivière	128	72—shale	53	Salty	Water at 128 feet in shale
	28	3	"	"	"	85		29	Good	Water at 85 feet in gravel
NW. ¼	30	3	"	"	Wood Bay	154	29—hard shale	24 ?	Good	Water at 154 feet in hard shale
	20	5	"	"	Swan Lake	119	5—blue shale	24		Water at 119 feet in dark grey shale, also at 70 feet in blue shale
	28	7	"	"	Treherne	216	60—shale	....		Water; gas; bad water in gravel at 60 feet
	11	8	"	"	"	15–50		....	Good	Water 15 to 50 feet in sand and gravel
SW. ¼	13	8	"	"	"	120		70	Good	Water at 120 feet in gravel
SE. ¼	35	8	"	"	"	65		33	Good	Water at 65 feet in quicksand
SW. ¼	36	8	"	"	"	65		40	Good	Water at 65 feet in quicksand
NW. ¼	36	8	"	"	"	70		30	Good	Water at 70 feet in quicksand
Methodist Church		......	"	..	Snow Flake	127	110—shale	27	Good	Water at 127 feet in shale
	18	1	XI	"	Crystal City	60	10—shale	10	Good	Water at 60 feet in shale
	8	3	"	"	Pilot Mound	70	Shale at surface	20	Good	Water at 70 feet in shale
	9	3	"	"	"	15–20	10—shale	....	Good	Water at 15 to 20 feet shale
	2	4	"	"	Wood Bay	256		....	Good	Water
	27	7	"	"	Holland	10–20	10—shale	....	Good	10 feet till—water from till and shale
	?	7	"	"	"	....		....		Water
	24	2	XII	"	Crystal City	90	20—shale	24	Good	Water at 90 feet in shale
	33	2	"	"	"	83	35—shale	40	Good	Water at 83 feet in shalo
	4	3	"	"	"	52	24—shale	20	Good	Water at 52 feet in shale
	7	7	"	"	Cypress River	10–17		....	Good	Water at 10–17 feet in fine silt
	34	1	XIII	"	Mather	97	20—shale	17	Good	Water at 97 feet in shale
	22	2	"	"	"	80	22—shale	18	Good	Water at 80 feet in shale

TABLE 2 (Cont'd.)

Wells of Dufferin Sheet (No. 22), Tps. 1 to 8, Ranges 5 to 19, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
13	3	XI	W.P.M.	Glenora	123		Flows	Good	Water at 123 feet in boulders and sand
6	2	XIV	"	Cartwright	76	68—shale	10	Good	Water at 76 feet in shale, coal at 62 feet in sand and gravel
6	2	"	"	"	63	60—shale	10	Good	Water at 63 feet in shale
4	3	"	"	Neelin	90	45—shale	15	Good	Water at 90 feet in shale
14	3	"	"	"	268		?		
20	4	"	"	"	94	11—shale	20	Good	Water at 94 feet in shale
10	7	"	"	Glenboro	10–17				Water at 10–17 feet in fine silt
SW. ¼ 6	1	XV	"	Cartwright	227	135—shale	127	Good	Water at 135 feet at contact of clay shale
32	3	"	"	Neelin	80		72	Good	Water at 80 feet in quicksand
34	3	"	"	"	80	50—shale	12	Good	Water at 80 feet in shale ?
35	3	"	"	"	105		49		Water at 105 feet in clay
36	3	"	"	"	61		24		Water at 61 feet in gravel
3	4	"	"	"	180	130—black shale	100		Water at 180 feet in black shale
3	4	"	"	"	109		55		Water at 109 feet in gravel
4	4	"	"	"	85	40—hard shale	43	Good	Water at 85 feet in hard shale
12	4	"	"	"	97	?	12	Good	Water at 97 feet in shale and gravel
12	4	"	"	"	95	?	27	Fair	Water at 95 feet in shale and sand
12	4	"	"	"	98	?	28	Very good	Water at 98 feet in clay and shale
14	4	"	"	"	85				Water at 85 feet in gravel and shale
24	4	"	"	"	60	?	20	Very good	Water at 60 feet
36	4	"	"	"	85		35	Good	Water at 85 feet in gravel
?	4	"	"	"	98	?	6	Salty	Water at 98 feet in shale
NW. ¼ 1	1	XVI	"	Enterprise	180	?	?	Good	Water at 180 feet
1	1	"	"	"	155	120—shale	17	Very good	Water at 155 feet in shale
16	1	"	"	"	50		Dry		Boulder clay
16	1	"	"	"	73	65—shale	38	Not very good	Water at 73 feet in shale
28	1	"	"	"	20		Dry		Clay and boulder clay
28	1	"	"	"	35		13	Good	Water at 35 feet in sand
NW. ¼ 31	1	"	"	"	175		77	Good	Water at 172 feet in fine gravel
31	1	"	"	"	120		72	Very good	Water at 120 feet in hardpan
5	2	"	"	"	73		28		Water at 73 feet in gravel
28	3	"	"	Glendenning	65	40—shale	25	Good	Water at 65 feet in shale
36	3	"	"	"	239		62	Fair	Water at 220 feet in hard clay?

	36	3	"	"	"	108		?		Clay and shale, gravel at bottom
	1	4	"	"	"	40		10	Good	Water at 40 feet in gravel
	11	4	"	"	"	65		32		Water at 62 feet in quicksand
	12	4	"	"	"	125		Dry		Shale and clay to bottom
	12	4	"	"	"	79		Strong spring		Water at 79 feet in gravel (shale 46 to 75 feet)
	19	5	"	"	Ninette	92			Good	Water
	24	5	"	"	"	92	30—shale	12		Water at 50 feet in shale
	30	5	"	"	"	84	44—shale	40	Good	Water at 84 feet in shale
	36	6	"	"	Hilton	92	12—shale	8	Good	Water at 92 feet in shale
	1	7	"	"	"	127	12—shale	31	Not good	Water at 127 feet in shale
NW. ¼	7	7	"	"	Ashdown	100	25—shale	45	Salty	Water at 60 feet in shale
	7	7	"	"	"	84	20—shale	20	Not good	Water at 84 feet in shale
NW. ¼	9	7	"	"	"	85	30—shale	40	Salty	Water at 60 feet in shale
NE. ¼	21	1	XVII	"	Bannerman	186		30	Fair	Water at 186 feet in ?
	21	1	"	"	"	185	137—shale	5	Fair	Water at 185 feet in shale
	36	1	"	"	Lena	256				Water, shale, gravel, and sand
	36	1	"	"	"	136		126	Alkaline	Water at 136 feet in gravel
	36	1	"	"	"	20	16?—shale	8	Good	Water at 20 feet in shale (black)
	12	2	"	"	"	210	140—shale	151	Good	Water at 205 feet in shale
	18	2	"	"	"	82		42	Good	Water at 82 feet in shale and sand
	18	2	"	"	"	116		40	Very good	Water at 116 feet in gravel
	19	2	"	"	"	86	47—shale	11		Water at 86 feet in shale
	19	2	"	"	"	20				Water, all blue clay
	28	2	"	"	Killarney	115	95—shale	32	Good	Water at 115 feet in quicksand
NE. ¼	34	2	"	"	"	156	80—shale	30	Good	Water at 148 feet in shale
NE. ¼	34	2	"	"	"	155		26	Good	Water at 150 feet in sand
	2	3	"	"	"	?			Fresh, hard	Water
NE. ¼	3	4	"	"	Fairhall	185	165—shale	?		
NE. ¼	3	4	"	"	"	447				Sand, clay, marl, and gravel, "wash" coal
SW. ¼	14	4	"	"	"	160		50	Good	Water at 160 feet? in quicksand
	14	4	"	"	"	100		70		Water at 100 feet in quicksand
SE. ¼	16	4	"	"	"	74		45	Good	Water at 72 feet in sand
SE. ¼	16	4	"	"	"	192			Not good	Water in quicksand, hardpan, and clay
	16	4	"	"	"	125		55	Good	Water at 125 feet in sand (15 feet clay, black)
	34	4	"	"	"	112	82—shale	24	Good	Water at 112 feet in shale
	28	6	"	"	Hilton	70		34	Good	Water at 70 feet in sand
	6	7	"	"	Elliotts	150	42—shale	60	Good	Water at 150 feet in shale
	18	7	"	"	"	72	26—shale	16	Fair	Water at 72 feet in shale
	19	7	"	"	"	110	65—shale	Dry		
	19	7	"	"	"	40		6	Good	Water at 40 feet at top of clay below gravel
SW. ¼	25	7	"	"	Wawanesa	215		Dry		All clay
	3	7	"	"	Elliotts	62				Water. All till
	34	7	"	"	Methven	101		76	Not good	Water at 101 feet in shale and sand

TABLE 2 (Cont'd.)

Wells of Dufferin Sheet (No. 22), Tps. 1 to 8, Ranges 5 to 19, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
1	2	XVIII	W.P.M.	Wakopa	120		10	Good	Water at 120 feet in sand and gravel
34	2	"	"	Rhodes	41		17	Good	Water at 41 feet in sand and gravel
19	3	"	"	Ninga	385	55—shale	12		Water at 385 feet in shale
SE. ¼ 19	3	"	"	"	42		30	Hard	Water at 38 feet in gravel
14	5	"	"	Margaret	130		Dry		Clay and sand
2	6	"	"	Langvale	18				Water at 18 feet in gravel
12	6	"	"	"	125	24—shale	35	Not good	Water at 125 feet in shale
SE. ¼ 32	6	"	"	Nesbitt	155		118	Good	Water at 140 feet in gravel
NW. ¼ 30	6	"	"	"	150	100—shale	130	Good	Water at 150 feet in shale
SE. ¼ 5	7	"	"	"	140	115—shale	90	Salty	Water at 140 feet in shale
NE. ¼ 8	7	"	"	"	415		Dry		All clay
NW. ¼ 18	7	"	"	"	75		30	Good	Water at 45 feet in boulder clay
SW. ¼ 19	7	"	"	"	135		90	Good	Water at 130 feet in gravel
28	7	"	"	"	76		23	Good	Water at 76 feet in sand
12	8	"	"	Reids	31		Dry		Sand, gravel, and boulder clay
24	8	"	"	Rounthwaite	66		25	Good	Water at 66 feet in sand
14	8	"	"	"	20			Good	Water 20 feet in boulder clay
6	4	XIX	"	Ninga	104		16	Good	Water at 104 feet in shale
7	5	"	"	Minto	112		37	Used for stock	Water at 112 feet in boulder clay
34	5	"	"	"	75	19—shale	19	Good	Water at 75 feet in shale
2	6	"	"	Heaslip	53	35—shale	18	Good	Water at 53 feet in shale
30	6	"	"	"	193	?	Dry		
30	6	"	"	"	153	?	53	Used for stock	Water at 153 feet in shale
NW. ¼ 9	7	"	"	Bunclody	200		Dry		Clay and sand
NW. ¼ 12	7	"	"	"	181	170—shale	165	Salty	Water at 181 feet in shale
SE. ¼ 12	7	"	"	"	270		Dry		Clay and boulder clay
NW. ¼ 17	7	"	"	"	130		20	Good	Water at 130 feet in gravel
SW. ¼ 17	7	"	"	"	130		40	Good	Water at 130 feet in hardpan
SW. ¼ 19	7	"	"	Carroll	145	125—shale	25	Good	Water at 145 feet in shale
SE. ¼ 24	7	"	"	"				Fresh	Water
30	7	"	"	"	256	175—red shale	30		Water at 130 feet in gravel

EMERSON SHEET (NO. 23)

The western half of the sheet includes a part of the Red River Valley plain which slopes gently from the west and east towards the comparatively narrow, inner valley of Red river. In the east, a partly wooded plain rises gradually to a highland drift area the highest part of which is traversed by the Canadian National railway from Bedford to Badger. Lake clay and alluvial clay along the stream valleys cover nearly all of Red River Valley plain, and in places extend to a depth of nearly 100 feet, concealing the bedrock entirely. Boulder clay, and in places sands and gravels, underlie the lake clays. These surface deposits have a maximum thickness of about 200 feet along Red River valley near the International Boundary, and about 300 feet along the western border of the sheet. A series of sand and gravel ridges (beaches of Lake Agassiz) rather closely define the eastern border of the lake clay plain and extend north from Ridgeville to near St. Pierre and thence northeast to Giroux. Much of the eastern part of the sheet is swampy and the soil over most of it, in contrast with the clay plain in the west, is formed from boulder clay or fine sand and gravel. The surface deposits are thick and entirely conceal the bedrock; well borings on the highest part of the upland show that they are over 300 feet thick. Shale underlies the surface deposits of the clay plain in the western and limestone in the eastern part, except in the northeastern corner of the sheet which may be underlain by Precambrian rocks.

The artesian water areas of the sheet are described on page 15. In the swampy areas in the eastern part of the sheet good water is easily obtained in shallow wells. The swamp waters are remarkably clear and potable because of the abundance of limestone in the surface deposits through which the waters seep. The lime dissolved in the water causes the organic matter in suspension to flocculate and settle to the bottom. In the higher parts of the upland area, which are mostly sandy, the groundwater level is at a considerable depth and wells may have to be sunk to depths of 100 feet or more in order to secure water. Shallow wells sunk in the sand and gravel deposits around the base of the highland area and in the numerous beach ridges in the eastern part of the sheet secure good water. In the western part, there are a number of low sand ridges extending northwest, in which well water is obtained at shallow depths; but over much of the clay plain in the western part of the sheet, only small amounts of seepage water are obtained in shallow wells and there is little use in drilling to depth in search of larger supplies. Over parts of the clay plain west of Red river " dug-outs " are resorted to for the storage of rain water or, for example at the town of Morris, ice obtained from Red river is used to some extent for domestic purposes. The " dug-outs " are of various sizes up to 100 feet long, 30 feet wide, and 8 to 15 feet deep, and are simply excavated in the surface clay.

Table 3

Wells of Emerson Sheet (No. 23), Tps. 1 to 8, Ranges 1 to 4, W. Prin. Mer., and 1 to 11, E. Prin. Mer.

Lot	Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
						Feet	Feet	Feet		
	22	2	I	E.P.M.	Letellier..........	250	....	....	Brackish.......	Water
	SW. ¼ 9	6	"	"	McTavish.........	105..	....	Flows	Slightly salty...	Water at 105 feet in sand, rises 3 feet above ground
	SW. ¼ 12	6	"	"	"	115	....	Flows	Fair..........	Water at 112 feet in sand, rises 10 feet above ground
	17	6	"	"	"	117	....	Flows	Salty..........	Water at 113 feet
	1	1	II	"	Emerson..........	10–25	....	....	Fair, hard......	
	3	1	"	"	"	108	....	....	Good..........	
	SE. ¼ 24	1	"	"	"	212	205	Flows	Salty..........	Water at 212 feet in shale
	36	4	"	"	At Ste. Elizabeth...	290	120	Flows	Fair..........	Water at 90 feet
	SE. ¼ 31	5	"	"	Silver Plain........	107	....	Flows	Salty..........	Water at 102 feet
	SE. ¼ 35	5	"	"	Aubigny..........	97	....	2	Good..........	Water at 97 feet in gravel
		6	"	"	At Aubigny Village.	432	103	Flows	Salty..........	Water at 200 feet
44	8	7	"	"	Ste. Agathe........	583	88	Flows	Salty..........	Water at 320 and 546 feet
44	8	7	"	"	"	530	85	15	Fair..........	Water at 120 feet in limestone
	20	2	III	"	Dominion City.....	170	....	Flows	Brackish.......	Water from surface deposits
	27	3	"	"	At Arnaud.........	710	177	....	Salty..........	Water at 710 feet in sandstone
	27	3	"	"	"	88	....	33	Good..........	Water at 88 feet
	18	3	"	"	Ste. Elizabeth......	73	....	....	Salty..........	
	28	2	IV	"	Green Ridge.......	46	....	....	Good..........	
	23	4	"	"	St. Malo..........	455	180	Flows	Good..........	Water at 455 feet, rises 10 feet above ground
28	....	5	"	"	St. Pierre..........	305	120	Flows	Good..........	Water at 175 feet, rises 14 feet above ground
	SE. ¼ 31	5	"	"	Carey.............	380	110	Flows	Good..........	Water at 380 feet, rises 14 feet above surface
28	....	5	"	"	St. Pierre..........	320	140	Flows	Good..........	Water at 320 feet, rises 17 feet above ground
44	9 and 10	5	"	"	"	350	135	Flows	Good..........	Water at 344 feet, rises 10 feet above ground
42	15	5	"	"	"	320	140	Flows	Good..........	Water at 300 feet in limestone
	34	5	"	"	"	172	....	Flows	Good..........	Water at 172 feet in sand
	35	5	"	"	"	359	130	Flows	Good..........	Water at 359 feet in limestone

19	9 and 10	6	"	"	"	195	130	Flows	Good	Water at 190 feet, rises 10 feet above ground
18	9 and 10	6	"	"	"	235	110	Flows	Good	Water at 230 feet, rises 10 feet above ground
18	9 and 10	6	"	"	"	250	120	Flows	Good	Water at 245 feet in limestone
17	9 and 10	6	"	"	"	255	110	Flows	Good	Water at 255 feet in limestone
16	9 and 10	6	"	"	"	235		Flows	Good	Water at 225 feet
23		6	"	"	"	273	120	Flows	Good	Water at 270 feet in limestone
	23	6	"	"	Otterburne	458	120	Flows	Good	Water at 117 feet in sand
	24	6	"	"	"	124		Dry		
20		6	"	"	"	245	125	Flows	Good	Water at 235 feet in limestone
	29	7	"	"	Niverville	115			Good	Water
	34	7	"	"	"	65				
	5	7	"	"	"	95	63	Flows	Excellent	
	5	7	"	"	"	107	70	Flows		
	23	5	VII	"	Marchand	154				
	5	5	I	W.P.M.	Lowe Farm	121			Salty	
	6	5	"	"	"	201		10	Salty	Water at 170 feet in quicksand
	6	5	"	"	"	250		Flows	Strongly saline	
	29	6	II	"	At Sperling	963	228		Salty	Water at 420 and 470 feet, small amount
	29	6	"	"	"	230		15	Salty	Water at 157 feet in sand
	32	4	"	"	Myrtle	146		50	Poor	
	SE. ¼ 15	6	"	"	Homewood	122		20	Good	Water at 122 feet
	10	1	"	"	Reinland	15–20			Excellent	Water
	27	2	IV	"	Winkler	120		10	Good	Water at 120 feet
	18	4	"	"	Kronsgart	139		Dry		
	4	5	"	"	Roland	815	315		Salty	Water at 100 to 200 feet in gravel
	4	5	"	"	"	958			Salty	
	4	5	"	"	"	110		20	Salty	Water at 110 feet
51		6	"	"	Carman	175		Dry		
	20	6	"	"	"	192		22	Excellent	Water at 192 feet in sand and gravel
	30	6	"	"	"	100		15	Good	Water at 100 feet in gravel
	25	6	"	"	"	10–15			Good	
	25	6	"	"	"	100				
	25	6	"	"	"	120			Brackish	Water
	28	7	"	"	Barnsley	223		20	Fair	Water at 223 feet in sand
	9	8	"	"	Elm Creek	156		20	Good	Water at 156 feet in sand
	17	8	"	"	"	159		25	Good	Water at 159 feet in sand
	18	8	"	"	"	155				
	19	8	"	"	"	148		30	Good	Water at 148 feet in sand
	19	8	"	"	"	655		Dry		
	19	8	"	"	"	272		20	Good	Water at 272 feet in sand

TABLE 3 (Conc'd.)

Wells of Emerson Sheet (No. 23), Tps. 1 to 8, Ranges 1 to 4, W. Prin. Mer., and 1 to 11, E. Prin. Mer.

Lot	Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
						Feet	Feet	Feet		
	SE. ¼ 22	8	IV	W.P.M.	Elm Creek	105		15	Salty	Water at 105 feet in gravel
	38	8	"	"	"	185½		30	Good	Water at 185 feet in gravel
	36	8	"	"	"	186		7	Good	Water at 186 feet in gravel
	36	8	"	"	"	155			Salty	
	5	1	I	"	Gretna	150				No water
	9	3	"	"	Rosenfeld	1,037	143	Strong flow	Brine	Water mainly at 925 feet from sandstone
	21	5	"	"	Lowe Farm	160	145		Bitter	
	28	5	"	"	"	328	135	Flows	Salty	
	SE. ¼ 23	6	"	"	McTavish	122	115	Flows	Salty	Water at 122 feet in limestone
	12	7	"	"	Osborne	39		Dry		
	21	8	"	"	Sanford	60		8	Good	Water at 60 feet in sand

VIRDEN SHEET (NO. 71), TPS. 9 TO 16, RANGES 20 TO 33, W. PRIN. MER.

The great part of the sheet is a rolling, partly wooded plain that is divided into two nearly equal parts by Assiniboine river whose valley trends southeast and ranges in depth from 150 to 300 feet. The surface rises gradually from an elevation of about 1,500 feet in the vicinity of Assiniboine valley, to 2,100 feet in the southwestern part of the sheet, and to about 2,000 feet in the northeastern part. A range of hills known as Arrow hills extends along the northeastern side of Assiniboine valley, and has a maximum relief of about 100 feet. Elsewhere in the sheet, except in Minnedosa and Pipestone River valleys, the local relief is not so great, though there are many hills and ridges 10 to 15 feet high. Much of the northwestern part of the sheet and a stretch along Pipestone river are wooded, as is also the central eastern part of the sheet.

Surface deposits cover the bedrock over all the sheet except a few places in the river valleys, and in many places have a thickness of over 100 feet. A broad area extending east along Assiniboine valley from Virden to Kemnay and northeast along the lower part of Minnedosa River valley to Rivers, is underlain by lake clays. South of Assiniboine river a belt of sand hills, partly wooded, extends southeast from near Virden to beyond Oak Lake. These deposits are in the bed of ancient Lake Souris, the highest shore-line of which is about a mile west of Virden and extends south along the west side of the road leading to Pipestone. A long, narrow arm of the lake extended north along Assiniboine valley to beyond the northern border of the sheet. Outside of the Lake Souris basin, except for the river valleys floored with alluvium and a few comparatively small areas of sand and gravel, the surface deposits consist of boulder clay underlain in places by sand and gravel and containing lenses of these materials. Shale underlies the surface deposits over the whole sheet, except in the southwest corner near Fairlight and Parkman, where sandstone and shale are reported to have been struck in wells.

Good well water is obtained at shallow depths in the sandy areas in the vicinity of Virden, Routledge, and Oak Lake, but in the clay areas in other parts of the Lake Souris basin, water is not so easily obtained. Many of the borings made in the southeastern part of the sheet in the vicinity of Griswold, Alexander, Kemnay, and Beresford were dry, but some good wells have been obtained. The chances of finding water depend upon the presence of sand or gravel below the clay; in places the clay extends down to the shale and in these places no water is found. As the surface deposits are very thick, only a few of the wells extend down into the shale. Some of these deep wells obtain water in the upper part of the shale, but others are dry.

In the northeastern part of the sheet, the well water in most places is of good quality and is found in the surface deposits at depths of a few feet to over 100 feet. Few of the wells extend down into the shale bedrock. In the area southwest of Assiniboine river conditions vary greatly from place to place. In the vicinity of Moosomin, and in general in the area along the Canadian Pacific railway from Kirkella to Wapella, small supplies of good water are obtained at shallow depths in the surface deposits, but at greater depths the water is saline and unfit for use. A deep well at Fleming obtained only a small supply of water at a depth of 15 feet. In the general area along the Assiniboine in the vicinity of old Fort Ellice and for several miles to the south, water is found in the gravel at depths of 50 to 100 feet; it does not occur near the surface except in a few places as the gravels are porous and the deposit is deeply trenched by streams. In the southwestern part of the sheet in the vicinity of Fairlight, Walpole, and Mair, water that is only slightly saline is obtained at depths of about 100 feet or somewhat more, in gravel at the base of the surface deposits or in the upper part of the shale below. The water is under pressure and generally rises to within a few feet of the surface.

TABLE 4

Wells of Virden Sheet (No. 71), Tps. 9 to 16, Ranges 20 to 33, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
32	9	XX	W.P.M.	Roseland	83		43		Water at 83 feet in gravel
32	9	"	"	"	95		20		
32	9	"	"	"	107		Dry		
36	9	"	"	"	70		20		Water at 70 feet in gravel
36	9	"	"	"	70		20		
36	9	"	"	"	70		20	Good	Water at 70 feet in gravel
36	9	"	"	"	70		20	Good	Water
NW. ¼ 19	10	"	"	Kemnay	70		40	Good	Water at 70 feet in gravel
20	10	"	"	"	82		57	Good	Water
20	10	"	"	"	65		25	Good	Water at 65 feet in gravel
NW. ¼ 20	10	"	"	"	97		50	Good	Water at 80 feet in gravel
SE. ¼ 21	10	"	"	Kemnay school	60		40	Good	Water
22	10	"	"	Kemnay	60		Dry		
NE. ¼ 22	10	"	"	"	150	100	20	Good	Water at 80 feet
23	10	"	"	"	177		Dry		
30	10	"	"	"	88		28	Good	Water at 80 feet in gravel
30	10	"	"	"	125		Dry		
1	11	"	"	"	120	35	Dry		
1	11	"	"	"	65		27	Good	Water at 65 feet in gravel
7	11	"	"	"	154		35	No good	Water at 154 feet in clay
SW. ¼ 18	11	"	"	"	75		40	Good	Water at 75 feet in sand
SW. ¼ 18	11	"	"	"	100		30	Good	Water at 100 feet in sand
SW. ¼ 18	11	"	"	"	215		70	Good	Water at 140 feet in sand
SW. ¼ 18	11	"	"	"	345			No good	Water
19	13	"	"	Pettapiece	40		15		
19	13	"	"	"	75		Dry		
19	13	"	"	"	57		Dry		
18	14	"	"	Moline	50		Dry		
18	14	"	"	"	49		23	Good	
6	15	"	"	Cardale	64		40	Good	Water
6	15	"	"	"	52		40	Good	Water
6	16	"	"	Newdale	116		91		Water
8	16	"	"	"	110		90		Water
14	9	XXI	"	Beresford	80		Dry		
19	9	"	"	Terence	125	123	20	Good	Water at 125 feet in shale
SW. ¼ 31	9	"	"	Alexander	145	140	26	Good	Water at 110 feet in sand

TABLE 4 (Cont'd.)

Wells of Virden Sheet (No. 71), Tps. 9 to 16, Ranges 20 to 33, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
NW. ¼ 5	10	XXI	W.P.M.	Alexander	173	130	88	Good	Water at 128 feet in sand
6	10	"	"	"	95		Dry		
17	10	"	"	"	?			Fresh	Water
NW. ¼ 25	10	"	"	"	70		20	Good	Water at 60 feet in gravel
NW. ¼ 25	10	"	"	"	190		Dry		
NE. ¼ 1	11	"	"	"	75		Dry		All clay
NE. ¼ 1	11	"	"	"	135		Dry		All clay
NE. ¼ 1	11	"	"	"	225		Dry		All clay
7	11	"	"	"	159		Dry		Sand below 100 feet
11	11	"	"	"	164		104	Good	Water at 162 feet in sand
12	11	"	"	"	164			Good	Water at 164 feet in sand
14	11	"	"	"	173		Dry		
23	11	"	"	"	103		85	Good	Water at 103 feet in sand
24	11	"	"	"	141		90	Good	Water at 141 feet in sand
NW. ¼ 1	13	"	"	Pettapiece	130		Dry		
NW. ¼ 2	13	"	"	"	275		75	Fresh	Water at 175 feet in sand
NW. ¼ 2	13	"	"	"	140		Dry		
NE. ¼ 2	13	"	"	"	95		Dry		
2	13	"	"	"	165		Dry		
18	13	"	"	"	94		Dry		
24	14	"	"	Moline	77	60			
12	15	"	"	Marney	104		Dry		
24	15	"	"	"	74	56	21		
28	9	XXII	"	Terence	129	85	29	Good	Water at 129 feet in shale
32	9	"	"	"	84		34	Good	Water at 84 feet in sand
36	9	"	"	"	116		25	Good	Water at 116 feet in sand
SE. ¼ 1	10	"	"	"	75		Dry		
SE. ¼ 1	10	"	"	"	225	105	Dry		
SE. ¼ 1	10	"	"	"	125	110	Dry		
SE. ¼ 1	10	"	"	"	115	115	15	Good	Water at 115 feet in shale
NW. ¼ 2	10	"	"	"	85		Dry		
NW. ¼ 20	10	"	"	"	115	85	Dry		
NE. ¼ 2	10	"	"	"	95		Dry		
NW. ¼ 2	10	"	"	"	250	110	Dry		
NW. ¼ 2	10	"	"	"	90	90?	Dry		
NW. ¼ 2	10	"	"	"	137	105?	Dry		

NW. ¼	2	10	"	"	"	375		Dry		
NW. ¼	2	10	"	"	"	106		21	Good	Water at 106 feet
SW. ¼	10	10	"	"	Alexander	120	115?	Dry		
SW. ¼	10	10	"	"	"	115		Dry		
SW. ¼	10	10	"	"	"	100		Dry		
SW. ¼	10	10	"	"	"	130	115?	34	Good	Water at 104 feet in sand
SW. ¼	10	10	"	"	"	206		Dry		
	12	10	"	"	"	155		Dry		
	12	10	"	"	"	218	160	Dry		
	12	10	"	"	"	125		Dry		
	10	11	"	"	Roden	98		68	Good	Water
	12	14	"	"	Oak River	59		49	Medium	Water
	25	9	XXIII	"	Griswold	328		Dry		Hardpan to 40 feet and clay below
	25	9	"	"	"	193	178	Dry		
	25	9	"	"	"	120		49	Good	Water
	10	11	"	"	Hillview	224		Dry		
	14	11	"	"	"	134			Good	Water at 100 feet
	14	11	"	"	Brierwood	118		Dry		
	22	11	"	"	"	244		Dry		
	22	11	"	"	"	153		128	Good	
	28	11	"	"	"	66		31	Good	Water at 66 feet in sand
	12	12	"	"	Harding	27				
	22	12	"	"	"	118		Dry		
	22	12	"	"	"	36		Dry		
	22	12	"	"	"	115		Dry		
SW. ¼	27	12	"	"	"	150	80	40	Good	Water at 70 feet in gravel
	24	13	"	"	Oakner	68			Good	
	3	14	"	"	Hamiota	91		51	Good	
	22	14	"	"	"	112		40		Water at 112 feet
	22	14	"	"	"	134	133	Dry		
	18	15	"	"	Lavinia	71		41	Not good	
	18	15	"	"	"	89		39	Good	
	28	13	XXIV	"	Pope	108		28	Good	Water in gravel
	35	13	"	"	"	91		34	Fair	Water in gravel
	14	14	"	"	Hamiota	75		50	Good	Water in sand
	22	14	"	"	"	246		Dry		Water at 175 feet but sand came in
	22	14	"	"	"	200		64	Good	Water in gravel
	35	14	"	"	Decker	194		94	Good	Water in gravel
	35	14	"	"	"	200			Good	
	33	16	"	"	Shoal Lake	115	97			Water at 67 feet in sand
	1	15	XXIV	"	Decker	74		28	Good	
	3	15	"	"	"	122		31		Water in gravel
	8	15	"	"	"	175	115?	Dry		
	8	15	"	"	"	120		Dry		
	8	15	"	"	"	110		Dry		
	8	15	"	"	"	172	129?	Dry		
	8	15	"	"	"	76			Good	Water at 76 feet in sand
	10	15	"	"	"	150	145?	95	Good	Water at 150 feet

TABLE 4 (Cont'd.)

Wells of Virden Sheet (No. 71), Tps. 9 to 16, Ranges 20 to 33, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
10	15	XXIV	W.P.M.	Decker	76		38	Good	
18	15	"	"	"	120	116	90	Good	Water in quicksand
23	15	"	"	Orrwold	76		34	Good	
23	15	"	"	"	103			Good	Water in sand
28	15	"	"	"	103		Dry		
25	15	"	"	"	122		91	Good	Water in gravel
28	15	"	"	"	124		91	Good	
8	15	"	"	"	122		Dry		
30	16	"	"	Kelloe	102		Dry		
30	16	"	"	"	95		87	Good	Water in sand
7	15	XXV	"	Isabella	1,115	100	Dry		Water
22	15	"	"	Orrwold	110		Dry		
23	15	"	"	Decker	115		74	Good	Water at 114 feet in sand
28	9	"	"	Routledge	302		100	Salty	Water at 110 feet and 302 feet in sand
16	15	"	"	Isabella	115		Dry		
4	15	"	"	"	26			Good	
16	15	"	"	"	120	100	90	Good	
22	15	"	"	"	100		23	Good	
22	16	"	"	"	96		78	Good	
29	9	XXVI	"	Maples	45		15	Good	Water in sand below clay
4	10	"	"	"	80		30	Good	Water in sand
4	10	"	"	"	70	60		Very salty	Water in shale
15	10	"	"	Virden	65		29	Good	
22	10	"	"	At Virden	358	90	10		Water at 70 feet in gravel and at 145 feet in shale
34	10	"	"	Virden	61		12	Good	Water in quicksand
2	11	"	"	Scallion	60		22	Good	Water in gravel below clay
2	11	"	"	"	60		30	Good	
21	12	"	"	Two Creeks	100		50		Water at 100 feet in gravel
10	15	"	"	Beulah	107		40	Good	
11	15	"	"	"	62		20	Good	
SW. ¼ 28	15	"	"	"	110	95	Dry		
NE. ¼ 32	15	"	"	"	65		17	Good	
NE. ¼ 35	15	"	"	"	130	125	Dry		

NE. ¼	35	15	"	"	"	120		10	Good	Water at 15 feet
NE. ¼	35	15	"	"	"	130		Dry		
	4	16	"	"	"	115		Dry		
	4	16	"	"	"	187	165	Dry		
	4	16	"	"	"	118		98	Good	
NE. ¼	14	16	"	"	"	178		Dry		Sand at 170 feet below boulder clay
	14	16	"	"	"	281	281	Dry		
	12	9	XXVII	"	Woodnorth	28		16	Good	
	12	9	"	"	"	44		14	Good	Water in sand below clay
	32	9	"	"	"	65		30	Good	Water in sand
	36	10	"	"	Homestead	50			Good	Water
	1	11	"	"	Hargrave	45		Dry		Boulders
	20	11	"	"	Reaper	39		21	Good	Water in sand below clay
	36	11	"	"	"	80	45		Good	Water in shale
NE. ¼	20	12	"	"	Two Creeks	88	35	16		Water in shale
	35	12	"	"	"	63	50			
	10	14	"	"	Willen	325				
	20	9	XXVIII	"	Ewart	138		38	Good	Water at 138 feet in sand
	28	9	"	"	Cromer	76				Water
	28	9	"	"	"	340		89	Salty	Water at 300 feet in sand
	30	9	"	"	"	122		Dry		
SW. ¼	9	10	"	"	Daly	110		30	Good	Water at 110 feet in sand
SW. ¼	19	10	"	"	Arawana	106		40	Good	Water at 106 feet in gravel
NE. ¼	20	10	"	"	"	101		30	Good	Water at 101 feet in gravel
	20	11	"	"	Elkhorn	70	60		Good	Water at 70 feet in shale
NW. ¼	18	11	"	"	"	80		6	Good	Water at 80 feet in gravel
SE. ¼	2	12	"	"	Kanage	89	25	14	Salty	Water at 87 feet in shale
NW. ¼	3	12	"	"	"	87	25	10	Fair	Water at 87 feet
SE. ¼	9	12	"	"	"	87		16	Good	
NE. ¼	16	12	"	"	"	86	25	10	Salty	
	36	16	"	"	Fort Ellice	46		20	?	Water in gravel
SE. ¼	24	9	XXIX	"	Ebor	45		21	Good	Water at 41 feet in sand
	25	9	"	"	Butler	150		Dry		
	25	9	"	"	"	93		Dry		
	25	9	"	"	"	115		Dry		
	26	9	"	"	Ebor	80		50	Good	Water at 80 feet in sand
	36	10	"	"	Arawana	30		6	Alkaline	
SE. ¼	32	10	"	"	"	195		30	Good	Water at 195 feet in gravel
	24	10	"	"	"	150		30		Water at 85 feet in gravel
NE. ¼	22	10	"	"	"	155	150	Dry		
NE. ¼	22	10	"	"	"	290	130	38	Salty	Water at 290 feet in shale
NE. ¼	22	10	"	"	"	175	145	Dry		
NE. ¼	22	10	"	"	"	275	140	25	Salty	Water at 275 feet in shale
NW. ¼	20	10	"	"	"	460	185	155	Salty	Water at 255 feet in shale
NW. ¼	20	10	"	"	"	200	165	140	Good	Water at 165 feet in gravel, small supply
NW. ¼	20	10	"	"	"	215	185	Dry		

TABLE 4 (Cont'd.)

Wells of Virden Sheet (No. 71), Tps. 9 to 16, Ranges 20 to 23, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
NW. ¼ 20	10	XXIX	W.P.M.	Arawana	220		Dry		
NW. ¼ 20	10	"	"	"	109		Dry		
NW. ¼ 20	10	"	"	"	180		40	Good	Water at 175 feet in gravel
NE. ¼ 17	10	"	"	"	245		55	Good	Water at 245 feet in gravel
SW. ¼ 14	10	"	"	"	332	170	80	Salty	Water at 332 feet in shale
12	10	"	"	Butler Station	64		Dry		
12	10	"	"	"	155		Dry		
SE. ¼ 9	10	"	"	Elkhorn	160		35	Good	Water at 150 feet in sand
7	10	"	"	Butler Station	150		130	Good	Water at 150 feet
NW. ¼ 5	10	"	"	"	257		45	Good	Water at 257 feet in sand and gravel
NW. ¼ 3	10	"	"	"	190	190	65	Very good	Water at 145 feet in gravel
SE. ¼ 1	10	"	"	"	190	145		Salty	Water at 190 feet in shale
NW. ¼ 3	11	"	"	Lippentott	215		27	Good	Water at 215 feet in sand
4	11	"	"	"	85		Dry		
4	11	"	"	"	98		Dry		
SE. ¼ 4	11	"	"	"	201		75		Water at 201 feet in coarse sand and gravel
SE. ¼ 10	11	"	"	"	136		86	Good	Water at 136 feet in sand and gravel
SW. ¼ 12	11	"	"	"	130		52	Good	Water at 127 feet in gravel
14	11	"	"	"	110		40	Good	Water at 100 feet in sand and gravel
SE. ¼ 22	11	"	"	"	145		45	Good	Water at 145 feet in gravel
22	11	"	"	"	52		Dry		
SE. ¼ 24	11	"	"	"	96		18	Good	Water at 96 feet in coarse sand
25	11	"	"	"	105	90	30		Water at 90 feet in shale
NW. ¼ 28	11	"	"	"	101		30	Good	Water at 101 feet in sand
10	15	"	"	McAuley	430	52	Dry		
8	9	XXX	"	Ryerson	510	280	Dry		
18	9	"	"	"	160		135	Hard	Water at 135 feet in gravel
17	10	"	"	Maryfield	380	235	60	Salty	Water at 360 feet from shale
14	12	"	"	Fleming	1,500	50?			Water at 15 feet. Dry below drift
14	12	"	"	"	100				
27	12	"	"	"	70			Good	
SW. ¼ 7	9	XXXI	"	Ryerson	106		Dry		
SW. ¼ 7	9	"	"	"	18		Dry		
SW. ¼ 7	9	"	"	"	86			Bitter	Very little water

SW. ¼	7	9	"	"	"	10–12				
SW. ¼	7	9	"	"	"	16				Water better after first year
	23	9	"	"	"	215	215+	Dry		
	31	9	"	"	"	147			Hard	
	18	10	"	"	Fairlight	105	30			
	19	10	"	"	"	78	38	20		Water at 75 feet in shale
	20	10	"	"	"	77	28	20		Water in shale
	26	10	"	"	"	110		19		Water in gravel
	27	10	"	"	"	105		25		Water in gravel
	30	10	"	"	"	18	4			
	31	10	"	"	"	75	30	18		
	32	10	"	"	"	77	30	20		
	34	10	"	"	"	240	160			Water at 180 feet in shale
	21	13	"	"	Moosomin	167		65		Water at 155 feet in gravel
	14	13	"	"	Rotave	210		20	Soft, salty	Water at 199 feet
	13	15	"	"	Hillburn	177			Good	
	17	9	XXXII	"	Mair	235		38		Water in gravel
	13	10	"	"	Fairlight	110	38	22		Water at 110 feet in shale
	14	10	"	"	"	112	82	30		Water at 112 feet in shale
	22	10	"	"	"	195		28	Hard	Water at 190 feet in gravel below shale
	35	10	"	"	"	25	8			
	1	11	"	"	Walpole	68	30	16	Slightly salty	Water at 65 feet in shale
	5	.9	XXXIII	"	Parkman	400	300?	Dry		
	23	10	"	"	Walpole	335	225?	23		Water at 335 feet in shale
	36	10	"	"	"	142	95	40		Water

BRANDON SHEET (NO. 72), TPS. 9 TO 16, RANGES 5 TO 19, W. PRIN. MER.

A nearly level plain, part of the Manitoba lowland, sloping gently to the east and northeast towards the southern end of lake Manitoba, forms the northeastern part of the sheet. Assiniboine river, in a shallow valley flowing east into Red river, drains the southern part of the plain; Whitemud river, in the northwestern part, drains into lake Manitoba. In the central part of the sheet, approximately along a line from Lavenham to Neepawa, there is an abrupt rise of 200 to 300 feet to an upland occupying the southwestern part of the sheet. Numerous small streams head a short distance back in the upland and occupy narrow, deep channels that trench the face of the steep slope. North of Neepawa there is a gradual rise to the higher upland of Riding mountain. In the south, Assiniboine river flows in a broad valley that gradually deepens downstream.

In the lowland part of the sheet, the surface deposits have a thickness in places of over 200 feet and entirely conceal the bedrock. A sand dune area of about 100 square miles lies south of Neepawa, and there are numerous sand and gravel ridges, that are ancient beaches, extending northwest through the lowland, much of which, however, is covered by lake and alluvial clays. Along Assiniboine river these clays form the Portage Plains, famous from the early days as wheat lands. A large marsh now drained and known as the Big Grass marsh lies in the central northern part of the lowland, and much of the northern part differs from the southern part in being underlain by stony clay and in having a more uneven surface. The southern part of the upland is part of the ancient delta of Assiniboine river, and is underlain by sands and clays having a thickness of over 100 feet in many places. In the northwest, on the slopes of Riding mountain, the great part of the surface deposits is stony clay.

Well water is obtained at shallow depths in the sandy areas and in the gravel ridges in the lowland, but in the clay areas it is frequently necessary to drill to depths of 100 to 200 feet to obtain water. In most cases the water at depth is under pressure and rises part way or nearly to the surface when reached by the drill. In most places the water occurs in sandy beds at the base of the surface deposits and in a few places in the bedrock below the surface deposits. In the vicinity of Gladstone and Westbourne the water at depth is saline and as a rule the nearer the surface the water is obtained the better it is likely to be, except in the area north and northeast of Portage la Prairie where limestone forms the bedrock. From the limestone good water, though hard, is usually obtained. There are very few places in the lowland where no water has been found in drilling. On the upland, water is obtained at shallow depths in the sandy and gravelly areas, except in such cases as along Assiniboine valley where these deposits are deeply trenched by streams that drain off the shallow ground-waters. In the clay areas water is found at many places in sand and gravel below the clay, but in other places where only clay is found many dry wells have been drilled. A few wells find water in the shale bedrock below the surface deposits.

TABLE 5

Wells of Brandon Sheet (No. 72), Tps. 9 to 16, Ranges 5 to 19, W. Prin. Mer.

Lot	Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
						Feet	Feet	Feet		
	NW. ¼ 22	9	V	W.P.M.	New Sydenham	134		34	Good	Water at 134 feet in gravel
	SW. ¼ 23	9	"	"	"	180		30	Salty	Water at 180 feet in gravel
	26	9	"	"	"	107		20	Salty	
	SE. ¼ 26	9	"	"	"	120		40	Good	Water at 120 feet in gravel
	NE. ¼ 32	9	"	"	"	168		50	Good	Water at 149 feet in gravel
	SE. ¼ 7	10	"	"	Layland	135		30	Good	Water at 135 feet in gravel
	SW. ¼ 10	10	"	"	"	132		30	Good	Water at 132 feet in gravel
	NW. ¼ 16	10	"	"	"	115		25	Good	Water at 115 feet in gravel
	NE. ¼ 17	10	"	"	"	135		20		Water at 135 feet in gravel
	NW. ¼ 18	10	"	"	"	140		30	Good	Water at 140 feet in gravel
	SW. ¼ 19	10	"	"	"	150		30	Good	Water at 115 feet in gravel
	SW. ¼ 20	10	"	"	"	155		20		Water at 155 feet in sand and gravel
	NW. ¼ 20	10	"	"	"	180		35		Water at 155 feet in sand
	NE. ¼ 21	10	"	"	"	134		40		Water at 130 feet in quicksand which rose 75 feet in well
	NE. ¼ 21	10	"	"	"	335	175	15	Good	Water at 335 feet in bedrock
	NE. ¼ 21	10	"	"	"	125		25		
	30	10	"	"	"	195		30	Good	Water at 195 feet in gravel
	SE. ¼ 34	10	"	"	"	120		20		Water at 120 feet in gravel
47	—	12	"	"	Poplar Point	23		10	Good	Water in sand
	NW. ¼ 19	12	"	"	High Bluff	136		10	Good	
	NW. ¼ 32	12	"	"	"	124		15	Good	Water at 124 feet in sand
	1	13	"	"	Poplar Point	124		2	Good	Water
	1	13	"	"	"	145	140	5		Water at 145 feet in bedrock
	3	13	"	"	"	223	157			Water in quicksand which filled hole
	22	9	"	"	Elm Creek	134			Good	Water
	SE. ¼ 5	13	"	"	High Bluff	121		14	Good	Water at 121 feet
	30	13	"	"	Flee Island	95		11		Water at 95 feet in sand
	31	13	"	"	"	70		5	Good	Water at 51 feet in gravel
	NW. ¼ 32	13	"	"	"	225	90	5	Salty	Water at 205 feet in bedrock
	10	14	"	"	St. Mark	203	100	100	Good	Water at 203 feet in limestone
	10	14	"	"	"	193	86	5	Fair	Water at 193 feet in limestone
	14	14	"	"	"	170	90	10	Good	Water in limestone below red shale
	17	14	"	"	"	65		5	Good	Water in gravel, small supply

TABLE 5 (Cont'd.)

Wells of Brandon Sheet (No. 72), Tps. 9 to 16, Ranges 5 to 19, W. Prin. Mer.

Lot	Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remaks
						Feet	Feet	Feet		
	22	14	V	W.P.M.	St. Mark	140	80	14	Good	Water in limestone
	24	14	"	"	"	142	90	12	Good	Water in limestone
	NE. ¼ 26	14	"	"	"	180	95	7	Good	Water at 180 feet in limestone
	36	14	"	"	"	159	75	.....	.....	
	36	14	"	"	"	60	.....	10	Good	
	SW. ¼ 1	15	"	"	St. Ambroise	193	70	11	Good	Water at 193 feet in limestone below red shale
	2	15	"	"	"	158	40	5	Good	
	NW. ¼ 12	15	"	"	"	120	57	3	Good	Water at 120 feet in limestone
	NW. ¼ 8	10	VI	"	Layland	140	.....	10	.....	Water at 140 feet in gravel
	NE. ¼ 13	10	"	"	"	125	.....	25	Good	Water at 125 feet in gravel
	NW. ¼ 24	10	"	"	Dunn	230	145	50	Salty	Water at 160 feet in shale
	SE. ¼ 25	10	"	"	"	130	.....	25	Good	Water at 130 feet in gravel
	34	10	"	"	"	119	.....	26	Good	Water in gravel
	NE. ¼ 35	10	"	"	"	140	.....	47	Good	Water at 105 feet in gravel
	SW. ¼ 1	11	"	"	"	127	.....	31	Good	Water at 127 feet in gravel
	SE. ¼ 2	11	"	"	"	145	.....	30	Good	Water at 145 feet in gravel
	SE. ¼ 1	13	"	"	High Bluff	118	.....	9	Good	Water at 114 feet in gravel
	SE. ¼ 3	13	"	"	"	100	.....	16	.....	
	NW. ¼ 9	13	"	"	"	127	.....	20	Salty	Water at 127 feet in gravel
	13	13	"	"	Flee Island	95	.....	Dry	.....	Sand came in at 80 feet
	13	13	"	"	"	75	.....	15	Very good	Water at 73 feet in sand
	SE. ¼ 13	13	"	"	"	117	.....	12	Good	Water at 112 feet
	23	13	"	"	"	115	.....	.....	Dry	
	25	13	"	"	"	79	.....	19	Good	Water at 79 feet in sand
	Court House	12	"	"	Portage la Prairie	227	174	50	Good	Water at 227 feet in bedrock
	21	13	"	"	"	16	.....	.....	.....	Water in quicksand
		11	VII	"	"	12–16	.....	.....	.....	Water in sand above clay
		11	"	"	"	30	.....	.....	.....	Water in sand above clay
	NE. ¼ 33	10	VIII	"	Edwin	215	.....	.....	.....	No water reported
	SE. ¼ 5	11	"	"	"	162	.....	134	Good	Water at 162 feet in hardpan ?. Sand
	NE. ¼ 5	11	"	"	"	281	235—shale	261	Good	Water sand between 245 and 281 feet
	NE. ¼ 18	11	"	"	"	205	.....	105	Good	Water. Hardpan sand at 203 feet

	2	12	"	"	Burnside	158		158	Saline	Water at 158 feet in shale
	17	12	"	"	Rignold	223	207—limestone	23	Muddy	Water, not stated where struck (some water at 188 feet)
	17	12	"	"	"	70		Dry		
SE. ¼	18	12	"	"	"	279	220—limestone	160	Salty	Water at 223 feet in limestone
SE. ¼	19	12	"	"	"	270	220—limestone		?	Water at 175 feet gravel in blue clay
	19	12	"	"	"	180		12	Good	Water horizon not stated—quicksand at bottom
	29	12	"	"	"	113		7		Water at base in gravel and sand
NE. ¼	1	13	"	"	MacDonald	115		100	Good	Water at 109 feet in sand
	20	16	"	"	Lake Manitoba	65		Flows	Good	Water at 63 feet in gravel
NW. ¼	20	16	"	"	"	86		3		Water at 86 feet in hardpan
NE. ¼	31	16	"	"	"	72	10	7	Salty	Water at 72 feet in limestone
NW. ¼	32	16	"	"	"	58	20	6	Good	Water at 58 feet in limestone
SE. ¼	32	16	"	"	"	65		Flows	Good	Water at 65 feet in gravel
NE. ¼	9	9	IX	"	Lavenham	235		Dry		Clay
SE. ¼	13	9	"	"	"	105		20	Good	Water at 85 feet. Base of 50 feet of sand
	22	10	"	"	Rossendale	188		Flows		Water at 188 feet in gravel
NW. ¼	1	12	"	"	Bagot	230		210	Salty	Water at 225 feet in sand
NW. ¼	1	12	"	"	"	595	290—shale	100	Very salty	Water sand at 595 feet. Bitter water at 235 and 340 feet. Chalk and gypsum at 350–370 feet
	13	12	"	"	"	185		Dry		
	24	12	"	"	"	160		140	Good	Water at 160 feet in sand
	15	12	"	"	"	135		35	Good	Water at 135 feet in sand and gravel
	15	12	"	"	"	227			Slightly salty	Water at 120 feet in hardpan
	19	12	"	"	"	100		7		Water at 100 feet in gravel and sand
	29	12	"	"	Youill	97				
SE. ¼	17	13	"	"	Westbourne	156		Flows	Slightly salty	Water at 156 feet in hardpan
NW. ¼	19	13	"	"	"	185	160—shale	Flows	Slightly salty	Water at 179 feet in shale
SW. ¼	19	13	"	"	"	185		Flows	Slightly salty	Water at 185 feet
	25	13	"	"	"	65		45	Very good	Water at 65 feet in hardpan
SW. ¼	26	14	"	"	"	90		8	Salty	Water at 90 feet in gravel
	28	14	"	"	"	52		40	Good	Water at 52 feet in sand
NE. ¼	¼	15	"	"	Lakeland	55		8	Good	Water at 46 feet gravel below boulder clay
	10	15	"	"	"	56		50	Good	Water sand at 55 feet
NW. ¼	11	15	"	"	"	45		5	Good	Water at 41 feet in clay and gravel
NW. ¼	11	15	"	"	"	45		5	Good	Water at 41 feet. Quicksand
	11	15	"	"	"	115				Abandoned
	11	15	"	"	"	50				Abandoned
SE. ¼	17	15	"	"	"	55		5	Good	Water at 40 feet in sand

TABLE 5 (Cont'd.)

Wells of Brandon Sheet (No. 72), Tps. 9 to 16, Ranges 5 to 19, W. Prin. Mer.

Lot	Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
						Feet	Feet	Feet		
	20	15	IX	W.P.M.	Lakeland....	85	....	60	Good..........	Water at 70 feet in hardpan
	SW. ¼ 28	15	"	"	"	75	....	11	Good..........	Water at 53 feet in quicksand
	NE. ¼ 28	15	"	"	"	90	....	12	Good..........	Water at 83 feet in quicksand
	NW. ¼ 33	15	"	"	"	87	....	77	Little salty.....	Water at 87 feet in sand
	34	15	"	"	"	52	....	30	....	Water at 52 feet in sand. First 20 feet red clay
	SE. ¼ 4	16	"	"	Langruth.....	80	....	65	Good..........	Water at 74 feet in sand
	6	16	"	"	"	112	....	96	Good..........	Water at 112 feet in sand
	10	16	"	"	"	96	....	33	Good..........	Water at 96 feet in gravel
	20	16	"	"	"	93	....	5	Good..........	Water at 93 feet in sand
	20	16	"	"	"	165	135	Dry	....	
	NE. ¼ 23	16	"	"	"	35	....	7	Good..........	Water at 32 feet in gravel
	NW. ¼ 31	16	"	"	"	55	....	3	Good..........	Water at 55 feet in gravel
	NW. ¼ 35	16	"	"	"	31	10—limestone	4	Good..........	Water at 31 feet in limestone
	SW. ¼ 36	16	"	"	"	95	10—limestone	3	Good..........	Water at 95 feet in gravel?
	33	11	X	"	MacGregor...	195	....	43	Good..........	Water at 195 feet in hardpan
	NW. ¼ 14	11	"	"	" ...	213	....	40	Salty..........	Water at 183 feet in fine sand
	SE. ¼ 29	11	"	"	" ...	237	....	55	Salty..........	Water at 227 feet in hardpan
	35	12	"	"	Beaver.......	210	....	50	Good..........	Water at 210 feet in sand and gravel, 180–205 feet rubber clay above gravel
	4	15	"	"	Lakeland.....	90	....	....	Good..........	A little water at 72 feet in gravel
	14	15	"	"	"	145	....	....	....	Abandoned
	14	15	"	"	"	98	....	....	....	Abandoned
	14	15	"	"	"	77	....	....	....	Abandoned
	14	15	"	"	"	180	....	100	Good..........	Water at 180 feet in gravel
	19	15	"	"	"	146	....	138	....	Water at 144 feet in gravel
	28	15	"	"	"	144	....	41	Good..........	Water at 144 feet in quicksand
	7	16	"	"	Isafold........	140	131—limestone	25	Good..........	Water at 140 feet in limestone
	SW. ¼ 29	16	"	"	"	90	....	18	Good..........	Water at 35 feet in gravel
	35	16	"	"	"	90	....	14	Good..........	Water at 90 feet in sand
	36	13	XI	"	Golden Stream....	210	....	60	Salty..........	Water horizon not given

	36	13	"	"	"	86	....	15	Good...........	Water at 86 feet in clay?
NE. ¼	32	14	"	"	Gladstone....	148	....	142	Salty...........	Water at 148 feet in sand
NE. ¼	32	14	"	"	"	210	205—shale..	110	Salty...........	Water at 150 feet in hardpan
	29	14	"	"	"	10–15	....	....	Excellent.......	Water in sandy, fine silt
NE. ¼	6	15	"	"	"	94	....	74	Fresh...........	Water at 94 feet in gravel
	6	15	"	"	"	90	....	80	Good...........	Water at 90 feet in gravel
NW. ¼	5	15	"	"	"	365	250—lime-stone	....	Salty...........	Water at 230 feet in sand
SW. ¼	9	15	"	"	"	162	....	145	Good...........	Water at 162 feet in gravel
NW. ¼	16	15	"	"	"	110	....	75	Good...........	Water at 100 feet in sand
	16	15	"	"	"	72	....	5	Good...........	Water at 72 feet in gravel
	20	15	"	"	"	80	....	Dry	....	
	20	15	"	"	"	101	....	6	Good...........	Water at 101 feet in gravel
	24	15	"	"	"	210	....	195	Salty...........	Water at 210 feet in gravel
	2	14	"	"	Golden Stream.....	256	....	10	Good...........	Water. Bottom in boulder clay
NW. ¼	16	15	"	"	Gladstone....	105	....	75	Good...........	Water at top of sand at 100 feet
SE. ¼	24	15	"	"	"	190	....	100	Good...........	Water at 120 feet in sand
NW. ¼	29	15	"	"	Ogilvie.......	215	....	200	Fair............	Water at 215 feet in boulder clay and hardpan
SE. ¼	30	15	"	"	"	125	....	100	Fair............	Water at 120 feet in hardpan
SE. ¼	30	15	"	"	"	185	....	180	Good...........	Water at 187 feet in quicksand
	18	16	"	"	"	128	....	Dry	....	
	18	16	"	"	"	99	....	14	Good...........	Water in gravel at 99 feet
	32	14	XII	"	Gladstone....	46	....	11	Good...........	Water in gravel
SW. ¼	12	15	"	"	"	65	....	....	Fair............	Water at 65 feet in sand
NW. ¼	12	15	"	"	"	65	....	....	Good...........	Water at 65 feet in sand
	14	15	"	"	Ogilvie.......	140	....	Dry	....	
	14	15	"	"	"	100	....	70	Good...........	Water at 100 feet in sand
	14	15	"	"	"	110	....	Dry	....	
	15	15	"	"	"	73	....	13	Little salty.....	Water at 73 feet in sand
	36	15	"	"	"	120	....	Dry	....	
	36	15	"	"	"	72	....	52	Good...........	Water at 72 feet in sand
SE. ¼	3	16	"	"	"	80	....	70	Fresh...........	Water at 80 feet in gravel
SE. ¼	3	16	"	"	"	85	....	70	Salty...........	Water at 85 feet in clay
NW. ¼	33	10	XIII	"	Melbourne....	55	....	30	Hard...........	Water at 50 feet in sand
NE. ¼	3	14	"	"	Mekiwin......	165	....	140	Salty...........	Water at 160 feet in sand
	13	14	"	"	"	52	....	14	Good...........	Water at 52 feet in gravel
	30	10	XIV	"	Carberry.....	10–20	....	....	Good...........	Water at 10–20 feet in sand
	13	15	"	"	Arden........	10–50	....	....	....	All boulder clay
	32	15	"	"	"	104	....	Dry	....	
NW. ¼	33	14	XV	"	Neepawa.....	1,798	40—shale..	150	Salty...........	Water. Last water at 1,420 feet—rose to 150 feet. Water also at 1,185 feet
	33	14	"	"	"	60	....	....	Good...........	Water at 60 feet in gravel
	33	14	"	"	"	15–25	....	....	....	Water in till
	33	14	"	"	"	205	150?—shale?	....	....	Black marl at 150 feet (shale?)

TABLE 5 (Cont'd.)

Wells of Brandon Sheet (No. 72), Tps. 9 to 16, Ranges 5 to 19, W. Prin. Mer.

Lot	Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
						Feet	Feet	Feet		
		14	XV	W.P.M.	Neepawa	210	200—shale?	60	Salty	Water at 210 feet in black clay and shale
	17	15	"	"	Rossburn Jct.	108	103—shale	12	Good	At 108 feet just below sand
	NW. ¼ 17	15	"	"	"	110	80—shale	Dry		No water on account of hole in shale
	29	15	"	"	"	48		33	Good	Water at 48 feet in sand
	27	16	"	"	Eden	210			?	?
	SW. ¼ 20	12	XVI	"	Brookdale	125				Till to bottom
	SW. ¼ 18	13	"	"	"	207				Marl clay 135–207 feet ?
		13	"	"		50–70		30	Fair	Water in till
	16	13	"	"	Brookdale	65		Dry		
	16	13	"	"	"	50		Dry		
	16	13	"	"	"	48		Dry		
	33	13	"	"	"	52		Dry		
	33	13	"	"	"	60		Dry		
	33	13	"	"	"	56		46	Good	Water at 56 feet in sand
	6	14	"	"	Glendale	80		Dry		
	6	14	"	"	"	45		33	Good	Water at 45 feet in sand
	30	14	"	"	Franklin	36		10	Good	Water at 36 feet in sand
	16	15	"	"	Orrville	48		Dry		
	16	15	"	"	"	50		Dry		
	16	15	"	"	"	40		15	Good	Water at 40 feet in sand
	25	15	"	"	Springhill	26		22	Good	Water at 26 feet in sand
	26	23	"	"	Makinak	200			Salty	Water
	12	24	"	"	Ste. Rose du Lac	78			Slightly salty	Water
	26	11	XVII	"	Madford	64		44	Good	Water at 64 feet in gravel
	NW. ¼ 23	12	"	"	Creeford	110		30	Good	Little water at 45 feet, best at 104 feet
	SW. ¼ 34	12	"	"	Moore Park	115		Dry		Yellow and blue clay
	SE. ¼ 34	12	"	"	"	50		15		Water in quicksand at 49 feet
	SW. ¼ 34	12	"	"	"	102		70	Good	Water at 102 feet in gravel
	5	13	"	"	"	117		22	Good	Water at 65 feet, main at 117 feet in quicksand
	23	13	"	"	Cordova	110				Mostly blue clay

	23	13	"	"	"	95				Mostly blue clay
	23	13	"	"	"	35				Yellow clay
	31	13	"	"	"	90				Mostly clay
NE. ¼	31	13	"	"	"	50		16	Good	Water at 33 feet in gravel
SW. ¼	7	14	"	"	"	106		Dry		Mostly blue clay
	7	14	"	"	"	107				Mostly blue clay
SW. ¼	7	14	"	"	"	110				Mostly blue clay
NW. ¼	11	14	"	"	"	120				Mostly blue clay
	11	14	"	"	"	90				Mostly boulder clay
NW. ¼	11	14	"	"	"	245		Dry		Mostly boulder clay
SE. ¼	14	14	"	"	"	80		Dry		Mostly boulder clay
NW. ¼	15	14	"	"	"	15		6		Water at 14 feet in gravel
SE. ¼	15	14	"	"	"	86		60	Good	Water at 86 feet in gravel
	15	14	"	"	"	96		12	Good	Water. Little in gravel at 75 feet, most at 96 feet in sand
	15	14	"	"	"	110		Dry		Mostly blue clay
	22	14	"	"	"	60		141	Good	Water at 60 feet at top of sand
	26	14	"	"	"	161	95	34	Good	Water at 137 feet in shale, smaller flow in shale at 152 feet
	4	15	"	"	Franklin	40		Dry		Blue boulder clay
	4	15	"	"	"	45		15	Good	Water at 45 feet in gravel
	4	15	"	"	"	64		Dry		Blue boulder clay
	27	10	XVIII	"	Chater	42				Water at 42 feet in till
	27	10	"	"	"	31				Water at 31 feet in till
	3	12	"	"	Justice	101		73	Fair	Water at 100 feet in sand below blue clay
	18	12	"	"	"	85		49	Good	Water at 85 feet in sand below clay
NE. ¼	27	12	"	"	Varcoe	101		55	Good	Water at 101 feet in gravel below hardpan
SW. ¼	31	12	"	"	"	145		70	Good	Water at top and bottom of 20 feet gravel between blue clay 80–100 feet
	31	12	"	"	"	108			Fresh ?	? Little water at 98 feet in gravel
	32	12	"	"	"	152		Dry		Mostly hardpan and blue clay
SE. ¼	32	12	"	"	"	67		50	Good	Water at 67 feet in sand below blue clay
SE. ¼	32	12	"	"	"	130		Dry		Mostly blue clay
SE. ¼	33	12	"	"	"	120		70	Good	Water. Small supply at 70 feet in gravel in blue clay, main flow in gravel at 120 feet
	15	13	"	"	"	151		Dry		Yellow and blue clay
	15	13	"	"	"	190		Dry		Mostly blue clay
	15	13	"	"	"	103		Dry		Mostly blue clay
	15	13	"	"	"	164		Dry		Mostly blue clay
SE. ¼	2	14	"	"	Rufford	345		Dry		Practically all clay
NE. ¼	5	14	"	"	"	86		12	Good	Water at 86 feet in sand below clay
	5	14	"	"	"	183		Dry		Clay and boulder clay
	10	14	"	"	"	159		Dry		All clay

TABLE 5 (Cont'd.)

Wells of Brandon Sheet (No. 72), Tps. 9 to 16, Ranges 5 to 19, W. Prin. Mer.

Lot	Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
						Feet	Feet	Feet		
	NE. ¼ 10	14	XVIII	W.P.M.	Rufford	232		Dry		Clay and boulder clay
	10	14	"	"	"	96		Dry		All clay
	10	14	"	"	"	180		Dry		All clay
	10	14	"	"	"	26		12	Good	Water in sand below 20 feet of red clay
	NW. ¼ 12	14	"	"	"	150		5		Water at 14 feet in gravel—from here to bottom blue clay
	12	14	"	"	"	375	345—shale	Dry		
	NW. ¼ 12	14	"	"	"	161				? Yellow and blue clay
	NW. ¼ 21	14	"	"	Minnedosa	116				Mostly boulder clay
	NW. ¼ 21	14	"	"	"	132				? Yellow and blue clay
	NE. ¼ 21	14	"	"	"	112				Yellow and blue clay
	SE. ¼ 22	14	"	"	"	90		24	Good	Water at 90 feet in sand below blue clay
	NW. ¼ 24	14	"	"	"	105		4	Good	Water at 8 feet in yellow clay—to bottom blue clay
	34	14	"	"	"	74		29	Good	Water at 74 feet in gravel below blue clay
	36	14	"	"	"	52		26	Good	Water at 52 feet in sand below blue clay
	NW. ¼ 36	14	"	"	"	70		22	Good	Water at 70 feet in sand below clay
	16	14	"	"	"	507				?
	12	16	"	"	Clan William	95		Dry		Blue clay, some sand
	12	16	"	"	"	76		72	Good	Water at 76 feet in gravel
	14	16	"	"	"	64				Water at 64 feet in gravel below blue clay
	14	16	"	"	"	46		36	Good	Water at 46 feet in gravel below boulder clay
	7	9	XIX	"	McKelvie	70		15	Good	Water at 70 feet in gravel
	9	9	"	"	"	95		Dry		Hardpan and blue clay
	SE. ¼ 9	9	"	"	"	200		Dry		Hardpan—mostly blue clay
	10	9	"	"	"	108	50—shale	Dry		
	10	9	"	"		70	60—shale	30	Fair	Water at 70 feet in shale
	SE. ¼ 15	9	"	"	McKelvie	70		Dry		Yellow clay and hardpan
	SE. ¼ 17	9	"	"	"	125		Dry		Hardpan—yellow and blue clay
	18	9	"	"	"	375		Dry		In shale and limestone

	18	9	"	"	"	100	....	Dry	....	Hardpan and boulder clay
	18	9	"	"	"	60	....	0	Very good......	Water at 60 feet in hardpan
	23	9	"	"	Brandon hills.	110	....	8	Good..........	Water at 110 feet in gravel below hardpan
	24	9	"	"	"	80	....	....	....	Clay—last 20 feet sand
	24	9	"	"	"	215	....	....	....	All clay
SE. ¼	24	9	"	"	"	225	....	Dry	....	All clay. Small gas flow at 185 feet
	30	9	"	"	Roseland.....	65	....	15	Good..........	Water at 65 feet in hardpan gravel
	30	9	"	"	"	65	....	40	....	Water at 65 feet in hardpan gravel
	31	9	"	"	"	70	....	30	Good..........	Water at 70 feet in ?
	34	9	"	"	"	66	....	45	Good..........	Water at 66 feet in gravel
	34	9	"	"	"	70	....	40	Good..........	Water at 66 feet in gravel and clay
	34	9	"	"	"	185	....	....	....	All clay
	35	9	"	"	"	75	....	40	Good..........	Water at 75 feet in gravel
	23	10	"	"	Brandon......	10–30	....	....	Good..........	Water 10–30 feet in gravel underlain by till
NW. ¼	27	10	"	"	"	28	....	25	Hard..........	Water at 27 feet in gravel
NW. ¼	27	10	"	"	"	25	....	20	Soft...........	Water at 25 feet in sand
NW. ¼	27	10	"	"	"	18	....	5	Soft...........	Water at 14 feet in gravel
NW. ¼	27	10	"	"	"	16	....	9	Soft...........	Water at 15 feet in gravel
	27	10	"	"	"	25	....	....	Soft...........	Water in sand and gravel
		....	....	....	"	25	....	22	Soft...........	Water at 23 feet in gravel (well at Dominion Experimental Farm, Brandon)
	10	11	"	"	"	70	....	?	....	Water at 70 feet in boulder clay
	13	11	"	"	"	47	....	20	Fair...........	Water at 47 feet in boulder clay
	13	11	"	"	Knox.........	48	....	22	Fair...........	Water at 48 feet in boulder clay
		12	"	"	"	95	....	Dry	....	Red and blue clay
		12	"	"	"	65	....	40	Good..........	Water at 65 feet in sand below hardpan
	25	12	"	"	"	241	187—shale	Dry	....	
	25	12	"	"	"	152	....	62	Good..........	Water at 152 feet in gravel below hardpan
	12	13	"	"	Varcoe........	80	....	Dry	....	Blue clay
	12	13	"	"	"	76	....	Dry	....	Blue clay
	12	13	"	"	"	65	....	47	Good..........	Water at 65 feet in sand below clay
	25	13	"	"	Rapid City...	84	....	Dry	....	Clay
	25	13	"	"	"	66	....	Dry	....	Clay
	25	13	"	"	"	90	....	Dry	....	Clay
	31	13	"	"	"	59	....	Dry	....	Clay
	31	13	"	"	"	78	....	Dry	....	Clay
	16	14	"	"	Riverdale.....	108	....	Dry	....	Clay
	16	14	"	"	"	128	....	Dry	....	Clay
	27	19	"	"	Brandon......	18	....	....	Medium soft....	Water in sand and gravel
	27	19	"	"	"	16	....	....	Soft...........	Water in sand and gravel
	27	19	"	"	"	25	....	....	Soft...........	Water in sand and gravel
	27	19	"	"	"	28	....	....	Hard...........	Water in sand and gravel
	11	16	"	"	Basswood.....	100	....	55	Good..........	Water at 100 feet in sand below hardpan

WINNIPEG SHEET (NO. 73), TPS. 9 TO 16, RANGES 1 TO 4, W. PRIN. MER., AND 1 TO 11, E. PRIN. MER.

A nearly level, stoneless clay plain, known as the Red River Valley plain, occupies the central and southeastern parts of the sheet. It extends only a few miles north of Assiniboine river to where it is bounded by a stony clay, partly wooded plain interrupted in places by gravel ridges and boulder clay hills, the most prominent of which is the "Big Ridge of the Assiniboine" a few miles northeast of Reaburn. The stoneless clay plain extends north along Red river to lake Winnipeg and for about 15 miles west of the lake. On the east side of the river it is bounded by a series of gravel hills and ridges, extending from Birds Hill, 7 miles northeast of Winnipeg, to the east side of lake Winnipeg. These hills are separated from another range of drift hills to the east by a stoneless clay plain, in part swampy, that is a continuation of the Red River Valley plain, the eastern border of which lies about 30 miles east of Winnipeg. Much of the eastern part of the sheet is swampy, and large parts are nearly level, but in places drift and rock hills rise above the general level. A clay plain extends along Whitemouth and Winnipeg rivers and forms the only extensive tract of naturally drained land in the eastern part of the sheet. The northeastern part is a rolling, stony, clay plain that is partly wooded and has many marshy tracts. Limestone underlies the surface deposits over the central and western parts of the sheet, except in the southwest where shale forms the bedrock. Precambrian rocks underlie the eastern part of the sheet, the boundary between these rocks and the limestone being approximately along Whitemouth river.

The artesian well areas of the sheet are described on pages 15-17. In the area along Assiniboine river water under pressure is obtained at depths of 40 to 100 feet in the limestone bedrock and in some places in gravel at the base of the surface deposits. The water rises nearly to the surface and, at a few places at low elevations, flows. In some cases the water is fresh and in others saline, the water from the limestone, except at considerable depths, being of better quality than that from the surface deposits or from the shale and gypsum that underlie the surface deposits in places along the south side of the river. Southwest of Assiniboine river in the vicinity of Starbuck and Fannystelle, small supplies of water are obtained in the surface deposits, but deep wells in the bedrock yield saline water. In the stony clay plain in the northwestern part of the sheet, good water is usually obtained at shallow depths in the surface deposits or at depths of 50 to 200 feet in the limestone bedrock. West Shoal lake and East Shoal lake in this part of the sheet are saline to some extent, but the water is usable for stock. In the sand and gravel areas in the eastern part, good water is obtainable at shallow depths; in the clay areas little water is obtainable from the clay itself, but in most places it is found in sand and gravel below the clay. The surface water in the swampy eastern part of the sheet is of good quality, and wells sunk to shallow depths yield large supplies.

The salinity of Red river is fairly high and in autumn averages, over its course from the International Boundary to Selkirk, over 500 parts a million.[1]

[1] Wallace, R. C., Baker, W. F., and Ward, G.: "The Red River as an Erosive Agent"; Trans. Roy. Soc., Canada, vol. 20, sec. IV, pp. 149-167 (1926).

TABLE 6

Wells of Winnipeg Sheet (No. 73), Tps. 9 to 16, Ranges 1 to 4, W. Prin. Mer., and 1 to 11, E. Prin. Mer.

Lot	Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
						Feet	Feet	Feet		
	4	9	I	E.P.M.	Oak Bluff	50		4	Extra good	Water at 50 feet in sand
	6	9	"	"	"	53	40—sandstone	10	Good	Water at 53 feet in sandstone
	NE. ¼ 12	9	"	"	"	65	50—limestone	25	Salty	Water at 60 feet in limestone
	SE. ¼ 17	9	"	"	"	50	50—rock	7	Salty	Water at 50 feet in rock
	19	9	"	"	"	54	40—rock	?	Poor	Water at 54 feet in rock
	21	9	"	"	"	32		8	Mineral	Water at 32 feet in boulder clay
	SE. ¼ 25	9	"	"	"	50		14	Salty	Water at 49 feet in sand
	NE. ¼ 26	9	"	"	"	145	50—red rock	30	Fair	Water at 144 feet in limestone
	27	9	"	"	"	40		13	Salty	Water at 40 feet in hardpan
	28	9	"	"	"	60	45—rock	?	Poor	Poor water at 50 feet
	NE. ¼ 28	9	"	"	"	105	40—limestone	15	First class	Water at 60–85 feet and 105 feet in limestone
	28	9	"	"	"	50	40—rock	11	Little salty	Water at 50 feet in rock
	34	9	"	"	"	54		12	Good	Water at 54 feet in "clay" ?
	35	9	"	"	"	50			Salty	Water
	36	9	"	"	"	34		Dry		Clay and boulder clay
	36	9	"	"	"	55	55	5	Splendid	Water at 55 feet in "rock"
	1	10	"	"	"	51	30	12	Good	Water at 51 feet
	1	10	"	"	"	40			?	Water at 40 feet
51		10	"	"	Headingly	83		Good flow	Fresh	Water
		10	"	"	"	71½			Good	Water
		10	"	"	"	48	39—limestone	5	Fresh	Water at 48 feet in limestone. Big flow
		10	"	"	St. Charles	66		Dry		
	13	10	"	"	"	50	29—limestone		Salty	Water at 50 feet in limestone
	27	11	"	"	Headingly	60	24—limestone	?	Good	Water at 60 feet in limestone

TABLE 6 (Cont'd.)

Wells of Winnipeg Sheet (No. 73), Tps. 9 to 16, Ranges 1 to 4, W. Prin. Mer., and 1 to 11, E. Prin. Mer.

Lot	Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
						Feet	Feet	Feet		
	33	11	I	E.P.M.	Headingly	15		?	Good	Water in gravel
	2	12	"	"	Rosser	52	20—red shale	13	Good	Water at 52 feet in bed-rock
	3	12	"	"	"	71	31—limestone	17	Good	Water at 71 feet in lime-stone
	3	12	"	"	"	49	31—limestone	12	Good	Water at 49 feet in lime-stone
	7	12	"	"	"	29	22—rock	8	Good	Water at 30 feet in rock
	8	12	"	"	"	73½	40—limestone	Dry		
	8	12	"	"	"	13		Dry		
	8	12	"	"	"	89	53—rock	14	Good	Water at 89 feet in lime-stone
	21	12	"	"	"	44	34—limestone	2	Good	Water at 44 feet in lime-stone
	21	12	"	"	"	58	46—limestone	8	Good	Water at 58 feet in lime-stone
	36	12	"	"	"	25			Good	Water
	31	13	"	"	Stonewall	60	41—limestone	12	Good	Water at 60 feet in lime-stone
	33	13	"	"	"	44	32—limestone	12	Good	Water at 44 feet in lime-stone
	36	13	"	"	"	31	12			Water
	36	13	"	"	"	82	12—limestone	?		Water at 82 feet in lime-stone
			"	"	Headingly	213			Salty	Water
14			"	"	"	213	109—red rock	28	Tinged with salt	Water at 201 feet in red shale
16			"	"	"	45	35—limestone	10	Good	Water at 45 feet in lime-stone
16			"	"	St. Charles	94	56—red rock	9	Good	Water at 94 feet in lime-stone
16			"	"	"	80		24	Good	Water at 80 feet in sand
47			"	"	Headingly	207		7	Slightly salty	Water at 207 feet in ?
47 and 48			"	"	"	30			Good	Water at 30 feet in gravel
38			"	"	"	90	44—red rock	6	Good	Water at 90 feet in lime-stone

53			“	“	“	51		2	Good	Water at 51 feet below boulder clay
59			“	“	“	133½		1	Good	Water at 133½ feet in red rock sand
60			“	“	“	56		8	Good	Water in quicksand at 56 feet
60			“	“	St. Charles	93		13	Good	Water at 93 feet in quicksand
60			“	“	“	108	60—red shale	15	Good	Water at 108 feet in ?
61			“	“	Headingly	127½	65—limestone	Flows	Good	Water at 127 feet in red rock below limestone
62			“	“	St. Charles	151	50—red shale	21	Good	Water at 151 feet in limestone
65			“	“	“	105	45—red shale	20	Very good	Water at 105 feet in red shale and white sand
66			“	“	“	98		23	A little salty	Water at 98 feet in gravel
68			“	“	Headingly	63	30—limestone	1	Good	Water at 63 feet in limestone
68			“	“	St. Charles	40		7	A little salty	Water at 48 feet in hardpan
72			“	“	“	35		10	A little salty	Water at 35 feet in sand
73			“	“	“	30		10	Good	Water at 30 feet in gravel
75			“	“	“	36		16	Good	Water at 36 feet in sand
77			“	“	“	50		15	Very good	Water at 50 feet in gravel
84			“	“	“	152	51—red shale	30	Good	Water at 152 feet in limestone
112			“	“	“	52		Dry		
76			“	“	“	22	15—limestone	7	Good	Water at 22 feet in limestone
214			“	“	Headingly	70	40	1	Good	Water at 70 feet in limestone
	17		“	“	“	55	45	15	Good	Water at 55 feet in red rock
	17		“	“	“	40		8	Good	Water at 40 feet in gravel
	17		“	“	“	41	31—limestone	4	Good	Water at 41 feet in limestone
	20	9	II	“	Oak Bluff	204	95—limestone	101	Poor	Water at 204 feet in limestone
	21	9	“	“	“	56	40—rock	24	Good	Water at 56 feet in rock
	21	9	“	“	“	106		56	Poor	Water at 106 feet in sand
	SE. ¼ 30	9	“	“	“	67		30	Salty	Water at 65 feet in sand
	SE. ¼ 29	12	“	“	Stony Mountain	1,010	0			Igneous rock at 708 feet
	11	13	“	“	“	14½				Water
	11	13	“	“	“	110				
	11	13	“	“	“	101				Water
	11	13	“	“	“	20½				Water

TABLE 6 (Cont'd.)

Wells of Winnipeg Sheet (No. 73), Tps. 9 to 16, Ranges 1 to 4, W. Prin. Mer., and 1 to 11, E. Prin. Mer.

Lot	Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
						Feet	Feet	Feet		
	SE. ¼ 7	15	II	E.P.M.	Stony Mountain.	94	11—limestone...	....	....	Water
17...............	....	......	"	"	St. James.......	55	45.............	15	Good..........	Water at 55 feet in rock
	....	9	III	"	St. Norbert.....	62	....	22	Good..........	Water at 62 feet in hard-pan
	....	10	"	"	Winnipeg........	48½	48½—rock.......	....	....	
	....	10	"	"	"	49½	49½—rock.......	....	....	
	....	10	"	"	St. Vital........	247	59—rock........	25	Good..........	Water at 52 feet in gravel and 247 feet in cavernous limestone
	....	10	"	"	"	62	62—rock........	27	Good..........	Water at 52 feet in gravel and 62 feet in rock
	....	11	"	"	Winnipeg........	....	....	....	....	
	NE. ¼ 31	11	"	"	"	300	69—shaly limestone	42·5	....	Water at 300 feet in limestone
	NW. ¼ 5	12	"	"	"	397	94—limestone...	37	....	Honeycombed rock at 304–310
	SE. ¼ 6	12	"	"	"	300	80.............	43	....	Water
	NE. ¼ 6	12	"	"	"	180	65—shale.......	37	....	Water at 135 feet in "broken rock"
	SW. ¼ 8	12	"	"	"	282	43—limestone...	34	....	Water. Bottom of well in "broken" limestone
	NW. ¼ 8	12	"	"	"	202·5	43—shale.......	25	....	Water 2 feet crevice at 150 feet in limestone
	SW. ¼ 17	12	"	"	"	150·5	40—shale.......	15	....	Water presumably at bottom in limestone
	NW. ¼ 17	12	"	"	"	201	57—shale.......	20	....	Water presumably at bottom in limestone
	SW. ¼ 20	12	"	"	"	205	45—limestone...	12	....	Water presumably at bottom in limestone
	NW. ¼ 20	12	"	"	"	198	38—shale.......	12	....	Water presumably at bottom in limestone
	SW. ¼ 29	12	"	"	"	203·4	39—shale.......	10½	....	Water seam at 91 feet and also at bottom
	NW. ¼ 29	12	"	"	"	207	92.............	5	....	Water
	NW. ¼ 32	12	"	"	"	198	42.............	4	....	Water

	SW. ¼	32	12	"	"	"	188	50—shale	4		Water presumably at bottom in limestone
	SW. ¼	5	13	"	"	"	205	48—shale	2½		Water presumably at bottom in limestone
	NW. ¼	5	13	"	"	"	96	?	5		Water presumably at bottom in clay and marl
	NW. ¼	8	13	III	"	Winnipeg	139	43?—limestone	5		Water. Water presumably at bottom in limestone
	SW. ¼	17	13	"	"	"	200	30—limestone	7		Water
	NE. ¼	33	16	"	"	Toulon	95	75—brown rock	?	Good	Water at 95 feet in brown rock
			14	IV	"	Selkirk	300	97—limestone			Water at 300 feet in sandy layers in shale
		6	14	V	"	West Selkirk	100	65			Water
	SE. ¼	9	11	VI	"	Dundee			5		Water
	Exhibition Grounds				"	St. Boniface	156	80—limestone			Water
					"	Winnipeg	50–100				Water 60 city wells
					"	"	225				Water at 225 feet
	Swift Packing Co., Elmwood				"	"	630	87—soft grey rock	18	Salty	Salt water 442–465 feet, gas ? 605–630 feet, granite 630 feet
River lot 37, Queen st.					"	"	227?	?	?		Water at 227 feet, also 100–190 feet. Oily at 135 feet
River lot 22, Oakdale park					"	"	365	67—limestone	36		Big water 315 to 325, also 21–27 in quicksand (some at 100 and 140 feet in limestone)
River lot 34, Fire Hall, Berry st.					"	"	363	43—limestone	41		Most water from 285–320 feet where rock very open (also 55, 71, 114, 265 feet)
	Close N. Assiniboine River, 1½ miles W. Osborne St. bridge				"	"	132	32—limestone	?	Good	Water at 132 feet in limestone
					"	"	38				Water
	Assiniboine park				"	"	109	68—limestone	30	Salty and iron taste	At 109 feet in limestone

Table 6 (Cont'd.)

Wells of Winnipeg Sheet (No. 73), Tps. 9 to 16, Ranges 1 to 4, W. Prin. Mer., and 1 to 11, E. Prin. Mer.

Lot	Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
						Feet	Feet	Feet		
106				E.P.M.	St. Paul Municipality	76	55—limestone	23	?	At 76 feet in limestone
60 (2 miles south of Assiniboine river)				"	St. Charles	50	29—limestone	?	Salty	Salty water at 40 feet in limestone
				"	Deacon	250	96—limestone	?	?	
				"	"	92				Clay, hardpan, and gravel
216–217			I	W.P.M.	St. Francois Xavier	71	28—limestone	1	Good	Water at 70 feet in limestone
216–217			"	"	"	30	?	3	Good	Water at 30 feet in gravel
	4	9	"	"	Starbuck	50			Good	Water
	36	9	"	"	Springstein	45	35	32	Good	Water at 45 feet in "rock"
		10	"	"	St. Francois Xavier	114	48—limestone	?	Brackish	Water at 114 feet in limestone
	7	12	"	"	Alder	53	35	5	Good	Water at 53 feet in "shale limestone rock"
	7	12	"	"	"	30			Good	Water
	8	12	"	"	"	73½		Dry		
	8	12	"	"	"	64		Dry		
	18	13	"	"	Hanlan	29		16	Fresh	Water at 29 feet
	SW. ¼ 20	13	"	"	Warrenton	36½	36	26		Water at 36 feet
	36	13	"	"	"	24		12	Good	Water in hardpan and rock at 24 feet
	32	14	"	"	Oswald	67	62—limestone	63	Good	Water at 67 feet in limestone
	6	15	"	"	"	95		Dry		
	6	15	"	"	"	147		37	Good	Water
	14	9	II	"	Starbuck	428				
	19	9	"	"	"	130		28	Second class	Water at 130 feet in limestone
	20	9	"	"	"	52		25	Good	Water at 52 feet in gravel
	32	9	"	"	Shiperlay	119		32	Good	Water at 119 feet in limestone

	32	9	"	"	"	126	....	20	Good..........	Water at 126 feet in gravel
	8	10	"	"	"	87	....	5	Good..........	Water at 87 feet in sand
144..............	....	11	"	"	Pigeon Lake....	269½	60—limestone...	9	Good..........	Water at 269 feet in red rock
61 and 72..........	....	11	"	"	"	60	10—limestone...	8	Good..........	Water at 38 feet in limestone—sulphur at 60 feet in limestone
61 and 72..........	....	11	"	"	"	47	30—limestone...	16	....	Water at 37 and 47 feet in limestone
180 and 181........	....	11	"	"	"	94	52—limestone...	5	Good..........	Water at 66 feet in limestone and at 94 feet in limestone
167, 168, and 170...	....	11	"	"	"	48	....	Flows	Good..........	Water at 42 feet in boulders
167, 168, and 170...	....	11	"	"	"	39½	?	4	Good..........	Water at 39 feet
158	....	11	"	"	"	70	....	10	Bad...........	Water at 25 feet, mineral, 53 feet, mineral, 70 feet bad. All clay gravel boulders
126..............	....	11	II	"	"	80	49—limestone...	8	Salty..........	Salty water at 65 and 75 feet in limestone
158..............	....	11	"	"	"	43	....	....	Fair............	
159..............	....	......	....	"	"	48	....	....	....	Clay and gravel—limestone at base
	23	12	II	"	Meadows.......	61	50—"rock".....	12	Medium........	Water at 61 feet in rock
	23	12	"	"	"	73	60—"rock".....	8	Salty..........	Water at 73 feet in "rock"
	6	13	....	"	Marquette......	72	66—limestone...	5	Good..........	Water at 72 feet in limestone below hardpan
	6	13	"	"	"	116	63—limestone...	2	Good..........	Water at 116 feet in limestone
	7	13	"	"	"	83	60—limestone...	5	....	Water at 60 feet in gravel and 83 feet in limestone
	8	13	"	"	"	31	....	11	Alkaline........	Water at 31 feet in boulder clay
	30	13	"	"	Meadowlea.....	20–95	....	....	....	Water. Does not reach bedrock
	27	14	"	"	Woodlands......	110	88—limestone...	36	Good..........	Water at 110 feet in limestone
	34	14	"	"	....	98	78—limestone...	68	Good..........	Water at 98 feet in limestone
	10	15	"	"	Woonona........	85	83—rock........	24	Good..........	Water at 85 feet in rock
	31	15	"	"	....	45	....	....	....	Water
	9	9	III	"	Fannystelle.....	80	....	4	Salty (very little)	Water at 80 feet in gravel
	17	9	"	"	"	77	....	....	....	Clay—rock fragments—quicksand

TABLE 6 (Conc'd.)

Wells of Winnipeg Sheet (No. 73), Tps. 9 to 16, Ranges 1 to 4, W. Prin. Mer., and 1 to 11, E. Prin. Mer.

Lot	Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
						Feet	Feet	Feet		
	1	11	III	W.P.M.	Elie	448	52—limestone			Water. Poor water in gravel just above limestone
	36	11	"	"	St. Eustache	65½		11	Good	Water at 65 feet in fine sand
165		12	"	"	Reaburn	92	50—limestone	6		Water at 92 feet in limestone
	3	13	"	"	"	85	84—limestone	0	First class	Water at 85 feet in limestone
	7	13	"	"	"	64		Flows	First class	Water at 64 feet in hardpan and rock
	15	13	"	"	"	115		30		Water at 115 feet in gravel
	15	13	"	"	"	114		2	Good	Water at 114 feet in gravel
	16	13	"	"	"	166	119—red rock	Flows	Good	Water at 166 feet in limestone
	17	13	"	"	"	134	120—limestone	10	Good	Water at 134 feet in limestone
	7	14	"	"	Bonnie Doon	149	132—red rock			Water. Abandoned
	7	14	"	"	"	223	138—red rock	37	Good	Water at 223 feet in limestone (old borings 138 feet)
	SW. ¼ 30	14	"	"	"	170	?	4	Good	Water at 170 feet
	4	15	"	"	"	115		50		Water at 115 feet in gravel
	4	15	"	"	"	55		Dry		Small amount at 28 feet in boulder clay
	22	15	"	"	Lake Francis	75	63—limestone	43	Good	Water at 75 feet in limestone
	30	15	"	"	"	54		15	Good	Water at 54 feet in hardpan
	36	15	"	"	"	95	60—red rock	5	Good	Water at 75 feet in "red rock"
	1	9	IV	"	Culross	164		34	Very good	Water at 164 feet in hardpan

		2	9	"	"	"	127	....	Dry	....	Clay, boulder clay, and sand
	SW. ¼	6	9	"	"	"	186	....	30	Good..........	Water at 170 and 186 feet in gravel
		8	9	"	"	"	112	....	19	Fair............	Water at 112 feet in gravel
		15	9	"	"	"	106	....	15	Not good.......	Water at 106 feet in hard-pan
		18	9	"	"	"	188	....	138	?	Water at 188 feet in quick-sand. (Coal fragments in last 9 feet)
		28	9	"	"	"	110	....	15	Good..........	Water
		18	10	"	"	"	87	....	2	Good..........	Water at 87 feet in sand
		2	11	"	"	Fortier.........	83½	....	16	Good..........	Water at 83 feet in gravel
79................	....		12	"	"	Poplar Point....	158	111.............	8	Good..........	Water at 158 feet in rock
		4	13	"	"	"	130	125.............	Flows	Good..........	Water at 130 feet in lime-stone
		8	13	"	"	"	133	130.............	Flows	First class......	Water at 133 feet in lime-stone
		9	13	"	"	"	154	149—rock.......	3	Good..........	Water at 154 feet in rock
		9	13	"	"	"	171	....	71	Good..........	Water
		15	13	"	"	"	54	....	Flows	Good..........	Water at 54 feet in gravel
		16	13	"	"	"	115	45—limestone...	....	Good..........	Water at 115 feet in gravel N.B. limestone 45 to 106 feet, then gravel ?
		16	13	"	"	"	113	47—limestone...	0	Good..........	Water at 113 feet in lime-stone
		22	13	"	"	Long Lake......	67	....	Flows	Good..........	Water at 67 feet in hard-pan
	SW. ¼	36	13	"	"	Poplar Point....	89	....	30	Good..........	Water at 81 feet good water, at 89 feet salt water
		2	14	"	"	Bonnie Doon....	90	....	40	....	Water at 90 feet in sand
		28	14	"	"	"	122	25.............	11	Good..........	Water at 122 feet
	SW. ¼	34	14	"	"	"	115	....	6	Good..........	Water at 122 feet in sand
		14	15	"	"	Lake Francis...	83	55—red rock....	Flows	Good..........	Water at 68 feet in lime-stone
		18	16	"	"	St. Laurent.....	49	....	5	?	Water at 49 feet in gravel
		18	16	"	"	"	49	....	4	Good..........	Water at 49 feet in gravel

RIDING MOUNTAIN SHEET (NO. 121), TPS. 17 TO 24, RANGES 20 TO 33, W. PRIN. MER.

All of the sheet, except the northeastern part known as Gilbert Plains drained by numerous small streams flowing northeast, is an upland, which has a general elevation of 1,600 to 2,400 feet above the sea, about 1,000 feet higher than the Manitoba lowland to the east. It is drained by Assiniboine river flowing south, and its tributaries, the largest of which is Qu'Appelle river coming from the west and joining the Assiniboine near the southern border of the sheet. A range of hills trending northwest in the central and eastern parts of the sheet forms the highest part and is known as Riding mountain. Much of this hilly region is included in the Riding Mountain Forest Reserve, and is forested. The part of the sheet west of Assiniboine river is a rolling plain a few hundred feet lower than the hilly region to the east, and for the most part is prairie. Assiniboine and Qu'Appelle rivers flow in narrow, flat-bottomed valleys 200 to 300 feet deep. The tributary valleys are narrow and deep for short distances from the main streams, and in their upper reaches flow on the upland, much of which is free from stream valleys. Surface deposits conceal the bedrock over the whole area except in a few places along the river valleys, and have a thickness in many places of over 100 feet. A large area of sand and gravel occurs at the junction of Qu'Appelle and Assiniboine rivers, and is deeply trenched by these streams. Gilbert Plains in the northwestern part of the sheet is underlain by clay containing a few boulders. Boulder clay forms the surface deposit over the rest of the sheet except in the river valleys floored with alluvium, and for small areas of sand and gravel. Shale underlies the surface deposits over the greater part if not all of the sheet.

In the Gilbert Plains area in the northeastern part of the sheet good water is obtained in sand and gravel below the surface clay, but wells sunk into the shale bedrock find saline water. In the hilly belt extending northwest through the central part of the sheet where there are a great many lakes and ponds, water is usually found at shallow depths in the surface deposits and the water in the lakes, especially those that have outlet streams, is of good quality. In the area between the hilly region and Assiniboine river on the west, water is usually found in the shale below the surface deposits. Many dry holes have been drilled in this area in the vicinity of Birtle, Foxwarren, and Solsgirth at places where only boulder clay occurs above the bedrock. At some places water is found in gravel below the boulder clay. In the vicinity of Binscarth the surface deposits are exceptionally thick and water is found in them at depths of 100 to over 200 feet. In the area west of Assiniboine river, well water is obtainable at some places, and not at others. Where the boulder clay extends down to the bedrock, only seepage water from the clay is available and the supply is small. At many places, however, there is gravel below the clay, and water is found in it or in the shale below. Water is readily found at shallow depths in the river valleys and it is of better quality than that found on the upland.

TABLE 7

Wells of Riding Mountain Sheet (121), Tps. 17 to 24, Ranges 20 to 33, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
	23	XX	W.P.M.	Keld..............	743	Shale at surface.	?	....	Pierre to Devonian—gypsum in Devonian
SW. ¼ 26	23	"	"	"	500	?	?	....	
26	23	"	"	"	245	70—sandstone...	....	....	Water. Some at 124 feet in shale. Salt water at 170 feet in shale
NW. ¼ 5	24	XXI	"	Gilbert Plains (Keld)	270	60—shale.......	....	....	No water
4	18	XXII	"	Menzie.............	100	....	65	....	Water at 100 feet in sand
4	18	"	"	"	85	....	....	....	Dry
10	24	"	"	Glenlyon...........	135	....	?	....	?
9	17	XXIII	"	Shoal Lake.........	176	....	19	Good..........	Water at 176 feet in shale, boulders and quicksand
NE. ¼ 9	17	"	"	"	85	....	10	Good..........	Water at 84 feet in gravel
19	17	"	"	"	150	....	Dry	....	
19	17	"	"	"	100	....	15	Good..........	Water at 100 feet in gravel—some shale
NW. ¼ 12	24	"	"	Glenlyon...........	435	?	Dry	....	
36	25	"	"	Grand View........	170	....	....	Salty..........	Water
27	17	XXIV	"	Kelloe.............	86	66—shale.......	50	Good..........	Water at 86 feet in very hard shale
14	24	"	"	Gilbert Plains......	68	....	38	Salty..........	Water at 68 feet in shale and stones
NE. ¼ 30	24	"	"	"	560	....	....	....	? Blue clay and shale
30	17	XXV	"	Solsgirth...........	360	....	....	....	Water
34	18	"	"	"	107	....	20	Good..........	Water at 107 feet in hardpan and shale
SW. ¼ 21	20	"	"	Birdtail............	140	130—soapstone..	Dry	....	Stony clay to 130 feet
22	20	"	"	"	....	....	....	....	
32	17	XXVI	"	Birtle..............	35	....	Dry	....	Clay and boulder clay
32	17	"	"	"	108	....	Dry	....	Clay and boulder clay
18	18	"	"	Foxwarren..........	110	....	13	....	Water at 110 feet in gravel
34	18	"	"	"	213	200—soapstone..	78	Good..........	Water at 213 feet in soapstone
16	19	"	"	Seeburn............	70	Started at 55 in shale	15	....	Water at 70 feet in shale
20	19	"	"	"	115	45—shale.......	25	....	Water at 102 feet in shale
21	19	"	"	"	70	Started at 33 in shale	17	....	Water at 70 feet in shale

TABLE 7 (Cont'd.)

Wells of Riding Mountain Sheet (121), Tps. 17 to 24, Ranges 20 to 33, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
21	19	XXVI	W.P.M.	Seeburn..........	69	Started at 33 in shale	20	....	Water at 69 feet in shale
10	20	"	"	Angusville.........	130	Started at 60–110 in shale	25	....	Water at 120 feet in shale
NW. ¼ 10	20	"	"	"	110	80—shale......	80	Good..........	Water at 110 feet in shale
SW. ¼ 15	20	"	"	"	120	105—shale.....	90	Good..........	Water at 120 feet in shale
NW. ¼ 18	20	"	"	"	60	....	37	Good..........	Water at 50 feet in gravel
	....	"	"	"	140	135—shale.....	123	Good..........	Water at 140 feet in shale
22	20	"	"	"	115	....	?	....	?
22	20	"	"	Silverton.........	170	....	90	....	Water at 170 feet in gravel
NW. ¼ 4	21	"	"	"	115	....	100	Good..........	Water at 115 feet in gravel
4	18	XXVII	"	Foxwarren.........	62	....	18	Good..........	Water at 62 feet in gravel
12	18	"	"	"	100	....	25	Good..........	Water at 100 feet in sand and shale
30	19	"	"	Lidford...........	98	....	Dry	....	Clay, gravel, and sand
NW. ¼ 30	22	"	"	Endcliffe.........	500	....	....	....	?
NW. ¼ 24	20	"	"	Silverton.........	128	....	90	Good..........	Water at 128 feet in gravel
24	20	"	"	"	90	....	30	Good..........	Water at 90 feet in shale and blue clay
3	17	XXVIII	"	Foxwarren.........	73	....	....	....	All clay
10	17	"	"	"	91	....	65	?	Water at 91 feet in gravel
12	17	"	"	"	256	....	....	....	Clay, sand, and quicksand
12	17	"	"	"	180	....	130	Good..........	Water at 180 feet in sand
15	17	"	"	"	227	215—soapstone..	Dry	....	Mostly clay
30	17	"	"	"	300	....	Dry	....	Sand, gravel, and quicksand
30	17	"	"	"	106	....	....	....	Clay, gravel, and boulder clay
30	17	"	"	"	78	....	....	....	?
32	17	"	"	"	194	....	....	....	Blue clay
32	17	"	"	"	310	....	....	....	Blue clay
33	17	"	"	"	33	....	20	20............	Water at 33 feet in sand
35	17	"	"	"	100	....	91	Good..........	Water at 100 feet in gravel
2	18	"	"	"	170	....	Dry	....	Clay and boulder clay
2	18	"	"	"	112	....	Dry	....	Clay and boulder clay
2	18	"	"	"	65	....	Dry	....	Clay and boulder clay
2	18	"	"	"	225	....	134	Good..........	Water at 225 feet in clay ?
3	18	"	"	"	110	....	30	....	Water at 100 feet in gravel
8	18	"	"	"	54	....	?	....	Some water at 20 or 54 feet ?

	15	18	"	"	"	140		96	Good	Water at 140 feet in sand
	21	18	"	"	"	55		38	Good	Water at 55 feet in clay
	28	18	"	"	"	175				A little water in sand at 165 feet
	28	18	"	"	"	207		60	Good	Water at 207 feet in gravel
	29	18	"	"	"	169		116	Good	Water at 169 feet in quicksand
	33	18	"	"	"	93		38	Good	Water at 93 feet in sand
	5	19	"	"	Binscarth	175	55—shale	Dry		
	10	19	"	"	"	170		90	Good	Water at 170 feet in gravel
	10	19	"	"	"	148		71		Water at 148 feet in gravel
	15	19	"	"	"	108		82	Good	Water at 108 feet in sand and gravel
	15	19	"	"	"	235		150	Good	Water at 230 feet in gravel
	15	19	"	"	"	147		97		Water at 147 feet in gravel
	15	19	"	"	"	127		?		Water at 127 feet in quicksand
	15	19	"	"	"	118		18	Good	Water at 118 feet in gravel
	15	19	"	"	"	277		?	?	? Clay, sand, and gravel to bottom
	17	19	"	"	"	30	20—shale	19	Good	Water at 30 feet in shale
	17	19	"	"	"	320	25—shale			Clay 25 feet—rest shale
	27	20	"	"	Russell	170				Water. Probably in shale
	3	21	"	"	"	100	3—shale	?		Water in shale at 100 feet
NE. ¼	7	21	"	"	"	65	10—shale	30	Good	Water at 65 feet in shale
SW. ¼	10	21	"	"	"	70		44	Good	Water at 68 feet in clay ?
NW. ¼	18	21	"	"	"	38	15—shale	20	Good	Water at 38 feet in shale
NW. ¼	30	22	"	"	Endcliffe	55		25	Fair	Water at 45 feet in clay ?
	31	24	"	"	Tumbell	194		Dry		Clay, gravel, and boulder clay
	32	24	"	"	"	233		Dry		Clay, sand, and boulder clay
	32	24	"	"	"	100		Dry		Clay, sand, and boulder clay
	2	20	XXIX	"	Millwood	217	20—shale	Dry		
	2	20	"	"	"	128	80—shale	58	Salty	Water at 128 feet in hard shale
	2	20	"	"	"	100	?	?		?
	27	20	"	"	Harrowby	100	8—shale	?		?
NE. ¼	1	21	"	"	Marchwell	75	25—shale	30	Good	Water at 75 feet in shale
	10	21	"	"	"	163			Good	Water at 163 feet in gravel
SE. ¼	13	21	"	"	"	40	20—shale	30	Good	Water at 38 feet in shale
NW. ¼	20	21	"	"	"	190		38	Good	Water at 168 feet in sand
NE. ¼	24	22	"	"	Endcliffe	238		188	Good	Water at 238 feet in quicksand at base of black sand
NE. ¼	24	22	"	"	"	67		Dry		Sand and gravel
	23	23	"	"	Dropmore	162			Good	Water at 162 feet in sand
	32	23	XXX	"	Landestrew	130				
	35	18	XXXI	"	Welby	70			Good	Water
	27	21	"	"	Langenburg	175				
	2	18	XXVIII	"	Foxwarren	80		68	Good	Water at 79 feet in boulders
	2	24	XXIX	"	Dropmore	155		77	Good	Water at 91 feet in gravel

MANITOBA HOUSE SHEET (NO. 122), TPS. 17 TO 24, RANGES 5 TO 19, W. PRIN. MER.

Lake Manitoba, Dog lake, and other small lakes cover much of the eastern part of the sheet. The part east of lake Manitoba is a rolling plain that has a maximum elevation of about 100 feet above lake Manitoba. Low ridges separated by marshy tracts extend northwest and there are few stream valleys, so that the area is poorly drained. West of lake Manitoba, a nearly similar plain extends for 40 miles to the foot of Riding mountain and rises gradually to a height of 400 feet above lake Manitoba. Much of the plain is poorly drained; there are numerous, low ridges extending north and northwest and these prevent drainage of the low-lying, marshy tracts between the ridges. Some of the ridges are composed of sand and gravel and are ancient beaches that continue for long distances. One of the most notable is the ridge extending along the railway from Embury to Alonsa a few miles west of lake Manitoba. Other low ridges are composed of boulder clay. The eastern and northeastern slopes of Riding mountain are much dissected by narrow and deep stream valleys, the largest of which is occupied by Ochre river flowing into Dauphin lake. Many of the smaller streams issue into marshes on the plain below and there disappear. The eastern face of the upland is steepest along the stretch west of the railway line from Bernie to Kelwood; there is a rise of 1,000 feet in 4 miles. Farther to the north and northwest the slope is more gentle, but presents everywhere few miles west of lake Manitoba. Other low ridges are composed of Riding mountain, which has a general elevation of about 2,200 feet above the sea, there are many lakes, some of which, for example Clear lake, are of considerable size and have inflow and outflow so that the water is fresh. These lakes form popular summer resorts. The upland is rolling and well forested; and most of it is included in the Riding Mountain Forest Reserve. Boulder clay forms the surface deposits over the greater part and is sufficiently thick to conceal the shale bedrock. There are lake sand and clay belts which form good farming lands along Ochre and Turtle rivers south of lake Dauphin; and numerous sand and gravel ridges extend northwest through the lowland. These are especially well developed and closely spaced near the base of Riding mountain. A lake clay area, which forms the most valuable tract of farming land in the sheet, extends along the Canadian National railway near the base of Riding mountain from Bernie to Laurier. Most of the central and eastern parts of the sheet are underlain by boulder clay having an average thickness of about 100 feet as shown by well records. Limestone underlies the surface deposits over nearly all the lowland part of the sheet; gypsum forms the bedrock over a small area in the vicinity of Amaranth, a few miles west of lake Manitoba.

Good well water, though hard, owing to the fact that it comes from limestone or dolomite, is obtained practically everywhere in the part of the sheet east of lake Winnipeg. Water is obtained at the base of the surface deposits or in the upper part of the bedrock below, at depths ranging from a few feet to about 100 feet. The water is under pressure and at a few places near the shores of lake Winnipeg and Dog lake, rises nearly to the surface or slightly above it when struck by the drill. The source of the water is the rain and snow that fall on the area and on the higher lands to the east between lake Manitoba and lake Winnipeg. At many places on these higher lands the bedrock is near the surface and is well jointed, so that the rain water readily passes downward into it and the water tends to flow underground down the slope towards lake Manitoba. Somewhat similar conditions exist on the west side of lake Manitoba where in a narrow strip along the lake flowing wells are obtained. In this area the source of the water is from the west. In the vicinity of Amaranth, where gypsum forms the bedrock and is overlain by boulder clay, water is obtained below the gypsum.

In the area between lake Manitoba and the foot of Riding mountain well water is generally obtained in the surface deposits at shallow depths, but in the north-central part it is necessary to drill into the bedrock, water being found at a depth of 100 feet or somewhat more. In the south-central part, in the vicinity of Glenella and Colby, the surface deposits have a thickness of over 100 feet. Water is found in sand and gravel in these deposits but is somewhat salty, and it is probable that the water in the bedrock below is also salty. In the vicinity of Ste. Rose du Lac, southeast of lake Dauphin, flowing wells are obtained. The water comes from the bedrock and is found at various depths from 75 feet to nearly 300 feet. On the upland of Riding mountain good water is obtained at most places at shallow depths in the surface deposits.

TABLE 8

Wells of Manitoba House Sheet (No. 122), Tps. 17 to 24, Ranges 5 to 19, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
36	19	V	W.P.M.	Lundar	45	0		?	?
1	20	"	"	"	22	8	5	Good	Water at 20 feet in hard, red rock
17	20	"	"	Cold Springs	33	33—limestone	Flows	Good	Water at 32 feet in gravel
17	20	"	"	"	60	29—limestone	0	Good	Water at 60 feet in limestone
20	20	"	"	"	48		23	Good	Water at 48 feet in gravel
21	20	"	"	"	59		9	Good	Water at 59 feet in sand
21	20	"	"	"	150		20	Good	Water at 150 feet in gravel below hardpan
SW. ¼ 31	20	"	"	"	33	5—limestone	15	Good	Water at 33 feet in red rock
NW. ¼ 31	20	"	"	"	43	33—limestone	20	Good	Water at 43 feet in red rock
3	21	"	"	Deer Horn	65	16—red rock	9	Good	Water at 65 feet in limestone
3	21	"	"	"	50	4—limestone	10	Good	Water at 50 feet in limestone
10	21	"	"	"	65	12—limestone	Dry		Red rock 12 to 65 feet
SW. ¼ 16	21	"	"	"	78	5—limestone	13	Good	Water at 75 feet in sandy limestone
21	21	"	"	"	21	0—limestone	3	Good	Water at 18 feet in limestone
25	21	"	"	"	60	17—limestone	20	Good	Water at 60 feet in limestone
25	21	"	"	"	34	23—limestone	12	Good	Water at 34 feet in limestone
27	21	"	"	Eriksdale	51		16	Good	Water at 51 feet in sand
27	21	"	"	"	82	5—limestone	9	Good	Water at 82 feet in limestone (small flow at 48 feet)
28	21	"	"	"	22	13—limestone	8	Good	Water at 22 feet in limestone and red rock
28	21	"	"	"	45	8—limestone	5	Good	Water at 37 feet in limestone
28	21	"	"	"	37	15—limestone	?	Good	Water at 37 feet in limestone
28	21	"	"	"	35	15—red rock	6	Good	Water at 35 feet in limestone
SE. ¼ 28	21	"	"	"	58	10—limestone	20	Good	Water at 58 feet in limestone
SE. ¼ 21	21	"	"	Deer Horn	42	15—limestone	3		Water at 38 feet in limestone
NE. ¼ 21	21	"	"	"	54	13—limestone	10		Water at 50 feet in red rock
33	21	"	"	Eriksdale	54	21—limestone	33?or10?	Good	Water at 54 feet in red rock
33	21	"	"	"	105	15—limestone	10		Water at 84 feet in limestone (also at 30 feet in limestone)
34	21	"	"	"	65	13—limestone	15		Water at 65 feet in limestone
NE. ¼ 32	21	"	"	"	54		20	Good	Water at 54 feet in sand
NW. ¼ 35	21	"	"	"	83	45—limestone	25	Good	Water at 80 feet in red rock
SE. ¼ 4	22	"	"	"	36	20—limestone	6	Good	Water at 25 feet in limestone
SW. ¼ 4	22	"	"	"	45	18—limestone	8	Good	Water at 38 feet in limestone

SW. ¼	4	22	“	“	“	50	18—limestone	10	Good	Water at 44 feet in red rock
	4	22	“	“	“	40	18—limestone	15		Water at 38 feet in limestone
	4	22	“	“	“	73	17—limestone	9		Water at 73 feet in red limestone (also at 25 feet in limestone)
SW. ¼	4	22	“	“	“	34	16—limestone	10		Water at 30 feet in limestone
	6	22	“	“	“	75	20—limestone	10		Water at 75 feet in limestone
	7	22	“	“	“	40		7	Good	Water at 33 feet in gravel (8 feet limestone block)
SW. ¼	19	22	“	“	“	50	10—red rock	8	Good	Water at 41 feet in limestone
	20	22	“	“	“	50	16—limestone	7		Water at 30 feet in limestone
SE. ¼	25	19	VI	“	Minnewakan	50	21—red rock	5	Good	Water at 32 feet in red rock
NE. ¼	34	19	“	“	“	267	195—gypsum	?	?	Water at 103 feet in conglomerate or cemented gravel—also at 73 feet at bottom of boulder clay
	10	20	“	“	“	20	10—limestone			
	14	20	“	“	“	30	22—limestone	10	Good	Water at 30 feet in limestone
	23	20	“	“	“	40		15	Good	Water at 90 feet in sand
	24	20	“	“	“	60	Limestone at surface	40	Good	Water at 60 feet in "red rock sand"
SW. ¼	25	20	“	“	Lily Bay	40	30—red rock	11		Water at 35 feet in red rock
NE. ¼	30	20	“	“	“	29	Limestone at surface	12	Good	Water at 27 feet in limestone
SE. ¼	31	20	“	“	“	26	6—grey sandstone	6	Good	Water at 26 feet in grey sandstone
	35	20	“	“	“	79	10—red rock	19	Good	Water at 60 feet in red rock, also in limestone at 79 feet
NE. ¼	35	20	“	“	“	19½	5—limestone	6		Water at 18 feet in limestone
NE. ¼	36	20	“	“	“	49	8—limestone	18	Good	Water at 49 feet in red rock
SE. ¼	2	21	“	“	“	22	5—limestone	6		Water at 20 feet in limestone
SW. ¼	3	21	“	“	“	37		18	Good	Water at 37 feet in red sand 0–10 feet hardpan, 10–20 feet limestone, 20–30 feet red rock, 30–37 feet red sand
SW. ¼	17	21	“	“	Eriksdale	60	40—limestone	48	Good	Water at 60 feet in red rock below 15 feet limestone
SE. ¼	4	21	“	“	Lily Bay	38	5—limestone	18		Water at 38 feet in red rock
NW. ¼	4	21	“	“	“	33	5—limestone	13		Water at 28 feet in red rock
SW. ¼	4	21	“	“	“	41	2—limestone	21	Good	Water at 41 feet in red rock
NE. ¼	4	21	“	“	“	42	16—limestone	25	Good	Water at 42 feet in red rock
SW. ¼	6	21	“	“	“	27	13—limestone	6	Good	Water at 25 feet in limestone
NE. ¼	9	21	“	“	Brewsterville	55	5—limestone	12	?	Water at 46 feet in limestone at lower contact with red rock
NE. ¼	11	21	“	“	“	56	36—red rock	15	Good	Water at 37 feet in red rock
SW. ¼	13	21	“	“	“	35	12—limestone	10	Good	Water at 25 feet in red rock
SW. ¼	14	21	“	“	“	46	10—limestone	32	Good	Water at 46 feet in red sand?
SW. ¼	15	21	“	“	“	49	2—limestone	28	Good	Water at 49 feet in red rock
SW. ¼	15	21	“	“	“	35	2—limestone	23	?	Water at 35 feet in limestone
SE. ¼	15	21	“	“	“	54	16—limestone	37	Good	Water at 54 feet in red rock

TABLE 8 (Cont'd.)

Wells of Manitoba House Sheet (No. 122), Tps. 17 to 24, Ranges 5 to 19, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
NE. ¼ 16	21	VI	W.P.M.	Brewsterville	25	13—limestone	14	?	Water at 24 feet in limestone
NE. ¼ 22	21	"	"	"	55	18—limestone	26	Good	Water at 51 feet in limestone
26	21	"	"	"	82	....	47	Good	Water at 82 feet in limestone. Old hole to 38 feet, new starts in red rock
SW. ¼ 27	21	"	"	"	60	32—limestone	35	....	Water at 47 feet in top of red rock below limestone
NW. ¼ 27	21	"	"	"	60	20—limestone	35	Good	Water at 60 feet in red rock
SE. ¼ 27	21	"	"	"	50	20—red rock	20	Good	Water at 45 feet in red rock
SE. ¼ 27	21	"	"	"	60	24—limestone	37	....	Water at 55 feet in red rock
NE. ¼ 27	21	"	"	"	55	11—limestone	32	Good	Water at 42 feet at top of red rock
28	21	"	"	"	60	15—limestone	?	Good	Water at 58 feet in red rock
NW. ¼ 28	21	"	"	"	30	10—limestone	15	Good	Water at 25 feet in limestone
SW. ¼ 28	21	"	"	"	40	15—limestone	15	Good	Water at 31 feet at top of red rock
NE. ¼ 31	21	"	"	Pine View	25	10—limestone	15	Good	Water at 25 feet in limestone
SW. ¼ 31	21	"	"	"	30	5—limestone	18	....	Water at 30 feet in limestone
NE. ¼ 32	21	"	"	"	68	5—limestone	30	Good	Water at 66 feet in yellow rock (limestone ?)
NW. ¼ 32	21	"	"	"	36	15—limestone	16	Good	Water at 36 feet in limestone
SE. ¼ 32	21	"	"	"	40	10—limestone	16	....	Water at 36 feet in limestone
33	21	"	"	"	50	5—limestone	?	....	?
SE. ¼ 33	21	"	"	"	60	13—limestone	18	Good	Water at 35 feet in limestone and 56 feet in red rock
SW. ¼ 34	21	"	"	"	50	11—limestone	26	Good	Water at 36 feet in red rock
34	21	"	"	"	37	5—limestone	22	Good	Water at 36 feet in red rock
35	21	"	"	"	53	12—limestone	25	Good	Water at 51 feet in red rock
NE. ¼ 35	21	"	"	"	50	5—limestone	30	Good	Water at 30 feet in red rock
36	21	"	"	"	36	....	26	Good	Water at 36 feet in sand
NW. ¼ 36	21	"	"	"	41	7—limestone	6	?	Water at 37 feet in red rock
1	22	"	"	"	50	5-40 limestone	15	....	Water at 50 feet in loose rock and clay, 40-50 feet "loose rock and clay"
1	22	"	"	Pine View	51	20—limestone	5	....	Water at 51 feet in limestone
2	22	"	"	"	65	15—limestone	30	....	Water at 65 feet in limestone
2	22	"	"	"	48	5—limestone	20	....	Water at 48 feet in limestone
NW. ¼ 2	22	"	"	"	50	10—limestone	10	....	Water at 48 feet in limestone

SE. ¼	3	22	"	"	"	35	14—limestone	15		Water at 30 feet in limestone (5 feet of red sand, but no limestone)
NE. ¼	5	22	"	"	"	75	10—limestone	20	Good	Water at 70 feet in red rock
SE. ¼	5	22	"	"	"	54		29	Good	Water at 53 feet in yellow sand
SE. ¼	6	22	"	"	"	50	10—limestone	20	Very good	Water at 46 feet in red rock
NE. ¼	6	22	"	"	"	45	10—limestone	20		Water at 36 feet in red rock
SE. ¼	7	22	"	"	"	25		9	Good	Water at 23 feet in sand
	12	22	"	"	"	23	5—limestone	10		Water at 23 feet in red rock
	12	22	"	"	"	66	10—limestone	5		Water at 66 feet in limestone
NW. ¼	18	22	"	"	"	35	14—limestone	12	Good	Water at 33 feet in limestone
SW. ¼	18	22	"	"	"	42	10—limestone	18	Good	Water at 40 feet in limestone
SW. ¼	21	22	"	"	Little Dog lake	38	20—limestone	16	Good	Water at 36 feet in limestone
	24	22	"	"	"	50	15—limestone	9		Water at 46 feet in limestone
NE. ¼	22	21	VII	"	Scotch Bay	32	10—limestone	10	Good	Water at 29 feet in limestone
NE. ¼	25	21	"	"	"	40	10—limestone	13	Good	Water at 36 feet in limestone
NW. ¼	25	21	"	"	"	28	12—limestone	12	Good	Water at 28 feet in limestone
SW. ¼	28	21	"	"	"	20		1	Good	Water at 19 feet in sand
SW. ¼	36	21	"	"	"	31	14—limestone	12	Good	Water at 30 feet in limestone
	1	22	"	"	Macross	35	13—limestone	17	Good	Water at 34 feet in red rock below limestone
SW. ¼	1	22	"	"	"	58	13—limestone	15	Good	Water at 58 feet in red rock
NW. ¼	36	22	"	"	Oatfield	29	15—limestone	10	Good	Water at 29 feet in limestone
NW. ¼	4	22	"	"	Macross	29	10—limestone	13	Good	Water at 29 feet in limestone
NE. ¼	36	22	"	"	Oatfield	16	2—limestone	7	Good	Water at 15 feet in limestone
SW. ¼	1	23	"	"	"	27	10—limestone	7	Good	Water at 24 feet in limestone
SW. ¼	5	17	VIII	"	Lake Manitoba	60	15—limestone	Flows	Very good	Water at 60 feet in limestone
NW. ¼	5	17	IX	"	Embury	145		50	Good	Water at 140 feet in gravel
SW. ¼	14	17	"	"	"	70		7	Good	Water at 70 feet in sand
SE. ¼	16	17	"	"	"	92		70	Good	Water at 87 feet in sand in clay
SW. ¼	16	17	"	"	"	89		40	Good	Water at 84 feet in boulder clay
SE. ¼	22	17	"	"	"	63		48	Good	Water at 62 feet in gravel
	31	17	"	"	"	120		?		A little water at 117 feet in hardpan
	31	17	"	"	"	140				A little water in sand at 112 feet
Priest's Res.		18	"	"		121		115	Excellent	Water at 121 feet in hardpan
	11	18	"	"		117		97	Good	Water at 117 feet in hardpan
	6	19	"	"	Amaranth	45		40	Good	Water at 43 feet in sand
	5	20	"	"	Beckville	61		?	Bad	Water at 40 feet in hardpan
NE. ¼	15	18	"	"	Amaranth	114	106—rock	Flows	Good	Water at 112 feet in rock
	17	21	X	"	Bluff Creek	66		1½	Good	Water at 66 feet in coarse sand, also 35 feet in sand
NE. ¼	20	21	"	"	"	45	38—limestone	Flows	Good	Water at 42 feet in limestone
	17	21	"	"	"	66			Good	Water
	7	21	XI	"	"	168	120—limestone		Good	Water at 168 feet in limestone
NW. ¼	9	21	"	"	"	87	85	19	Soft	Water at 86 feet in "rock"—also at 50 feet

TABLE 8 (Cont'd.)

Wells of Manitoba House Sheet (No. 122), Tps. 17 to 24, Ranges 5 to 19, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
18	21	XI	W.P.M.	Bluff Creek........	70	....	Flows sometimes	....	Water at 70 feet in hardpan and coarse sand
NE. ¼ 6	19	XII	"	Bellhampton........	180	....	?	Good..........	Water at 60 feet in quicksand
SE. ¼ 12	18	XIII	"	Glenella............	52	....	38	Good..........	Water at 50 feet in sand
NE. ¼ 24	18	"	"	"	142	....	70	Salty, black....	Water at 142 feet in quicksand
SE. ¼ 2	19	"	"	"	25	....	Dry	....	Clay, sand, and hardpan
NW. ¼ 2	19	"	"	"	95	....	64	Good..........	Water at 93 feet in sand
NW. ¼ 2	19	"	"	"	95	....	64	Good..........	Water at 92 feet in gravel
NW. ¼ 2	19	"	"	"	88	....	55	Little salty.....	Water at 85 feet in gravel
SW. ¼ 2	19	"	"	"	100	....	65	Little salty.....	Water at 99 feet in gravel
SE. ¼ 9	23	XIV	"	Ste. Amelie.........	80	80—rock........	16	Little salty.....	Water at 78 feet in rock
SW. ¼ 31	18	"	"	Kelwood...........	180	125—"cement rock"	100	Salty...........	Water at 170 feet in gypsum
SW. ¼ 18	19	"	"	"	68	....	Dry	....	Clay and boulder clay
SW. ¼ 19	19	"	"	"	45	....	35	Salty...........	Water at 35 feet in gumbo ?
?	23	"	"	....	175	120—shale......	140	Good..........	Water at 175 feet in shale
NW. ¼ 10	23	"	"	Ste. Amelie.........	26	....	18	Good..........	Water at 26 feet in hardpan
NE. ¼ 30	23	"	"	"	55	....	16	Good..........	Water at 56 feet in gravel
SW. ¼ 32	23	"	"	"	52	....	8	Good..........	Water at 52 feet in gravel
NE. ¼ 9	24	"	"	Ste. Rose du Lac...	70	....	37	Good..........	Water at 67 feet in gravel
NE. ¼ 17	24	"	"	"	192	....	162	Fair...........	Water at 192 feet in gravel ?
NE. ¼ 31	24	"	"	"	55	....	41	Good..........	Water at 56 feet in gravel
NE. ¼ 35	24	"	"	"	115	110—shale......	75	Good..........	Water at 115 feet in soft shale
9	18	XV	"	Riding Mountain....	351	36—shale.......	Dry	....	Reported mostly as shale
SW. ¼ 14	19	"	"	Kelwood...........	265	....	100	Salty...........	Water at 165 feet in blue clay
SE. ¼ 24	19	"	"	"	75	....	Dry	....	Clay, gravel, gumbo, and boulders
NW. ¼ 22	23	"	"	Ste. Rose du Lac...	90	45—shale.......	77	Slightly salty...	Water at 90 feet in limestone
								Slightly salty...	White shale 25 to 45 feet
SE. ¼ 20	23	"	"	"	300	120—shale......	30	Good..........	Water at 290 feet in "rock"
NW. ¼ 15	23	"	"	"	87	40—white shale.	65	Good..........	Water at 87 feet in "white" shale
3	24	"	"	"	22	....	....	Good..........	Water at 22 feet in boulder clay
6	24	"	"	"	100	78—limestone...	20	Salty...........	Water at 100 feet in limestone
NW. ¼ 9	24	"	"	"	155	40—white clay..	0	Good..........	Water at 155 feet in water strata below limestone

SE. ¼	8	24	"	"	"	145	105—red shale..	Flows	Good..........	Water at bottom in white shale
NE. ¼	8	24	"	"	"	135	45—shale.......	Flows	Good..........	Water at 133 feet in shale
SE. ¼	7	24	"	"	"	87	55—white shale.	77	Good..........	Water at 87 feet in limestone
	9	24	"	"	"	20	....	Dry	....	
	9	24	"	"	"	80	....	....	Salty..........	Water
	17	24	"	"	"	175	85—shale.......	174	Salty..........	Water at 175 feet in limestone
	22	24	"	"	"	75	55 ?—red clay	15	Good..........	Water at 75 feet in red clay
SE. ¼	22	24	"	"	"	102	40—red shale...	Flows	Good..........	Water at 102 feet in brown shale
NW. ¼	23	24	"	"	"	122	55—red shale...	120	Good..........	Water at 122 feet in white shale
SW. ¼	27	24	"	"	"	97	75—shale.......	Flows	Good..........	Water at 97 feet at shale-limestone contact
	28	24	"	"	"	48	....	Flows	Good..........	Water at 48 feet in boulder clay
NE. ¼	26	23	XVI	"	Makinak...........	200	125—rock.......	180	Salt...........	Water at 200 feet in red shale
	12	24	"	"	"	82	....	16	Slightly salty...	Water at 82 feet in gravel
	30	22	XVII	"	Laurier............	366	180............	....	Fresh..........	Water
	30	22	"	"	"	380	....	....	....	
NW. ¼	30	22	"	"	Ochre River.......	540	?	?	?	Fresh water at 512 feet, salt water at 532 feet, a little oil at 347 and 532 feet
NE. ¼	30	22	"	"	"	1,480	....	....	....	Dolomite, anhydrite, gypsum, shale

FORT ALEXANDER SHEET (NO. 123), TPS. 17 TO 24, RANGES 1 TO 11, E. PRIN. MER., AND 1 TO 4, W. PRIN. MER.

The western half of the sheet lies between lakes Winnipeg and Manitoba and is a partly wooded plain that has a maximum elevation in its central part, traversed by the Canadian National railway from Inwood to Fisher Branch, of 200 feet above lake Winnipeg and 100 feet above lake Manitoba. From its central highest part, there is a fairly gradual slope to the east and west. Low ridges trending north and northwest interrupt the general slope, and there are many marshy tracts and small lakes occupying the small depressions. Some of the ridges are composed of sand and gravel and are ancient beaches of Lake Agassiz. One of the most striking of these lies a few miles west of lake Winnipeg and extends throughout the greater part of the sheet. It becomes higher in elevation above sea-level towards the north, so that the beach is farther west of the lake and is higher above it in the north than in the south. The only streams of importance in the area are Icelandic river flowing east into lake Winnipeg, and Fisher river flowing north. Along these streams there are extensive flats of alluvial and lake clay that form valuable farm lands. A belt of lake clay a few miles wide extends along the west side of lake Winnipeg and forms the largest area of good agricultural land in the sheet. In the central and western parts, stony clay forms the soil for the most part and there are extensive marshy areas. Limestone or dolomite forms the bedrock over nearly all the western half of the sheet.

Lake Winnipeg occupies much of the eastern part of the sheet, only a small part of which, in the area traversed by the railway leading to Grand and Victoria beaches, has been mapped. In this area, ridges of glacial drift extend north paralled to the lake shore. Sand beaches formed by wave erosion of the drift occur at places along the lake shore and raised beaches of sand and gravel are found along the sides of drift hills which have a maximum elevation of 200 feet above the level of the lake.

An artesian water area lies along the west shore of lake Winnipeg and extends for some distance up the valley of Icelandic river (page 18). In the area along the Canadian Pacific railway from Malonton to Rembrandt good well water is obtained at depths of 80 to 300 feet in sand, in the lower part of the surface deposits or in the limestone bedrock below. The water is under pressure and in most places rises to within 50 feet of the surface. In a few places the water rises slightly above the surface of the ground; in other places it rises only to 100 feet from the surface. In the area along the Canadian National railway from Inwood to Fisher Branch, good water is obtained in most places in limestone that is near the surface over much of the area, but the water is not under pressure owing to the fact that the area is a highland or divide between lakes Winnipeg and Manitoba. Wells in the district are likely to be affected by drought in exceptionally dry years. The area to the west of the railway is only thinly settled. In places well borings have shown the surface deposits to be over 100 feet thick and in those places water is found in sand and gravel below boulder clay.

TABLE 9

Wells of Fort Alexander Sheet (No. 123), Tps. 17 to 24, Ranges 1 to 11, E. Prin. Mer., and 1 to 4, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
NW. ¼ 25	18	II	E.P.M.	Malonton	126	120	25	Good	Water at 120 feet in limestone
NE. ¼ 26	18	"	"	"	116	....	10	Good	Water at 116 feet in sand and gravel
NE. ¼ 26	18	"	"	"	115	115	15	Good	Water at 110 feet in sand and gravel
SW. ¼ 34	18	"	"	"	88	88	Flows	Good	Water at 88 feet
NE. ¼ 34	18	"	"	"	108	95	25	Good	Water at 105 feet in bedrock
SW. ¼ 36	18	"	"	"	125	125	25	Good	Water at 120 feet in sand and gravel
36	18	"	"	"	205	140	65	Good	Water at 190 feet in limestone
SE. ¼ 10	19	"	"	Fraserwood	133	122	46	Good	Water at 129 feet in limestone
NE. ¼ 10	19	"	"	"	119	115	32	Good	Water at 115 feet
NW. ¼ 10	19	"	"	"	120	115	30	Good	Water at 110 feet in sand
NW. ¼ 12	19	"	"	"	123	115	52	Good	Water at 112 feet in sand
SE. ¼ 12	19	"	"	"	131	116	55	Good	Water at 120 feet in limestone
NW. ¼ 13	19	"	"	"	116	116	80	Good	Water at 115 feet in sand
SW. ¼ 16	19	"	"	"	127	125	46	Good	Water at 122 feet in sand
SW. ¼ 14	20	"	"	Meleb	140	125	100	Good	Water at 135 feet in limestone
SW. ¼ 23	20	"	"	Meleb School	140	....	90	Good	Water at 135 feet in sand and gravel
SE. ¼ 23	20	"	"	Meleb	306	135	95	Good	Water at 300 feet in limestone
23	20	"	"	"	183	180	100	Good	Water at 183 feet in limestone
NW. ¼ 11	21	"	"	Rembrandt	112	93	36	Good	Water at 98 feet in limestone
SW. ¼ 36	22	"	"	Arborg	58	45	5	Good	Water at 58 feet in limestone
NW. ¼ 30	18	III	"	Malonton	140	125	40	Good	Water at 125 feet
SE. ¼ 1	19	"	"	Gimli	79	....	20	Good	Water at 79 feet in sand below hard clay
NW. ¼ 1	19	"	"	"	99	....	30	Good	Water at 99 feet in sand below hard clay
SW. ¼ 1	19	"	"	"	77	....	20	Good	Water at 77 feet in sand
SW. ¼ 19	19	"	"	Kreuzburg	120	100	80	Good	Water at 105 feet in limestone
SE. ¼ 31	19	"	"	"	105	90	25	Good	Water at 93 feet in limestone
SW. ¼ 7	19	"	"	"	137	125	73	Good	Water at 125 feet
NE. ¼ 12	19	"	"	Gimli	126	119	15	Good	Water at 126 feet in limestone
SE. ¼ 12	19	"	"	"	90	....	30	Good	Water at 90 feet in sand below clay
NE. ¼ 6	20	"	"	Meleb	115	115	85	Good	Water at 110 feet in sand
NW. ¼ 7	20	"	"	"	130	110	85	Good	Water at 120 feet in limestone
SW. ¼ 13	20	"	"	Haas	160	160	65	Good	Water at 156 feet in sand under clay
NW. ¼ 16	20	"	"	Meleb	135	130	75	Good	Water at 124 feet in sand
SW. ¼ 17	20	"	"	"	130	....	80	Good	Water at 120 feet in sand

TABLE 9 (Cont'd.)

Wells of Fort Alexander Sheet (No. 123), Tps. 17 to 24, Ranges 1 to 11, E. Prin. Mer., and 1 to 4, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
NE. ¼ 17	20	III	E.P.M.	Meleb	140	120	70	Good	Water at 120 feet in sand
SW. ¼ 19	20	"	"	"	170	100	80	Good	Water at 165 feet in limestone
NW. ¼ 20	20	"	"	"	135	....	85	Good	Water at 130 feet in sand
SE. ¼ 20	20	"	"	"	148	125	75	Good	Water at 125 feet
NW. ¼ 20	20	"	"	"	160	147	70	Good	Water at 147 feet
NE. ¼ 28	20	"	"	Berlo	155	140	90	Good	Water at 140 feet
14	17	IV	"	Whytewold	67	60	Flows	Good	Water at 67 feet in bedrock
14	17	"	"	"	150	60	Flows	Good	Water at 80 feet in bedrock (limestone)
15	17	"	"	"	40	....	....	Good	Water
15	17	"	"	"	62	62	8	Good	Water at 62 feet
15	17	"	"	"	150	60	5	Good	Water at 150 feet in bedrock
15	17	"	"	"	57	....	6	Good	Water at 42 feet
15	17	"	"	"	25	....	....	Good	Water
16	17	"	"	"	41	40	Flows	Good	Water at 41 feet
SE. ¼ 10	17	"	"	"	45	45	Flows	Good	Water at 45 feet from gravel below boulder clay
SE. ¼ 10	17	"	"	"	51	51	Flows	Good	Water at 51 feet
SW. ¼ 14	17	"	"	"	59	59	Flows	Good	Water at 59 feet
SW. ¼ 14	17	"	"	"	75	75	Flows	Good	Water
SE. ¼ 18	17	"	"	"	75	60	25	Good	Water at 75 feet in limestone
6	19	"	"	Gimli	82	....	29	Good	Water
6	19	"	"	"	80	....	10	Good	Water at 80 feet in sand below clay
6	19	"	"	"	105	....	21	Good	Water at 105 feet in sand below clay
8	20	"	"	Haas	128	....	38	Good	Water at 128 feet in sand below clay
SW. ¼ 10	20	VII	"	Victoria Beach	67	67	55	Good	Water in sand
SW. ¼ 24	19	II	W.P.M.	Neveton	106	100	75	Good	Water at 100 feet
SW. ¼ 28	22	III	"	Sharpewood	115	60	37	Bad	Water at 96 feet, peat or coal at 115 feet
30	22	"	"	"	45	....	Dry	....	Granite boulders
SE. ¼ 35	21	IV	"	Vannes	55	....	....	Good	Water at 55 feet in gravel below boulder clay
NE. ¼ 3	22	"	"	"	118	....	40	Good	Water at 115 feet in gravel below boulder clay
SW. ¼ 20	22	"	"	"	90	....	30	Good	Water at 90 feet in gravel below boulder clay

DUCK MOUNTAIN SHEET (NO. 171), TPS. 25 TO 32, RANGES 20 TO 32, W. PRIN. MER.

Duck mountain, most of which is included in a forest reserve, and the northern part of Riding mountain, occupy the central parts of the sheet. A broad depression occupied by Valley river flowing east separates the two uplands. Assiniboine river flowing south drains the western part of the sheet, which is a rolling plain only slightly lower than the " mountains " to the east. In the eastern part of the sheet a belt about 20 miles wide is a lowland plain that slopes gently towards the east and is drained by numerous, small streams coming from the eastern slope of Duck mountain. In the south, the broad depression of Valley river extends west about 40 miles. On the lowland plain there are numerous beach ridges extending north and northwest. One of the largest of these is followed by a highway for 10 miles north of Ashville where it passes to a lower beach which it follows nearly to Ethelbert. From Ethelbert north, this beach is followed by the Canadian National railway to the northern border of the sheet. One effect of the gravel ridges is to prevent free draining of the plain, for they act as natural dams, so that large areas of marshy land occur on the lowland plain. On the upland of Duck mountain, having a general elevation of 1,000 feet above the lowland to the east, and over much of the high plain to the west, there are thick deposits of glacial drift laid down irregularly to form uneven hills and ridges with intervening hollows occupied by ponds and lakes. Many of the lakes have outlet streams and contain good fresh water. The part of the sheet southwest of Assiniboine river has less relief and is a rolling plain only partly drained by streams. Much of the lowland part of the sheet is covered by the deposits of Lake Agassiz; there is a belt of lake and alluvial clay along Valley river, and sandy lake deposits are widespread. In places stony clay occupies the surface and boulders are numerous owing to erosion of the boulder clay by wave action during the existence of the ancient lake. Boulder clay, unaffected by erosion except by streams, forms the surface deposit on which the soil is developed over the central and western upland parts of the sheet, except in the stream valleys that are floored with alluvium and along the valley of Assiniboine river in the vicinity of Kamsack, where heavy clays of ancient Lake Assiniboine cover a small area. Probably shale forms the bedrock over all the upland part of the sheet. Borings and outcrops show that shale underlies the lowland part except for small areas northeast of the railway leading from Sifton to Pine River, where limestone forms the bedrock.

Good well water is obtained at shallow depths in the gravel ridges in the lowland part of the sheet and is also easily obtained in the sandy areas, but in the lake clay and boulder clay areas it is not of so good quality, and the chances of finding water depend upon the presence of sand and gravel below the clay. Wells sunk into the shale as a rule find "sulphur" or saline water, but where the water is found in limestone it is of better quality. Along Valley river, in the vicinity of Grand View and Gilbert Plains, water is obtained in the surface deposits, which have considerable thickness, and in the shale bedrock. The water in the bedrock is slightly saline; that in the surface deposits is of better quality and is found in sand and gravel below boulder clay at various depths up to about 100 feet. The water is under pressure and in a few places rises nearly or quite to the surface. In the area along the Canadian National railway from Shortdale to Runnymede, the surface deposits are very thick. Water is obtained at many places at shallow depths in these deposits, but there are areas, for example in the vicinity of Deepdale, where it is necessary to drill to depths of 100 to over 200 feet in order to obtain sufficient supplies. In the vicinity of Kamsack there is heavy clay at the surface and the bedrock is a sticky clay shale in which it is useless to drill for water. The chances of finding water depend on the presence of sand or gravel below the clay that forms the surface deposits. In the area southwest of Assiniboine river, in the vicinity of Wroxton and Calder, the surface deposits also have considerable thickness; boulder clay occurs at the surface and below it or in it in the form of lenses, sand and gravel carrying water may occur. As the sandy beds are absent in places, some wells fail to find water. The soft, clayey character of the bedrock throughout the western part of the sheet renders drilling at depth in it in search of water useless.

TABLE 10

Duck Mountain Sheet (No. 171), Tps. 25 to 32, Ranges 20 to 32, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
SW. ¼ 16	26	XXI	W.P.M.	Halicz	275		130	Salty	Water at 180 feet in sand and loose rock
NE. ¼ 4	25	XXII	"	Gilbert Plains	73		40	Good	Water at 73 feet in gravel
SE. ¼ 5	25	"	"	"	160	120—rock	80	Fair	Water at 155 feet in "rock"
SE. ¼ 8	25	"	"	"	180	160—rock	90	Salty	Water at 165 feet in "rock"
NW. ¼ 20	25	"	"	"	130	120—shale	60	Little salty	Water at 130 feet in shale
20	25	"	"	"	155		Dry		Clay and boulder clay
SW. ¼ 5/30	25	"	"	"	55		35	Good	Water at 55 feet in gravel
SW. ¼ 30	25	"	"	"	75		40	Little salty	Water at 75 feet in hardpan
NE. ¼ 30	25	"	"	"	180	75—shale	75	Little salty	Water at 175 feet in shale
SW. ¼ 36	25	"	"	"	150		20	Good	Water at 80 feet in 25 feet of rock in blue clay
SW. ¼ 9	26	"	"	"	85	80—rock	15	Good	Water at 80 feet in rock
NE. ¼ 4	26	"	"	Venlaw	100	80—rock	15	Good	Water at 80 feet at contact of rock and clay—10 feet clay below
SE. ¼ 5	26	"	"	"	120	95—rock		Good	Water at 95 feet at contact of shale and clay
NE. ¼ 5	26	"	"	"	150		Dry		Sand, clay, and boulder clay
NW. ¼ 8	26	"	"	"	35		18	Good	Water at 34 feet in gravel
NW. ¼ 9	26	"	"	"	100	75—rock	15	Good	Water at 80 feet in rock
SE. ¼ 9	26	"	"	"	100	80—rock	15	Good	Water at 80 feet at contact of rock and clay
SE. ¼ 20	26	"	"	"	80				Gas at 75 feet in hardpan
SE. ¼ 20	26	"	"	"	110		35	Alkali	Water at 105 feet in hardpan
NW. ¼ 22	26	"	"	"	105	85—black shale	80	Sulphur	Water at 90 feet in black shale
SW. ¼ 27	26	"	"	"	90	70—black shale	70	Sulphur	Water at 80 feet in black shale
NE. ¼ 28	26	"	"	"	130	95—rock	5	Good	Water at 30 feet in clay—water also 95 to 130 feet
SW. ¼ 32	26	"	"	"	105	80—black shale	60	Salty	Water at 85 feet in black shale
SE. ¼ 36	25	XXIII	"	Grand View	170		85		Water at 90 feet in 5 feet of shale in blue clay
SE. ¼ 1	26	"	"	Umatillo	110		30	Good	Water at 40 feet in gravel
NE. ¼ 1	26	"	"	"	145		Dry		Hardpan, gravel, and clay
1	26	"	"	"	32		28	Good	Water at 32 feet in gravel

TABLE 10 (Cont'd.)

Duck Mountain Sheet (No. 171), Tps. 25 to 32, Ranges 20 to 32, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
NW. ¼ 5	25	XXVIII	W.P.M.	Tummel	201		150		Water at 160 feet in gravel
NE. ¼ 7	25	"	"	"	105		88		Water at 104 feet in coarse sand
SW. ¼ 9	25	"	"	"	121		60	Good	Water at 121 feet in sand
NE. ¼ 18	25	"	"	"	62		40	Good	Water at 62 feet in clay ?
NE. ¼ 18	25	"	"	"	57		50	Good	Water at 57 feet in clay ?
4	26	"	"	Roblin	87		52		Water at 87 feet in gravel
NE. ¼ 5	26	"	"	"	73		45		Water at 73 feet in sand and gravel
NE. ¼ 5	26	"	"	"	55		35	Good	Water at 55 feet in clay ?
5	26	"	"	"	75		63		Water at 75 feet in gravel
5	26	"	"	"	60		40	Good	Water at 58 feet in gravel
NW. ¼ 5	26	"	"	"	63			Good	Water at 60 feet in gravel
NE. ¼ 5	26	"	"	"	100		Dry		Clay, sand, and boulder clay
5	26	"	"	"	57		48	Good	Water at 57 feet in gravel
8	25	"	"	Tummel	152		112		Water at 152 feet in gravel
8	26	"	"	Roblin	92		Dry		Clay and a little gravel
8	26	"	"	"	70		48		Water at 70 feet in gravel
SE. ¼ 8	26	"	"	"	67		40		Water at 67 feet in clay
NE. ¼ 31	26	XXIX	"	Deepdale	85		35	Good	Water at 70 feet at top of sand
NE. ¼ 33	26	"	"	"	243		98	Good	Water at 243 feet in quicksand
SE. ¼ 3	27	"	"	"	110		70	First class	Water at 109 feet in sand and gravel
NE. ¼ 9	27	"	"	"	194		87		Water at 194 feet in sand
21	27	"	"	"	160		130		Water at 140 feet in clay and gravel (Old well to 102 feet)
NE. ¼ 27	27	"	"	"	145		?		Water at 115 feet in sand
NE. ¼ 27	27	"	"	"	155		?		Water sand at 110 feet
NE. ¼ 27	27	"	"	"	145		30	Good	Water at 55 feet in quicksand
SE. ¼ 28	27	"	"	"	80		Dry		All clay
SE. ¼ 28	27	"	"	"	185		Dry		Clay—a little water in clay at 185 feet. (Old well to 73 feet)
SE. ¼ 28	27	"	"	"	470	320—rubber clay			Quicksand 210-250 feet. Water sand 255-320 feet
NE. ¼ 20	26	"	"		180		Dry		Blue and yellow clay
SE. ¼ 27	26	"	"		169		25	Good	Water at 169 feet in quicksand
34	29	XXXII	"	Kamsack	773	50—shale	Dry		Clay and shale to 770 feet
30	32	"	"	Fort Pelly	501		15	Fresh	Water at 28 feet in sand

FAIRFORD SHEET (NO. 172), TPS. 25 TO 32, RANGES 5 TO 19, W. PRIN. MER.

Lakes Dauphin, Winnipegosis, Manitoba, and St. Martin occupy large parts of the sheet. Dauphin lake in the southwest part is 23 feet above lake Winnipegosis and drains north into it by way of Mossy river. The fall from lake Winnipegosis to lake Manitoba by way of the outlet stream, Waterhen river, is only 7 feet, and from lake Manitoba to lake St. Martin by way of Fairford river 13 feet. The great part of the sheet is a gently undulating plain, only a little above the level of these large lakes which occupy shallow depressions in the surface deposits, and whose irregular shore-lines are due to uneven deposition of these deposits. The highest part of the sheet is in the southwest corner where the land slopes gradually upward towards the southwest to a height of 200 feet above Dauphin lake. The lake has an elevation of 854 feet above the sea. In the eastern part of the sheet there is also a fairly high area having a general elevation of 950 feet, or nearly 150 feet above lake St. Martin. A few isolated rock hills, such as Spear hill, rise about 100 feet above the general level. Surface deposits conceal the bedrock over nearly all the sheet, but have no great thickness except locally. The bedrock is near the surface at many places along the Canadian National railway from Ashern to Gypsumville, and in the area to the east of the railway. In the western part of the sheet fewer outcrops occur; the surface deposits, consisting chiefly of boulder clay, form long, narrow ridges trending north and northwest and between the ridges are extensive marshy tracts. In the area southwest of Dauphin lake and along the line of the railway from Sifton to Winnipegosis, lake deposits have formed valuable farm lands that have long been settled. The area between Dauphin lake and lake Manitoba is a stony clay area and is only thinly settled. In the area to the north of lake Manitoba and in the eastern part of the sheet, there are few settlers except along the line of the railway leading to Gypsumville. Areas of lake clay in the vicinity of Gypsumville form good agricultural lands, but in the district along the railway to the south and over nearly all the southeastern part of the sheet, the soil is formed on boulder clay and there are many boulders scattered over the surface.

Good well water is found at depths of a few feet to about 100 feet in the area along the Canadian National railway in the southeastern part of the sheet from Ashern to Fairford. In most places the water is found in the upper part of the limestone or dolomite bedrock beneath the surface clay. In the vicinity of Gypsumville, well water obtained at shallow depths in ancient beach ridges of sand and gravel is of good quality though hard, but that obtained from the bedrock, gypsum, and shale is somewhat saline. In the area between Dauphin lake and lake Winnipegosis and the western end of lake Manitoba, many of the wells sunk into the bedrock produce saline water, and in places the water obtained from the lower part of the surface deposits is saline also. That found in sands and gravels, where these are present near the surface, is of better quality. Farther to the east in the area between the southeastern end of Dauphin lake and lake Manitoba, water is found in places at shallow depths in the surface deposits, and at other places at depths of 80 to over 100 feet at the base of the surface deposits or in the limestone bedrock below. Saline water is also found in wells in the vicinity of Winnipegosis, but some of the wells in which the water comes from sand and gravel below the surface clay find fresh water. There are many salt water springs in a belt 1 to 6 miles wide along the south and west sides of lake Winnipegosis. The saline waters come from the bedrock, and in many places have so saturated the surface deposits that it is difficult to find fresh water at places in the vicinity of the springs. Flowing wells yielding fresh water occur in the vicinity of Fork river along the Canadian National railway between Sifton Junction and Winnipegosis. The water is found in sand below boulder clay at shallow depths. A few flowing wells are obtained along the west side of Dauphin lake in a restricted area near the mouths of Wilson and Vermilion rivers. The water comes from sand below boulder clay, as is the case at Fork river, but at a somewhat greater depth. In the heavy clay area in the vicinity of Dauphin, small supplies are obtained from sandy beds below the clay at depths of 40 to 80 feet. The town of Dauphin obtains its water supply from a small lake on the upland of Riding mountain to the south.

TABLE 11

Wells of Fairford Sheet (No. 172), Tps. 25 to 32, Ranges 5 to 19, W. Prin. Mer.

Section	Tp.	Range	Mer.	At or near	Depth of well	Depth to bedrock	Depth to water	Character of water	Source of water and remarks
					Feet	Feet	Feet		
SW. ¼ 4	32	IX	W.P.M.	St. Martin	55	25—limestone	Flows	Good	Water at 50 feet in limestone
SW. ¼ 18	25	XIV	"	Ste. Rose du Lac	75		62	Good	Water at 72 feet in hardpan and gravel
SE. ¼ 8	25	XV	"	"	135	120—limestone	Flows	Fresh	Water at 135 feet in limestone
NW. ¼ 9	26	"	"	East Bay	135	120—limestone	Flows	Good	Water at 135 feet in limestone
NW. ¼ 12	28	XVI	"	Magnet	95		Flows	Good	Water at 95 feet in gravel
29	30	XVII	"	Winnipegosis	1,473	25—brownish grey limestone	Big flow	Saline	Water at 250 and 280 feet in dolomite
NW. ¼ 6	26	XVIII	"	Dauphin	75	73—rock	50	Good	Water at 73 feet in contact of clay and rock
NW. ¼ 18	27	"	"	Sifton	122	105—shale	70	Good	Water at 122 feet in shale
SE. ¼ 6	30	"	"	Fork River	60		Flows	Good	Water at 60 feet in gravel
NW. ¼ 6	30	"	"	"	75		4	Good	Water at 75 feet in hardpan
NW. ¼ 36	27	XIX	"	Sifton	25		18	Good	Water at 25 feet in soft clay
26	29	"	"	Fork River	40		3	Good	Water at 40 feet in hardpan
26	29	"	"	"	50		4	Good	Water at 50 feet in hardpan
26	29	"	"	"	72		?	No good	Water and quicksand at 72 feet
35	29	"	"	"	20		4	Good	Water at 20 feet in boulder clay
27	32	"	"	Winnipegosis	70		Flows	Salty	Water at 70 feet in gravel
NE. ¼ 36	29	"	"	Fork River	250		Flows	Salty	Water
34	29	"	"	"	30		1	Good	Water at 30 feet in sand
2	30	"	"	"	63		Dry		Boulder clay
2	30	"	"	"	20		Dry		Boulder clay
NE. ¼ 26	31	"	"	Winnipegosis	75	65—limestone	2	Salty	Water at 70 feet in limestone
NE. ¼ 26	31	"	"	"	100	?	Flows	Little salty	Water at 95 feet in gravel
SW. ¼ 26	31	"	"	"	102		Flows	Good	Water at 102 feet in white sand
SW. ¼ 2	32	"	"	"	50	25—limestone	0	Good	Water at 46 feet in limestone
27	32	"	"	"	82		12	Very good	Water at 82 feet in hardpan
Pine Creek Mission			"	"	79		Flows	Salty	Water at 79 feet in hardpan
3	32	XIX	"	"	32		?	Little salty	Water at 32 feet in gravel

TABLE 12

Analysis of Waters from Southern Manitoba and Saskatchewan[1]

Results stated in parts per million

Identification No.	1	2	3	4	5	6	7	8	9	10	11	12
Laboratory No.	104646	104647	104648	104649	104650	104651	104652	104653	104654	104655	104656	104657
Free ammonia	0·84	1·24	0·07	0·01	0·01	1·41	0·02	Nil	0·17	0·02	Trace	2·33
Albuminoid ammonia	0·07	0·0	0·12	0·22	0·30	0·17	0·09	0·12	0·09	0·06	0·14	0·08
Nitrogen in nitrates and nitrites	0·164	Nil	0·206	1·917	1·769	0·502	4·707	4·378	0·905	4·345	4·082	Nil
Chlorine	200	216·5	86	124·5	213·3	164	247·5	100	4·1	95·9	270	73·5
Total solids at 212° F	660	2,306	2,489	1,403	2,947	1,044	3,428	1,821	515	673	2,010	1,860
Solids after ignition	604	2,060	2,121	840	2,593	970	2,694	1,315	363	390	1,490	1,629
Loss on ignition	56	246	368	563	354	74	734	505	152	283	520	231
Detailed Mineral Analysis												
Sulphates (SO_4)	49	1,141	1,327	280	412	Trace	1,252	547	Not*	62	662	929
Calcium (Ca)	23	387	233	64	203	Trace	448	Nil	taken	40	91	79
Magnesium (Mg)	43	113	323	295	405	84	232	270	too	44	95	94
Sodium (Na) by difference	129	140	....	46	139	290**	160	65	low	62	214	400**
Chlorine (Cl)	200	216·5	86	124·5	213·3	164	247·5	100	4·1	95·9	270	73·5
Hypothetical Combination												
Sodium chloride (NaCl)	329	357	....	118	352	270	408	165	....	158	445	121
Calcium sulphate ($CaSO_4$)	70	1,313	791	216	583	....	1,523	....	....	88	311	269
Magnesium sulphate ($MgSO_4$)	....	269	969	159	....	....	221	684	....	....	475	466
Calcium carbonate ($CaCO_3$)	7	....	....	....	79	....	....	....	....	36	....	....
Magnesium carbonate ($MgCO_3$)	148	207	338	836	1,410	293	652	466	....	155	....	....
Magnesium chloride ($MgCl_2$)	....	....	115	92	....	....	....	....	....	....	....	....
Sodium carbonate (Na_2CO_3)	....	....	....	....	....	424	....	....	....	....	....	267
Sodium sulphate (Na_2SO_4)	....	....	....	....	....	....	....	....	....	....	890	542

*Not taken, total solids too low. **Determined.

[1]Analyses made under the direction of Frank T. Shutt, Dominion Chemist.

Hardness of Waters from Southern Manitoba and Saskatchewan

Hardness, expressed as carbonate of lime—Results stated in parts per million and Clark's units

—	No. 1 St. Pierre school	No. 2 St. Pierre Modern Dairy	No. 3 Boisse-vain school	No. 4 Mac-donald town well	No. 5 Pierson highway	No. 6 Carnduff Cream-ery	No. 7 Morden Cream-ery	No. 8 Glad-stone shallow well	No. 9 Hnausa flowing well	No. 10 Arden shallow well	No. 11 Dauphin Daniel's well	No. 12 Mooso-min town well
Parts per million	91	910	1,392	1,410	1,785	293	2,142	1,750	486	403	1,032	822
Clark's units	6	63	97	98	125	20	150	122	34	28	72	57

Laboratory No.	Identification No.	Locality	Particulars: Depth of well Feet	Particulars: Character of rock	
104646	1	School, St. Pierre, Man.	About 300	Limestone	Flows about 4 gallons a minute
104647	2	Modern Dairy well, St. Pierre, Man.	153	In drift, gravel at bottom	Flows about 6 gallons a minute
104648	3	School, Boissevain, Man.	About 30	Boulder clay and gravel	
104649	4	Town well, Macdonald, Man.	12	Sand and clay	
104650	5	Public well, highway, Pierson, Man.	About 60	Boulder clay	
104651	6	Co-operative Creamery, Carnduff, Sask.	232	Through clay to sandstone at bottom	Flows 10 gallons a minute
104652	7	Creamery, Morden, Man.	19	Clay	
104653	8	Shallow well, Gladstone, Man.	12	Sand and gravel	
104654	9	Highway, Hnausa, Man.	80	Through clay to gravel	Flows about 4 gallons a minute
104655	10	Shallow well, Arden, Man.	About 35	Sand and gravel	
104656	11	Daniel's well, 1 mile southeast of Dauphin, Man.	12	Boulder clay	
104657	12	Town well, Moosomin, Sask.	About 180	Clay and gravel	

CHAPTER III

SOILS

GENERAL STATEMENT

Map 254A shows in a general way the distribution of the principal soils of the area according to the mode of origin and physical character of the materials upon which the soils are formed. The soil differs from the deposits upon which it is developed in that it has been affected by weathering; by the gradual accumulation in this stratum of vegetable and animal matter; and has been acted upon by bacterial and other kinds of life, so that it is productive. It may, therefore, be considered as distinct from the underlying stratum. Climatic conditions prevailing for a long period of time have a marked effect on the character of the soil and tend to develop on different kinds of parent materials soils that are similar in some respects. As the soils in Manitoba are youthful, geologically—they are formed on glacial drift or from only slightly weathered rock—similar soils tend to be developed on the same kinds of parent materials. Their character, however, is influenced by climatic and other conditions. Owing to the sub-humid climate the soils are only slightly leached; at many places crystals of gypsum occur in the soil and even the surface soil is slightly calcareous. Variations in the character of the soils also occur depending on whether the areas are forested or are prairie. In the prairie areas the soils as a rule are deep and are black except in the drier southwest part of the province where they are brown. In the forested areas they are not so deep and as a rule are lighter coloured. The geological classification of the soils may form a basis for grouping of the soils into series or suites having similar characteristics and for subdivision into smaller units such as will meet the needs of technical agriculturists.

Nearly all the soils of the area are drift soils, that is, they are formed from surface deposits of Pleistocene and Recent ages. At a few places in the southwestern part of the map-area and along the railway near the foot of Riding mountain, the shale is at the surface and the soil is formed from it. As the surface deposits throughout the map-area, except in the eastern part underlain by Precambrian rocks, contain large amounts of limestone and dolomite derived by glacial erosion of the Palæozoic rocks in the lowland, the soils are markedly calcareous, especially in their subsoil parts.

The total land area mapped is 43,380 square miles, of which 3,492 are swamps and rock outcrop. The following table gives the areal distribution of the soils exclusive of those parts occupied by swamps and rock outcrops.

	Square miles
Dune sand soils	1,250
Beach sand soils	370
Lake-bed and alluvial, sandy soils	3,000

	Square miles
Lake-bed and alluvial, silty soils	5,340
Lake-bed and alluvial, clay soils	4,955
Boulder clay, stony (lake-bed) soils	8,000
Boulder clay (unmodified) soils	9,668
Morainic soils	6,690
Glacial outwash soils	615

Of this total, 3,375 square miles are included in forest reserves.

SWAMP SOILS

Much of the highland area of southeastern Manitoba is occupied by swamps, and there are many small marshes in the inter-lake region. A large area known as the Big Grass marsh, but which has been drained, occupies part of the lowland west of lake Manitoba. Large parts of the Red River Valley plain were formerly marshy owing to the low gradients and lack of natural drainage; ditching has converted most of these areas into agricultural lands. Low-lying areas along Brokenhead river have a thin covering of peat, and in part have been drained by ditching. In the southwestern part of the sheet few marshes occur except on the uplands of Turtle and Riding mountains.

The peaty deposits that occupy the surface in the swampy areas are not true soils because they consist almost entirely of organic matter, but must be regarded as the soil in places where they are over a foot or so thick, that is of sufficient thickness to prevent the plough from reaching the under soil with which the peat requires to be mixed in order to render it productive, unless fertilizers are used. In places, for example along Brokenhead river and along other streams, the peat has been mixed with mineral soil by overflow of the river and is more the nature of muck which is naturally productive. Most of the peat being only slightly altered is brown, whereas the muck is black, and is further distinguished by the presence in it of sand and silt deposited during the overflow of streams from year to year. When the bogs have been drained and the peaty soil has been cultivated, it tends to disappear by oxidation and after a few years as much as a foot or even more may be removed. In places, for example along Brokenhead river where the undersoil is clay and the peat has a small thickness, valuable farm lands may be developed by drainage and cultivation of the peaty soil. Oxidation is aided by the application of manure or other fertilizers, and by liming to correct the naturally acid character of the peat. The drainage of peat lands is a difficult matter, because one of the properties of peat is its capacity for retaining water. For efficient drainage, a number of shallow drains leading to the main drain must be provided.

The character of the vegetation from which the peat has been formed in the numerous bogs varies from place to place; some bogs are quite different in origin from other bogs, and the character of the peat determines to some extent the treatment required for its successful cultivation. No special study, however, of the bogs from this standpoint has been made. It is generally held that grass peat soils are usually well suited for agricultural purposes. Sphagnum moss, which forms the upper part of many of the bogs, flourishes under acid conditions and liming is necessary to correct its acidity as a preliminary to any attempt at the raising of ordinary farm or garden crops. Most of the peat soils are of complex composition, and careful study is necessary of any particular bog that it is proposed to reclaim for agricultural purposes. After reclamation of a bog, having a depth after settling of more than 1 or 2 feet, the application of mineral fertilizers, particularly potash fertilizers, is necessary and their use must be continued because the peat soils, being composed of organic matter, afford no means of restoring these elements when used by growing plants as do ordinary mineral soils by the process of weathering. At present there is little incentive to the reclamation of peat bogs for agricultural use owing to the low prices for farm products and to the availability of ordinary farm lands. In the case of the shallow bogs, such as those along Brokenhead river north of Beausejour where the undersoil is clay and can be reached by deep ploughing, valuable farm lands are being developed.

DUNE SAND SOILS

The largest area of dune sand is in the ancient delta of Assiniboine river and is traversed for 50 miles by the Canadian National railway from Lavenham nearly to Brandon. A large part of this area is included in the Spruce Woods Forest Reserve. Other large tracts of dunes lie to the south of Portage la Prairie and in the vicinity of Oak Lake in the Souris River basin. Most of the dunes are clothed with vegetation, and only in a few places is the sand drifting. The soils are of little agricultural value, chiefly because if cultivation is attempted the sand is likely to drift.

BEACH SAND SOILS

The soils occur on low and relatively long, narrow ridges that are ancient beaches. Because of the ridged surface and loose, porous character of the soil, the natural drainage, especially on the upper parts of the ridges, is usually excessive and the soil, which consists of light-coloured sand mixed with gravel, is easily affected by drought.

LAKE AND ALLUVIAL SAND SOILS

These soils occupy the surface near the shores of the ancient lakes and along some streams where overflow has deposited sand. They consist of brown, fine sand containing few stones or boulders. The surface is nearly level or gently sloping and in places the natural drainage is poor, owing to the nearly level surface, but for this reason and the shallow ground-water level, the soil is not readily affected by drought.

LAKE AND ALLUVIAL SILTY SOILS

These soils occur in the ancient lake beds and along streams where there has been overflow, and are intermediate in character between the light sandy, and the heavy clay, lake, and alluvial soils. They occupy extensive areas and form valuable farm lands in Lake Souris basin and in the western part of Lake Agassiz basin. The soil is brown to black and in most cases is a heavy soil consisting of sandy loam or clay loam. The surface is nearly level or gently sloping.

LAKE AND ALLUVIAL CLAY SOIL

The black clay soil of Red River valley forms one of the most extensive and important soils of the area. The soil varies somewhat depending partly on whether it is developed on the alluvial clay along the stream valleys or on the lake clay, the former as a rule being a much deeper soil. Drainage conditions also cause variations. Assiniboine river in places between Winnipeg and Portage la Prairie overflows its banks in times of freshet and this causes marshy conditions. Red river, however, has overtopped its banks only twice since the earliest days of settlement, once in 1826 and again in 1852. Thus the soil profile along Red river is a mature one. Parts of the plain are poorly drained and are partly flooded in wet seasons but become dry in times of drought. In these areas there is no accumulation of peat at the surface; but in the northeast along the valley of Brokenhead river where flooding is more pronounced peat has accumulated at the surface and soil conditions are markedly different.

A soil profile on the alluvial clay at Winnipeg is as follows:

(1) Black humus-stained clay showing columnar structure in places, but for the most part breaking down into irregular lumps and eventually into a fine-grained, granular mass. Slightly calcareous, particularly in the lower part. Depth 12 to 14 inches.

(2) Greyish black clay showing poorly defined, columnar structure, and irregular blocks separated by vertical shrinkage cracks. The black clay extends downward in long tongues into yellowish grey clay. Soft, irregular masses of calcium carbonate up to 1 or 2 inches in diameter occur both in the black clay and in the grey clay which is somewhat sandy and silty. Maximum depth of the humus-stained clay about 30 inches.

(3) Yellowish grey, granular clay that is highly calcareous. There is a marked accumulation of calcium carbonate in the lower 6 inches which is sharply set off from the underlying material at a depth of 4 to $4\frac{1}{2}$ feet from the surface. The layer is a soft, marly clay.

(4) Light grey, stratified, calcareous clay.

In the lake clay areas, horizon No. 1 extends to about the same depth and is similar in character; horizon No. 2 is not so deep and contains comparatively little humus-stained clay. There is a gradual transition downward into the parent material and a gradual increase in the concentration of calcium carbonate to a depth of about 3 feet, but no very marked lime layer. The soil has been leached to some extent by downward passing surface waters, but not completely, for even the surface soil in places is slightly calcareous.

The most striking features of the Red River Valley clay soil are its deep black colour and great depth—3 feet or even more in places—to which the dark colour extends. The dark colour is due to the presence of colloidal humus that is uniformly distributed through the clayey mineral part of the soil and whose formation has been greatly favoured by climatic and other conditions. Roots of prairie grasses, and possibly in places vegetation buried beneath the silt deposited by flood waters, formed an abundant source of organic matter that was readily altered to humus owing to the character and structure of the mineral soil. The calcareous character of the clay tends to produce a granular structure, and owing to its colloidal character shrinkage cracks readily develop in the clay in times of drought, thus causing aeration of the soil and alteration of the organic matter to humus, though the exact process by which alteration takes place is not known and may be highly complicated. In places the burrowings of animals may account for humus-stained soil at a depth of as much as 3 feet, but at many places along Red river the black soil extends nearly to this depth in a fairly uniform layer and can hardly be accounted for in this way; more probably it is an alluvial soil. In the alluvial soil, however, the soil profile, as a rule, is a mature one owing to the infrequent periods of overflow of the stream.

It is doutful whether the calcium carbonate layer should be considered as part of the soil profile owing to the depth at which it occurs, though it has been formed to some extent at least by downward leaching from the soil horizons.

BOULDER CLAY, STONY SOILS

In the inter-lake area and in southeastern Manitoba at places where boulder clay is at the surface, much of the soil formed from the boulder clay is stony; the clay is in the bed of ancient Lake Agassiz and wave-action during the existence of the lake washed away the fine particles and left the stones and boulders on the surface. The surface is rolling or gently sloping and large parts of the areas are wooded. On the average, possibly 10 per cent of the areas are suited for agriculture, but for the most part are used for grazing or are not occupied.

BOULDER CLAY (UNMODIFIED) SOILS

These soils occupy large areas in the western and southwestern parts of the sheet in the areas not covered by ancient lakes. The boulder clay, therefore, was not modified by wave-action and as a rule contains few stones or boulders. The soil in most places is fine, sandy loam or clay loam, a somewhat " lighter " soil than the lake clay. The surface is undulating as a rule, but there are large areas of slight relief. The great part of the areas occupied by these soils forms good agricultural lands.

MORAINIC SOILS

These soils are similar in character to the boulder clay (unmodified) soils, but the surface is hilly. Large parts of the areas are timbered and are included in forest reserves.

GLACIAL OUTWASH SOILS

In these areas the soil is light coloured and is sandy. One of the largest areas lies at the junction of Qu'Appelle and Assiniboine rivers. Owing to the fact that there the sand and gravel deposits are deeply trenched by streams, the gravels are excessively drained so that the soil is easily affected by drought and is of little agricultural value. At other places, for example in the area on the north side of Pelican and Rock lakes in Pembina valley, the sand is not so well drained and forms agricultural lands.

SAND AND GRAVEL

Sand and gravel for ballast, road materials, and structural purposes occur in the beach ridges, in the lacustrine sand areas, and in the glacial outwash deposits. For concrete, for road construction, and for general purposes the main supply comes from Birds hill; from the "Big ridge of the Assiniboine " near Woodlands; from Marchand and along the Canadian National railway near Ste. Anne; and from near Molson. A great many small deposits are scattered throughout the map-area. In places the sands and gravels are concealed beneath a thin covering of boulder clay, or appear at the surface only on the tops of low hills and are quite extensive beneath the clay bordering the hills. This is the case at the gravel pits near Gonor and at the silica sand deposit near Beausejour.

Silica sands of sufficient purity to be used for the manufacture of glass rarely occur in the surface deposits because these sands as a rule are heterogeneous; they are derived from a variety of rocks. An unusual deposit occurs at Beausejour where the sand, which has a maximum thickness of about 30 feet, was formerly used for the manufacture of bottle glass.[1] The sand consists mainly of quartz grains, but contains some impurities. It outcrops as a low ridge, passes beneath boulder clay on the sides, and borings are reported to show that it is underlain by clay.

Moulding sands that are coarse in texture and have a natural bond are also rarely found in the surface deposits; the bonding material, which usually consists of clay and dark minerals resistant to weathering, is more commonly found in residual soils than in glacial deposits, for these as a rule are only slightly weathered. Fine sand containing some silt and clay that acts as a bond occurs in the Assiniboine delta deposits at Melbourne Siding and is used for light castings. It occurs at the surface and extends down for at least 9 feet. The delta deposits are in part wind-blown and contain in places some silt and clay deposited along with the sand, so that they form the most favourable source for moulding sands in the map-area. Sand very similar to that at Melbourne Siding occurs at Siding and Firdale. Most of the sand, however, is fine. A surface sand from mile 80 on the Greater Winnipeg Water District railway and a sand with no natural bond but mixed with core oil are also used, and are fairly coarse, angular sands. Fine-grained, clean sands are found near Molson and Sinnot. Those near Sinnot consist largely of quartz grains and appear to be similar in origin to the Beausejour deposit.

CLAYS

The surface clays have been used in the brick and hollow tile industry at many places in the map-area and differ somewhat in character from place to place, depending upon the mode of origin and physical character of the material. Nearly all the clays used are either alluvial deposits formed from overflow of the streams or are ancient delta deposits. The lake clays are not used to any great extent, because in most places they are

[1] Cole, L. H.: "Silica in Canada," Pt. 2; Mines Branch, Department of Mines, Canada, pp. 8-12 (1928).

Wallace, R. C., and Grier, L.: "The Non-metallic Mineral Resources of Manitoba," Winnipeg, Man., pp. 57-61 (1927).

too highly plastic. The brick clays thus occur along the streams and in the ancient delta of Assiniboine river. At Winnipeg and St. Boniface on Red river, Portage la Prairie on Assiniboine river, and at Whitemouth, the brick clays are 2 or 3 feet to 9 feet thick and contain sandy layers which when mixed with the clay render it workable. Sections along Red river at Winnipeg show the upper sandy clay beds to be 3 to 6 feet thick, or somewhat more. In places there is a 6-inch sand bed in the lower part of these beds. The underclays are finely laminated and are composed of extremely fine clay. They are deep, lake-water clays and are so highly plastic that they cannot be used in the manufacture of bricks without special treatment. These clays, however, together with the upper sandy clays, are used in the manufacture of cement at Tuxedo near Winnipeg. At Portage la Prairie the surface alluvial clay is 7 to 8 feet thick and contains a soil layer about 5 feet down from the surface. At Whitemouth, 3 to 4 feet of the upper sandy clay is used. In this section and in the highland area along the Greater Winnipeg Water District railway, the surface clays are in part Lake Agassiz clays, but differ in character from those of Red River valley in being more sandy and, therefore, are better suited for use in the clay industry. All the clays in Red and Assiniboine River valleys and in the districts to the east are highly calcareous. Bricks made from these clays are light coloured, the lime taking up the iron to form a colourless iron silicate when the bricks are burned. In the Assiniboine delta where the lime content of the clay is less in proportion to the iron, the clay burns to various shades of brown to red. At Sidney, Firdale, Edrans, and at other places in the Assiniboine delta, the brick clays have a much greater thickness and are more sandy than the alluvial clays of Red River valley. Sections near Sidney show thicknesses of as much as 30 feet. The sand occurs in the form of lenses at various levels in the clay and is present in greater amounts in some sections than in others, so that the character of the clay varies somewhat from place to place. Its sandy character renders the clay easily worked, and its red burning qualities give the product a pleasing appearence.[1]

PEAT

Numerous large peat bogs occur in southeastern Manitoba, in fact a large part of the region is swamp. Among the largest and most accessible of those that have been examined from the standpoint of the peat fuel and peat litter content, are the Julius bog along the line of the Canadian Pacific railway east of Julius station, and the Transmission bog along the railway leading from Molson to Lac du Bonnet. The former has an approximate area of 3,900 acres and an estimated possible production of peat litter of 2,449,000 tons, and the latter an approximate area of 1,375 acres and an estimated possible production of peat fuel of 936,000 tons.[2] A number of other smaller bogs including the Lac du Bonnet, Corduroy,

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[1] Ries, Heinrich, and Keele, Joseph: "Preliminary Report on the Clay and Shale Deposits of the Western Provinces"; Geol. Surv., Canada, Mem. No. 24-E, pp. 18-30 (1912).

[2] Haanel, B. F.: Facts about Peat; Mines Branch, Department of Mines, Canada, 1924, p. 32.

Boggy Creek, Mud Lake, and Litter bogs have also been examined. Most of the bogs are shallow and the material in many places may not be sufficiently altered to be of much value for the manufacture of peat fuel. Peat briquetting was attempted at the Lac du Bonnet bog in 1907, but operations were discontinued. The Julius bog and probably other bogs in this general region are well suited for the manufacture of peat litter, and probably for insulating wallboard.

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