CANADA
DEPARTMENT OF MINES

HON. T. A. CRERAR, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF HILLSBOROUGH No. 132 SASKATCHEWAN

BY

B. R. MacKay, & H. H. Beach

Water Supply Paper No. 47

OTTAWA
1936

CANADA

DEPARTMENT OF MINES

BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY OF HILLSBOROUGH NO. 132 SASKATCHEWAN

BY

B.R. MacKAY and H.H. BEACH

WATER SUPPLY PAPER NO. 47

CONTENTS

Illustrations

GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY OF HILLSBOROUGH, NO. 132, SASKATCHEWAN

INTRODUCTION

Lack of rainfall during the years 1930 to 1934 over a large part of the Prairie Provinces brought about an acute shortage both in the larger supplies of surface water used for irrigation and the smaller supplies of ground water required for domestic purposes and for stock. In an effort to relieve the serious situation the Geological Survey began an extensive study of the problem from the standpoint of domestic uses and stock raising. During the field season of 1935 an area of 80,000 square miles, comprising all that part of Saskatchewan south of the north boundary of township 32, was systematically examined, records of approximately 60,000 wells were obtained, and 720 samples of water were collected for analyses. The facts obtained have been classified and the information pertaining to any well is readily accessible. The examination of so large an area and the interpretation of the data collected were possible because the bedrock geology and the Pleistocene deposits had been studied previously by McLearn, Warren, Rose, Stansfield, Wickenden, Russell, and others of the Geological Survey. The Department of Natural Resources of Saskatchewan and local well drillers assisted considerably in supplying several hundred well records. The base maps used were supplied by the Topographical Surveys Branch of the Department of the Interior.

Publication of Results

The essential information pertaining to the ground water conditions is being published in reports, one being issued for each municipality. Copies of these reports are being sent to the secretary treasurers of the municipalities and to certain Provincial and Federal Departments, where they can be consulted by residents of the municipalities or by other persons, or they may be obtained by writing direct to the Director, Bureau of Economic Geology, Department of Mines, Ottawa. Should anyone require more detailed information than that contained in the reports such additional information as the Geological Survey possesses can be obtained on application to the director. In making such request the applicant should indicate the exact location of the area by giving the quarter section, township, range, and meridian concerning which further information is desired.

The reports are written principally for farm residents, municipal bodies, and well drillers who are either planning to sink new wells or to deepen existing wells. Technical terms used in the reports are defined in the glossary.

How to Use the Report

Anyone desiring information about ground water in any particular locality should read first the part dealing with the municipality as a whole in order to understand more fully the part of the report that deals with the place in which he is interested. At the same time he should study the two figures accompanying the report. Figure 1 shows the surface and bedrock geology as related to the ground water supply, and Figure 2 shows the relief and the location and type of water wells. Relief is shown by lines of equal elevation called "contours". The elevation above sea-level is given on some or all of the contour lines on the figure.

If one intends to sink a well and wishes to find the approximate depth to a water-bearing horizon, he must learn: (1) the elevation of the site, and (2) the probable elevation of the water-bearing bed. The elevation of the well site is obtained by marking its position on the map, Figure 2, and estimating its elevation with respect to the two contour lines between which it lies and whose elevations are give on the figure. Where contour lines are not shown on the figure, the elevations of adjacent wells as indicated in the Table of Well Records accompanying each report can be used. The approximate elevation of the water-bearing horizon at the well-site can be obtained from the Table of Well Records by noting the elevation of the water-bearing horizon in surrounding wells and by estimating from these known elevations its elevation at the well-site.[1] If the water-bearing horizon is in bedrock the depth to water can be estimated fairly accurately in this way. If the water-bearing horizon is in unconsolidated deposits such as gravel, sand, clay, or glacial debris, however, the estimated elevation is less reliable, because the water-bearing horizon may be inclined, or may be in lenses or in sand beds which may lie at various horizons and may be of small lateral extent. In calculating the depth to water, care should be taken that the water-bearing horizons selected from the Table of Well Records be all in the same geological horizon either in the glacial drift or in the bedrock. From the data in the Table

[1] If the well-site is near the edge of the municipality, the map and report dealing with the adjoining municipality should be consulted in order to obtain the needed information about nearby wells.

of Well Records it is also possible to form some idea of the quality and quantity of the water likely to be found in the proposed well.

GLOSSARY OF TERMS USED

Alkaline. The term "alkaline" has been applied rather loosely to some ground waters. In the Prairie Provinces a water is usually described as "alkaline" when it contains a large amount of salts, chiefly sodium sulphate and magnesium sulphate in solution. Water that tastes strongly of common salt is described as "salty". Many "alkaline" waters may be used for stock. Most of the so-called "alkaline" waters are more correctly termed "sulphate waters".

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

Aquifer or Water-bearing Horizon. A water-bearing bed, lens, or pocket in unconsolidated deposits or in bedrock.

Buried pre-Glacial Stream Channels. A channel carved into the bedrock by a stream before the advance of the continental ice-sheet, and subsequently either partly or wholly filled in by sands, gravels, and boulder clay deposited by the ice-sheet or later agencies.

Bedrock. Bedrock, as here used, refers to partly or wholly consolidated deposits of gravel, sand, silt, clay, and marl that are older than the glacial drift.

Coal Seam. The same as a coal bed. A deposit of carbonaceous material formed from the remains of plants by partial decomposition and burial.

Contour. A line on a map joining points that have the same elevation above sea-level.

Continental Ice-sheet. The great ice-sheet that covered most of the surface of Canada many thousands of years ago.

Escarpment. A cliff or a relatively steep slope separating level or gently sloping areas.

Flood-plain. A flat part in a river valley ordinarily above water but covered by water when the river is in flood.

Glacial Drift. The loose, unconsolidated surface deposits of sand, gravel, and clay, or a mixture of these, that were deposited by the continental ice-sheet. Clay containing boulders forms part of the drift and is referred to as glacial till or boulder clay. The glacial drift occurs in several forms:

(1) Ground Moraine. A boulder clay or till plain (includes areas where the glacial drift is very thin and the surface uneven).

(2) Terminal Moraine or Moraine. A hilly tract of country formed by glacial drift that was laid down at the margin of the continental ice-sheet during its retreat. The surface is characterized by irregular hills and undrained basins.

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

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

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

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

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

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

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

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

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

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

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

(1) Wells in which the water is under sufficient pressure to flow above the surface of the ground. These are called Flowing Artesian Wells.

(2) Wells in which the water is under pressure but does not rise to the surface. These wells are called Non-Flowing Artesian Wells.

(3) Wells in which the water does not rise above the water table. These wells are called Non-Artesian Wells.

NAMES AND DESCRIPTIONS OF GEOLOGICAL FORMATIONS, REFERRED TO IN THESE REPORTS

Wood Mountain Formation. The name given to a series of gravel and sand beds which have a maximum thickness of 50 feet, and which occur as isolated patches on the higher parts of Wood mountain. This is the youngest bedrock formation and, where present, overlies the Ravenscrag formation.

Cypress Hills Formation. The name given to a series of conglomerates and sand beds which occur in the southwest corner of Saskatchewan, and rest upon the Ravenscrag or older formations. The formation is 30 to 125 feet thick.

Ravenscrag Formation. The name given to a thick series of light-coloured sandstones and shales containing one or more thick lignite coal seams. This formation is 500 to 1,000 feet thick, and covers a large part of southern Saskatchewan. The principal coal deposits of the province occur in this formation.

Whitemud Formation. The name given to a series of white, grey, and buff coloured clays and sands. The formation is 10 to 75 feet thick. At its base this formation grades in places into coarse, limy sand beds having a maximum thickness of 40 feet.

Eastend Formation. The name given to a series of fine-grained sands and silts. It has been recognized at various localities over the southern part of the province, from the Alberta boundary east to the escarpment of Missouri coteau. The thickness of the formation seldom exceeds 40 feet.

Bearpaw Formation. The Bearpaw consists mostly of incoherent dark grey to dark brownish grey, partly bentonitic shales, weathering light grey, or, in places where much iron is present, buff. Beds of sand occur in places in the lower part of the formation. It forms the uppermost bedrock formation over much of western and southwestern Saskatchewan and has a maximum thickness of 700 feet or somewhat more.

Belly River Formation. The Belly River consists mostly of non-marine sand, shale, and coal, and underlies the Bearpaw in the western part of the area. It passes eastward and northeastward into marine shale. The principal area of transition is in the western half of the area where the Belly River is mostly thinner than it is to the west and includes marine zones. In the southwestern corner of the area it has a thickness of several hundred feet.

Marine Shale Series. This series of beds consists of dark grey to dark brownish grey, plastic shales, and underlies the central and northeastern parts of Saskatchewan. It includes beds equivalent to the Bearpaw, Belly River, and older formations that underlie the western part of the area.

WATER-BEARING HORIZONS OF THE MUNICIPALITY

The rural municipality of Hillsborough covers a land area of 179 square miles in the south-central part of Saskatchewan. Johnstone lake occupies the greater part of the southwest quarter of the municipality, and the third meridian forms the western boundary. The land area consists of three full townships and fractions of four others, all west of the second meridian. They are described as townships 13, 14, and 15, range 28; the northern part of township 14, and township 15, range 29; $6\frac{1}{2}$ square miles forming fractional township 14, range 30, and 3 square miles forming fractional township 15, range 30, the two fractional townships bordering the third meridian on the west.

The ground surface of the area rises gradually from Johnstone lake, at an elevation of 2,186 feet above sea-level, as a gently rolling plain which extends approximately 4 or 5 miles to the north and east of the lake, beyond which the surface becomes much more rugged to the north and northeast to form a part of the Missouri coteau. The coteau extends as a range of hills from the International Boundary in a northwesterly direction across southern Saskatchewan. In this municipality the coteau attains a maximum elevation of over 2,800 feet above sea-level, the highest elevation being in the northeastern part of township 14, range 28. Numerous small lakes in undrained depressions dot the northern and northeastern parts of the area, but no streams exist in the municipality.

A mantle of glacial drift, consisting of terminal moraine and glacial outwash gravels, occurs throughout the municipality. The variations in the water conditions throughout the area are closely related to the differences that exist in the character of the glacial deposits. These variations are due essentially to differences in the manner in which the deposits were laid down.

Many thousands of years ago two or more continental ice-sheets moved in a southwesterly direction over the province of Saskatchewan. As a result of the advance and retreat of the last ice-sheet a layer of till or boulder clay was laid down in places in the form of ground moraine. This material is composed essentially of bluish grey boulder clay which as a result of oxidation is yellow near the surface. Boulders and irregular pockets of sand and gravel, generally of small areal extent, are interspersed irregularly through the boulder clay. With the melting of the ice and the gradual north-easterly retreat of the ice front a more porous deposit of glacial drift was laid down and in the areas where the retreating ice front halted for a considerable period of time the accumulation of drift formed a belt of hillock topography known as "terminal moraine". Much of the morainic material is composed of boulder clay in which pockets of sands and gravels are more numerous and generally of greater areal extent than in the boulder clay of the ground moraine. Streams formed from the melting ice re-sorted much of the gravels and sands and carried them away from the highlands, depositing them as thin beds over the lowlands. Such deposits, designated glacial outwash sands and gravels, occur in the southwestern part of the municipality, in two localities covering a combined area of 15 square miles lying to the northeast of Johnstone lake. Deposits of fine sands and silts of glacial and recent origin floor the depression now occupied in part by Johnstone lake. The areal distribution of the several types of deposits is shown on the map (figure 1) accompanying this report. Boulder clay and sand and gravel laid down by one or more earlier ice-sheets probably underlie the deposits of the last ice-sheet and form part of the glacial drift.

Large amounts of mineral salts have been carried in solution into the lake basin, and as the lake does not overflow these dissolved mineral salts, of which sodium sulphate (Na_2SO_4) and magnesium sulphate ($MgSO_4$) are the dominant constituents, have accumulated by evaporation of the water and render the water in the lake unfit for any farm use. Few wells have been sunk in the sands and silts bordering the lake. The water from these wells is reported to be generally unfit even for stock, due to the high concentration of mineral salts in solution.

The glacial outwash gravels in general form the best source of ground water in the municipality. Shallow wells sunk into these deposits yield large supplies of hard, slightly mineralized water that is suitable for both domestic and stock requirements. The individual gravel beds do not extend over large areas. They occur in narrow zones trending more or less at right angles to the major axis of the northeastern range of hills. In places along hillsides, where these gravel beds come within a few feet of the surface, springs are common. Water in shallow wells tapping these gravel beds is under hydrostatic pressure, and in many places flows above the ground surface. Wells penetrating the larger sand and gravel pockets in the moraine provide an adequate supply of hard, drinkable water for farm requirements. These pockets are often difficult to locate. Residents in many places have found it necessary to dig several holes before a sufficiently productive pocket was encountered. Wells sunk entirely in boulder clay, and especially below depths of 35 feet, yield small quantities of very hard water. The large amount of dissolved mineral salts in solution generally renders this water unsuitable for drinking. In areas of boulder clay or till shallow wells located beside sloughs or excavated dugouts form the best source of water for household use.

Water-bearing Horizons in the Bedrock

Very little information is obtainable regarding the water conditions of the bedrock formations underlying the glacial drift of this municipality. One well, located in SW.$\frac{1}{4}$, sec. 12, tp. 15, range 28, was drilled to a depth of 115 feet into a dark grey shale at an elevation of 2,275 feet above sea-level without encountering water. Two other wells, located in sections 35 and 36 of the same township were sunk to depths of 115 and 105 feet, respectively, reaching a productive sand bed at an elevation of 2,015 feet above sea-level. The logs of these wells are not sufficiently descriptive to make it possible to determine whether this sand bed is at the base of the glacial drift or in the bedrock. The water from the well in section 35 is hard, and although containing small amounts of iron is suitable for both domestic and stock needs. Water from the well in section 36 contains considerable amounts of mineral salts in solution which render it unfit for household use.

The bedrock is not exposed at the surface at any point in the municipality. The meagre information obtained regarding ground water conditions from the three wells sunk into the bedrock in the northeastern township throws little light on bedrock conditions of the municipality. Any suggestions that can be made with regard to the possible existence of aquifers beneath the drift throughout the greater part of the area are based essentially on geological observations in adjoining municipalities. It is reasonable to assume that, barring unknown folds and faults, the series of beds comprising the bedrock formations will continue over considerable areas in this municipality at approximately the same elevations as observed in surrounding districts.

The data at hand are not sufficiently accurate to permit of plotting even approximately the formation boundaries on the geological map (Figure 1). Three bedrock formations, i.e., the Ravenscrag, the Eastend, and the Marine Shale series, are believed to be present beneath the glacial drift of the municipality. The Ravenscrag where exposed in adjoining municipalities consists of yellow to brown clays and shales, beds of coarse bluish grey sands, and thin seams of lignite coal. The sand beds and coal seams act as water-bearing horizons. The Ravenscrag overlies the other formations and occurs in the areas of high relief along the eastern and northern parts of the municipality lying above an approximate elevation of 2,300 feet above sea-level, but it probably does not extend over the lowland parts of the southwestern half area or the extreme northeast corner. The Ravenscrag formation is underlain by some 20 to 35 feet of fine grey sands and silts comprising the Eastend formation. This formation is believed to be continuous above 2,275 feet above sea-level throughout the area, and where not overlain by Ravenscrag occurs immediately beneath the glacial drift. The Eastend becomes shaly toward the base and grades downward imperceptibly into a series of fine, grey, compact shales known as the Marine Shale series. The shale is readily recognized in drilling by the dark grey colour, its soapy appearance when wet, and by the small, roughly cubical fragments into which it crumbles upon drying. The Marine Shale is believed to be approximately 600 feet in thickness, and should be encountered in the higher parts of the municipality at an approximate elevation of 2,275 feet above sea-level, whereas in the lower areas it may occur immediately underlying the glacial drift.

The water supply to be expected from the Ravenscrag should be satisfactory, and sufficient for local stock requirements. The character of the water, however, varies in different localities, which makes it impossible to comment upon this formation as a source of drinking water. The upper, and usually coarser, sand beds of the Eastend formation yield small supplies of water. At greater depths in the formation and in the underlying Marine Shale the supply is small. Large amounts of dissolved mineral salts are usually present in the water, rendering it unfit for drinking and usually unfit for stock. It is improbable that any adequate supply of water suitable for farm requirements will be obtained in the bedrock below an approximate elevation of 2,225 feet above sea-level in any part of the municipality.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 13, Range 28

The variations in the ground water conditions throughout this township are very closely related to the differences in the character of the glacial deposits that in places cover the area to a depth of 100 feet. Boulder clay forms the lower part of the glacial drift in the township. The generally impervious nature of the clay and the paucity of porous beds suitable for the retention of any large supplies of water make the sinking of wells below a depth of 50 feet in any locality inadvisable. The upper part of the glacial drift is in the form of a moraine, which is hillocky and is usually much more porous than the underlying boulder clay. Gravel beds occur in the moraine. In the northeastern half of the township gravels and sands have been washed down from the highlands to the east. Individual gravel beds do not cover large areas, but are concentrated in comparatively narrow zones extending from the eastern highlands. Remote from the hills in the southwestern half of the area water conditions are poor. The gravel or sand pockets in the moraine are small and sparsely scattered through the boulder clay. Unless such productive pockets can be located residents are obliged to rely for their water supply on shallow seepage wells sunk beside sloughs, or excavated dugouts. In a few places shallow wells sunk in ravines have yielded sufficient water for 10 to 15 head of stock. The majority of the wells located remote from natural depressions yield a very meagre supply, and the quantity of dissolved mineral salts in the water is in some instances sufficient to render the water unfit for drinking. It has been necessary on several farms to sink many holes before a productive sand pocket has been encountered. A zone has been outlined on the map in sections 3, 4, 9, and 10, in which a considerable amount of prospecting reveals that the ground water conditions are particularly poor.

In the northeastern half of the township little difficulty has been experienced in obtaining large supplies of good water from gravel or coarse sand beds at depths not exceeding 25 feet. Small knolls and gravel ridges have proved particularly good sites for wells. In places where the gravel beds come to the surface on hillsides or along the banks of coulées springs may occur. Such springs flow continuously yielding a supply of drinkable water in sufficient quantities for all local farm requirements. Here, as in the southwestern part of the township, deep drilling is not recommended. More extensive prospecting at shallow depths should produce an adequate water supply on any section of the northeastern half of the township.

A thin layer of sands and silts borders the lake in this township. The water of the lake itself contains a high concentration of salts in solution. It is probable that the small supplies to be obtained at shallow depths from the lake sands will be similarly charged with mineral salts. Such supplies are quite unfit for drinking, and would likely prove injurious to stock.

No wells have been sunk through the drift into the underlying bedrock in this township. Beds of fine grey sands and silts not exceeding 25 feet in thickness, known as the Eastend formation, probably immediately underlie the drift of the eastern half of the township. In adjoining areas the small supplies of water derived from this formation are of poor quality. At greater depths, beneath the Eastend and below the drift in the western part of the area, the Marine Shale is present. Due to its impervious character, however, it yields only very small supplies of water which cannot be used for domestic purposes. Prospects of obtaining an adequate supply of water for farm use below the drift are not encouraging in this township.

Township 14, Range 28

The mantle of glacial drift that covers the township to undetermined depths is the source of the entire ground water supply of this township. An extensive layer of outwash gravels occurs in the western part of the township. The gravels are in places concealed by 10 to 20 feet of blue-grey boulder clay. One well, located in NW.$\frac{1}{4}$, section 7, yields an adequate supply of drinkable water from the gravels below clay, at a depth of 23 feet. This is the only well known to be producing from these gravels in the township. Conditions indicate, nevertheless, that adequate water supplies should be obtainable in practically all parts of this narrow area within 25 to 30 feet of the surface. The ground water conditions in the irregular deposit of moraine that covers the remainder of the township are in general much poorer than in the area of outwash gravels. In the south-central, central, and northwestern parts the few pockets of sands and gravels that do occur are interspersed through the upper 30 feet of the drift. Wells that have penetrated such pockets yield small supplies of "alkaline", but generally drinkable, water. These wells do not usually yield sufficient water for more than a few head of stock. The impervious nature of the boulder clay overlying the area makes the excavation of dugouts feasible. Water retained in dugouts and in natural depressions and by dams constructed across the small ravines forms the chief supplies for stock. Deep drilling is not likely to produce any large amount of water. Only a more extensive prospecting of the glacial deposits at shallow depths, and particularly on gravel knolls and ridges, can be expected to yield a supply of water sufficient and suitable for farm requirements. An area in the central part of the township in which ground water conditions in the drift are particularly poor is indicated by a line on the accompanying map. The gravel beds become thicker and more extensive toward the high morainic ridge of the northeast corner of the township. Here less prospecting should be necessary in order to locate a buried deposit of water-bearing gravel than in the lowland plain. Several wells sunk to depths of 5 to 10 feet along the lower slopes of the hills have penetrated these buried gravel beds, which extend nearly at right angles to the line of hills. The water is under hydrostatic pressure and flows continuously from several wells and rises nearly to the surface in others. Springs occur along the hill-sides where the beds of gravels come to the surface. Water from these sources is generally exceedingly hard. The quantity of dissolved mineral salts, particularly sulphates, differs in different wells, but in most places is not sufficient to exclude the water from household use.

No wells have been sunk through the drift into the underlying bedrock formations. In the lowland area the fine sands and silts of the Eastend formation are believed to occur immediately beneath the drift. Such sands probably contain small supplies of water, but from a study of the bedrock wells in the municipality adjacent on the south it seems likely that such water will be quite highly mineralized and not suitable for drinking. In the higher land of the northeastern half of the township thin coal seams and the coarse blue-grey sands of the Ravenscrag are believed to occur above the Eastend. In other areas where this sand is present it yields fairly large supplies of hard water, with varying amounts of dissolved sulphate salts. The drilling of test holes to depths of 100 to 150 feet to tap this horizon in the northeastern part of the township would seem to be a worth while venture. Drilling greatly below this depth, however, would encounter the Eastend silts and finally the dark impervious Marine Shale, which is not generally water-bearing in this locality.

Township 14, Range 29

Along the southern part of the township, bordering Johnstone lake, the thin layer of Recent lake sands contains water that, due to its high concentration of dissolved mineral salts, is quite unfit for any farm use. Throughout most of the remainder of the township the mantle of glacial drift contains quite extensive beds of gravels within 30 feet of the surface. In years of normal precipitation shallow wells yield large supplies of hard, drinkable water. Due to the proximity of these porous beds to the surface periods of drought materially reduce the ground water supply. The areas in which the glacial outwash deposits are most extensively developed are indicated on Figure 1 of the accompanying map. In sections 20, 30, 31, and 32, the gravel beds slope to the south from the northern highland region. This condition causes the water to be under pressure. Shallow wells sunk on gravel ridges or encountering gravel beds beneath the top layer of boulder clay often flow for considerable periods of time. Springs in the same locality occur where these gravel beds come to the surface along hill-sides. The water is generally very hard and contains sulphate salts in solution. The concentration is not generally sufficient, however, to render the water objectionable for household use. In the areas of terminal moraine in the central part of the township the gravel beds although present are thinner and more sparsely scattered through the boulder clay. Several shallow holes may be put down before a productive gravel or sand pocket is penetrated. The yield is smaller than from wells in the outwash gravel areas, but is generally sufficient for local requirements. The water is hard and is usually more highly mineralized than water from the outwash gravels. In no place was the water reported to be unsuitable for household use.

No wells have been sunk through the drift into the underlying bedrock of this area. It is probable that fair supplies of hard water are to be obtained at depths less than 100 feet from the coal seams and blue-grey sand beds of the Ravenscrag formation, believed to underlie the extreme northeast corner of the area. Throughout the remaining part of the township the fine sands and silts of the Eastend or the Marine Shale series occur immediately below the drift. It is improbable that these beds will yield any large supply of water.

Township 14, Range 30

This fractional township occupies an area $1\frac{1}{2}$ miles in width lying on the east side of the third meridian. Water conditions are poor throughout the area. The sands and silts bordering the lake at the south yield water so highly charged with mineral salts as to be unfit for any farm use. Throughout the remainder of the area the pockets of sands and gravels scattered through the boulder clay covering the area offer the only possibility for any large accumulation of ground water. Two wells located on NE.$\frac{1}{4}$, section 23, and SE.$\frac{1}{4}$, section 24, yield adequate supplies of moderately hard water from sand and gravel beds at depths, respectively, of 9 and 30 feet from the surface. These beds occur beneath layers of blue-grey boulder clay. Several fruitless attempts have been made to obtain water at greater depths. Studies of this and adjoining areas seem to indicate, moreover, that there is little hope of finding more than small seepages of water, containing a high concentration of dissolved mineral salts, either from the lower part of the glacial drift or the underlying Eastend or Marine Shale bedrock formations. Residents are better advised to carry out systematic prospecting in the upper 30 feet of the glacial drift.

Township 15, Range 28

The blanket of glacial drift covering this township is the main source of ground water. The drift is in the form of terminal moraine. The pockets of sands and gravels interspersed through the upper 40 feet of the drift are thin and of very limited areal extent. This factor has made it difficult for many of the residents to obtain a ground water supply adequate for farm requirements. A considerable amount of careful prospecting may be necessary, during which many dry holes may be sunk penetrating only boulder clay, before even a small supply is encountered. Very shallow wells located near sloughs or dugouts form the best source of drinking water in the area. Water from wells sunk to greater depths in the drift is in many places highly charged with sulphate salts in solution. This condition renders the water objectionable for drinking and in several wells the water is reported to be too highly "alkaline" to be used for stock.

Little deep drilling has been done in this township, with the result that the water conditions in the underlying bedrock can only be surmised from conditions known to exist in adjoining areas. The lower part of the glacial drift from 40 to 60 feet or more below the surface over much of the area appears to be generally unproductive. A well located in section 10, sunk to a depth of 55 feet struck no water-bearing beds below a depth of 10 feet. Similarly a 115-foot bedrock well in section 12 was drilled down to an approximate elevation of 2,275 feet above sea-level without striking more than a very small seepage of water. This well passed through the blue-grey boulder clay down into a dark grey shale believed to be the Marine Shale. It is possible that wells sunk to depths not exceeding 150 feet in depth on the highlands of the south-central part of the township may encounter the coal seams and the blue-grey, coarse sands of the Ravenscrag formation, which generally contain water. The suggestion of such a possible occurrence is not a direct observation on well logs, but is based on elevation determinations of the position of this formation in areas to the south and northwest of this municipality. The water possibilities in the bedrock are discussed at greater length in the section dealing with the municipality as a whole.

Two wells located on NE.$\frac{1}{4}$, section 35, and SE.$\frac{1}{4}$, section 36, yield fair supplies of water at depths of 115 and 105 feet, respectively, from what is believed to be a continuous sand bed at the base of the drift or in the bedrock. This bed occurs at an approximate elevation of 2,015 feet above sea-level. It seems probable that this bed will be encountered at gradually increasing depths with the rising ground surface in a westerly direction along the northern edge of the township. For example, it would be necessary to drill to depths of 180 to 225 feet in the town of Abound before this horizon would be encountered. The water is hard and contains large quantities of dissolved mineral salts, particularly sulphates. The water in the well in section 35 is being used for drinking, but water from the well in section 36 was reported by the Provincial Analyst as being unfit for human consumption.

Wells sunk below an elevation of 2,200 feet above sea-level in any part of this township will enter the dark grey impervious marine shale, from which no adequate supplies of water suitable for farm requirements can be expected.

Township 15, Range 29

A blanket of terminal moraine covers the entire township to an unknown depth. Here, as in adjacent townships, the quantity of water available at any one locality is dependent largely upon the lateral extent of the porous sand and gravel pockets scattered through the boulder clay. In areas where gravel beds that extend down from the central hills come to the surface artesian wells are to be expected. It is improbable that these gravel beds are widespread, and that water under hydrostatic pressure will be found at shallow depths throughout the area. It seems more likely that the gravel deposits are narrow compared to their length and extend like tongues nearly at right angles to the trend of the hills. Gravel knolls, and particularly low, northeast-southwesterly trending ridges, have proved in several places to be good well sites. The water from the springs and shallow artesian wells is in general very hard, but the amount of sulphate salts in solution is small thus making the water quite suitable for household use. The flow from these springs and wells is small but is reported to be continuous and adequate for local farm requirements.

In areas remote from the springs and flowing wells considerable difficulty has been experienced in obtaining an adequate water supply. In several places it has been necessary to dig a number of holes before a productive sand or gravel pocket has been encountered. On other farms sloughs serve for watering stock and residents depend for drinking water upon shallow wells sunk beside the sloughs. In areas where few if any porous beds have been encountered in the boulder clay the small yields obtainable are in many cases too highly charged with dissolved sulphate salts to be used in the households.

No deep wells have been sunk in this township. Hence the water conditions existing in the bedrock underlying the drift can be conjectured only from findings in townships adjacent on the north and west. The Ravenscrag bedrock formation is believed to underlie the highland part of the township. The coal seams and coarse, blue-grey sand beds of this formation yield water to wells in many parts of the district. It seems probable that wells sunk in the highest parts of the area to depths not exceeding 150 feet should strike fair supplies of water suitable at least for stock. Throughout the lowland area of the southwest corner the fine grey sands and silts of the Eastend formation probably underlie the drift. There is less possibility of obtaining an adequate supply of ground water in the Eastend than in the Ravenscrag. Hence in this part of the township the extensive prospecting of the drift will more likely yield water suitable for farm use than will the deeper drilling into the underlying bedrock.

Township 15, Range 30

This township fraction consists of a small area 6 miles in length and ½ mile in width lying immediately to the east of the third meridian. No well information was obtained in this area. Water conditions in the drift probably resemble conditions in the western part of township 15, range 29, adjoining on the east. Gravel beds coming near the surface can be expected to yield water under hydrostatic pressure. Otherwise the drift will be sparingly productive. The Ravenscrag formation is believed to underlie the glacial deposits in the northern half of the area at depths not exceeding 100 feet. In the southern half of the township the Eastend formation is believed to immediately underlie the drift. Poorer water conditions are to be expected in the Eastend than in the Ravenscrag. In the southern half of the township systematic prospecting in the drift seems preferable to deep bedrock drilling.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF HILLSBOROUGH, NO.132, SASKATCHEWAN

Township	13	14	14	14	15	15	15	Total No. in municipality
West of 2nd mer. Range	28	28	29	30	28	29	30	
Total No. of wells in Township	31	26	32	14	52	25	0	180
No. of wells in bedrock	0	0	0	0	1	0	0	1
No. of wells in glacial drift	31	26	31	14	51	25	0	178
No. of wells in alluvium	0	0	1	0	0	0	0	1
Permanency of Water Supply								
No. with permanent supply	23	16	25	10	29	17	0	120
No. with intermittent supply	1	2	0	0	4	0	0	7
No. dry holes	7	8	7	4	19	8	0	53
Types of Wells								
No. of flowing artesian wells	1	3	2	0	2	4	0	12
No. of non-flowing artesian wells	6	2	4	1	8	2	0	23
No. of non-artesian wells	17	13	19	9	23	11	0	92
Quality of Water								
No. with hard water	21	15	12	9	27	15	0	99
No. with soft water	3	3	13	1	6	2	0	28
No. with salty water	0	0	1	0	0	0	0	1
No. with "alkaline" water	6	7	3	7	12	8	0	43
Depths of Wells								
No. from 0 to 50 feet deep	25	26	30	13	44	25	0	163
No. from 51 to 100 feet deep	6	0	2	1	5	0	0	14
No. from 101 to 150 feet deep	0	0	0	0	3	0	0	3
No. from 151 to 200 feet deep	-	-	-	-	-	-	-	-
No. from 201 to 500 feet deep	-	-	-	-	-	-	-	-
No. from 501 to 1,000 feet deep	-	-	-	-	-	-	-	-
No. over 1,000 feet deep	-	-	-	-	-	-	-	-
How the Water is Used								
No. usable for domestic purposes	21	16	24	2	26	17	0	106
No. not usable for domestic purposes	3	2	1	8	7	0	0	21
No. usable for stock	24	18	25	2	30	17	0	116
No. not usable for stock	0	0	0	8	3	0	0	11
Sufficiency of Water Supply								
No. sufficient for domestic needs	22	18	25	10	33	16	0	124
No. insufficient for domestic needs	2	0	0	0	0	1	0	3
No. sufficient for stock needs	19	14	23	10	32	14	0	112
No. insufficient for stock needs	5	4	2	0	1	3	0	15

ANALYSES AND QUALITY OF WATER

General Statement

Samples of water from representative wells in surface deposits and bedrock were taken for analyses. Except as otherwise stated in the table of analyses the samples were analysed in the laboratory of the Borings Division of the Geological Survey by the usual standard methods. The quantities of the following constituents were determined; total dissolved mineral solids, calcium oxide, magnesium oxide, sodium oxide by difference, sulphate, chloride, and alkalinity. The alkalinity referred to here is the calcium carbonate equivalent of all acid used in neutralizing the carbonates of sodium, calcium, and magnesium. The results of the analyses are given in parts per million--that is, parts by weight of the constituents in 1,000,000 parts of water; for example, 1 ounce of material dissolved in 10 gallons of water is equal to 625 parts per million. The samples were not examined for bacteria, and thus a water that may be termed suitable for use on the basis of its mineral salt content might be condemned on account of its bacteria content. Waters that are high in bacteria content have usually been polluted by surface waters.

Total Dissolved Mineral Solids

The term "total dissolved mineral solids" as here used refers to the residue remaining when a sample of water is evaporated to dryness. It is generally considered that waters that have less than 1,000 parts per million of dissolved solids are suitable for ordinary uses, but in the Prairie Provinces this figure is often exceeded. Nearly all waters that contain more than 1,000 parts per million of total solids have a taste due to the dissolved mineral matter. Residents accustomed to the waters may use those that have much more than 1,000 parts per million of dissolved solids without any marked inconvenience, although most persons not used to highly mineralized water would find such waters highly objectionable.

Mineral Substances Present

Calcium and Magnesium

The calcium (Ca) and magnesium (Mg) content of water is dissolved from rocks and soils, but mostly from limestone, dolomite, and gypsum. The calcium and magnesium salts impart hardness to water. The magnesium salts are laxative, especially magnesium sulphate (Epsom salts, $MgSO_4$), and they are more detrimental to health than the lime or calcium salts. The calcium salts have no laxative or other deleterious effects. The scale found on the inside of steam boilers and tea-kettles is formed from these mineral salts.

Sodium

The salts of sodium are next in importance to those of calcium and magnesium. Of these, sodium sulphate (Glauber's salt, Na_2SO_4) is usually in excess of sodium chloride (common salt, NaCl). These sodium salts are dissolved from rocks and soils. When there is a large amount of sodium sulphate present the water is laxative and unfit for domestic use. Sodium carbonate (Na_2CO_3) "black alkali", sodium sulphate "white alkali", and sodium chloride are injurious to vegetation.

Sulphates

Sulphates (SO_4) are one of the common constituents of natural water. The sulphate salts most commonly found are sodium sulphate, magnesium sulphate, and calcium sulphate ($CaSO_4$). When the water contains large quantities of the sulphate of sodium it is injurious to vegetation.

Chlorides

Chlorides are common constituents of all natural water and are dissolved in small quantities from rocks. They usually occur as sodium chloride and if the quantity of salt is much over 400 parts per million the water has a brackish taste.

Iron

Iron (Fe) is dissolved from many rocks and the surface deposits derived from them, and also from well casings, water pipes, and other fixtures. More than 0.1 part per million of iron in solution will settle as a red precipitate upon exposure to the air. A water that contains a considerable amount of iron will stain porcelain, enamelled ware, and clothing that is washed in it, and when used for drinking purposes has a tendency to cause constipation, but the iron can be almost completely removed by aeration and filtration of the water.

Hardness

Calcium and magnesium salts impart hardness to water. Hardness of water is commonly recognized by its soap-destroying powers as shown by the difficulty of obtaining lather with soap. The total hardness of a water is the hardness of the water in its original state. Total hardness is divided into "permanent hardness" and "temporary hardness". Permanent hardness is the hardness of the water remaining after the sample has been boiled and it represents the amount of mineral salts that cannot be removed by boiling. Temporary hardness is the difference between the total hardness and the permanent hardness and represents the amount of mineral salts that can be removed by boiling. Temporary hardness is due mainly to the bicarbonates of calcium and magnesium and iron, and permanent harness to the sulphates, and chlorides of calcium and magnesium. The permanent hardness can be partly eliminated by adding simple chemical softeners such as ammonia or sodium carbonate, or many prepared softeners. Water that contains a large amount of sodium carbonate and small amounts of calcium and magnesium salts is soft, but if the calcium and magnesium salts are present in large amounts the water is hard. Water that has a total hardness of 300 parts per million or more is usually classed as excessively hard. Many of the Saskatchewan water samples have a total hardness greatly in excess of 300 parts per million; when the total hardness exceeded 3,000 parts per million no exact hardness determination was made. Also no determination for temporary hardness was made on waters having a total hardness less than 50 parts per million. As the determinations of the soap hardness in some cases were made after the samples had been stored for some time, the temporary hardness of some of the waters as they come from the wells probably is higher than that given in the table of analyses.

Analyses of Water samples from the Municipality of Hillsborough, No. 132, Saskatchewan.

LOCATION						Depth of Well, Ft.	Total Dis'vd Solids	HARDNESS			CONSTITUENTS AS ANALYSED						CONSTITUENTS AS CALCULATED IN ASSUMED COMBINATIONS									Source of Water
No.	Qtr.	Sec.	Tp.	Rge.	Mer.			Total	Perm.	Temp.	Cl.	Alkalinity	CaO	MgO	SO_4	Na_2O	Solids	$CaCO_3$	$CaSO_4$	$MgCO_3$	$MgSO_4$	Fe_2O_3,Al_2O_3	Na_2SO_4	NaCl	$CaCl_2$	
1	NE.	16	13	28	2	38	3,721										3,721		(3)		(4)		(2)	(1)		xl
2	NW.	20	13	28	2	21	1,049										1,049	(3)	(1)		(2)		(4)		(5)	xl
3	SE.	36	15	28	2	105	2,880	1,250	1,050	200	36	340	180	191	1,650	815	2,738	321		17	545		1,796	59		xl
4	NW.	7	15	29	2	6	920	800	550	250	14	340	150	101	398	158	902	269		61	215		334	23		xl
5	SW.	18	15	29	2	6	1,360	950	600	350	34	375	100	122	636	375	1,319	179		165	128		791	56		xl
6	Lake Johnstone																6,313		126		1,288	10	4,842		Insoluble 47	

Water samples indicated thus, xl, are from glacial drift or other unconsolidated deposits.

Analyses are reported in parts per million; where numbers (1), (2), (3), (4), and (5) are used instead of parts per million, they represent the relative amounts in which the five main constituents are present in the water.

Hardness is the soap hardness expressed as calcium carbonate ($CaCO_3$).

Analyses Nos. 1 and 2, by Provincial Analyst, Regina; Analysis No. 6, by Mines Branch, Dept. of Mines, Ottawa.

For interpretation of this table read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

No analyses were made of ground water from the lake sands and silts bordering Johnstone lake. The water is reported to be highly mineralized and unfit for household use and for stock. The results of an analysis of the water from the lake are given on the accompanying table. It is probable that the salts indicated are present in solution in the waters in the lake sands, but in lower concentration.

The beds of sands and gravels forming the glacial outwash deposits provide one of the best sources of drinking water in the municipality. Analyses Nos. 4 and 5 are of waters derived from flowing wells tapping these beds of gravels. It will be noted that this water is very hard. The greater amount of this hardness is permanent and is not removed by boiling the water. Sodium sulphate is the predominant salt in solution. It is not in sufficient quantities however, to render the water very objectionable for drinking.

The character of the deposits comprising the moraine covering the greater part of the municipality shows marked variations within short distances and at different depths. Corresponding variations in the quality of the ground water derived from these deposits are to be expected. One well may yield a moderately hard, slightly mineralized water, whereas another well 100 feet away and sunk to a similar depth may give water so highly charged with dissolved mineral salts as to be unsuitable for either domestic or stock use. It should not be inferred, therefore, that if water of poor quality is found in one well such water conditions must of necessity exist over a large area in the district. In general, water from shallow depths in the glacial deposits is of better quality than that from isolated sand and gravel pockets overlain by any considerable thickness of boulder clay. The first and second analyses given on the accompanying table are of water derived from sand or gravel beds in the moraine. The analyses indicate the relative proportions of the main constituents present in the water. Common salt ($NaCl$) forms the dominant constituent in the water from the well on NE. $\frac{1}{4}$, sec. 16, tp. 13, range 28. It is in sufficient amounts to render the water objectionable for drinking. Water from the well on NW. $\frac{1}{4}$, section 20, in the same township contains less than one-third the total solids in solution, as exist in the waters of the well on section 16. Here calcium sulphate is the predominant salt and tends to make the water very hard. This water is considered to be suitable for all farm requirements. These two analyses serve to indicate the variations that are to be expected in waters in the glacial deposits in different localities. The small seepages derived from the compact boulder clay are in general highly mineralized. Such water is not usually suitable for drinking and has on occasions produced scour in stock.

The third analysis is of water derived from a 105-foot well that taps a quicksand aquifer, which is thought to be at the contact of the drift and the Eastend bedrock formation. The water is reported to be very hard and "alkaline", and slightly cloudy. Sodium sulphate is present as 1,796 parts per million, causing the water to be unfit for household use. It is, however, being used for watering stock. No other analysis of water from this horizon is available, but it is not probable that other wells sunk to this horizon will yield better water.

Water from the Bedrock

No wells have been sunk into the Ravenscrag or Eastend formations in this municipality and no information is available regarding the quality of the water to be expected from it. In areas to the east, the small seepages derived from the Marine Shale are highly mineralized and in few instances is it suitable even for stock. It is improbable that the Marine Shale will yield supplies of water of better quality in this municipality.

WELL RECORDS—Rural Municipality of HILLSBOROUGH, NO. 132, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE: Above (+) Below (−) Surface	HEIGHT TO WHICH WATER WILL RISE: Elev.	PRINCIPAL WATER-BEARING BED: Depth	PRINCIPAL WATER-BEARING BED: Elev.	PRINCIPAL WATER-BEARING BED: Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
1	NE.	1	13	28	2	Dug	6	2,200	+ 2	2,202	6	2,194	Glacial gravel	Hard, clear	42	D, S	Excellent supply.
2	SW.	1	"	"	"	Dug	18	2,210	− 12	2,198	12	2,198	Glacial gravel	Hard, clear	40	D, S	Sufficient for local needs.
3	NE.	3	"	"	"	Dug	12	2,215	− 5	2,210	10	2,205	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Insufficient for local needs; 11 dry holes.
4	SW.	3	"	"	"	Bored	24	2,210	− 2	2,208	2	2,208	Glacialclay	Hard, clear, "alkaline"	42	D, S	Insufficient for local needs; 20 or more dry holes; water hauled.
5	NE.	4	"	"	"	Dug	90	2,230					Glacial blue clay				Ten dry holes; no water found.
6	NE.	9	"	"	"	Dug	12	2,220	− 7	2,213	7	2,213	Glacial sand	Soft, clear		D, S	Three other farmers draw water from this well.
7	NW.	10	"	"	"	Bored	30	2,240	− 10	2,230	10	2,230	Glacial blue clay	Hard, clear, "alkaline"	40	D, S	Insufficient for local needs.
8	SE.	11	"	"	"	Dug	12	2,235	− 8	2,227	11	2 224	Glacial clay, sand	Hard, clear, "alkaline"		S	Water hauled for domestic use.
9	NE.	12	"	"	"	Bored	35	2,275	− 21	2,254	35	2,240	Glacial gravel	Hard, clear	42	D, S	Sufficient for local needs.
10	NE.	16	"	"	"	Bored	38	2,250	− 30	2,220	38	2,212	Glacial sand	Hard, clear, "alkaline"	42	S	Sufficient for stock; domestic water hauled;#.
11	SW.	16	"	"	"	Bored	20	2,240	− 19	2,221	19	2,221	Glacial blue clay	Hard, clear	40	D	Insufficient for local needs; good well $\frac{1}{2}$ mile away.
12	SW.	17	"	"	"	Dug	14	2,260	− 9	2,251	12	2,248	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs; good well $\frac{1}{4}$ mile away not"alkaline".This well 15 foot deep.
13	SE.	19	"	"	"	Dug	17	2,240	− 10	2,230	10	2,230	Glacial sand, clay	Hard, clear, "alkaline"	42	S	Sufficient for local needs. Another 28 foot well, $\frac{1}{4}$ mile away used for domestic purposes.
14	NW.	20	"	"	"	Dug	21	2,210	− 17	2,193	21	2,189	Glacial sand	Hard, clear	42	D, S	Sufficient for local needs; 15 foot seepage well for stock, #.
15	NE.	20	"	"	"	Dug	8	2,230	− 5	2,225	6	2,224	Glacial sand	Soft, clear	40	D, S	Sufficient for local needs;flowing spring 20 yards north.
16	NW.	23	"	"	"	Bored	13	2,240	− 10	2,230	12	2,228	Glacial gravel	Soft, clear	40	D, S	Sufficient for local needs.
17	NE.	24	"	"	"	Dug	26	2,420	− 22	2,398	22	2,398	Glacial sand, clay	Hard, clear		D, S	Insufficient for local needs
18	SE.	28	"	"	"	Dug	14	2,225	− 9	2,216	14	2,211	Glacial sand	Hard, clear	42	D, S	Sufficient for local needs; another 42 foot well; gravel aquifer; water harder.
19	NE.	35	"	"	"	Bored	65	2,306					Glacial blue clay				Several shallow dry holes.
20	SE.	36	"	"	"	Dug	23	2,440	− 20	2,420	20	2,420	Glacial sand	Hard, clear	42	D, S	Sufficient for local needs.
1	NW.	2	14	28	2	Bored	26	2,336	− 14	2,322	22	2,314	Glacial gravel	Hard, clear, iron, "alkaline"	42	D, S	Sufficient for local needs; well fed by underground spring.
2	NE.	3	"	"	"	Bored	20	2,316	− 8	2,308	17	2,299	Glacial gravel	Hard, clear, "alkaline"	42	S	Sufficient for stock; domestic water hauled.
3	NW.	7	"	"	"	Bored	23	2,296	− 10	2,286	23	2,273	Glacial sand	Hard, clear, iron	42	D, S	Sufficient for local needs.
4	NW.	9	"	"	"	Dug	12	2,300	− 11	2,289	11	2,289	Glacial clay	Hard, clear, "alkaline"	40	D	Insufficient for local needs; stock water hauled $\frac{1}{2}$ mile.
5	NE.	11	"	"	"	Dug	4	2,476	0	2,476	2	2,474	Glacial gravel	Hard, clear, iron	41	D, S	Sufficient for local needs; 17-foot dry hole on farm.
6	NE.	14	"	"	"	Dug	20	2,420	− 10	2,410	10	2,410	Glacial blue clay	Soft, clear, "alkaline"		D, S	Insufficient for local needs; seepage well used in summer only.

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

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of HILLSBOROUGH, NO. 132, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
7	SW.	15	14	28	2	Dug	18	2,300	- 11	2,289	11	2,289	Glacial clay	Hard, clear, "alkaline"	42	D	Insufficient for local needs; 20 test holes all dry.
8	NE.	16	"	"	"	Dug	30	2,340					Glacial gravel				Went dry in December, 1934.
9	NW.	16	"	"	"	Spring	7	2,306	0	2,306	7	2,299	Glacial gravel	Hard, clear	42	D, S	Sufficient for local needs; this well in bottom of lake.
10	SW.	22	"	"	"	Dug	22	2,358	- 18	2,340	18	2,340	Glacial clay	Hard, clear	41	D, S	Sufficient for local needs; slough seepage.
11	NW.	22	"	"	"	Dug	20	2,436	- 16	2,420	16	2,420	Glacial gravel	Hard, clear, "alkaline"	39	D, S	Insufficient for local needs; spring is used for auxiliary supply.
12	SW.	23	"	"	"	Dug	18	2,450	- 12	2,438	16	2,434	Glacial gravel	Hard, clear, iron	42	D	Insufficient for local needs; well dried up in autumn 1932 and every autumn since.
13	NW.	23	"	"	"	Dug	14	2,486	- 8	2,478	11	2,475	Glacial sand, gravel	Soft, clear	43	D, S	Sufficient for local needs.
14	SW.	27	"	"	"	Dug	5	2,537	0	2,537	3	2,534	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs. Spring fed.
15	SE.	32	"	"	"	Spring		2,475	0	2,475	0	2,475	Glacial gravel (boulders)	Soft, clear	42	D, S	Sufficient for local needs; flowing spring.
1	NE.	1	14	29	2	Dug	14	2,226	- 10	2,216	10	2,216	Glacial sand, gravel	Hard, clear, "alkaline"	43	D, S	Insufficient for local needs; water for drinking purposes hauled ½ mile.
2	SW.	12	"	"	"	Bored	22	2,316	-11	2,305	11	2,305	Glacial sand, clay	Soft, clear	42	D, S	Insufficient for local needs. A 17-foot hole dry, 150 feet north.
3	SW.	13	"	"	"	Dug	18	2,311	- 13	2,298	15	2,296	Glacial gravel	Soft, clear		D, S	Sufficient for local needs.
4	SW.	18	"	"	"	Dug	10	2,250	- 7	2,243	7	2,243	Glacial gravel	Soft, clear	43	D, S	Sufficient for local needs.
5	NE.	18	"	"	"	Dug	11	2,256	- 7	2,249	7	2,249	Glacial gravel	Soft, clear	43	D, S	Sufficient for local needs.
6	SE.	19	"	"	"	Dug	18	2,240	- 14	2,226	14	2,226	Glacial sand	Hard, clear	42	D, S	Sufficient for local needs.
7	NW.	19	"	"	"	Bored	54	2,290	- 29	2,261	54	2,236	Glacial gravel	Soft, clear, slightly iron	42	D, S	Sufficient for local needs.
8	NE.	19	"	"	"	Dug	27	2,295	- 21	2,274	25	2,270	Glacial gravel	Soft, clear	41	D, S	Sufficient for local needs.
9	SE.	20	"	"	"	Bored	24	2,271	- 18	2,253	20	2,251	Glacial sand	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
10	SW.	21	"	"	"	Dug	9	2,291	- 5	2,286	5	2,286	Recent alluvium	Soft, clear	40	D, S	Sufficient for local needs.
11	NW.	22	"	"	"	Bored	18	2,281	- 15	2,266	18	2,263	Glacial sand	Soft, clear	42	D, S	Sufficient for local needs; another similar well, also used.
12	SW.	27	"	"	"	Bored	50	2,336					Glacial blue clay				Three other dry holes.
13	NW.	27	"	"	"	Dug	14	2,350	- 11	2,339	11	2,339	Glacial sand	Hard, clear	42	D, S	Sufficient for local needs; but has to be hauled a ½ mile.
14	SE.	28	"	"	"	Dug	12	2,286	- 9	2,277	9	2,277	Glacial sand	Soft, clear	44	D	Sufficient for school.
15	SW.	30	"	"	"	Dug	20	2,300	- 18	2,282	18	2,282	Glacial sand	Hard, clear	40	D, S	Sufficient for local needs; another 28-foot well for stock.
16	NE.	30	"	"	"	Spring	0	2,286	0	2,286	0	2,286	Glacial gravel	Hard, clear, slightly iron	38	D, S	Sufficient for local needs; no difference in flow in last 20 years.

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

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of HILLSBOROUGH, NO. 132, SASKATCHEWAN

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
17	SE.	31	14	29	2	Dug	9	2,280	- 6	2,274	6	2,274	Glacial gravel	Hard, clear, iron	42	D, S	Sufficient for local needs.
18	SE.	32	"	"	"	Spring		2,335	+ 1	2,336	0	2,335	Glacial sand	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs; supplies water for stock in pasture.
1	NE.	23	14	30	2	Dug	9	2,290	- 6	2,284	6	2,284	Glacial gravel	Soft, clear	42	D, S	Sufficient for local needs.
2	SE.	24	"	"	"	Dug	30	2,270	- 22	2,248	30	2,240	Glacial sand	Hard, clear	42	D, S	Sufficient for local needs; 7 dry holes 16 to 22 feet deep. Two dry holes 85 feet deep. Another well high in iron unfit for use.
3	SE.	25	"	"	"	Bored	38	2,304					Glacial sand				Another 52 foot dry hole.
1	SW.	1	15	28	2	Dug	7	2,385	0	2,385	2	2,383	Glacial sand, gravel	Hard, clear, "alkaline"	42	D, S	Oversufficient for local needs.
2	SW.	6	"	"	"	Dug	16	2,320	- 10	2,310	16	2,304	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
3	SW.	7	"	"	"	Dug	3	2,390	0	2,390	3	2,387	Glacial gravel	Hard, clear, slightly iron	42	D, S	Sufficient for local needs; steady flow through 1-inch pipe.
4	NE.	10	"	"	"	Bored	55	2,440	- 10	2,430	10	2,430	Glacial gravel	Hard, clear	42	D, S	Sufficient for local needs; well deepened into blue clay for reservoir.
5	SW.	12	"	"	"	Bored	115	2,390					Marine shale, bedrock				
6	SW.	14	"	"	"	Bored	90	2,360	- 30	2,330	90	2,270	Glacial gravel	Hard, iron, red	42	S	Insufficient for local needs; well filled in now.
7	NE.	15	"	"	"	Dug	16	2,485	- 8	2,477	16	2,469	Glacial gravel	Hard, clear	42	D, S	Sufficient for local needs; is a seepage well.
8	NW.	15	"	"	"	Dug	15	2,340	- 10	2,440	15	2,435	Glacial sand	Hard, clear	44	D, S	Sufficient for local needs.
9	NE.	16	"	"	"	Bored	30	2,460	- 15	2,445	30	2,430	Glacial sand	Hard, clear	43	D, S	Sufficient for local needs.
10	SW.	16	"	"	"	Dug	28	2,420	- 23	2,397	28	2,392	Glacial sand	Hard, clear	42	D, S	Sufficient for local needs.
11	SE.	20	"	"	"	Bored	35	2,420	- 30	2,390	35	2,385	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs; 2 other slough wells for stock.
12	SW.	21	"	"	"	Dug	30	2,435	- 15	2,420	30	2,405	Glacial blue clay	Hard, clear, "alkaline"	43	D, S	Insufficient for local needs; 7 dry holes at 25 feet.
13	NW.	22	"	"	"	Dug	20	2,385	- 10	2,375	20	2,365	Glacial blue clay	Hard, clear	42	D, S	Sufficient for local needs; another well 20 feet deep. 10 feet water, very "alkaline"; stock
14	NE.	22	"	"	"	Dug	15	2,350	- 7	2,343	15	2,335	Glacial gravel	Hard, clear	42	D, S	Sufficient for local needs; another well 20 foot deep too "alkaline" for use.
15	NW.	23	"	"	"	Dug	12	2,330	- 3	2,327	12	2,318	Glacial blue clay	Hard, clear, "alkaline"	42	S	Insufficient for local needs.
16	SW.	24	"	"	"	Dug	18	2,215	- 8	2,207	18	2,197	Glacial gravel	Hard, clear	42	D, S	Sufficient for local needs. 2 other well 18 feet deep; water soft, used for stock only.
17	NE.	24	"	"	"	Dug	18	2,190	- 2	2,188	18	2,172	Glacial blue clay	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs.
18	SE.	31	"	"	"	Dug	18	2,350	- 16	2,334	18	2,332	Glacial gravel	Soft, clear	42	D	Sufficient for local needs.
19	SE.	34	"	"	"	Bored	25	2,300	- 13	2,287	25	2,275	Glacial sand	Soft, clear	42	D, S	Sufficient for local needs.
20	NE.	35	"	"	"	Bored	115	2,130	- 55	2,075	115	2,015	Glacial(?) sand	Hard, clear, iron	40	D, S	Sufficient for local needs.

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

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of HILLSBOROUGH, NO. 132, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
21	NW.	36	15	28	2	Bored	35	2,090	- 32	2,058	35	2,055	Glacial sand	Hard, clear, "alkaline"	42	N	Unfit for use.
22	SE.	36	"	"	"	Bored	105	2,120	- 55	2,065	105	2,015	Glacial(?)sand	Hard, slightly cloudy, "alkaline"	43	S	Sufficient for local stock needs; #.
1	SE.	2	15	29	2	Dug	11	2,310	- 8	2,302	11	2,299	Glacial gravel	Hard, clear	42	D, S	Sufficient for local needs.
2	SE.	5	"	"	"	Dug		2,385	0	2,385	0	2,385	Glacial gravel	Soft, clear		D, S	Sufficient for local needs.
3	SW.	6	"	"	"	Dug	14	2,345	- 8	2,337	14	2,331	Glacial clay	Hard, clear	42	S, D	Sufficient for local needs.
4	NW.	7	"	"	"	Dug	6	2,280	0	2,280	6	2,274	Glacial gravel	Hard, clear, slightly "alkaline"	42	S	Sufficient for local needs; steady flow through 1-inch pipe. #.
5	NE.	11	"	"	"	Dug	22	2,425	- 21	2,404	22	2,403	Glacial sand, clay	Hard, clear	42	D	Sufficient for local needs.
6	NE.	13	"	"	"	Dug	13	2,460	- 3	2,457	13	2,447	Glacial gravel	Hard, clear	42	D	Insufficient for local needs.
7	SW.	18	"	"	"	Dug	6	2,280	0	2,280	6	2,274	Glacial gravel	Hard, clear, "alkaline"	42	D, S	Sufficient for local needs. #.
8	NW.	23	"	"	"	Dug	20	2,490	- 5	2,485	20	2,470	Glacial gravel	Hard, clear, "alkaline"	36	D, S	Sufficient for local needs.
9	NE.	24	"	"	"	Dug	16	2,440	- 12	2,428	16	2,424	Glacial gravel, clay	Hard, clear	42	D	Sufficient for local needs.
10	NE.	30	"	"	"	Bored	16	2,380	- 10	2,370	16	2,364	Glacial sand	Hard, clear	40	D, S	Sufficient for local needs.
11	NW.	30	"	"	"	Dug	16	2,300	- 13	2,287	16	2,284	Glacial clay	Hard, clear, "alkaline"	42	D, S	Insufficient for local needs.
12	SW.	31	"	"	"	Dug	14	2,300	- 6	2,294	14	2,286	Glacial clay	Hard, clear, "alkaline"	42	S	Sufficient for local needs.
13	SE.	31	"	"	"	Dug	5	2,320	0	2,320	5	2,315	Glacial gravel, sand	Soft, clear	68	D, S	Sufficient for local needs.
14	SW.	32	"	"	"	Dug	20	2,325	- 15	2,310	20	2,305	Glacial blue clay	Hard, clear	41	D, S	Insufficient for local needs; well caving in.

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

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.