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 .... No. 17 SASKATCHEWAN

BY

B. R. MacKay, H. H. Beach & D. P. Goodall

Water Supply Paper No. 84

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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 boundry 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 supplies 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

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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

Rural Municipality No. 17 is an area of 324 square miles lying along the International Boundary in southwestern Saskatchewan. The municipality consists of nine townships described as tps. 1, 2, and 3, ranges 13, 14, and 15, W. 3rd mer. The village of Valmarie, situated on the west side of Frenchman River valley in the northeastern part of the municipality, lies approximately 72 miles due south of Swift Current. The Valmarie branch of the Canadian Pacific railway enters the municipality on the western side, 12 miles north of the International Boundary, swings south and east through the villages of Orkney and Masefield, then northeast to its terminus at Valmarie.

The land surface rises gradually in a northwesterly direction from an elevation of about 2,500 feet above sea-level in the southeastern part to elevations exceeding 3,000 feet in the northwestern township of the municipality.

Figure 2 of the accompanying map indicates the approximate relief of the area by means of 100-foot contour lines. This map has been copied from the best sources available, but discrepancies appear at some places between the elevations as given by contours and those established by aneroid barometer observations made in the course of this investigation. These discrepancies are particularly in evidence in the steeply rolling area immediately to the west of the town of Valmarie.

A southeasterly drainage is well developed in the southern townships by Whitewater creek and its tributaries. These streams have cut valleys to depths of 150 to 200 feet in township 1, range 15, otherwise the township is a gently rolling upland plain with average elevations of 2,700 to 2,800 feet above sea-level.

The northeastern part of the municipality is drained by Frenchman river, known locally as Whitemud river, and by a few intermittent tributary streams. The main stream flows in a southeasterly direction through a flat-bottomed valley, in places over 2 miles wide and 150 to 200 feet in depth. The river channel itself is small compared with the valley it occupies. Throughout the year, however, it supplies ample water for stock in this vicinity.

The numerous small coulées in these two drainage areas are dry through the greater part of the year, but on account of the impervious character of the soil they offer splendid sites for dams and reservoirs to conserve the spring run-off throughout the dry season. Water conserved in this way is the main source of supply for stock in the municipality.

Between these two drainage areas a belt of irregular hills trends in a southeasterly direction through the municipality and occupies a large part of townships 1 and 2, range 13, and townships 2 and 3, range 14. In this area there is less opportunity for conserving the surface water in a satisfactory usable condition. The small sloughs and lakes usually become dry in the early summer months or, due to the concentration of mineral salts, the water becomes too "alkaline" for stock use.

Water-bearing Horizons in the Unconsolidated Deposits

In the northeastern part of the municipality Recent deposits of clays interbedded with layers of sand and gravel occur in the bottom of Frenchman River valley. These extensive terrace deposits were laid down during flood periods of the river to depths of 30 feet or more in the central part of the valley, but to lesser depths near the edges of the valleys and in the tributary coulées. Much of this sediment was derived from the bedrock shales of marine origin outcropping in the areas. Surface waters percolating down from the highlands into the valleys in their passage dissolve large amounts of the soluble salts inherent in the shales. These mineral salts become gradually concentrated in the sediments of the valley floor. Water encountered at shallow depths in wells dug into these sediments is invariably hard, highly mineralized, and is not very satisfactory for domestic use. Wells sunk in the higher terraces along the borders of the valley and in the bottoms of the smaller coulées generally yield water of better quality. The yield is variable and supplies from this source cannot always be relied upon throughout the year.

In the southern drainage area the Recent stream deposits of water-bearing sands and gravels are confined mostly to narrow strips in the beds of the steep-banked coulées. These water supplies are utilized in localities where they are convenient to farm buildings. Individual shallow wells as a rule yield sufficient water for 30 to 40 head of stock. The water is hard, but is not as a rule highly mineralized and is considered quite suitable for drinking.

Glacial drift with great variations in thickness and composed essentially of compact boulder clays interspersed with occasional pockets and beds of sand or gravel covers the bedrock surface of the municipality. The drift was deposited by one or more great continental ice-sheets that many thousands of years ago passed in a southwesterly direction across the province of Saskatchewan. As each ice-sheet advanced it distributed its load of boulders and ground up rock commonly known as till, unevenly over the land surface. Over the uplands of the northeast corner of this municipality this till is very thin and is even absent on some of the hillsides. It becomes gradually thicker in a southwesterly direction and may have a thickness exceeding 100 feet at points along the southern border. Where the ice front halted during its retreat a thicker accumulation and a more porous type of drift, called moraine, containing fairly extensive pockets of sands and gravels was deposited. Such deposits are characterized by a rough, hillocky topography with many undrained depressions. In places the moraine is composed partly of sands and gravels sorted by the action of streams issuing from the front of the melting ice and in other places it consists of unsorted boulder clay. The belt of irregular hills or moraine trending in a northwest-southeasterly direction through the central part of this municipality was no doubt formed during one of these pauses of the retreat of the ice-sheet toward the north. This moraine area is shown on Figure 1 of the map accompanying this report.

Porous beds of sands and gravels have been encountered at depths not usually exceeding 30 feet from the surface in many parts of the moraine-covered area. Individual wells to these pockets yield a hard, drinkable water in sufficient quantities for 20 to 40 head of stock. In places when these pockets have not been located, residents have found it necessary to sink wells beside sloughs or to construct reservoirs for their household water supply. These wells derive their water by seepage from the surface and are dependable only as long as water remains in the reservoir.

Water-bearing pockets of sand and gravel occur sparingly in the upper part of the drift throughout the remainder of the municipality. In places where shallow wells have tapped these deposits the yield is generally sufficient for only a few head of stock and in some places the water is too highly mineralized for household use.

Water-bearing beds of sand and gravel are known to occur at or near the base of the glacial drift in some localities. These beds may have a much wider distribution than that indicated by existing wells. Their occurrence is not influenced by the surface distribution of the types of glacial drift and may be present under the moraine-covered area as well as under areas of the more evenly distributed glacial till or boulder clay. One area in which a productive horizon is known to occur in the lower part of the drift in the southwestern part of the municipality is indicated by the "B" line on Figure 1 of the accompanying map. This area is believed to be an eastern continuation of a similar water-bearing horizon known to occur in the municipality to the west. The ground water conditions of the horizon in this municipality will be described in detail in a later section dealing with the water conditions of townships 1 and 2 in range 15.

Water-bearing Horizons in the Bedrock

Two bedrock formations, the Bearpaw and the Belly River, are known to underlie the drift in different parts of the municipality. The upper or Bearpaw formation consists of dark grey marine shales through which are interspersed occasional thin beds of fine-grained, dark grey sands. These shales are locally referred to as "soapstone". They are readily recognized in drilling by their dark grey appearance and soapy feel when wet and by small, roughly cubical fragments into which they crumble upon drying.

Logs of the deep wells at Bracken and Climax in the municipality to the west suggest that this dark, compact shale of the Bearpaw formation will be encountered to depths of 500 to 600 feet in the northern townships of the area. The formation is believed to rise gradually in a southeasterly direction and becomes thinner in this direction because of erosion of the upper part. In the lowlands of the southern townships the Bearpaw is absent and the Belly River formation underlies the glacial drift.

Small supplies of ground water undoubtedly occur in the sand beds of the Bearpaw formatioh. These beds, however, are very limited in their occurrence. Drill holes have been sunk in this formation to depths of 50 to 200 feet in various parts of the municipality without encountering water. The possibility of locating suitable water supplies at greater depths in the Bearpaw formation is very remote owing to the impervious character of these shales and the almost entire absence of porous beds in the lower parts of the formation.

The Belly River formation underlying the Bearpaw consists of soft, grey shale with occasional hard bands of a more calcareous nature, interbedded with beds of soft, greenish grey sandstone. The formation is exposed in several places on East Fork Whitemud creek at an elevation of about 2,650 feet. The Belly River formation underlies the drift, also, in Whitewater creek and Cottonwood coulée at about the same elevation. Despite the apparent porosity of this formation attempts to find water in it have been disappointing.

A dry hole at the customs house in the SW.$\frac{1}{4}$, sec. 4, tp. 1, range 14, penetrated this formation to a depth of about 150 feet after drilling through about 100 feet of drift. Several other drill holes in this vicinity have also penetrated this formation to less depths without striking water.

A possible explanation of this lack of water in the Belly River formation is found in the structural conditions or attitude of the strata of the area. In the southern townships of this municipality and in adjoining parts of Montana the beds in the upper part of the bedrock are steeply dipping, and the water that seeps down from the surface probably flows underground down the slope of the beds. Away from the upturned edges of the beds, the possibilities of ground water accumulation appear to be much better as evidenced by water being encountered in the Belly River formation at both Climax and Bracken. No wells have been sunk into this formation in the area intervening between these villages and the centre of the disturbed area. It is possible, however, that water will be found in this formation in the northern two-thirds of the municipality. Drillers prospecting for aquifers in it must be prepared to drill 300 to 400 feet in the central parts of the area and to depths of 400 to 600 feet in the northern parts of the municipality. It is emphasized, moreover, that despite the possibility of the existence of water-bearing horizons in it no definite assurance of finding water in this formation can be given. Residents of moderate means are better advised to confine their search for water supplies to the overlying glacial drift.

The water found in the Bracken well contains sodium carbonate and smaller amounts of other mineral salts in solution. Due to its soft character the water is used for washing and for watering stock, but not for drinking. It is improbable that the Belly River formation will yield water suitable for drinking in this municipality.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 1, Range 13

The land surface throughout the greater part of this township is gently rolling. The higher ground in the northern and the northeastern parts are underlain by moraine and the remainder is covered by glacial till. Several east-west trending coulées cut across the southern area. Much of the land surface in this area is literally paved with quartzite pebbles, rendering it quite unsuitable for farming. In places where these gravels and interbedded sands and silts are accumulated to any appreciable thickness, particularly in coulée bottoms, shallow wells yield fairly large supplies of water. These water-bearing beds usually lie within 20 feet of the surface. The water contains sufficient dissolved mineral salts to render it hard, but it is seldom so highly mineralized as to be unfit for household use.

Isolated pockets of gravel and occasionally sand occur surrounded by boulder clay of the moraine in the northeastern part of the township. These water-bearing beds have been tapped by several wells in this locality at an average depth of 40 feet. The water does not rise above the aquifer, but the supply is ample for average farm requirements. It is hard and in some instances is sufficiently mineralized to have a laxative effect on persons not accustomed to its use.

Throughout the till-covered southwestern half of the township the sand and gravel pockets in the drift are sparsely distributed and are probably of small individual areal extent. Many of the residents in this part of the township have sunk wells adjacent to sloughs and dugouts. These shallow wells derive their supplies by seepage. The yield from this source materially decreased during recent dry years, however, due to the drying up of sloughs. Such wells serve as sources of domestic supply, but cannot be counted upon as a continuous supply of water for more than a few head of stock. The possibilities of water-bearing beds occurring at depths greater than 25 feet in the glacial drift in this township have not been accurately determined as little boring or drilling has been done. One well located on the SW.$\frac{1}{4}$, section 3, was sunk to a bed of sand and gravel at a depth of 30 feet below the surface. The well yields a constant, large supply of hard, slightly mineralized water. One test hole bored to a depth of 92 feet on the SE.$\frac{1}{4}$, section 17, struck sand and gravel, but it did not yield water. These results cannot, however, be considered to be indicative of water conditions at depths of 25 to 90 feet in the other parts of the township. The gravels appear to be in isolated pockets rather than as continuous beds over large areas. The thickness of the drift has not been determined. It is known to be very thin on the slopes of the coulée in the southwest corner, but over the uplands of the central and northern parts the drift may exceed 100 feet in thickness.

The dark grey shales of the Bearpaw formation are believed to occur immediately beneath the drift in the northern third of the township. Only small supplies of water can be expected from the shale and they will probably be of a highly mineralized character and generally unsuitable for farm use. The Belly River formation underlies the drift throughout the remainder of the area. Although little success was experienced in obtaining water from the sands of this formation in the township to the west it is possible wells sunk to depths less than 150 feet in the southern and central parts of the township may yield at least small supplies of "soda-bearing" water. Porous sand beds outcrop in the creek valley in the southwest corner and may extend with a slight downward slope to the north over the remainder of the township. Boring or drilling to this horizon should be considered, however, only if water has not been found either in the shallow surface gravels or beds occurring at or near the base of the drift.

Township 1, Range 14

The land surface throughout most of this township is markedly undulating with higher relief in the irregular hilly region of the moraine-covered northern parts. The east-central part is dissected by several coulées with an easterly trending drainage.

Only a few sections along the south and western sides of the township are farmed; the remainder of the area is used as community grazing leases. Dams in the coulées at several points in the area conserve surface water for stock. A few wells in the farming community yield water from sand and gravel pockets in the upper 20 feet of the glacial drift. These pockets are probably more numerous in the moraine-covered area which occurs in the northern part of the township, but no test holes are known to have been sunk in these deposits. Some difficulty has been encountered in obtaining suitable supplies of drinking water in the southern part of the township as several of the seepage wells yield water that is too highly mineralized for domestic use. Two wells, situated on the SW.$\frac{1}{4}$, section 3, and the SW.$\frac{1}{4}$, section 9, yield small supplies of hard, drinkable water from sand and gravel deposits in the upper 30 feet of the drift. These wells contribute at least part of the drinking water supply for the community, although the yield is insufficient for the stock. Drilling to greater depths has not proved satisfactory in this area.

The dark grey shales of the Bearpaw formation are believed to immediately underlie the drift throughout most of the northwestern half of the township, as indicated by the geological boundary (Figure 1) of the map accompanying this report. Although not positively identified as such, a few feet of these shales are thought to have been penetrated in one well drilled to a depth of 100 feet on the NE.$\frac{1}{4}$, section 5.

Greater thicknesses of this formation are expected to occur toward the north and northwest, reaching a maximum thickness of about 75 feet in the northwestern corner of the township. Little if any water can be expected from these shales. Small supplies of "soda-bearing" water may occur, however, in porous beds of the underlying Belly River formation at depths of 175 feet or more. Due to an arching of the beds comprising the bedrock formations in this township, as has been described in the general discussion of the municipality, the logs of wells will be found to differ in the western and eastern parts of the township. Along the western boundary and in the neighbourhood of the northwest corner drillers can expect to encounter in turn some 80 to 100 feet of glacial drift and 50 to 75 feet of Bearpaw shales before penetrating the sandy shales of the Belly River formation. In a southeasterly direction the beds of the bedrock formations rise slightly to the southern part of the eastern boundary of the township. The Bearpaw shales gradually decrease in thickness and within the area bounded by the line separating the Bearpaw formation from the Belly River, as shown on Figure 1 of the accompanying map, they are absent and the Belly River formation immediately underlies the drift. Attempts to find water in the Belly River formation in this area have been discouraging. Three dry holes have been sunk to depths of 100, 156, and 250 feet in sections 4 and 5. The deepest of these was drilled at the customs house in the SW.¼, section 4. Glacial drift at this location was found to be about 100 feet thick, below which the sandy shales of the Belly River formation were encountered. In the 156-foot well in the NW.¼, section 5, dry, white sand with a small gas showing was reported at a depth of 94 to 100 feet or at an elevation of about 2,660 feet above sea-level, followed by sandy clay shales to the base of the well. No deep drilling has been done in the northwestern half of the township. On account of the slight downward slope of the beds towards the northwest corner conditions for the accumulation of ground water in the Belly River formation should be better in this part of the township, but as explained above the added thickness of the overlying Bearpaw shales will increase the depths necessary to drill before water can be obtained. Owing to the uncertainty of striking water in this formation residents are advised to thoroughly prospect for water-bearing sands or gravels in the upper 30 feet of the glacial drift before undergoing the expense of drilling deep holes.

Township 1, Range 15

The land surface in this area is comparatively level with a gentle slope to the southeast. The drainage system is well developed by Whitewater creek and Cottonwood coulée and their tributaries. Dams constructed at favourable points in the numerous, small coulées conserve the spring run-off for stock in many of the farms in the township. Drinking water is obtained from shallow seepage wells sunk beside such reservoirs at points where better supplies have not been located in the stream deposits or in the porous beds of the glacial drift.

Accumulations of sand and gravel in the beds of the stream channels in the eastern half of the township yield good supplies of water for a few of the settlers in this area. These water-bearing beds are encountered at depths not greater than 15 feet from the surface. The yield from individual wells in these areas is sufficient in most cases for 20 to 40 head of stock. The water is reported to be soft to moderately hard and is used for the household drinking supply.

Small pockets of water-bearing sands and gravels occur sparsely distributed through the boulder clays in the upper 30 feet of the glacial drift. These aquifers, where encountered in wells, yield only small seepages of water sufficient for a few head of stock and for household requirements. Wells sunk in boulder clay beside sloughs are also unsatisfactory as most of the sloughs in this area are shallow and become dry in the early summer months.

Water-bearing sand and gravel beds are known to occur at greater depths in the drift from the central to the north-western part of the township. These are probably flood-plain deposits of early glacial or pre-glacial age. They occur at or near the base of the glacial drift at depths of 125 to 160 feet from the surface. The approximate boundary of the area in which these water supplies occur is outlined by the "B" line on Figure 1 of the map accompanying this report. This boundary is at best only approximately located, as the most substantial evidence for the continuity of this water-bearing horizon is found in townships 1, and 2, range 16, in the area adjacent to this municipality on the west.

The water supplies in the lower part of the glacial drift have been tapped by only three wells situated in the central part of the township at depths of 125 to 160 feet. The water occurs in sand and is under sufficient hydrostatic pressure to cause it to rise in the wells from 15 to 40 feet above the aquifer. The mineral salt content of these waters renders them hard. Water from one of these wells situated in the SE.¼, section 21, is considered to be too highly mineralized for drinking. It is, however, used for watering stock. Iron is also present in some of the water from this horizon rendering it unsatisfactory for washing clothes.

No wells in the township are definitely known to have been sunk to the bedrock underlying the drift.

Bearpaw shales are thought to underlie the drift throughout the township, with the exception of areas occupied by Cottonwood coulée and Whitewater creek where these stream channels have cut their beds down to the Belly River formation underlying the Bearpaw at an elevation of about 2,650 feet above sea-level. The Bearpaw formation is not expected to be water-bearing in this township owing to the almost entire absence of porous beds in the part of the formation underlying this area.

Ground water supplies may, however, occur in porous beds of the Belly River formation below the Bearpaw. The top of this formation is expected to lie at an approximate elevation of 2,650 feet in the southern part of the township, but owing to a slight northerly dip to the bedrock strata it will probably be necessary to sink wells to depths of 250 to 300 feet before encountering these beds in the northern sections. One well situated in the SE.¼, section 9, encountered a small supply of hard, drinkable water in quicksand at a depth of 68 feet or at an elevation of approximately 2,642 feet. The elevation at which this aquifer occurs and the fine-grained texture of the sand suggest that the aquifer belongs to the top of the Belly River formation. The bed has not been positively identified as such, however, and is tentatively listed as in glacial drift. Should water be obtained in the Belly River formation at greater depths in the northern part of the township it will probably be soda-bearing and similar in character to supplies obtained from the village well in Bracken in the municipality to the west.

Township 2, Range 13

Frenchman river has cut a broad valley through the northern part of the township. The land surface of the highlands south of the river is steeply rolling with numerous small hills and depressions typical of moraine-covered areas. Round quartzite boulders are thickly strewn over the surface of this area, especially in the southern part of the township. No wells are known to have been sunk in the eastern half of the township as this area is unsuited to farming and is given over entirely to grazing. The greater part of the ground water supply in the farming community of the western half of the township is derived from shallow seepage wells 20 feet or less in depth. These wells are usually situated beside sloughs and in the small valleys and depressions between the hills. Most of the wells are sunk in the boulder clay and derive their water by seepage from the clay, but a few have encountered pockets of water-bearing sands and gravels. These pockets, where tapped, lie within 20 feet of the surface and seldom yield more than sufficient water for 10 to 15 head of stock. Varying amounts of soluble salts are reported in these waters, but the concentration is not considered too great for human consumption.

More abundant supplies of water are to be expected from sand and gravel beds at greater depths in this moraine-covered area. These beds have been tapped by wells sunk to depths of 30 to 60 feet in the township to the south and west of this area. Much of the water from this source is highly mineralized, however, and not very suitable for drinking.

Owing to the shallow depths to which wells have been sunk in this township and to the absence of bedrock exposures little is known regarding the thickness of the glacial drift. It probably extends to depths of 75 to 100 feet, however, throughout most of the township. Bearpaw shales are thought to form the bedrock formation immediately underlying the drift. These shales would probably yield very little, if any, water in this part of the municipality, but ground water may occur in the more porous Belly River formation that lies beneath the Bearpaw.

In the southern part of the township it may be necessary to drill wells to depths of 200 feet or more before reaching the possible productive beds of the Belly River formation. No definite assurance can be given that water will be found in sufficient quantities to justify deep drilling. Residents contemplating the sinking of wells to this formation are advised to read the sections of this report dealing with the township to the south and the municipality as a whole.

Township 2, Range 14

Moraine covers the land surface over most of this township. A wide depression or basin extending in a westerly direction through the east-central part of the township shows evidence of having contained a large body of water in recent years, but was nearly dry in 1935. Most of the smaller sloughs occupying depressions between the hills were also dry during the summer of that year. Dams and dugouts constructed in some of the draws and depressions conserve water for stock. The permanency of these water supplies depends principally upon the size of the reservoir and the extent of the surrounding catchment area.

Wells sunk in boulder clay beside sloughs can seldom be relied upon for a water supply during the late summer or the winter months. High concentration of mineral salts in solution are reported from some of these waters, rendering them unsuitable for household use. Small pockets of water-bearing sands or gravels have been encountered in a few wells in this area, generally at depths of 20 feet or less. The yields from individual wells vary from large supplies, sufficient for 20 to 30 head of stock, to small seepages adequate only for household use. These waters are not highly mineralized and are reported to be quite suitable for drinking.

A deeper water-bearing horizon is tapped by several wells in the northern third of the township at depths of 59 to 75 feet from the surface. The water occurs in dark, blue-grey sand. It is hard and contains a high concentration of soluble salts and iron, rendering it unsuitable for domestic use, but it is used for watering stock with no apparent ill effects. Water-bearing beds of similar character may occur in other parts of the township, although none are known to have been located to date. The thickness of the drift in this township is not known, but probably reaches a depth of 100 to 150 feet as indicated by wells in the township adjoining on the west. Water-bearing beds of sand or gravel may occur at the base of the glacial drift in a few isolated localities similar to those encountered farther west. No predictions can be made, however, regarding the location or depths to these beds or the character of the waters to be expected from them.

The Bearpaw formation immediately underlies the drift and is not known to be water-bearing in this part of the municipality. Settlers are advised to confine their search for water to the glacial drift or be prepared to sink wells through the Bearpaw into the underlying Belly River formation, the character of which is more favourable for ground water accumulation. The possibility of water occurring in this latter formation is discussed in earlier sections of this report dealing with the southern townships and with the municipality as a whole.

The top of the Belly River formation may occur at depths of 350 to 400 feet in the northern part of the township, but at lesser depths toward the south to a minimum of about 200 feet along the southern border.

Township 2, Range 15

The land surface of this township is gently rolling with a few localities of higher relief, especially in the moraine-covered area of the east-central part. Whitewater creek crosses the southwestern corner. This stream channel is shallow in the western part, but deepens toward the south and carries water only during the early spring. Dugouts and dams constructed in the coulées conserve surface water for stock. Only a few of the largest of these reservoirs contained water when visited during the late summer of 1935. A body of water held by a large dam on the farm of Mr. W. Denis, in section 30, was supplying water for stock within a radius of several miles but was also nearly dry.

It is improbable that the water supply will prove to be adequate to meet the demands for stock water in the district throughout a dry year.

Wells sunk in the boulder clay beside sloughs or dugouts yield water for only a short period after the reservoir becomes dry, making it necessary for most of the settlers in the township to haul their drinking water from the few continuously productive wells. In some localities it is necessary to haul for distances of several miles.

A few small pockets of fine sand, or quicksand, are encountered irregularly distributed through the upper 20 feet of the glacial drift. Only one well, situated in section 22, is reported to yield water from these shallow deposits in sufficient quantities for more than 25 head of stock. This water is reported to be soft and suitable for drinking. In other localities, where these sand pockets have been located, the wells yield small supplies of hard water.

Water-bearing beds in the lower part of the glacial drift have been encountered only in a few isolated localities. One of these horizons occurs in the area south of Whitewater creek in the southwest corner of the township. This horizon is tapped by a well situated in the NW.$\frac{1}{4}$, section 6, at a depth of about 115 feet. The water from this well is reported to be hard and suitable for drinking, but the supply is insufficient for more than a few head of stock. The underlying Bearpaw shale was struck below the water horizon and the hole was carried down to a total depth of 168 feet without encountering a better supply.

Highly mineralized water suitable only for watering stock was encountered in glacial drift in the NE.$\frac{1}{4}$, section 3, at a depth of about 115 feet. At approximately 1$\frac{1}{4}$ miles north of this location, in the SW.$\frac{1}{4}$, section 15, a 196-foot dry hole encountered dry sand and gravel at a depth of 90 feet. Dry holes have also been sunk to a depth of 230 feet in section 20 and 132 feet at Orkney in section 23. In the latter drill hole "soapstone" (Bearpaw shale?) was encountered at 100 feet from the surface. Another well in this vicinity situated in the SE.¼, section 26, is 190 feet deep. Water too highly mineralized for drinking was encountered in it at an undetermined depth. The yield is not known as the well is not used.

The most satisfactory water supply obtained from the lower part of the glacial drift is encountered in a well sunk to a depth of 150 feet in the NE.¼, section 34. Gravel pockets were encountered at several horizons in this well, but the principal water supply comes from a bed of sand at the base. A thin seam of coal was encountered at a depth of 138 feet and overlies the water sand. This coal and sand are probably a pre-glacial river or flood-plain deposit overlying bedrock. The water supply in this well decreased during the dry years of 1930-1934, but when visited in 1935 the water-level was 80 feet from the surface and the supply was quite sufficient for the farm requirements. This water is reported as soft and is considered quite suitable for household use. From a review of these drilled holes it is readily seen that no definite horizon can be outlined for the water-bearing beds of the lower part of the glacial drift in this township. They are apparently of small extent and may occur in any of the untested localities.

The possibility of obtaining water from the bedrock is discussed in earlier sections dealing with the municipality as a whole and with the township to the south. The part of the total section of the Bearpaw formation that is represented in this township is composed almost entirely of shale and offers scant prospects of finding ground water suitable either in quality or quantity for farm use. The Belly River formation underlying the Bearpaw will probably yield soft water containing soda. It may be necessary to drill to depths of 300 to 400 feet in the southern part of the area and to 400 to 500 feet in the northwestern sections before productive horizons are tapped. Residents are advised to prospect the drift carefully before considering deep drilling.

Township 3, Range 13

The highlands region of this township is dissected by the broad valley of Frenchman river which flows in a southeasterly direction through the central part of the township. The valley flat attains a width of over 2 miles, south of Valmarie, and extends to the western border of the township in this locality. It narrows, however, to less than a mile in width at the southern border in section 3. The sides of the valley rise abruptly from the flats at an elevation of approximately 2,575 feet above sea-level to over 2,700 feet at the top of the valley, from which the ground surface rises gradually toward the eastern and southwestern borders of the township where the highlands reach elevations exceeding 2,800 feet. In the southeastern part of the township, the erosion of numerous small coulées into the highlands has formed many small buttes and other features characteristic of badlands topography. Sources of surface waters in this township are confined largely to Frenchman river as there are very few sloughs on the uplands. A few dams and dugouts are being used to store spring surface run-off. Large supplies of ground water are obtained from beds of sand and gravel in the river flats. These beds lie within 20 feet of the surface at Valmarie and are encountered by digging wells or by driving sand-points to this depth. The water is hard and reported as slightly "alkaline", but is used for drinking and for watering stock.

A drilled hole in section 17, which was terminated in bedrock at a depth of 150 feet, failed to encounter water below this shallow sand horizon. Bluish grey boulder clay grading into more compact finer clays, neither of which yields more than small seepages of water was encountered below the shallow water-bearing sands.

Several wells, situated on the western edge of the river flat, yield small supplies of soft water from gravel deposits at depths of 20 feet or less. These are probably terrace gravels and are not extensive.

A few wells sunk to gravel and sand beds in the bottoms of the smaller coulées on the highlands east of the river yield water sufficient for about 15 head of stock. Some of these waters are reported to be soft and all are suitable as a household drinking supply. On the highlands isolated pockets of water-bearing sands and gravels may occur interspersed through the boulder clay in the upper 20 feet of the glacial drift, particularly in the moraine-covered area west of the river valley. As far as known, however, no wells have been sunk into these deposits.

The thickness of the glacial drift varies considerably in different parts of the township. On the highlands east of the river it may reach a thickness 50 feet or more in some localities, although it is quite thin on the south and western slopes as indicated by the numerous exposures of the bedrock. Thicker accumulations of drift probably occur on the western side of the valley. A dry hole situated in the NW.$\frac{1}{4}$, section 8, was dug through clays, presumably drift, to a depth of 90 feet.

The Bearpaw formation underlies the drift or outcrops at the surface throughout this township. A dry hole, situated in the NW.$\frac{1}{4}$, section 17, was sunk to a depth of 150 feet and is known to have penetrated these shales to a considerable depth. Little if any water can be expected to occur in this formation due to the impervious nature of the shales and the lack of porous beds suitable for the accumulation of any large supply of ground water. Residents of this township are advised to confine their search for ground water supplies to the Recent valley deposits and to the mantle of glacial drift.

The Belly River formation, below the Bearpaw, probably does not occur at depths of less than 300 to 400 feet in the river valley at the southern border of the township, and will lie at correspondingly greater depths over the highlands region. Should water be obtained from this formation it will probably be "soda bearing" and suitable for laundry and stock requirements.

Township 3, Range 14

The land surface throughout the northern half of this township is steeply rolling and is devoted principally to grazing. In the southern parts the surface is less rolling, making farming possible in this part of the township.

A few isolated pockets of water-bearing sand or gravel occur in the upper 20 feet of the glacial drift and have been tapped by several wells in the farming community of the southern half of the township. Wells sunk to these pockets in sections 2 and 10 yield only sufficient water for a few head of stock. The majority of the farmers of the community have failed to encounter these water supplies, although a number of dry holes have been sunk to depths of 20 feet or more in this area. The irregular distribution of these pockets makes any prediction of their location or extent in untested areas practically impossible. Unsuccessful efforts to find water at shallow depths in these parts should not be taken as conclusive evidence that productive beds do not exist. Seepage wells sunk beside reservoirs serve as drinking water supplies on many of the farms, but some residents prefer to haul their drinking water, in some localities the distance measuring several miles. Beds of sands and gravels yielding large supplies of water have been located in sections 24, 25, and 36. A well sunk to a depth of 10 feet in the NE.$\frac{1}{4}$, section 25, yields sufficient water for 30 head of stock. An analysis of this water is given in the table of water analyses in a later section of this report. This well is situated on the western edge of Valmarie flat at an approximate elevation of 2,614 feet above sea-level. Similar gravels occur on the edge of the flat at about the same elevation in section 24. Springs issue from some of these deposits where they come to the surface on the valley sides. This water-bearing horizon is probably an old terrace deposit of Frenchman river and cannot be expected to extend west of the river valley.

The thickness of the drift throughout the highlands is not known, but probably exceeds 100 feet. A few isolated pockets or beds of sand or gravel may occur in the lower part of the glacial drift, but it would probably be necessary to drill a number of test holes before locating an adequate water supply.

Sinking drill holes to greater depths than the base of the glacial drift is not recommended in this township. The impervious character of the Bearpaw shales that underlie the drift throughout this area cannot be considered to be favourable for ground water accumulation. The great depths that would be necessary to drill before the sands of the Belly River formation would be penetrated makes it advisable to confine prospecting for water to the glacial drift in this area.

Township 3, Range 15

The land surface throughout the central and southern parts of this township is slightly undulating with a gradual rise toward the southeastern sections. Along the eastern and western sides of the township the ground surface is more irregular, and low hills and undrained depressions typical of moraine-covered areas are common.

The southern part of the area is well drained by numerous shallow, southward-trending valleys and in the northeastern part Black Horse lake serves as a reservoir for shallow coulées of the surrounding area.

The ground water supply of this township is very poor. Most of the farmers in this area have constructed dugouts and dams to conserve the spring run-off and those possessing wells that supply sufficient water for more than household use are to be considered fortunate. Few of the reservoirs are large enough or have a sufficiently large collective area to supply water throughout extensive dry periods or during the winter months. Even in years of normal precipitation many have found it necessary to haul part of their water supply.

Most of the few producing wells in the township are sunk in the clay of the upper 20 feet of the glacial drift. These are usually situated in depressions or beside reservoirs and derive their water by seepage. A few small pockets of sand and occasionally gravel have been encountered interspersed through the clay, but these deposits seldom yield more than enough water for household use and 10 to 20 head of stock. Waters from these shallow wells are not generally highly mineralized and in nearly all places are reported to be quite suitable for household use. It is the general opinion of the farmers throughout this area that water from the drift at depths greater than 35 feet will contain a high concentration of salts in solution and be unfit for either human or stock use. It is improbable, however, such a prediction can be made for the entire township, as waters showing considerable variation in quality have been encoutered in the deeper sand and gravel beds in township 2, range 15, to the south of this area. Extensive water-bearing beds are not expected to occur in the lower part of the drift, although more extensive drilling might locate a few localized areas such as have been found in the township to the south. Several dry holes have been sunk to the base of the drift in the southern half of this township. One of these holes, situated in the NW.$\frac{1}{4}$, section 9, penetrated the underlying bedrock at a depth of 90 feet and was abandoned at a depth of 300 feet after passing through dark grey, non-water-bearing shales of the Bearpaw formation.

The possibilities of obtaining water from the Belly River formation underlying the Bearpaw formation is discussed in an earlier section dealing with the municipality as a whole.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF NO. 17, SASKATCHEWAN

West of 3rd meridian — Township / Range	1 13	1 14	1 15	2 13	2 14	2 15	3 13	3 14	3 15	Total No. in Municipality
Total No. of Wells in Township	13	10	27	16	29	36	15	9	46	201
No. of wells in bedrock	0	3	0	0	0	3	0	0	1	7
No. of wells in glacial drift	13	7	22	16	29	33	11	9	45	185
No. of wells in alluvium	0	0	5	0	0	0	4	0	0	9
Permanency of Water Supply										
No. with permanent supply	8	5	13	6	11	16	12	6	16	93
No. with intermittent supply	4	1	7	10	12	17	1	2	20	74
No. dry holes	1	4	7	0	6	3	2	1	10	34
Types of Wells										
No. of flowing artesian wells	0	0	0	0	0	0	0	0	0	0
No. of non-flowing artesian wells	1	0	2	1	2	3	0	0	0	9
No. of non-artesian wells	11	6	18	15	21	30	13	8	36	158
Quality of Water										
No. with hard water	11	6	16	13	22	31	9	8	36	152
No. with soft water	1	0	4	3	1	2	4	0	0	15
No. with salty water	0	0	0	0	0	0	0	0	0	0
No. with "alkaline" water	9	2	4	6	15	17	6	3	4	66
Depths of Wells										
No. from o to 50 feet deep	11	7	22	16	25	29	13	8	43	174
No. from 51 to 100 feet deep	2	1	3	0	4	0	1	1	0	12
No. from 101 to 150 feet deep	0	0	1	0	0	3	0	0	2	6
No. from 151 to 200 feet deep	0	1	1	0	0	3	1	0	0	6
No. from 201 to 500 feet deep	0	1	0	0	0	1	0	0	1	3
No. from 501 to 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
No. over 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
How the Water is used										
No. usable for domestic purposes	12	5	19	16	21	24	10	6	25	138
No. not usable for domestic purposes	0	1	1	0	2	9	3	2	11	29
No. usable for stock	12	5	20	16	22	31	13	8	36	163
No. not usable for stock	0	1	0	0	1	2	0	0	0	4
Sufficiency of Water Supply										
No. sufficient for domestic needs	8	5	13	6	11	16	12	6	16	93
No. insufficient for domestic needs	4	1	7	10	12	17	1	2	20	74
No. sufficient for stock needs	8	2	9	5	7	14	8	3	14	78
No. insufficient for stock needs	4	4	11	11	16	19	5	5	22	89

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 No. 17, Saskatchewan

No.	LOCATION Qtr.	Sec.	Tp.	Rge.	Mer.	Depth of Well, Ft.	Total dis'vd solids	HARDNESS Total	Perm.	Temp.	CONSTITUENTS AS ANALYSED Cl.	Alkalinity	CaO	MgO	SO_4	Na_2O	CONSTITUENTS AS CALCULATED IN ASSUMED COMBINATIONS Solids	$CaCO_3$	$CaSO_4$	$MgCO_3$	$MgSO_4$	Na_2CO_3	Na_2SO_4	NaCl	$CaCl_2$	Source of Water
1	NW.	4	1	14	3	21	3,911											(4)	(1)		(2)		(3)		(5)	x-1
2	NE.	25	3	14	3	10	1,140	480	380	100	40	385	180	108	418	178	1,015	322		53	244		330	66		x-1

Water samples indicated thus, x-1, are from glacial drift.
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 ($CaCO_3$).

Analysis No. 1, by Provincial Analyst, Regina.
For interpretation of this table, read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

Ground-waters in the deposits of sand and gravel that occur along the bottoms of the small stream valleys or coulées are largely derived from surface run-off from the uplands. These ground waters usually contain only small amounts of mineral salts in solution. They are moderately soft to hard, and form suitable supplies for household use. The water in shallow wells located in depressions and valleys, however, is easily contaminated and care should be exercised in keeping the catchment area free from sewage and decaying organic matter.

Flood-plain deposits occurring along the bottom of Frenchman valley are composed mostly of clays, silts, and fine sands derived from erosion of the glacial drift and the Bearapaw formation. Mineral salts contained in the drift and bedrock are readily dissolved by ground waters as they slowly pass from the uplands into the valley. The concentration of mineral salts in these waters varies in different localities. The sulphates of sodium and magnesium are usually present in sufficient amounts to impart a bitter taste to the waters. These salts in solution have a laxative effect upon persons unaccustomed to water so mineralized.

Supplies obtained from the coarse sand and gravel deposits that occur on the flats of Frenchman River valley and at the confluence of tributary stream channels are not usually as highly mineralized as supplies from the sands and silts. The second analysis listed on the accompanying table is of water derived from a gravel bed that occurs on the western edge of Valmarie flat. This water has a total dissolved solid content of 1,140 parts per million. This concentration is not excessive for water from this type of deposit. The sulphates of sodium (Na_2SO_4 or Glauber's salt), and magnesium ($MgSO_4$ or Epsom salts), are the most harmful salts present. These salts are not present in sufficient quantity, however, to cause the water to be unfit for domestic use. The magnesium sulphate contributes to the hardness of the water. The carbonates of calcium ($CaCO_3$) and magnesium ($MgCO_3$) are not considered detrimental to health but they impart hardness to the water.

The water represented by Analysis No. 2 is considered to be fairly suitable for garden irrigation. The "white alkali" (Na_2SO_4) may, however, accumulate in the soil over a period of years, particularly if the subsoil is impervious and the surface evaporation is excessive, thus allowing little opportunity for the removal of these salts from the soil.

The quality of water from wells sunk in the glacial drift shows a wide variation throughout the municipality. The following discussion is based on conclusions drawn from observations at the well sites and from the opinions of the residents of the municipality.

Wells sunk in boulder clay in this municipality are usually situated beside sloughs or artificially constructed dugouts and derive their water by seepage. The clay acts as a filter and if the surface water in the reservoir does not contain a high concentration of salts in solution due to continuous evaporation, or is not contaminated by sewage or other decaying organic material, water in the well will be quite suitable for drinking.

Water from wells sunk to the sand and gravel pockets that occur in the upper 30 feet of the glacial drift shows a wider variation in the amounts of dissolved solids. Many of these waters contain a sufficiently high concentration of magnesium sulphate to impart a bitter taste and to have a laxative effect when drunk by persons not accustomed to its use. These waters are seldom too highly mineralized for watering stock. The first analysis on the accompanying table is of water from a well sunk in this type of deposit. The analyses show the relative amounts of the dissolved salts present. The total dissolved solids, 3,911 parts per million, greatly exceed that of waters considered suitable for household use. The sulphate salts of calcium ($CaSO_4$), magnesium ($MgSO_4$), and sodium (Na_2SO_4) are present in the greatest abundance. Calcium sulphate is not considered detrimental to health, but it imparts hardness to the water and forms scale if the water is used in steam boilers. Magnesium sulphate (Epsom salts) and sodium sulphate (Glauber's salt), are the most harmful salts present. It is the general opinion of the residents of this municipality that the lower part of the glacial drift yields water too highly mineralized for drinking. This statement does not hold true for all parts of the area, however. Several of the deep wells on the western side of the municipality yield water that is apparently quite suitable for human consumption. No water samples were taken for analysis from these wells, but in other municipalities to the west where water conditions in the lower part of the glacial drift are apparently similar, samples analysed showed a wide variation in the amounts of salts present in solution. The sulphates of sodium and magnesium usually predominate in the more highly mineralized types. Although these waters are not always suitable for household use, they are being used for watering stock with no apparent ill effects.

Water from the Bedrock

No wells in this municipality are known to yield water from the bedrock formations.

In the municipality to the west, deep wells sunk in the villages of Bracken and Climax derive a sodium carbonate-bearing water from the upper part of the Belly River formation or possibly the base of the Bearpaw formation. The high soda content of this water gives it a flat taste and makes it unsuitable for drinking, but it is used for watering stock and for washing purposes. The water is soft, but the sodium carbonate or "black alkali" renders it unfit for irrigation. It is probable that water of similar quality will be found in this formation in the northern and central parts of this municipality.

WELL RECORDS—Rural Municipality of NO. 17, 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
1	SW.	3	1	13	3	Bored	30	2,550	- 28	2,522	28	2,522	Glacial gravel	Hard, clear	45	D, S	Sufficient supply; supplies water for neighbours.
2	SE.	17	"	"	"	Bored	92	2,613					Base in Glacial till			N	Dry hole; another well with plenty of water 25 feet deep in quicksand.
3	NW.	19	"	"	"	Dug	20	2,713	- 0	2,713	0	2,713	Glacial sand and gravel	Hard, clear, "alkaline"		D, S	Insufficient supply.
4	SE.	20	"	"	"	Dug	25	2,710	- 0	2,710	0	2,710	Glacial drift	Hard		D, S	Insufficient supply.
5	NE.	20	"	"	"	Dug	20	2,715	- 0	2,715			Glacial drift	Hard, "alkaline"		D, S	Sufficient for 6 head stock.
6	SW.	21	"	"	"	Dug	15	2,730	- 0	2,730			Glacial drift	Hard, clear, "alkaline"		D, S	Insufficient supply; hauls water in very dry years.
7	NE.	26	"	"	"	Bored	30	2,745	- 20	2,725	28	2,717	Glacial gravel	Hard, clear		D, S	Sufficient for 10 head stock.
8	SW.	28	"	"	"	Dug	8	2,710	- 5	2,705	5	2,705	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for neighbours.
9	SW.	33	"	"	"	Dug	25	2,750	- 0	2,750	0	2,750	Glacial drift	Hard, clear, "alkaline"		D ,S	Insufficient supply.
10	SW.	34	"	"	"	Bored	40	2,720	- 32	2,688	32	2,688	Glacial blue sand	Hard, clear, "alkaline"		D, S	Sufficient for 10 head stock.
11	NE.	34	"	"	"	Bored	45	2,740	- 38	2,702	38	2,702	Glacial gravel	Hard, clear, "alkaline"		D, S	Very good supply.
12	SE.	36	"	"	"	Bored	56	2,655	- 30	2,625	48	2,607	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient supply; not good for human consumption.
1	SW.	3	1	14	3	Bored	22	2,875	- 8	2,867	8	2,867	Glacial gravel and sand	Hard, clear		D, S	Insufficient for 16 head stock.
2	SW.	4	"	"	"	Drilled	250	2,835					Base in Belly River formation				Dry hole.
3	NW.	4	"	"	"	Dug	21	2,804	- 15	2,789	19	2,785	Glacial gravel	Hard, clear, "alkaline"	45	D, S	Waters 30 head stock. #.
4	NE.	5	"	"	"	Bored	100	2,795					Base in Bearpaw Shale				Dry hole.
5	NE.	5	"	"	"	Dug	30	2,771					Glacial drift	Hard, "alkaline"		N	Insufficient supply; water unfit to drink.
6	NW.	5	"	"	"	Bored	156	2,755					Base in Belly River formation				Dry hole.
7	SW.	9	"	"	"	Dug	32	2,771	- 10	2,761	10	2,761	Glacial drift	Hard, clear		D, S	Insufficient supply for 40 head stock.
8	SW.	18	"	"	"	Bored	40	2,845	- 24	2,821	24	2,821	Glacial sand	Hard, clear		D	Sufficient supply for school.
9	NW.	31	"	"	"	Dug	21	2,770	- 0	2,770	0	2,770	Glacial clay	Hard, clear	45	D, S	Insufficient supply for 2 head stock.
1	NW.	4	1	15	3	Dug	25	2,680					Glacial drift	Hard		D, S	Insufficient supply.
2	SE.	9	"	"	"	Bored	78	2,710	- 66	2,644	66	2,644	Glacial quicksand	Hard, clear		D, S	Insufficient for 20 head stock.
3	NE.	10	"	"	"	Dug	27	2,720					Recent alluvium	Soft			Insufficient supply.
4	SE.	14	"	"	"	Dug	14	2,630	- 10	2,620	10	2,620	Recent alluvium, gravel	Hard, clear, "alkaline"	45	D, S	Sufficient for 16 head stock.
5	SE.	15	"	"	"	Dug	35	2,725					Base in Glacial till			N	Dry hole; 6 other dry holes.
6	NE.	20	"	"	"	Bored	125	2,820	- 94	2,726			Glacial sand and gravel	Hard, clear, "alkaline"	45	D, S	Waters 12 head stock and household.

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 NO. 17, 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	SE.	21	1	15	3	Bored	137	2,750	-122	2,628	137	2,613	Glacial sand	Hard, iron, "alkaline" red sediment	45	S	Sufficient for stock; this water is unfit to use in house.
8	SW.	22	"	"	"	Bored	164	2,780	- 97	2,683	144	2,636	Glacial black sand	Hard, clear		D, S	Sufficient supply.
9	NW.	22	"	"	"	Bored	29	2,790	- 17	2,773	17	2,773	Glacial sandy clay	Soft, clear		D, S	Sufficient for 6 head stock.
10	SW.	24	"	"	"			2,810					Glacial drift	Hard, clear, "alkaline"		D, S	Sufficient supply.
11	SE.	24	"	"	"	Bored	65	2,800	- 60	2,740	60	2,740	Glacial gravel	Hard, clear	45	D, S	Sufficient supply; three 60-foot dry holes.
12	NW.	24	"	"	"	Dug	30	2,790					Glacial drift	Soft		D, S	Insufficient supply.
13	SW.	25	"	"	"	Dug	25	2,820					Glacial drift	Hard		D, S	Sufficient supply in wet seasons.
14	SW.	26	"	"	"	Dug	9	2,835					Recent alluvium	Hard		D, S	Sufficient supply in wet seasons.
15	NE.	27	"	"	"	Dug	4	2,830					Recent alluvium	Hard		D, S	Sufficient supply in wet seasons.
16	SW.	28	"	"	"	Dug	20	2,835					Glacial drift	Hard		S, D	Insufficient supply.
17	NE.	28	"	"	"	Bored	18	2,828	- 12	2,816	12	2,816	Glacial sand	Hard		D	Only sufficient for house use; several other wells usually dry.
18	SE.	35	"	"	"	Spring	6	2,850	0	2,850	0	2,850	Recent gravel	Soft, clear	45	D, S	Sufficient for 40 head stock and house.
19	NW.	36	"	"	"	Bored	45	2,820	- 15	2,805			Glacial sand	Hard, clear	45	D, S	Insufficient supply.
1	SE.	4	2	13	3	Dug	15	2,730					Glacial drift	Soft		D, S	Insufficient supply.
2	NE.	4	"	"	"	Dug	14	2,725	- 11	2,714	11	2,714	Glacial gravel	Hard, "alkaline"		D, S	Sufficient for 15 head stock.
3	NW.	4	"	"	"	Bored	14	2,720					Glacial drift	Hard, "alkaline"		D, S	Insufficient supply.
4	NW.	5	"	"	"	Dug	16	2,743	- 8	2,735			Glacial sand and gravel	Hard, clear, "alkaline"		D, S	Insufficient supply.
5	SE.	6	"	"	"	Dug	18	2,734	- 10	2,724			Glacial sand and gravel	Hard, "alkaline"		D, S	Insufficient supply.
6	NE.	9	"	"	"	Dug	8	2,730					Glacial drift	Soft		D, S	Normally sufficient.
7	SE.	17	"	"	"	Dug	12	2,770	- 10	2,760			Glacial drift	Hard, clear		D, S	Insufficient supply.
8	SW.	18	"	"	"	Dug	12	2,624	- 0	2,624			Glacial drift	Hard, "alkaline"		D, S	Insufficient supply.
9	NW.	19	"	"	"	Dug	10	2,775	- 5	2,770	10	2,765	Glacial gravel	Hard, clear		D, S	Sufficient for 16 head stock.
10	SE.	19	"	"	"	Dug	20	2,760					Glacial drift	Hard		D, S	Insufficient supply.
11	NW.	21	"	"	"	Dug	18	2,780					Glacial drift	Hard, "alkaline"		D, S	Oversufficient supply.
12	NW.	29	"	"	"	Dug	14	2,820	- 10	2,810			Glacial drift	Hard, clear		D, S	Only sufficient for 4 head stock.
13	SE.	30	"	"	"	Dug	14	2,800	- 10	2,790			Glacial gravel	Hard, clear		D, S	Only sufficient for 6 head stock; also an 18-foot well, water soft.

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(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of NO. 17, 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
14	NE.	30	2	13	3	Dug	16	2,810	− 0	2,810			Glacial drift	Soft, clear		S	Insufficient supply.
15	SW.	32	"	"	"	Dug	25	2,830	− 19	2,811	19	2,811	Glacial gravel	Hard, clear		D, S	Sufficient for 10 head stock.
1	NE.	4	2	14	3	Bored	13	2,681	− 9	2,672	10	2,671	Glacial gravel	Soft, clear		D, S	Only sufficient for 3 head stock.
2	NE.	4	"	"	"	Dug	18	2,681					Base in Glacial till				4 dry holes.
3	NE.	9	"	"	"	Dug	28	2,650					Glacial drift	Hard, "alkaline"		D, S	Insufficient supply.
4	SE.	12	"	"	"	Dug	13	2,660					Glacial drift	Hard, clear, "alkaline"		D, S	Sufficient for house use only.
5	NE.	12	"	"	"	Dug	14	2,660					Glacial drift	Hard, "alkaline"		D, S	Sufficient in years of normal rainfall.
6	SW.	13	"	"	"	Dug	10	2,580					Glacial drift	Hard, clear, "alkaline"		D, S	Insufficient supply.
7	NW.	14	"	"	"	Dug	25	2,639	− 17	2,622	20	2,619	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient for 10 head stock.
8	NE.	15	"	"	"	Dug	6	2,570					Glacial drift	Hard, clear, "alkaline"		D, S	Insufficient supply.
9	NW.	21	"	"	"	Dug	10	2,530					Glacial drift	Hard, clear, "alkaline"		D, S	Sufficient supply.
10	SW.	22	"	"	"	Bored	25	2,486	− 20	2,466	22	2,464	Glacial sand	Hard, clear		D, S	Oversufficient for 30 head stock; town of Masefield obtains water from this well; two 90-foot wells nearly dry.
11	SE.	23	"	"	"	Dug	11	2,725	− 9	2,716			Glacial sand and gravel	Hard		D, S	Only sufficient for 9 head stock; also a 17-foot well, waters 20 head stock.
12	NW.	26	"	"	"	Dug	10	2,710	− 7	2,703			Glacial sand	Hard, clear, lime, "alkaline"		D, S	Sufficient for 20 head stock.
13	NE.	26	"	"	"	Bored	75	2,714	− 35	2,679	65	2,649	Glacial sand	Hard, iron, cloudy, "alkaline"		S	Sufficient for 20 head stock; second seepage well for house use.
14	SE.	28	"	"	"	Bored	62	2,745					Glacial drift	Hard, iron, "alkaline"		N	Insufficient; not used at all.
15	NW.	31	"	"	"	Dug	18	2,950	− 8	2,942	8	2,942	Glacial sand	Hard, clear		D	
16	SE.	33	"	"	"	Dug	25	2,700	− 23	2,677	23	2,677	Glacial sand	Hard, clear, "alkaline"		D, S	Only sufficient for house use.
17	SE.	33	"	"	"	Bored	70	2,700					Base in Glacial clay				Two dry holes.
18	SE.	34	"	"	"	Dug	15	2,760	0	2,760			Glacial clay	Hard		D	Only sufficient for house use; several dry holes.
19	NW.	34	"	"	"	Dug	16	2,700	− 13	2,687	11	2,689	Glacial sand	Hard, clear		D, S	Oversufficient for 20 head stock.
20	SE.	35	"	"	"	Dug	16	2,750					Glacial drift	Hard, clear, "alkaline"		D, S	Sufficient for 15 head stock.
21	NE.	36	"	"	"	Dug	5	2,680					Glacial drift	Hard, clear, "alkaline"		D, S	Insufficient supply.
22	NW.	36	"	"	"	Dug	16	2,690					Glacial drift	Hard, clear, "alkaline"		D, S	Insufficient supply.
1	SW.	1	2	15	3	Dug	25	2,830	− 15	2,815	20	2,810	Glacial sand	Hard, clear, "alkaline"		S	Only sufficient for 14 head stock.

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WELL RECORDS—Rural Municipality of NO. 17, 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
2	NE.	1	2	15	2	Dug	18	2,850	- 10	2,840	18	2,832	Glacial sand	Hard, clear, slightly "alkaline"		D	Sufficient for house use; second well waters only 9 head stock.
3	SE.	2	"	"	"	Dug	12	2,820	- 8	2,812			Glacial drift	Hard, clear		D	Only sufficient for house use.
4	SE.	3	"	"	"	Dug	10	2,860					Glacial drift	Hard		D, S	Insufficient supply.
5	NE.	3	"	"	"	Bored	115	2,898	- 75	2,823			Glacial drift	Hard, clear, "alkaline"		S	Insufficient supply; unfit for human use.
6	NW.	6	"	"	"	Bored	168	2,830	-111	2,719			Glacial drift	Hard		D, S	Insufficient supply; three seepage wells.
7	SW.	7	"	"	"	Dug	18	2,800	- 14	2,786			Glacial drift	Hard, clear		D, S	Sufficient for 10 head stock.
8	NW.	8	"	"	"	Dug	16	2,850					Glacial drift	Hard, "alkaline"		D, S	Insufficient supply.
9	NW.	10	"	"	"	Bored	30	2,900	- 28	2,872	28	2,872	Glacial gravel	Hard, clear		D	Insufficient for stock.
10	SW.	15	"	"	"	Bored	196	2,900					Base in Bearpaw				Dry hole; also a shallow well.
11	NW.	15	"	"	"	Dug	12	2,925					Glacial drift	Hard, "alkaline"		D, S	Sufficient for local needs.
12	NE.	15	"	"	"	Dug	21	2,930					Glacial drift	Hard		D, S	Sufficient for local needs.
13	NW.	16	"	"	"	Dug	12	2,875					Glacial drift	Hard		D, S	Sufficient for local needs.
14	SW.	17	"	"	"	Dug	16	2,870					Glacial drift	Hard, clear, "alkaline"		D, S	Insufficient for local needs.
15	NW.	17	"	"	"	Dug	16	2,880					Glacial drift	Hard, clear		D, S	Insufficient for local needs.
16	NE.	19	"	"	"	Dug	12	2,870					Glacial drift	Hard, clear		D, S	Sufficient for local needs.
17	NW.	20	"	"	"	Dug	16	2,895					Glacial drift	Hard, "alkaline"		D, S	Sufficient for local needs.
18	SE.	20	"	"	"	Drilled	230	2,880					Base in Bearpaw				Dry hole.
19	NE.	22	"	"	"	Bored	32	2,860	- 26	2,834	26	2,834	Glacial gravel and sand	Soft, clear	45	D, S	Sufficient for 25 head stock; second well for house use.
20	NE.	23	"	"	"	Bored	132	2,868					Base in Bearpaw				Dry hole.
21	NE.	23	"	"	"	Bored	50	2,868	- 43	2,825			Glacial drift	Hard, "alkaline" iron, yellow		N	Second shallow well supplies abundant water with salt content too high for human use.
22	SE.	26	"	"	"	Drilled	190	2,910					Glacial (?)	Hard, "alkaline"		N	Too "alkaline" for use; sufficient supply.
23	SW.	28	"	"	"	Dug	20	2,860	- 7	2,853			Glacial drift	Hard, clear		D, S	Only enough for house use; second similar well.
24	NE.	28	"	"	"	Dug	20	2,850					Glacial drift	Hard, "alkaline"		D, S	Insufficient supply.
25	SE.	29	"	"	"	Dug	20	2,835					Glacial drift	Hard, clear		D, S	Insufficient supply.
26	SE.	30	"	"	"	Bored	32	2,830					Glacial drift	Hard, "alkaline"		D, S	Oversufficient supply.
27	NE.	30	"	"	"	Dug	14	2,850					Glacial drift	Hard		D, S	Insufficient supply.

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(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of NO. 17, 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
28	NW.	32	2	15	3	Dug	16	2,800					Glacial drift	Hard		D, S	Insufficient supply.
29	NW.	33	"	"	"	Dug	14	2,795					Glacial drift	Hard, clear "alkaline"		D, S	Insufficient supply.
30	NE.	34	"	"	"	Bored	150	2,790	- 29	2,761	138	2,652	Glacial(?) sand	Soft, clear		D, S	Sufficient for 30 head stock.
1	SW.	3		13	3	Dug	20	2,600	- 17	2,583			Glacial drift	Soft, clear		D, S	Sufficient for 50 head stock.
2	NW.	4	"	"	"	Dug	40	2,767					Glacial drift			N	Very little water.
3	NW.	8	"	"	"	Dug	90	2,700					Base in Glacial clay				Dry hole.
4	NW.	17	"	"	"	Dug	22	2,572	- 19	2,553	5	2,567	Recent sand	Hard, clear, "alkaline"		S	Sufficient for 15 head stock.
5	NW.	17	"	"	"	Bored?	150	2,572					Base in Bearpaw?				Dry hole.
6	NE.	19	"	"	"	Dug	16	2,600	- 13	2,587	0	2,600	Recent sand and gravel	Soft, clear		D, S	Sufficient for 2 head stock; second well 20 foot deep.
7	NE.	23	"	"	"	Bored	32	2,793	- 29	2,764			Glacial gravel	Soft, clear	45	D, S	Only sufficient for 13 head stock.
8	SE.	24	"	"	"	Dug	20	2,823	- 16	2,807			Glacial gravel	Hard, clear		D, S	Only sufficient for 15 head stock.
9	NE.	27	"	"	"	Dug	9	2,750	- 7	2,743	7	2,743	Glacial gravel	Soft, clear		D, S	Sufficient for 10 head stock.
10	NW.	28	"	"	"	Dug	14	2,602	- 12	2,590			Recent alluvium	Hard, slightly "alkaline"		D	Oversufficient supply; several other wells.
11	NE.	34	"	"	"	Dug	40	2,662	- 38	2,624			Glacial sand	Hard, "alkaline"		D, S	Only sufficient for 6 head stock; also a seepage well.
12	NW.	36	"	"	"	Bored	42	2,737	- 22	2,715	20	2,717	Glacial drift	Hard, clear, "alkaline"	45	D, S	Only sufficient for 1 head stock; second well for house and stock.
1	SW.	2	3	14	3	Dug	75	2,760					Base in Glacial clay				Dry hole.
2	NW.	2	"	"	"	Dug	13	2,775	- 8	2,767			Glacial sand	Hard, iron, "alkaline"		S	Only sufficient for 10 head stock at period of best supply.
3	NE.	9	"	"	"	Dug	10	2,830					Glacial drift	Hard		D, S	Sufficient for local needs.
4	SW.	10	"	"	"	Dug	20	2,825	- 16	2,809			Glacial sand and gravel	Hard, clear		D, S	Only sufficient for 7 head stock.
5	SE.	17	"	"	"	Dug	9	2,950					Glacial drift	Hard, "alkaline"		D, S	Insufficient supply.
6	NE.	25	"	"	"	Dug	10	2,614	- 8	2,606			Glacial sand	Hard, clear		D, S	Sufficient for 30 head stock; second well for house. #.
7	SE.	36	"	"	"	Dug	30	2,654	- 26	2,628			Glacial sand and gravel	Hard, "alkaline"		D	Insufficient; second well for stock on NW.¼, section 36.
1	SE.	2	3	15	3	Dug	17	2,900			17	2,883	Glacial drift	Hard, "alkaline"		D, S	Insufficient supply.
2	SE.	2	"	"	"	Dug	30	2,900					Base in Glacial clay				Dry hole.
3	NW.	2	"	"	"	Bored	120	2,885					Base in Glacial clay				Dry hole; seepage well in slough.
4	NE.	3	"	"	"	Dug	20	2,890					Glacial clay	Hard, "alkaline"		S	Sufficient supply; unfit for man.
5	SE.	8	"	"	"	Dug	8	2,910					Glacial sand	Hard		D	Insuffient for stock.

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(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of NO. 17, 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
6	SW.	9	3	15	3	Dug	20	2,900					Glacial drift	Hard		D, S	Insufficient supply.
7	NW.	9	"	"	"	Drilled	300	2,875					Base in Bearpaw				Dry hole; several shallow dry holes.
8	NW.	10	"	"	"	Dug	15	2,880					Glacial drift	Hard		D	Insufficient supply.
9	NW.	10	"	"	"	Bored	150	2,880					Base in Glacial?				Dry hole; several shallow dry holes.
10	NE.	10	"	"	"	Dug	16	2,880			16	2,864	Glacial drift	Hard		D	Insufficient for stock.
11	NE.	11	"	"	"	Dug		2,900					Base in Glacial clay				Dry hole.
12	NW.	12	"	"	"	Dug	16	2,989	− 13	2,976			Glacial gravel	Hard, clear		D, S	Sufficient for 24 head stock; several dry holes.
13	SW.	13	"	"	"	Dug	17	2,990					Glacial drift	Hard			Insufficient supply.
14	SE.	14	"	"	"	Dug		2,950					Glacial drift	Hard			Insufficient supply.
15	SE.	14	"	"	"	Dug		2,950					Base in Glacial clay				Five dry holes.
16	SE.	15	"	"	"	Dug	12	2,880	− 8	2,872			Glacial sand	Hard, clear		D, S	Only sufficient for 14 head stock; also a 9-foot seepage well.
17	SE.	16	"	"	"	Dug	20	2,890					Glacial drift	Hard		D, S	Sufficient supply.
18	NW.	16	"	"	"	Dug	16	2,910			16	2,894	Glacial drift	Hard		D, S	Sufficient supply.
19	NW.	17	"	"	"	Dug	20	3,000			20	2,980	Glacial drift	Hard		D, S	Sufficient supply.
20	SW.	18	"	"	"	Dug	20	2,980			20	2,960	Glacial drift	Hard		D, S	Oversufficient supply.
21	SW.	19	"	"	"	Dug	16	2,990			16	2,974	Glacial drift	Hard			Insufficient supply.
22	NW.	21	"	"	"	Dug	20	2,950			20	2,930	Glacial drift	Hard		D, S	Oversufficient supply.
23	NE.	21	"	"	"	Dug	21	2,960					Glacial drift	Hard		D, S	Insufficient; several wells.
24	SE.	22	"	"	"	Dug	25	2,899	− 24	2,875	24	2,875	Glacial drift	Hard, clear	45	N	Very little water; seepage well for house and dugout for stock.
25	SW.	23	"	"	"	Dug	18	2,890					Glacial drift	Hard		D, S	Sufficient supply; second well.
26	SW.	24	"	"	"	Dug	18	2,975					Glacial drift	Hard		D, S	Very poor supply.
27	SW.	24	"	"	"	Dug	30	2,975					Base in glacial clay				Dry holes.
28	SW.	25	"	"	"	Dug		2,965					Glacial drift	Hard		D	Only sufficient for house use.
29	NW.	26	"	"	"	Dug	22	2,910					Glacial drift	Hard, "alkaline"		D, S	Insufficient supply.
30	NE.	27	"	"	"	Dug	15	2,900					Glacial drift	Hard, "alkaline"		D, S	Sufficient supply.
31	NE.	28	"	"	"	Dug	20	2,925					Glacial drift	Hard		D, S	Sufficient; several wells.
32	NW.	30	"	"	"	Dug	18	2,959	− 8	2,951	8	2,951	Glacial sand	Hard, clear		D	Insufficient supply.
33	NE.	34	"	"	"	Dug	15	2,940			15	2,925	Glacial drift	Hard		D, S	Sufficient supply.
34		35	"	"	"	Dug	15	2,960			15	2,945	Glacial drift	Hard		D, S	Oversufficient supply.

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.