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. 22 SASKATCHEWAN

BY

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

Water Supply Paper No. 110

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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 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 fine the approximate depth to a water-bearing horizon, be 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 given 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.

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

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

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

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

<u>Water Table</u>. 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.

<u>Wells</u>. 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 <u>Flowing Artesian Wells</u>.

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

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

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 rests 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. 22 occupies an area of approximately 309 square miles in the extreme southwestern corner of Saskatchewan. The International Boundary forms the southern border, and the Saskatchewan-Alberta interprovincial boundary (the Fourth meridian) forms the western border, of the area. The municipality consists of six full townships and three fractional townships, described as tps. 1, 2, and 3, ranges 28, 29, and 30, W. 3rd mer. The fractional townships occur in range 30, adjacent to the Fourth meridian.

The greater part of the area consists of range land, the farming community being confined almost entirely to township 3, range 28, and townships 2 and 3, range 29. The small village of Govenlock, situated in sec. 23, tp. 3, range 29, on the Lethbridge-Weyburn line of the Canadian Pacific railway, is the sole trading centre in the area. There is a railway siding at Altawan near the interprovincial boundary, west of Govenlock.

As the area has not been topographically mapped, it has not been possible to indicate the relief by contour line on Figure 2 of the accompanying map. The elevations quoted in the report were determined by aneroid barometer readings, and during the course of this investigation were checked where possible by reference to railway and boundary survey benchmarks. As fairly large discrepancies in the barometric readings are bound to occur, the elevations must be regarded as only approximate.

The municipality consists for the most part of undulating to gently rolling prairie land, the surface of which rises in a northerly direction from an average elevation of about 2,800 feet above sea-level at the International Boundary, to elevations of between 3,050 feet and 3,150 feet in the northern parts. Drainage of the area is to the southeast through Lodge creek. This stream enters the municipality near the northwestern corner and flows diagonally through the central part of the area, to cross the International Boundary in sec. 5, tp. 1, range 28. Middle creek enters the municipality from the north, and flows southward to join Lodge creek in the central part of the area. Other small tributaries serve as feeders to the main stream in the southwestern part. On the eastern side of the area drainage is to the east, and southeast, through Woodpile creek and other small tributaries of Battle creek.

Although all streams within the municipality are intermittent, Lodge creek and Middle creek usually flow until midsummer. Dams constructed in these channels and in the small tributaries contribute most of the water for stock use, and at several points for moderate irrigation. The cost of these dams is relatively small as most of the streams have a low gradient and flow through coulées that form natural sites for the construction of reservoirs. The subsoil in most places is nearly impervious, so the greatest loss from these surface water supplies is through surface evaporation.

Water-bearing Horizons in the Unconsolidated Deposits

The unconsolidated deposits consist of Recent sands and silts in the stream channels and the coulée bottoms, and of a thick mantle of glacial drift overlying the bedrock throughout the remainder of the area. The glacial drift was deposited by a great continental ice-sheet that moved in a generally southwesterly direction, over the province of Saskatchewan, many thousands of years ago. As the ice-sheet retreated to the north, due to the melting of its southern margin, it left an accumulation of boulder clays known as glacial till distributed unevenly over the old bedrock land surface. Two small areas of glacial moraine, characterized by small irregular hills and undrained depressions, occur in the mid-western part of the area in secs. 19, 20, and 21, tp. 2, range 30, and in the northwestern corner in secs. 32, 33, and 34, tp. 3, range 30. These moraines are thought to have been formed at the places where the ice front remained stationary for a considerable period of time during its retreat. Waters issuing from the melting ice gathered in depressions to form lakes, into which were washed fine sediments from the adjoining uplands. The presence of one of these now extinct lakes is indicated by a layer of compact, light bluish grey lake clays, covering an area of about 3,850 acres at the junction of Lodge and Middle creeks in the central part of the area.

The stream channels have been developed since the removal of the ice-sheet from the area. Flood waters of Lodge creek and Middle creek deposited extensive flats of alluvium in the bottoms of the valleys. The materials forming these flats consist essentially of clays, silts, and fine sands interbedded in places with irregular pockets of coarser sands and gravels.

Although surface waters contribute most of the stock water supplies throughout the range land, and at many points in the farming community, ground waters in the unconsolidated Recent and glacial drift deposits are also being used, or remain as a potential source of water supply.

Wells sunk in the Recent stream deposits in the bottoms of the small coulées are seldom over 20 feet deep. The water-bearing beds usually consist of sand or gravel overlain by 5 to 10 feet of clay. These water supplies are not everywhere present and it is advisable to sink test holes to locate water-bearing sand or gravel beds. Where encountered, the water is usually of good quality and is quite suitable for domestic use. The yield from these aquifers is variable. Those buried under several feet of impervious clays lose very little water by surface evaporation, and if the aquifer is sealed at its lower end by clays the water cannot escape by underground flow. The volume of water contained in the aquifer depends chiefly upon the porosity and extent of the porous beds.

The yield and quality of the waters obtained from the flood-plain deposits in Lodge Creek and Middle Creek valleys are also variable. Wells sunk in these deposits and encountering only clays and silts seldom yield more than sufficient water for domestic use. The water is hard and usually contains appreciable amounts of the mineral salts in solution. Sand and gravel beds, encountered at some places below the finer sediments, generally yield small to moderate supplies of drinkable water. These supplies occur at depths not exceeding 30 feet from the surface.

The lake clays that occur in the vicinity of the forks of Lodge creek and Middle creek are probably too impervious to form reservoirs for ground water accumulation. The clays are, however, in some places underlain by, or interbedded with, water-bearing sands. These aquifers are tapped by shallow wells in secs. 3 and 4, tp. 2, range 29. The sand beds are not everywhere present, however, as several dry holes have also been sunk in this locality.

Wells sunk in the till-covered areas obtain water from isolated sand and gravel pockets that occur interspersed at irregular intervals through the upper 20 feet of the till. Such wells are confined to the farming community in township 3, range 28, and townships 2 and 3, range 29. The supplies obtained vary as to quality and quantity. Very few large yields are reported from this type of deposit, although individual wells usually supply sufficient water for household use and for a few head of stock. Where encountered, the drift waters are invariably hard and at many places they contain noticeable amounts of the mineral salts in solution. The stock water supplies are in most places supplemented by surface waters collected in reservoirs or behind dams.

Owing to the erratic distribution of the porous sand and gravel pockets their location can be found only by sinking test holes to a suitable depth. Wells sunk in the surface depressions between hills or at the bases of steep slopes are usually in a more favourable location than those sunk on the ridges or level plains.

Little more than mere seepages of highly mineralized water can be expected from wells encountering only clay, unless the well is situated beside a reservoir from which water may be derived.

As few deep wells have as yet been sunk in the municipality, the ground water conditions existing in the lower part of the glacial drift remain unknown. Sand and gravel beds that occur at the base of the drift form an extensive water-bearing horizon in the municipality to the north and northwest. Similar beds may continue southward into this municipality. They cannot be expected to form a continuous horizon, however, although they may occur in isolated localities, particularly in the northern townships. The depth of this potential water-bearing horizon is not known, but it is probably less than 100 feet throughout most of the area.

Water-bearing Horizons in the Bedrock

Two bedrock formations, known as the Bearpaw and Belly River formations, are thought to immediately underlie the glacial drift in the municipality. The upper or Bearpaw formation occurs throughout most of the area with the possible exception of the southwestern part where it is thought to have been removed by erosion prior to the deposition of the glacial drift. In this part of the area, including several sections in the southwestern corner of township 1, range 29, and slightly more than the southwestern half of township 1, range 30, the Belly River formation forms the bedrock below the glacial drift. This formation underlies the Bearpaw throughout the rest of the municipality.

The Bearpaw formation consists of dark grey clay shales, interbedded at irregular intervals by bands of hard ironstone, and occasionally fine sandstone. Where encountered in wells it is known locally as "soapstone". This formation is readily distinguished in drilling from the overlying drift deposits by the absence of pebbles, by the more soapy feel to the touch when wet, and by the small, roughly cubical fragments into which it breaks upon drying.

The bedrock formations are believed to dip gradually and uniformly toward the northeast at the rate of about 18 feet to the mile. As the land surface also rises toward the northeast, there is a corresponding thickening of the Bearpaw formation in this direction to a maximum thickness of about 500 feet in the northwestern corner of the area. This estimation is based upon the log of a deep well drilled at the village of Senate, in sec. 3, tp. 4, range 28, less than a mile north of this municipality. The lower 500 feet of the Bearpaw formation is not known to be water-bearing in this part of the province, as it contains very few beds sufficiently porous to allow for ground water accumulation.

The Belly River formation underlying the Bearpaw is more likely to contain ground water supplies. This formation is composed essentially of alternating beds of light to dark grey shales, medium- to fine-grained grey sandstones, and several seams of lignite coal. In the Senate well a seam of coal, in what is thought to be the top of this formation, was encountered at a depth of 590 feet. Drilling was continued to a depth of 635 feet, but no water was obtained.

Another well was drilled in this formation near the International Boundary, about 3 miles east of this municipality. Two water-bearing horizons were encountered at this location at depths of 240 and 535 feet. As this well was drilled for oil, the yield and quality of the water obtained was not determined. No other wells are known to have been sunk to this formation in the municipality or in the vicinity, so that no prediction can be made as to depths at which water may occur.

Residents in the northern part of the area are advised to confine their search for ground water supplies to the shallow unconsolidated deposits, rather than undergo the expense of drilling deep wells for the uncertain production in the Belly River formation. In the central part of the municipality it is possible that water will be found at depths of less than 300 feet, and at correspondingly lesser depths towards the southwest corner. Sinking wells into the bedrock is an expensive procedure at best, but the drilling or boring of a community test well in the central or southern parts seems a worth-while undertaking, to prove or disprove the Belly River formation in this area as a source of water for stock.

GROUND WATER CONDITIONS BY TOWNSHIP

Township 1, Range 28

This township is an undulating to gently rolling prairie land. The western part of the area drains southward through Lodge creek and its tributaries, and the eastern half is drained to the southeast through tributaries of Woodpile creek.

No wells have been sunk in the township, as it is devoted entirely to grazing. Water for range stock is obtained from the creeks and by constructing dams in the coulées. Although only the surface waters are being used, the unconsolidated stream and glacial drift deposits are also expected to contain small to moderate supplies of ground water at isolated points. The Recent stream deposits that occur in the valley bottoms are probably the best potential source of these ground water supplies.

Lodge creek and its north branch occupy wide valleys with gently sloping sides, the bottoms of which are floored with flood-plain deposits consisting mostly of clays, silts, and fine sands. The fine sands and silts may be water bearing in some places. The stream deposits are not expected to exceed 25 feet in thickness, and are, no doubt, much thinner in some of the smaller stream channels. Waters from this source are usually charged with a relatively high concentration of mineral salts.

Surface deposits throughout the rest of the township consist of boulder clay through which are interspersed a few isolated pockets of more porous sand and gravels. Little if any water can be expected from the boulder clay. Wells sunk to sand and gravel beds may strike water in some parts of the township. These water supplies usually occur at shallow depths of 25 feet or less, particularly along the bases of slopes and in depressions. They may, however, be relatively scarce or absent in many sections of this township.

The glacial drift is thought to be immediately underlain by the impervious marine shales of the Bearpaw formation. The thickness of the overlying drift deposits no doubt vary, but depths to the shales are not expected to exceed 60 feet at any point, as indicated by the numerous exposures of the shale at the surface in Woodpile coulée, about a mile east of this township. Although it is improbable that suitable water supplies occur in the Bearpaw formation, porous sands and sandy shales of the underlying Belly River beds may be water bearing. Depths to this formation are not known, but are probably not greater than 100 feet in the valley of Lodge creek, in the southwestern corner of the area. In the northeastern corner, however, the Belly River-Bearpaw contact may occur at depths of 200 feet or more, owing to a probable northeasterly dip of the bedrock formation and to the rise in surface elevations of 100 to 150 feet toward that part of the area. No predictions can be made, however, as to the quality of the water to be expected, or as to the depth at which the water-bearing beds may occur within the formation.

Township 1, Range 29

The land surface of this township is gently rolling to undulating, with an average surface elevation of about 2,825 feet above sea-level. The area is drained to the southeast by Lodge creek and several small tributaries.

Stream deposits are possibly the best potential source of ground water supply. As most of the streams flow through fairly wide valleys with a low gradient, their deposits consist largely of silts and fine sands. These sediments may be underlain in some places by more porous sand and gravels washed down from the valley sides or carried in by flood waters of the smaller streams. A 12-foot well, located at the customs house, in section 12 yields a small supply.

As no records of any other wells having been sunk in this township were obtained, little is known as to the ground water conditions existing in other parts of the area.

Away from the valley bottoms the surface deposits throughout the township consist of the blue-grey boulder clay, in which may be interspersed a few irregular pockets of well-sorted sands and gravels. Suitable water supplies are not expected to occur in the boulder clay, but the sand and gravel pockets may in some places be water bearing. Where encountered in the northern part of the municipality, these water supplies are confined mostly to the upper 20 feet of the glacial drift. They are not expected to occur at greater depths in this township, and may be non-water bearing or even absent in many sections. The thickness of the glacial drift is not known, but it probably does not exceed 60 feet throughout most of the area, and may be much thinner in the valleys.

The impervious shales of the Bearpaw formation underlie the glacial drift throughout the township, with the possible exception of the southwestern corner of the area where the drift may be underlain by the Belly River formation. No water can be expected from wells sunk in the Bearpaw shales. The Belly River formation probably occurs at a depth of about 200 feet in the northern part of the area, and at shallower depths toward the south. The beds comprising this formation are considered to be sufficiently porous to be water bearing. It may be necessary to put wells down several hundred feet in the formation, however, before a water-bearing horizon is encountered. The quality of water to be expected has not been determined.

Township 1, Range 30

This fractional township lies adjacent on the east to the Fourth meridian and consists of approximately 33 square miles of range land. The ground surface is nearly level to undulating, and slopes south and southeastward from an elevation of about 2,930 feet above sea-level in the northwestern part, to an average elevation of about 2,815 feet along the southern and eastern borders. The area is drained by several small tributaries of Lodge creek. Dams constructed across these creeks, and in coulées, could be used to conserve surface run-off for watering range stock.

The ground water resources of the township are unknown, as no information was available of any wells having been sunk within the area, or in the immediate vicinity.

Recent sand and gravel beds that occur in the bottoms of the stream channels are considered to be the best potential source of water supply in the unconsolidated deposits. Where these porous sediments occur they are thought to be comparatively thin, and overlie the glacial till that forms the surface deposits throughout the remainder of the area. They may have a sufficient thickness at many points, however, to ensure that wells dug into them will yield an adequate supply of drinking water, but large yields from them cannot be expected.

The glacial drift consists mostly of blue-grey boulder clay and silts. Wells sunk to tap sand and gravel pockets, which occur in the upper 20 feet of the drift in the central and northern parts of the municipality, produce variable yields of water, most yields being inadequate for farm requirements. These waters contain mineral salts in solution, but are being used for drinking. Similar water supplies may occur at shallow depths in the glacial drift in some parts of this township, particularly in depressions where greater accumulations of porous sediments are generally found. Wells encountering only boulder clay cannot be expected to yield water, unless they are located beside dams or similar surface water supplies and derive their supply by seepage.

The non-water bearing Bearpaw formation is thought to immediately underlie the glacial drift in slightly less than the northeastern half of the area. The Belly River formation occurs below the Bearpaw and underlies the drift deposits in the southwestern half of the township.

The latter formation is probably water bearing, although no prediction can be made as to depths of wells necessary to reach productive horizons. Persons contemplating drilling wells in this formation are advised to read the earlier section of this report, dealing with the bedrock of the municipality as a whole.

Township 2, Range 28

This township consists of nearly level to undulating prairie land, the surface of which lies at an average elevation of about 3,000 feet above sea-level. A few, small intermittent streams occur along the eastern and southern borders and join Woodpile creek. A small tributary of Lodge creek drains the southwest . corner. These stream channels carry water only during flood periods.

As the greater part of the township forms a community grazing lease, such ground water resources as exist are almost entirely undeveloped. Two shallow wells are reported to have been put down on the eastern side of the area. At several points in the area dams constructed in the coulées would undoubtedly conserve sufficient water for range stock for considerable periods of time.

Stream deposits consisting largely of silts, interbedded with discontinuous layers of sands and gravels of variable thickness, occur in the bottoms of the stream channels. These deposits may be relatively thin in most of the small coulées and draws, but are known to be fairly well developed in Woodpile coulée on the eastern side of the township. A well, situated in this coulée, in section 13, encountered water in a 7-foot bed of gravel, overlain by 3 feet of clay. This water is reported to be hard, suitable for drinking, and to occur in sufficient quantities to adequately supply the stock in the vicinity. Similar water supplies are expected to occur in this type of deposit elsewhere in the township, although at some places the water may be more highly mineralized.

The other well, situated in section 36, yields a moderate supply of slightly "alkaline" water from a sand pocket in the glacial drift, at a depth of 12 feet. As wells sunk in the drift deposits in the townships bordering on the north and west are seldom over 20 feet in depth, it seems probable that these water supplies may also be confined to shallow depths in this township.

The Bearpaw formation immediately underlies the glacial drift throughout the township, at depths probably not exceeding 80 feet from the surface. Suitable water supplies are not expected to occur in this formation. Water may occur in porous sands of the Belly River formation below the Bearpaw, however, although in the absence to date of any deep drilling, no prediction can be made as to the depth of well required to reach the productive horizons, or the quality of water obtainable from this source.

Township 2, Range 29

The land surface of this township rises gradually in a northerly direction, from an average elevation of about 2,840 feet above sea-level in the southern part to elevations ranging from 2,960 to 3,000 feet along the northern boundary. The surface of the eastern part of the area is gently rolling prairie land. The western part has lower relief, and is dissected by the valleys of Lodge creek and its tributary Middle creek.

Lodge creek enters the township in section 19, and flows in a southeasterly direction through an old glacial lake basin, to cross the southern boundary in section 4. Middle creek enters the area in section 32, and flows southward to join Lodge creek in section 4. The lake basin, formed by a widening of these stream channels in the southern half of the area, is overlain by a thin layer of glacial lake clays. In the northern part of the township the valleys are comparatively narrow, and contain porous flood deposits consisting of clays, silts, fine sands, and, more rarely, gravels. Throughout the remainder of the township the surface deposits consist of glacial till in which are sparingly interspersed irregular pockets of sands and gravels.

The water supplies being used in this township are obtained by constructing dams in the creeks and from shallow wells sunk in the unconsolidated stream and glacial drift deposits.

Three wells sunk to depths of 10 to 17 feet, in sections 18, 20, and 32, encountered water in gravel pockets in the stream channels of Lodge and Middle creeks. The well in section 32 is now abandoned, but is reported to have yielded a large supply of soft water several years ago. The other two wells, in sections 18 and 20, produce small supplies sufficient for household use only. Larger yields could probably be located at other places in these stream channels by careful testing at shallow depths. No other attempts to find water in these deposits have been reported to date. The glacial lake clay is very compact and does not yield more than small seepages of ground water. Small seepages are reported to have been obtained from this clay in the SW.$\frac{1}{4}$, section 3, and in the NE.$\frac{1}{4}$, section 4, at depths of 12 and 16 feet, respectively. A small spring also flows from the creek bank, near the last-named location. This water-bearing horizon probably occurs as a more sandy phase at the base of the lake deposits, and may be considered to be of only local occurrence, as several dry holes have been sunk to depths of about 20 feet in this vicinity.

On the uplands, east of Middle creek, water is obtained from shallow wells sunk to pockets of sand or gravel in the upper 30 feet of the glacial drift. The yield from individual wells varies, but most of them supply sufficient water for household use, and several large yields are reported. These waters are not highly mineralized. Residents who contemplate digging wells to these water-bearing beds are advised to first carefully prospect their location with a test auger, as water-bearing sand and gravel pockets are discontinuous, and may be absent in many parts of the area.

No wells in the township are known to have been put down to bedrock. The Bearpaw formation is considered to immediately underlie the glacial drift throughout the area at variable depths, probably not exceeding 80 feet. Little if any water can be expected from wells sunk in this formation, although it is possible that water-bearing sand beds may occur over limited areas at the contact of the drift and the underlying shales. The Belly River formation underlying the shales of the Bearpaw is more porous, and hence better suited to ground water accumulation. It is probable, however, that at most points the productive beds may be buried under 200 to 300 feet of glacial drift and Bearpaw shales. In the absence of any wells reaching the bedrock in the district, no prediction can be made as to the depth to the productive beds or quality of water to be expected from them.

Township 2, Range 30

This fractional township, comprising about 33 square miles, lies adjacent to the Fourth meridian. From an elevation of about 2,850 feet above sea-level in the southeastern corner of the area, the land surface rises in a northwesterly direction to an elevation of about 3,025 feet in sections 31 and 32. The land surface in the eastern and southern sections is lower and dissected by several small stream valleys, but is nearly level in some places. In the northwestern part the surface is more irregular, and in sections 19, 20, and 21 a narrow belt of moraine occurs. North and south of the moraine the gently rolling plains are dissected by several eastward flowing coulées that are occupied by intermittent tributaries of Lodge creek. Lodge creek flows in a southeasterly direction across the northeastern corner of the area. It occupies a flat-bottomed coulée, which in some places is nearly a quarter of a mile wide. Stream flood-plain deposits consisting mostly of silts and fine sands form extensive flats along the bottom of this valley. Stream deposits also occur in the tributary coulées, and may include, in addition to the fine sediments, a few pockets of coarse sands and gravels. With the exception of the stream deposits and the above-mentioned moraine-covered area, the township is overlain by glacial till of undetermined thickness.

As almost the entire township is range land, the ground water resources have not been developed. Water for range stock is obtained from Lodge creek, and from sands formed by several dams that have been constructed in the coulée bottoms. Water from Lodge creek is also used to irrigate about 300 acres of land in section 13 and vicinity.

Only two wells are reported to have been sunk in this township. Both these wells are situated in section 13, and are sunk to beds of sand and gravel in a coulée bottom at depths of 10 and 18 feet. The owner of the shallower well has increased its intake area by laying 24 feet of loosely connected tile horizontally in a trench dug from the bottom of the well. As these wells are situated near reservoirs, they may derive part of their supply by seepage from this source. The water is hard and contains noticeable amounts of mineral salts in solution, but is being used for the household drinking supply. Shallow wells sunk in the stream deposits elsewhere in the township should yield small to moderate supplies of drinkable water, particularly if sand or gravel beds are encountered.

Irregular pockets of sand and gravel interspersed through the upper 30 feet of the glacial drift are also a potential source of water supply, although these pockets may be sparsely distributed throughout some parts of the area. They may be fairly numerous, however, in and along the edges of the moraine, as these deposits are usually more porous than those of the till plains. Small, discontinuous beds of water-bearing sands and gravels may also occur at the contact of the glacial drift and the underlying bedrock. The location of these beds can be ascertained only by sinking wells to the top of the bedrock, as their presence is not indicated by the character of the surface deposits. A 76-foot dry hole bored in section 13 failed to locate such beds. As a complete log of this test hole is not available, the geological position of its base is unknown. Even though it may have penetrated the glacial drift-bedrock contact, it is not to be considered as indicative of the ground water conditions existing at this horizon in all parts of the township.

The Bearpaw formation is believed to underlie the drift deposits throughout this entire township. Although these shales may be comparatively thin in the southwestern corner of the area, they probably attain a thickness of 100 feet or more in the northeastern part. Residents who contemplate putting down deep wells in the bedrock should be prepared to drill through the Bearpaw to the more porous, underlying Belly River formation where conditions are more favourable for ground water accumulation. Owing to the uncertainty of obtaining water at great depths, this undertaking is recommended only in localities where surface or shallow ground water supplies are not available, or are inadequate for local requirements.

Township 3, Range 28

In general, the land surface of this township rises in a northerly direction, from an average elevation of about 3,025 feet above sea-level on the southern boundary to elevations ranging from 3,100 to 3,150 feet in the northern parts. In the central part of the area the surface rises to a slightly higher elevation, and forms a drainage divide between the eastern flowing tributaries of Battle creek and the smaller tributaries of Middle creek in the western part. The land surface throughout most of the area is gently undulating to moderately rolling, and is dissected by numerous small coulées.

Water supplies of the township are obtained by conserving part of the surface run-off by means of dams, and by digging shallow wells in the unconsolidated stream and glacial drift deposits.

Nearly one-half the wells listed are situated in the coulée bottoms. The water-bearing beds consist of sand or gravel, generally buried under 5 to 10 feet of clay. The yield from individual wells varies, but most of them are reported to supply sufficient water for domestic and stock requirements. These waters although generally hard do not contain excessive amounts of the laxative salts in solution, and are suitable for drinking.

The rest of the wells in the township obtain water from sand and gravel pockets that occur sparsely interspersed through the upper 20 feet of the glacial drift. Owing to the erratic distribution of these water-bearing sand pockets it is frequently found necessary to sink several test holes before locating a suitable water supply. They can be expected to occur more frequently, however, in the depressions, and at the bases of steep slopes where the adjacent sloping ground surface lends to the greater accumulation of percolating ground waters. The yield and the quality of the waters obtained from these deposits do not differ essentially from those of the stream deposits, as no water is reported to be too highly mineralized for domestic use.

Wells sunk in the boulder clay and encountering only clay aquifers seldom yield more than intermittent seepages of mineralized water.

Little is known regarding the ground water conditions existing in the drift at depths greater than 20 feet from the surface. Dry holes have been sunk to depths of 40 feet in section 33, and 50 feet in section 6. Although the thickness of the glacial drift is unknown, these test holes probably did not reach the base of the drift where water-bearing sand and gravel beds are most likely to occur. As described in an earlier section of this report, gravels lying at the base of the glacial drift form a water-bearing horizon over an extensive area about 2 miles north of this township. The southern limit of this horizon is not well defined. A dry hole sunk to bedrock in the village of Senate, in sec. 3, tp. 4, range 28, failed to locate these gravels. They may, however, extend southward into the northern part of this township, but are not expected to be continuous over large areas. This potential horizon is expected to be less than 100 feet below the surface in the township.

The Bearpaw formation underlying the glacial drift in this township is probably too compact to be water bearing. The porous beds of the Belly River formation probably lie from 500 to 550 feet below the surface. The uncertainty of obtaining water from this horizon makes it inadvisable for residents of limited means to consider drilling to such depths.

Township 3, Range 29

The land surface in the southern part of the township lies at an average elevation of about 2,975 feet above sea-level. The land is undulating to gently rolling, the surface rising gradually in a northerly direction to elevations of about 3,100 feet in the more hilly country north of the railway line. A wide, flat-bottomed valley occupied by Middle creek extends southward from section 34, through the central part of the township, to cross the southern border in section 4. Farms are confined mostly to the area south of the railway line, in the eastern half of the township. The rest of the area is devoted almost entirely to grazing.

The township is covered by a mantle of glacial drift extending to depths probably nowhere greatly exceeding 100 feet. With the exception of the flood deposits that occur in Middle Creek valley, the surface deposits consist of glacial till or boulder clay, through which are interspersed isolated pockets of sands and gravels. The flood-plain deposits in the valley are composed mainly of silts and fine sands. The thickness of these deposits is undetermined, and they may overlie the till or possibly the bedrock in this area.

Water supplies of the township are obtained chiefly from springs and from shallow wells sunk to sand and gravel beds in the stream deposits. Middle creek and a few small dams and dugouts provide part of the stock water supplies.

The greater part of the ground water supply of the township is obtained from springs that flow from sand and gravel deposits in the valley of Middle creek. The source beds are not definitely known, but are probably a part of the stream sediments deposited in old river terraces on the valley sides. One of these springs, situated in the SW.$\frac{1}{4}$, section 15, yields a steady flow estimated at about 48 barrels of water an hour. This water is used in the households and for watering stock by several residents in the surrounding district. It is reported to be soft and is quite suitable for domestic use. Water of a similar quality is also obtained from a 16-foot well in the NW.$\frac{1}{4}$ of this section, and from a 3-foot well in the SW.$\frac{1}{4}$, section 22. The water in the wells maintains a constant level at the surface, and no doubt has its origin in aquifers similar to those of the flowing springs. No wells are reported to have been dug in these stream deposits north of the railway line. It is quite probable that water-bearing beds of sand or gravel may also underlie the creek flats in this part of the area.

Water-bearing beds are apparently difficult to locate in the till-covered plains. In the SE.$\frac{1}{4}$, section 23, two wells dug in sand to depths of 16 and 38 feet obtained moderate yields of hard, slightly "alkaline" water. These wells are situated in a depression in the land surface, and the sands probably represent hill-wash material from the bordering uplands. Elsewhere in this locality the settlers have sunk dry holes in the boulder clays to depths as great as 100 feet. Little is known of the ground water conditions in the drift deposits in the north and western areas of range land. Residents in search of shallow ground water supplies in the drift are advised to prospect in the depressions and at the bases of steep slopes in preference to the points of higher elevation.

Water-bearing sands and gravels may occur overlying the bedrock at the base of the glacial drift. Should these beds occur in the township, they are not expected to form a continuous water-bearing horizon, but they may be present in a few isolated localities.

The Bearpaw formation immediately underlies the glacial drift throughout the area. The impervious shales that comprise this formation are not known to be water bearing in this vicinity. Sinking deep wells in these shales is not recommended. Still deeper drilling into the Belly River formation is not advisable, as it would be necessary to drill at least to depths of 500 feet in most localities, and no definite assurance can be given that even when porous beds are penetrated they will be water bearing.

Township 3, Range 30

This fractional township, situated adjacent to the Fourth meridian, consists of slightly less than 27 square miles of undulating to moderately rolling range land.

Lodge creek crosses the western boundary of the area in section 20, and flows in a southeasterly direction down a shallow, flat-bottomed valley to leave the township in section 1. This valley is about a mile in width in its upper reaches, but narrows to one-quarter mile or less near the southern boundary. The valley bottom is underlain by flood deposits consisting of clays, silts, and fine sands.

A small area, comprising most of sections 33 and 34, on the northern border of the township is overlain by moraine. Surface deposits throughout the remainder of the area consist of glacial till.

As this entire area is range land, the ground water resources are little developed. Stock obtain water from Lodge creek and from a few small dams constructed in the coulée bottoms.

Attempts have been made to locate a ground water supply in the valley of Lodge creek, in section 16. A number of dry holes have been sunk in the silts and sands comprising the flood deposits in this area. Several of these wells encountered the underlying bedrock, but at what depths was not reported. In one well, situated near the creek, 4 feet of gravel was reached after digging through 26 feet of clay. This well apparently derives its water supply from the creek, as it goes dry soon after the stream ceases to flow. Its water is hard and slightly "alkaline", but is being used for the domestic drinking supply.

Although digging wells in the flood-plain deposits of Lodge creek has met with little success, these sediments are probably the best potential source of ground waters in the township. Careful testing will be necessary in most places, however, to ensure finding beds sufficiently porous to yield a year round supply. The till-covered areas can be expected to contain water supplies in only a few isolated pockets of sand or gravel that may occur interspersed through the boulder clays. The moraines are frequently more porous and are considered to be favourable for ground water accumulation. As no wells are reported to have been sunk in glacial till, or in the moraine, in this township or in the immediate vicinity, no prediction can be made as to the quality of these waters or the depths at which they may occur.

The Bearpaw formation underlying the drift deposits is not likely to prove productive in any part of the area. Residents are advised to confine their search for ground water supplies to the unconsolidated deposits.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF No. 22, SASKATCHEWAN

West of 3rd mer. Township / Range	1 28	1 29	1 30	2 28	2 29	2 30	3 28	3 29	3 30	Total No. in municipality
Total No. of Wells in Township	0	1	0	2	24	3	24	15	5	74
No. of wells in bedrock	0	0	0	0	0	0	0	0	1	1
No. of wells in glacial drift	0	0	0	1	20	1	15	8	1	46
No. of wells in alluvium	0	1	0	1	4	2	9	7	3	27
Permanency of Water Supply										
No. with permanent supply	0	1	0	2	14	2	18	10	0	47
No. with intermittent supply	0	0	0	0	4	0	3	0	1	8
No. dry holes	0	0	0	0	6	1	3	5	4	19
Types of Wells										
No. of flowing artesian wells	0	0	0	0	0	0	0	0	0	0
No. of non-flowing artesian wells	0	0	0	0	2	0	2	1	0	5
No. of non-artesian wells	0	1	0	2	16	2	19	9	1	50
Quality of Water										
No. with hard water	0	1	0	2	14	2	15	6	1	41
No. with soft water	0	0	0	0	4	0	6	4	0	14
No. with salty water	0	0	0	0	0	0	0	0	0	0
No. with "alkaline" water	0	1	0	1	1	2	6	2	1	14
Depths of Wells										
No. from 0 to 50 feet deep	0	1	0	2	24	2	24	14	5	72
No. from 51 to 100 feet deep	0	0	0	0	0	1	0	1	0	2
No. from 101 to 150 feet deep	0	0	0	0	0	0	0	0	0	0
No. from 151 to 200 feet deep	0	0	0	0	0	0	0	0	0	0
No. from 201 to 500 feet deep	0	0	0	0	0	0	0	0	0	0
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	0	1	0	2	17	1	20	10	1	52
No. not usable for domestic purposes	0	0	0	0	1	1	1	0	0	3
No. usable for stock	0	1	0	2	17	1	20	10	1	52
No. not usable for stock	0	0	0	0	1	1	1	0	0	3
Sufficiency of Water Supply										
No. sufficient for domestic needs	0	1	0	2	12	2	15	10	0	42
No. insufficient for domestic needs	0	0	0	0	6	0	6	0	1	13
No. sufficient for stock needs	0	0	0	2	10	2	14	9	0	37
No. insufficient for stock needs	0	1	0	0	8	0	7	1	1	18

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.

Water from the Unconsolidated Deposits

No samples of ground water were taken from this municipality for analysis by the Geological Survey. The following discussion on the general characteristics of these waters is based upon information given by the residents, and upon analysis of water from other municipalities where the source beds are similar.

Water from shallow wells sunk in the pockets of sand and gravel in the upper 20 feet of the glacial drift are not essentially different from water obtained from the coarse stream deposits. These waters all show a great variation as to the amounts of mineral salts contained in solution, although most of them are not so highly mineralized as to be undrinkable. Sodium sulphate (Glauber's salt) and magnesium sulphate (Epsom salts) usually predominate, with sodium sulphate in the greater concentration. Sodium sulphate (Na_2SO_4) is nearly tasteless in solution, but waters containing large amounts of it have a laxative effect upon humans. Waters containing magnesium sulphate ($MgSO_4$) have a bitter taste and a strong laxative effect. This salt also contributes to the hardness of the water. Waters containing a combined concentration of both these salts in excess of 1,000 parts per million are usually considered unsuitable for human consumption, but in many places in the Prairie Provinces waters containing higher concentrations are being used with no apparent ill effects. Stock are less affected by highly mineralized waters and have been reported to thrive on waters containing concentrations of sulphate salts in excess of 3,000 parts per million. During the winter months when stock are fed on dry fodder, a slight laxative may be beneficial.

Waters obtained from the flood deposits of fine sand and silts, such as occur in the valley of Lodge creek and Middle creek, are as a rule more highly mineralized than waters from coarser and more porous sands and gravels. The fine texture of these sediments, and the consequent slowness with which water percolates through them, lend to this greater concentration. Surface evaporation is a further cause of concentration of mineral salts, particularly in extensive flood-plain flats where ground water occurs at slight depths.

Wells sunk in boulder clay are usually situated beside dams or artificially constructed reservoirs, and derive their water by seepage. The clay acts as a filter to the water in the reservoir, and if this water is not contaminated by sewage or similar organic matter, or does not contain a high concentration of mineral salts, due to surface evaporation, it will be suitable for drinking. Waters that are derived by seepage from the boulder clay itself are almost invariably too highly charged with sulphate salts to be used in the household, and are frequently found to be unfit for watering stock. Such waters may contain sulphate salts in solution in concentrations of 4,000 to over 10,000 parts per million.

Water from the Bedrock

No wells in the municipality are known to obtain water from the bedrock formations. The lower part of the Bearpaw formation, such as occurs in this municipality, is composed almost entirely of impervious marine shales. These shales are found to be water bearing in only a few places in this part of the province. Should water be obtained from the shales, or from fine sand beds that occur sparingly interbedded with the shales, it will probably be highly charged with mineral salts, rendering it unsuitable for domestic use, and possibly unfit for stock. Such analyses as have been made indicate that the water commonly contains 3,000 or more parts per million of sulphate salts, together with considerable amounts of common salt.

Waters obtained from the Belly River formation are usually of better quality than those of the lower Bearpaw. These waters where obtained from deep wells at Climax and Bracken, 56 and 69 miles east of this area, are soda bearing and are not particularly suitable for drinking, although of excellent quality for laundry work. The soda tends to give the water a flat taste, and if used for irrigation kills vegetation. The Belly River formation in this municipality, however, may contain water that is less highly mineralized.

WELL RECORDS—Rural Municipality of NO. 22, 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.	12	1	29	3	Dug	12	2,740	- 8	2,732	8	2,732	Stream deposits	Hard,clear, iron,"alkaline"	43	D	Insufficient supply.
1	SE.	13	2	28	3	Dug	10	3,019	- 2	3,017	2	3,017	Stream deposits	Hard,clear		S	Sufficient supply.
2	NE.	36	"	"	"	Dug	12	2,936	- 8	2,928	8	2,928	Glacial sand	Hard,clear, "alkaline"		S	Sufficient for stock; dam holds water for 2 months.
1	NW.	1	2	29	3	Dug	15	2,808	- 9	2,799	9	2,799	Glacial clay	Hard,clear	50	D, S	Intermittent supply; sufficient at present from rainfall.
2	SW.	3	"	"	"	Dug	12	2,838	- 10	2,828	10	2,828	Glacial clays	Hard,clear, "alkaline"	48	D	Sufficient supply; also 6 dry holes in coulée.
3	NE.	3	"	"	"	Bored	30	2,848	- 23	2,825	27	2,821	Glacial black sand	Hard,iron, clear	45	D, S	Sufficient for local needs.
4	NE.	4	"	"	"	Spring	0	2,820					Glacial drift	Soft,clear	52	S	Sufficient supply.
5	NE.	4	"	"	"	Dug	16	2,828	- 8	2,820	8	2,820	Glacial clay	Hard,clear	46	D	Sufficient supply; use creek for stock.
6	NW.	12	"	"	"	Dug	12	2,829	- 9	2,820	9	2,820	Glacial gravel	Hard,clear	48	D	Sufficient supply.
7	SW.	13	"	"	"	Dug	12	2,848	- 9	2,839	9	2,839	Glacial gravel	Soft,clear	47	D	Insufficient supply; stock use creek.
8	SW.	14	"	"	"	Dug	16	2,853	- 14	2,839	14	2,839	Glacial gravel	Medium hard, clear		D, S	Sufficient supply.
9	SE.	15	"	"	"	Dug	18	2,870	- 10	2,860	10	2,860	Glacial sand	Hard,iron, clear	47	D, S	Insufficient supply.
10	NE.	18	"	"	"	Dug	12	2,848	- 4	2,844	4	2,844	Stream deposits	Hard,clear, iron	50	D, S	Sufficient supply; a similar well.
11	SE.	20	"	"	"	Dug	10	2,838	0	2,838			Stream deposits	Soft,clear	42	D, S	Intermittent, insufficient supply; also use creek for stock and irrigation.
12	NW.	21	"	"	"	Dug	18	2,950	- 8	2,942	8	2,942	Glacial gravel	Medium hard clear		D, S	Insufficient supply.
13	SW.	22	"	"	"	Dug	20	2,910	- 17	2,893	17	2,893	Glacial gravel	Hard,clear		D, S	Sufficient supply.
14	NW.	22	"	"	"	Dug	12	2,920	- 6	2,914	6	2,914	Glacial quicksand	Hard,clear, iron	48	D, S	Intermittent, insufficient supply.
15	NE.	25	"	"	"	Dug	6	2,930	- 3	2,927	3	2,927	Glacial quicksand	Hard,clear		D, S	Sufficient supply.
16	SW.	27	"	"	"	Dug	12	2,938	- 6	2,932	6	2,932	Glacial quicksand	Hard,clear, iron	48	D, S	Intermittent, insufficient supply.
17	NW.	32	"	"	"	Dug	17	2,967	- 12	2,955	15	2,952	Stream deposits	Medium soft soda		N	Sufficient supply, well abandoned.
1	NE.	13	2	30	3	Dug	10	2,852	- 7	2,845	7	2,845	Stream deposits	Hard,clear, "alkaline"	48	N	Sufficient supply.
2	NE.	13	"	"	"	Dug	18	2,848	- 9	2,839	9	2,839	Stream deposits	Hard,clear, "alkaline"	46	D	Sufficient supply; 76-foot dry hole.
1	SW.	1	3	28	3	Dug	12	2,960	- 10	2,950	10	2,950	Stream sand	Hard,clear, "alkaline"		N	Constant supply.
2	SE.	2	"	"	"	Dug	14	3,032	0	3,032	5	3,027	Glacial gravel	Hard,clear, "alkaline"	46	D, S	Sufficient supply.
3	SW.	2	"	"	"	Dug	20	3,016	- 17	2,999	20	2,996	Glacial sand	Hard,clear		D, S	Sufficient supply.
4	SE.	4	"	"	"	Dug	18	3,065	0	3,065	16	3,059	Glacial black sand	Soft,clear	47	D	Insufficient supply.
5	NE.	5	"	"	"	Dug	20	3,070	0	3,070	10	3,060	Stream sand	Hard,clear	44	D, S	Sufficient supply; a similar well.

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. 22, . 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	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
6	NE.	6	3	28	3		50	3,050 ?									Dry hole in glacial drift.
7	SE.	7	"	"	"	Dug	12	2,990	- 8	2,982	9	2,981	Stream deposits	Hard,clear	46	D	Sufficient supply; dam used for stock.
8	NW.	7	"	"	"	Dug	11	3,000	0	3,000	9	2,991	Stream deposits	Hard,clear, "alkaline"	46	D, S	Sufficient supply.
9	SW.	9	"	"	"	Dug	20	3,075	- 12	3,063	20	3,055	Glacial drift	Hard,clear	44	D, S	Sufficient supply.
10	SW.	13	"	"	"	Dug	18	3,170	- 8	3,162	8	3,162	Glacial drift	Hard,clear	48	S	Sufficient supply.
11	NW.	15	"	"	"	Bored	18	3,185	- 8	3,177	16	3,169	Glacial sand	Soft,clear, "alkaline"	44	S	Insufficient supply; dam for stock.
12	NW.	16	"	"	"	Dug	14	3,200	0	3,200	10	3,190	Glacial drift	Hard,clear, "alkaline"	47	D	Insufficient and intermittent supply; dugout also used.
13	NE.	21	"	"	"	Dug	15	3,235	- 10	3,225	14	3,221	Stream sand	Hard,clear	44	D, S	Sufficient supply.
14	SW.	25	"	"	"	Dug	20	3,150	- 8	3,142	20	3,130	Glacial drift	Hard,clear	46	D, S	Sufficient supply.
15	SE.	28	"	"	"	Dug	12	3,225	0	3,225	10	3,215	[illegible] sands	Soft,clear	46	D, S	Sufficient supply.
16	SW.	31	"	"	"	Dug	21	3,110	- 9	3,101	12	3,098	Glacial gravel	Soft,clear	46	D, S	Sufficient supply.
17	SW.	33	"	"	"	Bored	20	3,285	- 10	3,275	20	3,265	Glacial drift	Medium hard, "alkaline" clear	47	D	Intermittent, insufficient supply; another similar well; several dry holes from 10 to 40 feet deep.
18	SE.	34	"	"	"	Dug	8	3,135	0	3,135	3	3,132	Stream deposits	Hard,clear	46	D, S	Sufficient supply; well fed by spring.
19	NE.	34	"	"	"	Dug	10	3,146	0	3,146	5	3,141	Glacial sandy loam	Soft,clear	47	D, S	Sufficient supply.
20	NW.	36	"	"	"	Dug	12	3,100	- 5	3,095	9	3,091	Stream deposit	Soft,clear	47	D, S	Sufficient supply.
1	SE.	4	3	29	3	Dug & Spring	4	2,972			4	2,968	Stream sands	Medium hard, clear		S	Sufficient supply; a similar spring also.
2	NW.	9	"	"	"	Spring	4	2,987	0	2,987	4	2,983	Stream gravels	Soft,clear	44	D, S	Insufficient supply; 6 barrels a day.
3	SW.	15	"	"	"	Dug& Spring	3	3,010	0	3,010	3	3,007	Stream sands and coarse gravel	Soft,clear	42	D, S, I	Sufficient supply; 48 barrels an hour.
4	NW.	15	"	"	"	Dug	16	3,013	0	3,013	16	3,097	Stream sands	Soft,clear	45	D, S	Sufficient supply.
5	SE.	22	"	"	"	Spring	3	3,045	0	3,045	3	3,042	Stream sand	Soft,clear	46	D, S	Sufficient supply.
6	SE.	23	"	"	"	Dug	16	3,060	- 13	3,047	13	3,047	Glacial sand	Hard,clear, "alkaline"	48	D, S	Sufficient supply; a 38-foot well in sand.
7	NW.	23	"	"	"	Dug	16	3,057	- 2	3,055			Stream gravels	Hard, "alkaline"			40,000 gallons, well beside C.P.R. reservoir.
		23	"	"	"		100										Dry hole, other dry holes in vicinity of Govenlock, base in clay.
8	SE.	25	"	"	"	Bored	14	3,120	- 5	3,115	9	3,111	Glacial drift	Hard,iron, clear	46	D	Sufficient supply; dam for stock.
1	NW.	16	3	30	3	Dug	30	3,032	- 15	3,017	26	3,006	Recent or Glacial gravel	Hard,clear, "alkaline"	46	D, S	Intermittent supply; dry holes in clay and sand, Bearpaw shale at base.

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.