CANADA
DEPARTMENT OF MINES

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BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF .... No. 82 SASKATCHEWAN

BY

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

Water Supply Paper No. 108

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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.

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 ind 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 côteau. 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. 82 comprises an area of about 270 square miles on the Cypress Hills uplands in the southwestern part of southern Saskatchewan. The municipality consists of six full townships and three fractional townships, described as tps. 7, 8, and 9, ranges 28, 29 and 30, W. 3rd mer. The fractional townships lie adjacent on the east to the Alberta-Saskatchewan boundary, the Fourth meridian. There are no towns and few improved roads in the area. A few farms occur on the lower flanks of the hills in the northern part of the municipality, but the rest of the area is devoted almost entirely to ranching The town of Maple Creek, situated on the main line of the Canadian Pacific railway about 8 miles north and 8 miles east of the northeast corner of the municipality, serves as the chief trading centre for these residents. The three northern townships and the Cypress Hills Forest Reserve, including the northern third of township 7 and the southern two-thirds of township 8, ranges 29 and 30, have been topographically mapped in detail and the relief is shown by means of contour lines on Figure 2 of the accompanying map. Unfortunately no detailed topographic map exists for the rest of the area. Elevations cited for these parts were ascertained by the use of an aneroid barometer, and since appreciable errors are bound to occur they are regarded as only approximate.

The three northern townships are situated on the steep northern slopes of Cypress hills. Surface elevations in the vicinity of the northern border range from 2,900 feet above sea-level in the east to 3,200 feet in the west. Toward the south the surface rises rapidly to an elevation of about 4,000 feet in the first 6 miles. The southern two-thirds of the area is situated on the top of the Cypress Hills uplands, where surface elevations range as high as 4,546 feet, in a flat-topped ridge that extends in a southeasterly direction through the forest reserve in the mid-western part of the municipality. A broad valley known as the Gap trends in a northwest-southeast direction across the eastern part of the uplands, at an average elevation of about 3,745 feet. Intermediate elevations occur throughout the rest of these rolling uplands. The drainage of the uplands is for the most part to the south through Battle creek, a small stream crossing the southwestern part of the municipality, and a tributary stream that flows southward through the central part. Both streams occupy deep, steep-banked valleys, the bottoms of which lie at an average elevation of about 3,600 feet above sea-level. The northern slopes are drained by the numerous small channels of Gap and Boxelder creeks. Most of the streams in the area are spring-fed, but only Battle creek maintains a permanent flow. The springs and the small streams resulting from their flow are the chief sources of water for range stock. These supplies are supplemented in a few places by sloughs, and in the northern part by dams and dugouts that have been constructed in the coulée bottoms. Any development of the ground water resources of the municipality has been confined almost entirely to the farming community in the northern townships where wells have been put down in the unconsolidated deposits of Recent and glacial origin.

Water-bearing Horizons in the Unconsolidated Deposits

The unconsolidated deposits consist of Recent sediments laid down by flood waters in the bottoms of the stream channels, and of a mantle of glacial drift of greatly varying thickness that covers the bedrock throughout much of the area.

In the stream deposits water is usually concentrated in the porous beds of sand and gravel that occur interspersed through the less pervious clay and silt. The small stream channels usually have steep gradients and their deposits consist largely of coarser sediments thinly distributed over the valley floors. Such deposits are not likely to yield a permanent water supply to wells unless they are constantly replenished by spring waters seeping from the valley side or by direct seepage from the stream. In the larger stream channels such as Battle creek the gradient is less steep and the flood-plain deposits consist largely of finer sands and silts. These sediments are in some places interbedded with coarser sands and gravels and are usually water bearing. Wells drawing water from the stream deposits are rarely over 20 feet deep and their waters are usually suitable for domestic use unless they are contaminated by sewage or other decaying organic materials.

The glacial drift, forming the surface deposits in most parts of the municipality, consists essentially of boulder clay, or till, interspersed in some places with irregular pockets of well-sorted sands and gravels. This drift was deposited by a great continental ice-sheet that spread in a general southwesterly direction over the province of Saskatchewan many thousands of years ago. During the melting of the ice-sheet and its retreat to the northeast it is thought to have paused for considerable periods of time over some of the areas of higher land, resulting in a greater, or more unevenly distributed, accumulation of rock debris than is spread over the remainder of the area. These unevenly surfaced areas, characterized by numerous low hills and intervening areas of undrained depressions or sloughs, are known as moraine as distinguished from the more evenly distributed boulder clay constituting the till plains. The moraines in this municipality are confined to a narrow belt extending in a northwesterly direction through "The Gap" from the eastern side of township 7, range 28, to the western side of township 8, range 28. Smaller moraine-covered areas occur farther to the northwest in the northern part of township 8, range 29, and in the southern part of township 9, range 30. The till plain areas are also irregular in most places, due largely to the uneven surface upon which the drift was deposited.

The ice-sheet apparently either did not extend over the highest parts of the uplands or was so thin that it left no evidence of its presence on the top of the ridge that extends through the forest reserve or over an extensive area south of Battle creek in the southwestern part of the municipality. A small area of no drift also occurs along the western edge of the moraine in the central part of township 7, range 28. The surface deposits in these areas consist entirely of a few feet of residual soil, formed from the weathered bedrock. Over large areas throughout the municipality the drift is less than 10 feet thick, and at many points along the steeper slopes it is absent and the bedrock is exposed at the surface.

Ground water supplies of the drift are usually concentrated in the small pockets of sand and gravel that occur irregularly interspersed through the less pervious boulder clay. The porous beds are absent or non-water bearing at some places in the northern townships where wells have been sunk in search of these supplies. The low depressions and draws are usually regarded as being more favourable for the accumulation of these water supplies than the ridges or level till plains, hence they may be expected to be fairly numerous in the moraine-covered areas.

No prediction can be made as to the quantity of water to be expected in any one locality, owing to the large variation in thickness and porosity of the water-bearing beds. Wells producing from the drift in this municipality range in depth from 5 to 45 feet. The yields from individual wells vary, but most of the wells do not yield more than sufficient water for domestic use and for a few head of stock. Some of the springs issuing from the drift, however, produce a fairly constant flow and form a valuable addition to the stock water supplies. The quality of the drift waters varies greatly within short distances. Most of the waters obtained from wells in the lowlands in the northern part of the area contain appreciable amounts of sulphate salts in solution, but nearly all are reported to be drinkable. Only one well, situated in sec. 35, tp. 9, range 29, produces water that is considered to be so highly charged with Epsom salts as to be unfit even for stock use. Although few wells are reported to have been sunk in the uplands, the mineral salt concentration in the drift waters here is expected to be much lower than in the waters from the drift in the northern lowlands. As a rule, the spring waters are reported to be of a quality that is quite suitable for domestic use. Most of these springs issue from gravels and are listed as drift waters in the tables of well data accompanying the report, but some of them probably have their origin in the bedrock. Since the bedrock underlying the lowlands produces only small supplies of water of poor quality, careful prospecting of the unconsolidated deposits is necessary to ensure adequate supplies of drinkable water. On the uplands bedrock capable of producing large quantities of water of good quality is reached at shallow depths, and it is advisable to sink wells into the bedrock rather than to attempt to find water in the thin mantle of drift.

Water-bearing Horizons in the Bedrock

Four bedrock formations, designated the Cypress Hills, Ravenscrag, Eastend, and Bearpaw formations, are known to underlie the unconsolidated deposits in different parts of the municipality. All these formations at one time, presumably, extended over the entire area, in the descending order given. Erosion, most of which took place before the deposition of the unconsolidated deposits, either has greatly reduced the original thickness of, or entirely removed, the upper formations over much of the area, so that now only the lowest, the Bearpaw formation, extends throughout the municipality. The other formations extend over lesser areas, so that the uppermost or Cypress Hills beds cap only the highest ridges and hills that occur in the southwestern half of the area at an elevation usually greater than 4,000 feet above sea-level.

The Cypress Hills formation is composed essentially of alternating layers of medium- to coarse-grained sands and sandstones and hard, cemented conglomerate. Its thickness probably does not greatly exceed 100 feet in most places. The Cypress Hills formation is the chief source of water in many districts to the east of this municipality, where these beds have a wider distribution. In this municipality the formation, owing to its isolated position on the highest uplands, has little opportunity of obtaining or retaining any large ground water supplies. Water from the Cypress Hills aquifers is almost invariably of good quality and is frequently soft or only moderately hard.

The Ravenscrag formation is known to provide water for numerous springs that occur in various parts of the uplands, but no wells are reported to have been sunk into it in this municipality. This formation consists chiefly of soft shales interbedded with variable thicknesses of fine- to medium-grained sands and sandstones and an occasional seam of lignite coal. The sands are usually grey or greenish grey, but on rock exposures weather to a light grey or buff. The shales are darker in colour. The sand and coal seams commonly form the aquifers, although sandy shales may also be water bearing at some places. The waters as a rule are of good quality and do not differ essentially from those found in the Cypress Hills formation. The Ravenscrag formation is believed to underlie most of the uplands in the southern two-thirds of the area at elevations greater than 3,800 feet above sea-level. It is known to be absent, however, in "The Gap" and in the deep coulées formed by Battle creek and its tributaries. Here the Eastend formation underlies the unconsolidated deposits. The Eastend formation also forms the uppermost bedrock on the northern slope from the uplands, over small areas in the southeastern and southwestern parts of township 9, range 28, and through the southern half of townships 9, ranges 29 and 30. The drift throughout the remaining parts of the northern townships is underlain by the Bearpaw formation.

The Eastend formation is composed largely of soft grey shales and silts interbedded with a few layers of porous sands and sandstones. Seams of lignite coal are also reported to occur in the upper beds. The lower part of the formation is of marine origin and grades without any apparent break into the dark shales of the underlying Bearpaw formation. Water obtained from the upper sandy beds of the Eastend is not expected to be highly mineralized. Water from the lower marine sediments and from the upper part of the Bearpaw may, however, contain fairly large amounts of sulphate salts in solution, and this high mineral salt content may be reflected to some extent in the character of the waters obtained from the overlying, unconsolidated deposits.

The thickness of the Bearpaw formation has not been determined, but it is probably as great as 600 feet. It consists largely of dark grey, friable shales interbedded at intervals by bands of hard ironstone and occasionally a thin bed of fine-grained sandstone. Outcrops of these shales occur at several places along the banks of Boxelder creek and in other coulées farther east. Where encountered in wells they may be distinguished from the overlying clays of the drift by their bedding and more or less distinct soapy feel, by the almost entire absence in them of pebbles, and by the small, roughly cubical, and frequently iron-stained, fragments into which they crumble when dry.

The sinking of deep wells in the Bearpaw formation is not recommended, as these shales contain very few beds that are sufficiently porous to form reservoirs for any large accumulations of water. Such water as it may contain is possibly too highly charged with mineral salts to be used for drinking, and may not be even satisfactory for stock.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 7, Range 28

This township consists almost entirely of range-land which has an irregular surface, with elevations ranging from about 3,600 to 4,300 feet above sea-level. A broad valley, occupying most of the eastern half of the township, is covered by a roughly rolling moraine with an average surface elevation of about 3,700 feet above sea-level. From the edge of the moraine westward the surface rises to form a roughly eroded upland extending along the western side of the area with a maximum elevation of about 4,300 feet. This upland is dissected by a deep, steep-sided, flat-bottomed coulée that extends southward through the western sections. The coulée bottom is, in part, formed of Recent flood-plain deposits. The rest of the area, with the exception of several sections along the edge of the moraine in the central part, is covered with glacial till. The till in some places has been largely eroded away and at other places has been partly reworked by stream action. The area in the central part was apparently never covered by the ice-sheet as the surface material here consists of a few feet of residual soil formed from the weathering of the bedrock.

As the township consists of ranch land the ground water resources have been little developed. Stock may obtain water from a few small creeks and sloughs, and these supplies could be supplemented in some places by constructing dams.

Shallow wells sunk in the flood-plain deposits that occur in the coulée bottoms may obtain a satisfactory water supply, particularly if sand or gravel beds are encountered. A 12-foot well situated in section 6, is reported to yield an adequate supply of hard, drinkable water from this type of deposit.

The glacial drift may also be water bearing at shallow depths, particularly in the moraine-covered eastern part of the township. These waters are usually concentrated in small pockets of sand or gravel that occur interspersed through the upper 20 feet of the boulder clay. The low depressions between the hills and the bases of steep slopes are considered to be the most favourable locations for these shallow wells. The drift waters are mostly hard, but are satisfactory for household use.

Wells sunk to water-bearing sands in the bedrock, as a rule yield a more permanent water supply than shallow wells in the overlying unconsolidated deposits, as they are less affected by drought conditions. The bedrock aquifers can be expected to occur in both the Ravenscrag formation underlying the drift, in the western uplands, and the Eastend formation that forms the uppermost bedrock throughout the rest of the township. The Cypress Hills beds cap only the highest hills in the township and are not expected to be water bearing.

Depths to the bedrock aquifers may vary from about 20 feet to as great as 200 feet on some of the higher points of the uplands. No difficulty is anticipated in finding water in the area provided wells are sunk sufficiently deep. The water is of good quality and may be used for drinking.

Township 7, Range 29

The maximum difference in surface elevation in this township approximates 800 feet. The lowest point occurs at an elevation of about 3,500 feet above sea-level in the bottom of Battle Creek valley where it crosses the southern boundary in section 3. The average elevation of the land surface in the southern sections remote from the valley is about 3,700 feet. The surface rises rapidly toward the north, however, to attain a maximum elevation of about 4,400 feet above sea-level on a narrow belt of bench-land that extends along the northern border from sections 33 to 36. Battle creek, where it enters the township in section 31, occupies a wide, flat-bottomed valley, the base of which lies at an elevation of about 700 feet below the bordering uplands.

As the township is devoted almost entirely to grazing the ground water resources have not been developed. Springs that occur on the valley sides and the creek form the chief sources of water for range stock.

The stream deposits are regarded as the best potential source of ground water supplies at shallow depths in the unconsolidated deposits. In Battle Creek valley these sediments consist largely of silts and clays that are underlain by, and in places interbedded with, layers of well-sorted sands and gravels. Although no wells are recorded from the township these deposits are expected to be water bearing in most places along the valley bottom at depths of less than 20 feet. Stream deposits in the smaller tributary coulées may also be water bearing in some parts, but owing to the steep gradient of these streams the water-bearing beds may not contain a permanent water supply unless they are replenished by springs flowing from the valley sides.

The glacial drift may be capable of yielding small supplies of water in the southeastern part of the township, but these sediments have apparently never been deposited or have been eroded from the uplands in the southwestern and northeastern parts. The valley sides are also covered with little if any drift, and such thin layers as are present have been largely reworked by stream action.

The bedrock formations yield water through springs at many places on the valley sides. These waters seep from both the Ravenscrag and the Eastend sands and coal seams. The Cypress Hills beds that cap the uplands in the northeastern and west-central parts may also be water bearing, but it is doubtful if they would yield any large supplies owing to their limited extent and to their isolated position on the uplands.

The Ravenscrag formation may extend down to an elevation of about 3,900 feet above sea-level, and occurs throughout most of the upper slopes in the northeastern and western parts of the township. The Eastend formation underlies the unconsolidated deposits in the bottom of Battle Creek valley and along the lowlands that extend through the southeastern part of the area. Waters from both these formations are reported to be suitable for domestic use.

Township 7, Range 30

This fractional township, comprising about 18 square miles, consists entirely of range-land. Battle creek flowing through the northeastern corner of the area and its small, spring-fed tributaries coming from the southwest supply some water for stock. No information was obtained of any wells having been sunk in the area.

The unconsolidated deposits consist chiefly of Recent deposits in Battle Creek valley. Glacial drift occurs only on the steep valley slopes and has been largely reworked by stream action. The southern two-thirds of the township have apparently never been glaciated as the surface deposits here consist of weathered bedrock.

The Cypress Hills formation forms the uppermost bedrock throughout a fairly extensive area in the central part of the township. The rest of the area with the exception of the lower banks and bottom of Battle creek is underlain by the Ravenscrag formation. The Eastend formation underlies the unconsolidated deposits in the valley bottom. All these formations are expected to be water bearing, and are described in an earlier section dealing with the municipality as a whole. The water in the unconsolidated deposits is thought to be similar to that occurring in the township adjacent on the east, as described in a previous section.

Township 8, Range 28

The surface run-off in this township is carried northward through Gap creek and its tributaries. A large part of tho area, particularly in the southwestern half, is poorly drained, however, and shallow sloughs occupy many of the depressions. The land surface is steeply rolling and is little suited to farming, but it forms satisfactory ranch land.

Range stock obtain water from sloughs and from the creeks. These supplies are supplemented in some places by springs.

Although surface waters are the chief source of supply, the waters contained in the unconsolidated deposits and in the bedrock formations could be tapped by wells sunk to depths probably nowhere greatly exceeding 100 feet, and in most places at much shallower depths. Of the unconsolidated deposits, the stream sediments that occur in the coulée bottoms probably contain the most readily located water-bearing beds, the water being usually found in sand or gravel beds underlying 5 to 10 feet of clay.

The glacial drift, forming the surface deposits throughout the rest of the area, is composed largely of till, but a northwesterly trending, irregular moraine covers an area of over 8 square miles in the southwestern half of the township. These two types of glacial deposits are believed to be very similar in their water-bearing possibilities, and both types are regarded as sources of water supply at depths of less than 25 feet, especially where wells are dug in the depressions or at the bases of slopes. As only two wells are recorded as having been sunk in the township, little definite information regarding these waters is available. They are not expected to differ greatly in quality, however, from those found at other places in the Cypress hills, and everywhere the water if not polluted by animal refuse should be quite suitable for drinking.

The bedrock formations underlying the drift consist in the higher, southwestern and eastern parts of the Ravenscrag beds, and throughout almost all the rest of the township, of the Eastend formation. The Bearpaw formation forms the uppermost bedrock in a small area of low elevation extending along the northern border in sections 33, 34, and 35. The two upper formations at least are expected to contain water-bearing sands or sandstones that might be tapped by wells sunk in most places to depths of less than 100 feet, and in the areas of highest elevation to depths of not more than 200 feet. Persons contemplating sinking such wells are referred for more detail to the general section of this report dealing with the water-bearing horizons in the bedrock, and to the section on the analyses and quality of the water from the bedrock.

Township 8, Range 29

This township consists entirely of range-land. The southern two-thirds of the area lie within the Cypress Hills Forest Reserve. The timbered area is restricted to ravines and patches along both slopes of a high, flat-topped ridge that trends in a northwest-southeast direction across the reserve, with an elevation slightly greater than 4,400 feet above sea-level. The southwestern slope terminates in Battle Creek valley. On the northern side of the ridge the surface drops off more abruptly to the bottom of a winding coulée that extends across the northeastern corner of the forest reserve at an elevation of about 3,900 feet above sea-level. From here northward the land surface again rises steeply to form a rolling upland with isolated sloughs occupying depressions between the low hills. Elevations in this part of the township range from about 3,800 feet to 4,200 feet above sea-level.

No wells are reported to occur in this township. Springs supply water for domestic use for the few settlers in the district, and the range stock water at sloughs, creeks, and springs.

The thickness of the glacial drift is believed to vary greatly in different parts of the township. There is no evidence of drift having been deposited on the high ridge in the forest reserve, and it is probably quite thin on the steeper slopes in the other parts. The drift may be fairly thick, however, in the irregularly rolling upland that extends over the northern sections. As no wells are reported to have been dug in the unconsolidated deposits, their water possibilities are not known. It seems reasonable to suppose, however, that water-bearing sand or gravel beds may occur at shallow depths in many parts of the area, particularly in the coulée bottoms and in the depressions between the hills.

The bedrock formations are known to be water bearing, as springs are reported to occur at many places on the coulée banks. Most of these are probably flowing from beds of sand or coal seams in the Ravenscrag formation, although the Cypress Hills beds that cap the highest hills and ridges at elevations greater than about 4,300 feet above sea-level may also be water-bearing in some places. The Eastend formation forms the uppermost bedrock formation in small areas in the northeastern and mid-eastern parts where the surface lies below approximately 3,850 feet above sea-level. It is probable that at least moderately large supplies of water of good quality will be found at all points, provided wells are sunk sufficiently deep. In the area underlain by the Bearpaw formation, however, careful prospecting of the unconsolidated deposits seems preferable to deep drilling. For information regarding the general character of the bedrock formation and the character of the aquifers the reader is referred to the section dealing with the municipality as a whole.

Township 8, Range 30

This fractional township lying adjacent to the Fourth meridian, 3 miles in width and covering 18 square miles, is too irregularly rolling to be cultivated, and is given over entirely to ranching. The topographic features of the area are, in general, similar to those of the township bordering on the east which are discussed in the preceding sections. Battle creek in the southern part of the area lies at an elevation of about 3,850 feet above sea-level, and the highest elevation of about 4,460 feet is attained on the flat-topped ridge that extends through the central part.

Although no wells are reported to have been sunk in this township springs are known to occur at intervals along Battle Creek valley. These springs supplemented by a few sloughs and creeks provide water for stock. Ground water conditions existing in the Recent alluvium, in the glacial till, in the bedrock formations are believed to be essentially similar to those of other parts of the Cypress Hills uplands, as described in an earlier section of this report dealing with the municipality as a whole.

Township 9, Range 28

This township, situated on the northern flank of Cypress hills, consists of moderately rolling and irregularly stream-carved uplands, in which occur several wide, flat-bottomed valleys. Surface elevations range from 2,900 to 3,100 feet above sea-level in the northern part to elevations slightly greater than 3,500 feet at some places along the southern border. The surface run-off is carried northeastward by small tributaries of Gap creek, most of which converge to cross the eastern border in sections 24 and 36. Although most of these streams are fed by small springs near their sources in the southern part of the township, and here maintain a fairly constant flow, the lower reaches of the channels usually become dry in midsummer. The surface run-off is conserved in some places, however, by dams constructed in the small coulées.

Ground water supplies of the township are obtained from wells sunk in the unconsolidated Recent and glacial drift deposits. The Recent stream deposits are possibly the most reliable source of ground water. They consist mostly of clay and silt that are interbedded with irregular layers of porous sand and gravel. Wells dug to the sand and gravel beds usually encounter water, although the supply obtained is rarely sufficient for more than household use. As a rule these waters contain noticeable amounts of sulphate salts in solution, but they are being used for the domestic drinking supply. Depths of wells sunk to these water-bearing beds rarely exceed 20 feet.

The glacial drift is also water bearing, although in most parts of the area the aquifers in these deposits may be difficult to locate. They usually consist of gravel pockets that occur sparsely interspersed through the boulder clay. Several wells situated in the northern half of the township are drawing water from these gravel pockets at depths of less than 25 feet. Springs also occur at places where the water-bearing beds have been intersected by stream channels. Although the flow of the springs is usually small, some of them flow throughout the year. As the presence of the gravel pockets at depth are not generally indicated at the surface, it may be necessary in most sections to sink a number of test holes before locating a water supply. Where obtained, the drift waters are reported to be hard, and most of them contain sufficient mineral salts in solution to impart a slightly bitter taste to the water. Some of the springs are also reported to be "alkaline". On a few of the farms where a suitable ground water supply has not been located seepage wells have been sunk beside dams in order to obtain a domestic drinking supply.

The bedrock formations throughout most of the township are not regarded as being sufficiently porous to favour the accumulation of ground water. In the southern part, where surface elevations range higher than 3,400 feet above sea-level, the drift is thought to be underlain by the Eastend formation. This formation, together with the upper sandy part of the Bearpaw formation, may be water bearing, and probably forms the source of some of the springs in this part of the township. These waters are usually drinkable, although they may contain appreciable amounts of sulphate salts in solution. The deeper Bearpaw beds such as occur below the drift on the lower slopes throughout the central and northern parts of the township are expected to contain little, if any, water that would be suitable for farm use.

Township 9, Range 29

Only in the northern third of this township is the land sufficiently level to be farmed. Toward the south the rough, hillocky land surface rises rapidly from an average elevation of about 3,200 feet above sea-level at the northern boundary to elevations ranging from 3,600 to 4,000 feet along the southern border of the township. This part of the area is used only as range-land.

Springs flowing from the drift that mantles the entire area, provide water for range stock. Numerous small stream valleys occur along the northern slope, but owing to the rapid run-off in the area these carry water only during flood seasons, at a few places where they are constantly replenished by spring waters.

In the northern farming settlement ground water conditions are unsatisfactory in both the unconsolidated deposits and in the underlying bedrock. Although a number of wells are reported to have been put down, most of them to shallow depths, only boulder clay yielding very little water was encountered. Such water as does occur contains appreciable amounts of mineral salts in solution, and in one well on section 35 the water is so highly mineralized as to be unfit even for stock use. A more satisfactory drinking water supply might be obtained in this part of the area by sinking seepage wells beside dams constructed across the coulées. In the southern half of the township the water conditions are believed to be much better. The spring waters are reported to be drinkable, and it is reasonable to suppose that wells sunk to the level of the aquifers that supply the springs will also produce drinkable water. Just how numerous these water-bearing beds are in the drift has not been determined, however, and it would probably be necessary to sink several test holes in some places before locating water. The depressions and coulée bottoms are regarded as the most favourable locations for wells.

The bedrock formations underlying the drift in the southern half of the township are also regarded as a potential source of ground water.

The Cypress Hills formation is known to cap the uplands in the southeastern part of section 5, but owing to its isolated position on the hill-top it is not expected to retain any large water supplies.

The Ravenscrag formation, which underlies the Cypress Hills beds and in their absence the unconsolidated deposits, extends through sections 4, 5, and 6, down to an elevation of about 3,800 feet above sea-level. The Eastend formation, which in places underlies the Ravenscrag, is of much wider areal extent, and may occur throughout most of the southern two-thirds of the township down to an elevation of about 3,300 feet above sea-level. Outcrops of this formation are reported to occur on the creek banks in the southern part of section 22. In the northern part of the township the drift is underlain by the Bearpaw formation.

Both the Ravenscrag and Eastend formations are expected to contain water-bearing sands and coal seams. Such beds are usually sufficiently porous to form reservoirs for large accumulations of water. These aquifers are possibly the sources of some of the springs that flow from the drift along the hill-sides.

The Bearpaw formation contains few beds that are sufficiently porous to allow of any large accumulation of water, and such water as may be obtained from it is usually so highly mineralized as to be unsuitable for domestic use. Hence, in the northern lowlands it is advisable to thoroughly prospect the unconsolidated deposits rather than to bore or drill to greater depths into the bedrock.

Township 9, Range 30

The topography of this fractional township is slightly less rugged than the township bordering on the east. Surface elevations in the northern lowlands range from 3,200 feet in the northwestern corner to 3,550 feet on the top of a prominent ridge that extends across the northern border from section 35 to section 25. In the southern half of the area the land surface rises to a maximum elevation of about 3,900 feet on the southern border.

The area is drained by Boxelder creek, a small stream flowing in an easterly direction along the base of the southern escarpment to cross the eastern border in the northeast corner of section 24. This stream with a few sloughs and springs provides some water for range stock. These supplies are supplemented in some places by dams constructed in the coulée bottoms.

Ground water is obtained by sinking shallow wells in the unconsolidated deposits. Most of these are located in the coulée bottoms, and are drawing their water from beds of sand or gravel underlying 5 to 10 feet of clay. The largest yields recorded are obtained from wells sunk in the NE. $\frac{1}{4}$, section 25, and the SE. $\frac{1}{4}$, section 36, where water-bearing sands were encountered at depths of less than 10 feet. These waters are reported to be suitable for domestic use. Other shallow wells in the area, particularly those tapping aquifers in the more compact clay, yield water that is more highly charged with mineral salts, and the yield at most places is sufficient only for household use.

Deep drilling in the northern part of the township is not recommended, as the unconsolidated deposits here are underlain by the Bearpaw shales from which little if any water may be expected. A well situated in section 34 struck a small flow at the contact of the glacial drift with the underlying Bearpaw, bedrock at a depth of 15 feet, but deepening the well to 46 feet failed to increase the yield.

The bedrock underlying the drift in the southern half of the township is more likely to be water bearing. The Eastend formation forms the uppermost bedrock in this part of the township, with the exception of a narrow belt that extends along the southern border at elevations greater than 3,850 feet, where the overlying Ravenscrag may occur. Such waters as occur in these formations are usually suitable for household use.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL
MUNICIPALITY OF NO. 82, SASKATCHEWAN

West of 3rd mer. Township / Range	7 / 28	7 / 29	7 / 30	8 / 28	8 / 29	8 / 30	9 / 28	9 / 29	9 / 30	Total No. in Municipality
Total No. of Wells in Township	1	0	0	2	0	0	19	16	8	46
No. of wells in bedrock	0	0	0	0	0	0	0	0	0	0
No. of wells in glacial drift	0	0	0	2	0	0	17	15	4	38
No. of wells in alluvium	1	0	0	0	0	0	2	1	4	8
Permanency of Water Supply										
No. with permanent supply	1	0	0	2	0	0	13	3	7	26
No. with intermittent supply	0	0	0	0	0	0	2	1	1	4
No. dry holes	0	0	0	0	0	0	4	12	0	16
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	0	0	1	0	2	3
No. of non-artesian wells	1	0	0	2	0	0	14	4	6	27
Quality of Water										
No. with hard water	1	0	0	0	0	0	14	4	7	26
No. with soft water	0	0	0	2	0	0	1	0	1	4
No. with salty water	0	0	0	0	0	0	0	0	0	0
No. with "alkaline" water	0	0	0	0	0	0	12	4	4	20
Depths of Wells										
No. from 0 to 50 feet deep	1	0	0	2	0	0	19	16	8	46
No. from 51 to 100 feet deep	0	0	0	0	0	0	0	0	0	0
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	1	0	0	1	0	0	11	3	6	22
No. not usable for domestic purposes	0	0	0	1	0	0	4	1	2	8
No. usable for stock	1	0	0	2	0	0	14	3	8	28
No. not usable for stock	0	0	0	0	0	0	1	1	0	2
Sufficiency of Water Supply										
No. sufficient for domestic needs	1	0	0	2	0	0	13	2	7	25
No. insufficient for domestic needs	0	0	0	0	0	0	2	2	1	5
No. sufficient for stock needs	1	0	0	1	0	0	11	2	6	21
No. insufficient for stock needs	0	0	0	1	0	0	4	2	2	9

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 differance between the total hardness and the permanent hardness and represents the amount of mineral salts that ban be removed by boiling. Temporary hardness is due mainly to the bicarbonates of calcium and magnesium and iron, and permanent hardness 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 water were taken for analysis from this municipality. The following discussion of the general characteristics of the waters from different sources is based upon opinions of the residents, and upon analyses of waters taken from other municipalities to the east where the source beds are similar.

Nearly all waters obtained from the stream deposits apparently contain sufficiently low concentrations of mineral salts to permit their use in the household. The lowest concentrations are expected to occur in the waters contained in stream deposits on the uplands in the southern two-thirds of the municipality. The sediments forming these aquifers are derived largely from erosion of the Cypress Hills and Ravenscrag bedrock formations, and contain only small amounts of the readily soluble salts. The springs that issue from the bedrock on the valley sides are the sources of at least part of these waters. Such waters contain only small amounts of salts in solution, and owing to their fairly rapid circulation through the coarse stream sediments they are afforded little opportunity of dissolving additional salts. The flood-plain deposits, which occur in the lowland area in the northern part of the area, are composed largely of fine silts and sands, derived from erosion of the marine shales of the Bearpaw and Eastend formations, and of the overlying boulder clay. Mineral salts from these sediments may be taken into solution in sufficient quantities to render the water in some places unsuitable for domestic use.

Relatively large amounts of the objectionable sulphate salts are encountered in glacial drift waters in this municipality. Marked variations may be noted, however, in the quality of these waters, even within limited areas. The compact boulder clay contains large amounts of readily soluble mineral salts. Even shallow wells sunk entirely in boulder clay, or tapping only thin sand pockets, yield water that contains sufficient quantities of sodium sulphate (Na_2SO_4) and magnesium sulphate ($MgSO_4$) to render the water unfit for both humans and stock. Water derived from porous pockets of sand and gravel that occur at shallow depths, and hence are not covered by appreciable thicknesses of boulder clay, are, as a rule, drinkable. The quantities of dissolved salts present appear to increase with depth in the drift. Another important factor determining the quality of water from the drift in this municipality is the character and porosity of the underlying bedrock. Where the drift overlies the compact shales of the Bearpaw formation, the downward percolating waters collect above the drift-bedrock contact, and tend to dissolve salts from both the drift and the bedrock. In areas where the underlying bedrock consists of the more porous, younger formations the water is less confined in its underground course, and has less opportunity of taking up mineral salts in solution. Such waters as may occur in the drift on the uplands of this municipality are expected to be suitable for domestic use.

The so-called "alkali" waters usually contain sodium sulphate (Na_2SO_4), magnesium sulphate ($MgSO_4$), calcium carbonate ($CaCO_3$), and calcium sulphate ($CaSO_4$), with minor amounts of sodium carbonate (Na_2CO_3) and common salt (NaCl). These salts are listed in the decreasing order of their usual relative abundance. The sulphates of sodium and magnesium are the most objectionable salts present. Water containing in excess of 1,000 parts per million of both these salts tends to have a laxative effect when taken by persons unaccustomed to highly mineralized waters, although waters containing concentrations of nearly twice this amount are frequently used for drinking by residents in different parts of the province without imparting any noticeable ill effects.

Water from the Bedrock

Although no wells are reported to yield water from the bedrock formations, and the quality of the spring waters was determined in only a few places, these waters are not expected to differ essentially from those obtained in other parts of the Cypress Hills uplands, where the source beds are similar.

Waters obtained from the Cypress Hills formation rarely contain objectional amounts of mineral salts in solution. The Cypress Hills sediments are composed largely of quartzite grains, consolidated in part by a lime cement. The carbonates are the only readily soluble salts present, and form the chief constituents in waters from this formation. The carbonates of calcium and magnesium are usually present in the greatest abundance. They are tasteless and are not regarded as detrimental to health, although they contribute to the hardness of the water. A large part of this hardness is temporary and may be removed by boiling the water.

Waters from the Ravenscrag, and from the upper part of the Eastend formation, may contain a slightly higher average mineral salt concentration, but it is doubtful if these waters are at any place too highly mineralized for domestic use. The coal seams and the sandy shales are usually the sources of the objectionable salts, and may contribute small amounts of iron and sulphur.

The Eastend beds and the Bearpaw formation frequently yield water containing large amounts of the laxative-acting sulphate salts. Their waters are so variable in quality, however, that it is difficult to predict the type of water that may be obtained in any one locality. As a rule, the sandstone beds that occur in the lower part of the Eastend, and in the upper part of the Bearpaw formation, yield drinkable waters. Water obtained from the sandy shales and fine silts usually contains a relatively large concentration of sulphate salts. This concentration may also increase with depth to such an extent that wells sunk to a depth of over 200 feet below the top of the Bearpaw formation may yield water so highly charged with sodium sulphate and sodium chloride (common salt) as to be unfit even for watering stock.

WELL RECORDS—Rural Municipality of NO. 32, 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.	6	7	28	3	Dug	12	2,740	- 5	3,735	5	3,735	Recent gravel	Hard, clear		D, S	Sufficient for local needs.
1	SW.	23	8	28	3	Dug	19	3,585	- 4	3,581	4	3,581	Glacial gravel	Soft, clear		D	Sufficient only for domestic needs.
2	SW.	28	"	"	"	Dug	30	3,585	- 10	3,575			Glacial drift	Soft, clear		S	Sufficient for local needs.
1	SW.	2	9	28	3	Spring		3,100	0	3,100	0	3,100	Glacial gravel	Hard, clear, "alkaline"		D, S	Abundant supply.
2	SE.	3	"	"	"	Dug	33	2,990	- 25	2,965			Glacial drift	Hard, clear, "alkaline"		N	Sufficient supply, but not used.
3	NW.	13	"	"	"	Dug	18	3,170	- 12	3,158	12	3,158	Recent gravel	Hard, clear, "alkaline"		D, S	Insufficient for local needs; a creek is used for stock.
4	SW.	22	"	"	"	Dug	15	3,040	- 9	3,031	9	3,031	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
5	NE.	22	"	"	"	Dug	7	3,060	0	3,060	7	3,053	Glacial gravel	Soft, clear		D, S	Sufficient for local needs; also a creek for stock.
6	NE.	25	"	"	"	Dug	12	2,860	- 10	2,850	30	2,850	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
7	SW.	28	"	"	"	Spring		3,025	0	3,025	0	3,025	Glacial gravel	Hard, clear, "alkaline", iron		S	Oversufficient for 60 head stock.
8	SE.	30	"	"	"	Dug	16	2,970	- 10	2,960	10	2,960	Recent silt	Hard, clear, "alkaline"		D, S	Sufficient for local needs.
9	NW.	31	"	"	"	Dug	14	2,970	- 10	2,960	10	2,960	Glacial sandy clay	Hard, clear, "alkaline"		D, S	Also another similar well.
10	NW.	33	"	"	"	Dug	11	3,085	- 7	3,078			Glacial drift	Hard, clear, iron		S	Sufficient for stock needs; haul drinking water.
11	SE.	34	"	"	"	Bored	20	2,925	- 18	2,907			Glacial drift	Hard, clear, "alkaline"		D, S	Insufficient supply; also four dry holes 10 to 20 feet deep.
12	NW.	34	"	"	"	Dug	16	2,960	- 10	2,950	14	2,946	Glacial gravelly clay	Hard, clear		D, S	Intermittent supply; also dams used for stock.
13	NE.	35	"	"	"	Dug	10	2,870	0	2,870	9	2,851	Glacial gravel	Hard, clear, iron, "alkaline"		D	Intermittent supply; a creek is used for stock.
14	NE.	36	"	"	"	Spring		2,850	0	2,850	0	2,850	Glacial drift	Hard, clear, "alkaline"		S	Sufficient for local needs.
1	SW.	32	9	29	3	Dug	14	3,200	- 10	3,190	10	3,190	Recent gravelly clay	Hard, clear, "alkaline"		D, S	Intermittent supply.
2	SE.	35	"	"	"	Dug	8	3,140	- 6	3,134			Glacial drift	Hard, clear, "alkaline"		N	Unfit for use.
3	NE.	36	"	"	"	Dug	13	2,985	- 6	2,979			Glacial drift	Hard, clear, "alkaline"		D, S	Sufficient for local needs; also a dam is used for stock.
4	SE.	36	"	"	"	Bored	45	2,960	- 42	2,918			Glacial drift	Hard, clear, "alkaline"		D	Insufficient supply; also twelve dry holes 12 to 50 feet deep.
1	NW.	15	9	30	3	Dug	18	3,350	- 8	3,342	8	3,342	Recent sand and gravel	Hard, clear		D, S	Sufficient for local needs; also a creek is used for stock.
2	NE.	22	"	"	"	Dug	11	3,300	- 6	3,294			Glacial drift	Hard, clear, "alkaline"		D, S	Sufficient for local needs; also a creek is used for stock.
3	NE.	25	"	"	"	Dug	10	2,380	- 5	2,375	10	3,370	Recent sand	Hard, clear		D, S	Sufficient for local needs; also a creek is used for stock.
4	SE.	34	"	"	"	Bored	45	3,240	- 12	3,228	14	3,226	Glacial sand	Hard, clear, "alkaline", iron		D	Sufficient supply; a dam is used for stock.

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. 82, 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
5	SE.	35	9	30	3	Dug	7	3,285	0	3,285	6	3,279	Recent sand	Soft, clear		D	Sufficient supply; a spring is used for stock.
6	NW.	35	"	"	"	Dug	5	3,400	− 1	3,399			Recent silt	Hard, clear, "alkaline"		S	Intermittent supply.
7	NE.	35	"	"	"	Dug	15	3,290	− 9	3,281			Glacial drift	Hard, clear, "alkaline"		S	Insufficient for local needs.

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

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