CANADA

DEPARTMENT OF MINES

AND

TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 73

PRELIMINARY REPORT

GROUND-WATER RESOURCES

OF THE

RURAL MUNICIPALITY OF ....

NO. 15

SASKATCHEWAN

By

B. R. MacKay, H. H. Beach and E. L. Ruggles

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BUREAU OF ECONOMIC GEOLOGY

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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 find the approximate depth to a water-bearing horizon, he must learn: (1) the elevation of the site, and (2) the probable elevation of the water-bearing bed. The elevation of the well site is obtained by marking its position on the map, Figure 2, and estimating its elevation with respect to the two contour lines between which it lies and whose elevations are 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 wind since the disappearance of the continental ice-sheet.

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

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

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

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

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

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

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

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

Cypress Hills Formation. The name given to a series of conglomerates and sand beds which occur in the southwest corner of Saskatchewan, and 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. 15 is an area of 324 square miles located along the International Boundary in the Wood Mountain upland area in the western part of southern Saskatchewan. The municipality consists of nine townships, described as tps. 1, 2, and 3, ranges 7, 8, and 9, W. 3rd mer. The centre of the municipality is approximately 100 miles southwest of the city of Moose Jaw, and 75 miles south-southeast of Swift Current. The greater part of the area is a plateau into which have been cut many valleys and coulées, the larger of which are now occupied by Bluff, McEachern, and Horse creeks. The eastern part of Pinto butte forms an east-west drainage divide extending across the northern townships of the municipality.

From elevations of approximately 2,600 feet above sea-level in the southeast corner the ground surface rises in a northwesterly direction to elevations exceeding 3,200 feet above sea-level in the northwestern part of the municipality. The rugged topography of the municipality makes the area generally unsuitable for farming, and it is given over largely to grazing. Since the population is very small the demand for water for domestic purposes is not great, but considerable supplies are required for stock. Springs and spring-fed creeks are numerous throughout the area and supply sufficient water for the stock at most points. However, wells have been dug in a few localities. The ground water is being derived from the Recent alluvial deposits in the valley bottoms, from the glacial drift that mantles the remainder of the area, and from the underlying bedrock formations. Wells are not numerous enough, however, to make possible the accurate tracing of water-bearing horizons over an extensive area.

Water-bearing Horizons in the Unconsolidated Deposits

The Recent alluvium along the valley bottoms of the larger creeks is sufficiently thick to form a reservoir for surface and spring waters coming off the hill-sides. Waters percolating through boulder clay leach out considerable amounts of mineral salts and deposit them in the valley alluvium deposits, particularly where this consists largely of silts and fine sands. The water is rendered often quite "alkaline" and unfit for household use. The yield from wells sunk into the silts is also very small. In places beds of gravel have been encountered in the silts at depths of 15 feet or less, and yield water sufficient for 40 to 100 head of stock. Wells into the alluvium have been located in sec. 34, tp. 1, range 8, and sec. 4, tp. 2, range 8, and fairly large supplies are probably to be found at many points in the flats of the larger valleys.

Many thousands of years ago a continental ice-sheet passed in a southwesterly direction over the province of Saskatchewan. As it advanced it deposited a layer of drift upon the bedrock. Such a veneer of boulder clay or till covers the bedrock over the greater part of this municipality. The till is composed largely of a yellowish brown clay grading into a more compact, bluish grey clay at depth. Boulders and occasional beds or pockets of sands and gravels are interspersed irregularly through the clay. The thickness of the drift varies greatly being less than 10 feet on many of the hill-sides, and probably not exceeding 50 feet at any point in the municipality. Wells sunk entirely in the boulder clay yield very small supplies of generally highly mineralized water. Where sand beds have been encountered at shallow depths these form a source of larger supplies of soft or moderately hard, slightly mineralized water for household use and for watering a few head of stock. The few wells that have tapped pockets or lenses of gravel yield sufficient water for 10 to 40 head of stock. These generalizations are based on meagre information collected at widely separated localities in the municipality. They are believed to be sufficiently substantial, however, to give a fairly accurate conception of the quality and quantity of ground water to be expected from the various types of deposits that make up the drift covering of the area. Gravels are in many places found in greater concentrations near the bottoms of slopes and wells so situated yield the best supplies obtainable from the drift. On the uplands there is little evidence on the surface of the presence of the more porous beds in the drift, so that it is often necessary to sink several shallow wells before an adequate supply of water is secured. Throughout the south-eastern half of township 3, range 7, and most of township 3, ranges 8 and 9, residents who have sunk wells into the drift without obtaining adequate supplies of ground water are advised to continue the wells down into the underlying Ravenscrag bedrock formation, from which fairly large supplies are generally obtainable. At other places in the municipality the bedrock underlying the drift is less productive and more extensive prospecting in the Recent alluvium and glacial deposits is advisable.

Water-bearing Horizons in the Bedrock

Three formations known as the Ravenscrag, Eastend, and Bearpaw, have been recognized in this municipality. The areal distribution of these three formations in the township is indicated on Figure 1. The Ravenscrag is the uppermost of the three formations, and is confined to the areas of higher elevation in township 3, ranges 7, 8, and 9, where it either outcrops at the surface or immediately underlies the glacial drift. The formation consists of yellow to brown clays and shales, coarse bluish or greenish grey sands, and thin seams of lignite coal. In many places the sands are firmly cemented and form ledges which outcrop along the valley sides. The sand beds and coal seams form the water-bearing horizons in the Ravenscrag formation and are the best source of ground water in the bedrock of the municipality. Springs occur at many points on the slopes where the Ravenscrag beds are outcropping or lie within a few feet of the surface. Many of the springs flow continuously throughout the year and are the sources of the creeks. By excavating reservoirs around these springs a water supply sufficient for fairly large herds of stock is obtainable. At other places both on the slopes and on the uplands wells sunk to depths ranging from 10 to 40 feet encounter the water-bearing sand beds and coal seams of the formation. The yield from individual wells is variable. Two of the wells investigated yield small supplies, but in general sufficient water for 10 to 50 head of stock is obtainable at shallow depths, and one well located on SW.$\frac{1}{4}$, sec. 2[illegible], tp. 3, range 9, yields sufficient water for 100 head of stock.

Some 25 to 40 feet of fine grey silts and sands, comprising the Eastend formation, underlie the Ravenscrag formation at an approximate elevation of 2,950 feet above sea-level in the NE. corner of township 2, range 7, and due to a slight northwesterly rise of the bedrock, at an elevation approximately 100 feet higher in the northwest corner of the municipality. The Eastend has approximately the same areal extent as the overlying Ravenscrag beds. The sandy nature of the Eastend formation suggests that it will prove to be water-bearing. Since it is covered in most places by the Ravenscrag formation, and also by 100 feet or more of glacial drift, it is questionable if the necessity will arise for sinking wells through the upper beds into this formation.

The Eastend formation becomes shaly towards its base and grades downward imperceptibly into the compact, buff to yellow-brown weathering, dark grey marine shales that comprise the Bearpaw formation. Thin beds of brownish grey sands, generally of limited areal extent, occur sparingly through the upper part of the shale. At greater depths, however, the shale contains a considerable amount of bentonite which tends to make it very compact and generally a very poor reservoir for ground water. The Bearpaw immediately underlies the drift throughout the southern two-thirds of the municipality and in the lowlands in the northern parts of township 3, ranges 7 and 8.

The Bearpaw formation is found to yield larger supplies of water of better quality in this municipality than are generally found in this formation in other areas. The shale that comprises the greater part of the formation usually yields only small seepages of generally highly mineralized water. In areas where the overlying drift is thin and the shale has been exposed to the weathering action it becomes more porous. Wells sunk to depths not exceeding 30 feet into the shale in the south-western part of the municipality yield sufficient quantities of water for 10 to 20 head of stock. Another aspect of the shale lending to its productivity in this area is the presence of fairly extensive beds of sand. Wells that have penetrated these beds yield water of better quality than that derived from the shale. The yield in a few of the wells is sufficient for 50 head of stock. In places where the sand beds come to the surface along the sides of valleys or lie within a few feet of the surface springs occur. Two of these springs examined were reported each to yield sufficient quantities of water for 10 head of stock. No deep drilling has been done in the areas underlain by the Bearpaw formation. It is improbable, however, that any large supply of water will be obtained at depths greater than 50 feet from the surface.

At points some 20 miles west of the western boundary of this municipality the Bearpaw formation is known to be underlain by the Belly River formation, which is composed largely of sand beds.

In the areas examined the formation was water-bearing. It would be necessary, however, to drill to depths of 200 to 400 feet even in the lowlands part of this municipality before the Belly River horizon would be encountered, and there is no assurance that if the sand beds were penetrated that they would prove to be water-bearing. Residents of the southern two-thirds of the municipality are better advised to confine their search for water to the drift or to the upper 50 feet of the underlying Bearpaw formation.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 1, Range 7

This entire township is devoted to ranching and there are very few residents in the area. The demand for domestic water supplies is, therefore, very small and adequately met by shallow seepage wells situated close to creeks. Much greater supplies are required for the stock in pasture. In years of normal rainfall ample supplies are found in sloughs and in the creeks. When this source fails the stock must be driven to the springs occurring on the higher land to the north.

Recent stream deposits of silts, sands, and gravels occur along the creek valleys. The silts are generally only sparingly water-bearing, but elsewhere in the municipality where beds or pockets of sands and gravels have been encountered supplies sufficient for 15 to 50 head of stock are obtained. These pockets lie within 15 feet of the ground surface. They are not generally continuous and several wells may be sunk in these areas without striking one of these aquifers. Only by testing can their location be determined. As the alluvial deposits in the valleys often contain large amounts of mineral salts ground water obtained from them is often highly "alkaline", and although the water may not be fit for domestic use it is quite satisfactory for stock.

No information was obtained regarding the producing properties of the glacial drift that covers the remaining parts of the township. It consists largely of impervious boulder clay or till. Isolated pockets of water-bearing sand and gravel undoubtedly occur in the boulder clay at some points, but the quality or quantity of water to be expected from them is not known.

The Bearpaw formation underlies the whole township, but as yet has not been penetrated by wells at any point. At several places it has been found outcropping at the surface. The depth of covering of glacial drift probably nowhere exceeds 25 feet.

In nearby townships water is being derived from the Bearpaw formation, so that it is probable that ground water could also be obtained from the shales and sandy beds underlying the glacial drift in this township. Supplies obtained from individual wells should be ample for 15 to 50 head of stock. The quality of water obtainable is uncertain. In some instances good water is found in the Bearpaw formation, but in many wells it is very highly mineralized. It is, however, satisfactory for stock use.

Township 1, Range 8

The small supplies of water required for domestic purposes in this township are obtained from shallow wells dug into the Recent alluvium in the valleys, and the mantle of glacial drift which caps the hill-sides. The Recent deposits occurring in the valley of McEachern creek and its tributaries consist of silts, sands, and gravels. Wells 15 feet deep, or less, on section 34, obtain water supplies sufficient for 15 to 50 head of stock from these silts and gravels. This yield is not sufficient for local farm requirements, but additional stock water is obtained from the creek and from springs. The water from all wells in the creek beds contains large amounts of dissolved mineral salts, which in some instances makes the water unfit for domestic use. Similar supplies can be expected in other parts of the valleys.

The glacial drift covering the township consists of boulder clay which is too impermeable to be a good source of ground water. A few shallow seepage wells have been dug into the clays, but they produce only small quantities of highly mineralized water. No sand or gravel aquifers have been encountered in these wells, but such doubtless occur in some localities and should be found at depths not exceeding 35 feet. The water from these pockets would undoubtedly contain fairly large amounts of mineral salts in solution.

but should be of better quality than the water obtained from the Recent deposits. The yield from wells sunk in the drift of the uplands will probably not be as large as from wells located in the creek flats.

The Bearpaw formation underlies the glacial drift throughout the entire township. As no wells have as yet penetrated the formation in this township its local water-bearing characteristics are not known. The formation will doubtless possess similar properties to those it exhibits in the nearby townships. Water having a high content of dissolved mineral salts should be available at most points in the township from wells dug to depths not exceeding 50 feet. In some places the water will probably be found to be too highly mineralized for domestic use. Where only the heavy clays and shales are penetrated the water supplies available will doubtless be very small, but where the shales are more sandy supplies ample for 25 or more head of stock are to be expected. The Bearpaw formation seems to offer the best possibilities of ground water supplies in this township.

Township 1, Range 9

So far as could be learned no wells have been sunk in this township. The entire area is given over to grazing and the ground water requirements of stock are supplied by the creeks and a few springs on the valley sides, two of which are shown in Figure 2.

Both the Recent alluvium covering the valley bottoms and the layer of glacial drift exposed elsewhere over the township can be expected to form sources of domestic supply in the event of settlement in the area. Pockets of gravel occur interspersed through the upper 15 feet of the alluvial deposits covering the bottoms of McEachern and Bluff creeks. The pockets are not generally continuous over any great length in the valleys, and hence careful prospecting at shallow depths may be necessary before any large water supply is obtained. Much of the water found in the silts is highly mineralized and not fit for drinking, but supplies from the more extensive gravel beds generally are suitable for all domestic requirements.

The boulder clay will yield only small seepages of water, but isolated sand and gravel pockets in it are expected to be water bearing. Considerable difficulty may be experienced in locating such reservoirs, as their presence is not generally indicated on the ground surface. These pockets are to be expected within 35 feet of the surface, and are probably more plentiful in the dirft of the northern parts of the township than in the south. Water obtained from such sources is generally hard and slightly mineralized. The yield from individual wells sunk in the drift in any part of the municipality is not large, but is usually sufficient for household needs and for 10 to 20 head of stock.

The Bearpaw formation underlies the glacial drift throughout the whole township. No outcrops have been recorded, but the presence of springs in the coulées and valleys indicates that the formation lies very close to the surface on the slopes. These springs provide water for the stock and feed the creeks traversing the area. Wells sunk at any point in the township should obtain water from the sands or shales of the Bearpaw formation at depths not exceeding 50 feet. The water will probably be highly mineralized and may not be suitable for domestic use. Supplies ample for at least 10 head of stock may be expected from individual wells.

Township 2, Range 7

This township is not settled and is devoted entirely to stock grazing. The water requirements for stock use are being met by sloughs and creeks and by the numerous springs occurring in the northern part of the township.

Stream deposits of silts, sands, and gravels occur in the valleys of the creeks. The sands and gravels generally occur in isolated pockets interspersed through the silts and form fairly large reservoirs for ground water. Elsewhere in the municipality these pockets are tapped by wells usually not exceeding 15 feet in depth. It may be necessary to sink several test holes before locating such an aquifer, as the lenses are not usually continuous along the valley bottoms. Water from these deposits in this district is commonly very highly mineralized and at some places to such an extent as to be unsuitable for drinking. The yields to be expected from individual wells vary depending largely upon the size of the pocket tapped. The quantity is expected to be sufficient for 10 to 50 head of stock.

Glacial till, or boulder clay, covers practically all the township. The thickness of the glacial drift is not known, but probably does not exceed 50 feet at any point. Only one well has been sunk into the boulder clay and it gives very little information as to its water-bearing properties. This well, on NW.$\frac{1}{4}$, section 18, sunk to a depth of 14 feet, yields a small, intermittent water supply. The water has a very high content of dissolved mineral salts and is not suitable for household use. Pockets of water-bearing sands and gravels scattered through the boulder clay are to be expected, and such doubtless exist in the drift at many points in the township. They should be found by careful testing at depths generally less than 35 feet. The water will likely be hard, but generally of good quality. Supplies will not be large and it is improbable that any one well will produce more than enough water for 25 head of stock.

Ravenscrag, Eastend, and Bearpaw bedrock formations occur in this township. The areas in which each of these formations is encountered immediately beneath the layer of glacial drift is indicated on the accompanying map, Figure 1. The Ravenscrag formation exists on the uplands in the northern sections, and is probably the source of the springs occurring along the valley sides. Ground water has been found in wells tapping the Ravenscrag formation in the township to the north, and water conditions of this formation will probably be similar in this area. The water occurs in sand beds near the top of the formation. As the glacial covering is thin in this area the water-bearing beds should be encountered in wells usually not exceeding 50 feet in depth. Water of good quality is to be expected and supplies should be ample for 15 to 30 head of stock.

The Eastend formation underlies the Ravenscrag formation and occurs immediately beneath the drift in a narrow area extending along the base of the northern hills, as shown on the map. Little is known of the water-producing properties of the Eastend formation in this area, but due to its sandy nature small supplies at least are probably to be found in it. The water may, however, be highly mineralized.

Throughout the remainder of the township the Bearpaw formation occurs immediately beneath the glacial drift. Water conditions will doubtless be similar to those in nearby townships where a few wells have penetrated the formation. Highly mineralized water may be expected from the shale or from thin sand beds interspersed through it at depths ranging from 15 to 30 feet. The quantity of water to be expected in any one well cannot be foretold as great variations exist among wells producing at present from this horizon. Some wells yield only very small supplies, whereas the yield from others is ample for 30 to 60 head of stock.

Township 2, Range 8

The ground water supply for the McEachern settlement in the southern part of the township is obtained from a good well on NW.$\frac{1}{4}$, section 4, and from several less productive, shallow seepage wells. In years of subnormal precipitation these latter wells do not provide sufficient water.

The well located in the valley on section 4, derived its supply from a gravel bed at a depth of 12 feet. The water from this well is of good quality and the supply is adequate for more than 100 head of stock. This well is exceptional and water supplies as large as this are to be expected at all points in the valleys, but where sand or gravel lenses can be located by testing good supplies should be found.

A covering of glacial till, or boulder clay, the thickness of which has not been determined, occurs over the township. Although the drift consists mainly of impervious clay there are also present generally isolated pockets and beds of water-bearing sands and gravels. The location of such beds cannot be ascertained except by careful testing. It is probable, however, that they will occur within 35 feet of the ground surface. Water of fairly good quality should be obtained, but large supplies are not to be expected.

The Ravenscrag formation underlies the glacial drift in the northeastern part of the township, as indicated on the map, Figure 1. No wells have been sunk in this area, but from information obtained in adjacent townships it appears that water-bearing beds of sand occur in this formation and should lie within 50 feet of the ground surface. Water from the Ravenscrag formation is of good quality, and individual wells should yield supplies ample for at least 20 head of stock.

Ground water also occurs in the Bearpaw formation which underlies the glacial deposits in the remaining area. In the township immediately to the west water supplies are being obtained from wells tapping the Bearpaw formation at depths of 15 to 30 feet. The water is highly mineralized and is not always suitable for domestic use but is satisfactory for stock. Supplies sufficient for 15 to 60 head of stock are being obtained from individual wells. Similar conditions should exist in the Bearpaw formation in this township.

Township 2, Range 9

Satisfactory water supplies are being obtained at several points in this township, both from the glacial drift and from the underlying bedrock.

Recent alluvial deposits of silts, sands, and gravels cover the floors of the creek valleys to shallow depths. These deposits have not been prospected for ground water but the sand or gravel beds which are dispersed through the silts should act as reservoirs, for at least small quantities of ground water. The water will probably be rather highly mineralized and may be unsatisfactory for household use. It is improbable that individual wells into the alluvium will yield a sufficient supply for stock requirements.

The glacial till, or boulder clay, which covers all other parts of the township is found to include water-bearing gravel pockets or thin beds of sand. Two wells located on section 32, are tapping aquifers of this nature lying within 50 feet of the ground surface. The water obtained is soft and of good quality. One well produces only sufficient water for 10 head of stock, whereas the other well yields a supply ample for 40 head. These gravels are not continuous throughout the drift, and in some localities extensive testing may be necessary before an adequate ground water supply is obtained. Throughout the township the depth of glacial covering ranges from 30 to 50 feet.

The Ravenscrag formation occurs immediately beneath the glacial drift in the upland area of approximately 4 square miles in the north-central part of the township as indicated on the map, Figure 1. On section 32 it lies immediately below the gravel aquifer of the drift, at an elevation of about 3,130 feet above sea-level. The sand beds of the Ravenscrag formation are generally water-bearing, and supplies of good water should be found in this area by sinking wells into the bedrock to depths not exceeding 50 feet from the surface.

The Eastend formation underlies the Ravenscrag formation and extends beneath the glacial drift as a narrow fringe bordering the highlands area, as shown on the map. No water is being drawn from the Eastend formation in this area, but water-bearing beds probably do exist in the formation. The water will doubtless be quite highly mineralized, and will not be of as good quality as that from the Ravenscrag formation. It should not be necessary, however, to sink wells into the Eastend formation as ample supplies to meet requirements can probably be obtained from the overlying Ravenscrag formation at shallower depths.

Throughout the greater part of the township the Ravenscrag and Eastend formations are absent, and the Bearpaw formation occurs below the glacial drift. Wells 14 to 30 feet deep on sections 4, 15, and 27, are drawing water from the Bearpaw shales at elevations of 2,854, 2,930, and 3,191 feet above sea-level, respectively. Although continuous water horizons may exist in the formation they are not traceable from the information at hand. However, it appears that water is present in the upper part of the formation at all points and should be found immediately below or a few feet beneath the drift. Water in the Bearpaw formation is highly mineralized and the water from the well in section 4 is not suitable for household use. The supplies being obtained from the wells in sections 4 and 15 are sufficient for 15 head of stock, and 60 head may be watered from the well in section 27.

Township 3, Range 7

The ground water supplies in this township are adequate for the present domestic and stock requirements. Supplies are being derived from the glacial drift and from the underlying Ravenscrag and Bearpaw bedrock formations.

Thin deposits of Recent alluvium composed of silts, sands, and gravels occur in the valleys. No wells have been dug in these deposits, but it is probable that supplies of ground water could be obtained from them at shallow depths where sand or gravel pockets can be located. Water of fair quality is to be expected.

The surface covering of the remainder of the township is glacial till or boulder clay. Sand or gravel lenses lying within 35 feet of the surface have been penetrated in five wells in the township and similar deposits may be expected in other localities. The quality of the water is good, but supplies are small. Individual wells are producing only enough water for 5 to 10 head of stock, and in one case 20 head.

The Ravenscrag formation immediately underlies the drift throughout the eastern half and most of the southern part of the township, as indicated on the accompanying map,(Figure 1). Wells in sections 9 and 10 are deriving water from sandstone beds at elevations of 3,017 and 2,925 feet above sea-level, respectively. The water is of good quality in both instances, and supplies are ample for 15 and 30 head of stock. Similar water supplies may be expected from wells within a maximum depth of 35 feet over that part of the area in which this formation occurs.

The Eastend formation underlies the Ravenscrag and projects beyond it beneath the drift cover as a narrow strip extending through sections 22, 27, and 34. No wells have been sunk in this narrow strip, nor have any been dug deep enough to pass through the Ravenscrag formation into the Eastend in other localities. Water can doubtless be obtained from the Eastend formation, but the quality and quantity of the supply to be expected is inferior to that to be derived from the Ravenscrag. However, as water supplies are to be obtained at lesser depths from aquifers in the overlying Ravenscrag formation there is no necessity for drilling deeper in search for water in the Eastend formation.

The Ravenscrag and Eastend formations are absent in the northwestern corner of the township and the Bearpaw formation underlies the glacial drift. Water is being derived from blue shales of this formation at an elevation of 2,917 feet above sea-level on section 17. In a 75-foot well on section 32 the shales were reached at an elevation of 2,800 feet. The surface of the formation conforms generally with the present land surface, and the covering of drift seldom exceeds 35 feet. The well on section 17 yields a small supply of water of good quality. A spring on the same section, believed to issue from the Bearpaw formation, produces ample water for 50 head of stock. Water supplies of varying quantity and quality are to be expected throughout the northwestern part of the township from wells similar to that sunk on section 17.

Township 3, Range 8

Good supplies of ground water are available throughout the township from the springs occurring along the hill-sides. As most of the area is devoted to grazing these springs provide a suitable source of water for stock. Only one well has been dug in the township.

The glacial drift that forms a mantle over the whole township consists mainly of boulder clay. Very small quantities of water might be obtained from the clay but such would probably be very highly mineralized. Isolated sand or gravel pockets occur in the glacial drift and are usually found within 35 feet of the surface. Careful prospecting in the drift will undoubtedly locate such aquifers on many of the lower hill-slopes. Hard water of good quality will be found in the sands and gravels, but large supplies cannot be expected.

As shown on the map, Figure 1, the greater part of the township is underlain by the Ravenscrag formation. The thickness of the glacial covering throughout the area is not known, but it is believed to be everywhere less than 25 feet. Outcrops of the bedrock are numerous, and good water issues from many of them as springs. Indications in adjoining townships are that water occurs close to the top of the Ravenscrag formation. Thus, throughout the part of this township in which this formation occurs water should be found in the sand beds at depths nowhere exceeding 50 feet. Water from this source is usually of good quality. The amount of water to be obtained cannot be predetermined as supplies from existing wells range from that required by 10 head of stock to ample quantities for 100 head. The well on section 32 was dug 30 feet deep to tap a water-bearing sand bed at an elevation of 3,045 feet above sea-level. This sand bed may occur in the Ravenscrag formation or it may represent the top of the Eastend formation. The water is highly mineralized and more typical of supplies from the Eastend than the Ravenscrag. The supply is ample for 30 head of stock. The Eastend formation underlies the Ravenscrag formation in most places and is probably water-bearing throughout. However, as water may be obtained from the overlying Ravenscrag formation it should seldom be necessary to sink wells to tap this lower horizon.

The Bearpaw formation immediately underlies the boulder clay in the northeast and southwestern parts of the township. Ground water supplies should be obtainable from these shales or sand beds of this formation at depths not exceeding 50 feet. Water from this formation is highly mineralized, and may be suitable only for stock.

Township 3, Range 9

No lack of good ground water has been experienced by the residents of this township at any time. As there is only a small number of inhabitants the demand for domestic supplies is small. Numerous springs and creeks in the area provide sufficient water for the stock.

Glacial till covers the entire township to depths not exceeding 35 feet. Only one well, situated on section 34, is deriving water from these deposits. The aquifer in this well is a bed of gravel lying 17 feet below the ground surface and immediately above the Ravenscrag bedrock formation. The water is hard and of good quality and the supply is sufficient for 21 head of stock. Doubtless similar supplies could be obtained at similar depths throughout the township. Gravel beds such as encountered on section 34 are not generally continuous over any large area, so that considerable testing may be necessary before an adequate supply is obtained.

The Ravenscrag formation immediately underlies the glacial drift throughout the greater part of the township, as may be seen from the accompanying map, Figure 1. Numerous springs issue from outcrops of this bedrock and wells have been sunk into the sand beds of the formation on sections 16 and 23. The elevations of the various water-producing horizons encountered range from 3,240 to 3,125 feet above sea-level. These aquifers may or may not be continuous, but in any case water will probably be found to be present near the top of the Ravenscrag formation at all points. The two wells that are tapping the formation are 25 and 26 feet deep, and it is doubtful if depths greatly in excess of these will be necessary to obtain a water supply in other places. The quality of the water in all instances reported is good. The well on section 16 yields only a small supply, but sufficient water for at least 100 head of stock may be drawn from the well on section 23. A spring on section 9 supplies water for 47 head of stock.

The Eastend formation underlies the Ravenscrag formation at an approximate elevation of 3,050 feet above sea-level and in small areas in the northeast and southwestern parts of the township, where the Ravenscrag is absent it is encountered immediately beneath the glacial drift. These areas are shown on the map, Figure 1. No water is being obtained from this formation although some of the more permeable sandy beds are probably water-bearing. Although ground water could probably be obtained from the Eastend formation in those areas in which it underlies the drift, or by passing through the overlying Ravenscrag formation at other points, the quality and quantity of water to be expected from this horizon are as a rule inferior to that obtained from the Ravenscrag formation.

In the southeast and southwest corners of the township the Bearpaw formation occurs below the glacial drift. No attempts have been made to obtain ground water in these parts of the area, but water-bearing horizons doubtless exist here similar to those in the Bearpaw formation in other townships. Mineralized water could undoubtedly be obtained from the sands or shales at depths not exceeding 35 feet. It is improbable, however, that supplies suitable for any large number of stock are to be found

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF NO.15, SASKATCHEWAN

West of 3rd meridian — Township / Range	1 / 7	1 / 8	1 / 9	2 / 7	2 / 8	2 / 9	3 / 7	3 / 8	3 / 9	Total No. in Municipality
Total No. of Wells in Township	3	13	2	1	4	16	11	6	9	65
No. of wells in bedrock	0	0	2	0	0	14	3	6	8	33
No. of wells in glacial drift	3	10	0	1	3	2	8	0	1	28
No. of wells in alluvium	0	3	0	0	1	0	0	0	0	4
Permanency of Water Supply										
No. with permanent supply	3	2	2	0	1	16	11	6	8	49
No. with intermittent supply	0	11	0	1	3	0	0	0	1	16
No. dry holes	0	0	0	0	0	0	0	0	0	0
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	0	1	0	1
No. of non-artesian wells	3	13	2	1	4	16	11	5	9	64
Quality of Water										
No. with hard water	3	13	2	1	4	14	7	6	4	54
No. with soft water	0	0	0	0	0	2	4	0	5	11
No. with salty water	0	0	0	0	0	0	0	0	0	0
No. with alkaline water	0	13	0	1	3	1	1	1	0	20
Depths of Wells										
No. from 0 to 50 feet deep	3	13	2	1	4	15	10	6	9	63
No. from 51 to 100 feet deep	0	0	0	0	0	1	1	0	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	3	13	2	0	4	15	11	6	9	63
No. not usable for domestic purposes	0	0	0	1	0	1	0	0	0	2
No. usable for stock	3	13	2	1	4	16	11	6	9	65
No. not usable for stock	0	0	0	0	0	0	0	0	0	0
Sufficiency of Water Supply										
No. sufficient for domestic needs	3	13	2	1	4	16	10	6	9	64
No. insufficient for domestic needs	0	0	0	0	0	0	1	0	0	1
No. sufficient for stock needs	0	0	2	0	1	15	7	6	8	39
No. insufficient for stock needs	3	13	0	1	3	1	4	0	1	26

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 boilders 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 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 ground water either from the unconsolidated deposits or from the bedrock formations of this municipality were collected for analysis. The generalizations here given are drawn from observations made at the wells and from descriptions by residents of the quality of the water, and from analyses of waters from adjoining municipalities in which water conditions are similar.

Waters from the Recent deposits in the valleys are generally very highly mineralized and contain large amounts of the sulphates of sodium and magnesium in solution. These salts when present in large quantities have a laxative effect on man and produce scour in stock. In some parts of the valleys the presence of the salts is evidenced by the whiteness of the soils. Any water percolating through such deposits will dissolve large amounts of the salts. Water from gravel beds in the Recent deposits is found to be less highly mineralized than the water from the silts, and in some places is considered to be suitable for household use.

Supplies obtained at shallow depths in gravel beds in the glacial drift are soft or moderately hard and since the water contains only small quantities of dissolved sulphate salts it is considered suitable for all domestic requirements. Water from sand beds or gravel beds covered by a greater thickness of boulder clay is appreciably higher in dissolved salts. The small seepages derived from the boulder clay itself are often highly mineralized and quite unsuitable for drinking. In general, however, the few wells sunk in the drift on the hill-sides in this municipality yield water of better quality than is found in wells tapping productive horizons in the silts covering the valley floors.

Water from the Bedrock

The water being derived from the Ravenscrag formation is of good quality and is quite suitable for all farm requirements. The water is reported to be soft in a few of the wells sunk into this formation, but the majority of the wells yield a hard water. Of the salts in solution, sodium sulphate is found in the largest proportion with the carbonates of calcium and magnesium and the sulphate of magnesium occurring in lesser quantities. Small amounts of iron are found in some of the waters coming from coal seam aquifers. The Ravenscrag formation is the best source of good ground water in the municipality.

Very little is known about the quality of the water from the Eastend formation. The water will probably be fairly high in dissolved mineral salts, and should be comparable in quality with water from the underlying marine shales of the Bearpaw formation. These waters may be suitable only for stock.

Considerable variation exists in the quality of the water from the Bearpaw formation in different parts of the area. The water is nearly always found to be highly mineralized, but the total dissolved solids in waters analysed ranges from 300 to 10,280 parts per million with an average of about 2,000 parts per million. Water containing such large amounts of mineral salts is not suitable for domestic use and in some cases is harmful to stock. The water being derived from the Bearpaw formation in this municipality is in general of better quality, however, than supplies from this formation in surrounding districts. This condition may be attributed to the presence of more continuous sand beds interspersed through the shale and to the more sandy character of the shale itself.

Sodium sulphate (Glauber's salt) is the predominant salt in solution in waters from the Bearpaw. The carbonates of calcium and magnesium and in some cases sodium are present in varying amounts. Magnesium sulphate (Epsom salts) was found in some samples. Sodium chloride is always present in the water. These latter two salts are more undesirable in water for human consumption, but if not present in large concentration do not render the water unsuitable for stock use. If stock are being fed on dry fodder during winter months the slight laxative effect of these salts in solution is by no means harmful.

It is probable that the mineral salt content of the water increases with greater depths in the shale. No information is available regarding the quality of water that is to be expected from the Belly River formation which is believed to occur below the Bearpaw formation in the southwestern part of the municipality.

WELL RECORDS—Rural Municipality of ND. 15, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE: Above (+) Below (−) Surface	HEIGHT TO WHICH WATER WILL RISE: Elev.	PRINCIPAL WATER-BEARING BED: Depth	PRINCIPAL WATER-BEARING BED: Elev.	PRINCIPAL WATER-BEARING BED: Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
1	SW.	34	1	8	3	Dug	14	2,720	- 9	2,711			Stream gravels	Hard, clear, "alkaline"		D, S	Sufficient for 50 head stock only.
2	NW.	34	"	"	"	Dug	14	2,745	- 10	2,735			Alluvial clay	Hard, "alkaline", clear		D, S	Insufficient for 15 head stock.
1	NW.	9	1	9	3	Spring		2,800	0	2,800	0	2,800	Bearpaw? sandy clay	Hard, clear		D, S	Sufficient for 10 head stock.
2	NW.	17	"	"	"	Spring		2,800	0	2,800	0	2,800	Bearpaw? sandy clay	Hard, clear		D, S	Sufficient for 10 head stock.
1	NW.	18	2	7	3	Dug	14	2,800	- 0	2,800			Glacial drift	Hard, iron, "alkaline"		D, S	Insufficient supply; unfit for drinking.
1	NW.	4	2	8	3	Dug	12	2,728	- 8	2,720			Recent gravel	Hard		D, S	Oversufficient for 100 head stock.
1	SE.	4	2	9	3	Dug	30	2,860	- 7	2,853	6	2,854	Bearpaw clay	Hard, clear, "alkaline" iron		S	Sufficient for 15 head stock.
2	NW.	15	"	"	"	Dug	30	2,960	- 25	2,935	30	2,930	Bearpaw shale	Hard, clear		D, S	Sufficient for 15 head stock.
3	NW.	27	"	"	"	Dug	14	3,195	- 4	3,191	4	3,191	Bearpaw shale	Hard, clear		D, S	Sufficient for 60 head stock.
4	SE.	32	"	"	"	Bored	60	3,185	- 48	3,137	54	3,131	Glacialgravel	Soft, clear		D, S	Insufficient for 10 head stock.
5	NE.	32	"	"	"	Dug	36	3,160	- 33	3,127			Glacial gravel	Soft, clear		D, S	Sufficient for 40 head stock.
1	NE.	9	3	7	3	Dug	10	3,025	- 8	3,017	8	3,017	Ravenscrag sand	Soft, clear		D, S	Sufficient for 15 head stock.
2	NW.	10	"	"	"	Bored	35	2,950	- 26	2,924	25	2,925	Ravenscrag sandstone	Hard, clear		D, S	Sufficient for 30 head stock.
3	NE.	17	"	"	"	Bored	38	2,955	- 35	2,920	38	2,917	Bearpaw? clay	Hard, clear		D, S	Insufficient for local needs.
4	NE.	19	"	"	"	Dug	15	2,812	- 11	2,801	12	2,800	Glacial gravel	Hard, clear		D, S	Sufficient for 8 head stock.
5	SE.	28	"	"	"	Bored	32	2,890	- 26	2,864	32	2,858	Glacial sand	Soft		D, S	Insufficient for 2 head stock.
6	SW.	28	"	"	"	Bored	21	2,880	- 19	2,861	19	2,861	Glacial sand	Soft, clear		D, S	Sufficient for 5 head stock.
7	NE.	32	"	"	"	Bored	75	2,836	- 35	2,801	35	2,801	Glacial gravel	Hard, clear, "alkaline"		D	Insufficient for local needs.
1	NW.	32	3	8	3	Dug	30	3,075	- 5	3,070	30	3,045	Ravenscrag East-end(?) sand	Hard, clear, "alkaline"		D, S	Sufficient for 30 head stock.
1	SW.	9	3	9	3	Spring		3,240	0	3,240	0	3,240	Ravenscrag clay	Soft, clear		D, S	Sufficient for 47 head stock.
2	SE.	16	"	"	"	Bored	26	3,200	- 14	3,186			Ravenscrag	Soft, clear		D, S	Insufficient for local needs.
3	SW.	23	"	"	"	Dug	25	3,150	- 18	3,132			Ravenscrag clay	Hard, clear		D, S	Sufficient for 100 head stock.
4	SE.	34	"	"	"	Dug	17	3,030	- 13	3,017	13	3,017	Glacial gravel	Hard, clear		D, S	Sufficient for 21 head 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.