CANADA

DEPARTMENT OF MINES

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BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF WISE CREEK NO. 77 SASKATCHEWAN

By

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

WATER SUPPLY PAPER No. 89

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CONTENTS

Illustrations

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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 age.

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

The rural municipality of Wise Creek, No. 77, covers an area of 324 square miles in southwestern Saskatchewan. The municipality consists of nine townships described as tps. 7, 8, and 9, ranges 13, 14, and 15, W. 3rd mer.

The Lethbridge-Weyburn line of the Canadian Pacific railway extends along the valley of Notukeu creek, in a general east-west direction across the northern third of the area. The village of Cadillac, situated on the railway, in sec. 6, tp. 9, range 13, is approximately 38 miles south of the city of Swift Current, and 50 miles north of the International Boundary. The village of Crichton and Admiral are also located on the railway at distances of 6 and 12 miles, respectively, west of Cadillac.

The principal drainage of the area is to the northeast corner by means of Notukeu creek and its tributary streams. Notukeu creek is a permanent stream entering the municipality from the west in sec. 30, tp. 8, range 15, and flowing in a general northeasterly direction leaves the area in the northeastern corner. Bull creek, a southern branch of Notukeu creek, crosses the western border at the southwest corner of tp. 8, range 15, and flows east and then northeast through the central part of the area, to join the main stream in sec. 9, tp. 9, range 13. At most points, the valley floors of both Notukeu and Bull creeks are wide and the sides gently sloping, but for a distance of several miles along the valley, south of Crichton, the valley is narrow and the sides in many places are quite steep.

The central part of the municipality is a gently rolling lowland with surface elevations rising from 2,500 feet above sea-level in the creek valley in township 9, range 13, to 2,600 feet in the interstream. To the west, north, and south,

the land is more irregularly rolling, and rises to form uplands along the boundaries of the municipality. Elevations exceed 2,900 feet in the western part of the interstream area, and south of Bull creek the land rises to 3,100 feet or somewhat more in the hills in the southeast corner. North of Notukeu creek, the uplands are lower, nowhere exceeding elevations of 2,850 feet above sea-level, but are in many places deeply dissected by narrow coulées and ravines.

Throughout the greater part of the municipality little difficulty has been experienced in obtaining an adequate water supply for all farm requirements. The unconsolidated deposits, the principal sources of ground water in many parts of the province, are either thin or sparingly productive in several of the townships of this municipality. Deeper drilling into the bedrock in most places, however, has produced sufficient water. Many of the coulées are suitable sites for small dams that would conserve the surface run-off. To date, few residents have found it necessary to build dams or excavate dugouts to supplement the supplies from wells. Should drought conditions continue, however, conservation of the spring run-off or the flows of the creeks will become increasingly important to provide water for stock.

Water-bearing Horizons in the Unconsolidated Deposits

Water-bearing beds of silts, sands, and gravels occur in the bottom of Notukeu Creek valley to depths of 10 to 20 feet or possibly more in some localities. Wells sunk in these deposits usually yield moderately large supplies of water. Wells situated close to the stream channel probably derive their water by seepage from the creek, and yield water that is reported to be quite suitable for household use. Hard and probably "alkaline" water is to be expected at shallow depths

at some places in the wider valley flats along Notukeu creek remote from the stream. The sediments forming these flats are generally silts or fine sands that are too fine-grained to permit water to circulate rapidly through them. Mineral salts present in solution in the waters tend to be concentrated by surface evaporation. Coarse sand or gravel pockets that occur interspersed through the silts yield water of better quality. The supply obtainable from the silts is not everywhere sufficient for the farm requirements.

Little is known as to the ground water conditions existing in the valley of Bull creek, and in the smaller tributary channels, but it is quite probable that their stream deposits may also be water-bearing at some places.

The surface deposits throughout the remainder of the area consist of boulder clay in which pockets of well-sorted sands and gravels are irregularly interspersed. The glacial drift was deposited unevenly over the surface of the bedrock by a great continental ice-sheet that spread in a general southwesterly direction across the province of Saskatchewan many thousands of years ago. Throughout extensive areas, particularly over the highland, the surface of the drift deposits is characterized by numerous small hills and undrained depressions. These irregular areas are known as moraines, in contrast with the more gently rolling areas of boulder clay known as till plain.

The glacial drift varies in thickness from place to place. It is generally thin over the southern highlands, and is absent at some places in the valley of Notukeu creek, where erosion has exposed the underlying bedrock. The greatest thickness of drift encountered in wells occurs in the vicinity of Crichton, in sec. 7, range 14, tp. 9, where quicksand in the drift was found at a depth of 185 feet. Its thickness

throughout most of the area, however, ranges from 20 to 40 feet. The bluish grey boulder clay is generally too compact to form a source of more than small seepages of ground water, but the porous sand and gravel pockets that occur interspersed at various depths through the boulder clay are generally productive. The areal extent and thickness of the bed forming the aquifer, its porosity, and the thickness and porosity of the overlying sediments, in addition to variations in the amount of annual precipitation in the area, are all factors determining the character and amount of the water supply to be expected from this source. These porous beds are apparently more numerous in the eastern part of the municipality in range 13 than in the drift over the remainder of the municipality. In this area, water-bearing sand and gravel pockets are usually encountered at depths of 20 to 40 feet from the surface. From most of the wells the water supply is sufficient for 10 to 30 head of stock, although a few farmers report an inadequate supply. The water is usually hard, but is seldom too highly mineralized to be used for household purposes.

Throughout the remainder of the municipality, water-bearing beds are less numerous in the glacial drift, and most of the settlers have sunk their wells through the thin mantle of drift into the underlying bedrock formation.

Springs are of common occurrence on both sides of Notukeu Creek valley. Some of these flow throughout the year, and contribute a valuable addition to the supply of water for stock in the neighbourhood. Springs also occur in other parts of the municipality, particularly along the northwestern slope of the highlands in townships 7 and 8, range 14. Most of these springs are situated in the coulées; some of them have an appreciable flow, whereas others tend only to form marshes. At occurrences of the latter type of spring it is usually

necessary to dig a shallow well before a water supply is obtained. As a rule the spring waters are of good quality for domestic and stock use, although a few are reported to be slightly "alkaline".

Wells sunk through the boulder clay, which forms the greater part of the drift, have encountered water in several localities in sand or gravel beds, occurring either at the base or at the contact of the drift and the underlying bedrock. The individual water-bearing beds at this horizon are apparently of small areal extent, as at no place are they traceable for more than a mile in any direction, and are generally much more limited in extent. The supply and quality of waters from these basal sand beds are variable, but lie within the limits of variability found at higher horizons in the glacial drift.

It has been found a good practice in some localities to test the ground at proposed well sites with a 2-inch test auger before expending time and labour in digging a well. If boulders are not numerous in the clay, these test holes can be sunk successfully to a depth of 25 feet or even more. Owing to the irregular shape and often abrupt termination of the water-bearing sand and gravel pockets, several test holes may be required before an adequate water supply is located. For this reason the glacial drift should not be condemned as non-productive in any area where it has any appreciable thickness, until it has been thoroughly prospected down to the underlying bedrock.

Water-bearing Horizons in the Bedrock

Three bedrock formations known as the Ravenscrag, Eastend, and Bearpaw formations immediately underlie the glacial drift in different parts of the municipality. The uppermost or Ravenscrag formation consists of grey to greenish

grey sands and sandstones interbedded with medium to dark grey shales and an occasional thin seam of lignite coal. This formation is exposed in a road cut between secs. 11 and 12, township 7, range 14. The exact areal distribution of the Ravenscrag is not known, but it is thought to occur through slightly less than the southeastern half of this township, and all of township 7, range 13, with the exception of a few sections in the northeastern corner, as indicated on Figure 1 of the geological map accompanying this report. Its thickness varies from place to place, depending principally upon the thickness of the overlying glacial drift, and upon the surface elevation. Throughout this area the Ravenscrag extends down to an approximate elevation of 2,950 feet above sea-level.

Large supplies of water of good quality are obtained from wells sunk to the sand and sandstone members that occur near the base of this formation on the western side of the upland area in which this formation occurs. Smaller yields are also obtained from the coal and shale beds that occur at higher elevations in this vicinity. Little is known regarding the ground water conditions on the eastern side of the area, as only a few wells have as yet been sunk through the glacial drift in this part of the municipality. It is quite possible, however, that water-bearing sands may also occur in some parts of this area where surface elevations exceed 3,050 feet above sea-level.

The Eastend formation underlies the Ravenscrag, and since it occurs at lower elevations it is thought to extend for at least a mile beyond the northern border of the Ravenscrag formation as outlined above. The thickness of the Eastend probably does not exceed 50 feet. It consists of soft clay shales, interbedded with fine-grained, light to dark grey

silts and sands. This formation greatly resembles the upper part of the underlying Bearpaw formation into which it grades at its base. Some of the wells situated in this part of the municipality probably obtain their supplies from sand beds in the Eastend, although this geological horizon is difficult to identify in well logs.

The Bearpaw formation is of wide areal extent and occurs immediately beneath the Eastend and beneath the glacial drift throughout the remainder of the municipality. It consists essentially of soft, medium grey to nearly black clay shales, interbedded with a few thin beds of fine sand and hard iron-stone. Water has been found in this formation at depths of 20 to over 250 feet below the surface. Sand beds occurring occasionally between the layers of shale probably form the aquifers in some of the wells. Most of the wells, however, derive their water from the upper weathered 20 feet of the formation. It is presumable that the water is contained in joints and bedding planes of the shale. At greater depths below the surface of the bedrock the shale becomes more compact and more difficulty may be experienced in obtaining an adequate water supply. The finding of large supplies of soft, drinkable water at depth in the Bearpaw formation at several points in this area would suggest, however, that the formation is more porous in this area than in many municipalities lying to the north and east. Difficulty has been experienced when sinking wells in distinguishing the shales of the Bearpaw formation, from the overlying clays of the glacial drift. The shale is characterized by the absence of pebbles or boulders, but may contain concretions. The shale has a darker colour, and a more soapy feel to the touch than the glacial clay. Where encountered in dug or bored wells an examination of the shale fragments taken from the well usually shows some indication of

bedding, and, when exposed to the air for some time, the shale will gradually crumble into small, roughly cubical, iron-stained fragments.

As many of the present well owners of the municipality acquired their land after the well was dug, little information can be obtained as to the nature of the water-bearing bed. Some of the wells listed as obtaining their water from bedrock formations may be wholly in glacial drift. Waters obtained from the upper weathered zone of the Bearpaw and those from the clays of the glacial drift apparently do not differ greatly in character.

Although a shortage of water is reported at several places, most of the wells presumed to be tapping the upper few feet of the shale yield sufficient water for the average farm requirements of 20 to 30 head of stock. The quality of these waters shows a wide variation, and no prediction can be made regarding the type of water obtainable in any one locality. They are usually hard, and some are reported to be quite suitable for household use. Some are too highly mineralized to be used domestically, but all are used for watering stock.

At many places in the western, southern, and central townships, wells sunk to greater depths in the Bearpaw formation encounter a soft water of better quality than that found in the drift or in the upper weathered zone of the bedrock. A lack of uniformity in the elevations at which water is reported to have been found would suggest that many of the aquifers are of limited areal extent. In several townships, however, evidence points to the possible continuity of individual aquifers over several square miles. These horizons are penetrated at elevations between 2,650 and 2,550 feet above sea-level, or at depths of 50 to 260 feet below the surface. The water is under

hydrostatic pressure, and rises in different wells from 20 to 150 feet above the aquifer. It is possible that this pressure is created by the underground water seeping down from the highlands to the south and west. Many residents have reported the water-bearing bed to be "blue clay". The large supplies derived from many of these wells would suggest rather that the water occurs in thin beds of fine sand interlaminated with the shale or from sandy phases of the shale itself. Such aquifers as have been traced will be discussed under the individual townships in which they occur. The existing wells seem to indicate that in the western, southern, and central townships, water of fairly good quality can be expected at elevations between 2,650 and 2,550 feet above sea-level. No wells have been continued below this latter elevation, but it is possible that the Bearpaw below this horizon is less sandy, and may yield smaller supplies of much more highly mineralized water. Since lower beds of the Bearpaw underlie the northeastern corner of the municipality, it is possible that deep drilling will not prove to be as successful here as in the western and southern parts. No evidence to substantiate this assumption exists in the northeastern part of this municipality, but in the southwest corner of municipality No. 106, adjacent to this area on the northeast, a highly "alkaline" water, unfit for drinking, and of poor quality for stock use was found within 100 feet of the surface, and drilling to depths of 400 feet in one location yielded no water. In the northeastern township it seems advisable to confine the search for water to the glacial drift or the upper part of the Bearpaw, rather than to sink wells to depths greater than 150 feet.

At a few locations in the municipality, a very highly mineralized water that is unsuited to any farm use has been found at comparatively shallow depths. It has not been determined definitely whether this water is derived from the boulder clay or from compact phases of the shale. Such findings are not sufficiently numerous, however, to suggest that any distinct horizon yielding water of poor quality exists over any large area, either in the drift or in the upper part of the Bearpaw formation.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 7, Range 13

The land surface is steeply rolling in the southern and eastern upland part of this township, reaching elevations exceeding 3,100 feet above sea-level in the central parts. The surface becomes less irregular toward the north and northwest where the land slopes down toward the central lowland parts of the municipality. A large proportion of the township is devoted to grazing, and hence only a few wells have been sunk in the area to date.

Although the bedrock formations are considered to be the most reliable source of ground water, small to moderately large supplies may also occur at shallow depths in the overlying glacial drift. These waters are usually contained in sand and gravel pockets interspersed through the upper 20 feet of the boulder clay. Sand and gravel pockets also occur in the bottoms of coulées and in depressions in the land surface, or at the bases of steep slopes where materials washed down from the uplands form porous beds capable of retaining part of the surface run-off. A well situated in the NE.$\frac{1}{4}$, section 9, is yielding a fair supply of water from this type of deposit at a depth of about 6 feet. The water occurs in gravel. It is hard and is reported to be slightly "alkaline", but is being used for drinking.

Where the shallow water-bearing beds are not present the settlers have found it necessary to sink wells into the bedrock. The Ravenscrag formation immediately underlies the drift throughout the township, with the possible exception of sections 34, 35, and 36 in the northeastern corner. The base of the formation is thought to lie at an elevation of about 2,950 feet above sea-level. The depth to the Ravenscrag varies

considerably in different parts of the area, owing to differences in surface elevations, and to the irregular deposition of the overlying glacial drift. The formation has been encountered in wells at depths of 10 to 35 feet, but it may occur at greater depths in some of the unexplored localities. Wells encountering sands and sandy shales in the Ravenscrag usually yield sufficient water for about 10 to 20 head of stock. These waters are reported to be slightly "alkaline", but are not too highly mineralized to be used in the household.

A 95-foot well in the SW.¼, section 17, and a 34-foot well in the SW.¼, section 20, failed to encounter water in the Ravenscrag, but obtain large yields of water from shale or sandy shales in the Eastend formation or possibly in the upper part of the Bearpaw formation at an elevation of about 2,900 feet. The water is under hydrostatic pressure and rises in the wells to points about 30 feet above the aquifer. Although these wells apparently obtain water from the same aquifer the quality of the water differs greatly. The water from the well on section 17 is hard and is reported to be quite suitable for drinking, but the water from the other well is too highly mineralized to be used even for stock. The areal extent of this water-bearing bed is not known as no other wells have been sunk in the vicinity to a sufficient depth to tap this horizon. Other water-bearing horizons may occur in the Eastend and in the upper 200 feet of the underlying Bearpaw formation. No prediction can be made, however, as to the quality of the water. The generally porous character of the sediments comprising the Ravenscrag, Eastend, and the upper part of the Bearpaw formations, together with the information obtained from existing wells, strongly suggest that little difficulty

should be experienced in obtaining an adequate supply of mineralized but drinkable water within 100 feet of the surface at practically any point in the township.

Township 7, Range 14

The southeastern part of this township consists of high plateau-land with an average surface elevation of about 3,150 feet above sea-level. Toward the northwestern part the land surface drops away rapidly to a moderately rolling plain with elevations ranging from about 2,850 feet to 2,750 feet. These lowlands occupy slightly more than the northwestern half of the township.

The glacial drift is very thin over the highlands and in most places where wells have been sunk through it consists of only a few feet of top soil.

On the western slope, particularly in the southwestern part of the township, large supplies of water are obtained at depths of less than 20 feet from Recent sand and gravel beds in the lowland and from the glacial drift. Some of these beds are apparently fed by seepage from the bedrock aquifers of the highlands, as the yield has remained fairly constant throughout the recent drought period. Flowing springs are also of common occurrence in this area at surface elevations between 2,800 and 2,900 feet. These waters are, as a rule, not highly mineralized and are apparently quite suitable for the household drinking supply.

Several wells sunk to sand and gravel pockets that occur near or at the base of the glacial drift at depths of 10 to 20 feet in the western lowlands yield abundant supplies of water. Unfortunately many of these waters are highly mineralized and at some places the concentration of soluble salts renders them unfit for stock use.

The bedrock formations constitute the most reliable source of ground water throughout the township.

The Ravenscrag formation underlying the drift on the highlands in the southeastern part of the township yields water from two horizons. The upper horizon occurs at elevations between 3,100 and 3,050 feet above sea-level and has been tapped by several wells at depths of 40 to 85 feet. This horizon is known to occur in sections 10, 11, 12, and possibly extends into sections 13 and 14. The water occurs in fine sand and sandy shale and coal seams, and is of satisfactory quality for domestic use, but the supply from individual wells is not sufficient for more than 20 head of stock.

The second horizon occurs at or near the base of the Ravenscrag between elevations of 3,000 and 2,950 feet above sea-level, and is considered to extend through most of the south-eastern half of the township, although it has been tapped only by wells situated in sections 1, 2, and in the south half of section 12. The water occurs in thick beds of sand and sandstone. It is under sufficient hydrostatic pressure to cause it to rise in the wells to points 10 to 20 feet above the water-bearing bed. This water is soft to moderately hard and is reported to be quite suitable for the household drinking supply. The analysis of water from a well on section 2 is given in the table of water analyses of this report.

Moderately large supplies of water can also be expected to occur in the Eastend formation underlying the Ravenscrag in the southeastern half of the township at elevations ranging from about 2,950 feet to 2,900 feet above sea-level. In the absence of wells sunk to this horizon no prediction can be made as to the quality of water to be expected, as many of the supplies from the Eastend show considerable variation in different localities. It is quite probable that some of the springs

occurring on the western hill slope derive their supply from this source.

The Bearpaw formation underlies the Eastend and immediately underlies the glacial drift in the northwestern half of the township. Little similarity of elevation of water-bearing beds is found in the wells producing from the Bearpaw formation in this township. The water occurs in sand beds interbedded in the shales. The areal extent of individual beds is probably limited, but they appear to be sufficiently numerous to assure the finding of water at depths not exceeding 120 feet at most points in the northwestern half of the township. A 116-foot well located on the hill-side in the SW.¼, section 8, produces a large supply of hard, drinkable water from sandy clay at an elevation of 2,752 feet. Another well, situated in section 30, yields a similar supply of a dark-coloured but drinkable water probably from a sand bed at an elevation of 2,665 feet or from a depth of 50 feet. At other points wells have penetrated sand pockets at depths of 30 feet or less. The yields are generally sufficient for 10 to 20 head of stock and the water of satisfactory quality for household use.

Township 7, Range 15

A moderately rolling plain or lowland area extends over the eastern half of this township, with surface elevations ranging from about 2,750 feet in the vicinity of Bull creek in the northern part to about 2,650 feet along the southern border. Toward the western side of the township the surface rises rather abruptly to form a narrow belt of high plateau land extending along the western border at an elevation of about 3,000 feet above sea-level. The farming settlement is at present confined to the lowland.

Moderate to large supplies of water may be obtained at shallow depths from sand and gravel deposits that occur in small coulées and along the bottom of Bull Creek valley. Water is also obtained from beds of sand and gravel at, or near, the base of the glacial drift in the south-central part of the township. The latter water-bearing deposits have as yet been tapped only in sections 3 and 9, where they have been encountered in wells sunk to depths of 30 to 60 feet. The water from one of these wells is reported to be slightly "alkaline", but drinkable. The yield from individual wells is adequate for the usual farm requirements of 20 to 40 head of stock. Similar water-bearing beds may occur at this horizon in other sections in this vicinity. Morainic deposits cap the uplands along the western sections and since the moraine is often more porous than the till it is possible that moderately large supplies of drinkable water will be found at shallow depths in this area, although as yet there has been little or no prospecting in the area.

Wells sunk into the bedrock have encountered water at elevations of about 2,700 to 2,720 feet throughout an extensive area in the central and northeastern parts of the township. The water occurs in shale, or fine sand interbedded with the shale, in the Bearpaw formation at depths of 50 to 125 feet, depending on the surface elevation at the well site. The supply is usually sufficient for 30 or more head of stock, but unfortunately some of these waters on the western side of the area are too highly mineralized for human consumption, although apparently having no ill effects upon stock. In the eastern part the waters contain smaller amounts of dissolved solids and one well, situated in section 25, yields soft water, an analysis of which is given in the table of water analyses in a later section of this report. The water is under hydrostatic

pressure in some of those wells and rises 15 to 20 feet above the aquifer. This horizon may extend through the unprospected territory along the southern and western sides of the township.

A higher aquifer is encountered in a well in the southeastern part of the township in section 12 at an elevation of about 2,770 feet at a depth of 40 feet from the surface. This water is under sufficient hydrostatic pressure to cause it to rise in the well about 20 feet above the water-bearing bed. The analysis of this water is also given in the table of water analyses. This horizon is probably confined to the extreme southeastern part of the area. Other water-bearing horizons in the Bearpaw formation, some at higher elevations, probably occur in the highlands on the western side of the township, but in the absence of any prospecting and the lack of outcrops of bedrock, no definite evidence has been obtained.

Township 8, Range 13

The land surface of this township in general is moderately rolling and rises gradually from an average elevation of about 2,600 feet in the northern part to slightly over 2,900 feet along the southern border.

Recent deposits of sand or gravel in the coulée bottoms yield fair to large supplies of water in a few localities where wells have been sunk in them, particularly in the southern third of the township. Springs issuing from the sides of the coulées also provide small but constant sources of water for stock and, where conveniently located, for household use.

The principal ground water supplies of the township are obtained from wells sunk to sand or gravel pockets in the glacial drift. These porous beds occur interspersed through the boulder clay at various depths from 10 to 50 feet from

the surface. It is doubtful if any of the aquifers are of wide areal extent, as the hydrostatic pressure is seldom sufficient to raise the water more than a few feet above the aquifer in the wells. The supply, however, is usually sufficient for the average farm requirements and several large yields are reported. Most of these waters do not contain objectionable amounts of salts in solution and are apparently quite suitable for drinking.

Only two wells in the township are known to have penetrated the underlying bedrock. These wells, situated in section 18 and 19, encountered abundant supplies of water in the Bearpaw formation at an elevation of about 2,640 feet above sea-level or at depths of 65 and 130 feet, respectively. Both waters are hard and are reported to be quite suitable for drinking. Water from the deeper well contains iron. The areal extent of this aquifer is not known, but it probably underlies most of the southwestern half of the township where surface elevations are relatively high. Other water-bearing beds may also occur in the upper part of the Bearpaw and in the overlying Eastend formation, at depths of less than 100 feet, in the highlands in the southwestern corner of the township.

Little is known regarding ground water conditions in the Bearpaw formation in the northeastern half of the township where surface elevations range below 2,650 feet. Several wells situated less than a mile north of this township are yielding water from the Bearpaw shales at an elevation of about 2,550 feet. This water-bearing horizon or others may underlie this half of the township at depths of less than 100 feet below the surface. No prediction can be made, however, as to the quality or quantity of water to be expected from the bedrock in this part of the township.

Township 8, Range 14

For the most part the land surface of this township is an undulating plain with a few areas of more irregular relief. Bull creek flows in a northeasterly direction through the central part of the township to cross the eastern border in section 25 at an elevation of slightly less than 2,650 above sea-level. In a southwesterly direction from the creek the surface rises to a maximum elevation of about 2,975 feet in the southeast corner of the area.

Recent deposits of sand and gravel are apparently limited to the bottoms of the small coulées and the valley of Bull creek. These deposits are probably too thin in most places to form a permanent source of ground water, but shallow dug wells in these areas would probably provide sufficient water for household requirements.

The thickness of the glacial drift varies from place to place, but probably does not greatly exceed 50 feet at any point in the township. No essential differences in water conditions were noted between the moraine covering the southern uplands and the till covering the lowlands. Fine sands and quicksand are a source of water in the southeastern part of the township. These sands are thought to occur at the base of the drift as they are overlain by 30 to 50 feet of clay. These beds have been tapped by wells in sections 3, 10, and 11. The water obtained is of good quality and the quantity is usually quite sufficient for local farm requirements. Several springs issuing from the banks of the coulées in this vicinity also supply water for stock. The spring waters are reported to be slightly "alkaline" and may come from a different source bed in the drift, or even from the Bearpaw formation which is exposed along the creek in the SE.¼, section 31.

Sand and gravel beds irregularly interspersed through the boulder clay are a source of water in the northern part of the township. Wells sunk in sections 26, 27, 31, 35, and 36 produce moderate yields from such beds at depths of 10 to 50 feet from the surface. Some of these waters are soft and none is considered to be too highly mineralized for household use.

Two water-bearing horizons apparently occur in the Bearpaw formation, which underlies the glacial drift throughout the entire township with the possible exception of the extreme southeast corner, where a few feet of the Eastend formation may be present. The upper horizon has been tapped by wells ranging in depth from 60 to 100 feet. The elevations at which the productive beds occur vary considerably from place to place, suggesting the presence of a number of aquifers of limited individual areal extent in the upper weathered zone of the shale immediately under the glacial deposits rather than one extensive sand aquifer. This general horizon is either being tapped or forms a potential source of water throughout the greater part of the township. The water is seldom under sufficient hydrostatic pressure to cause it to rise in the well more than a few feet above the aquifer. The water is hard and in many localities is too highly mineralized to be used in the households. Very shallow wells in the drift provide drinking water on several of these farms. The second horizon in the bedrock occurs at an elevation of about 2,590 feet along the western side of the township. A well situated on the NW.¼, section 19, is yielding soft water from this horizon at a depth of 250 feet. The water occurs in fine sand and rises in the well to roughly 50 feet of the surface. The areal extent of this aquifer is not known as this is the only well in the township yielding water from this elevation in the bedrock. It seems probable, however, that this horizon or others may occur

at depths not greatly exceeding 250 feet from the surface in other parts of the township, and can generally be expected to yield a better quality of water than most of the wells in the upper, weathered horizon of the shale.

Township 8, Range 15

This township is a gently rolling upland area lying between Notukeu creek extending along the northern border and Bull creek along the southern border. The land surface rises gradually from an elevation of about 2,700 feet along the northern border and slightly greater elevations along Bull creek, to elevations not greatly exceeding 2,900 feet throughout the central and west-central parts of the area. Thin beds of Recent deposits, consisting principally of silt, sands, and gravel, occur along the bottoms of Notukeu and Bull Creek valleys. As these deposits are confined to the northwestern and southwestern corners of the township they do not form an important source of ground water in the township. Shallow wells sunk in these deposits would provide a household supply for residents in the vicinity of the creek. The mantle of glacial drift covering the township varies irregularly in thickness over the township, but probably is not more than 50 feet thick at any point. Water-bearing beds of sand or gravel are apparently not plentiful in the glacial drift, as nearly all the existing wells in the township were sunk down into the bedrock without encountering any appreciable amounts of water in the drift. Moraine covers the northeast corner and forms a belt about 2 miles in width extending from section 2 to section 30. Beds of water-bearing gravels may form knolls and ridges in these areas, but all wells sunk in the areas have penetrated the bedrock.

The Bearpaw formation underlies the drift throughout the entire township. Wells sunk in the Bearpaw usually encounter water at depths of 25 to 100 feet from the surface. The water is reported to occur in blue clay. From most of these wells the supply is quite sufficient for 20 to 30 head of stock, but the quality of the water varies widely throughout the township. Several wells situated in the northern third of the township and a well in section 13 yield highly mineralized water that is used only for watering stock. Other wells in the township yield water containing lesser amounts of dissolved salts and are being used for the household drinking supply. Only one well, situated in the NE.$\frac{1}{4}$, section 15, is yielding soft water. Other water-bearing beds are expected to occur at greater depths in the formation down to elevations as low as 2,550 feet. The findings in the township to the south would suggest that water of better quality can be obtained at depths of 100 to 250 feet from the surface in this township, in localities where unsatisfactory water conditions have been encountered at shallower depths. No wells have been sunk sufficiently deep in this area as yet to verify this assumption.

Township 9, Range 13

This township lies at lower elevation than other parts of the municipality. A minimum elevation of about 2,475 feet above sea-level occurs in the valley of Notukeu creek in the northeastern corner of the area. In general the land surface rises toward the south and west to elevations of 2,600 to 2,650 feet along these borders of the township. Drainage is to the northeast through Notukeu creek.

Recent deposits of clays and silts interbedded at some places with sands and gravels occur in the valley of Notukeu creek, but little is known regarding ground water

conditions existing in these sediments. Wells encountering sand and gravel beds can be expected to yield moderate supplies of water. Careful prospecting to depths of 20 feet may be required, however, in locating an adequate supply, as individual sand and gravel beds are usually of limited areal extent. The glacial till covering the entire township, except where it is overlain by Recent stream deposits, consists essentially of boulder clays, sandy clays, and silts, through which are interspersed discontinuous beds of porous sands and gravels. The thickness of the drift probably does not exceed 35 feet. The top soil is quite sandy in the eastern third of the township and soil drifting is a common occurrence in some localities.

Wells sunk to the sand and gravel deposits are the chief source of water supply in the township. These wells range in depth from 20 to 30 feet. The yield from individual wells is usually sufficient for the household use and for 10 to 20 head of stock, although several residents report a shortage of water during dry seasons. These waters vary considerably in the dissolved mineral salts content, but at most places the water is being used for drinking.

Four wells situated in the western third of the township yield water from what is reported to be blue clay or shale. These wells have probably penetrated the Bearpaw formation that occurs beneath the glacial drift throughout the area. These wells vary in depth from 48 to 110 feet. The yield from wells situated in sections 5, 6, and 19 is adequate, but the well on the NW.¼, section 17, yields only a small quantity of hard, "alkaline" water. Although these waters contain appreciable amounts of mineral salts in solution, the water from wells in sections 6 and 19 is being used for drinking and all the waters are used for stock. Since the Bearpaw formation becomes less

sandy at greater depths in this area, a better quality of water is not to be expected by deeper drilling. Residents are better advised to confine the search for water to the drift or upper weathered zone of the bedrock. Drilling should not greatly exceed 75 to 125 feet in the southwestern part of the area, but wells exceeding 50 feet in depth in the northeast corner will probably yield a highly mineralized, undrinkable water that may not be suitable even for watering stock.

Township 9, Range 14

The land surface of this township rises gradually from an average elevation of about 2,650 feet in the eastern side to slightly over 2,800 feet above sea-level on the upland part remote from the creek along the western border of the township. Notukeu creek flows from west to east across the southern half of the township. It has carved a narrow, steep-banked valley through the western highlands, but east of Crichton the valley widens out into extensive, silt-covered flats.

Springs are a common occurrence in the valley and on some farms they form the chief source of stock water supply. Wells sunk to depths of 10 to 25 feet in the valley bottom usually encounter quicksand that flows into the wells and shuts off the water. It is probable that the use of sand-points driven in the creek flats near the stream would provide a continuous supply of water suitable for domestic use. Similar conditions of running sand have been encountered in two wells sunk to depths of 60 and 130 feet in the moraine covering the highlands in section 7. Water, where obtained from these sands, is apparently of good quality and at several places is reported to be soft. North of the river valley, in an area including most of the northern two-thirds of the township, the glacial drift is apparently quite thin and only a few, isolated pockets

of water-bearing sand and gravel have been located. Even in the extensive area of moraine covering the northwest corner of the township, the existing wells have been sunk through the drift into the bedrock.

The Bearpaw formation underlies the drift throughout the entire township, and wells at many widely separated localities encounter water at depths of 20 to 125 feet below the surface. The water is reported to occur in shale or blue clay, although little is known regarding the actual character of these aquifers.

A 40-foot well, situated in the SE.¼, section 21, yields a moderate supply of highly mineralized water from an aquifer at an elevation of about 2,600 feet. An analysis of this water is listed in the table of analyses in a later section of the report. This water-bearing horizon probably extends southwestward through sections 22, 15, and 14, where large supplies of water are obtained from approximately the same elevation, and at various depths from 60 to 125 feet depending upon the surface elevations at the well site. Water obtained from wells on sections 15 and 22 is less highly mineralized and provides the household drinking supply.

Throughout the remainder of the township water is obtained from the Bearpaw clays or shales at various depths ranging from 20 to 60 feet below the surface. These aquifers are apparently of only local extent and the water is not under sufficient pressure to cause it to rise in the well more than a few feet above the water-bearing bed. The supply from individual wells varies, but is rarely sufficient for more than 20 head of stock. Most of these waters contain appreciable amounts of salts in solution, but they are being used for drinking where better water supplies are not available.

Township 9, Range 15

The drainage system is well developed in this township by Notukeu creek flowing to the east through the southern sections and by many tributary intermittent streams coming from coulées in the northwestern part. The land surface rises gradually to the north and west from an average elevation of about 2,675 feet in the valley flats in the southeast corner, reaching elevations of about 2,800 feet along the northern and western borders.

Recent stream deposits in the coulée bottoms are apparently thin and of little value as a source of ground water. Better supplies are obtained in a few localities from sand deposits in the stream channel of Notukeu creek, but these are only utilized where conveniently located to farm buildings. A few springs occur in the valleys in the southern half of the township and contribute a valuable addition to the water supply for stock.

The depth of the glacial drift covering the area varies considerably in different parts of the township. Bedrock is exposed in several places in the coulées in the southern half of the township, but 50 to 70 feet of boulder clay is reported in several wells in the central and northern parts of the township. A few isolated pockets of sand and gravel are encountered at various depths in the glacial drift. These porous beds where they have been penetrated in dug or bored wells usually yield sufficient water for household use and for 10 to 30 head of stock.

A number of wells widely distributed through the township yield water from what is apparently the upper weathered zone of the Bearpaw shale a few feet below the base of the glacial drift. The depths of these wells range from

20 to 60 feet. This horizon lies at correspondingly greater depths in areas where the glacial drift is thicker. The quality of the water from the upper part of the shales varies from the hard, highly mineralized type of soft waters containing relatively small amounts of mineral salts in solution. The supply in most of these wells is sufficient only for a few head of stock and some have shown a considerable decrease in yield during drought years.

A well-defined, soft water horizon occurs in the northwestern part of the township at an elevation of about 2,560 feet above sea-level. This horizon has been tapped by a well situated on the SW.¼, section 28, at a depth of about 86 feet, and by wells in the SW.¼, section 32, and the NE.¼, section 33, drilled to depths of 204 and 258 feet, respectively. In the latter well the depth to the water-bearing bed is uncertain, and the horizon may occur at a point much above the base of the well, probably at a depth of about 215 feet. An analysis of water from this well is listed in the table of water analyses in a later section of this report. These waters are reported to occur in "blue clay" or shale. The supplies from the two deeper wells are ample for all farm requirements, but only sufficient water for household use is obtained from the well situated in section 28. The areal extent of this water horizon is not known, but it very probably underlies sections 29, 30, and 31, as similar soft water supplies are obtained at about the same elevation from wells situated several miles west of this area.

A small supply of soft water is also obtained from a well sunk to a depth of 28 feet on the NE.¼, section 30. This water is apparently similar to that obtained at greater depth in this vicinity. It occurs in sandy clays and shales a few

feet below the base of the glacial drift at an elevation of about 2,713 feet. This supply is only sufficient for household use and the aquifer is probably of local occurrence In areas in which water from the Bearpaw formation is not satisfactory for household use, extensive prospecting with an auger in the upper few feet of the drift or in valley and coulée deposits may encounter a small supply of drinkable water. Wells sunk beside dams constructed to conserve the surface run-off in coulées can be expected to provide at least small supplies of water.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF WISE CREEK, NO. 77, SASKATCHEWAN

Township	7	7	7	8	8	8	9	9	9	Total No. in municipality
West of 3rd meridian Range	13	14	15	13	14	15	13	14	15	
Total No. of Wells in Township	7	25	24	23	31	33	17	27	25	212
No. of wells in bedrock	6	13	11	2	12	23	4	13	15	99
No. of wells in glacial drift	1	8	9	20	19	10	13	14	8	102
No. of wells in alluvium	0	4	4	1	0	0	0	0	2	11
Permanency of Water Supply										
No. with permanent supply	7	24	24	23	28	30	17	24	22	199
No. with intermittent supply	0	1	0	0	0	0	0	3	3	7
No. dry holes	0	0	0	0	3	3	0	0	0	6
Types of Wells										
No. of flowing artesian wells	0	0	0	0	0	0	0	0	0	0
No. of non-flowing artesian wells	2	4	4	7	3	6	2	5	5	38
No. of non-artesian wells	5	21	20	16	25	24	15	22	20	168
Quality of Water										
No. with hard water	7	20	22	19	25	28	17	23	20	181
No. with soft water	0	5	2	4	3	2	0	4	5	25
No. with salty water	0	0	0	0	0	0	0	0	0	0
No. with "alkaline" water	6	5	9	3	17	12	8	12	9	81
Depths of Wells										
No. from 0 to 50 feet deep	5	20	12	21	19	18	14	16	15	140
No. from 51 to 100 feet deep	2	4	11	1	10	14	2	8	7	59
No. from 101 to 150 feet deep	0	1	1	1	1	1	1	2	1	9
No. from 151 to 200 feet deep	0	0	0	0	0	0	0	1	0	1
No. from 201 to 500 feet deep	0	0	0	0	1	0	0	0	2	3
No. from 501 to 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
No. over 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
How the Water is Used										
No. usable for domestic purposes	5	20	18	21	17	24	12	21	22	160
No. not usable for domestic purposes	2	5	6	2	11	6	5	6	3	46
No. usable for stock	6	24	24	23	27	29	17	27	25	202
No. not usable for stock	1	1	0	0	1	1	0	0	0	4
Sufficiency of Water Supply										
No. sufficient for domestic needs	7	24	24	22	27	29	16	24	22	195
No. insufficient for domestic needs	0	1	0	1	1	1	1	3	3	11
No. sufficient for stock needs	4	19	22	20	23	26	10	19	18	161
No. insufficient for stock needs	3	6	2	3	5	4	7	8	7	45

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 ropresents 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.

Analyses of Water Samples from the Municipality of Wise Creek, No. 77, Saskatchewan

No.	LOCATION					Depth of Well, Ft.	Total dis'vd solids	HARDNESS			CONSTITUENTS AS ANALYSED						CONSTITUENTS AS CALCULATED IN ASSUMED COMBINATIONS								Source of Water
	qtr.	Sec.	Tp.	Rge.	Mer.			Total	Perm.	Temp.	Cl.	Alka-linity	CaO	MgO	SO_4	Na_2O	Solids	$CaCO_3$	$CaSO_4$	$MgCO_3$	$MgSO_4$	Na_2CO_3	Na_2SO_4	NaCl	
1	SE.	2	7	14	3	42	500	280	200	80	9	250	30	54	86	293	375	54		113		66	127	15	×2
2	NW.	20	7	14	3	1o	6,239												(2)		(3)	(4)	(1)	(5)	×1
3	SE.	12	7	15	3	40	1,140	800	700	100	34	235	190	119	537	129	1,013	235	141		355		226	5o	×3
4	NW.	25	7	15	3	oo	1,820	170	oo	110	17	555	30	25	832	822	1,830	54		52		465	1,231	28	×3
5	NE.	7	8	15	3	o3	1,120	3oo	200	1oo	13	3oo	90	86	529	343	1,129	1o1		167	18		762	21	×3
o	NE.	15	8	15	3	5o	1,760	340	180	160	23	645	90	54	750	720	1,793	161		113		371	1,110	38	×3
7	SE.	21	9	14	3	45	7,oo0	1,oo0	1,400	200	62	705	240	281	4,399	2,634	7,182	430		232	507		5,911	102	×3
8	SE.	15	9	15	3	64	2,200	170	30	140	34	725	20	29	1,078	1,107	2,401	36		61		653	1,595	56	×3
9	NE.	33	9	15	3	258	1,060	30			103	630	5	14	148	549	1,048	9		29		621	219	170	×3

Water samples indicated thus, ×1, are from glacial drift or other unconsolidated deposits.
Water samples indicated thus, ×2, are from bedrock, Ravenscrag formation.
Water samples indicated thus, ×3, are from bedrock, Bearpaw formation.
Analyses are reported in parts per million; where numbers (1), (2), (3), (4), and (5) are used instead of parts per million, they represent the relative amounts in which the five main constituents are present in the water.
Hardness is the soap hardness expressed as calcium carbonate ($CaCO_3$).
Analysis No. 2 by Provincial Analyst, Regina.
For interpretation of this table read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

No samples of water were collected for analyses by the Geological Survey from wells deriving their supplies from the glacial drift in this municipality. These waters vary so greatly, even within short distances, that it is impossible to predict the character of the water obtainable in any locality. The following discussion is based upon one analysis by the Provincial Analyst, the opinions of the well owners, and upon analyses of waters taken from the glacial drift in neighbouring municipalities. In general, waters obtained from the sand and gravel deposits occurring near the surface are not highly mineralized. A few of these waters are reported as soft, but the majority of them are hard to excessively hard. Some of the waters from deeper wells in the drift have a total hardness exceeding 1,500 parts per million, the greater part of which is permanent and not removable by boiling the water. Dissolved mineral salts are not generally present in sufficient quantities to impart an objectionable taste or cause any apparent ill effects on persons drinking the waters from shallow sources in the drift. Water from such wells is generally of better quality than supplies either from the lower part of the drift or from many of the horizons in the underlying bedrock formations. The boulder clay is generally regarded as being the source of the mineral salts, which, upon being taken into solution by the waters percolating from the surface, tend to give the waters a bitter taste and create decided laxative effects upon persons not accustomed to their use. Waters derived by seepage from the boulder clays, contain sodium sulphate (Na_2SO_4), magnesium sulphate ($MgSO_4$), calcium carbonate ($CaCO_3$), and calcium sulphate ($CaSO_4$), and minor amounts of sodium carbonate (Na_2CO_3) and common salt (NaCl). These salts are listed in the decreasing order of their abundance in waters from the drift.

Most of the waters from the boulder clay contain at least 500 parts per million of sodium sulphate in solution, but the concentration is known to exceed 5,000 parts per million at many scattered localities over the province. Water containing more than 1,000 parts per million of combined sodium and magnesium salts tends to have laxative effects and should not be used if better supplies can be obtained. Waters containing more than twice this amount of dissolved sulphate salts have been used for watering stock without any apparent ill effects.

The second analysis, given in the accompanying table, was made by the Provincial Analyst, Saskatchewan, and is of water of the highly mineralized type that is considered unfit for any farm use. The salts present are listed in their relative order of abundance. The seventh analysis of water from a 45-foot well in sec. 27, tp. 9, range 14, indicated as water from the Bearpaw formation, is probably more nearly typical of the highly mineralized waters from the glacial drift. This water is being used for stock, but cannot be regarded as satisfactory.

Water from the Bedrock

Waters from the basal sands of the Ravenscrag formation are usually of good quality. The first analysis listed in the table is of water from a 42-foot well drawing its supply from this horizon on sec. 2, tp. 7, range 14. The total dissolved solid content of the water is low, compared with waters from the drift or the weathered zone of the Bearpaw formation, and the total hardness of 280 parts per million renders the water only moderately hard.

Higher concentration of salts in solution usually occur in waters from coal and sandy shale beds of this formation than from the massive, coarse-grained sand beds, but these waters are rarely too highly mineralized to be usable for domestic needs.

Waters obtained from the Eastend and Bearpaw formations vary greatly as to character in different localities and at different horizons. Water from wells sunk in the soft clay shales immediately underlying the glacial drift apparently do not differ greatly in quality from those of the overlying drift, although the average concentration of salts in solution may be slightly higher. Analyses Nos. 3 to 8, inclusive, are of waters obtained from this upper water-bearing zone of the Bearpaw formation. The total dissolved solids content varies from 1,140 to over 7,000 parts per million, and the salt in the greatest abundance in most of these waters is sodium sulphate (Na_2SO_4).

The high concentration of this salt and of magnesium sulphate indicated in the seventh analysis renders this water unfit for any farm use. Analyses Nos. 4, 6, and 8 show the presence of relatively large amounts of sodium carbonate (black alkali). These waters should not be used for irrigation on account of the injurious effects of this salt upon vegetation.

The last analysis in the list is from a 258-foot well in the Bearpaw formation. This water is quite suitable for drinking, but the presence of 621 parts per million of sodium carbonate renders it unsuitable for irrigation. It will be noted that many of the waters from the Bearpaw formation are not excessively hard due to the absence of any large amounts of calcium and magnesium salts. Analyses Nos. 4, 5, 6, 8, and 9 all have total hardnesses less than 400 parts per million, of which a considerable amount is temporary and removable by boiling. Many of these waters from the lower soft water horizon in the Bearpaw tend to have a flat taste due to the presence of the sodium carbonate and may prove objectionable to persons unaccustomed to their use, but are being used for household requirements of many residents of the district without reported ill effects.

B 4-4
R. 7526

WELL RECORDS—Rural Municipality of WISE CREEK, NO. 77, 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	NE.	7	7	13	3	Bored	86	3,022	- 82	2,942	82	2,940	Ravenscrag or upper Eastend	Hard, clear, "alkaline"		D, S	Insufficient for 16 head stock.
2	NE.	9	"	"	"	Dug	10	3,086	- 6	3,080	7	3,079	Glacial gravel	Hard, clear, "alkaline"		D, S	Sufficient supply for 20 head stock.
3	NE.	14	"	"	"	Dug	25	3,150	- 15	3,135	15	3,135	Ravenscrag sand	Hard, clear, "alkaline"		D, S	Insufficient supply for 25 head stock. Another 40-foot well unfit for human use.
4	SW.	17	"	"	"	Bored	95	3,002	- 65	2,937	95	2,907	Eastend or upper Bearpaw shale	Hard, clear, iron		D, S	Sufficient supply for 80 head stock.
5	SE.	19	"	"	"	Dug	10	2,965	- 6	2,959	6	2,959	Ravenscrag sand	Hard, clear, "alkaline"		D, S	Sufficient for 15 head stock.
6	SW.	20	"	"	"	Bored	34	2,935	- 8	2,927	34	2,901	Eastend or upper Bearpaw, clay	Hard, cloudy "alkaline"		N	Unfit for stock.
1	NE.	1	7	14	3	Bored	35	3,035	- 28	3,007	35	3,000	Ravenscrag sand	Soft, clear		D, S	Sufficient supply.
2	SE.	2	"	"	"	Bored	82	3,043	- 55	2,988	82	2,961	Ravenscrag sandstone	Medium soft, clear		D, S	Oversufficient supply; #.
3	NW.	6	"	"	"	Dug	30	2,860	- 20	2,840	20	2,840	Bearpaw, sand	Hard, clear	45	D, S	Sufficient for 14 head stock.
4	NE.	7	"	"	"	Dug	22	2,815	- 17	2,798	22	2,793	Glacial sand	Hard, clear, "alkaline"		S	Insufficient for stock. Well in pasture for humans; also 12-foot well with good supply, but water unfit for stock.
5	SW.	8	"	"	"	Bored	116	2,868	- 75	2,793	116	2,752	Bearpaw, sandy clay and sand	Hard, clear		D, S	Sufficient for 14 head stock.
6	SE.	8	"	"	"	Dug	18	2,930	- 15	2,915	15	2,915	Recent alluvium	Soft, clear	45	D, S	Sufficient for 17 head stock.
7	W	9	"	"	"	Dug	12	2,900	- 2	2,898	2	2,898	Recent alluvium	Hard, clear		D, S	Sufficient supply always.
8	NE.	10	"	"	"	Bored	72	3,170	- 60	3,110	72	3,098	Ravenscrag sandy clay	Hard, clear, iron		D, S	Insufficient supply; waters 12 head stock and household.
9	SW.	12	"	"	"	Dug	45	3,058	- 38	3,020			Ravenscrag sand	Soft, clear, slightly "alkaline"	45	D, S	Waters 20 head stock and household.
10	NW.	12	"	"	"	Bored	85	3,140	- 70	3,070	70	3,070	Ravenscrag blue clay	Hard, clear		D, S	Insufficient for 10 head stock.
11	NE.	12	"	"	"	Bored	75	3,160	- 68	3,092	68	3,092	Ravenscrag coal and sandy clay	Hard, clear		D, S	Insufficient supply for 4 head stock; another well 100 feet deep; also one 85 feet deep, caved in.
12	SE.	13	"	"	"	Dug	15?										
13	SE.	16	"	"	"	Dug	35	2,848	- 33	2,815	33	2,815	Recent alluvium or glacial quicksand	Hard, clear	45	D, S	Sufficient for 30 head stock.
14	NW.	20	"	"	"	Dug	16	2,758	- 14	2,744	14	2,744	Glacial sand	Hard, clear, "alkaline"		N	Unfit for stock; another well near slough used for stock only; #.
15	SW.	28	"	"	"	Dug	38	2,810	- 30	2,780	30	2,780	Bearpaw blue clay	Hard, "alkaline"		D, S	Insufficient supply for 4 head stock.
16	NW.	28	"	"	"	Dug	20	2,810	- 10	2,800	10	2,800	Glacial sand, gravel	Soft, clear		D, S	Sufficient supply for 10 head stock.
17	SW.	30	"	"	"	Bored	50	2,715	- 20	2,695	50	2,665	Bearpaw	Hard, dark colour		D, S	Sufficient supply.
18	SE.	33	"	"	"	Spring		2,830					Bearpaw ?	Hard, clear		D, S	Sufficient supply for 30 head stock; also 25-foot well good supply, not used.

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 WISE CREEK, NO. 77, SASKATCHEWAN.

B 4-4
R. 7526

WELL No.	LOCATION					TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE		PRINCIPAL WATER-BEARING BED			CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
	¼	Sec.	Tp.	Rge.	Mer.				Above (+) Below (−) Surface	Elev.	Depth	Elev.	Geological Horizon				
1	NW.	3	7	15	3	Bored	65	2,840	- 53	2,787	53	2,787	Glacial gravel	Hard, clear		D, S	Sufficient supply for 20 head stock; another 12-foot well, small supply.
2	SW.	3	"	"	"	Bored	65?						Glacial gravel	Hard, clear		D, S	Sufficient supply.
3	SE.	9	"	"	"	Dug	35	2,835	- 31	2,804	30	2,805	Glacial sand	Hard, clear, "alkaline"	45	D, S	Sufficient supply; two other wells, 12 and 15 feet deep for stock use.
4	NE.	9	"	"	"	Dug	20	2,800					Glacial gravel	Hard, clear		D, S	
5	SE.	12	"	"	"	Bored	40	2,810	- 20	2,790	40	2,770	Bearpaw sand and clay	Hard, clear, "alkaline"		D, S	Sufficient supply; #.
6	SE.	15	"	"	"	Dug	14	2,790	- 8	2,782	8	2,782	Recent alluvium sand and gravel	Soft, clear		D, S	Sufficient supply; 3 wells all 14 feet deep in creek bed or on flat.
7	NW.	16	"	"	"	Bored	85						Bearpaw, shale	Hard, "alkaline"		N	Sufficient supply.
8	NE.	16	"	"	"	Bored	85	2,870	- 77	2,793	77	2,793	Bearpaw, shale	Hard, "alkaline"		S	Sufficient for 15 head stock.
9	SE.	17	"	"	"	Dug	60	2,880	- 30	2,850	30	2,850	Bearpaw, blue clay ?	Hard, clear		D, S	Sufficient for 30 head stock.
10	SW.	21	"	"	"	Bored	85?						Bearpaw, shale	Hard, clear		N	Sufficient for 15 head stock.
11	SE.	23	"	"	"	Bored	55	2,760	- 30	2,730	55	2,705	Bearpaw, blue clay	Hard, "alkaline"		D, S	Sufficient for 10 head stock; very large supply.
12	NE.	23	"	"	"	Dug	80	2,770	- 45	2,725			Bearpaw, soft shale	Hard, clear, "alkaline"		D, S	Sufficient for 20 head stock.
13	NW.	25	"	"	"	Bored	60	2,780	- 41	2,739	60	2,720	Bearpaw, blue clay	Soft, clear		D, S	Sufficient for 30 head stock; 4 springs in the coulée; aquifer gravel.
14	NE.	27	"	"	"	Dug	27	2,740	- 24	2,716	24	2,716	Glacial sand	Hard, clear		D, S	Good supply for 30 head stock.
15	NW.	33	"	"	"	Bored	65	2,780					Bearpaw	Hard, clear, "alkaline"		S	Laxative on human beings. Supplies 30 head stock; also shallow well near creek.
16	SE.	33	"	"	"	Bored	126	2,825					Bearpaw blue clay ?	Hard, clear		S	Insufficient for stock. Laxative on human beings; also shallow well in coulée.
17	NW.	36	"	"	"	Bored	70	2,760	- 44	2,716	44	2,716	Bearpaw blue clay ?	Hard, clear		D, S	Waters 25 head stock.
1	NW.	5	8	13	5	Dug	7	2,865	- 2	2,863	3	2,862	Glacial drift	Hard, clear, "alkaline"		S	Sufficient for 80 head stock.
2	NE.	7	"	"	"	Spring			0		0		Glacial sand	Hard, clear		S	Sufficient for stock
3	NW.	7	"	"	"	Spring			0		0		Glacial drift	Hard, clear		S	Sufficient for stock.
4	SW.	9	"	"	"	Dug	20	2,828	- 15	2,813			Glacial gravel	Hard, clear		D, S	Sufficient for 12 head stock.
5	NE.	9	"	"	"	Dug	7	2,635	- 5	2,630	5	2,630	Glacial sand	Soft, clear		D, S	Sufficient for 25 head stock.
6	NW.	12	"	"	"	Dug	4	2,670	0	2,670			Recent alluvium sand	Hard, clear, "alkaline"		D, S	Sufficient for 12 head stock; sufficient supply.
7	SW.	14	"	"	"	Bored	28	2,665	- 18	2,647	18	2,647	Glacial sand	Hard, clear			Sufficient for 10 head stock; another well 15 feet deep with sand aquifer.
8	SE.	17	"	"	"	Dug	22	2,720	- 19	2,701	21	2,699	Glacial gravel	Soft, clear		D, S	Sufficient supply.
9	NE.	18	"	"	"	Bored	65	2,711	- 45	2,666	65	2,646	Bearpaw ?	Hard, clear		D, S	Sufficient for 30 head stock.
10	SW.	18	"	"	"	Dug	14	2,785	- 1	2,784	14	2,771	Glacial sand	Soft, clear		D, S	Waters 20 head stock; another well 20 feet deep

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 ~~TISE CREEK, NO. 77, SASKATCHEWAN.~~

B 4-4
R. 7526

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
11	SW.	19	8	13	3	Drilled	130	2,768	- 50	2,718	130	2,638	Bearpaw, black sand	Hard, iron, clear		D, S	Waters 50 head stock; another 50-foot well in quicksand
12	SW.	24	"	"	"	Dug	18	2,570	- 15	2,555	17	2,553	Glacial gravel	Hard, clear		D, S	Insufficient supply; another well 8 feet deep waters 20 head stock.
13	SE.	25	"	"	"	Dug	40	2,595	- 33	2,562	33	2,562	Glacial sand	Hard, clear		D, S	Waters 30 head stock.
14	SW.	27	"	"	"	Bored	40	2,638	- 22	2,616	40	2,598	Glacial sand	Hard, clear		D, S	Waters 15 head stock.
15	NE.	28	"	"	"	Bored	40	2,644	- 34	2,610	40	2,604	Glacial gravel	Soft, clear		D, S	Waters 30 head stock.
16	SW.	30	"	"	"	Dug	20	2,635	- 17	2,618	17	2,618	Glacial clay	Hard, clear		D	Insufficient supply.
17	SW.	31	"	"	"	Bored	50	2,616	- 20	2,596	48	2,568	Glacial gravel	Hard, clear		D, S	Sufficient supply.
18	NW.	32	"	"	"	Dug	10	2,567	- 8	2,559	8	2,559	Glacial sand	Hard, clear		D	Insufficient supply.
19	NE.	33	"	"	"	Dug	32	2,620	- 30	2,590	30	2,590	Glacial sand	Hard, clear		D, S	Sufficient supply for 15 head stock.
1	NW.	3	8	14	3	Bored	35	2,845	- 32	2,813	32	2,813	Glacial sand	Hard, clear		D	Insufficient supply; seepage well and spring used for stock.
2	NE.	4	"	"	"	Bored	100	2,850					Bearpaw blue clay or shale	Hard, clear, very "alkaline".		S	Sufficient supply for stock; also use a spring for stock; laxative on humans.
3	NE.	9	"	"	"	Dug	13	2,780					Glacial clay	Hard, clear, "alkaline"		D, S	Another well used for stock.
4	NW.	10	"	"	"	Bored	56	2,770	- 41	2,729	41	2,729	Glacial sand	Hard, clear		S	Waters 18 head stock.
5	NE.	11	"	"	"	Bored	50	2,800	- 44	2,756	44	2,756	Glacial sand	Hard, clear		D, S	No remarks.
6	SW.	15	"	"	"	Bored	35	2,765	- 15	2,750	15	2,750	Bearpaw	Hard, clear, "alkaline"		D, S	Large supply.
7	NW.	15	"	"	"	Bored	85	2,710	- 45	2,665	85	2,625	Bearpaw blue clay	Hard, clear		S	Laxative on humans; waters 20 head of stock; another 12-foot well for household; also a spring.
8	SW.	16	"	"	"	Bored	104	2,720					Bearpaw blue clay	Hard, clear, "alkaline"		S	Waters 16 head stock; another well 20 feet deep for house.
9	NW.	19	"	"	"	Drilled	250	2,840	- 50	2,790	250	2,590	Bearpaw sand	Soft, clear		D, S	Waters 15 head stock; another seepage well used for stock.
10	NW.	20	"	"	"	Bored	84	2,840	- 72	2,768	72	2,768	Bearpaw blue clay	Hard, "alkaline"		D, S	Waters 15 head stock.
11	NE.	21	"	"	"	Bored	75	2,800					Bearpaw blue clay	Hard, "alkaline"		D, S	Waters 15 head stock; a similar well, small supply.
12	NW.	26	"	"	"	Dug	23	2,720	- 20	2,700	20	2,700	Glacial sand	Hard, clear, "alkaline"		D, S	Waters 10 head stock.
13	SE.	27	"	"	"	Bored	60	2,770	- 45	2,725	45	2,725	Bearpaw blue clay	Hard, clear, "alkaline"		S	Waters 14 head stock.
14	NE.	27	"	"	"	Dug	33	2,752	- 32	2,720	32	2,720	Glacial sand	Hard, clear		D, S	Insufficient supply; 12 head stock; another well in coulee, small supply; several dry holes.
15	SW.	28	"	"	"	Bored	60	2,800	- 50	2,750	50	2,750	Bearpaw blue clay	Hard, "alkaline"		S	Insufficient for 20 head stock.
16	NW.	28	"	"	"	Bored	60	2,760	- 30	2,730	60	2,700	Bearpaw sand	Hard, clear		S	Waters 15 head stock.
17	NE.	29	"	"	"	Spring	0						Glacial drift	Hard, clear, "alkaline"		D, S	Flows throughout the year.

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 RISE CREEK, NO. 77, 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
18	NE.	31	8	24	3	Bored	55	2,892	- 50	2,842	50	2,842	Glacial sand	Hard, clear		D, S	Waters 15 head stock.
19	SE.	35	"	"	"	Dug	11	2,662	- 6	2,656	9	2,653	Glacial gravel	Soft, clear		D, S	Waters 30 head stock.
20	SW.	36	"	"	"	Bored	20	2,665	- 18	2,647	18	2,647	Glacial sand	Soft, clear		D, S	Sufficient supply; another well 92 feet deep with "alkaline" water; not used.
21	SE.	36	"	"	"	Bored	22	2,635	- 19	2,616	19	2,616	Glacial sand	Hard, clear, "alkaline"		D, S	Waters 20 head stock.
1	NW.	1	8	15	3	Bored	85	2,770					Bearpaw blue clay	Hard, "alkaline"		D, S	Good supply for 20 head stock.
2	SE.	3	"	"	"	Dug	25	2,760	- 22	2,738	22	2,738	Bearpaw blue clay	Hard, clear		D, S	Waters 16 head stock.
3	SW.	4	"	"	"	?							Bearpaw clay				Several dry holes. Bases probably in Bearpaw.
4	NW.	4	"	"	"	Bored	60	2,840	- 40	2,800	40	2,800	Bearpaw sand	Hard, clear		D, S	Good supply; waters 10 head stock.
5	NE.	5	"	"	"	Bored	56	2,820	- 41	2,779	41	2,779	Bearpaw	Hard, clear		D, S	Insufficient supply.
6	NE.	7	"	"	"	Bored	63	2,893	- 33	2,860	63	2,830	Bearpaw	Hard, clear		D, S	Waters 15 head stock; very strong supply; #.
7	SE.	8	"	"	"	Dug	42	2,892					Bearpaw blue clay	Hard, clear, "alkaline"		D, S	Waters 5 head stock; other shallow wells used for stock.
8	SE.	10	"	"	"	Dug	27	2,790	- 25	2,765	25	2,765	Bearpaw?	Hard, clear		D, S	Large supply.
9	NW.	12	"	"	"	Bored	50						Bearpaw	Hard, clear		D, S	Sufficient supply.
10	SW.	13	"	"	"	Bored	50	2,800	- 34	2,766	34	2,766	Bearpaw blue clay	Hard, iron, "alkaline" blue colour			
11	NW.	14	"	"	"	Bored	68?						Bearpaw	Hard, clear, "alkaline"		D, S	Sufficient supply.
12	NE.	15	"	"	"	Dug	56	2,854	- 48	2,806	48	2,806	Bearpaw blue blue clay	Soft, clear		D, S	Steady supply for 15 head stock; another similar well; #.
13	NW.	15	"	"	"	Dug	35	2,855	- 31	2,824	31	2,824	Glacial sand	Hard, clear		D, S	Sufficient for 12 head stock.
14	SE.	16	"	"	"	Bored	60	2,865	- 40	2,825	40	2,825	Bearpaw	Hard, clear, iron		D, S	Good supply.
15	NW.	16	"	"	"	Bored	54	2,848	- 39	2,809	52	2,796	Bearpaw?	Hard, clear, "alkaline"		D, S	Waters 15 head stock.
16	NW.	17	"	"	"	Dug	35	2,878	- 30	2,848	30	2,848	Bearpaw blue clay	Hard, clear		D, S	Waters 20 head stock.
17	NE.	19	"	"	"	Bored	65	2,850	- 56	2,794	56	2,794	Bearpaw "blue clay"	Hard, clear		D, S	Waters 15 head stock.
18	SW.	23	"	"	"	Bored	68	2,715	- 20	2,695	58	2,657	Bearpaw blue clay	Hard, clear, iron, "alkaline"		D, S	Waters 30 head stock.
19	SW.	24	"	"	"	Dug	19	2,770	- 13	2,757	14	2,750	Glacial clay and gravel	Hard, clear		D	Sufficient supply; another well 48 feet deep; hard, "alkaline" water.
20	SW.	24	"	"	"	Bored	60	2,768	- 12	2,756	60	2,708	Bearpaw blue clay	Hard, clear, "alkaline"		S	Sufficient for 24 head stock.
21	NW.	26	"	"	"	Bored	63	2,792	- 58	2,734	56	2,734	Bearpaw blue clay	Hard, clear, "alkaline"		S	Waters 10 head stock.
22	NE.	27	"	"	"	Drilled	137	2,735	- 80	2,655	137	2,598	Bearpaw blue clay	Hard, clear, "alkaline"		S	Laxative on humans; waters 8 head stock; another well for house.

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

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

WELL RECORDS—Rural Municipality of ELSE CREEK, NO. 77, SASKATCHEWAN.

B 4-4
R. 7526

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
23	SW.	30	8	15	3	Dug	67	2,852	- 63	2,789	63	2,789	Bearpaw blue clay	Hard, clear, red sediment, "alkaline"		S	Laxative on humans; waters 10 to 30 head stock.
24	SE.	30	"	"	"	Spring	0						Glacial drift	Soft, clear		D, S	Sufficient supply.
25	NW.	33	"	"	"	Dug	35	2,685	- 29	2,656	29	2,656	Glacial sand	Hard, "alkaline"		D, S	Waters from 15 to 30 head stock.
26	NW.	34	"	"	"	Drilled	60	2,688	- 10	2,678	60	2,628	Bearpaw?	Hard, clear		D, S	Waters 55 head stock.
27		35	"	"	"	Springs							Glacial drift			S	Sufficient for stock.
1	SW.	5	9	13	3	Drilled	60	2,620	- 40	2,580			Bearpaw blue clay	Hard, clear, "alkaline"		S	Good supply for 20 head stock. Gets drinking water from neighbours.
2	NE.	6	"	"	"	Drilled	55	2,608	- 35	2,573			Bearpaw blue clay	Hard, clear, "alkaline"		D, S	Good supply for 20 head stock.
3	SW.	6	"	"	"	Dug	30	2,612	- 22	2,590	30	2,582	Glacial clay	Hard, clear		D, S	Waters 20 head stock; good supply.
4	SE.	15	"	"	"	Dug	12	2,516	- 8	2,508	8	2,508	Glacial gravel	Hard, clear, "alkaline"		S	Laxative on humans; waters 35 head stock.
5	SE.	17	"	"	"	Dug	20	2,565	- 15	2,550	-15	2,550	Glacial sand	Hard, clear		D, S	Waters 15 head stock.
6	NE.	17	"	"	"	Bored	48	2,610	- 42	2,568	42	2,568	Bearpaw blue clay	Hard, clear, "alkaline"		S	Insufficient supply.
7	NE.	19	"	"	"	Bored	110	2,645	- 23	2,622	110	2,535	Bearpaw clay	Hard, clear, "alkaline"		D, S	Good supply for 20 head stock.
8	SW.	20	"	"	"	Dug	28	2,640	- 23	2,617	23	2,617	Glacial sand	Hard, clear		D, S	Waters 10 head stock.
9	SW.	21	"	"	"	Dug	34	2,620	- 30	2,590	32	2,588	Glacial sand	Hard, clear		D, S	Waters 30 head stock.
10	NW.	22	"	"	"	Dug	30	2,600	- 27	2,573	27	2,573	Glacial clay	Hard, clear, "alkaline"		S,	Insufficient supply; another well in coulée; supplies 20 head stock.
11	SW.	29	"	"	"	Dug	14	2,600	- 6	2,594	6	2,594	Glacial clay	Hard, clear		D, S	Waters 12 head stock.
12	NW.	29	"	"	"	Dug	30	2,600	- 28	2,572	28	2,572	Glacial gravel	Hard, clear		D	Insufficient supply; another well 15 feet deep; "alkaline" water, good supply.
13	NE.	32	"	"	"	Dug	30	2,540	- 14	2,526			Glacial sand	Hard, clear		D, S	Waters 15 head stock.
14	SW.	34	"	"	"	Bored	23	2,595	- 19	2,576	19	2,576	Glacial sand	Hard, clear		D, S	Insufficient supply.
15	NW.	35	"	"	"	Dug	25	2,485	- 24	2,461	24	2,461	Glacial drift	Hard, clear		D	Insufficient supply; only waters 3 head stock.
1	SE.	2	9	14	3	Dug	13	2,562	- 12	2,550	12	2,550	Bearpaw blue clay	Hard, clear, "alkaline"		S	Waters 15 head stock; laxative on humans.
2	NE.	5	"	"	"	Dug	60	2,608	- 55	2,553	55	2,553	Bearpaw sand	Hard, clear		D	Sufficient supply; springs used for stock.
3	NE.	6	"	"	"	Bored	50	2,833	- 42	2,791	42	2,791	Bearpaw blue clay	Hard, clear		D, S	Insufficient supply; another well in coulée 12 feet deep; waters 100 head stock.
4	SW.	7	"	"	"	Bored	65	2,780	- 64	2,716	64	2,716	Glacial sand			N	Wells are useless because quicksand cuts off the water supply.
5	NE.	7	"	"	"	Drilled	185	2,780	-130	2,650	130	2,650	Glacial sand	Soft, clear		N	Well not used owing to quicksand; several similar wells.
6	NE.	8	"	"	"	Spring							Glacial drift			D, S	C. P. R. spring.
7	NE.	9	"	"	"	Bored	95	2,633					Bearpaw	Hard		D, S	Sufficient supply

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

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

WELL RECORDS—Rural Municipality of WISE CREEK, NO. 77, 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
8	SE.	10	9	14	3	Dug	18	2,622	- 13	2,609	13	2,609	Glacial sand	Soft, clear		D, S	Insufficient supply; quicksand in test holes.
9	NW.	11	"	"	"	Bored	55	2,635	- 53	2,582	53	2,582	Glacial clay	Hard, clear, "alkaline"		S	Sufficient for 8 head stock; another 16-foot well; soft water, seepage from dam.
10	SW.	12	"	"	"	Dug	18	2,568	- 17	2,551	17	2,551	Glacial sand	Hard, clear		D	Insufficient supply; well caved in.
11	SE.	12	"	"	"	Bored	26	2,558	- 10	2,548	26	2,532	Glacial gravel	Soft, slightly "alkaline"		D, S	Waters 30 head stock; also have a spring.
12	SW.	13	"	"	"	Dug	22	2,628					Bearpaw blue clay	Hard, clear, "alkaline"		S	Waters 15 head stock; laxative on humans.
13	SW.	14	"	"	"	Bored	70	2,652					Bearpaw blue clay	Hard, clear, "alkaline"		S	Waters 30 head stock; laxative on humans; another well 18 feet deep used for house.
14	SE.	15	"	"	"	Bored	50	2,677	- 30	2,647			Bearpaw ?	Hard, clear, "alkaline"		D, S	Waters 30 head stock.
15	SE.	17	"	"	"	Bored	75	2,685	- 45	2,640	45	2,640	Glacial gravel	Hard, clear		D, S	Waters 15 head stock.
16	NE.	18	"	"	"	Bored	70	2,665					Bearpaw	Hard, clear, "alkaline"		D	Insufficient supply; also have a spring for stock use.
17	SE.	21	"	"	"	Bored	45	2,650	- 28	2,622	45	2,605	Bearpaw shale	Hard, clear, "alkaline"		S	Waters 20 head stock; laxative on humans; good supply.
18	SW.	22	"	"	"	Bored	125	2,720					Bearpaw blue clay	Hard, clear, "alkaline"		D, S	Waters 25 head stock.
19	SW.	24	"	"	"	Dug	16	2,670	- 12	2,658	12	2,658	Glacial sand	Soft, clear		D, S	Waters 15 head stock; seepage well.
20	SW.	32	"	"	"	Dug	13	2,770	- 8	2,762	8	2,762	Bearpaw blue clay	Hard, clear, "alkaline"		D, S	Waters 10 head stock.
21	NW.	34	"	"	"	Dug	28	2,695	- 18	2,677			Bearpaw blue clay	Hard, clear		D, S	Waters 22 head stock.
22	NE.	34	"	"	"	Bored	30	2,700	- 24	2,676	24	2,676	Bearpaw blue clay	Hard, clear, "alkaline"		D, S	Insufficient supply.
23	SW.	36	"	"	"	Dug	12	2,635	- 11	2,624	11	2,624	Glacial sand	Hard, clear		D	Insufficient supply; another seepage well 10 feet deep, good supply.
1	SW.	3	9	15	3	Dug	9	2,665	- 6	2,659	6	2,659	Recent alluvium	Hard, clear		D	Sufficient supply; stock are watered at creek.
2	SE.	5	"	"	"	Dug	20	2,660					Bearpaw blue clay	Hard, clear, "alkaline"		D, S	Waters 10 head stock.
3	SW.	6	"	"	"	Bored	42	2,750	- 27	2,723	27	2,723	Glacial gravel	Hard, clear, "alkaline"		D, S	Waters 15 head stock.
4	NE.	7	"	"	"	Bored	42	2,798	- 20	2,778			Bearpaw	Hard, clear		D, S	Waters 15 head stock.
5	SE.	13	"	"	"	Dug	12	2,600	- 8	2,592	12	2,588	Recent alluvium or Glacial drift?	Hard, clear, sulphur		S	Good supply for 40 head stock. 80-foot well; small supply of hard water.
6	SE.	14	"	"	"	Bored	60	2,655	- 45	2,610	60	2,595	Bearpaw	Hard, clear, "alkaline"		D, S	Waters 20 head stock easily.
7	SW.	14	"	"	"	Bored	100	2,680	- 97	2,583	97	2,583	Bearpaw blue clay	Hard, clear		D, S	Insufficient supply; another well 16 feet deep; small supply in sand.
8	SE.	15	"	"	"	Dug	64	2,680	- 60	2,620	60	2,620	Bearpaw clay	Soft, clear		D, S	Insufficient supply for 15 head stock.
9	NE.	18	"	"	"	Dug	20	2,730	- 15	2,715	15	2,715	Glacial gravel	Hard, clear		D, S	Waters 14 head stock.
10	SW.	18	"	"	"	Bored	68	2,840	- 48	2,792	48	2,792	Bearpaw blue clay	Hard, clear, "alkaline"		S	Waters 20 head stock; another 14-foot well for household use.

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 RISE CREEK, NO. 79, 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
11	SW.	25	9	15	3	Bored	50	2,824	- 30	2,794	30	2,794	Bearpaw sandstone	Hard, "alkaline"		S	Second well for domestic use; depth 50 feet.
12	NE.	27	"	"	"	Drilled	110	2,850	-100	2,750	110	2,740	Bearpaw shale	Hard, iron, "alkaline"		D, S	Never been pumped dry.
13	SW.	28	"	"	"	Bored	88	2,842	- 42	2,800	80	2,762	Bearpaw blue clay	Soft, clear		D	Insufficient; second well 20 feet deep was good supply; caved in; also springs in coulée.
14	NE.	30	"	"	"	Bored	25	2,738	- 25	2,713	25	2,713	Bearpaw sandy clay	Soft, clear		D	Insufficient; another 12-foot well, ample supply of hard "alkaline" water.
15	SW.	32	"	"	"	Drilled	204	2,764	- 50	2,714	204?	2,560?	Bearpaw blue clay	Soft, clear		D, S	Good supply; waters 60 head stock.
16	NE.	33	"	"	"	Drilled	253	2,775	-100?	2,675?			Bearpaw	Soft, clear		D, S	Good supply; waters 60 head stock.
17	NW.	35	"	"	"	Bored	70	2,850	- 60	2,790	60	2,790	Glacial clay	Hard, clear		D, S	Sufficient supply; waters 20 head stock.
18	SE.	36	"	"	"	Bored	27	2,845	- 23	2,822	23	2,822	Bearpaw	Hard, red sediment, "alkaline"		D, S	Sufficient for 3 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.