CANADA

DEPARTMENT OF MINES

AND

TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 170

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF ..... NO. 227 SASKATCHEWAN

By

B. R. MacKay, and D. C. Maddox

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BUREAU OF ECONOMIC GEOLOGY

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INTRODUCTION

Lack of rainfall during the years 1930 to 1934 over a large part of the Prairie Provinces brought about an acute shortage both in the larger supplies of surface water used for irrigation and the smaller supplies of ground water required for domestic purposes and for stock. In an effort to relieve the serious situation the Geological Survey began an extensive study of the problem from the standpoint of domestic uses and stock raising. During the field season of 1935 an area of 80,000 square miles, comprising all that part of Saskatchewan south of the north boundary of township 32, was systematically examined, records of approximately 60,000 wells were obtained, and 720 samples of water were collected for analyses. The facts obtained have been classified and the information pertaining to any well is readily accessible. The examination of so large an area and the interpretation of the data collected were possible because the bedrock geology and the Pleistocene deposits had been studied previously by McLearn, Warren, Rose, Stansfield, Wickenden, Russell, and others of the Geological Survey. The Department of Natural Resources of Saskatchewan and local well drillers assisted considerably in supplying several hundred well records. The base maps used were supplied by the Topographical Surveys Branch of the Department of the Interior.

Publication of Results

The essential information pertaining to the ground water conditions is being published in reports, one being issued for each municipality. Copies of these reports are being sent to the secretary treasurers of the municipalities and to certain Provincial and Federal Departments, where they can be consulted by residents of the municipalities or by other persons, or they may be obtained by writing direct to the Director, Bureau of Economic Geology, Department of Mines, Ottawa. Should anyone require more detailed information than that contained in the reports such additional information as the Geological Survey possesses can be obtained on application to the director. In making such request the applicant should indicate the exact location of the area by giving the quarter section, township, range, and meridian concerning which further information is desired.

The reports are written principally for farm residents, municipal bodies, and well drillers who are either planning to sink new wells or to deepen existing wells. Technical terms used in the reports are defined in the glossary.

How to Use the Report

Anyone desiring information about ground water in any particular locality should read first the part dealing with the municipality as a whole in order to understand more fully the part of the report that deals with the place in which he is interested. At the same time he should study the two figures accompanying the report. Figure 1 shows the surface and bedrock geology as related to the ground water supply, and Figure 2 shows the relief and the location and type of water wells. Relief is shown by lines of equal elevation called "contours". The elevation above sea-level

is given on some or all of the contour lines on the figure.

If one intends to sink a well and wishes to find the approximate depth to a water-bearing horizon, he must learn: (1) the elevation of the site, and (2) the probable elevation of the water-bearing bed. The elevation of the well site is obtained by marking its position on the map, Figure 2, and estimating its elevation with respect to the two contour lines between which it lies and whose elevations are given on the figure. Where contour lines are not shown on the figure, the elevations of adjacent wells as indicated in the Table of Well Records accompanying each report can be used. The approximate elevation of the water-bearing horizon at the well-site can be obtained from the Table of Well Records by noting the elevation of the water-bearing horizon in surrounding wells and by estimating from these known elevations its elevation at the well-site.[1] If the water-bearing horizon is in bedrock the depth to water can be estimated fairly accurately in this way. If the water-bearing horizon is in unconsolidated deposits such as gravel, sand, clay, or glacial debris, however, the estimated elevation is less reliable, because the water-bearing horizon may be inclined, or may be in lenses or in sand beds which may lie at various horizons and may be of small lateral extent. In calculating the depth to water, care should be taken that the water-bearing horizons selected from the Table of Well Records be all in the same geological horizon either in the glacial drift or in the bedrock. From the data in the Table

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[1] If the well-site is near the edge of the municipality, the map and report dealing with the adjoining municipality should be consulted in order to obtain the needed information about nearby wells.

of Well Records it is also possible to form some idea of the quality and quantity of the water likely to be found in the proposed well.

GLOSSARY OF TERMS USED

Alkaline. The term "alkaline" has been applied rather loosely to some ground-waters. In the Prairie Provinces, a water is usually described as "alkaline" when it contains a large amount of salts, chiefly sodium sulphate and magnesium sulphate in solution. Water that tastes strongly of common salt is described as "salty". Many "alkaline" waters may be used for stock. Most of the so-called "alkaline" waters are more correctly termed "sulphate waters".

Alluvium. Deposits of earth, clay, silt, sand, gravel, and other material on the flood-plains of modern streams and in lake beds.

Aquifer or Water-bearing Horizon. A water-bearing bed, lens, or pocket in unconsolidated deposits or in bedrock.

Buried pre-Glacial Stream Channels. A channel carved into the bedrock by a stream before the advance of the continental ice-sheet, and subsequently either partly or wholly filled in by sands, gravels, and boulder clay deposited by the ice-sheet or later agencies.

Bedrock. Bedrock, as here used, refers to partly or wholly consolidated deposits of gravel, sand, silt, clay, and marl that are older than the glacial drift.

Coal Seam. The same as a coal bed. A deposit of carbonaceous material formed from the remains of plants by partial decomposition and burial.

Contour. A line on a map joining points that have the same elevation above sea-level.

Continental Ice-sheet. The great ice-sheet that covered most of the surface of Canada many thousands of years 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 760 feet or somewhat more.

Belly River Formation. The Belly River consists mostly of non-marine sand, shale, and coal, and underlies the Bearpaw in the western part of the area. It passes eastward and northeastward into marine shale. The principal area of transition is in the western half of the area where the Belly River is mostly thinner than it is to the west and includes marine zones. In the southwestern corner of the area it has a thickness of several hundred feet.

Marine Shale Series. This series of beds consists of dark grey to dark brownish grey, plastic shales, and underlies the central and northeastern parts of Saskatchewan. It includes beds equivalent to the Bearpaw, Belly River, and older formations that underlie the western part of the area.

WATER-BEARING HORIZONS OF THE MUNICIPALITY

Rural municipality No. 227 is in southern Saskatchewan. The municipality is roughly rectangular in shape with South Saskatchewan river forming the southern boundary. It embraces tps. 21, 22, and 23, ranges 13, 14, and 15, W. 3rd mer., and that part of township 20, ranges 13, 14, and 15, north of South Saskatchewan river. The Canadian Pacific railway passes through the western part of the municipality. Matador, the terminus of this railway line, is 108 miles south and a little west of Saskatoon, about 109 miles west and a little north of Moose Jaw, and about 36 miles north and a little west of Swift Current. The larger settlements are on the railway line. Kyle is the only town in the municipality. Most of the eastern two-thirds of the municipality is very thinly settled and is devoted to ranching, the Matador ranch being in the southern part of the municipality.

Most of the eastern two-thirds of the municipality is rough and hilly, and is occupied by Missouri coteau. In township 22, range 13, a ridge which trends a little west of north rises to over 2,850 feet above sea-level. There are many lakes and dry lake bottoms in the coteau country. Most of the lakes are comparatively shallow and many contain "alkaline" water, but Clearwater lake, 15 miles northeast of Kyle, is 27 feet deep in places and the water is fresh. There are no permanent streams in the municipality. In the south several intermittent streams extend back for a few miles from South Saskatchewan river. In the northwest an intermittent stream which discharges into Whitebear lake drains a large part of townships 22 and 23, range 15. Drainage and direction of surface water in the coteau area is principally towards the lakes or lake bottoms which have no outlets. A low area which is occasionally marshy occurs in the centre of township 21, range 14. That part of the western third of the municipality not occupied by the coteau is flat to gently rolling.

In this part elevations range from a little over 2,350 feet above sea-level in the southeast to a little less than 1,900 feet in the northwest. South Saskatchewan river where it borders the municipality occupies a valley that is about 350 to 450 feet deep. Water-level in the river ranges from about 1,788 feet above sea-level at the western boundary of the municipality to approximately 1,745 feet above sea-level at the eastern boundary of the municipality. The slopes to the river are steep and are much dissected by coulées and stream valleys, but in parts of township 20, range 14, the slopes flatten out considerably. A highway passes northwards through range 15. There are several springs in the coteau country. Large springs occur in sec. 33, tp. 21, range 13, and in sec. 34, tp. 22, range 13, and there are springs west of Kyle, in the vicinity of Clearwater lake and elsewhere.

Water-bearing Horizons in the Unconsolidated Deposits

Moraine underlies the greater part of the coteau country. A northwestward-trending belt of glacial outwash sands and gravels about 7½ miles long, with an average width of about 1½ miles lies within the coteau country, and within this belt lie Clearwater lake and an associated chain of lakes. An area of about half a square mile in the northwest corner of the municipality is underlain by boulder clay. A belt of till or boulder clay borders the moraine on the west and south. On the west this belt is about 1 to 2 miles wide, but in the south it widens out to about 4 miles. West of the belt of boulder clay there is a comparatively flat area of glacial lake clays that extends to the western boundary of the municipality. Ground water in the boulder clay and the moraine is found only in beds or pockets of sand or gravel that are generally disconnected and have small extent. The water in both these types of deposits generally contains much dissolved matter, as drainage conditions generally are poor and circulation of ground water is restricted. In the glacial outwash deposits ground water is more abundant than in the boulder clay and moraine, and the

water is generally much less mineralized than in the latter deposits. The glacial lake clays are generally very impervious to water, but there are beds of sand in the clay that contain ground water which is often rather highly mineralized. Towards the eastern margin of the glacial lake clay the deeper wells probably pass into the underlying boulder clay. Most of the wells in the unconsolidated deposits of this municipality are less than 40 feet deep, many of them are seepage wells, and a few are fed by springs. In the western third of the municipality several wells over 100 feet deep have been put down in the glacial drift. In the southeast the glacial drift is very thick, two wells 310 and 312 feet deep not having reached bedrock. In the northwest a well 145 feet deep did not reach bedrock. The thickness of glacial drift in the coteau is not known. In the southeast there are thick deposits of dry sand interbedded with blue clay, in the glacial drift. The sands were probably deposited in an interglacial lake or in an old river channel; the interbeds of clay suggest the lake origin.

In the eastern two-thirds of the municipality the wells are from 5 to 30 feet deep. No widespread aquifer is known and many of the wells are either seepage wells or are supplied by springs. In the western third of the municipality there are no well-defined aquifers in the unconsolidated deposits. In this part there are several springs on the western slope of the coteau country.

Water-bearing Horizons in the Bedrock

The Eastend formation overlies the Bearpaw formation and underlies the glacial drift in a series of detached areas in the higher parts of the coteau. The Eastend formation is thought to have covered originally the whole municipality, but has since been removed by erosion from all but the higher elevations. Elsewhere in the municipality the Bearpaw formation underlies the glacial drift or is exposed at the surface in the banks of South Saskatchewan river. A narrow band of the Belly River formation which underlies the Bearpaw

outcrops in the valley of South Saskatchewan river. In this municipality the only wells that obtain water from bedrock are two in townships 20 and 21, range 15. These obtain soft water from a sandy horizon in the Bearpaw formation which is about 1,840 to 1,860 feet above sea-level. In the well on township 20, range 15, the supply of water was small. These soft water wells are about 8 miles apart and about mid-way between them a well obtains hard water from a black sand aquifer that is probably in the glacial drift and is about 1,865 feet above sea-level. A well at Matador station 200 feet deep obtained no water, the base of the well being about 1,980 feet above sea-level. No other wells in the municipality reach the Bearpaw sand aquifer, and it is impossible to say what parts of the municipality are underlain by it. This aquifer does not seem to be a very good source of water.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 20, Range 13

This township is entirely devoted to ranching. There are no houses in the township and no records of wells in it were obtained. About 4 square miles in the northeast is underlain by moraine. The remainder of the township is underlain by boulder clay or till except for those parts of the banks of South Saskatchewan river where the Bearpaw formation is exposed. Two intermittent streams extend back from South Saskatchewan river.

Township 20, Range 14

The eastern two-thirds of this township are used for ranching. There are a few farms in the western third of the township. Two square miles in the western half of the township are underlain by glacial lake clays; elsewhere boulder clay underlies the township. The Bearpaw formation directly underlies the glacial drift and is exposed at one place on the slopes of South Saskatchewan river. The Belly River formation underlies the glacial drift in a narrow belt near water-level in this river. Several intermittent streams extend back from the river valley.

Township 20, Range 15

That part of the township north of the valley of South Saskatchewan river is underlain by glacial lake clays and topographical relief is low. In the valley of South Saskatchewan river there are several outcrops of Bearpaw formation that are overlain by glacial till or boulder clay. Near river level the Belly River formation underlies the glacial drift. Two wells on section 28 obtained water from a glacial outwash gravel deposit that is about 2,250 feet above sea-level. The log of a well 290 feet deep, on the SW. $\frac{1}{4}$, section 32, shows brown and blue clay from the surface to 137 feet, dry sand from 137 feet to 171 feet, blue clay from 171 to 193 feet, dry sand from 193 to 281 feet,

blue clay from 281 to 288 feet, and coarse gravel containing water from 288 feet to 290 feet. A well 312 feet deep, on section 26, is reported as passing through quicksand from 147 to 272 feet and then into blue clay from 272 to 312 feet. A well 350 feet deep, on the SW. ¼, section 25, obtained a small supply of soft water from sand thought to be in the lower part of the Bearpaw formation. This aquifer is about 1,860 feet above sea-level and is lower than the bottoms of the deep wells in the drift, as the base of the well on the SW. ¼, section 32, is about 1,987 feet above sea-level and the base of the well on section 26 is about 1,938 feet above sea-level. The supply of water from the Bearpaw aquifer was small and the sand is probably very fine grained. The aquifer in the Bearpaw formation is about 80 feet above water-level in South Saskatchewan river at a point south of the well, and the aquifer seems to have been cut through by the valley of South Saskatchewan river on the south and by an inter-glacial or pre-glacial depression on the north.

Township 21, Range 13

This township is in the Missouri coteau. It is used only for ranching and no well records were obtained. Moraine underlies the township except in an area of a little over one square mile in the southwest which is underlain by boulder clay. There is a spring in the NE. ¼, section 33.

Township 21, Range 14

The northeast half of this township is hilly to rolling and the southwest half is comparatively flat. There are several shallow lakes in the northeastern part and a spring occurs on section 28. Most of the northeast half of the township is underlain by moraine, but a small area of glacial outwash sands and gravels forms a narrow belt around the lakes mentioned. About 6 square miles in the southwest is underlain by glacial lake clay. A belt of boulder clay 2 to 3 miles wide lies between the moraine and the lake clays. The township is used

for ranching and there are no houses in it.

Township 21, Range 15

Topographical relief is low, the land rising gently southwards to the southern boundary of the township and northeastwards to the northeast corner of the township. An area of about 6 square miles in the northeast is underlain by boulder clay; elsewhere the township is underlain by glacial lake clays. The depth of the wells in the boulder clay area ranges from 7 to 55 feet. The supply of water from these wells is satisfactory except from the well on the NE. ¼, section 26, in which the water is "alkaline" and laxative. The water in the well on the NW. ¼, section 24, is reported to turn black if kept long; this may be due to iron or manganese in the water. The well, now dry, on the SE. ¼, section 3, is 240 feet deep, and passed through 225 feet of blue clay. The top of the sand in this well is about 2,040 feet above sea-level, and this sand may correspond with that found in the well on the SW. ¼, sec. 32, tp. 20, range 15, at depths of 193 to 281 feet. If so the upper sand in the latter well does not extend far north. In the well on the NW. ¼, section 15, water which was unusable was found in a black sand aquifer at a depth of approximately 310 feet, or approximately 1,865 feet above sea-level.

A well 286 feet deep in the town of Kyle obtained soft water from sands thought to be in the Bearpaw formation. The elevation of the aquifer in this well is close to the elevation of the aquifer in the well on the SW. ¼, sec. 25, tp. 20, range 15, and it is probable that the Bearpaw sand underlies this township except in places where erosion has removed it.

Township 22, Range 13

Most of the southwest half of this township is very hilly and is used chiefly for ranching. A nearly flat-bottomed valley separates the hilly area in the southwest from the hilly area in the north. The entire township is underlain by moraine. A large spring

occurs on the NE. ¼, section 33, and there are several shallow lakes in the township. The Bearpaw formation directly underlies the glacial drift in the lower parts of the township; the Eastend formation overlies the Bearpaw formation and underlies the glacial drift over the higher parts of the township.

All the wells except one are in the eastern third of the township. The depth of the wells ranges from 8 to 30 feet. In many of the wells the supply is intermittent and the wells yield no water in dry seasons. Three wells, on sections 13, 14, and 23, are supplied by an aquifer, about 2,400 feet above sea-level, from which a spring issues. The water from the spring flows into Minnie lake. The water of one well in the township is soft; in all the others the water is hard. The aquifer that supplies the spring in the NE. ¼, section 33, is a little over 2,450 feet above sea-level at that point. There are no wells within several miles of the aquifer and it is not known how far it extends. It is probably an alluvial fan formed by streams flowing from the higher land to the north. No wells have reached bedrock and the thickness of the unconsolidated deposits is not known.

Township 22, Range 14

In the northeast half of this township an elevated tract rises to over 2,650 feet above sea-level. In the southwestern half of the township a chain of lakes extends in a generally northwesterly direction through the township. A northwesterly trending belt of glacial outwash sands surround these lakes. The remainder of the township is underlain by moraine. There are no streams in the township. There is a summer resort at Clearwater lake, but the remainder of the township is very thinly settled and is chiefly used for ranching. Several springs occur near Clearwater lake, in section 33 and elsewhere. The depths of the wells in this township ranges from 5 to 16 feet. South of Clearwater lake two wells are fed by an aquifer in which the water is comparatively soft. The intake area for this aquifer, from which a spring issues into Clearwater lake is the highland south of the lake. A

sand-point is used to obtain water on the SE. ¼, section 16. Two of the wells in the northern third are seepage wells, but they supply enough water for local use. The quality of the water in this township is good; in no case is water reported as "alkaline".

Township 22, Range 15

Glacial lake clays underlie all the western half of this township except about one square mile along its eastern border and this is underlain by boulder clay. The topographical relief in the eastern half of the township is low. It is underlain by moraine and boulder clay except for about 1½ square miles near the centre of the eastern boundary of the township which is underlain by glacial outwash sands and gravels. Topographical relief in the western half is fairly high, especially in the southeastern part. Depth of the wells in this township ranges from 8 to 32 feet, and none of them enter bedrock. Several wells were put down in the valleys of the intermittent streams and the well on the SW. ¼, section 2, is spring fed and the water contains very little dissolved matter. In several wells in the creek valleys farther north the water is "alkaline". Several springs discharge westwards into the valleys in which the creeks lie. In the northeast there are two seepage wells in which the water supply is insufficient for local needs. The thickness of the glacial lake clays in this township is not known as most of the well records are of wells near the eastern boundary of the glacial lake clay area.

Township 23, Range 13

This township lies in Missouri coteau. The entire township is very rolling to hilly. In the northwest a ridge rises to over 2,700 feet above sea-level and has a steep, southwesterly facing slope. There are many lakes in the township, but none of them is over half a square mile in extent. The township is used chiefly for ranching and

is largely unoccupied. The entire township is underlain by moraine. In the higher parts of the township the Eastend formation underlies the unconsolidated deposits; in the lower part the Bearpaw formation underlies the unconsolidated deposits.

Township 23, Range 14

The land surface in this township slopes gently westwards. Topographical relief is low. A few small lakes occur near the eastern boundary of the township. An intermittent stream that flows northwestwards enters the southwestern part of the township. The township is thinly settled. All well records except one were obtained from the northern half of the township. Moraine underlies the township except for an area of about 4 square miles in the northwest which is underlain by boulder clay. The Bearpaw formation directly underlies the unconsolidated deposits. At and near the northwest corner of the township there is about half a square mile of glacial lake clays. All well records are obtained from the moraine-covered part of the township. The supply of ground water in this township is not very satisfactory. Several wells are supplied by seepage from dams or dugouts. Two wells on the western slope are spring fed. In one of these wells the water is soft, in the other the water is highly mineralized and is used only for stock.

Township 23, Range 15

Most of this township is underlain by glacial lake clays, and the topographical relief is very low. The land surface slopes gently westward towards the long, narrow depression in which Whitebear lake lies. An intermittent stream passes through the township and discharges into this depression. A belt of boulder clay underlies approximately 4 square miles in the southeast part of the township, and moraine underlies a square mile in its extreme southeast corner. In the eastern half of the township the depth of the producing wells, except one, ranges from 5 to 30 feet. In the western half of the

township the wells are 14 to 40 feet deep. Several shallow wells were put down in the valleys of the intermittent streams, and obtain a fair supply of hard water. A well on the SW. $\frac{1}{4}$, section 11, is spring fed. In section 13, a shallow well obtained laxative water and a well 130 feet deep was a dry hole. Water-bearing gravels occur in the vicinity of the depression in the northwest. The well 145 feet deep on the NW. $\frac{1}{4}$, section 27, obtained an ample supply of water, but is not now used.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF NO. 227, SASKATCHEWAN.

West of 3rd mer.	Township	20	20	20	21	21	21	22	22	22	23	23	23	Total No. in Municipality
	Range	13	14	15	13	14	15	13	14	15	13	14	15	
Total No. of Wells in Township		0	0	5	0	0	12	7	6	14	0	7	11	62
No. of wells in bedrock		0	0	1	0	0	1	0	0	0	0	0	0	2
No. of wells in glacial drift		0	0	4	0	0	11	7	6	14	0	7	11	60
No. of wells in alluvium		0	0	0	0	0	0	0	0	0	0	0	0	0
Permanency of Water Supply														
No. with permanent supply		0	0	5	0	0	11	4	6	14	0	7	9	56
No. with intermittent supply		0	0	0	0	0	0	3	0	0	0	0	1	4
No. dry holes		0	0	0	0	0	1	0	0	0	0	0	1	2
Types of Wells														
No. of flowing artesian wells		0	0	0	0	0	0	0	0	0	0	0	0	0
No. of non-flowing artesian wells		0	0	3	0	0	4	1	0	2	0	1	2	13
No. of non-artesian wells		0	0	2	0	0	7	6	6	12	0	6	8	47
Quality of Water														
No. with hard water		0	0	2	0	0	10	6	5	13	0	6	10	52
No. with soft water		0	0	2	0	0	1	1	1	1	0	1	0	7
No. with salty water		0	0	0	0	0	0	0	0	0	0	0	0	0
No. with "alkaline" water		0	0	0	0	0	4	0	0	4	0	2	3	13
Depths of Wells														
No. from 0 to 50 feet deep		0	0	2	0	0	7	7	0	14	0	7	9	52
No. from 51 to 100 feet deep		0	0	0	0	0	1	0	0	0	0	0	0	1
No. from 101 to 150 feet deep		0	0	0	0	0	0	0	0	0	0	0	2	2
No. from 151 to 200 feet deep		0	0	0	0	0	1	0	0	0	0	0	0	1
No. from 201 to 500 feet deep		0	0	3	0	0	3	0	0	0	0	0	0	6
No. from 501 to 1,000 feet deep		0	0	0	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	0	0	0
How the Water is Used														
No. usable for domestic purposes		0	0	4	0	0	8	7	5	11	0	6	7	48
No. not usable for domestic purposes		0	0	0	0	0	3	0	1	3	0	1	3	11
No. usable for stock		0	0	4	0	0	9	7	6	13	0	7	9	55
No. not usable for stock		0	0	0	0	0	2	0	0	1	0	0	1	4
Sufficiency of Water Supply														
No. sufficient for domestic needs		0	0	3	0	0	8	2	5	9	0	5	7	39
No. insufficient for domestic needs		0	0	1	0	0	3	5	1	5	0	2	3	20
No. sufficient for stock needs		0	0	3	0	0	7	2	4	9	0	4	7	36
No. insufficient for stock needs		0	0	1	0	0	4	5	2	5	0	3	3	23

ANALYSES AND QUALITY OF WATER

General Statement

Samples of water from representative wells in surface deposits and bedrock were taken for analyses. Except as otherwise stated in the table of analyses the samples were analysed in the laboratory of the Borings Division of the Geological Survey by the usual standard methods. The quantities of the following constituents were determined; total dissolved mineral solids, calcium oxide, magnesium oxide, sodium oxide by difference, sulphate, chloride, and alkalinity. The alkalinity referred to here is the calcium carbonate equivalent of all acid used in neutralizing the carbonates of sodium, calcium, and magnesium. The results of the analyses are given in parts per million--that is, parts by weight of the constituents in 1,000,000 parts of water; for example, 1 ounce of material dissolved in 10 gallons of water is equal to 625 parts per million. The samples were not examined for bacteria, and thus a water that may be termed suitable for use on the basis of its mineral salt content might be condemned on account of its bacteria content. Waters that are high in bacteria content have usually been polluted by surface waters.

Total Dissolved Mineral Solids

The term "total dissolved mineral solids" as here used refers to the residue remaining when a sample of water is evaporated to dryness. It is generally considered that waters that have less than 1,000 parts per million of dissolved solids are suitable for ordinary uses, but in the Prairie Provinces this figure is often exceeded. Nearly all waters that contain more than 1,000 parts per million of total solids have a taste due to the dissolved mineral matter. Residents

accustomed to the waters may use those that have much more than 1,000 parts per million of dissolved solids without any marked inconvenience, although most persons not used to highly mineralized water would find such waters highly objectionable.

Mineral Substances Present

Calcium and Magnesium

The calcium (Ca) and magnesium (Mg) content of water is dissolved from rocks and soils, but mostly from limestone, dolomite, and gypsum. The calcium and magnesium salts impart hardness to water. The magnesium salts are laxative, especially magnesium sulphate (Epsom salts, $MgSO_4$), and they are more detrimental to health than the lime or calcium salts. The calcium salts have no laxative or other deleterious effects. The scale found on the inside of steam boilders and tea-kettles is formed from these mineral salts.

Sodium

The salts of sodium are next in importance to those of calcium and magnesium. Of these, sodium sulphate (Glauber's salt, Na_2SO_4) is usually in excess of sodium chloride (common salt, NaCl). These sodium salts are dissolved from rocks and soils. When there is a large amount of sodium sulphate present the water is laxative and unfit for domestic use. Sodium carbonate (Na_2CO_3) "black alkali", sodium sulphate "white alkali", and sodium chloride are injurious to vegetation.

Sulphates

Sulphates (SO_4) are one of the common constituents of natural water. The sulphate salts most commonly found are sodium sulphate, magnesium sulphate, and calcium sulphate ($CaSO_4$). When the water contains large quantities of the sulphate of sodium it is injurious to vegetation.

Chlorides

Chlorides are common constituents of all natural water and are dissolved in small quantities from rocks. They usually occur as sodium chloride and if the quantity of salt is much over 400 parts per million the water has a brackish taste.

Iron

Iron (Fe) is dissolved from many rocks and the surface deposits derived from them, and also from well casings, water pipes, and other fixtures. More than 0.1 part per million of iron in solution will settle as a red precipitate upon exposure to the air. A water that contains a considerable amount of iron will stain porcelain, enamelled ware, and clothing that is washed in it, and when used for drinking purposes has a tendency to cause constipation, but the iron can be almost completely removed by aeration and filtration of the water.

Hardness

Calcium and magnesium salts impart hardness to water. Hardness of water is commonly recognized by its soap-destroying powers as shown by the difficulty of obtaining lather with soap. The total hardness of a water is the hardness of the water in its original state. Total hardness is divided into "permanent hardness" and "temporary hardness". Permanent hardness is the hardness of the water remaining after the sample has been boiled and it represents the amount of mineral salts that cannot be removed by boiling. Temporary hardness is the difference between the total hardness and the permanent hardness and represents the amount of mineral salts that can be removed by boiling. Temporary hardness is due mainly to the bicarbonates of calcium and magnesium and iron, and permanent hardness to the sulphates and chlorides of calcium and magnesium. The permanent hardness

can be partly eliminated by adding simple chemical softeners such as ammonia or sodium carbonate, or many prepared softeners. Water that contains a large amount of sodium carbonate and small amounts of calcium and magnesium salts is soft, but if the calcium and magnesium salts are present in large amounts the water is hard. Water that has a total hardness of 300 parts per million or more is usually classed as excessively hard. Many of the Saskatchewan water samples have a total hardness greatly in excess of 300 parts per million; when the total hardness exceeded 3,000 parts per million no exact hardness determination was made. Also no determination for temporary hardness was made on waters having a total hardness less than 50 parts per million. As the determinations of the soap hardness in some cases were made after the samples had been stored for some time, the temporary hardness of some of the waters as they come from the wells probably is higher than that given in the table of analyses.

Analyses of Water Samples from the Municipality of No. 227, Saskatchewan

LOCATION						Depth of Well, Ft.	Total dis'vd solids	HARDNESS			CONSTITUENTS AS ANALYSED						CONSTITUENTS AS CALCULATED IN ASSUMED COMBINATIONS									Source of Water
No.	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	$CaCl_2$	
1	SW.	35	21	15	3	7	457											(4)	(1)		(2)				(3)	✱1
2	SW.	2	22	15	3	12	340											(2)	(1)		(3)				(4)	✱1

Water samples indicated thus, ✱1, are from glacial drift.
Analyses are reported in parts per million; where numbers (1), (2), (3), and (4) 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 ($CaCO_3$).
Analyses Nos. 1 and 2 by Provincial Analyst, Regina.
For interpretation of this table read the section on Analyses and Quality of Water.

Water from the Unconsolidated Deposits

The glacial drift was deposited by the continental ice-sheet, and the materials of the drift differ so widely in chemical composition and texture, and in the agencies that have acted upon them, that it cannot be expected that water from the drift will be uniform in composition. The influence of the velocity of flow of ground water upon the chemical composition of the water is well shown by the relative purity of spring water as compared with well water. Both the analyses listed in the table represent water from wells that are spring fed, and in both the amount of total solids is comparatively small. In analysis No. 2 the total solids are considerably less than in analysis No. 1; this may be due to the fact that the well from which sample No. 2 is taken is located at the edge of a stream valley where circulation of ground water would probably be more rapid than in the gently sloping plain on which the other well is located.

Reference to the two analyses shows that all the dissolved solids present are compounds of calcium and magnesium, sodium salts being absent. In both analyses calcium sulphate, $CaSO_4$, is predominant, and in both magnesium sulphate, $MgSO_4$, forms a large proportion of the dissolved solids. Calcium carbonate, $CaCO_3$, however, is present in analysis No. 2 in a larger proportion than in analysis No. 1, and, therefore, boiling would soften the water represented by analysis No. 2 more than that represented by analysis No. 1.

The influence that the nature of the sediment has upon the composition of water from the glacial drift is shown by the fact that the water in Clearwater Lake, on sec. 18, tp. 22, range 14, which is in an area of glacial outwash sand and gravel, is fresh whereas the water in many of the shallow lakes in the coteau country, which is underlain by moraine, is "alkaline".

No analyses of water from wells in this municipality not fed by springs are available. Most waters from wells in the finer grained sediments, such as boulder clay, moraine, or glacial lake clays, contain over 1,000 parts per million of total solids and many of them contain several thousand parts per million of total solids. The relative abundance of salts varies widely, but usually calcium sulphate, $CaSO_4$, is predominant, with magnesium sulphate, $MgSO_4$, second in order of abundance, and sodium sulphate, Na_2SO_4, rather variable in amount but sometimes predominant. The proportion of sodium chloride, NaCl, is usually very small. Sodium carbonate, Na_2CO_3, is usually either absent or present in very small amounts. Calcium carbonate, $CaCO_3$, is usually present, but is generally subordinate in amount to calcium sulphate. These facts show that the well water from the fine-grained glacial drift is usually very hard, due to the presence of the salts of calcium and magnesium, and that the hardness is usually not removed to any great extent by boiling, due to the large proportion of the sulphates of calcium and magnesium present. Sodium chloride and sodium carbonate are seldom present in sufficient quantities to give a salty or a "soda" taste to ground water in the glacial drift, but waters containing sufficient magnesium sulphate to make them bitter are of common occurrence.

The sulphates of sodium and magnesium are the laxative salts in ground water. Continued use of slightly laxative waters tends within reasonable limits to build up a resistance to their laxative properties. For stock a slightly laxative water is advantageous with the dry feed usually given during the winter.

The small proportion of black alkali, Na_2CO_3, found in ground water from the glacial drift makes this water better adapted for irrigation than water from the bedrock. Sodium sulphate, Na_2SO_4, "white alkali", however, may be present in considerable amounts, and it, as well as the magnesium sulphate, may be harmful to vegetation.

The yield of water from wells in the glacial drift is usually too small for irrigation purposes except on a very small scale. Iron is often present in ground water from the drift, and it is objectionable in water for domestic use as it gives a taste to water and stains clothes. It is easily removed by aerating or by boiling the water.

Water from the Bedrock

No analyses of water from wells in the bedrock in this municipality are available. The water from the Bearpaw formation in municipalities to the east is known to contain sodium salts almost entirely, and to be very soft. The relative abundance of the salts of sodium is usually sulphate, carbonate, chloride, but in some waters the sodium sulphate is absent. Such waters have a "soda" taste which is rather objectionable unless the water is quite cold. The waters are slightly laxative if sodium sulphate is predominant, and occasionally they contain enough sodium chloride to give them a salty taste. They are not good for irrigation, as they contain so large a proportion of "black alkali" and "white alkali", but they are excellent for washing. The sodium carbonate in these waters extracts the colours from some vegetable compounds such as tea or coffee, and, therefore the tea or coffee becomes dark when the water is boiled.

WELL RECORDS—Rural Municipality of NO. 227, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
1	SW.	25	20	15	3	Drilled	350	2,210			350	1,860	Bearpaw sand	Soft		D, S	Never has been sufficient supply.
2		26	"	"	"	Drilled	312	2,250			312	1,938	Glacial quick-sand				Quicksand 147 feet to 272 feet; large supply
3	SE.	28	"	"	"	Dug	14	2,265	0	2,265	14	2,251	Glacial gravel	Hard, clear	48	D, S	Sufficient supply; near dugout.
4	NW.	28	"	"	"	Dug	14	2,270	- 10	2,260	14	2,256	Glacial gravel	Hard, clear	48	D, S	Sufficient supply.
5	SW.	32	"	"	"	Drilled	290	2,275	-285	1,990	288	1,987	Glacial gravel			S	Unfit for domestic use.
1	SE.	3	21	15	3	Drilled	240	2,265			240	2,025	Glacial drift	Hard, "alkaline"	44	N	Well dry in 1935.
2	NW.	15	"	"	"	Drilled	310	2,175	-306	1,869	310	1,865	Glacial sand	Hard, clear, "alkaline"	44	N	Unfit for use.
3	NE.	21	"	"	"	Dug	26	2,165			26	2,139	Glacial quick-sand	Hard, clear	43	D, S	Sufficient supply.
4	NE.	22	"	"	"	Dug	14	2,160	- 4	2,156	14	2,146	Glacial drift	Hard, clear	44	D	Insufficient supply; seepage well.
5	SE.	24	"	"	"	Dug	18	2,175	- 16	2,159	18	2,157	Glacial sand	Hard, clear	42	D	Also 200-foot dry hole.
6	NW.	24	"	"	"	Dug	35	2,200	- 27	2,173	35	2,165	Glacial sand	Hard, clear	43	D, S	Sufficient for local needs.
7	SW.	25	"	"	"	Dug	16	2,220	- 12	2,208	16	2,204	Glacial quick-sand	Hard, clear, "alkaline"	44	D, S	Sufficient supply.
8	NE.	26	"	"	"	Dug	35	2,215	- 29	2,186	35	2,180	Glacial quick-sand	Hard, clear, sulphur "alkaline"	43	S	Sufficient for stock; laxative.
9	NE.	32	"	"	"	Drilled	236	2,127	-246	1,881	236	1,841	Bearpaw	Soft			
10	NE.	34	"	"	"	Bored	55	2,200	- 40	2,160	55	2,145	Glacial drift	Hard, iron	44	D, S	Sufficient supply.
11	SW.	35	"	"	"	Dug	7	2,220	0	2,220	7	2,213	Glacial gravel	Hard, cloudy, odorous	43	D, S	Sufficient supply; fed by spring. #.
1	SW.	1	22	13	3	Dug	22	2,450	- 10	2,440	12	2,438	Glacial drift	Hard, clear	45	D, S	Insufficient, intermittent supply.
2	SW.	12	"	"	"	Dug	8	2,440	- 4	2,036	8	2,032	Glacial quick-sand	Soft, clear	45	S	Insufficient supply.
3	NW.	13	"	"	"	Dug	10	2,415	- 4	2,411	10	2,405	Glacial drift	Hard, clear	43	D, S	Intermittent supply.
4	NE.	13	"	"	"	Dug	28	2,360	- 8	2,352	28	2,332	Glacial quick-sand	Hard, clear	45	S	Intermittent supply.
5	NE.	14	"	"	"	Dug	16	2,420	- 12	2,408	16	2,404	Glacial quick-sand	Hard, clear	43	D, S	Insufficient supply.
6	SE.	19	"	"	"	Dug	30	2,600	- 20	2,580	30	2,570	Glacial sand	Hard, clear	45	D, S	Sufficient supply.
7	NW.	23	"	"	"	Dug	9	2,410	0	2,410	9	2,401	Glacial sand and gravel	Hard, clear	48	D, S	Sufficient supply; this is a spring.
1	NE.	2	22	14	3	Dug	12	2,500	- 9	2,491	12	2,488	Glacial sand	Hard, clear	43	D, S	Insufficient supply.
2	SE.	16	"	"	"	Dug	16	2,375			16	2,359	Glacial quick-sand	Hard, clear	43	D, S	Sufficient supply.
3	SE.	18	"	"	"	Dug	5	2,245	0	2,245	5	2,240	Glacial quick-sand	Hard, clear	45	D, S	Sufficient supply; spring fed.
4	SW.	18	"	"	"	Dug	6	2,250	0	2,250	6	2,294	Glacial sand and gravel	Hard, clear	45	D, S	Sufficient supply; spring at base.

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

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

WELL RECORDS—Rural Municipality of NO. 227, 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
5	SW.	27	22	14	3	Dug	11	2,330	- 8	2,322	11	2,319	Glacial drift	Hard, clear	48	D, S	Sufficient supply.
6		28	"	"	"	Dug	8	2,380	0	2,380	8	2,372	Glacial sand	Soft, clear	44	D, S	Sufficient supply.
1	SW.	2	22	15	3	Dug	12	2,220	- 6	2,214	12	2,208	Glacial sand	Hard, clear		D, S	Sufficient supply; #.
2	SE.	9	"	"	"	Dug	32	2,100	- 20	2,080	32	2,068	Glacial quick-sand	Hard, clear, "alkaline"		N	Caved in.
3	SW.	9	"	"	"	Dug	8	2,075	- 2	2,073	8	2,067	Glacial sand	Hard, clear		S	Sufficient for stock.
4	SW.	10	"	"	"	Dug	18	2,115	- 8	2,107	18	2,097	Glacial drift	Hard, clear, "alkaline"	44	S	Sufficient for stock; has also a dam.
5	SE.	20	"	"	"	Dug	13	2,020	- 7	2,013	13	2,007	Glacial sand	Hard, clear	48	D, S	Sufficient for local needs.
6	NE.	21	"	"	"	Dug	20	2,025	- 15	2,010	20	2,005	Glacial sand	Hard, clear	44	D, S	Sufficient supply.
7	NW.	21	"	"	"	Dug	17	2,035	- 13	2,022	17	2,018	Glacial sand	Hard, clear	46	D, S	Insufficient supply.
8	SW.	25	"	"	"	Dug	25	2,050	- 20	2,030	25	2,025	Glacial sand	Hard, clear	45	D, S	Sufficient supply.
9	SE.	28	"	"	"	Dug	18	2,020	- 18	2,002	14	2,006	Glacial sand	Hard, clear	45	D, S	Sufficient supply.
10	NE.	28	"	"	"	Dug	11	2,016	0	2,016	11	2,005	Glacial gravel	Soft, cloudy	45	D, S	Insufficient supply; seepage well.
11	SE.	32	"	"	"	Dug	15	1,985	- 15	1,970	12	1,973	Glacial sand	Hard, clear, "alkaline"	47	D, S	Insufficient supply.
12	NW.	34	"	"	"	Dug	12	2,005	0	2,005	12	1,993	Glacial drift	Hard, clear, "alkaline"	45	D, S	Sufficient supply; seepage well.
13	SW.	34	"	"	"	Dug	20	2,015	0	2,015	20	1,995	Glacial sand	Hard, clear, "alkaline"	43	D, S	Sufficient supply.
14	SE.	35	"	"	"	Dug	10	2,100	0	2,100	10	2,090	Glacial gravel	Hard, clear	43	D, S	Insufficient supply; seepage well.
1	NW.	15	23	14	3	Dug	29	2,350	0	2,350	29	2,321	Glacial drift	Hard, clear, odorous, slightly "alkaline"	44	D, S	Insufficient supply.
2	NE.	21	"	"	"	Dug		2,242					Glacial drift	Hard, clear	41	D, S	Insufficient supply.
3	SE.	21	"	"	"	Dug	20	2,240	- 8	2,232	20	2,220	Glacial drift	Hard, clear, iron	40	D, S	Sufficient supply.
4	NW.	22	"	"	"	Dug	16	2,240	- 4	2,236	16	2,224	Glacial gravel	Hard, clear	43	D, S	Sufficient supply.
5	SW.	28	"	"	"	Dug	8	2,200	0	2,200	8	2,192	Glacial drift	Soft, cloudy, odorous	42	D, S	Sufficient supply; seepage.
6	SE.	34	"	"	"	Dug	26	2,250	- 14	2,236	26	2,224	Glacial sand	Hard, clear, "alkaline"	41	S	Insufficient supply; bad taste.
7	SW.	35	"	"	"	Dug	10	2,350	- 4	2,346	10	2,340	Glacial sand	Hard, clear	42	D, S	Sufficient supply.
1	NE.	10	23	15	3	Dug	17	2,005	- 13	1,992	17	1,988	Glacial sand	Hard, clear	42	D, S	Insufficient supply.
2	SW.	11	"	"	"	Dug	5	2,050	0	2,050	5	2,045	Glacial sand	Hard, clear	43	S	Sufficient for stock needs; spring fed well.

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

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

WELL RECORDS—Rural Municipality of NO. 227, SASKATCHEW.

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
3	SE.	13	23	15	3	Dug	12	2,075	- 6	2,069	12	2,063	Glacial sand	Hard, clear, odorous	42	D, S	Intermittent supply; also 130-foot dry hole.
4	SE.	14	"	"	"	Dug	16	2,000	- 14	1,986	16	1,984	Glacial gravel	Hard, clear	43	D, S	Insufficient supply.
5	NE.	15	"	"	"	Dug	30	1,968	- 25	1,943	30	1,938	Glacial drift	Hard, clear, "alkaline", odorous	43	D	Insufficient supply.
6	SE.	16	"	"	"	Bored	40	1,950	- 22	1,928	40	1,910	Glacial sand	Hard, clear, slightly "alkaline"	45	S	Sufficient for stock needs.
7	SE.	21	"	"	"	Dug	15	1,945	- 13	1,932	15	1,930	Glacial sand	Hard, clear	43	N	Insufficient; used to supply household and stock but unused at present.
8	NE.	27	"	"	"	Bored	145	1,930	- 60	1,870	145	1,785	Glacial drift	Hard, clear, "alkaline"	43	D, S	Sufficient supply.
9	NE	30	"	"	"	Dug	14	1,900	11	1,889	14	1,886	Glacial gravel	Hard, clear	45	D, S	Sufficient supply.
10	NE.	30	"	"	"	Bored	40	1,900	- 27	1,873	40	1,860	Glacial drift	Hard, clear	41	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.