CANADA
DEPARTMENT OF MINES
AND
TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 200

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF FERTILE VALLEY NO. 285 SASKATCHEWAN

By

B. R. MacKay, H. N. Hainstock & G. Graham

OTTAWA
1936

NOTE:

Because of difficulties involved in reproduction, the tables of well records referred to are not included with this report. Information regarding individual wells may be obtained by writing to the Director, Geological Survey of Canada, Ottawa.

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GROUND WATER RESOURCES OF THE RURAL MUNICIPALITY OF FERTILE VALLEY, NO.285, SASKATCHEWAN

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 Fertile Valley, No. 285, comprises an area of 390 square miles in western Saskatchewan. It consists of nine full townships described as tp. 27, ranges 8, 9, and 10, and tps. 28, 29, and 30, ranges 9 and 10, and four partial townships described as tp. 27, range 7, and tps. 28, 29, and 30, range 8, all W. 3rd mer. Saskatchewan river forms the eastern boundary of the municipality and only that part of the partial townships lying west of the river is covered by this report. The centre of the area lies approximately 47 miles south and 23 miles west of the city of Saskatoon. The Eatonia Section of the Canadian National railways traverses the area in a north-south direction, roughly paralleling the river. On it are located Ardath, Conquest, Bratton, and Macrorie. A branch line also traverses the southern part of the area, entering the municipality in sec. 2, tp. 27, range 8, following a chain of lakes, and leaving the area in sec. 31, tp. 27, range 10. The Outlook Section of the Canadian Pacific railway crosses the northern half of the municipality and on it are located Conquest and Bounty. Provincial Highways Nos. 15 and 44 cross the area in an east-west direction, and No. 45 in a north-south direction.

The northern half of the municipality is comparatively level with most of the drainage being towards the river. The river valley in this part is from 50 to 75 feet deep. Macdonald creek in the northwestern corner has eroded a fairly wide, steep-sided valley. The southern half of the municipality is more rolling and in parts it is rugged, especially along the river where numerous deep ravines occur. The river valley in this area averages more than 150 feet deep. A chain of lakes, including Coteau, Stockwell, Anerley, and the southern part of Milden, occupies an old river valley extending from Elrose Junction in a general northwest direction to Surbiton and thence in a general

westerly direction to the western boundary of the area. The valley in which the lakes occur is fairly wide and is steep-sided, the banks in places being more than 150 feet high. South of the lakes the ground surface is decidedly rolling and the elevation ranges from approximately 2,000 feet above sea-level, along the plain above the valley, to more than 2,250 feet above sea-level along the southern boundary.

Recent deposits of dune sand cover a small area in secs. 34 and 35, tp. 30, range 10, and glacial lake sands cover almost all of tp. 30, range 8, and small areas in tp. 28, range 8, and tp. 30, range 9. The remainder of the municipality is covered by glacial lake clay, boulder clay or glacial till, and moraine. The greater part of the northern half of the municipality is covered by lake clay. An area in the south-central part of the municipality and a narrow area paralleling the chain of lakes on the north are mantled by moraine.

Water-bearing Horizons of the Unconsolidated Deposits

One well has been dug in the Recent dune sands and it obtains water at a depth of 10 feet. The supply is small, but the water is satisfactory for domestic use.

In most parts of the glacial lake sand-covered areas, water is obtained at shallow depth, but in a few localities the lake sands do not contain water, and wells are sunk into the underlying boulder clay or glacial till. The supply from the shallow wells dug in the lake sand varies considerably and is readily affected by drought conditions. An individual well yields sufficient water for domestic use and a few head of stock, but on some farms it is necessary to use more than one well in order to obtain sufficient water for farm requirements. The water varies from moderately soft to hard, but it is usable for domestic purposes.

The glacial lake clay does not yield much water, but deposits of sand and gravel that occur at the contact of the lake clay and boulder clay, usually within 30 feet of the surface, are supplying some wells with sufficient water for farm needs. Water is also derived from scattered deposits of sand and gravel that occur in the underlying boulder clay at depths ranging from 30 to 120 feet. Some correlation can be established in the occurrence of aquifers supplying wells on adjoining quarter-sections, but as a rule each aquifer appears to be of small areal extent.

The water conditions in the moraine and glacial till-covered areas are quite similar. The deposits consist of a thin layer of top soil; a zone of yellow or oxidized clay that seldom extends to a depth of more than 30 feet and which contains scattered deposits of sand and gravel at or near its base; and an unweathered zone of compact, blue clay that also contains scattered deposits of sand and gravel. Approximately one-half the wells in the municipality obtain water from the scattered deposits of sand and gravel that occur in the weathered zone of the drift. The deposits show little or no continuity in their occurrence, but along valleys or ravines, or in depressions, they appear to be more numerous than elsewhere. The supply from the shallow wells is usually sufficient for domestic purposes and a few head of stock, but the wells are readily affected by drought conditions. The supply from a few wells is sufficient for a number of farms. The water from the shallow wells varies considerably in quality, being moderately soft to extremely hard. Some of the water is too highly mineralized for drinking, but that from most wells is usable for all farm needs.

Wells greater than 35 feet deep tap deposits of sand or gravel in the unweathered zone of the glacial drift. In some localities these deposits appear to be continuous over a small area,

but in this municipality it was impossible to outline any large area in which a continuous water-bearing horizon occurs. The scattered occurrence of the water-bearing deposits is shown by the fact that many dry holes are dug in the vicinity of producing wells. The supply of water from wells tapping the water-bearing deposits in the unweathered glacial drift, although not so directly affected by annual precipitation, varies considerably, and quite a number of residents find it necessary to supplement the supply. The water is usually very hard and fairly highly mineralized, but most of the water is used for domestic purposes as well as for stock, although that from some wells has a laxative effect on those not accustomed to its use.

Other sources of water than those tapped by wells sunk into water-bearing deposits are: (1) wells sunk beside sloughs, depressions, or beside dams or dugouts. These wells obtain water by direct seepage from the impounded surface water, and they cease to yield water when the slough, dam, or dugout becomes dry. If they are deepened as the water table recedes a supply sufficient for at least domestic needs can be obtained in many places. (2) Saskatchewan river and some of its intermittent tributaries, and creeks and lakes. The water from the Saskatchewan and the creeks is used for stock; the water from the lakes is highly mineralized and is not used. (3) Springs that occur along the banks of the lakes and also along the banks of stream valleys. The supply from most of these springs is sufficient for a large number of stock and the water from some of them is usable for domestic needs. The yield from the springs can be increased by digging out the source, or by the installation of a small collecting gallery, and the supply available for use can be increased by conserving the overflow in a reservoir. (4) Artificial reservoirs such as dams and dugouts. Many favourable sites are present in this municipality for the economical erection of dams, and some of the

residents are using them to conserve surface water. The impounded water is used for stock and the supply impounded is usually sufficient during most of the year. Dugouts are not so common, but they can be excavated economically in some areas and can be used to supplement the supply from wells. A dugout should be at least 12 feet deep in order to retain sufficient water for stock use.

Water-bearing Horizons in the Bedrock

The Bearpaw formation is thought to immediately underlie the glacial drift in the area south of the geological boundary shown on Figure 1 of the accompanying map. To the north of the boundary line the drift is immediately underlain by the Belly River formation, which also underlies the Bearpaw formation. The Bearpaw formation outcrops along Saskatchewan river, but the exact elevation at which the outcrops occur is not known. However, it is thought to be somewhat less than 1,700 feet above sea-level. The Belly River formation also outcrops along the river. In most parts of the municipality bedrock is thought to occur at about 1,700 feet above sea-level, although in the northern part it may occur below this elevation. A well located in township 28, range 10, is thought to be obtaining water from the bedrock at an elevation of 1,786 feet above sea-level. The Bearpaw formation over most of the area is very thin and with the possible exception of the well mentioned above it is doubtful if any wells in this municipality are obtaining water from aquifers in the formation. Aquifers in the Belly River formation have been tapped at depths ranging from 237 to 600 feet, or at elevations ranging from 1,680 to 1,403 feet above sea-level. Lack of information does not permit the outlining of any area in which continuous water-bearing horizons occur. The sand deposits in the Belly River formation appear to be lenticular. Dry holes have been drilled to depths of 395 to 1,003 feet or to elevations ranging from 1,690 to 1,127 feet above sea-level, and the

water-bearing horizons are not continuous. A 766-foot well and the 1,003-foot well may have passed through the Belly River formation into a lower non-water-bearing formation. The water obtained from the bedrock varies from moderately soft to hard, and many aquifers yielding soft water are found at elevations above those that yield very hard water. When a bedrock aquifer is tapped the supply of water is usually abundant and the water is as a rule under sufficient pressure to rise 100 feet or more above the aquifer. The water is quite highly mineralized, but with few exceptions it is used for domestic purposes as well as for stock.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 27, Range 7

South Saskatchewan river forms the eastern boundary of the municipality and only that part of the township west of the river is discussed in this report. The river bank is steep, rising from an elevation of 1,640 feet above sea-level at the river to 1,850 feet on the plain. The surface of the plain is undulating, and in the vicinity of the river is cut by coulées. The elevation rises to approximately 1,975 feet above sea-level in the south-western corner of the area. With the exception of parts of section 5 and 6 that are mantled by moraine, the area is covered by boulder clay or glacial till. The Bearpaw formation outcrops in section 19, but at what elevation is not known.

The shallow wells in this township are less than 30 feet deep and tap scattered pockets of sand and gravel in the upper part of the drift. Dry holes will probably be dug in some areas before a water-bearing deposit is located, as the deposits do not form a continuous water-bearing horizon. Ravines and depressions are suitable locations for shallow wells. The use of a small test auger to locate the water-bearing deposits is recommended. The shallow wells do not yield large supplies of water, but a few yield adequate supplies for local needs and the remainder yield sufficient water for domestic purposes. The water is hard, but it is not highly mineralized and is being used for domestic purposes.

The lower part of the glacial drift has not been extensively investigated, but it does not appear to contain many water-bearing deposits in this township. One well located in section 10 derives water from a sand aquifer at a depth of 60 feet, but dry holes were sunk in sections 5 and 7 to depths of 200 and 100 feet, respectively. On section 18 it was found necessary to drill to a depth of 175 feet before water was obtained. It would appear advisable, therefore, to prospect for shallow water-bearing deposits first.

The well located in section 18 may be obtaining part of its supply from an aquifer in the bedrock, but the aquifer is not a large producer as only sufficient water is obtained for domestic purposes. The well is 175 feet deep and is drilled to an elevation of 1,645 feet above sea-level. The 200-foot dry hole located in section 5 may also be sunk into the bedrock. The depth to which it would be necessary to drill in order to obtain adequate supplies of water from the underlying bedrock has not been ascertained in this area.

Most of the water for stock in the township is obtained by impounding surface water by dams. The amount of water impounded by the dams is not always sufficient for local needs, but in years of normal rainfall the supply is usually adequate. Wells dug beside the impounded waters should yield sufficient water for domestic purposes. Such waters, when care is taken to prevent surface pollution, should be satisfactory for drinking. Spring waters are also used for stock.

Township 27, Range 8

The ground surface throughout this township varies from gently undulating to fairly rough. The northeastern half of the township is comparatively level except where cut by tributaries of the Saskatchewan. A fairly wide valley trending from section 3 to section 30 contains Stockwell and Coteau lakes. The elevation increases from approximately 1,875 feet at the lakes to 2,150 feet in the southwestern corner. The minimum elevation of approximately 1,635 feet above sea-level occurs at Saskatchewan river in the northeastern corner. A small area in the northeastern corner is mantled by glacial lake sands. A strip approximately 1½ miles wide paralleling the lakes on the north, and a small area in the southwestern corner, are mantled by moraine. The remainder of the area is covered by boulder clay or glacial till. The

glacial lake sands have not been tested for water, but unless they are very thin they should yield usable water at shallow depth. Some water should also be obtained from scattered sand and gravel deposits that are thought to occur in the glacial till underlying the lake sands.

The water conditions in the areas covered by moraine and glacial till are somewhat similar. In general the drift consists of a few feet of top soil; a weathered zone of yellow clay that in most places extends to a depth of at least 25 feet; and an unweathered zone of compact, dark clay that extends to the underlying bedrock. The sand and gravel deposits that occur in the weathered zone of the drift form aquifers for a number of shallow wells in the township. The deposits appear to be more numerous in the vicinity of the creeks and lakes. A few wells derive water by direct seepage from impounded surface water. The supply from most of the shallow wells is adequate for farm needs and in all cases it is sufficient for at least domestic purposes. The water is usable for all farm requirements.

The unweathered zone of the drift has been tested fairly extensively and water-bearing deposits have been tapped at depths ranging from 40 to 110 feet. The water-bearing deposits appear to be of scattered distribution, but they may form continuous water-bearing horizons over very small areas. No dry holes were recorded in the township, but in sections 10 and 28 it was found necessary to drill to 250 and 350 feet before water was obtained. It was not recorded whether either of these wells passed through water-bearing deposits above the aquifers that are now supplying the wells. The supply from the wells tapping deposits in the unweathered zone varies considerably, although most wells yield sufficient water for stock needs. A few wells, however, yield sufficient water for only domestic purposes, and water for stock use must be obtained from other sources. Many of the wells

included in this group yield water that is too highly mineralized for domestic purposes.

Two wells located in section 10 and section 28 have been sunk to depths of 250 feet and 350 feet, respectively. The well in section 10 may be obtaining its supply from the bedrock, or wholly from the glacial drift. The well in section 28, however, is thought to obtain its supply from an aquifer in the Belly River formation. Over most of this area the Bearpaw formation, which overlies the Belly River formation, is very thin and it may not contain water-bearing deposits. The Belly River formation, however, no doubt contains aquifers, but the sand deposits are thought to be lenticular in shape and the depth to the aquifers may vary over short distances. A large supply of water is available from both the producing wells, and the hydrostatic pressure is sufficient to raise the water 100 feet above the aquifer in the well in section 10, and 200 feet above the aquifer in the well in section 28. The water from both wells is hard, but that from the well in section 28 is salty and is used only for stock. Water can doubtless be obtained at similar depths in other parts of the township.

A number of small dams have been constructed throughout the township and have proved a satisfactory means of retaining surface water for stock use. Where topography is suitable the use of dams is recommended. Wells sunk near the water impounded by dams usually yield a sufficient supply of water for domestic purposes. Care should be taken to see that the water in these wells does not become contaminated by polluted surface waters.

Township 27, Range 9

With the exception of the northwestern part of this township, where the surface is relatively level, the remainder is fairly rolling and hilly. Stockwell lake trends in a general northwest-southeast direction through the northeastern part of the

township. The drainage of the township is towards this lake. The elevation decreases from 2,300 feet above sea-level in the south-central part of the township to less than 1,880 feet above sea-level at Stockwell lake. An area one-quarter mile in width on the northeastern side of the lake, and an area approximately 1½ miles in width on the southwestern side, are mantled by boulder clay or glacial till. The remainder of the township is covered by moraine. The water conditions existing in the area covered by moraine and till are quite similar. In general the drift over this township consists of a few feet of top soil; a weathered zone of light-coloured clay that probably extends to a depth of at least 25 feet, and which contains scattered deposits of sand and gravel; and an unweathered zone of compact, dark-coloured boulder clay that also contains scattered deposits of sand and gravel at various depths.

The deposits of sand and gravel located at or near the base of the weathered zone, usually within 25 feet of the surface, do not contain large supplies of water, but wells tapping them yield sufficient water for domestic purposes and more than half of them yield adequate supplies for local needs. The deposits do not form a continuous water-bearing horizon, but they appear to be more numerous in the southern half of the township. In some areas dry holes will probably be dug before a producing deposit is tapped, and it is advisable to locate the deposits by means of a test auger before making a final selection of a well site. The water obtained from the shallow wells is generally usable for domestic purposes, but that from one well located in section 21 is too salty for even stock use.

Deposits of water-bearing sand and gravel have been encountered at depths of 45 to 149 feet in the unweathered blue boulder clay, but they appear to form continuous aquifers only over very small areas. The deposits are mostly of scattered

distribution and dry holes have been sunk in various parts of the township to depths of 30 to 1,003 feet. The wells that have tapped water-bearing deposits yield varying supplies of water. The supply from a few of the wells is adequate only for domestic purposes, whereas others yield a supply sufficient for local needs. The water is usually quite hard and contains a considerable amount of mineral salts in solution, and that from only a few wells is not being used for domestic purposes.

Two wells located in the NW.$\frac{1}{4}$, section 33, obtain water at depths of 249 and 209 feet, respectively, or at elevations of 1,926 and 1,946 feet above sea-level. The aquifer in the well in section 33 is formed by gravel. It is doubtful if these wells tap a common and continuous aquifer as a hole in section 22 was drilled to a depth of 200 feet or to an elevation of 1,900 feet above sea-level without encountering water. It appears that both wells obtain water from near the contact of the drift and bedrock. The well in section 12 yielded a large supply of hard, "alkaline" water, but the well was filled in. The well in section 33 yields a large supply of hard, mineralized water that is used for both domestic and stock needs.

The supply from wells is supplemented by the use of springs, dams, dugouts, sloughs, and by hauling water. Springs are common along the lakes, and the water is as a rule used only for stock. Dams have been erected to impound surface water in those parts of the township where the surface topography favours their economical construction. Dugouts are used extensively and they have not proved particularly satisfactory. Sloughs are used for stock during part of the year. Dugouts excavated in slough basins will probably prove satisfactory. Water is hauled only for domestic purposes. Shallow wells sunk near water impounded by dams or dugouts will yield water that should be usable for domestic purposes. The water in the lakes is too highly mineralized to be used for stock.

The bedrock has not been extensively investigated in this township. A hole 1,003 feet in depth was drilled in the SW.¼, section 20, without encountering water-bearing horizons. This well passed through the Bearpaw formation immediately underlying the glacial drift and appears to have been drilled through the Belly River formation into dark shales that belong to the Lea Park formation. The sinking of a dry hole in one area, however, does not indicate widespread, non-water-bearing conditions, as the water-bearing deposits in the Belly River formation appear to be lenticular in shape. No areas can be outlined, however, in which aquifers in the bedrock are known to occur.

Township 27, Range 10

The surface of this township is comparatively level to slightly rolling. The elvation decreases from more than 2,200 feet above sea-level at the southeastern corner, to less than 1,900 feet above sea-level in the northwestern corner. The elevation decreases abruptly in the vicinity of the valley that contains Milden and Anerley lakes. The ground surface in the vicinity of the lakes is more irregular than elsewhere in the township. Approximately the northwestern half of the township is covered by glacial till or boulder clay, whereas the remainder is mantled by moraine. The water conditions in both the moraine and till-covered areas are somewhat similar. The deposits consist of a few feet of top soil; a weathered zone of light-coloured clay that may extend to a depth of 30 feet, and which contains scattered deposits of sand and gravel; and an unweathered zone of dark, compact boulder clay that also contains scattered deposits of sand and gravel.

A few wells obtain water from the scattered deposits of sand and gravel that occur in the weathered zone of the glacial drift, usually within 32 feet of the surface. Some of these wells

derive at least part of their supply by direct seepage from bodies of surface water. The best locations for shallow wells in this township are in or near depressions and ravines. The water-bearing deposits are not numerous and in no locality do they form continuous aquifers, and dry holes may be sunk within short distances of producing wells. It is advisable to locate the water-bearing deposits by means of a small auger before sinking a well. The supply from the shallow wells varies considerably and depends upon the amount of annual precipitation and upon the size of the aquifer encountered. All of the wells yield sufficient water for domestic purposes and a few head of stock. The water from a few, however, is too highly mineralized for domestic use.

The unweathered zone of the drift has proved fairly productive in this township, although dry holes to depths of 70 and 100 feet are recorded in sections 4 and 13. The water-bearing deposits in this part of the drift do not form continuous water-bearing horizons but occur as scattered pockets, and water may be obtained at widely varying depths. The producing wells in this township vary in depth from 40 to 155 feet and only in section 22 do the aquifers appear to show any relationship in their occurrence. The supply from at least three of the wells in this group is inadequate for local needs and must be supplemented by the use of a second well. The water is hard, and from some wells is highly mineralized, but in only two places was it not being used for drinking.

The bedrock has not been investigated in this area, and from the evidence at hand it appears probable that it would be necessary to drill to depths of at least 400 feet before a usable supply would be obtained. An adequate supply of water for local needs should be obtained from aquifers in the glacial drift, and there should be no need to drill into the bedrock in search of water.

Township 28, Range 8

That part of this township lying to the west of South Saskatchewan river is included in the municipality of Fertile Valley. It consists of approximately 24 square miles. The valley sides of the Saskatchewan are much steeper in the northern part of the area. A flat plain along the river in the east-central part of the area is under cultivation, and it is mantled by glacial lake deposits. To the west of this plain the elevation rises rapidly in less than a mile, and the remainder of the area although somewhat irregular is only slightly rolling. The southwestern sections are mantled by moraine, but the remainder of the township is covered by boulder clay or glacial till.

A number of wells obtain water from the glacial lake sands at depths less than 20 feet. From the evidence at hand little or no difficulty should be experienced in obtaining water in this part of the township. The supply from these wells is always sufficient for domestic needs, but it is not always adequate for stock requirements. The deficient supply can be supplemented by hauling from the river or by using a second well. The water is reported as being satisfactory for all farm purposes.

Wells are also obtaining water at shallow depths from scattered deposits of sand and gravel in the areas covered by moraine and glacial till. The shallow wells in these areas seldom exceed 30 feet in depth. The deposits do not show any correlation in their occurrence and dry holes may be dug before a producing pocket is tapped. It is always advisable to locate the water-bearing deposits with a small test auger before digging a well, as this eliminates the chance of digging a dry hole. With one exception the shallow wells in these areas yield sufficient water for local requirements and the water from all the wells has been found suitable for domestic purposes. The lower part or unweathered zone of the drift has not been extensively tested and only a few wells are drawing

water from deposits in this part of the glacial drift. The deepest producing well is 60 feet, but dry holes were sunk in section 4 to depths of 80 and 85 feet. This shows the scattered distribution of the pockets and it is unlikely that general and continuous aquifers exist in this township at depths to at least 85 feet. The supply from the wells that are dug or bored in the lower part of the drift is sufficient for farm needs, but one well located in the SE.$\frac{1}{4}$, section 4, yields water that is too highly mineralized for domestic use.

A few dams have been constructed across some of the ravines and the impounded surface water is used for stock. It is possible in many places to obtain sufficient water for domestic purposes from wells sunk near bodies of water impounded by dams. Such water if not polluted by surface refuse will no doubt be found quite satisfactory for drinking.

Township 28, Range 9

The surface of this township, except where cut by the valley containing Anerley and Stockwell lakes, and a smaller valley in the northeastern corner, is fairly level. The valley containing the lakes in the southern part of the township is at least a mile wide and approximately 150 feet deep. The elevation of the lakes is 1,878 feet above sea-level. The maximum elevation of more than 2,100 feet is attained in section 31. In the northeastern corner the elevation decreases rapidly to 1,800 feet above sea-level. An area surrounding the lakes, and part of section 36, are covered by glacial till or boulder clay and the remainder of the township is mantled by moraine.

The water conditions in the moraine and till-covered area are quite similar. A few wells in the township obtain water at shallow depths, usually within 30 feet of the surface, from sand and gravel deposits that occur in the yellow boulder clay or

weathered zone of the drift. In no part of the township do the deposits form a continuous aquifer, although in the vicinity of depressions and ravines they appear to be more numerous than elsewhere. A number of dry holes have been dug and it is always advisable to locate the water-bearing deposits by means of a small test auger before sinking a well. The supply from the shallow wells varies with the amount of annual precipitation and the size of the water-bearing deposit encountered, and in dry years the wells do not yield adequate supplies for local needs. The water is suitable for stock, but that from some wells is too highly mineralized for domestic purposes.

The lower part of the drift has not proved a good source of supply. From the information at hand it appears evident that no continuous aquifers of wide areal extent exist in the unweathered zone of the glacial drift to a depth of at least 100 feet. In an area consisting of parts of sections 12, 13, 14, 23, and 24, no great difficulty should be experienced in obtaining water from this part of the drift. Over the remainder of the area dry holes are interspersed with producing wells and the water-bearing deposits appear to be sparsely distributed. In sections 19 and 30 this part of the drift is very unproductive and wells failed to encounter any water. In section 4 water can be obtained at depths of 95 feet or less, but the very fine sand of the aquifer shuts off the supply within a few days.

The producing wells in the unweathered drift vary in depth from 40 to 147 feet, and most of the wells yield sufficient water for farm needs. The water, with few exceptions, is used for domestic purposes as well as for stock, although that from some of the wells is quite highly mineralized.

Deficient well water supplies are supplemented by the use of springs and water impounded by dams and dugouts. Three springs located in the SE.$\frac{1}{4}$, section 8, the NW.$\frac{1}{4}$, section 10, and

the SE.¼, section 17, yield large supplies of water, the later one yielding 25 gallons a minute. The water from these springs is used for drinking as well as stock. Dams are located in sections 5 and 10, and many other favourable sites exist throughout the area. Dugouts are also used to conserve surface water and some of them hold sufficient water during the summer months for stock use. Dugouts should be at least 12 feet deep in order to retain a supply of water throughout the year. Many of the wells sunk near water impounded by dams or retained in dugouts will yield sufficient water for domestic purposes, and when care is taken to see that the water is not contaminated by surface pollution it should be satisfactory for drinking.

Township 28, Range 10

The elevation in this township decreases from 2,100 feet above sea-level in the east-central part to less than 1,950 feet at the northwestern corner and to approximately 1,885 feet at Anerley lakes in the southern part of the township. The area in the vicinity of the valley containing Anerley lakes is quite rough, but throughout the remainder of the township it is comparatively level. The northeastern corner of the township is mantled by moraine, but glacial till or boulder clay mantles the remainder of the township. Only a very few wells in this township obtain water from deposits of sand and gravel that occur at or near the base of the weathered zone of the glacial drift. The water-bearing deposits do not form continuous water-bearing horizons, and appear to be very scattered, and dry holes will no doubt be dug before a producing well is obtained. The producing shallow wells do not yield large supplies of water, and they usually produce sufficient water for only household purposes and a few head of stock. The water, with few exceptions, is usable for domestic purposes.

The water-bearing deposits of sand and gravel that occur in the unweathered zone of the drift supply most of the wells in this township. In three wells, located in section 28, the deposits appear to be continuous, but in no other part of the township do they appear to show continuity. The deposits are located at depths ranging from 40 to 162 feet, but it is possible that the 162-foot well located in the SE.$\frac{1}{4}$, section 2, may be obtaining part of its supply from the underlying bedrock. Dry holes have been sunk in sections 15, 22, and 24, the well in section 15 having been drilled into the bedrock. The other dry holes were sunk to maximum depths of 80 feet. With few exceptions wells sunk into this zone of the drift yield large supplies of water, many of them considerably more than is required for local needs, but the water from some of the wells contains such a large amount of mineral salts in solution that it cannot be used for drinking. The water from the wells in the northern half of the township appears to be of better quality than that obtained elsewhere.

Aquifers in the bedrock are thought to be the source of supply for wells located in the NE.$\frac{1}{4}$, section 7, and the NE.$\frac{1}{4}$, section 16. A well located in the SW.$\frac{1}{4}$, section 2, may also be deriving water from the bedrock. The depths of these wells are 420, 313, and 260 feet, respectively, and the aquifers they tap are located at elevations of 1,628, 1,786, and 1,680 feet above sea-level. The bedrock formation immediately underlying the glacial drift in this township probably is the Bearpaw, but it is thought to be very thin in this area. The wells have probably passed through this formation and encountered aquifers in the underlying Belly River formation. The aquifers in the three wells do not appear to be continuous and each well probably taps an aquifer of small areal extent. A 400-foot dry hole was drilled in section 15, and drilling was discontinued at an elevation of 1,690 feet above sea-level. This indicates that no water-bearing horizons of large

areal extent underlie the township at depths of less than 400 feet. Producing wells have been drilled, however, a short distance from dry holes. The producing bedrock wells yield large supplies of water, but the water from all three wells is so highly mineralized that it is used only for stock.

Springs, and the water retained by dams and dugouts, are also used in this township. Some of the springs have a large flow and the water can be used for domestic purposes. One spring located in section 1 yields water that is unsuitable for drinking. A municipal dam in section 13, and another dam in section 18, impound large supplies of surface water that is used for stock. Dugouts are also used, and the dams and dugouts retain sufficient water in years of normal precipitation to last until the autumn months. In many places it is possible to obtain enough water for domestic purposes from shallow wells sunk near water impounded by dams, or near water retained by dugouts. Care must be taken to see that the water does not become polluted.

Township 29, Range 8

Only that part of this township west of Saskatchewan river, an area of approximately 12 square miles, is included in this report. The land surface is fairly flat until the river valley is reached, where it drops abruptly to river-level at an elevation of approximately 1,615 feet above sea-level. The north-eastern part of the area is covered by lake sands, but the remainder is mantled by glacial lake clay. The thickness of the lake deposits is not known, but they are underlain throughout by boulder clay or glacial till. The Belly River formation outcrops along the river in section 17, at an approximate elevation of 1,700 feet above sea-level.

The glacial lake sands usually contain water at shallow depths, and at least two wells obtain water from them at

depths of 15 feet, but most of the wells in the lake sand-covered area appear to be obtaining water from sand and gravel deposits that occur at or near the contact of the lake deposits and underlying boulder clay. There does not appear to be much difficulty in obtaining water in this area within 30 feet of the surface, but the supply from most of the wells is small and it must be augmented by using a second well, or by hauling water. The water from at least two wells is too highly mineralized for drinking, but it is being used for stock. The water-bearing deposits should be located by means of a test auger before a well is dug. The glacial lake clay yields little or no water and wells in this area obtain water from the underlying boulder clay.

The lower part of the glacial drift in this township has not been investigated for water, but scattered deposits of water-bearing sand or gravel no doubt occur at various elevations in it. It is improbable that they form continuous water-bearing horizons. Dry holes may be sunk before a pocket is encountered, and the water, if obtained, will possibly be too highly mineralized for domestic use.

The well located in the SE.$\frac{1}{4}$, section 19, is believed to derive its supply from an aquifer located in the Belly River formation. The well is 280 feet deep and the aquifer is located at an elevation of 1,460 feet above sea-level. The drift to bedrock is not known, but it is probable that bedrock was encountered at an elevation of more than 1,600 feet above sea-level. The areal extent of the aquifer tapped by this well is unknown, but other wells sunk to the same depth should encounter water. The well in section 19 yields an abundant supply of water, but it is highly mineralized and is unfit for drinking.

Township 29, Range 9

The surface of this township is relatively level in the northeastern part, but becomes hilly in the southern portion and somewhat rolling in the west. A small, intermittent stream has

eroded a narrow ravine in the southeastern corner of the area. Along parts of the southern boundary the elevation rises to more than 2,050 feet above sea-level, and the minimum elevation of less than 1,800 feet above sea-level occurs in the northeastern corner. A small area in the southern part of the township is covered by moraine, and a narrow strip to the north of this area is mantled by glacial till or boulder clay. The remainder of the township is covered by glacial lake clay.

A number of wells in this township tap water-bearing deposits at depths ranging from 8 to 30 feet. In the areas covered by boulder clay and moraine, these deposits are located in the upper or weathered zone of the drift, whereas in the area covered by glacial lake clay they are thought to occur at or near the contact of the lake clay and boulder clay. The lake clay contains few deposits of water-bearing sands and gravels, and water-bearing deposits at shallow depth throughout the township are not numerous. A number of the shallow wells yield inadequate supplies for local requirements and two or more wells are used or water is hauled. The water from most of the wells is usable for domestic purposes, but that from a few is too highly mineralized for drinking.

The lower part or unweathered zone of the drift, which consists of compact, blue boulder clay, has been rather extensively investigated between depths of 37 and 90 feet. Scattered pockets of sand and gravel occur at various elevations within this range of depth and are the source of water for a number of wells. The deposits do not form a continuous water-bearing horizon and dry holes have been dug in sections 28 and 32. The supply from wells tapping the deposits in this part of the drift varies considerably, but a few wells yield an oversufficient supply. The water is mostly very hard and highly mineralized, and that from some wells is suitable only for stock use.

Four wells located on sections 6, 13, 14, and 32 have been drilled into the bedrock. The first three tapped aquifers at elevations of 1,475, 1,538, and 1,403 feet above sea-level, but the well in section 32 failed to locate an aquifer and drilling was discontinued at an elevation of 1,127 feet above sea-level, or at a depth of 765 feet. All of the wells were drilled into the Belly River formation and it is possible that the well in section 32 may have passed through the Belly River into the Pakowki or Lea Park formation. The aquifers of these wells do not appear to form a common horizon and water-bearing horizons of large areal extent apparently do not exist in the Belly River formation. In the southern half of the township, however, it is probable that wells sunk to elevations of at least 1,400 feet above sea-level should tap aquifers in the Belly River formation. The supply from the three producing wells is abundant. The hydrostatic pressure is sufficient to raise the water 350 feet above the aquifer in the well in section 6, and to 224 feet above the aquifer in the well in section 14. The water from the wells is recorded as soft, but it is very highly mineralized, and that from the well in section 6 is used only for stock. Although the water from the well in section 14 is recorded as usable for domestic use, a shallow well is used for domestic purposes.

A few dams are used to impound surface water for stock use in this township.

Township 29, Range 10

The surface of this township is fairly level to gently rolling and the difference in elevation amounts to 200 feet. The minimum elevation of 1,800 feet occurs at Macdonald creek in the northwestern corner and the maximum of more than 2,000 feet occurs in the southeastern corner. The village of Bounty, in section 33, is at an approximate elevation of 1,885 feet above sea-level. The greater part of the township is mantled by glacial

till or boulder clay. Part of section 1 is mantled by moraine and a large area in the northwestern half is covered by glacial lake clay. The lake clay is underlain by boulder clay. The approximate boundaries of the different surface deposits may be ascertained by consulting Figure 1 of the map accompanying this report.

No particular difference in the water conditions appears to exist in the areas covered by the different glacial deposits. The lake clay is thin and yields little or no water, and water in the glacial lake clay-covered area is obtained from water-bearing deposits in the underlying boulder clay.

More than half the wells in this township obtain water from pockets of sand and gravel that occur within 30 feet of the surface. Although these deposits are by no means sufficiently numerous to form a general horizon they do appear to be present in all parts of the township. Dry holes will probably be dug, and many wells had to be sunk to depths greater than 30 feet before water was obtained. In low-lying areas, such as in the vicinity of sloughs or valleys, the deposits appear to be more numerous than elsewhere, but a well should not be dug without first locating a water-bearing deposit by means of a test auger. The supply from the shallow wells varies considerably and is readily affected by the amount of annual precipitation. Most of the wells, however, yield sufficient water for domestic use and a few head of stock, but only a few yield a supply that is more than adequate for farm needs. The quality of the water also varies considerably and that from some wells is too highly mineralized for drinking.

In some localities pockets of sand and gravel that occur at depths of 35 to 87 feet in the unweathered blue boulder clay form aquifers for a number of wells. The drift below a depth of 87 feet has not been investigated as an adequate supply of water

is obtained at depths of less than 100 feet throughout the township. The deposits, however, do not appear to be continuous and it has been found impossible to outline any general water-bearing horizons. A 60-foot dry hole was dug in section 35, but the deposits appear to be fairly numerous throughout the remainder of the area. The supply of water from this group of wells is more dependable than that from the shallower wells, and only two wells yield inadequate supplies. The water is more highly mineralized and that from some of the wells is only used for stock.

Springs, dugouts, and water that is hauled from wells, are used to supplement the supply from wells yielding small supplies. A spring in section 1 yields a good supply of usable water and is the source from which several farmers haul water. The dugouts retain water during part of the year and are used for stock. To retain water throughout the year, dugouts should be at least 12 feet deep.

No wells have been drilled into the bedrock, but water-bearing horizons should occur in the Belly River formation that underlies the glacial drift in this township.

Township 30, Range 8

Only the part of this township lying east of Saskatchewan river is within the municipality of Fertile Valley and is discussed in this report. Saskatchewan valley is fairly steep-sided, approximately 100 feet deep in the southern part of the area, but in the northern part the slope from the plain level to the river is gradual. The elevation throughout the plain is from somewhat less than 1,700 feet to 1,750 feet above sea-level, and the river lies at an elevation of approximately 1,615 feet above sea-level. This township is covered by glacial lake deposits. Parts of sections 6 and 7 are mantled by lake clay and the remainder of the area is covered by lake sands.

With few exceptions, wells dug into the glacial lake sands have obtained water at depths of not more than 30 feet and usually less than 20 feet. Little difficulty should be experienced in obtaining water in this area, although a dry hole was sunk in section 35. The glacial lake clay yields little or no water. The yield from the wells sunk into the lake sands is not large, but it is usually sufficient for local needs. The water varies from moderately soft to hard, and it is not highly mineralized, and is as a rule satisfactory for drinking and other domestic purposes.

The boulder clay that underlies the lake deposits has not been extensively investigated, but a well in section 32 obtains water from it at a depth of 70 feet. Scattered deposits of sand and gravel no doubt occur at various elevations in the boulder clay, but if it is possible to obtain sufficient water for farm needs from one or more shallow wells it does not appear advisable to attempt to locate water in the lower part of the drift. The well in section 32 yields sufficient water for 20 head of stock and the water is usable for all farm needs.

One well located in section 34, and drilled to a depth of 237 feet, taps a sand aquifer in the Belly River formation at an elevation of 1,498 feet above sea-level. As this is the only well that taps the bedrock it is not known if a general aquifer exists at this elevation, but from information obtained from surrounding areas it is doubtful if the aquifer is of large areal extent. Wells drilled to an elevation of approximately 1,450 feet above sea-level, however, will probably tap an aquifer in the bedrock, although a dry hole was drilled to a depth of 395 feet in section 14, in the township immediately to the west, drilling being discontinued at an elevation of 1,395 feet above sea-level. The supply obtained from the well in section 34 is abundant and the water is under sufficient hydrostatic pressure to rise to a point 15 feet above the surface. The water is soft and has a salty taste, but it is being used for domestic purposes as well as for stock.

Township 30, Range 9

The surface of this township is fairly level to gently undulating. The maximum elevation of 1,885 feet above sea-level occurs in the southwestern corner and the minimum elevation of approximately 1,750 feet occurs in the northeastern corner. Parts of sections 25, 35, and 36 are mantled by glacial lake sand, and the remainder of the township is covered by glacial lake clay. The thickness of the lake deposits has not been determined, but it is probable that they are more than 25 feet thick in some areas. They are underlain by boulder clay or glacial till.

The lake sands have not been extensively investigated, but wells in sections 24 and 36 obtain a moderate supply of usable water at depths of 22 and 10 feet. It is reported that an abundant supply of water can be obtained at shallow depth in section 36.

The glacial lake clay yields little or no water, but water is obtained at depths of 8 to 32 feet from sand and gravel deposits that are assumed to be at or near the contact of the lake clay and the underlying boulder clay. In no areas do the deposits appear to form a general horizon and dry holes have been dug in some sections. Considerable difficulty is experienced in obtaining sufficient water in the southwestern quarter of the township. Water-bearing deposits should be located by a small test auger before the wells are dug as this eliminates the chance of digging a dry hole. Wells sunk near undrained depressions or in small valleys may encounter sand deposits that will yield sufficient water for at least domestic purposes and a few head of stock. Wells that tap pockets of sand and gravel at or near the contact of the glacial drift and lake clay are readily affected by drought conditions. The supply is always sufficient for domestic needs, and a few wells yield oversufficient supplies for farm requirements. The water is hard and most of it fairly highly mineralized, but it can generally be used for drinking with no apparent ill effects.

A number of wells in this township obtain water from sand and gravel deposits in the lower part of the boulder clay. These wells are from 35 to 70 feet deep. It is doubtful if water-bearing horizons of large areal extent occur within the upper 100 feet of the glacial drift. In the southeastern part of the township considerable difficulty is experienced in locating water-bearing deposits in the upper 100 feet of the drift, especially in section 14 where several wells 90 feet deep and one 395 feet deep failed to obtain water. The supply from wells that have encountered water-bearing deposits is not as readily affected by variations in annual precipitation as that from the shallow wells, but it varies considerably and in many places the yield is inadequate for local requirements. The water from the wells is very hard, and contains a considerable quantity of mineral salts in solution, and that from some wells can be used only for stock. One well located in section 5 obtains water from an aquifer at a depth of 170 feet or at an elevation of 1,715 feet above sea-level. The areal extent of this aquifer is not known. This well yields an abundant supply of water that rises to a point 20 feet below the surface. The water is hard and contains a considerable amount of mineral salts in solution, but it is being used for drinking as well as for stock. Similar water-bearing deposits may occur in other parts of the township.

Three wells, located in sections 2, 14, and 16, have been drilled through the glacial drift into the underlying bedrock, which in this area is believed to be the Belly River formation. The depths of the wells are 280, 395, and 398 feet, respectively. In the well in section 2 water was obtained from a sand aquifer at an elevation of 1,545 feet above sea-level, but drilling was discontinued in the other two wells at elevations of 1,385 and 1,442 feet above sea-level, without encountering a water-bearing horizon. This would appear to indicate that no general water-

bearing horizons of large areal extent are present in the Belly River formation above an elevation of 1,385 feet above sea-level. The water-bearing deposits in the Belly River formation are thought to be lenticular in shape and it is possible that dry holes may be drilled in the immediate vicinity of producing wells. The well in section 2 yields an abundant supply of water that is usable for all farm needs. Unless water cannot be obtained from the drift, and finances permit risk of not obtaining water, drilling into the bedrock is not advised.

In the southeastern corner of the municipality springs are used to supplement the supply from deficient wells. The water from the springs is satisfactory for stock, but is not used for drinking. In this township it has been found necessary to haul a considerable amount of water for drinking and domestic purposes. Dugouts could be used throughout most of the township to collect surface water for stock use. The dugouts should be at least 12 feet deep to retain water to last throughout the winter months. Many of the shallow wells dug near the dugouts will yield sufficient water for domestic purposes. If such water is not polluted by surface refuse it should be found quite satisfactory for drinking.

Township 30, Range 10

The surface of this township is fairly level to gently undulating. Macdonald creek has eroded a valley, 50 to 75 feet deep, and runs in a northeasterly direction through the western part of the township. The general drainage of the township is towards this valley, which lies at an elevation of less than 1,800 feet above sea-level. In parts of sections 34 and 35 the surface deposits are in the form of Recent dune sand, whereas with the exception of two narrow strips along the creek that are mantled by boulder clay or glacial till, the remainder of the township is covered by glacial lake clay. The dune sand is not thought to be

more than 20 feet in thickness and the lake clay probably is not more than 30 feet thick in this area, and both are underlain by boulder clay, which extends to the bedrock. In this township the Belly River formation is thought to underlie the glacial drift.

A well in section 35 is thought to obtain water from the Recent dune sands at a depth of 10 feet. This well yields an inadequate supply of water for farm needs. The water is moderately hard and usable for all farm needs. Other wells sunk in these dune sands should yield similar supplies of water.

Most of the wells in this township obtain water within 30 feet of the surface from sand and gravel pockets thought to occur near the contact of the lake clay and the underlying boulder clay. The lake clay is not thought to contain water-bearing deposits. The shallow deposits are probably fairly numerous in distribution, but in the northwestern corner wells were sunk to a considerable depth before water was encountered. A dry hole was dug in section 14, and the water-bearing deposits are scattered and do not form a continuous horizon. They should be located with a small test auger before a well is dug or bored. Water will probably be more readily encountered in the vicinity of depressions and valleys than on the uplands. The supply from the shallow wells is sufficient for domestic needs and a few head of stock, but it is not always adequate for all stock requirements. The water varies from moderately soft to very hard and some of it is too highly mineralized for drinking.

The lower part of the drift, with the exception of the northwestern corner of the township, has not been extensively prospected for water. The wells in this area are sunk to depths ranging from 50 to 120 feet. The wells located in sections 30, 31, and 32 may be obtaining water from a common aquifer, but the aquifers of the other wells in the township show little or no correlation to each other, or to the above-mentioned group. In

section 14 a dry hole was sunk to a depth of 75 feet. Water-bearing deposits no doubt exist in the lower part of the drift to the east of Macdonald creek. The supply from the wells that have obtained water is, with few exceptions, sufficient for local needs, and although the water is hard and quite highly mineralized, only that from two wells is not being used for domestic purposes.

Macdonald creek and springs that occur along its valley are used for stock, and dugouts have been excavated in some sections to collect and retain surface water for stock. Dams could be constructed on Macdonald creek, and the impounding of surface water is recommended in this township.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL MUNICIPALITY OF FERTILE VALLEY, NO. 285, SASKATCHEWAN

Township	27	27	27	27	28	28	28	29	29	29	30	30	30	Total No. in municipality
West of 3rd meridian Range	7	8	9	10	8	9	10	8	9	10	8	9	10	
Total No. of Wells in Township	9	37	49	31	23	61	41	13	00	51	20	03	46	516
No. of wells in bedrock	0	1	3	0	0	0	4	1	4	0	1	3	0	17
No. of wells in glacial drift	9	30	40	31	23	61	37	12	62	51	25	58	46	497
No. of wells in alluvium	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Permanency of Water Supply														
No. with permanent supply	7	37	42	28	16	32	35	10	63	48	25	48	43	434
No. with intermittent supply	0	0	0	1	5	1	0	3	1	2	0	0	1	20
No. dry holes	2	0	7	2	2	28	0	0	2	1	1	9	2	62
Types of Wells														
No. of flowing artesian wells	0	1	0	0	0	3	2	0	0	0	1	2	0	9
No. of non-flowing artesian wells	0	11	10	14	0	5	17	1	20	11	1	9	3	102
No. of non-artesian wells	7	25	32	15	21	25	10	12	44	39	23	43	41	343
Quality of Water														
No. with hard water	0	34	37	25	20	32	31	11	57	47	19	54	42	415
No. with soft water	1	3	5	4	1	1	4	2	7	3	6	0	2	39
No. with salty water	0	1	1	0	1	0	0	0	0	0	1	0	0	4
No. with "alkaline" water	0	8	4	1	5	3	3	2	23	19	2	9	11	90
Depths of Wells														
No. from 0 to 50 feet deep	5	22	29	15	19	31	25	12	48	44	24	50	38	302
No. from 51 to 100 feet deep	2	12	11	10	4	25	0	0	14	7	1	8	7	107
No. from 101 to 150 feet deep	0	1	4	5	0	5	2	0	0	0	0	1	1	19
No. from 151 to 200 feet deep	2	0	1	1	0	0	1	0	0	0	0	1	0	6
No. from 201 to 500 feet deep	0	1	3	0	0	0	7	1	2	0	1	3	0	18
No. from 501 to 1,000 feet deep	0	1	0	0	0	0	0	0	2	0	0	0	0	3
No. over 1,000 feet deep	0	0	1	0	0	0	0	0	0	0	0	0	0	1
How the Water is Used														
No. usable for domestic purposes	7	33	37	26	18	30	30	12	46	33	24	47	35	378
No. not usable for domestic purposes	0	4	5	3	3	3	5	1	18	17	1	7	9	76
No. usable for stock	7	37	40	29	21	31	34	13	59	48	24	53	42	438
No. not usable for stock	0	0	2	0	0	2	1	0	5	2	1	1	2	16
Sufficiency of Water Supply														
No. sufficient for domestic needs	7	37	41	28	14	28	35	10	59	48	25	47	42	421
No. insufficient for domestic needs	0	0	1	1	7	5	0	3	5	2	0	7	2	33
No. sufficient for stock needs	4	26	28	24	12	24	29	7	39	41	25	33	33	325
No. insufficient for stock needs	3	11	14	5	9	9	0	0	35	9	0	21	11	139

ANALYSES AFT 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 Fertile Valley, No. 285, 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.	18	27	9	3rd	9o	2,oc3											(4)	(1)		(2)		(3)		(5)	×1
2	S.½	9	28	8	3rd	50	1,734											(4)	(1)		(2)		(3)		(5)	×1
3	NW.	10	28	9	3rd	Sand	1,340	1,100	900	200	18	445	250	198	595	95	1,247	445			590		182	30		×1
4	SE.	14	28	9	3rd	100	3,9o0											(4)	(1)		(2)		(3)		(5)	×1
5	SE.	2	28	10	3rd	1o2	2,051												(2)		(3)	(4)	(1)	(5)		×1 ?
o	SE.	19	29	8	3rd	280	3,180	90	20	70	373	590	50	11	1,o44	1,o77	3,o64	90			23	502	2,433	616		×2
7	SE.	6	29	9	3rd	o00	3,280	o0	10	50	495	380	50	25	1,54o	1,570	3,489	90		52		242	2,288	817		×2
8	SW.	13	29	9	3rd	312	3,180	45	10	35	445	305	20	18	1,49o	1,489	3,259	36		38		237	2,21h	734		×2
9	SE.	14	29	9	3rd	424	3,300	55	10	45	750	345	30	18	1,15o	1,554	3,302	54		38		260	1,711	1,238		×2
10	SE.	17	29	9	3rd	8	288											(1)		(2)				(3)		×1
11	NE.	32	29	9	3rd	20	1,417											(3)	(1)		(2)		(4)		(5)	×1
12	SW.	2	29	10	3rd	16	2,243												(2)		(3)	(5)	(1)	(4)		×1
13	W.½	33	29	10	3rd	1o	834											(3)	(1)		(2)				(4)	×1
14	SE.	34	30	8	3rd	237	3,180	280	180	100	595	350	90	32	1,201	1,377	3,128	161		67		141	1,777	982		×2
15	SW.	2	30	9	3rd	280	2,340	750	650	100	201	180	110	140	1,22o	740	2,247	180	22		417		1,29o	332		×2
1o	NE.	32	30	9	3rd	13	408											(2)	(1)		(3)				(4)	×1
17	NE.	32	30	9	3rd	12	483											(2)	(1)		(3)				(4)	×1

Water samples indicated thus, ×1, are from glacial drift.
Water samples indicated thus, ×2, are from bedrock, Belly River 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 ($CaCO_3$).
Analyses Nos. 1, 2, 4, 5, 10, 11, 12, 13, 16 and 17 by Provincial Analyst, Regina.
For interpretation of this table read the section on Analyses and quality of Water.

Water from the Unconsolidated Deposits

One sample of water from the unconsolidated deposits was collected by the field party in 1935, but the analyses of a number of samples were obtained from the Provincial Analyst and the results are tabulated in the accompanying table.

No water from the Recent dune sands or from the glacial lake sands was analysed. It is improbable that water from these deposits will be excessively mineralized, and water from most of the wells should be found suitable for domestic purposes as well as for stock.

Samples 11, 13, 16, and 17 are from wells tapping deposits of sand and gravel in the boulder clay at the base of the lake clay. These samples are quite similar and should be fairly representative of the type of water derived from this part of the glacial drift. These waters should be satisfactory for drinking as well as for stock use. Wells tapping shallow deposits in the glacial till and moraine will probably yield water similar in quality to that shown by samples 10 and 12. Sample 12 is quite highly mineralized and may not be suitable for domestic purposes as it may have a slight laxative effect. The striking of highly mineralized water in one locality, however, does not indicate widespread conditions, and slightly mineralized water may be derived in the immediate vicinity. The water of sample 10 should be usable for all farm purposes. Sample 3 may be fairly representative of the water from springs in this area. It is hard and contains a considerable amount of magnesium sulphate (Epsom salts) and may act as a laxative. Most of the spring waters in this municipality are used only for stock.

Samples 1, 2, and 4 are from wells sunk into the lower part of the drift. The water from the lower part of the drift is generally harder and more highly mineralized than that from shallow wells. It is usable for stock, but that from some

wells may act as a laxative if used for drinking. The waters analysed were being used for drinking without any apparent ill effects.

Sample 5 indicates a water somewhat similar to that obtained from aquifers located in the bedrock and it may be this well obtains part of its supply from the bedrock. The total dissolved solid content is not excessively high and the water is suitable for stock and may be usable for drinking, but it may have a laxative effect on those not accustomed to its use.

Wells that obtain water by seepage from sloughs, or from impounded water in dams or dugouts, unless contaminated by polluted surface waters can be used for domestic purposes. It is advisable to have the water tested regularly for bacteria.

Water from the Bedrock

Six samples of water from wells tapping aquifers in the bedrock were analysed and the results are listed on the accompanying table. The waters analysed are thought to be obtained from wells tapping aquifers in the Belly River formation. A few wells may be obtaining water from the Bearpaw formation. The total dissolved solid content of the various samples ranges from 2,340 to 3,300 parts per million. Sample 15 is very hard, having a total hardness of 750 parts per million, but the other samples are soft, especially samples 6, 7, 8, and 9, which have a total hardness of from 45 to 90 parts per million. The total dissolved solid content is composed of the following mineral salts: sodium sulphate, sodium chloride, sodium carbonate, calcium carbonate, and magnesium sulphate, their abundance decreasing in the order given. Sample 15 does not contain sodium carbonate, and magnesium sulphate is second in abundance. The water is usable for stock and will have no harmful effects if used for drinking, although it may be unpalatable

as it usually has a soda and salty taste. Samples 6 and 7 are not used for domestic purposes. Due to the large amount of sodium carbonate (black alkali) in solution, the waters from the Belly River formation are not usable for irrigation.