

GROUNDWATER RESOURCES IN THE
MUNICIPALITY OF WEST ST. PAUL

February, 1978

Prepared by:
M. Rutulis, P. Eng.,
Planning Branch

1 INTRODUCTION

In practically all of the R.M. of West St. Paul (Figure 1) groundwater is readily available and at present it is used for all water requirements. Because the availability of groundwater is likely to play an important role in future development of the district, in this report general information on groundwater resources in the district for development policy formulation and for public information is provided.

The report is based on available information consisting of numerous water well driller's reports, groundwater monitoring data and a report on the geohydrology of the Metropolitan Winnipeg area. *

The International System of Units (SI, commonly referred to as the metric system), and the following symbols of the SI units are used in the report:

metre	m
square metre	m ²
cubic metre	m ³
kilometre	km
square kilometre	km ²
litre	L
second	s
litres per second	L/s
cubic metres per day	m ³ /d
cubic metres per year	m ³ /a (annum)
milligrams per litre	mg/L

* F.W. Render, 1970, Geohydrology of the metropolitan Winnipeg area as related to groundwater supply and construction. Canadian Geotechnical Journal, 7, pp. 243 - 274.

2 GEOLOGICAL SETTING

Because groundwater flows through and is stored in the strata underlying an area, an understanding of the local geological conditions is desirable to appreciate the groundwater resources in the area. Figure 2 depicts typical geological conditions in the R.M. of West St. Paul to a depth of about 35 m below ground level, which is the most important zone in respect to groundwater supply for new development in the area.

The geological conditions of the West St. Paul district are fairly uniform. From surface to the Precambrian granitic basement rock, which forms the base of groundwater movement in the area, the area is underlain by the following major stratigraphic units:

1. The upper unit consists of clay overlain by a thin layer of silt or silty clay; the thickness of this unit ranges from 3 m to 20 m. The thickness of the clay unit in the area is indicated on the map in Figure 3.
2. The clay is underlain by glacial till. The till thickness ranges from about 2 m to 10 m. About one metre thick pockets of sand, gravel and rock rubble appear to be common at the base of the till. As illustrated in Figure 2 the till and associated deposits form the basal unit of the surficial deposits. The total thickness of the surficial deposits ranges from 12 m to 30 m. The thickness of the surficial deposits in the district is indicated by the depth to bedrock in Figure 4.
3. The surficial deposits are underlain by carbonate bedrock (limestone and dolostone). The base of the carbonate rock is at about 160 m below ground level.
4. The carbonate rock is underlain by a shale and sandstone formation about 45 m thick.

5. The shale and sandstone beds are underlain by Precambrian granitic rocks. The Precambrian rocks are practically impermeable and, therefore, are considered as the base of groundwater movement in the area.

The topography of the bedrock surface in the area is fairly flat and changes in depth to bedrock in most of the area are gradual. A low buried escarpment appears to exist between Pipeline and Blackdale roads. The depth to bedrock in this zone changes some 6 to 10 m in a fairly narrow zone (Figures 2 and 4).

3 GROUNDWATER

3.1 Aquifers

Three distinct water bearing zones or aquifers exist in the strata between the clay and till surficial deposits and the granitic rock at the base of the sedimentary rocks. In the order of importance as sources of water supply they are:

1. The Upper Carbonate Aquifer (Render, *ibid.*) that is formed by fractured carbonate rock within the upper 15 m or so of the bedrock. Sand and gravel and rock rubble at the base of the surficial deposits essentially are part of the Upper Carbonate aquifer. Because the Upper Carbonate Aquifer is the main source of water in West St. Paul it is discussed in more detail elsewhere.
2. A second water bearing zone, called the Lower Carbonate Aquifer (F. Render, *ibid.*), exists in the lower part of the carbonate rock. A few wells drilled to more than 100 m below ground level indicate that the zone between the Upper Carbonate aquifer and the Lower Carbonate aquifer yields very little water. Because of the depth to it and poorer quality of water, the Lower Carbonate aquifer is not used as a source of domestic water supply.
3. The sandstone beds of the shale and sandstone formation constitute the deepest water bearing zone in the municipality. Water in the sandstone aquifer is very salty. Indications are that the direction of groundwater movement in the sandstone is northeasterly.

3.2 Upper Carbonate Aquifer

3.2.1 Dimensions

The average thickness of the Upper Carbonate aquifer is 15 m. However, in some places it may be only a metre thick and in others more than 15 m. The

Upper Carbonate aquifer is the most extensive aquifer in Manitoba and laterally it extends for many kilometres in all directions outside the West St. Paul area.

3.2.2 Groundwater Movement

Groundwater movement in the Upper Carbonate aquifer in West St. Paul area is southeasterly towards the Red River. Groundwater movement as indicated by the potentiometric surface (the surface of water level elevation in wells in the Upper Carbonate aquifer) is indicated in Figure 5. Near the southeast corner of the area groundwater flow seems to be noticeably affected by groundwater use in the City of Winnipeg. Most of the groundwater flowing through the Upper Carbonate aquifer in West St. Paul originates in the area west of the Municipality and discharges into the Red River or enters the Winnipeg drawdown cone.

The quantity (Q) of water flowing through the Upper Carbonate aquifer can be estimated from transmissivity (T), hydraulic gradient (I) and width of the area perpendicular to the direction of flow (L). In West St. Paul the transmissivity of the Upper Carbonate aquifer ranges from 750 to 1500 m²/d (Render, *ibid.*). The hydraulic gradient is about 10 m in 10 km or 1 m per kilometre and the width of the area is 8 km.

The equation for estimating the flow is:

$$Q = TIL \text{ m}^3/\text{d}$$

Hence, assuming $T = 750 \text{ m}^2/\text{d}$

$$Q = 750 \times 1 \times 8 = 6000 \text{ m}^3/\text{d} \text{ or } 70 \text{ L/s sustained pumping rate.}$$

For $T = 1500 \text{ m}^2/\text{d}$ the corresponding flow rates would be 12000 m³/d or 140 L/s.

3.2.3 Recharge

Because in West St. Paul the Upper Carbonate aquifer is overlain by thick clay and till deposits the recharge area of the aquifer is outside the

Municipality. Most of the recharge likely takes place in the uplands of the Interlake region and in the vicinity of Stoney Mountain. The area of the recharge area that may contribute significant amount to the recharge of the Upper Carbonate aquifer in West St. Paul appears to be at least 50 km^2 . Indications are that yearly recharge in the Uplands of the Interlake region is at least 0.03 m of water over the recharge area. The annual recharge of the flow system then is around $1.5 \times 10^6 \text{ m}^3$ of water. This is equivalent to a sustained pumping rate of 50 L/s . As in at least some parts of the recharge area the recharge could be 0.06 m , it is likely that the total yearly recharge could be equal to around 75 L/s sustained pumping rate.

3.2.4 Present Use

At present there are approximately 750 dwellings in the municipality. Assuming a daily consumption of 1000 L per unit (or about 250 L per person per day) the total consumption is $750 \text{ m}^3/\text{d}$ or 8.7 L/s sustained pumping rate. In addition to the private dwellings groundwater is used to supply a senior citizens home (about 250 residents) and some commercial establishments. Hence, it can be assumed that the water consumption in West St. Paul is about 10 L/s sustained pumping rate or $860 \text{ m}^3/\text{d}$.

3.2.5 Groundwater Availability

The fact that the water level in wells in the Upper Carbonate aquifer is considerably above the aquifer is an indication that groundwater for additional development is available. The level of the surface to which water rises in wells or the potentiometric surface is indicated in Figure 2 and the available drawdown in the municipality is indicated on the map in Figure 6.

In the section on groundwater flow it was indicated that some 6 000 m^3 to 12 000 m^3 a day flow through the Upper Carbonate aquifer in West St. Paul. Estimates based on recharge indicate that the recharge of the aquifer on which the groundwater supply depends, is equal to a sustained pumping rate of at

least 50 L/s and probably up to 75 L/s or 4 300 m³ to 6 500 m³ a day. Because the estimated present consumption of 860 m³/d is only a fraction of the recharge or the quantity of groundwater that flows under the area, it can be assumed that considerable quantities of groundwater are available for development.

One of the best indicators of the groundwater availability in the Municipality is the fact (Render, *ibid.*) that prior to completion of the aquaduct to the Lake of the Woods a well field along Pipeline Road supplied most of the 45 500 m³/d used by the City of Winnipeg. As 45 500 m³/d is nearly 530 L/s sustained pumping rate it is a good indication that the potential yield of the aquifer is several hundred litres per second.

The maximum quantity of groundwater that would be available for development in West St. Paul is difficult to estimate for the following reasons:

1. The availability to a great extent depends on groundwater development outside West St. Paul. For example, because the groundwater flow of the area originates outside the Municipality, intensive development in the recharge area could reduce the inflow into the West St. Paul area.
2. Full groundwater development in West St. Paul could have detrimental effect on groundwater supply in Winnipeg. Thus at some point development may have to be restricted to allow for adequate supply in Winnipeg south of the Municipality.

Assuming that the average water consumption per dwelling is 1000 L/d a sustained pumping rate of 7.5 L/s or 655 m³/d would supply seven hundred units. Because the estimated groundwater flow through the Upper Carbonate aquifer in West St. Paul is 50 to 75 L/s, and the present consumption is about 10 L/s, it is reasonable to assume that at least 40 L/s is available for

additional development. This would supply some 3500 new dwelling units.

It is possible that increased groundwater use in West St. Paul would change the groundwater flow pattern in the vicinity and increase the recharge area contributing to groundwater flow through the Municipality. Consequently, the quantity of groundwater available for development could be considerably more than estimated under present conditions.

In general, groundwater in adequate quantity for domestic requirements is readily available from the Upper Carbonate aquifer at almost any point in the Municipality.

3.2.6 Quality

Water in the Upper Carbonate aquifer is of fairly good quality, the total dissolved solids concentration ranges from 1000 to 1500 mg/L and hardness from 465 to 650 mg/L. The water is of somewhat better quality in the western part (West of Blackdale Road) of the Municipality than near Red River. For example the total dissolved solids concentration ranges from 1000 mg/L in the western part to 1330 mg/L near the Red River and hardness ranges from less than 500 mg/L in the western part to more than 600 mg/L along the Red River.

The hardness is high but it can be reduced by conventional water softeners. Ion exchange softeners, however, may increase sodium concentration, which ranges from 140 to 330 mg/L, to undesirable levels, particularly for people on low salt diets.

3.3 Pollution Hazard

The surficial deposits in most of West St. Paul consist of more than 3 m of clay underlain by glacial till. The total thickness of the surficial deposits ranges from 12 to 30 m. Because the surficial deposits are practically impermeable, it is not likely that seepage from septic tank drain fields or other pollutants will cause groundwater pollution by seepage through the

surficial deposits. This, however, does not prevent well pollution caused by improper design and construction of wells and domestic waste disposal systems.

3.4 High Groundwater Level Area

The water level in wells in the area west of Blackdale Road, particularly along Pipeline Road, is above or near ground surface. In this area improperly constructed wells that allow passage of water outside the casing and that flow uncontrolled may cause several problems: e.g., flooding of basements, damp basements, flooding of septic tank drain fields, icing-up of drains, etc. Hence, in this area, wells should be constructed so that there is no seepage outside the well casing and, in case of flowing wells, the discharge can be controlled.

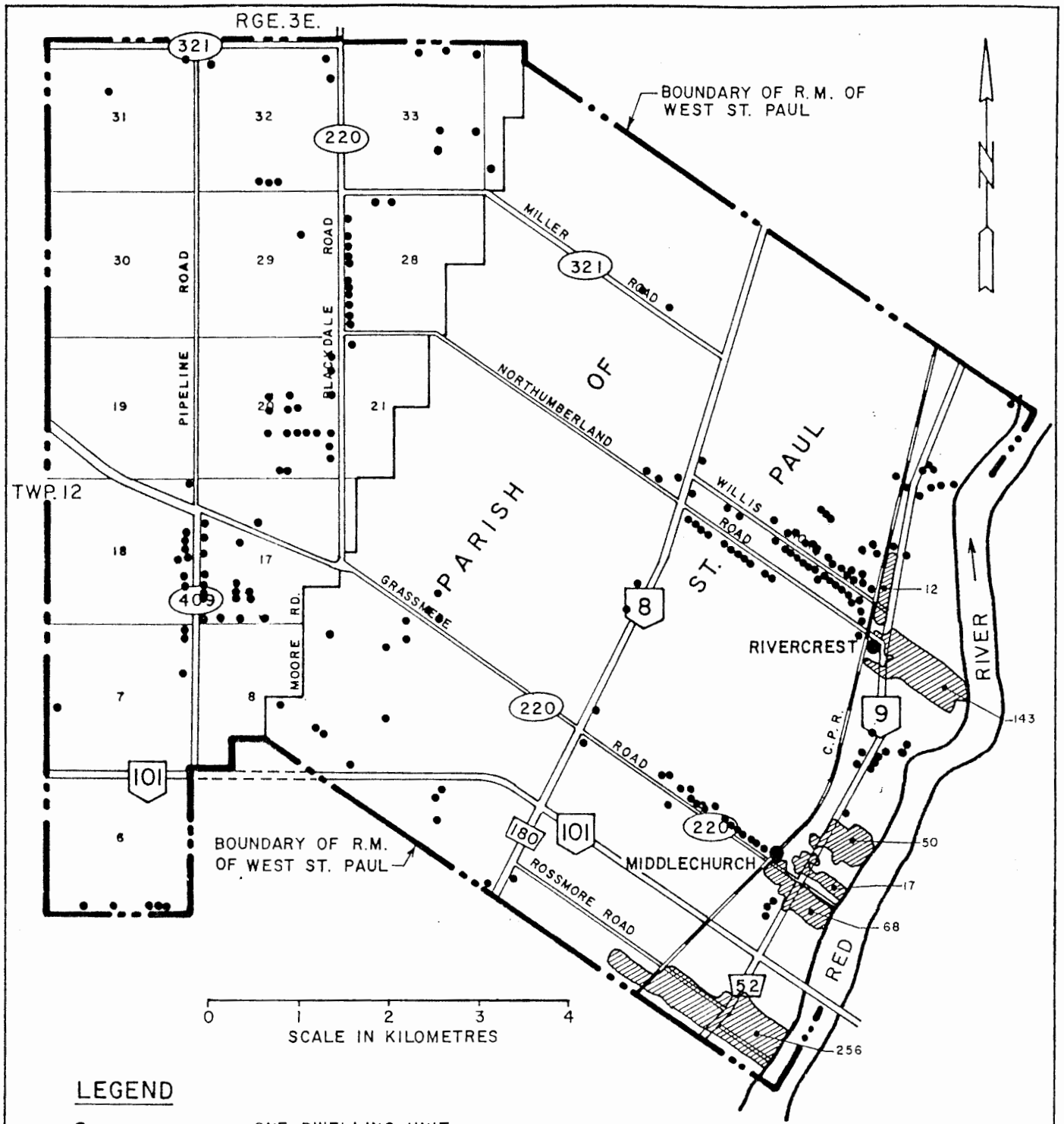
4 GROUNDWATER DEVELOPMENT SUGGESTIONS

Although large quantities of groundwater are available for new development, it would be advisable from a resource development point of view to consider the following in preparing the district plan:

1. Additional large scale (more than 100 units) and high density developments should not be planned in or near the lowest available drawdown area north of Willis Road (Figure 6). The area, however, could tolerate some development.
2. The best groundwater conditions appear to be in the western part of the Municipality, i.e. the area west of the river lots.
3. In high density developments a municipal water system would be preferable to individual private wells.

5 SUMMARY

1. The main aquifer in the R.M. of West St. Paul is the Upper Carbonate aquifer. It consists of fractured carbonate rock (limestone and dolostone) that underlies the area at 12 m to 30 m below ground level.
2. The yield of most wells drawing water from the Upper Carbonate aquifer is adequate for domestic water supply.
3. Water in the Upper Carbonate aquifer in the R.M. of West St. Paul is of fairly good quality; the total dissolved solids concentration ranges from 1000 to 1500 mg/L and hardness from 400 to 650 mg/L. The hardness can be reduced by conventional water softeners. Groundwater quality is somewhat better in the western half than in the eastern half of the Municipality.
4. Estimates based on general aquifer properties in the Municipality and recharge conditions of the aquifer indicate that up to 3500 new dwellings could be supplied with groundwater from the Upper Carbonate aquifer without interfering with water supply from existing wells.
5. The new developments could be supplied by private wells or municipal wells.
6. The availability of groundwater for new development in the R.M. of West St. Paul depends on development in adjacent municipalities; increased groundwater use in adjacent areas would reduce groundwater availability in West St. Paul.
7. Because the whole Municipality is underlain by thick clay and glacial till deposits, aquifer pollution by seepage of pollutants through the overlying strata is not likely.
8. At present in the R.M. of West St. Paul there are no areas where groundwater development for domestic requirements using private wells would noticeably reduce water supply from existing wells.



LEGEND

- ——— ONE DWELLING UNIT
- ▨ ——— TOTAL DWELLING UNITS

MODIFIED DISTRICT PLAN OF WEST ST. PAUL
 (THE CITY OF WINNIPEG—DEPARTMENT OF ENVIRONMENTAL PLANNING—DISTRICT PLAN BRANCH)

FIGURE 1

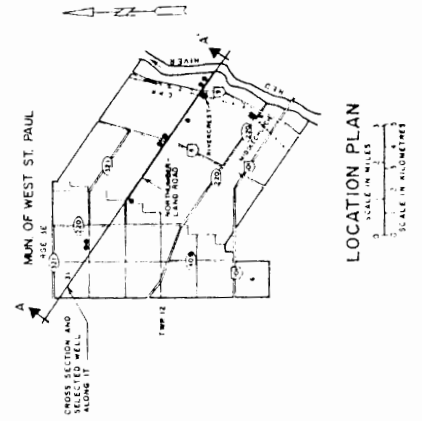
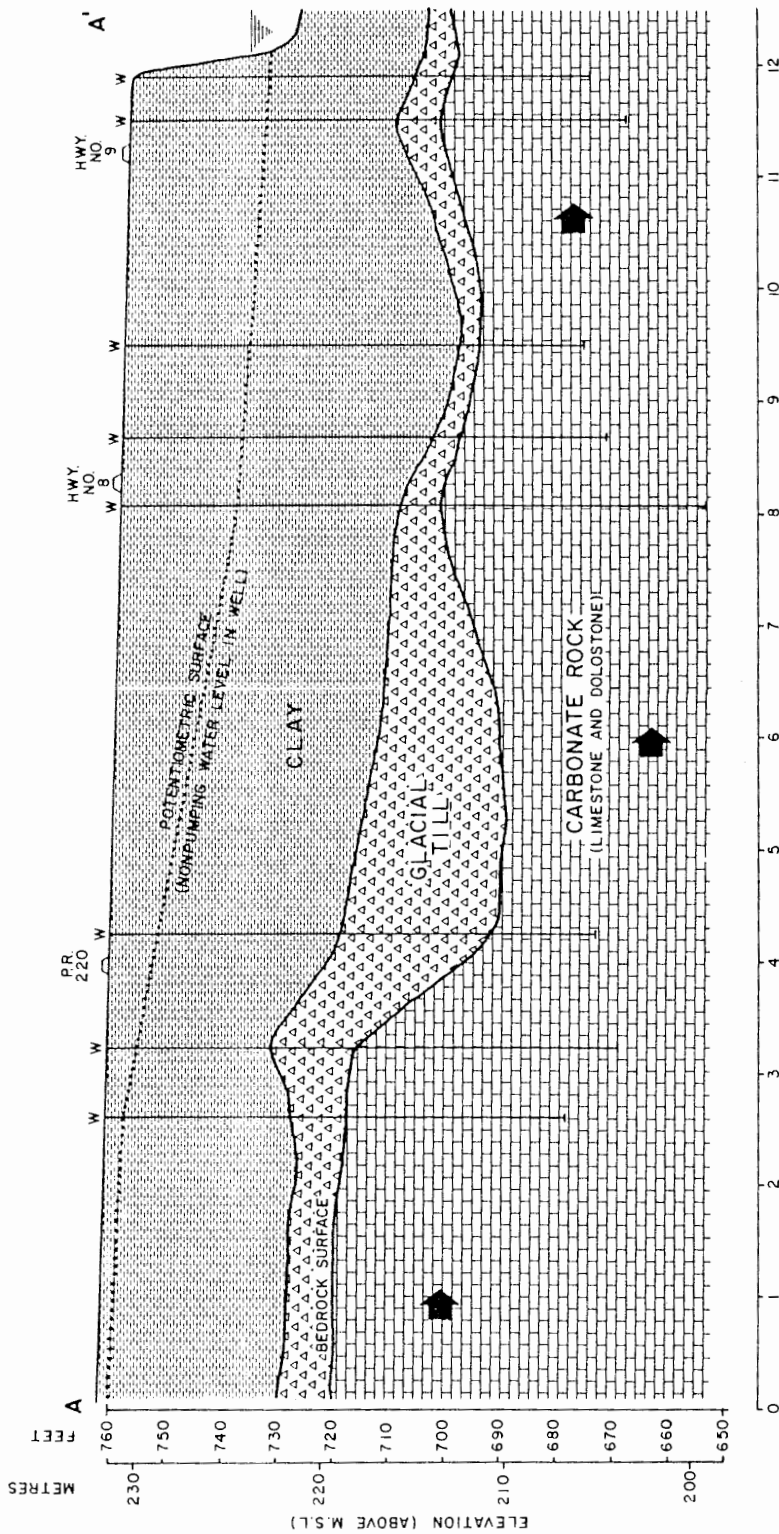
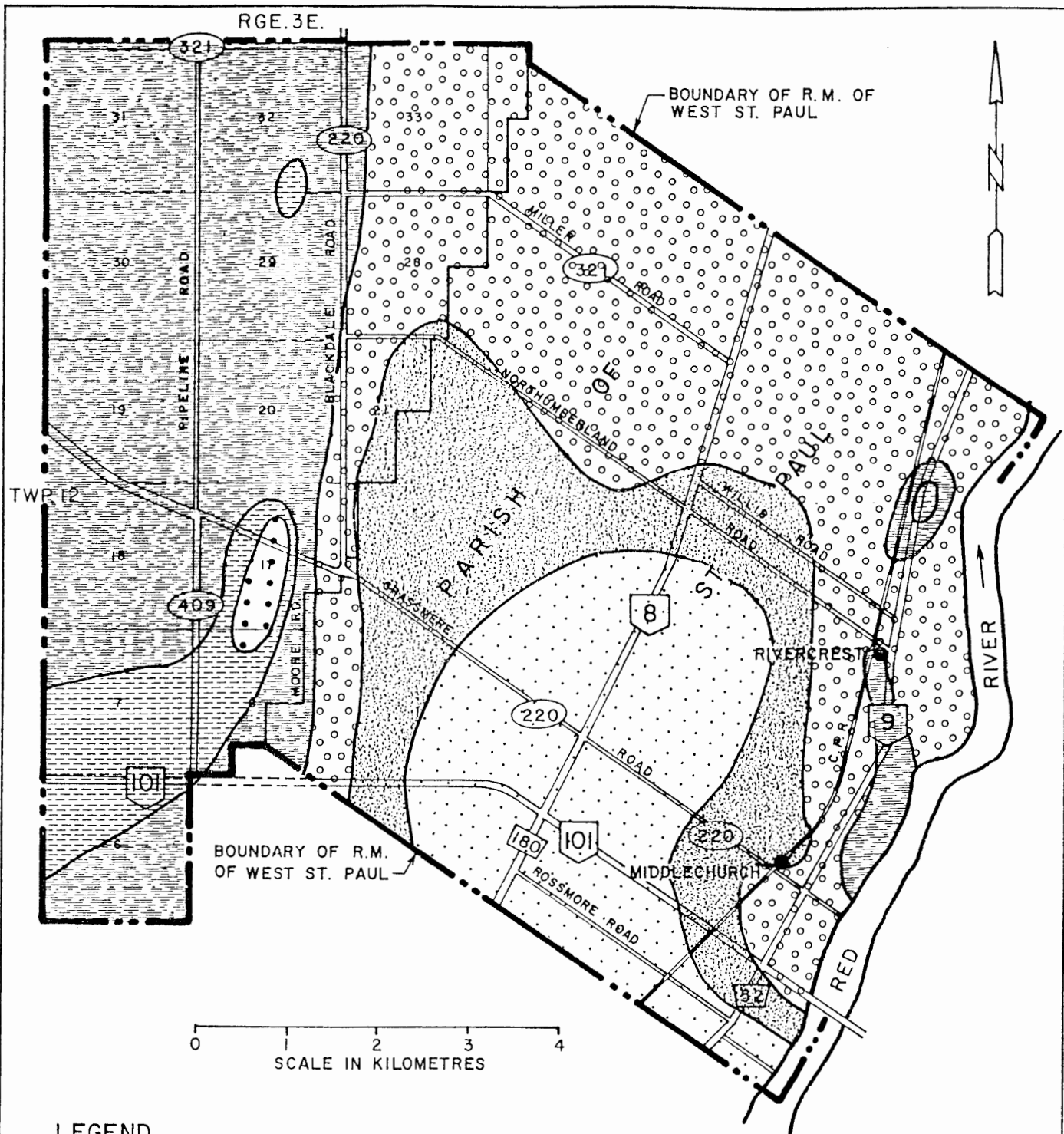


FIGURE 2



LEGEND

	3 m - 6 m		12 m - 15 m
	6 m - 9 m		15 m - 18 m
	9 m - 12 m		18 m - 21 m

FIGURE 3

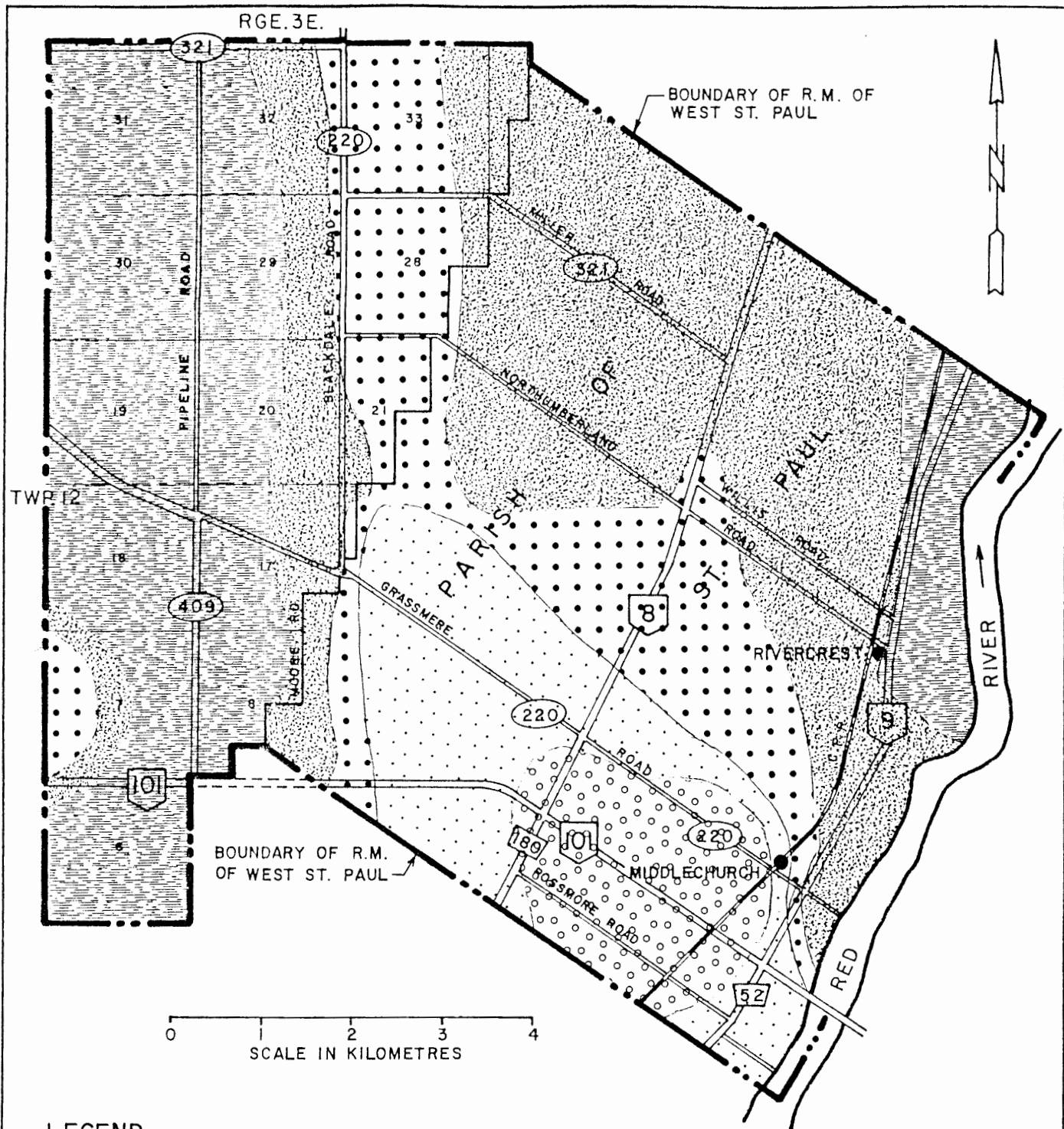
PROVINCE OF MANITOBA

DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT

WATER RESOURCES BRANCH

WEST ST. PAUL DISTRICT

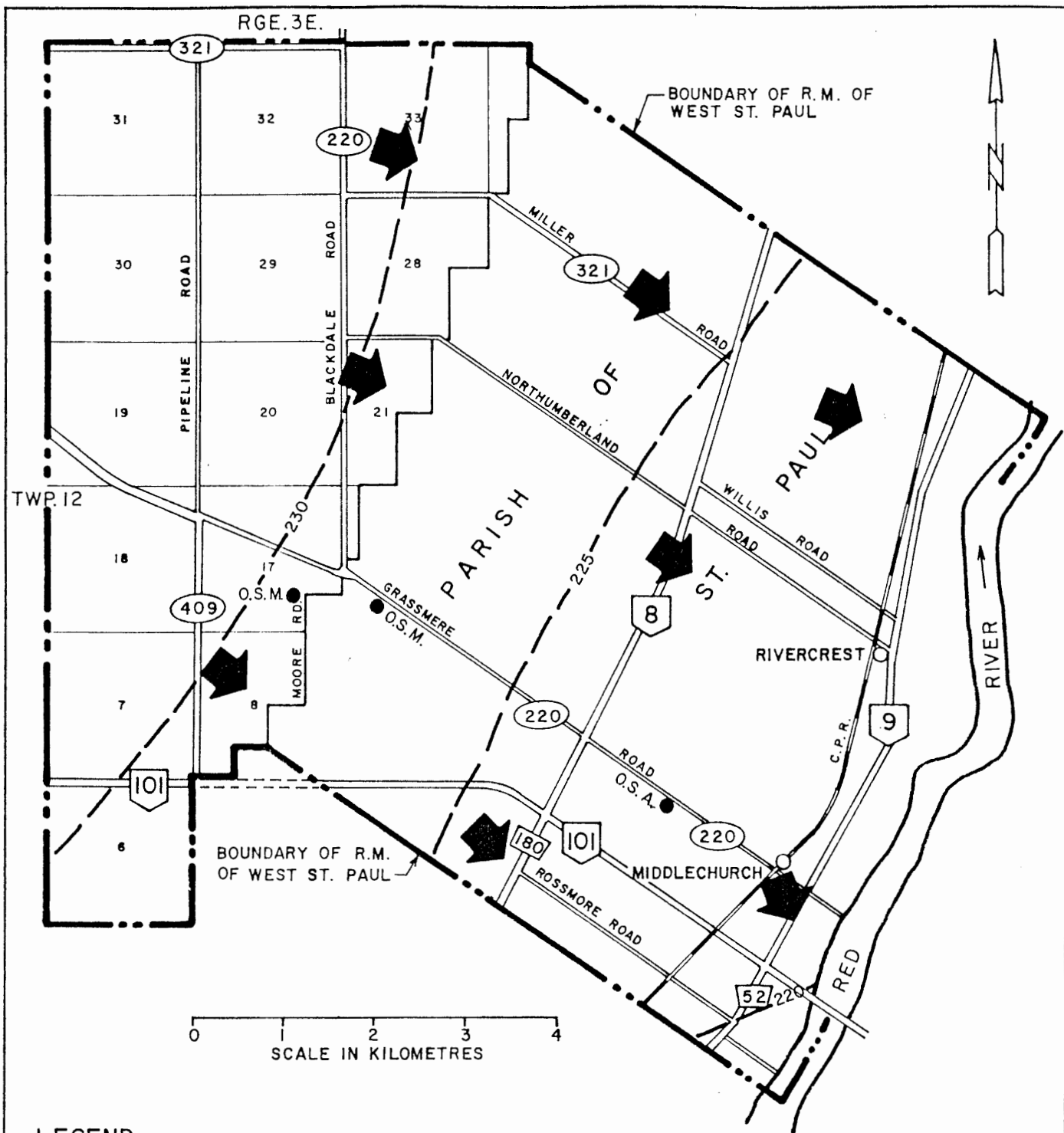
SURFACE CLAY THICKNESS



LEGEND

- | | | | |
|--|---------------|--|---------------|
| | — 12 m - 15 m | | — 21 m - 24 m |
| | — 15 m - 18 m | | — 24 m - 27 m |
| | — 18 m - 21 m | | |

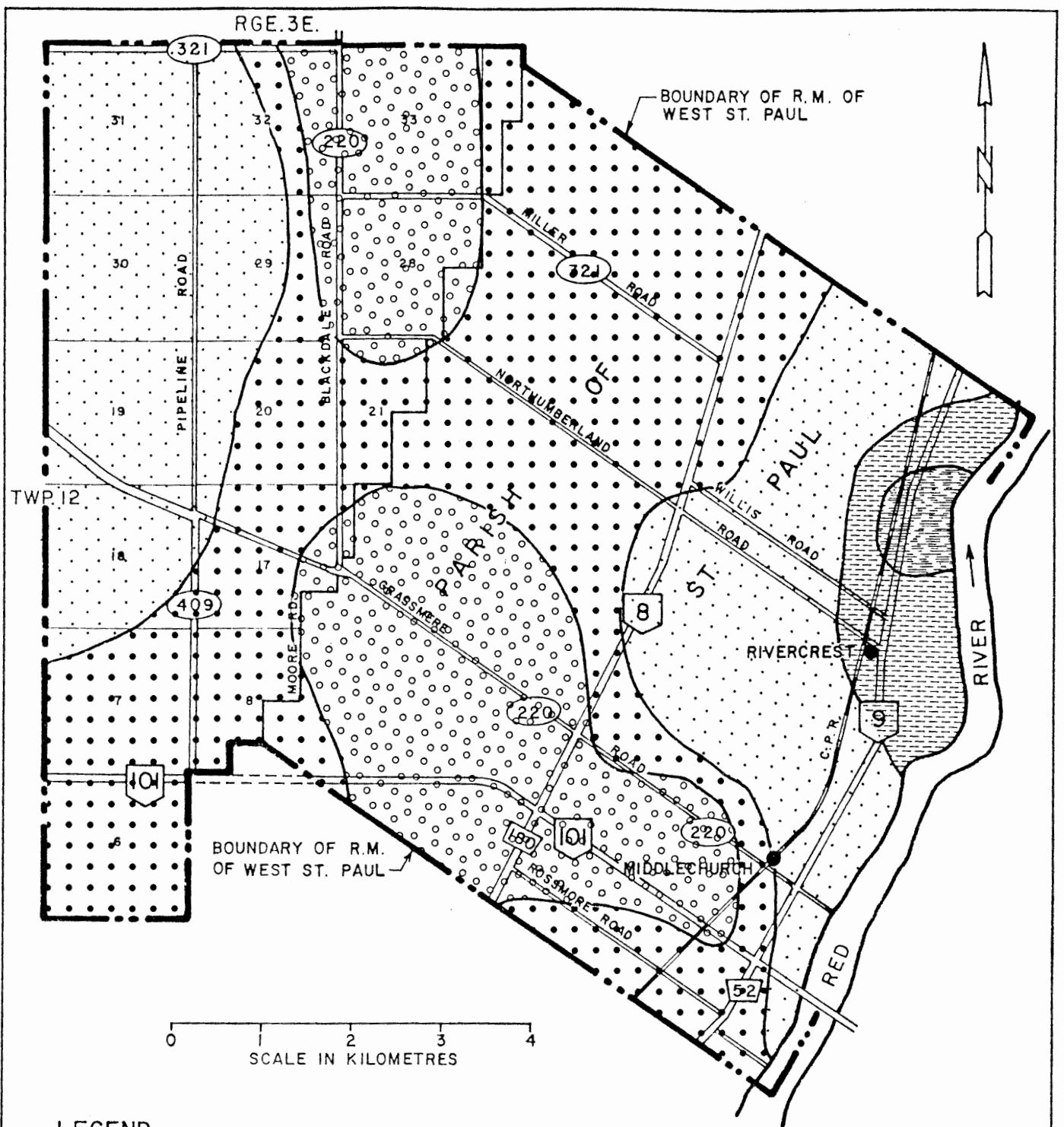
FIGURE 4



LEGEND

- 230 --- CONTOUR OF POTENTIOMETRIC SURFACE, ELEVATION ABOVE SEA LEVEL IN METRES.
- ➔ DIRECTION OF GROUNDWATER FLOW
- O.S.M. GROUNDWATER LEVEL OBSERVATION STATION, MANUAL
- O.S.A. GROUNDWATER LEVEL OBSERVATION STATION, AUTOMATIC RECORDER

FIGURE 5



LEGEND






	— 3 m - 6 m		— 12 m - 15 m
	— 6 m - 9 m		— 15 m - 18 m
	— 9 m - 12 m		

FIGURE 6