PROVINCE OF MANITOBA

DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT

WATER RESOURCES DIVISION

GROUNDWATER RESOURCES IN SOUTH ST. VITAL

AND NORTHERN R.M. OF RITCHOT

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GROUNDWATER RESOURCES IN SOUTH ST. VITAL AND NORTHERN R.M. OF RITCHOT

1 INTRODUCTION

In this report groundwater resources and probable effect of limited urban expansion on them in the urban expansion area of South St. Vital and Northern R.M. of Ritchot are discussed.

The purpose of the report is to provide background information for policy formulation and for public information.

The report is based on available information consisting of groundwater monitoring data, numerous water well drillers' reports and published reports*.

The area under consideration and existing zoning in it are shown in Figure 1.

2 GEOLOGICAL SETTING

As groundwater flows through and is stored in the surficial deposits and the underlying rocks an understanding of the geological conditions in the area is essential to appreciate the groundwater resources is an area.

In the South St. Vital and Northern R.M. of Ritchot district the sequence of surficial deposits and sedimentory rock formations from surface to the Precambrian granitic rocks is as follows:

1. The upper layer of surficial deposits consists of from 40 to 60 feet thick lake clay deposits with thin silty clay beds at surface.

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*F. Render 1970 Geohydrology of the metropolitan Winnipeg area as related to groundwater supply and construction Canadian Geotechnical J. 3, p.p. 243-274

2. The clay is underlain by till; the thickness of it ranges from a few feet to about 60 feet. The clay thickness at a number of points in the area is given in Figure 2.
3. In some places, particularly in channels in the bedrock surface, the till is underlain by sand and gravel. The thickness of the sand and gravel deposits is up to 40 feet.
4. The till or the sand and gravel deposits underlying the till are underlain by carbonate bedrock (limestone and dolostone). A typical cross section through the surficial deposits and the upper part of the carbonate rock is shown in Figure 3.
5. At a depth of about 500 feet the carbonate rock is underlain by shale and sandstone beds.
6. The shale and sandstone formation which is about 140 feet thick is underlain by Precambrian granitic rocks.

The main topographic features of the bedrock surface are buried stream channels; one of them is located near the Red River and a second one in the vicinity of Seine River. As the land surface in the area is very flat the channels show up as zones of thicker surficial deposits in the depth to the bedrock map (Figure 2). (Incidentally, the depth to bedrock shown in the map is related to general prairie level; features such as present stream channels and the Red River Floodway have been ignored).

3 GROUNDWATER

3.1 Aquifers

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

1. The Upper Carbonate aquifer (Render, 1970) formed by fractured

carbonate rock within the upper 50 feet or so of the bedrock. As it is the most important source of water supply in the area the Upper Carbonate aquifer is the main concern of this report. Therefore, it will be discussed further in the next section. Sand and gravel deposits laid down directly on the carbonate rock essentially are part of the Upper Carbonate aquifer.

2. A second water bearing zone exists in the lower part of the carbonate rock. A few wells in the area have been drilled to the lower water bearing zone.
3. The sandstone beds of the shale and sandstone formation form the deepest water bearing zone in the area. Because of the depth to the sandstone and indications that water in it is salty, the sandstone aquifer is not used as source of domestic water supply.

3.2 Upper Carbonate Aquifer

3.2.1 Dimensions

As already mentioned the thickness of the Upper Carbonate aquifer is about 50 feet. Laterally it extends for many miles in all directions outside the St. Vital - R.M. of Ritchot area and is the most extensive aquifer in Manitoba.

3.2.2 Groundwater Flow

At present groundwater in the upper carbonate aquifer in St. Vital - R.M. of Ritchot Additional Zone, in general, flows northward parallel to the Red River. Groundwater flow in the area as determined by the configuration of the piezometric surface is shown in Figure 4.

The direction of groundwater flow is governed by the piezometric surface (the imaginary surface to which water rises in wells penetrating the aquifer); it flows perpendicular to contour lines on the piezometric surface from areas of high piezometric surface to areas of low piezometric surface. Fracture orientation in the bedrock can contort the flow direction.

As long as there are no changes in the piezometric surface the groundwater flow pattern remains unchanged. The configuration of the piezometric surface, however, can change because of changes in natural conditions or, more often, because of man's activities, such as increased pumping at some point or in some area. Our main concern here is possible changes caused by new development in the St. Vital - R.M. of Ritchot urban expansion area.

As shown in Figure 3 in cross section and Figure 4 in plan the piezometric surface is nearly flat in the direction perpendicular to Red River; there is only a slight depression along Red River. Because there is only a slight depression in the piezometric surface at Red River and the piezometric surface perpendicular to the River is nearly flat, a slight lowering of the piezometric surface in the area east of Red River may cause change in groundwater flow from the west side of the River to the east side. As will be explained later this may have a serious detrimental effect on groundwater quality east of the River.

Indications are that groundwater level on the east side of the River is dropping in relation to the west side (Table 2). In the development area east of Red River no definite trends in groundwater level (Table 3) near the eastern boundary relative to that near Red River can be discerned during the last few years.

It appears that at present fairly delicate equilibrium of groundwater flow exists in the St. Vital - R.M. of Ritchot urban expansion area and, therefore, the problems that may be caused by disturbing the balance by increased use of groundwater must be considered.

3.2.3 Water Quality

Water quality in the Upper Carbonate aquifer in the Area ranges from good potable water to saline water unfit for domestic use. In general, the water is saline west of the Centre line of the meander belt of Red River and fresh east of it.

The fresh-water and salt-water boundary as indicated by available water analyses is shown in Figure 5. In this report water containing more than 500 mg/l chloride ion is considered salty, because it is saline to taste and therefore not satisfactory for potable water supply. The fresh-water and salt-water boundary has been stable since groundwater equilibrium was attained following the stopping of dewatering of the Red River Floodway inlet structure in 1966. However, the boundary may move if the existing conditions, particularly groundwater use, are changed. Salty water has been reported in a few wells near the eastern end of Paul Boulevard and at the South End Water Pollution Control Center in St. Vital. The cause of this occurence of saline water in the fresh-water area is not known.

In the fresh-water area water in the Upper Carbonate Aquifer has dissolved solids concentrations between 700 and 1200 mg/l, hardness between 170 and 500 mg/l, and chloride ion concentration between 130 and 400 mg/l. The water is suitable for domestic supply without treatment or can be readily softened to desired level. A number of water analyses from wells in the area are listed in Table 1 and the locations of the sampling stations are shown in Figure 5.

3.2.4 Present Groundwater Use

Most of the wells in the area are used for domestic supply. A few market gardeners use groundwater for watering plants in greenhouses during the winter months; most of the latter are located in the area between St. Mary's road and Red River.

About 160 new wells have been reported in the area since 1963. It indicates an increase in water consumption of between 30,000 and 60,000 gallons per day. This new development has not had any noticeable detrimental effect on groundwater conditions in the area.

3.2.5 Groundwater Requirements for Development

If the 5000 acres of the A-5 zone (Figure 1) were divided into 5 acre lots and possibly some 2 acre lots and the residences were supplied by individual wells, it would increase the number (about 300) of domestic wells in the area by about 1000; a severalfold increase of the present number of wells. This would result in average additional groundwater use of 200,000 to 400,000 gallons per day (200 to 400 gallons a residence a day) or an additional total sustained pumping rate from 140 to 280 gallons per minute.

Considering the large area over which this additional pumping would be spread the increased sustained rate probably would not cause drastic changes in the groundwater regime in the St. Vital - R.M. of Ritchot Additional zone. However, the intermittent total pumping rate of the additional wells could be several times higher than the sustained rate; for example one can visualize a period of drought with some 1000 lawn sprinklers discharging water at 5 gallons per minute or around 5000 gallons per minute for several days or a few weeks in addition to existing users. Pumping of this magnitude is very likely to change the groundwater flow pattern in the development area and vicinity.

3.2.6 Pollution Hazard

The St. Vital - R.M. of Ritchot limited urban expansion area is underlain by 40 to 60 feet thick clay deposits that, in turn, in most of the area are underlain by till. Both materials have very low permeability and for all pratical purposes may be considered as an impermeable layer. Hence, it is not likely that seepage from septic tank drain fields will cause groundwater pollution in the development area.

A more serious threat to groundwater quality in the area is the salty water west of Red River. This is discussed in more detail in the next section.

4 GROUNDWATER DEVELOPMENT PROBLEMS

4.1 Salt-water Encroachment

In the area west of the Red River the water in the Upper Carbonate aquifer is salty and not suitable for domestic supply. The boundary between fresh and salt water is at its present location because of dynamic conditions that exist in the groundwater flow system. A considerable increase in the rate of pumping in the area east of the boundary would change the present conditions, because it would lower the piezometric surface and, consequently, change the groundwater flow pattern in the area. It is possible that the piezometric surface, if not permanently, at least periodically during periods of heavy pumping, will be lowered sufficiently to cause eastward flow at the boundary between fresh and salt water resulting in movement of salt-water into the fresh-water area. Incidentally, if this happened, the first people to suffer would be the residents and the greenhouse operators that live west of St. Mary's Road.

The available information is not adequate to determine at what point in future development salt-water intrusion into the fresh-water area would happen. The groundwater flow pattern in the development area likely is strongly influenced by local conditions, e.g. channels in the rock surface, sand and gravel deposits on the bedrock, high and low transmissivity areas and density of development. Hence, a very detailed study of groundwater regime in the area would be required to determine more precisely what effect the urban expansion would have on groundwater resources in the area.

4.2 Control of Salt-water Encroachment

Because it is not possible to calculate exactly how much additional development can take place without causing salt-water encroachment, and it is doubtful that prevention of salt-water intrusion into the fresh-water area can be guaranteed without some control of groundwater flow in the area, methods to control salt-water encroachment should be considered.

Basically the control measures would require maintaining a lower piezometric surface along the fresh-water and salt-water boundary than east of it. This could be accomplished by one of the following two methods:

1. By artificially maintaining a depression in the piezometric surface along the boundary; it would require pumping a series of wells discharging into Red River.
2. By artificially recharging the aquifer east of Red River with fresh water to maintain a higher piezometric level than at the boundary.

The first method may be objectionable because it would require discharge of salty water into Red River and would waste a valuable resource used by industry in Winnipeg. The second method has disadvantages because it will make the development dependent, at least to some extent, on water from another source such as Winnipeg's Municipal Water System.

Both methods would be costly and would require careful management of the operation.

5 GROUNDWATER AVAILABILITY

From the preceeding discussion it follows that the groundwater available for development in the South St. Vital - Northern R.M. of Ritchot Additional zone will be limited to quantities that can be pumped without causing salt-water encroachment into the fresh-water area, if no control works to prevent it are installed. To determine how much water is available would require an extensive study. It appears that some additional development in the eastern part, e.g. along St. Anne's Road, would have practically no effect on groundwater conditions near the fresh-water and salt-water boundary. On the other hand, development along St. Mary's road and west of it would affect the groundwater flow pattern along the boundary the most.

Until it is determined by detailed studies that the proposed development in the limited urban expansion district of St. Vital and R.M. of Ritchot will not cause salt-water encroachment into the fresh-water area, or control works to prevent the encroachment are installed, intensive groundwater development in the district, particularly in the zone along St. Mary's road, is not advisable.

In the area west of Red River there is practically no fresh groundwater available for new development.

6 SUMMARY

Based on the available information it appears that there is danger that intensive urban expansion in the South St. Vital - Northern R.M. of Ritchot area using groundwater may cause salt-water encroachment into the present fresh-water area.

The encroachment of saline water could be prevented by creating either a depression or a mound on the piezometric surface that would control groundwater flow in the area.

One of the most important questions that must be answered if development in the St. Vital - R.M. of Ritchot additional zone is allowed is: Who would be responsible for damages to existing groundwater users, if salt-water intrusion should occur?

An extensive groundwater investigation would be required to determine how much development could be allowed without causing salt-water encroachment into the present fresh water area or to implement artificial control of groundwater [illegible]

TABLE I. WATER QUALITY IN UPPER CARBONATE AQUIFER

Reference No.*	Cations mg/l			Anions mg/l			Hardness mg/l As $CaCO_3$	Dissolved solids mg/l	E.C. micromhos 25°C	Sampling Date
	Ca^{++}	Mg^{++}	$N^{+}+K^{+}$	HCO_3^{-}	SO_4^{--}	Cl^{-}				
1	252	119	1860	270	660	2900	1120	5960	9400	24/08/71
2	280	141	2050	185	820	3360	1280	7030	10760	18/06/72
3	140	68	698	178	300	1275	630	2650	4350	12/11/74
4	48	14	370	316	200	305	176	1154	1900	16/04/72
5	115	64	450	239	350	800	350	2020	3340	03/10/75
6	145	78	620	256	415	1010	683	2540	4240	10/09/75
7	75	46	199	257	200	235	377	940	1510	12/11/74
8	260	75	902	161	580	1350	960	3590	5200	17/09/73
9	126	67	558	262	376	818	590	2246	3400	26/02/74
10	80	54	150	296	242	180	423	908	1270	26/02/74
11	107	59	906	310	322	1325	513	3028	5100	26/02/74
12	62	39	147	259	153	186	318	787	1010	25/02/74
13	79	56	151	316	239	145	431	854	1230	/06/75
14	70	60	138	274	249	127	422	867	1240	/06/75
15	77	57	160	281	250	167	427	910	1495	17/05/74
16	38	52	130	217	202	140	308	696	1160	22/08/75
17	51	44	165	216	189	250	308	886	–	23/03/63
18	83	53	155	288	312	142	428	980	1375	20/11/67
19	126	79	479	250	377	770	640	2034	3100	24/09/71
20	56	39	221	116	158	363	301	972	1700	26/02/74

* The locations of sampling stations are shown in Figure 5.

TABLE II PIEZOMETRIC SURFACE (WATER LEVEL) ELEVATIONS

Date	Observation Station 50C-MN1 Elev. Ft.	50C-MN2 Elev. Ft.	Elev. Difference (50C-MN1)-(50C-MN2) Ft.
31/12/63	738.00	739.30	-0.70
31/12/64	725.90	724.40	1.50
31/12/65	736.20	734.20	2.00
31/12/66	739.70	738.90	0.80
31/12/67	737.70	737.70	0.40
31/12/68	739.25	738.80	0.55
31/12/69	739.60	739.15	0.45
31/12/70	739.40	738.90	0.50
31/12/71	740.50	740.00	0.50
31/12/72	739.15	738.75	0.40
31/12/73	739.00	738.70	0.30
31/12/74	738.80	738.50	0.30

TABLE III PIEZOMETRIC SURFACE (WATER LEVEL) ELEVATIONS

Date	Observation Station* 50H - MN3 Elev. Ft.	50C - MN1 Elev. Ft.	Elev. Difference (50H-MN3) - (50C-MN1)
31/12/63	739.55	738.00	1.55
31/12/64	739.30	725.90	13.40**
31/12/65	739.45	736.20	3.25**
31/12/66	739.85	739.70	0.15
31/12/67	738.10	737.70	0.40
19/10/68	740.20	741.25	-1.05
30/12/69	739.40	739.45	-0.05
30/12/70	739.20	739.40	-0.20
15/12/71	739.60	740.70	-1.10
21/12/72	738.10	738.80	-0.70
11/12/73	738.25	739.35	-1.10
17/12/74	738.00	739.05	-0.95
19/11/75	738.65	739.80	-1.15

* Locations of stations shown in Figure 4 .

** Dewatering at Floodway inlet structure.

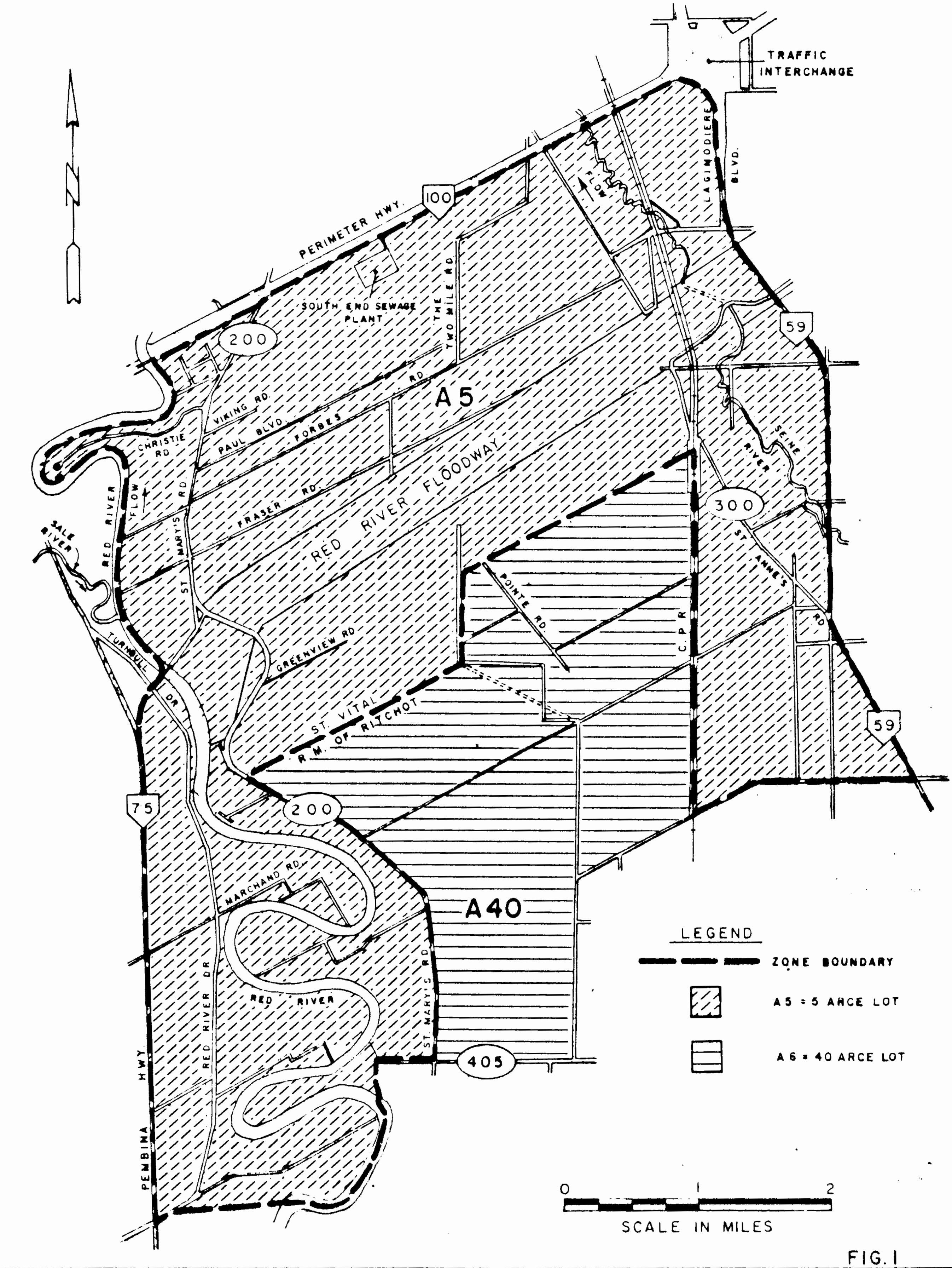


FIG. I

PROVINCE OF MANITOBA

DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT

WATER RESOURCES BRANCH

SOUTH ST. VITAL AND NORTHERN R.M. OF RITCHOT

EXISTING ZONING

PREPARED | DRAWN N.S. | SUBMITTED | APPROVED

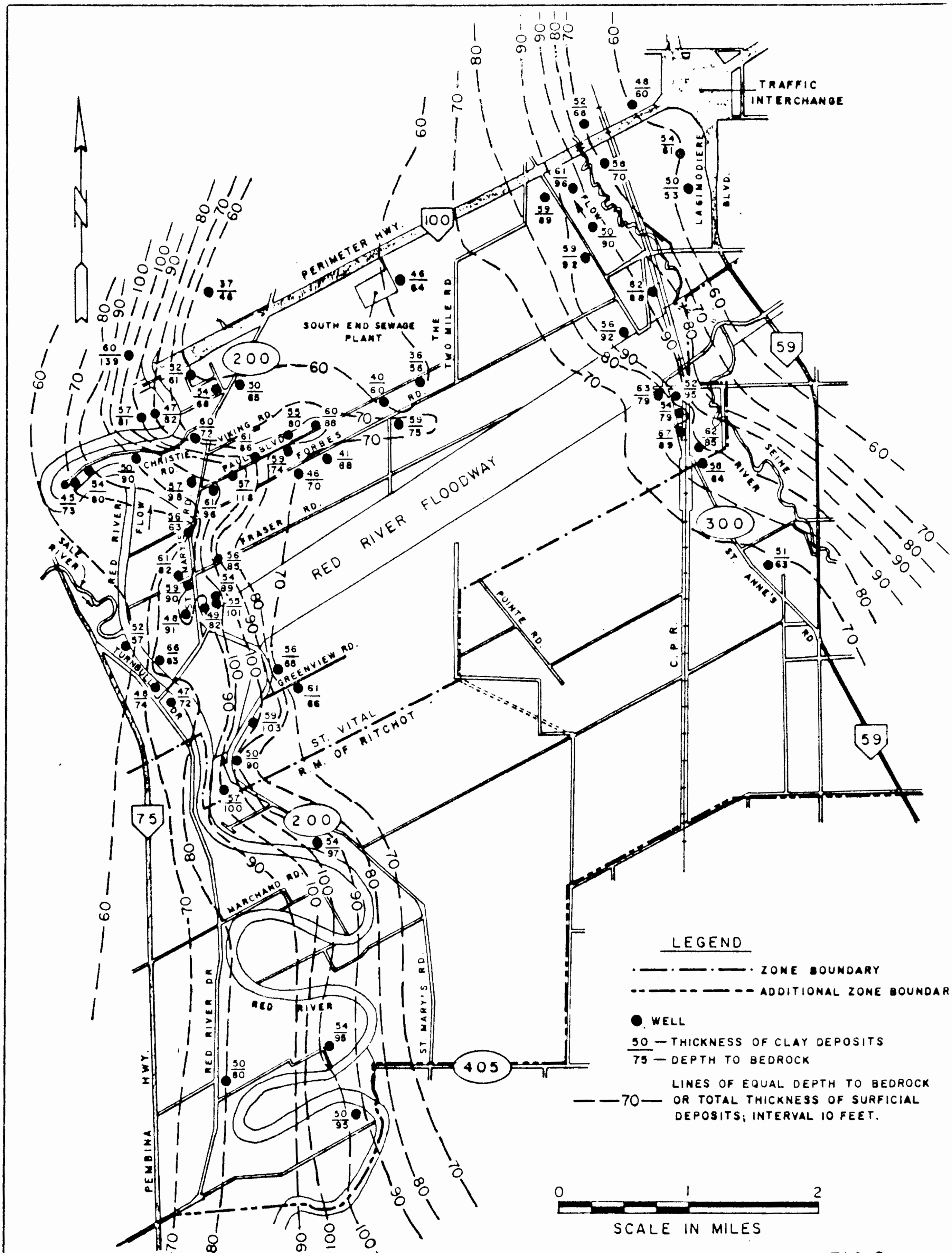
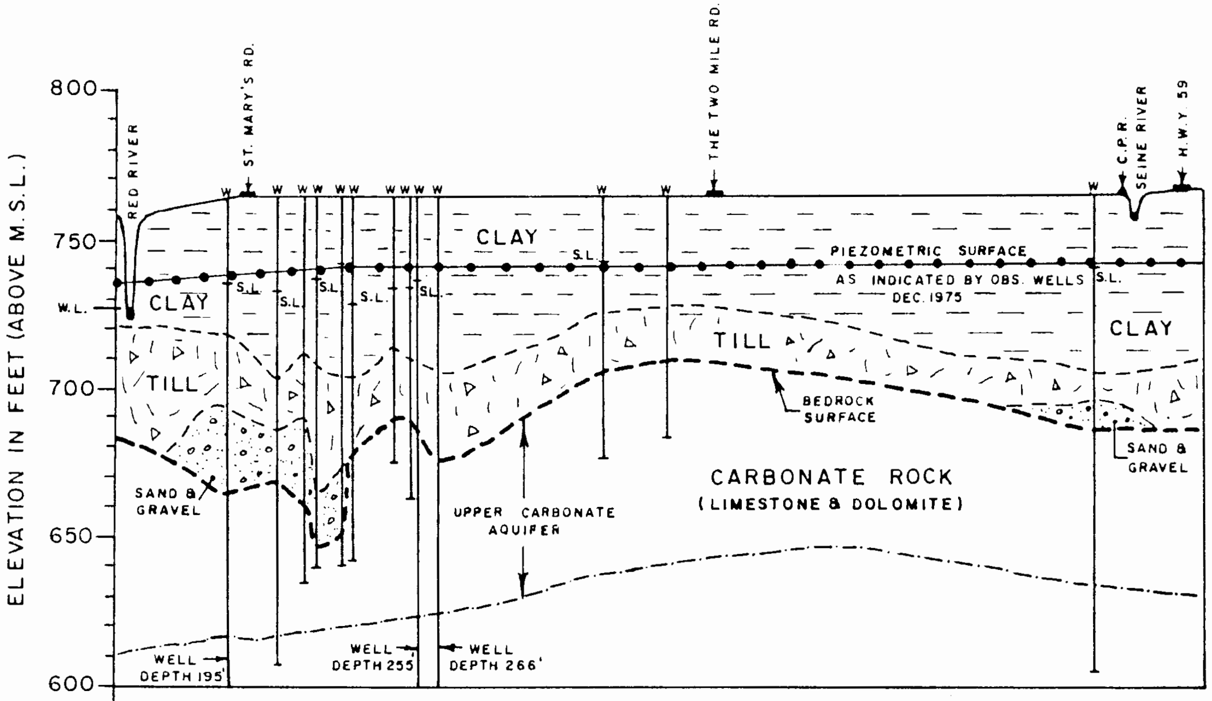


FIG. 2

PROVINCE OF MANITOBA DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT WATER RESOURCES BRANCH	SOUTH ST. VITAL AND NORTHERN R.M. OF RITCHOT DEPTH TO BEDROCK



SECTION A-A

LEGEND

W – WATER WELL

S.L. – STATIC LEVEL IN WELL AS REPORTED BY DRILLER.

0 1 2

SCALE IN MILES

FIG. 3

PROVINCE OF MANITOBA

DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT

WATER RESOURCES BRANCH

SOUTH ST. VITAL AND NORTHERN R.M. OF RITCHOT

CROSS SECTION A-A THROUGH SURFICIAL DEPOSITS AND UPPER CARBONATE AQUIFER

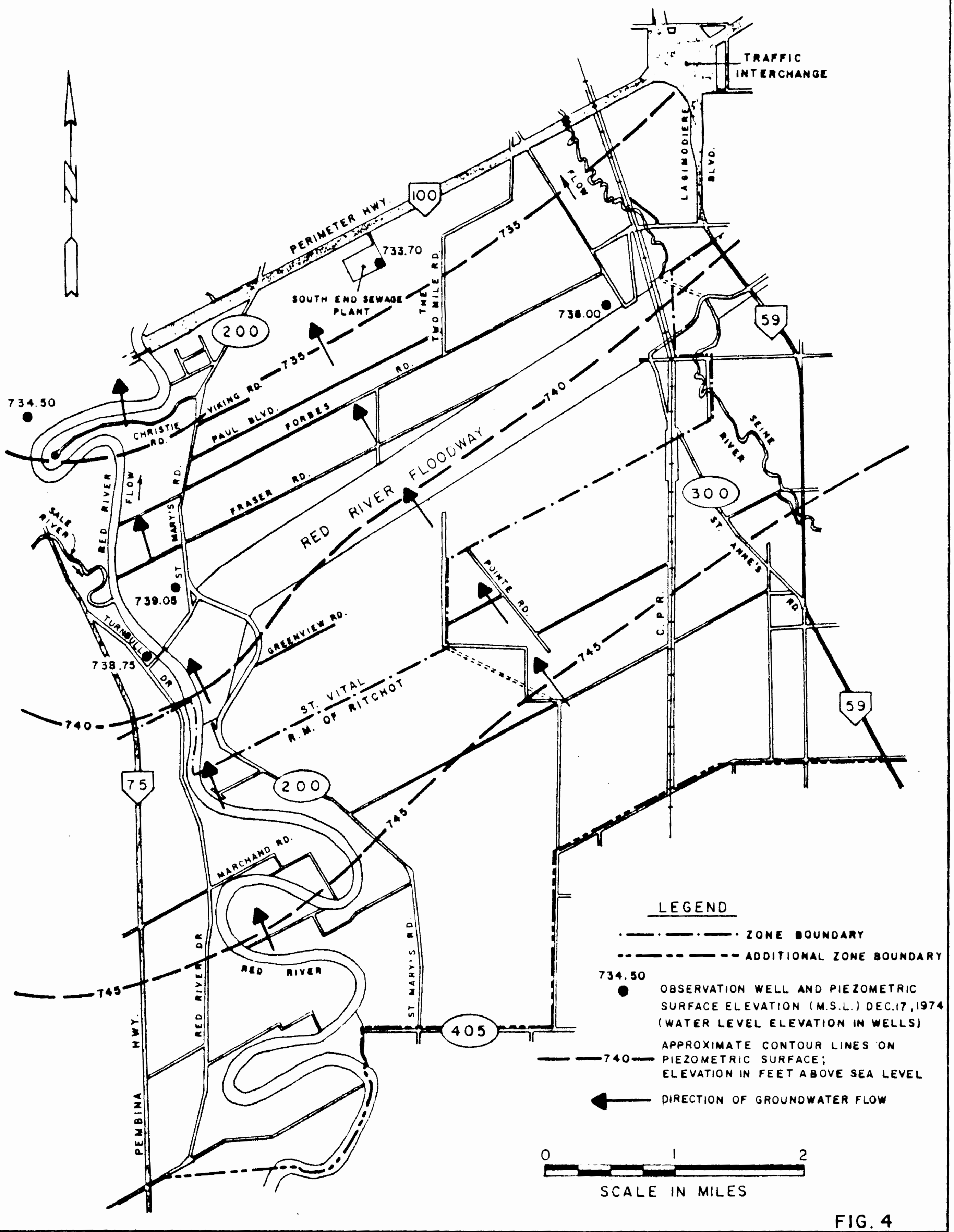


FIG. 4

PROVINCE OF MANITOBA DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT WATER RESOURCES BRANCH	SOUTH ST. VITAL AND NORTHERN R.M. OF RITCHOT PIEZOMETRIC SURFACE DEC. 31, 1974

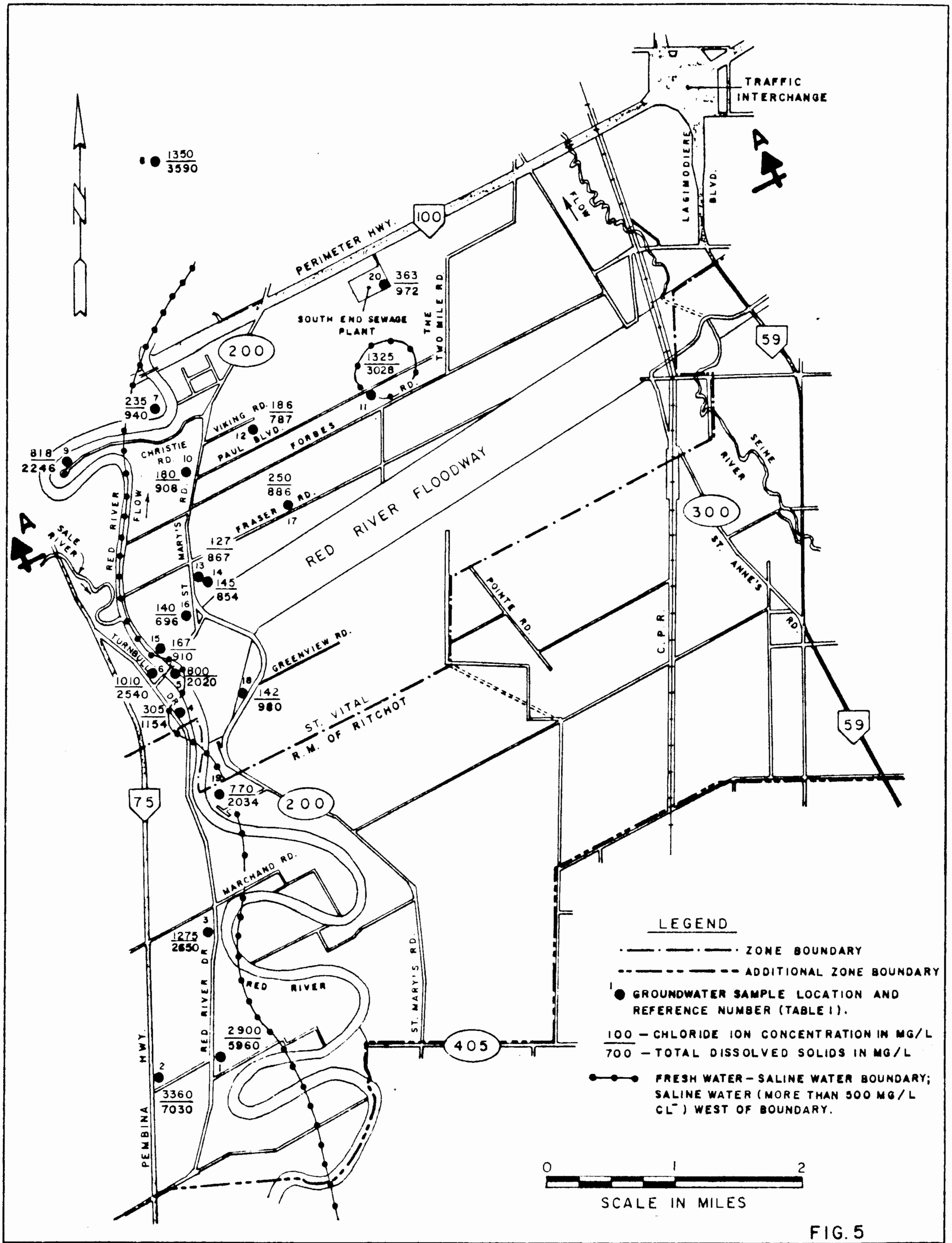


FIG. 5

PROVINCE OF MANITOBA

DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT

WATER RESOURCES BRANCH

SOUTH ST. VITAL AND NORTHERN R.M. OF RITCHOT

GROUNDWATER QUALITY