GROUNDWATER AVAILABILITY STUDIES
Report No. 3

GROUNDWATER AVAILABILITY IN THE ETHELBERT AREA
(Rural Municipality of Ethelbert)

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Abstract

The Ethelbert area is located in the west central part of the Province of Manitoba. It covers the Rural Municipality of Ethelbert, an area of 432 square miles.

A ground-water availability study was carried out to determine the ground-water potential with respect to stock and domestic farm use.

The subcropping bedrock in the area consists of Jurassic shale and the Swan River, Ashville, Favel, Vermillion River and Riding Mountain formations of Cretaceous age. The surficial deposits range from 10 to approximately 600 feet in thickness. These deposits consist mainly of till and related sands and gravels. Deltaic, beach, lacustrine, alluvial and swamp deposits overlie till.

The best aquifers in the area are the sands and gravels associated with till and the Swan River formation. Other aquifers which contain suitable quality ground water are sands and gravels of deltaic, beach and alluvial deposits but wells in these aquifers are not always reliable. Jurassic limestone is also a suitable aquifer.

Approximately forty percent of the locations visited in the area report unsatisfactory ground-water supplies. This study indicates that only sixteen percent of these locations appear to have a legitimate problem and that the remainder could develop a suitable ground-water supply.

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INTRODUCTION

The ground-water availability study of the Ethelbert area was carried out at the request of the Municipality of Ethelbert because of difficulties experienced in obtaining suitable ground water supplies for domestic and stock use.

The purpose of the study is to outline the sources of ground water in the area and to evaluate the quantity and quality of water available from each source. The investigation covers the Rural Municipality of Ethelbert, an area of 432 square miles. The investigated area is shown in Figure 1.

Investigation

Field work was carried out during the summer of 1966. An inventory of wells and other water sources in the municipality was made. Water samples were taken from each source for field analysis and several samples were taken for complete analysis. A total of 266 farms were visited.

Twenty-four sites were tested. At each test site a stratigraphic test hole was drilled and electric logged, if possible, to a depth which would intercept all potential aquifers. All potential water bearing zones were tested to determine quantity and quality of water available.

Topography and Climate

The Rural Municipality of Ethelbert is situated mainly within the Manitoba Lowland Plain but the western portion of the area extends into the Duck Mountains which form a segment of the Manitoba Escarpment.

The highest point of elevation within the municipality is approximately 2500 feet above sea level; the lowest point, on the lowland plain, is approximately 1025 feet above sea level.

The area is drained by several streams flowing east to Lake

Winnipegosis, Mossy River and Lake Dauphin.

The area is sub-humid with approximately 75% of the precipitation falling as rain from April to October and approximately 25% as snow from November to March. The nearest meteorological station with long term records available is located at Dauphin approximately 30 miles southeast of Ethelbert. The mean annual precipitation for Dauphin is 18.01 inches. An average of 13.5 inches falls as rain from April to October. The month of June has the highest average of 3.21 inches. An average of 4.5 inches falls as snow from November to March. The month of February is driest with an average of 0.76 inches. The mean annual temperature at Dauphin is 36°F.

GEOLOGY

Bedrock

The bedrock geology and elevation contours of the bedrock surface are shown in Figures 2 and 3. The subcropping bedrock consists of shales of Jurassic age, and the Swan River, Ashville, Favel, Vermilion River formations and the Millwood member of the Riding Mountain formation of Cretaceous age. There are no known bedrock outcrops in the area. The outstanding features of the bedrock surface are an apparent bedrock channel coming off the highland and a trough parallel to the escarpment. The trough appears to be an ice gouge feature. These features and stratigraphic relationships are shown in Figures 4 and 5.

Jurassic Formation: The Jurassic formations underlie the Swan River formation and subcrop beneath till as shown in Figure 2. They consist of vari-coloured silty, sandy and clayey shales and white limestone. The Jurassic formations were the oldest beds drilled in this study. The vari-coloured shales are probably part of the Melita formation and the white limestone part of the Reston formation. At some of the test sites there is difficulty in distinguishing between silty and sandy shales of the Swan River formation and similar shales of the Jurassic age. The contact between the Swan River formation and the Jurassic formations is an erosional unconformity which appears well illustrated in the sections. The top of the Jurassic, or the erosion surface is very regular between apparent channels. Elevations of this surface, obtained at eight of the test sites, are between 908 and 938 feet above sea level. The white limestone was penetrated at five test sites.

Swan River Formation: The Swan River formation overlies the Jurassic formations and subcrops beneath till as shown in Figure 2. At two of the

test sites the whole formation has been eroded and till overlies Jurassic shales. Where complete sections of the formation were drilled, thicknesses ranged from 38 to 183 feet. The formation varies considerably in composition. In the vicinity of Ethelbert and east and northeast of the town the formation is composed dominantly of white clay, silt and sand with grey shale, coal, carbonaceous shale and pyrite in varying amounts. Throughout the rest of the area the formation is dominantly a non-calcareous, light grey silt to silty shale with varying amounts of white, green and brown silts, layers of sand and sandstone, pyrite, coal, carbonaceous shale, firm grey shale, thin limestone bands and traces of bentonite. Generally the sands and silts, which are dominantly quartz, are not cemented but some cemented layers were noted and in SW 26-31-21W most of the sands in the formation were partially cemented.

Ashville Formation: The Ashville formation overlies the Swan River formation and subcrops beneath till as shown in Figure 2. Only two test holes penetrated the whole formation and thicknesses logged were 192 and 194 feet. The formation can be divided into two units which show considerable differences at some locations and little at others. The upper unit which is similar throughout the area is composed of firm, non-calcareous, greasy, dark grey to almost black shale which occasionally contains thin layers of calcareous shale and bentonite. The lower unit of shale which is lighter grey than the upper, is usually silty with thin silt or sand layers and occasionally has thin layers of calcareous shale, argillaceous limestone and layers or concretions of pyrite. Some green shale (glauconitic) was noted. In the vicinity of the Village of Ethelbert the lower unit is quite sandy. The contact between the lower Ashville formation and the underlying Swan River formation is essentially transitional.

Favel Formation: The Favel formation overlies the Ashville formation and subcrops beneath till as shown in Figure 2. The thickness of the Favel formation in the area is between 70 and 80 feet. The formation is composed of hard, dark grey, calcareous white speckled shale with grey argillaceous limestone beds and occasionally thin bands of bentonite. The shale and limestone is commonly fractured and blocky.

Vermilion River Formation: The Vermilion River formation overlies the Favel formation and subcrops beneath till as shown in Figure 2. The formation is composed of various types of grey shale. The formation includes three members; the Morden, Boyne and Pembina. The lower member, the Morden, consists of dark grey, non calcareous shale; the Boyne member is composed mainly of medium grey, calcareous speckled shale with some non-calcareous, dark grey shale; and the Pembina member is a dark grey bentonitic shale with bentonite beds. A complete thickness of 133 feet for the formation was reported in an oil exploration well. The thicknesses of the members was reported as: Morden 26 feet, Boyne 87 feet and Pembina 20 feet.

Riding Mountain Formation (Millwood Member): The Millwood member of the Riding Mountain formation is the youngest bedrock in the area. This member overlies the Vermilion River formation and subcrops beneath till as shown in Figure 2. The Millwood member is composed of soft, greenish-grey, bentonitic shales. A thickness of 89 feet is reported in an oil exploration test hole drilled in the subcrop area. None of the test holes drilled for this study penetrated this formation.

Surficial Deposits

The surface deposits in the investigated area are shown in Figure 6. The deposits within the Duck Mountain Forest Reserve are not shown but this area is essentially all till. The stratigraphic relationships of the surface deposits are shown in Figures 4 and 5.

The surficial deposits in the area vary in thickness from less than 10 feet to approximately 600 feet. The maximum thickness of surficial deposits drilled at the test sites was 207 feet. A thickness of approximately 585 feet is reported from an oil exploration test hole. Figure 7 shows the contours of thickness of the surficial deposits. The bedrock channel does not appear to contain significant sand and/or gravel deposits.

Till and related sands and gravels overlie bedrock throughout the area and outcrops over much of the area. The till, which makes up the bulk of the surficial deposits, is overlain by deltaic, beach, lacustrine, alluvial and swamp deposits.

Till and Associated Sands and Gravels: The thickness of till and associated sands and gravels varies from 8 to 205 feet at the ground-water test sites. The composition and texture of the till varies greatly. Generally, the till consists of an unsorted mixture of clay, silt, sand, gravel and boulders. The till is composed mainly of sedimentary rocks underlying the area or found within short distances and generally contains sand and gravel beds. The till varies in texture from a stony clay to a "dirty gravel" and usually has concentrations of boulders. The stoniness of the till is evident at the surface over large portions of the till outcrop area. Thick blocks of shale or shale boulders within the till were encountered at several test sites. Where till outcrops it is oxidized to a brown colour which grades into unoxidized grey at a depth usually less than 20 feet. Brown till was encountered below grey till at several locations and may represent tills of different ages. At several test sites where till thicknesses are relatively great, sections of the till were composed almost entirely of shales or silts of the underlying bedrock. These sections could be easily mistaken for bedrock if they are not completely penetrated to the "regular" till or sand and gravel found below.

Sand and gravel with some silt and clay is found within or at the base of the till throughout most of the area. These deposits vary from several inches to 65 feet in thickness. Where till is thin these beds are often absent. Thick sections of sand and gravel were found at three test sites: 50 feet at SW 13-29-22W, 37 feet at SE 23-29-22W and 65 feet at NW 3-29-21W. The sand and gravel is continuous between the first two sites and appears to extend over several square miles.

Deltaic Deposits: Deltas, formed near the base of the Duck Mountains, overlie till. On the surface deposits map, the surface sand and gravel of the deltas are not differentiated but these deposits occur near elevation 1300 feet, in the mapped portion of the area. Beach ridges have been formed from the surface sand and gravel of the deltas. At three test sites deltaic sections of sand and/or gravel, over silt, over clay were intersected. The maximum thickness of deltaic deposits is at least 50 feet. The deltas were formed where streams coming off the highlands of the Duck Mountains discharged into glacial Lake Agassiz in an early stage of its development.

Beach Deposits: Numerous beach deposits in the form of north to northwest trending ridges are found at surface throughout the area. These beaches consist of sand and gravel and are generally less than 20 feet thick. P.T.H. #10 and the railway north from Ethelbert are built on the most prominent beaches. Many farmsteads and gravel pits are also located on the major beaches. East of, and between major beach ridges are beach deposits which consist mainly of sand and are generally very thin. Some major beach development in the west part of the area is on the deltas.

Lacustrine Deposits: Thin deposits of lacustrine clay and silt are found in Tp. 29, Rge. 21W and Tp. 28, Rge. 22W.

Recent Deposits: Alluvium is found along or associated with present stream channels. These deposits are generally less than 12 feet thick and are composed of silt, sand, gravel and clay.

Swamp deposits, although very thin, form a large part of the surface deposits throughout the area. The swampy areas appear to be a result of poor drainage caused by the beach ridges in the lower portions of the area and by ground-water discharge near the base of the Duck Mountains.

GROUND WATER

Aquifers

A rock formation or stratum that will yield water in sufficient quantity to be of consequence as a source of supply is called an "aquifer" or simply a "water bearing formation", "water bearing stratum", or "water bearer" (Meinzer, 1923). The term "rock" here applies to consolidated as well as unconsolidated materials.

The aquifer classification given below is based on geologic units discussed previously. The lacustrine deposits are too thin to be considered as an aquifer. The Riding Mountain and Vermilion River shales do not contain hard fractured layers in this area and therefore are not favourable for ground-water development.

The aquifers present in the Ethelbert area are:

(a) Alluvium

(b) Beach Deposits

(c) Deltaic Deposits

(d) Till and Associated Sands and Gravels

(e) Favel Formation

(f) Ashville Formation

(g) Swan River Formation

(h) Jurassic Formations

Alluvium: Alluvium is developed as an aquifer mainly when other sources are not available or difficult to locate. The wells in this aquifer type are unreliable having a failure rate of 30% in 1961. The quantity of water available is partially dependent on recharge from stream flows, thus in extended dry periods wells dry up. Well water supplies are usually supplemented from other sources.

Water quality is good. Of the field samples analysed electrical conductivity, measured as equivalent NaCl, was less than 1000 ppm. (parts per million); hardness was less than 720 ppm. and iron varied from 0.1 to 12.0 ppm. Dissolved iron is the only quality that makes water from this aquifer type unsuitable for domestic use.

Beach Deposits: The major beach ridges are aquifers in the Ethelbert area. Wells in this aquifer type had a failure rate of 25% in an extended dry period.

Water quality is generally good. Of the samples collected and analysed in the field only one showed electrical conductivity (equivalent NaCl) greater than 1000 ppm.; only one showed sodium chloride greater than 250 ppm., dissolved iron greater than 1.0 ppm. or hardness greater than 1000 ppm. The water quality appears to vary greatly within short distances within this aquifer type.

Deltaic Deposits: The major ground-water development in these deposits appears to occur in and north of township 29, range 22W.

The wells in this aquifer type ranged in depth from 8 to 27 feet. This type of aquifer supplies sufficient quantities on the farms using it north of section 19-30-22W. Almost all of the wells in this aquifer south of section 19-30-22W go dry in winter and dry periods. The sand and gravel in the deltas is dry in places.

Water quality in this aquifer type is very good. Electrical conductivity (equivalent NaCl) and hardness for field samples from this aquifer ranged from 200 to 1000 ppm. but are generally less than 700 ppm. Sodium chloride ranged from 0 to 155 ppm. but is generally less than 100. Dissolved iron in all samples from farm wells was less than 1.0 ppm.

Till and Associated Sands and Gravels: Approximately two-thirds of the farms in the area obtain a water supply from wells completed in sand and gravel beds in or at the base of the till. Forty-one percent of these wells do not provide a sufficient amount of water through the critical periods. Of the wells that have failed, approximately 45% are located where deeper wells in the till or better well construction would probably result in sufficient ground-water supplies for farm needs.

Dry gravel beds were encountered deep in the till at the test sites in SE 24-30-23W and NE 21-31-22W. Flowing artesian conditions are found in the thick sand and gravel aquifer in SW 13 and SE 23 of 29-22W.

Water quality in this aquifer type varies considerably and can be classified as good to fair. Of 23 laboratory analysis of samples from this aquifer type, total dissolved solids varied from 418 to 1770 ppm.; total hardness varied from 86 to 1045 ppm.; chloride ion concentration varied from 2 to 365 ppm. but generally was less than 50 ppm.; and dissolved iron varied from 0 to 4 ppm. but was generally less than 1.0 ppm.

Favel Formation: There are no farm wells completed in this aquifer in the area. The formation was tested at three of the sites and pumped easily from the fractured zones. The ground water from this formation contains less than 2000 ppm. dissolved solids where tested but is highly charged with hydrogen sulphide and for this reason is unsuitable for stock or domestic use.

Ashville Formation: Two farms reported drilled wells completed in the Ashville formation. These wells were not screened and produced only a small quantity of water. Water samples from these wells and from field tests in this formation contained total dissolved solids greater than 10,000 ppm.

The formation is probably capable of producing a sufficient quantity of water for farm supplies but the quality is unsatisfactory.

Swan River Formation: A summary of the data obtained for the Swan River formation at each of the test sites of the availability study, representative sites of an investigation for the Town of Ethelbert and farm wells completed in this formation is given in Table 1.

Examination of the data in Table 1 indicates that in the area west of the 1250 foot contour of elevation, wells to the Swan River formation would be greater than 300 feet in depth and the well potential is very poor due to the absence of coarse material in the formation. In the area roughly east of the 1250 foot contour the well potential in the Swan River formation is rated as good to excellent at all of the test sites and farms where the formation was tested or developed.

Water quality varies greatly within this formation, but is generally within quality requirement limits for livestock use. Further considerations on the suitability of the ground water will be given in a later section.

An aquifer test was carried out in the Swan River formation at NE 31-29-21W as part of the municipal water supply investigation. The coefficients of transmissibility and storage as determined for the aquifer at this site are 5000 Imperial gallons per day per foot and 1×10^{-4} respectively. A potential sustained yield for a well at this site of 100 I.G.P.M. was determined.

Flowing artesian conditions from the Swan River formation were not encountered within the study area. However these conditions probably exist in, and east of, the northeast corner of the area since the piezometric

surface at the test site in SW 26-31-21W was 6 feet from ground level and the land slopes to the east at approximately 20 feet per mile which is greater than the slope of the piezometric surface.

It must be emphasized that when drilling water wells to develop the Swan River formation, great care must be taken to distinguish between the lower portion of the Ashville and Swan River formations because of the differences in the quality of water found within these formations. Also, very careful formation logging with properly designed and installed wells will be required for any development of water from the Swan River formation. The few farm wells that have been completed in this formation have been unsatisfactory.

Jurassic Formations: Two formation tests were done in the Jurassic formations. At the test site in SW 2-30-21W the white limestone was pumped at 5 I.G.P.M. producing good quality water of 1530 ppm. dissolved solids. At the test site in NW 36-29-22W a layer of fine sand within the varicoloured shales was pumped at 1/2 I.G.P.M. producing water at 4500 ppm. dissolved solids.

Although little information was obtained to determine the availability of ground water in the Jurassic formations, the white limestone of the Reston formation is certainly a potential aquifer at least in the eastern part of the area. The Melita formation, where it is definitely different from the Swan River formation, has little potential as an aquifer.

Quality

In the inventory, water samples were collected from all water sources for field analysis of hardness, sodium chloride and iron. The electrical conductivity expressed as equivalent grains per gallon NaCl was also

Table I: Summary of Data for Swan River Formation

Location	Depth to Swan River Formation	Thickness of Swan River Formation	Overlying Formations	General Description of Swan River Formation	Tests in Swan River Formation: Depth Tested	Pumping Rate I.G.P.M.	T.D.S. (ppm.)	Approx. Static Water Level (in feet below ground)	Well Potential in Swan River Formation
NW 1-28-21W	107'	38'	66' of till 41' of Ashville shale	Grey, sandy shale & sand	130'	15	3238	40	Good; (very poor quality)
SE 13-29-21W	?	?	?	Fine, white sand & clay	90'	?	2000	18	Good
SW 19-29-21W	?	?	15' of till ?' of Ashville Shale	—	190'	?	3200	36	Good; (very poor quality)
SE 1-30-21W	44'	66'	4' of sand 40' of till	White clay, silt & sand	50' 100'	15 15	770 806	12 15	Good
SW 2-30-21W	88'	50'	88' of till	White clay, silt & sand	130'	15	1400	--	Good
SE 5-30-21W	118'	66+'	118' of till	White, grey shale, sand & silt	150'	15	674	21	Good
SE 6-30-21W	106'	160+'	13' of till 86' of Ashville shale	White clay, sand & silt	115'	25	622	33	Excellent
SE 17-30-21W	?	?	—	Clay & sand	90'	4	790	30	Good
SE 18-31-21W	No Swan River Formation								
NW 21-31-21W	No Swan River Formation								
SW 26-31-21W	40'	144+'	9' sand and clay 31' of till	Grey shale with coal; white shale & sandstone	70' 160'	30 42	532 602	— 6	Excellent
SW 24-28 22W	182'	122'	5' of sand & gravel 12' of till 165' of Ashville shale	Grey & brown silty shales with sandstone	240' 290'	8 12	2002 2242	167 167	Good
SE 33-28-22W	328'	60'	4' of sand 57' of till 77' of Favel shale 194' of Ashville shale	Grey silt	365'	0.5	2260	175?	Very poor
SE 23-29-22W	160'	117'	18' of till 142' of Ashville shale	Grey & white sandy shale & sandstone	165' 230' 270'	2 5 0.1	9624 5314 8600	38 140 140	Good; (quality Limitations)
NE 26-29-22W	140'	60+'	15' of till 125' of Ashville shale	white, silty, shale; clay & sand	160'	4	1268	17	Good
NW 36-29-22W	136'	86'	22' of till 114' of Ashville shale	Grey & white shale, sand & silt.	185'	15	1394	90	Excellent
SE 4-30-22W	225'	89'	205' of till 20' of Ashville shale	Grey & white silty shale	—	—	—	—	Poor
SW 22-30-22W	180'	183'	11' of till 169' of Ashville shale	Grey & all colours, silty shale & sand	200' 360'	5 20	5706 5530	130 140	Good; (but deep & quality limitations)
SE 2-31-22W	152'	89'	7' of sand & gravel 34' of till 111' of Ashville shale	Grey, silty shale with sand	165'	12	1074	—	Good
NE 21-31-22W	226'	95+'	48' of till 178' of Ashville shale	Grey, silty shale with sand	235' 300'	5 8	1128 1268	119 120	Good
SE 24-30-23W	337'	89+'	16' of sand & gravel 42' of till 87' of Favel shale 192' of Ashville shale	Grey, green, brown & white silt.	—	—	—	—	None

Note: In overlying formations the thickness of till includes sands and gravels
I.G.P.M. - Imperial Gallons Per Minute
T.D.S. - Total Dissolved Solids
p.p.m. - parts per million

TABLE 2: CHEMICAL ANALYSES OF GROUND WATER, ETHELBERT AREA

LOCATION	AQUIFER	DEPTH TESTED OR WELL	PUMPING RATE IGPM.	pH	ELECTRICAL CONDUCTANCE (MICROMHOS/cm @ 25°C.	CATIONS: CALCIUM mg/l.	CATIONS: MAGNESIUM mg/l.	CATIONS: SODIUM (and POTASSIUM) mgs/.	CATIONS: IRON * mg/l.	ANIONS: BICARBONATE mg/l.	ANIONS: SULPHATE mg/l.	ANIONS: CHLORIDE mg/l.	ANIONS: NITRATE mg/l.	ANIONS: FLUORIDE mg/l.	ALKALINITY ($CaCO_3$) mg/l.	TOTAL HARDNESS mg/l. $CaCO_3$	TOTAL DISSOLVED SOLIDS mg/l.	REMARKS
NW 1-28-21W	S.R. Fm.	126-137	15	8.2	4,000	23	8	1150	0.1	551	1730	235	Neg.	< 1.50	452	90	3,238	S.W. corner of quarter
NE 35-28-21W	S. & Gr. (T)	38- 48	3	8.1	1,850	85	85	325	0.8	307	950	15	Neg.	< .74	252	560	1,602	
NW 3-29-21W	S. & Gr. (T)	39- 50	20	7.7	680	109	33	13	0.2	293	177	6	Neg.	0.38	240	400	536	
SW 15-29-21W	S. & Gr. (T)	26- 36	20	7.8	920	72	87	90	0	459	336	7	Trace	0.38	376	540	766	N.W. corner of quarter
SE 31-29-21W	S. & Gr. (B)	0- 25	-	8.3	730	57	45	33	-	193	62	57	89	-	170	326	542	Farm Well
NE 31-29-21W	S. R. Fm.	102-112	7	8.2	900	36	28	180	2.8	572	120	10	< .44	0.76	468	204	678	S.E. corner of quarter
NE 31-29-21W	S.R. Fm.	100-140	23	7.9	-	55	44	54	1.7	465	77	6	N.D.	0.72	381	318	514	Beginning of Pump Test
NE 31-29-21W	S.R. Fm.	100-140	23	8.1	-	37	43	55	1.0	384	82	6	Trace	0.73	314	270	368	End of Pump Test
SW 32-29-21W	S.R. Fm.	110-121	5	8.5	1,600	6	4	420	-	576	<10	350	N.D.	0.72	472	34	1,500	
NE 32-29-21W	S. & Gr. (T)	20	-	7.5	2,150	112	72	350	-	542	807	39	N.D.	-	444	576	1,772	Farm Well
SE 1-30-21W	S (T)	20- 30	5	7.6	1,100	123	122	20	0	791	192	2	< 4	0.31	648	810	824	
SE 1-30-21W	S.R. Fm.	44- 53	15	7.7	1,100	86	153	56	0	673	384	5	< 4	0.50	552	860	770	Test Hole
SE 1-30-21W	S.R. Fm.	95-106	15	7.7	1,100	70	118	133	0	595	407	15	< 4	0.55	488	660	806	
SW 2-30-21W	S. & Gr. (T)	80- 88	12	8.0	1,150	46	35	208	0	449	303	17	<45	0.91	368	260	984	
SW 2-30-21W	S. R. Fm.	126-137	15	8.0	1,800	46	43	410	0	547	660	60	<45	< 1.34	448	290	1,420	Test Hole
SW 2-30-21W	Ls. (Jur.)	200	5	8.4	1,950	22	23	478	0.1	634	480	119	< 45	< 1.20	520	150	1,530	
SE 5-30-21W	S.R. Fm.	147-157	15	8.0	900	32	18	185	2.3	483	179	9	< 44	1.05	396	154	674	
SE 6-30-21W	S.R. Fm.	112-120	25	7.7	725	70	48	45	0.2	459	82	5	N.D.	0.80	376	372	622	S.W. corner of Quarter
NE 6-30-21W	S.R. Fm.	147-157	10	8.0	820	50	39	110	1.88	493	106	8	N.D.	1.00	404	286	600	
NE 6-30-21W	S.R. Fm.	107-118	30	8.6	450	29	39	23	1.1	242	52	3	< 40	0.12	218	232	254	N.E. Corner of Quarter
SE 17-30-21W	S.R. Fm.	96	-	8.0	1,100	20	10	290	0.1	775	67	2	-	-	635	90	790	Farm Well
NW 21-31-21W	S. & Gr. (T)	125-135	2	7.7	1,950	30	13	490	0	429	372	365	< 45	1.07	352	128	1,386	
SW 26-31-21W	S. & Gr. (T)	20- 30	5	7.5	1,100	117	115	70	0	595	394	8	< 4	0.59	488	588	862	
SW 26-31-21W	S. R. Fm.	65- 75	30	7.7	750	47	26	120	0	461	91	6	< 4	1.06	396	226	532	Test Hole
SW 26-31-21W	S.R. Fm.	158-169	42	7.8	800	26	13	200	0.1	464	144	12	< 4	1.06	380	118	602	
NW 26-31-21W	S. & Gr. (T)	27	-	7.3	1,850	232	113	66	0.2	572	370	148	155	-	468	1045	1,418	Farm Well
NW 9-28-22W	S. & Gr. (T)	40- 50	7	7.6	1,500	154	123	115	0	410	760	10	<40	< .58	336	890	1,518	N.E. corner of quarter
NW 9-28-22W	S. & Gr. (T)	86- 96	4	7.7	1,350	128	104	95	0	415	572	17	Neg.	< .54	340	750	1,242	Test Hole
NW 9-28-22W	S. & Gr. (T)	120-130	42	7.6	1,450	99	69	215	0	478	502	60	<40	< .77	392	530	1,168	
SW 24-28-22W	S.R. Fm.	233-244	8	7.9	2,900	26	13	700	0	473	562	470	<40	<1.38	388	118	2,002	Beside Mink River
SW 24-28-22W	S.R. Fm.	284-295	12	7.8	2,100	28	13	875	0	488	787	570	Neg.	<1.4	400	122	2,242	Test Hole
SE 33-28-22W	S (T)	48- 59	15	7.9	600	58	40	44	0	329	120	9	<40	0.34	270	312	426	Test Hole
SE 33-28-22W	S.R. Fm.	358-369	< 1	8.8	2,750	4	1	975	0.7	805	624	580	Neg.	<2.00	700	14	2,260	
SW 13-29-22W	S. & Gr. (T)	52- 63	42	7.7	749	77	44	52	0	432	101	17	< 5	-	354	372	556	
SW 16-29-22W	S. & Gr. (T)	20- 30	1	7.7	710	39	26	170	0	254	336	8	< 44	0.47	208	206	548	Test Hole
SW 16-29-22W	Fav. Fm.	75- 85	42	8.3	2,000	4	1	550	0.1	854	346	108	Neg.	<1.50	700	16	1,458	Charged with H_2S
SE 23-29-22W	S. & Gr. (T)	42- 53	42	7.7	600	83	42	15	0.1	398	72	4	< 5	-	325	380	418	S.W. corner of quarter
SE 23-29-22W	Ash. Fm.	100-130	1/8	7.7	15,000	49	35	3700	0	1061	288	5000	Neg.	0.42	870	292	9,566	
SE 23-29-22W	S.R. Fm.	160-175	2	7.7	15,500	86	37	3680	0.4	1110	149	5100	Neg.	0.46	910	368	9,624	Test Hole
SE 23-29-22W	S.R. Fm.	215-245	5	8.0	8,500	40	20	1900	0	744	677	2100	< 44	< 1.70	610	184	5,314	
SE 23-29-22W	S.R. Fm.	265-279	1/8	8.1	13,500	34	38	3300	0	769	1048	4050	< 44	< 1.40	630	240	8,604	
SW 24-29-22W	Ash. Fm.	136	-	7.4	16,000	118	113	4000	0	756	1488	5150	< 44	< 0.54	620	760	10,356	Farm Well
NE 26-29-22W	S.R. Fm.	160-200	-	7.9	1,700	36	32	370	0.2	666	453	71	< 44	-	546	222	1,268	Farm Well
NW 36-29-22W	S.R. Fm.	179-190	15	8.0	1,700	30	18	400	0	512	384	132	< 45	< 1.10	420	150	1,394	Test Hole
NW 36-29-22W	S. & Sh. (Jur)	275-286	1/3	8.5	5,000	22	16	1300	0.4	594	430	1395	N.D.	< 1.43	530	120	4,500	
SE 4-30-22W	Gr. (T)	115-126	8	7.9	900	107	45	67	0.3	337	259	19	<45	0.34	296	452	806	Test Hole
SE 4-30-22W	S. & Gr. (T)	196-207	4	7.8	1,850	23	7	353	0.4	498	384	27	<45	< 0.98	408	86	1,600	
SE 6-30-22W	Fav. Fm.	85-100	4	8.9	1,650	3	3	500	2.4	891	110	104	neg.	-	850	18	1,248	Charged with H_2S
SW 22-30-22W	S.R. Fm.	196-201	5	8.3	5,250	42	0	2400	0	1147	1720	1850	< 5	-	960	104	5,706	Test Hole
SW 22-30-22W	S.R. Fm.	352-363	20	8.3	5,250	46	9	2300	0	854	2064	1600	< 5	-	720	300	5,530	
SE 2-31-22W	S.R. Fm.	160-170	12	8.2	1,800	30	22	325	0	732	173	61	< 4	-	600	168	1,074	Test Hole
SE 2-31-22W	S.R. Fm.	200-211	8	8.2	1,400	22	6	300	0	647	199	40	< 4	-	530	78	888	
NE 11-31-22W	S. & Gr. (T)	25	-	7.2	1,250	141	57	120	0.3	698	210	16	N.D.	-	572	588	1,010	Farm Well
SW 12-31-22W	Ash. Fm.	80	-	8.0	14,000	378	190	3500	0	840	6720	985	97	-	688	1730	11,608	Farm Well
SE 18-31-22W	S. & Gr. (T)	65- 75	<1	7.7	992	149	59	100	0.1	429	413	30	< 4	0.54	352	610	934	Test Hole
SE 18-31-22W	Gr. (T)	130-140	10	7.7	1,050	58	18	190	0	351	326	9	< 45	0.50	288	210	802	
SE 18-31-22W	S. & Gr. (T)	180-190	8	7.9	900	39	11	180	0	434	151	5	< 45	0.59	356	142	716	
SW 21-31-22W	S. & Gr. (T)	18	-	7.7	1,550	275	86	62	0.2	349	816	14	< 44	-	286	1040	1,616	Farm Well
NE 21-31-22W	S.R. Fm.	232-242	5	8.2	1,500	12	1	440	0.3	517	345	136	< 5	-	468	33	1,128	Test Hole
NE 21-31-22W	S.R. Fm.	295-305	8	8.4	1,600	6	0	470	0.3	576	370	120	< 5	-	496	14	1,268	
SE 24-30-23W	Fav. Fm.	116-126	20	8.7	1,950	4	3	500	0.4	830	383	38	Neg.	-	680	22	1,922	Charged with H_2S

S - Sand
Gr - Gravel
(T) - Associated with Till
(B) - Beach Deposit
S.R. Fm. - Swan River Formation
Fav. Fm. - Favel Formation
Ash. Fm. - Ashville Formation
(Jur.) - Jurassic
sh - shale
l.s. - Limestone

* Iron analyses do not include iron precipitated between time of sampling and time of analysis.

All samples from test holes except as noted. Test Holes near section corners except where noted.

All samples collected and analysed between June 1969 and November 1969 by Water Control and Conservation Branch.

determined for these samples. Water samples were collected for complete analysis from most of the formations pumped in the testing and from several of the inventory stations. Fifty-three samples were analysed for this study and analyses were done on eight samples for the town investigation. These analyses are presented in Table 2.

The water quality characteristics for each of the aquifers has been generally covered in the preceding section.

At several of the test sites where water analyses are available for aquifers at different depths, a natural softening of the water occurs with depth through ion exchange. This process appears to occur throughout most of the area and is especially evident in aquifers in the till at test sites in SE 18-31-22W and NW 9-28-22W. At the test site in SW 26-31-21W, the process is evident in aquifers in the till and Swan River formation resulting in water rated as more suitable for human and stock use, with depth.

The temperature of the ground water in the area is approximately 41°F.

Suitability of Water: The suitability of the ground water for use by humans and livestock can be determined from the following guide which is a modified form of the Manitoba Department of Health and Social Services, Environmental Sanitation circular ES 174. This guide gives practical limits for water quality in Western Canada.

WATER AND FARM ANIMALS

Highly mineralized waters generally do not have much effect on health as long as there is no objectionable continuing laxative effect and as long as normal amounts of water are consumed. The limiting figures given below are for a mineral content that makes the water either too bad in taste to drink or, if used for drinking, can be expected to have a very serious detrimental effect on health. It appears to make little difference whether the total quantity of dissolved salts or dissolved solids is made up of a single salt or a number of salts. The limits of tolerance for animals may depend

upon the kinds of salts present, the species of animal, its diet, age, health the season of the year, the climate, etc.

The University of Saskatchewan suggests the following guide:

USED BY	Dissolved Solids (milligrams per litre or parts per million)				
	GOOD	FAIR	POOR	VERY POOR	LIMIT
Humans	0-800	800-1600	1600-2500	2500-4000	5000
Horses - working	0-1000	1000-2000	2000-3000	3000-5000	6000
- others	0-1000	1000-2000	2000-4000	4000-6000	10000
Cattle	0-1000	1000-2000	2000-4000	4000-6000	10000
Sheep & Poultry	0-1000	1000-3000	3000-6000	6000-10000	15000
Chickens	0-1000	1000-2000	2000-3000	3000-5000	6000
Swine (Young pigs and market pigs appear to tolerate less than cattle)					

At present there is no established rigid standard that will indicate absolutely whether or not a certain water sample is good or bad for birds since their tolerance may change with age, season of year, feed being used and the nutritional state of the flock.

Nitrates: A high nitrate content interferes with the oxygen-absorbing power of the blood and, in infants, gives rise to a "blue baby" condition that may prove fatal. Nitrate poisoning appears to be confined to infants during their first few months of life; adults drinking the same water are not affected but breast-fed infants of mothers drinking such water may be poisoned. Cows drinking water containing nitrate may produce milk sufficiently high in nitrate to result in infant poisoning. Both man and animals can be poisoned by nitrate if the concentration is sufficiently great. There is also the risk of associated bacterial pollution. Ten milligrams per litre of nitrate (N) is a limit which should not be exceeded for humans.

Cud chewing animals at any age can be affected by nitrates in the same way as human infants. They are, however, able to tolerate much higher concentrations of nitrate, perhaps at least 100 milligrams per litre (mg/l) nitrate (N), as long as the fodder is not also unusually high in nitrates. The University of Saskatchewan reports that no bad effects have been observed in chickens and turkey poults receiving water with 100 milligrams per litre (mg/l) of nitrates. Nitrates can not be reduced or removed economically.

Sulphates:
A threshold limit of 1000 mg/l is suggested. In humans, excess sulphates in water may cause a laxative effect and is likely to do so with animals.

Sodium: Sodium is a factor to be considered where renal, cardiac, and circulatory diseases are involved. A limit of 2000 mg/l is suggested

in available literature as a threshold limit for livestock. One report indicates that 7000 mg/l was toxic to poultry.

Chlorides:
Available literature indicates that chlorides in excess of 4000 mg/l may cause injury to livestock. Fifteen hundred milligrams per litre (1500 mg/l) was reported as safe and a limit of 3000 mg/l was suggested.

Calcium: A threshold limit of 1000 mg/l was suggested.

- modified from Manitoba Department of Health and Social Services Environmental Sanitation form ES 174.

On the basis of the above dissolved solids guide, the ground water available in the Ethelbert Area is rated as given in Table 3.

Table 3

Suitability of Ground Water in the Ethelbert Area-Based on Dissolved Solids

Aquifer	Rating of Ground Water Available
Recent Alluvium	- Good quality, dissolved iron is high in many cases.
Beach Deposits	- Good quality.
Deltas	- Good quality.
Till and Associated Sands and Gravels	- Good to fair quality.
Favel Formation	- Fair to poor in dissolved solids; may be completely unsatisfactory due to hydrogen sulphide gas.
Ashville Formation	- Unsuitable in all cases.
Swan River Formation	- Ranges from good to unsuitable; generally within limits for most domestic and stock uses.
Jurassic Formations	- Similar to Swan River Formation

Where the water quality is in the range of poor to limit classification, the concentration of specific ions must be considered. Recommended limits

for these are also given in the outline above. At all sites where tested, except in SW 22-30-22W and NW 1-28-21W, the Swan River formation produced water within the suggested limits for livestock use. At the sites in SW 22-30-22W and NW 1-28-21W water pumped from the Swan River formation is within the recommended limit for dissolved solids, but contains sodium and/or sulphate above the limits suggested. In cases such as these, and where the dissolved solids are near or slightly greater than the recommended limit, a tolerance for the water may be built up or the water may be diluted to improve the quality. In all cases when drinking water for humans and livestock is changed to a source of poorer quality, the changeover should be gradual.

There are a sufficient number of water analyses completed to rate the suitability of the ground water available from the aquifers for particular industries if required.

Pollution: Large diameter dug wells and shallow aquifers are highly susceptible to pollution. Of the five shallow large diameter wells sampled for complete analyses, three contained excess nitrates. A large percentage of the wells in the area are probably polluted.

Utilization

Present use: Almost all of the wells in the Ethelbert area are shallow, large diameter and hand dug. Thus many of these are affected by low ground-water levels of late winter and dry periods. Ground-water supplies are supplemented by streams, dugouts, springs or hauled water.

Forty-one percent of the inventory stations reported that ground-water supplies were unsatisfactory because present wells were not dependable at all times or aquifers could not be found.

There were no large capacity wells in the area at the time of this study.

Expansion of Water Supplies From Wells: Forty-one percent of the locations visited in the inventory reported insufficient ground-water supplies. Many of the unreliable wells reported are a result of poor ground-water development practices. Also, at many of the locations reporting insufficient ground-water supplies, improved exploration practices would probably result in locating a suitable ground-water source. It is estimated that 60% of the locations reporting insufficient ground water could obtain sufficient supplies, mainly through deeper wells. Thus, only 16% of the total locations visited in the inventory appear to have a legitimate problem in locating and developing a ground-water supply.

As pointed out in the section on water suitability, most of the ground-water tested in this study area satisfies the quality requirements for stock use.

Many potential water wells are abandoned because of low pumping rates which are not considered to produce a sufficient quantity of water. Average water requirements for domestic and stock use (Hudek, 1965) are as follows:

Type of Facility	Gallons per Person per day
Well - water carried to home	5 to 7
Running Water - kitchen tap only	10 to 12
Complete plumbing facilities	50 to 75

Water Requirements for Livestock

Dairy Cattle (each) - 30 gallons per day

Dry Feeders (each) - 12 gallons per day

Swine (Each) - 4 gallons per day

Hens - 5 to 10 gallons per hundred per day.

Table 4 illustrates that water wells pumping at very low rates on a continuous basis or for long periods can supply enough water for most farm needs and certainly for all domestic needs. The table gives the number of dairy cattle or dry feeders supplied in addition to the maximum water requirement for four people. If complete plumbing facilities are not in use and livestock other than cattle are to be watered the quantities of water available will supply larger numbers of livestock than indicated in the table. With low pumping rates and more or less continuous pumping, a storage system is required.

Table 4

Farm Water Supplies From Low Yield Wells

Pumping Rate (Gallons Per Min.)	Quantity Per Hour (Gallons)	Quantity Per 12 Hours (Gallons)	Quantity Per 24 Hours (Gallons)	No. of Dairy Cattle Supplied in Addition to 4 people (Max. Requirements)		No. Dry Feeder Cattle Supplied in Addition to 4 People (Max. Requirements)	
				Pumping 12 Hrs.	Pumping 24 Hrs.	Pumping 12 Hrs.	Pumping 24 Hrs.
1/2	30	360	720	2	14	5	35
1	60	720	1440	14	38	35	95
1 1/2	90	1080	2160	26	62	65	155
2	120	1440	2880	38	86	95	215
3	180	2160	4320	62	134	155	335
4	240	2880	5760	86	182	215	455
5	300	3600	7200	110	230	275	575

AVAILABILITY OF GROUND WATER

The availability of ground water in the Ethelbert area is indicated in Figure 8. This map presents a breakdown of the area into zones, which are based on the aquifers present and the quality of ground water available. A summary of the aquifers present, depths, and water quality ranges is also given. The availability of ground water as given in the map is based on the assumption that proper exploration and development techniques are used. The zones of ground-water availability only reflect the general conditions present.

Where ground water suitable for stock use only is available, water required for domestic use must be hauled from other sources.

SUMMARY AND RECOMMENDATIONS

The aquifers in the Ethelbert Area are:

(a) Alluvium
(b) Beach Deposits
(c) Deltaic Deposits
(d) Till and Associated Sands and Gravels
(e) Favel Formation
(f) Ashville Formation
(g) Swan River Formation
(h) Jurassic Formations

The alluvial, beach deposits and deltaic deposits aquifers are found at surface. A large percentage of the shallow dug wells in these aquifers go dry during extended dry periods. Water quality from these aquifers is generally good.

The bedrock Favel and Ashville formation aquifers are unsuitable on the basis of water quality. The white limestone of the Jurassic formations appears to have potential for development of fresh ground water in the eastern portion of the area.

The most dependable aquifers are sands and gravels associated with till and the Swan River formation. Although the majority of wells in the area are completed in sand and gravel aquifers associated with till, this aquifer type is not highly developed. The present wells are shallow dug wells generally completed in the first sand and gravel bed encountered, thus a high percentage of these wells go dry during dry periods. In many cases, wells completed in deeper sand and gravel beds would yield sufficient quantities of water at all times. Water quality in this aquifer type ranges from good to fair and is generally suitable for all purposes.

The Swan River formation aquifer is essentially undeveloped in the area. Throughout most of the area where this aquifer is suitable for development, drilled wells ranging in depth from 50 to 300 feet will be required. Water quality in this aquifer ranges from good to unsuitable

but is generally within the limits for most stock requirements.

Forty-one percent of the locations visited reported unsatisfactory ground-water supplies. It is estimated that 60% of these locations could obtain sufficient supplies through deeper or better designed wells. Thus only 16% of the locations visited appear to have a legitimate problem in locating a suitable ground-water supply.

Pollution of shallow wells throughout the area is probably common due to the poor construction of the wells.

This study indicates that much of the problem of obtaining reliable ground-water supplies in the Ethelbert area has been due to a lack of knowledge of ground-water conditions and proper development methods. In portions of the area the development of suitable ground-water supplies will be limited by quality requirements or costs of installing the deep wells necessary. In these areas surface water sources will have to be utilized.

Recommendations for the development of ground-water supplies in the Ethelbert area are as follows:

1. Development of aquifers in the till and Swan River formation will require screened wells. Careful formation logging and properly designed and installed wells are required. In many cases gravel packed screens will be necessary.

2. In the area west of a line roughly following the 1250 contour of elevation there is little potential for ground water in the bedrock. Therefore, water well test holes in this area should only penetrate the drift.

3. When drilling water wells in the Swan River formation great care must be taken to distinguish between the lower part of the Ashville formation and the Swan River formation because of the great changes in water quality that occur between the two.

4. If wells are installed that are capable of pumping only at low rates, before abandoning these wells the daily water requirements should be determined to see if the well will meet these if pumped continuously or for long daily periods.

5. When new wells are installed in the till or Swan River formation aquifers the water should be analysed to determine the suitability for use.

6. In many cases the ground water may be suitable for stock use and not for domestic use.

7. Large diameter wells installed to develop shallow aquifers, should be properly constructed to prevent pollution from the surface.

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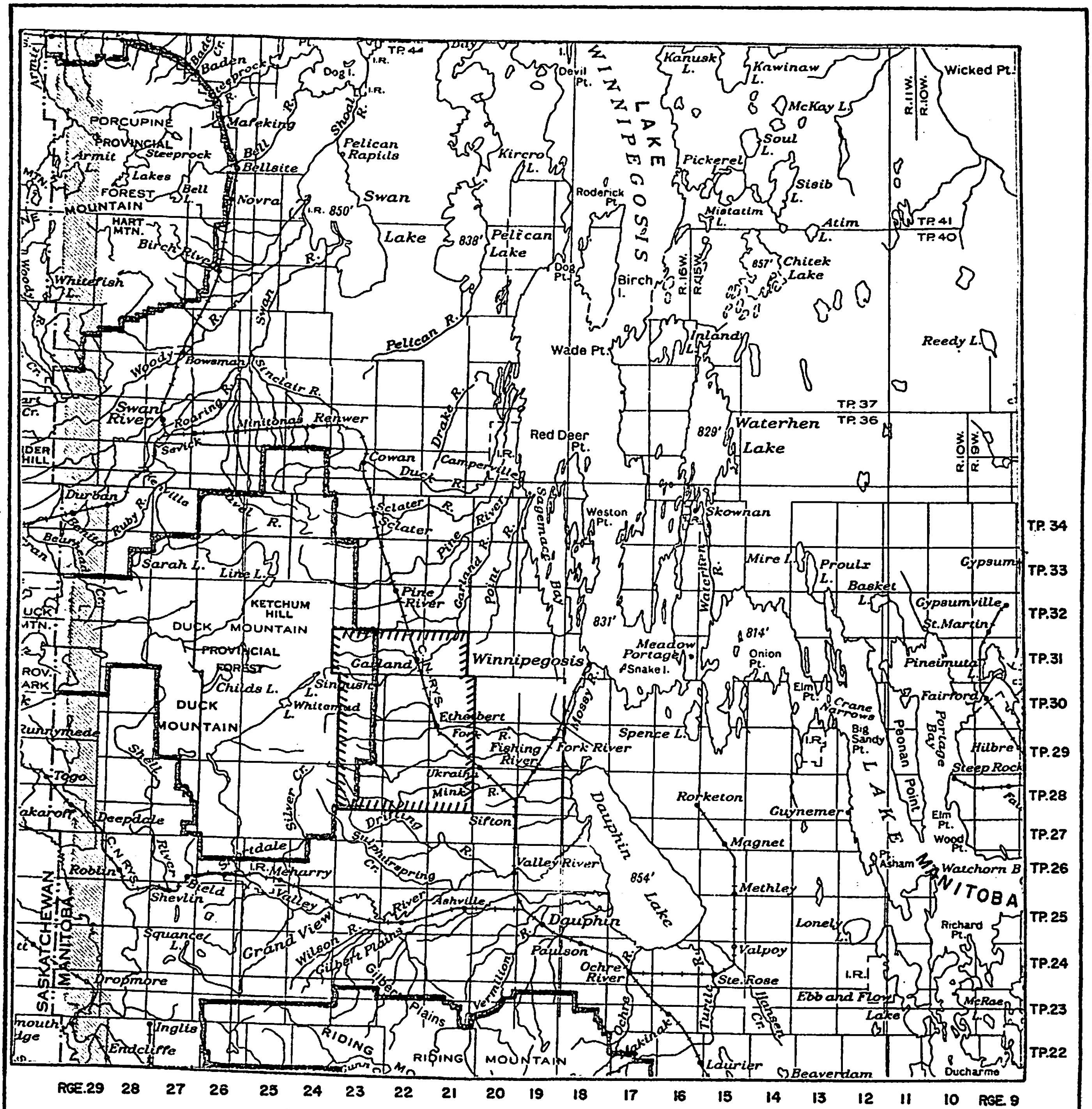


5 0 5 10 15 20

SCALE IN MILES

LEGEND

BOUNDARY OF AREA STUDIED

PROVINCE OF MANITOBA

DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT

WATER RESOURCES BRANCH

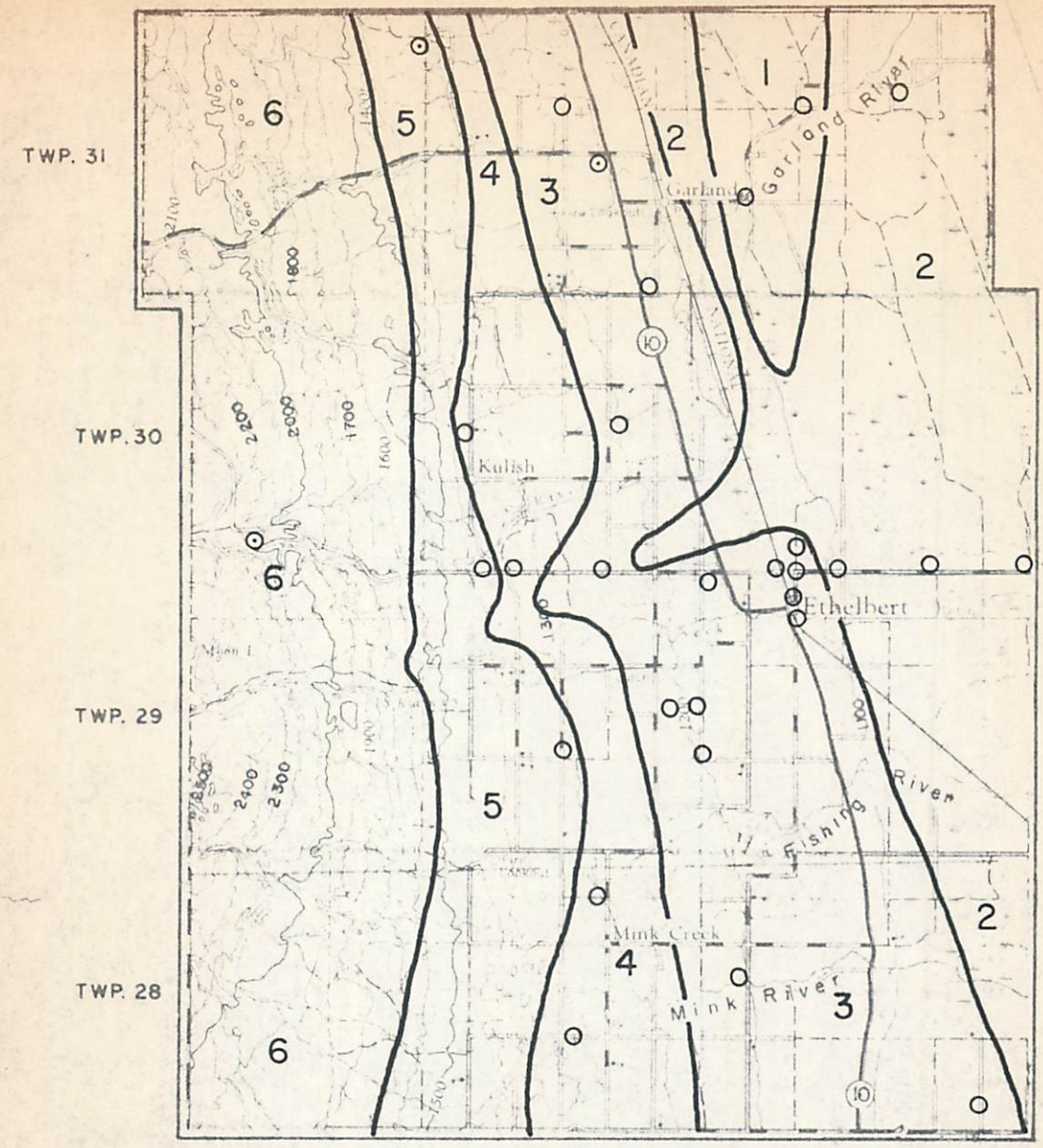
GROUND-WATER AVAILABILITY STUDY

ETHELBERT AREA

INDEX MAP

PREPARED BY: A. PEDERSEN	DATE: APRIL 15/1969
DRAWN BY: R.R.P.	FILE NO. 80 - 1 - 7 - 1011

FIGURE 1



LEGEND

- 6 Riding Mountain Formation Millwood Member
- Cretaceous
  - 5 Vermilion River Formation
  - 4 Favel Formation
  - 3 Ashville Formation
  - 2 Swan River Formation
- Jurassic
  - 1 Melita Formation

- W.R.B. Test site
- Oil exploration test site
- Formation Boundary

0 1 2 3 4 5 6 7 8
SCALE IN MILES

REFERENCE

Town
Village or Settlement
Post Office
School
Church
Stream, intermittent or Dry
Lake, Intermittent
Airport or Airfield
Road
hard surface, all weather
loose surface, all weather
wagon, cart track
Railway, normal gauge
Spot Elevation in feet
Power transmission line

PROVINCE OF MANITOBA
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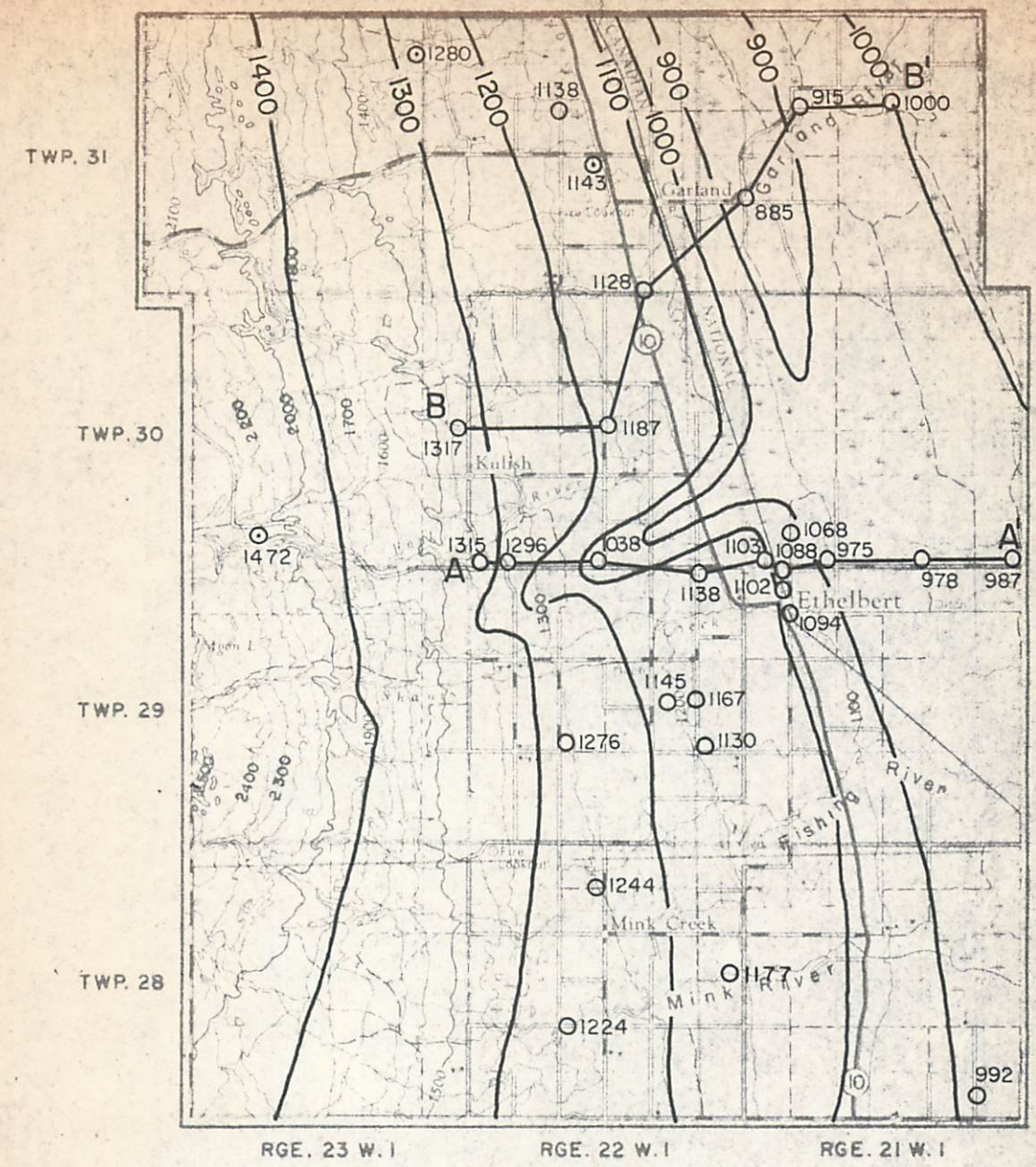
WATER RESOURCES BRANCH

GROUND-WATER AVAILABILITY STUDY
ETHELBERT AREA

BEDROCK GEOLOGY

PREPARED BY: A. PEDERSEN
DRAWN BY: R.R.P
DATE: MARCH 70
FILE NO. 80-1-7-1012

FIGURE 2



LEGEND

Contour of bedrock elevation (100 foot interval)

Stratigraphic section line

978 W.R.B. test hole and bedrock elevation

1138 Oil exploration test well and bedrock elevation

0 1 2 3 4 5 6 7 8

SCALE IN MILES

REFERENCE

Town

Village or Settlement

Post Office P

School

Church

Road
hard surface, all weather: more than 2 lanes; 2 lanes; less than 2 lanes
loose surface, all weather: 2 lanes or more; less than 2 lanes; dry weather
wagon, cart track; trail or portage

Railway, normal gauge: station; multiple track; stop; single track; (abandoned)

Spot Elevation in feet 2550.

Power transmission line

Stream, intermittent or Dry

Lake, Intermittent

Airport or Airfield

PROVINCE OF MANITOBA

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WATER RESOURCES BRANCH

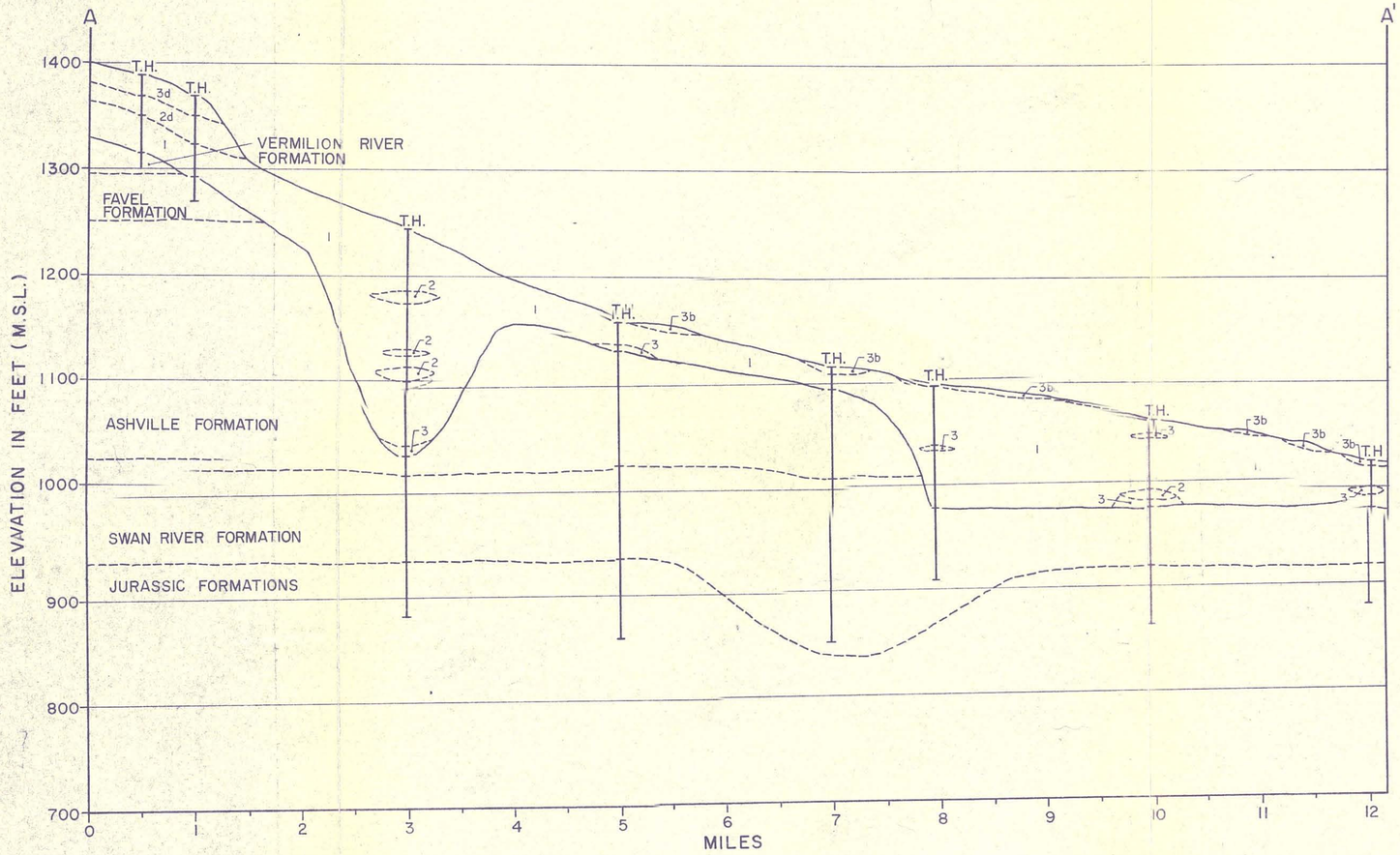
GROUND-WATER AVAILABILITY STUDY

ETHELBERT AREA

BEDROCK SURFACE TOPOGRAPHY

PREPARED BY: A. PEDERSEN	DATE: MARCH 70
DRAWN BY: R.R.P.	FILE NO. 80-1-7-1013

FIGURE 3



LEGEND

- 3 GRAVEL AND/OR SAND
- 2 SILT AND CLAY
- 1 TILL
- b - BEACH
- d - DELTAIC

VERMILION RIVER FORMATION: carbonaceous shale (Morden member), calcareous speckled shale (Boyne member), non-calcareous shale and bentonite (Pembina member).

FAVEL FORMATION: calcareous speckled shale, minor limestone and bentonite.

ASHVILLE FORMATION: grey non-calcareous shale; minor bentonite; lower part of formation contains sand in places.

SWAN RIVER FORMATION: silt, sand, shale light grey to white mainly, minor lignite.

JURASSIC FORMATIONS: Melita Formation; varicoloured shales, some argillaceous limestone: Reston Formation; argillaceous limestone.

LAND AND BEDROCK SURFACE

STRATIGRAPHIC CHANGE

T.H. TEST HOLE

PROVINCE OF MANITOBA
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WATER RESOURCES BRANCH

GROUND-WATER AVAILABILITY STUDY
ETHELBERT AREA

SECTION A-A'
(SECTION LINE SHOWN IN FIG. 3)

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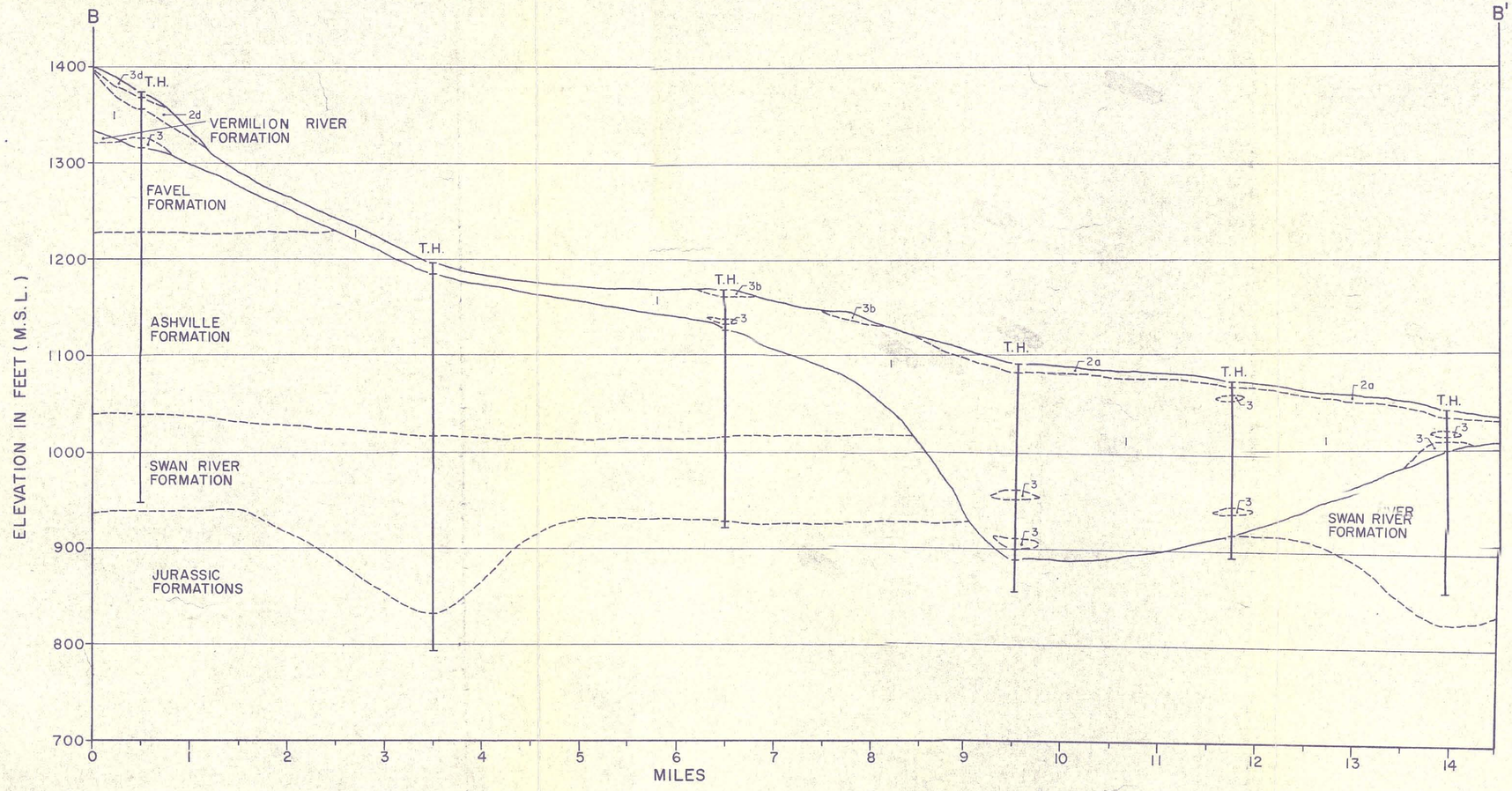
DATE: MARCH / 1970
FILE NO. 80-1-7-1014

FIGURE 4



LEGEND

- 3 GRAVEL AND/OR SAND
- 2 SILT AND CLAY
- 1 TILL
  - a - ALLUVIAL
  - b - BEACH
  - d - DELTAIC

VERMILION RIVER FORMATION: carbonaceous shale (Morden member), calcareous speckled shale (Boyne member), non-calcareous shale and bentonite (Pembina member).

FAVEL FORMATION: calcareous speckled shale, minor limestone and bentonite.

ASHVILLE FORMATION: grey non-calcareous shale; minor bentonite; lower part of formation contains sand in places.

SWAN RIVER FORMATION: silt, sand, shale light grey to white mainly, minor lignite.

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LAND AND BEDROCK SURFACE

STRATIGRAPHIC CHANGE

T.H. TEST HOLE

PROVINCE OF MANITOBA
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GROUND-WATER AVAILABILITY STUDY
ETHELBERT AREA

SECTION B-B'
(SECTION LINE SHOWN IN FIG. 3)

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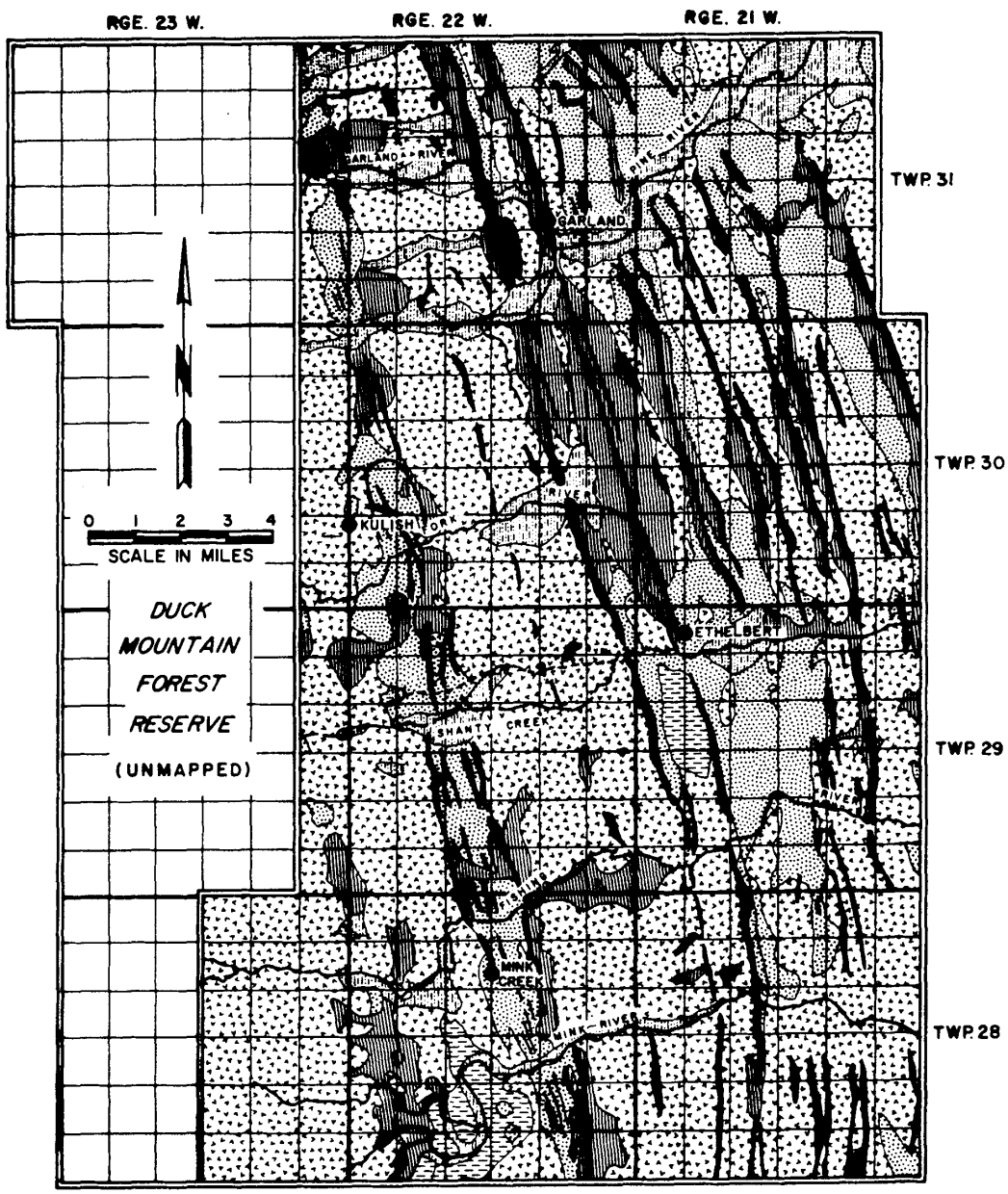
FILE NO. 80-1-7-1015

FIGURE 5



LEGEND

- Swamp deposits
- Alluvium
- Lacustrine clay
- Beach deposits as ridges (sand and gravel)
- Off beach and outwash deposits (sand and gravel)
- Till

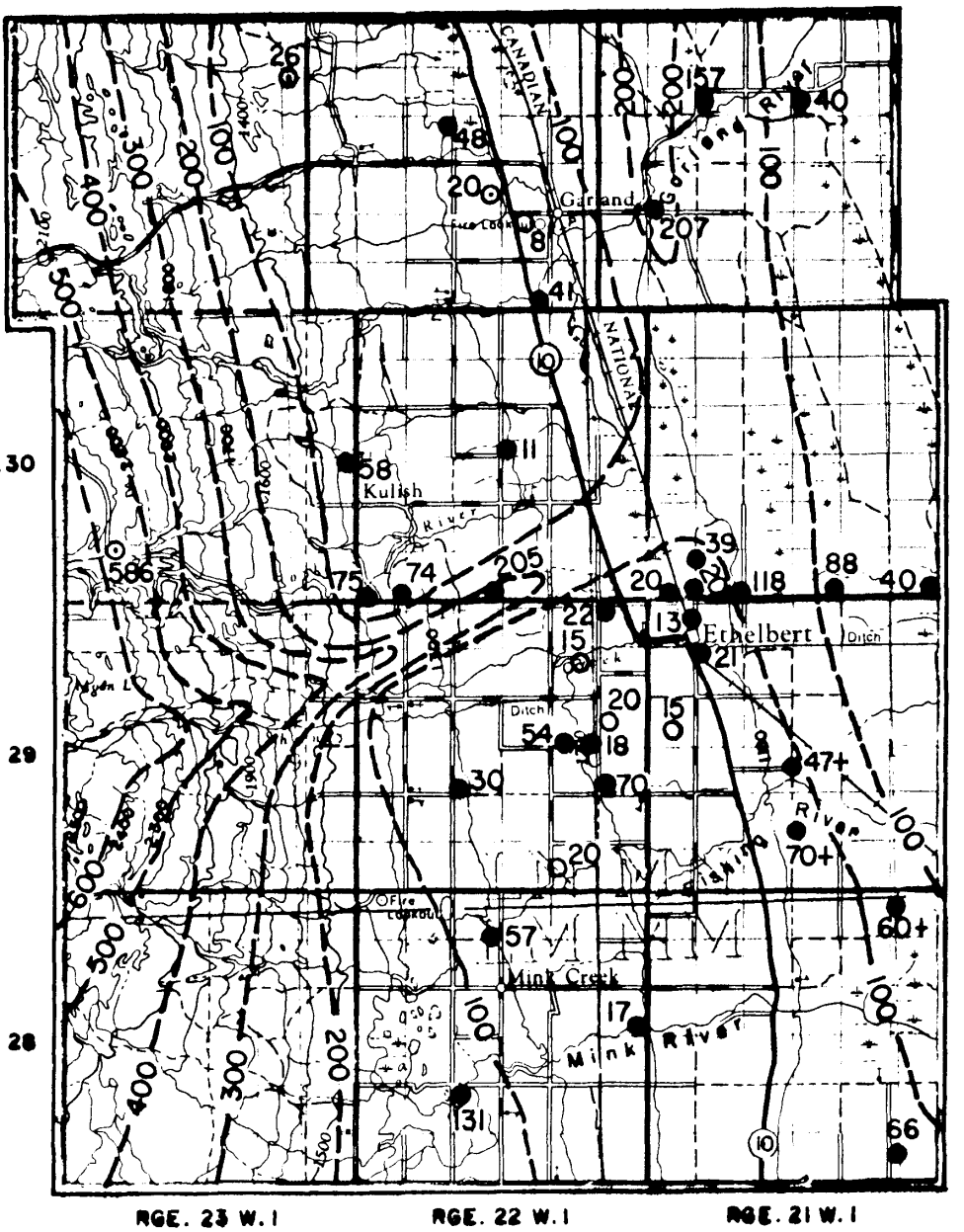
Modified Soils Map

PROVINCE OF MANITOBA
DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT
WATER RESOURCES BRANCH

GROUND-WATER AVAILABILITY STUDY
ETHELBERT AREA

SURFACE DEPOSITS

PREPARED BY: A. PEDERSEN
DRAWN BY:
DATE: MARCH 71
FILE NO. 80-1-7-1016



LEGEND

- ● 58 — W.R.B. test site and thickness
- ○ 20 — Reported drilled well and thickness
- ⊙ 26 — Oil exploration test well and thickness
- Contour of drift thickness contour interval 100'

0 1 2 3 4 5 6 7 8

SCALE IN MILES

REFERENCE

Town	□	Stream, Intermittent or Dry	
Village or Settlement	○	Lake, Intermittent	
Post Office	P	Airport or Airfield	
School	S		
Church	⛪		

Road
- hard surface, all weather — more than 2 lanes | 2 lanes | less than 2 lanes
- loose surface, all weather — 2 lanes or more | less than 2 lanes | dry weather
- wagon, cart track — trail or portage
- Railway, normal gauge — station | multiple track | stop | single track | (abandoned)
- Spot Elevation in feet — 2550.
- Power transmission line

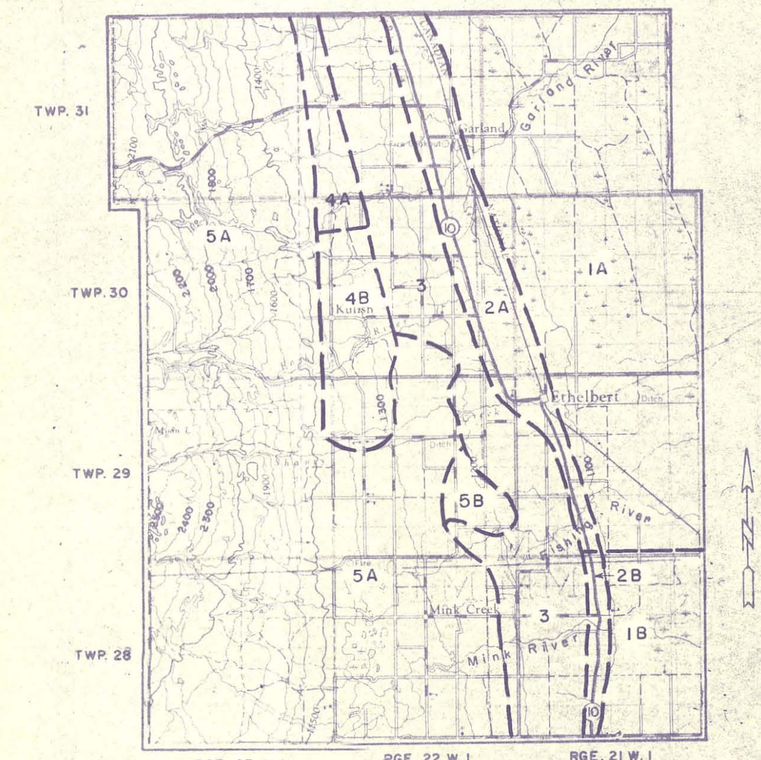
PROVINCE OF MANITOBA
DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT
WATER RESOURCES BRANCH

GROUND-WATER AVAILABILITY STUDY
ETHELBERT AREA
THICKNESS OF SURFICIAL DEPOSITS

PREPARED BY: A. PEDERSEN	DATE: MARCH 70
DRAWN BY: R.R.P.	FILE NO. 80-1-7-1017

AREA	AQUIFERS PRESENT	DEPTH TO AQUIFERS	WATER QUALITY RANGES	REMARKS
1A	Sand and Gravel in Till	Generally less than 100 feet but up to 200 feet.	Generally less than 1,000 p.p.m. T.D.S. but up to 1,500 p.p.m.	In many cases sands and gravels in till will be found above the Swan River Formation and similarly there are likely aquifers present above the Jurassic Limestone. Well water supplies very reliable.
	Swan River Formation	Generally less than 150 feet but varies between 50 and 200 feet.	Ranges from 250 to 1,500 p.p.m. T.D.S.; generally less than 1000 ppm	
	Jurassic Limestone	In order of 200 feet where present.	Probably less than 2000 p.p.m. T.D.S.	
1B	Sand and Gravel in Till	Less than 100 feet.	Less than 2,000 p.p.m. T.D.S.	As Above
	Swan River Formation	Generally less than 150 feet.	Probably up to 4000 p.p.m. T.D.S.	
	Jurassic Formations	No Data	No Data	
2A AND 2B	Surface Sand & Gravel (Beach Deposits)	Less than 20 feet	Less than 1000 p.p.m. T.D.S.	Many of the wells in this aquifer are unreliable in dry periods.
	Other; Area 2A Similar to 1A, Area 2B to 1B	Area 2A similar to 1A. Area 2B similar to 1B.	Area 2A similar to 1A. Area 2B similar to 1B.	Area 2A similar to 1A. Area 2B similar to 1B.
3	Sand and Gravel in till; (Till commonly contains no aquifer.)	Till generally less than 25 feet. thick, but ranges up to 50 feet.	Generally less than 1000 p.p.m. T.D.S. but ranges up to 2000 p.p.m.	Area in which there is much difficulty in developing ground-water supplies. Present development is from shallow dug wells in sand and gravel layers in till. Many of these wells are unreliable and are supplemented by surface water. Swan River Formation essentially undeveloped. This aquifer has good potential but development will require deep wells.
	Swan River Formation	Less than 350 feet; generally between 200 and 300 feet.	Up to 6500 p.p.m. T.D.S. but generally less than 2500 p.p.m.	
4A	Surface Sand and Gravel (Deltas)	Less than 35 feet.	Less than 1000 p.p.m. T.D.S.	Surface aquifer reliable in this area. Little is known of till potential in this area, however it is probably good. Swan River Formation potential poor due to depth, water quality, and low permeability. Water From Favel Formation unsuitable due to H_2S.
	Sand and Gravel in Till	Less than 100 feet.	No Data. Probably good quality	
	Favel Formation	Generally less than 100 feet, but ranges up to 200 feet.	Less than 2000 p.p.m. T.D.S. but highly charged with H_2S gas.	
4B	Similar to 4A, except as noted.			Surface aquifer unreliable in this area. Well failures high. May be improved by exploration for deeper parts of the aquifer.
5A	Sand and Gravel in Till	Generally less than 75 feet but up to 200 feet in developed portion of area. No data on thick drift in west portion of area.	Less than 1500 p.p.m. T.D.S.	Ground water easily available throughout this area from sand and gravel in till. Swan River Formation is deep in this area and indications are that aquifer properties are poor. Favel Formation also underlies till in much of this area with same properties as in area 4.
5B	Sand and Gravel in Till	Less than 75 feet.	T.D.S. less than 800 p.p.m.	This area contains an extensive, thick aquifer of sand and gravel in till which will flow at surface in some parts. Other than this, the area is similar to 5A.

NOTE: T.D.S. - Total Dissolved Solids; p.p.m. - parts per million



SCALE IN MILES 0 1 2 3 4 5 6 7 8

REFERENCE

Town; Village or Settlement; Post Office; School; Church; Stream, intermittent or Dry; Lake, Intermittent; Airport or Airfield; Road: hard surface, all weather (more than 2 lanes, 2 lanes, less than 2 lanes); loose surface, all weather (2 lanes or more, less than 2 lanes, dry weather); wagon, cart track; trail or portage; Railway, normal gauge (station, multiple track, stop, single track, (abandoned)); Spot Elevation in feet (2550.); Power transmission line

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DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT
WATER RESOURCES BRANCH

GROUND-WATER AVAILABILITY STUDY
ETHELBERT AREA

GROUND-WATER AVAILABILITY MAP

PREPARED BY: A. PEDERSEN
DRAWN BY: M. W.
DATE: MARCH 69
FILE NO. 80-1-7-1018

FIGURE 8