Aggregate Report AR87-1

Aggregate Resource Inventory of the Rural Municipality of South Norfolk

By R.V. Young

Manitoba
Energy and Mines
Mines Branch

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ABSTRACT

An aggregate resource inventory was carried out in the Rural Municipality of South Norfolk. Field investigations included aerial photograph interpretation, ground reconnaissance and backhoe testing of undeveloped deposits. Sand and gravel resources are found in glaciofluvial and outwash deposits, Lake Agassiz glaciolacustrine deposits, and Assiniboine River alluvium. Total estimated resources are in excess of 84 million cubic metres with an estimated 29 million cubic metres of aggregate classified as reserves. Sufficient reserves are available to supply municipal road maintenance requirements in excess of 25 years for pit run and road gravel, but the high shale content excludes end uses such as concrete and asphalt.

TABLE OF CONTENTS

FIGURES

TABLES

MAPS

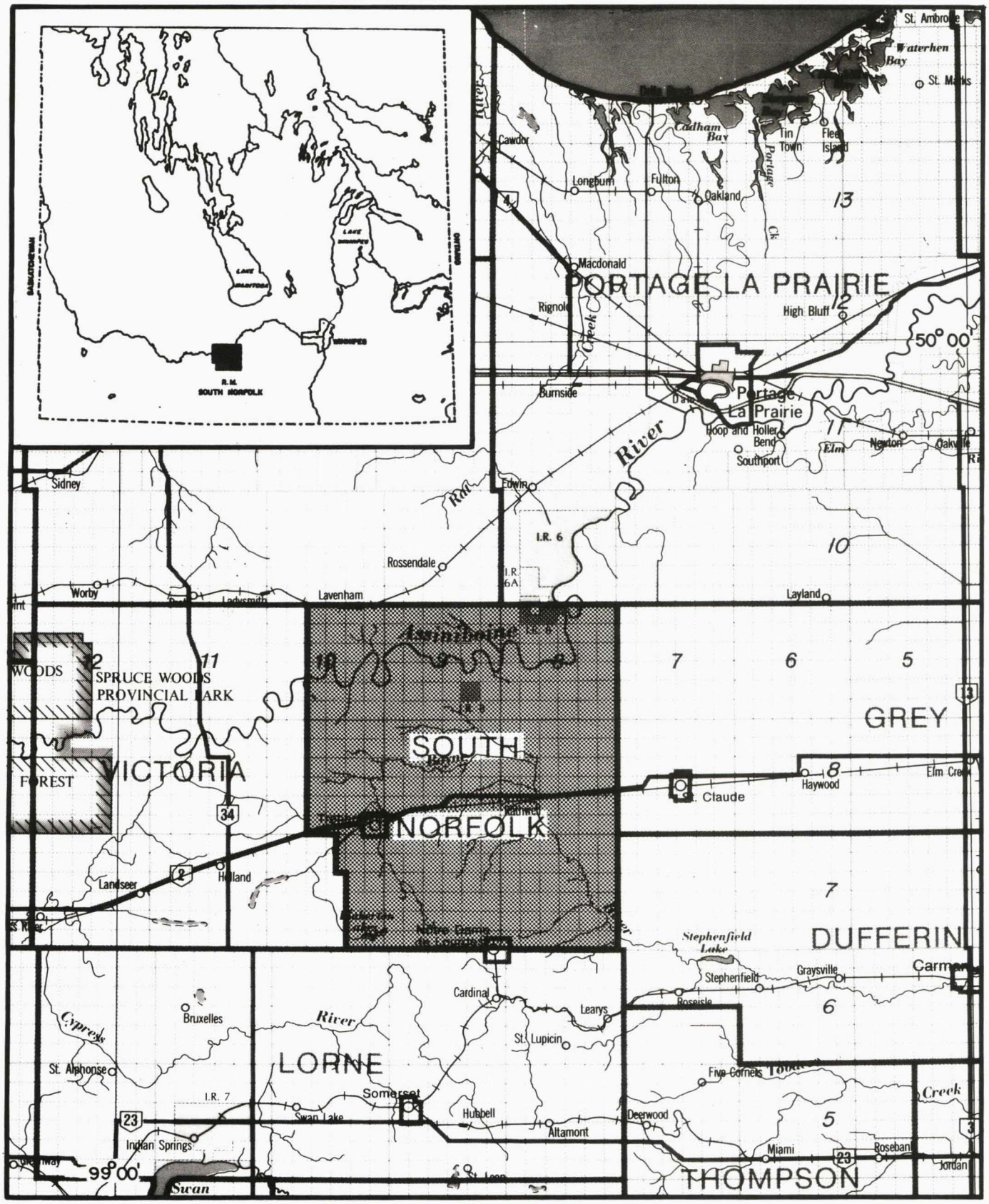

Figure 1: Location of the Rural Municipality of South Norfolk.

INTRODUCTION

Objectives

An aggregate resource inventory was carried out in the Rural Municipality of South Norfolk with the objective of determining location, and reserves of aggregate resources. The information contained within this report may be used to provide information for mineral land-use planning and for consumers of sand and gravel. Aggregate deposits are shown on Map AR87-1 accompanying this report.

Location and access

The study area (Fig. 1) comprises 717 km^2 and is located 93 km southwest of Winnipeg between latitudes 49°32' to 49°48' north and longitudes 98°25' to 98°44' west. It includes Townships 7 to 9 and Ranges 8 to 9 and a portion of Range 10 west of Principal Meridian. The largest settlement is the Town of Treherne. The main access is by Provincial Highway 2 and Provincial Roads 242, 244, 245 and 305. The municipality is served by the Canadian Pacific Railway.

Topography and drainage

The study area is at elevations between 273 and 486 m above sea level (a.s.l.), with the lowest elevations in the north along the Assiniboine River. The Manitoba Escarpment rises above the Lake Agassiz plain in the southern portion of the municipality. Isolated hills associated with the Darlingford Moraine are found along the top of the Escarpment in the southern portion of the study area.

Most of the municipality is drained towards the southeast by the Boyne River. The northern portion is drained eastward by the Assiniboine River.

Previous work

Early studies by Upham (1890) and later by Johnston (1946) discussed in detail Lake Agassiz beach elevations in the Treherne area. Elson (1955) mapped the surficial geology and interpreted the Pleistocene history of southwestern Manitoba. These topics and groundwater resources are discussed by Halstead (1959). Ice marginal positions and the development of Lake Agassiz within the study area are described by Klassen (1975). Included within Klassen's report are stratigraphic cross-sections across the Assiniboine River and several radiocarbon wood dates from the Assiniboine River alluvium which date the inundation of the study area by Lake Agassiz. The thickness of fine grained sediment, geology and topography of buried bedrock surfaces are shown on a series of maps by Teller et al. (1976). A stratigraphic cross-section along the Assiniboine River is included in Teller (1976). Notes on the Quaternary geology and surficial geology are shown on Mineral Resources Division Geological Map AR80-7 (1980) at 1:250 000 scale. Soils of several townships within the study area are presented by St. Jacques (1984).

Surficial geology studies and aggregate resource inventories at 1:50 000 scale were previously conducted adjacent to and within part of the study area. Studies to the north in the Westlake area were undertaken by Western Groundwater Consultants (1981) and in the municipality west and adjacent to the study area by Underwood McLellan Limited (1984). Surficial geology and an aggregate inventory east of Notre Dame de Lourdes are described by Ringrose and Mihychuk (1978) up to part of Range 8 west.

Methodology

Geological field investigations were conducted during the summers of 1985 and 1986. Airphotos at scales of 1:50 000 and 1:15 840 were used to identify potential aggregate deposits. Backhoe testing was conducted to depths of 4 m to define limits of deposits and to sample undeveloped deposits. Samples were sieved to determine grain size between 0.074 to 101.6 mm and pebble lithologies were determined from the 4.76 to 15.9 mm size fraction. Sizes less than 0.074 mm were recorded as the combined silt/clay fraction. Material larger than 150 mm was not sampled but was recorded in the field as crushable material. The grain size classification used in this study is shown in Appendix A. Deposit reserve estimates were calculated using the Aggregate Resources Section computer system. Estimated annual demand for sand and gravel was also calculated for the municipality.

Acknowledgements

The author wishes to thank staff of the Aggregate Resources Section and B. Bannatyne for critically reviewing the text. Maps and figures were drafted by M. Carvalho under the supervision of E. Truman. The report was typed by staff of the Word Processing Centre.

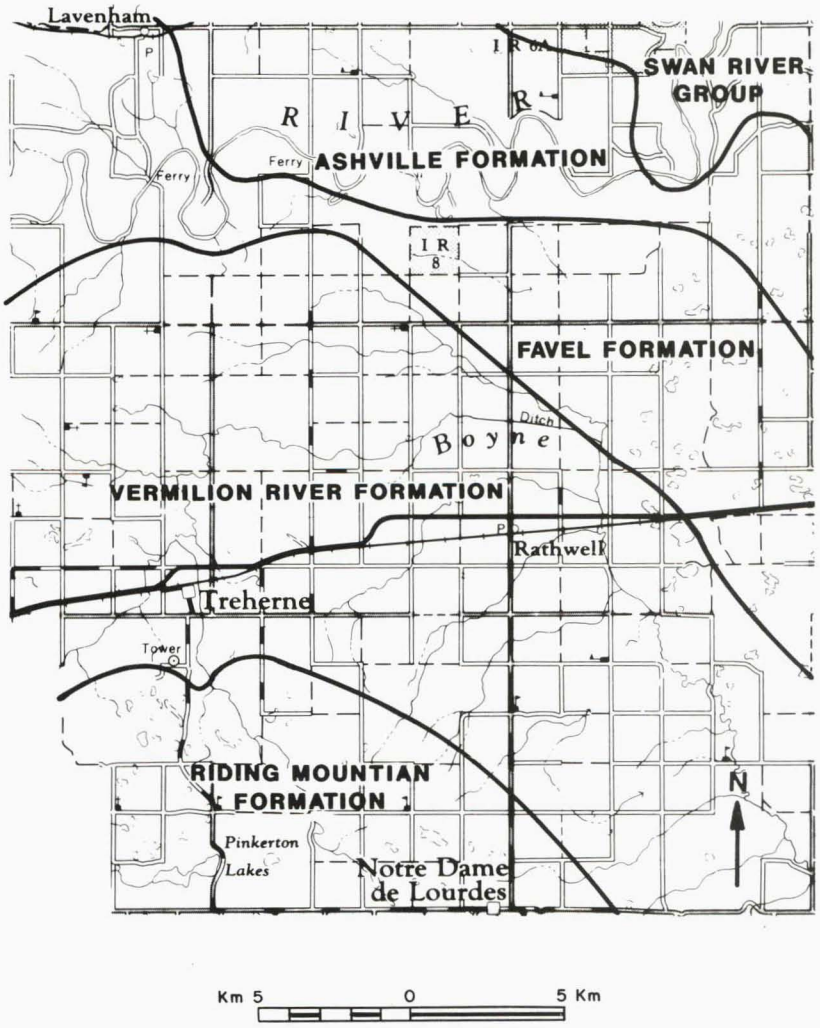

Figure 2: Bedrock geology formations of the study area (Bannatyne, 1970).

GEOLOGY

Bedrock geology

The bedrock geology (Fig. 2) consists of Cretaceous shale and minor sandstone as described by Halstead (1959) and by Bannatyne (1970). The Swan River Group in the northeastern portion of the study area consists of sandstone, kaolinitic shale and minor lignite. Along the Assiniboine River the bedrock comprises the Ashville Formation which consists of dark grey carbonaceous shale with minor sand, silt and bentonite. The Favel Formation south of the Assiniboine River consists of shale, minor limestone, bentonite and oil shale. The Vermilion River Formation is located within the central portion of the study area. The Pembina Member which is the upper member of the Vermilion River is a dark grey or black carbonaceous shale interbedded with bentonite. The Riding Mountain Formation forms the bedrock along the Escarpment in the southwestern portion of the study area. The upper part, the Odanah Member, consists of a light grey, hard, siliceous shale and outcrops where glacial drift is absent.

Surficial geology

Surficial geology units are shown in Figure 3. The area west of the Manitoba Escarpment consists of till. The Darlingford Moraine is located along the top of the Escarpment and consists of till hummocks, glaciofluvial kames and areas of outwash consisting of fine sand, silt and minor gravel. Along the edge of the Escarpment are a series of beach ridges and offshore spits and bars. These deposits consist primarily of sand with minor gravel. The beach deposits overlie two glaciofluvial deposits. Below the Escarpment the surficial deposits consist of lacustrine silt and clay and large areas of fine sand and silt deposited as Assiniboine Delta sediments. Within the Assiniboine River floodplain are alluvial deposits consisting of silt, fine sand and minor gravel.

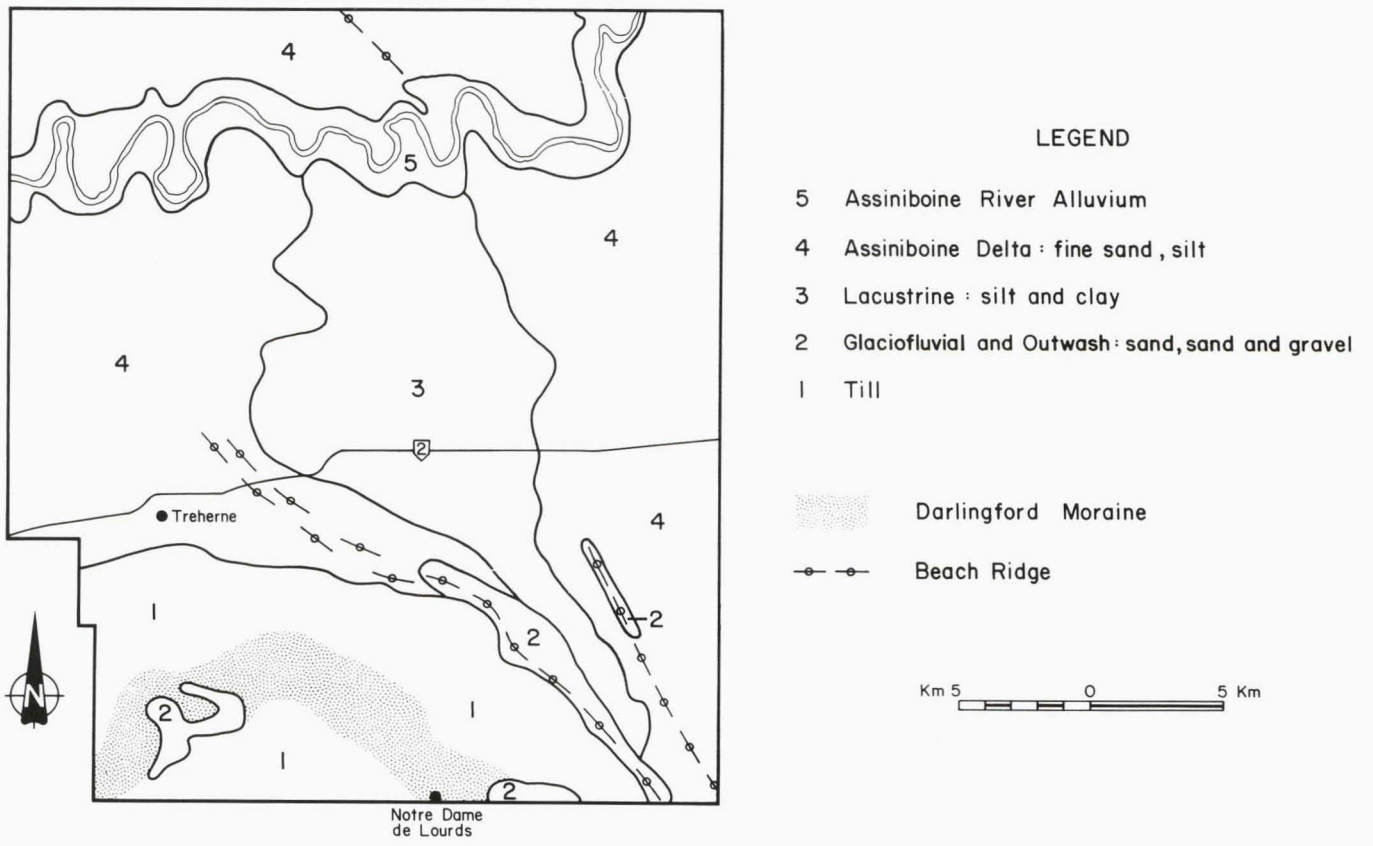

Figure 3: Generalized surficial geology of the study area (modified from Mineral Resources Division Geological Map AR80-7).

Figure 4: Shale exposed in a quarry at site RY100, NW36-7-10WPM. Person for scale.

Bedrock is exposed in several roadcuts where the glacial drift is thin. The Vermilion River Formation has been used as a source of aggregate (Fig. 4) for some local municipal roads

AGGREGATE RESOURCES

Introduction

A total of 19 aggregate deposits were identified as well as several minor strandlines consisting of sand and gravel less than 1 metre deep. A total of 19 samples were analyzed from 11 different deposits. In addition one alluvium and one dune sample were analyzed. The grain size distribution for each sample is shown in Appendix B and the deposit characteristics are shown in Appendices C and D. Deposit and sample locations are shown on map AR87-1 accompanying this report. Additional information concerning sample sites is available upon request from the Aggregate Resources Section computerized data base.

The Department of Highways and Transportation aggregate specifications state the permitted maximum shale content for bituminous plant mix is 3-7 per cent, concrete 1 per cent and base course and traffic gravel is up to 15 per cent. These specifications were part of the criteria used to classify the deposits into reserves and resources. A review of Appendices C and D shows considerable variability in the shale and gravel content of sampled deposits.

The aggregate deposits are divided into two types, aggregate resources and aggregate reserves. For this study aggregate resources are deposits of sand and gravel having a high shale content (>8 per cent), high silt and clay content, and a low gravel content (<10 per cent). In addition, untested deposits are categorized as a resource. Sand and gravel resources have low potential for development but may be utilized for fill or road gravel where specifications are not as stringent.

Aggregate reserves are those sand and gravel resources with high potential for development. These deposits may be utilized for some specific end uses depending upon the amount of processing required. The presence of gravel pits within any deposit may not be considered to be an indication of quality as many deposits are utilized as borrow pits, or the location of the deposit may be advantageous for mineral extraction rather than material quality. Any deposit containing a large active gravel pit was classified as a reserve.

Sand and gravel resources

Map AR87-1 shows the sand and gravel resources within the municipality. Resources consist of glaciofluvial and outwash deposits associated with the Darlingford Moraine, Lake Agassiz beach and nearshore deposits, Assiniboine River alluvium and eolian dunes.

Glaciofluvial and outwash deposits consist of either isolated kames associated with the Darlingford Moraine or large areas of outwash primarily located in the Pinkerton Lakes area. Two kame deposits, 10208 and 10212, contained active gravel pits. The pit in deposit 10208 is in excess of 8 m deep. Beach ridges overlie glaciofluvial deposit 10210 shown in Figure 5. At sample site RY114 the deposit consists of 9 m of bedded, pebbly sand overlain by beach sediments composed of fine sand. Deposit 10214 (Fig. 6) shows a depositional sequence consisting of glaciofluvial sand and gravel overlain by a diamicton interpreted as a flowtill which in turn is overlain by lacustrine fine sand and silt with dropstones.

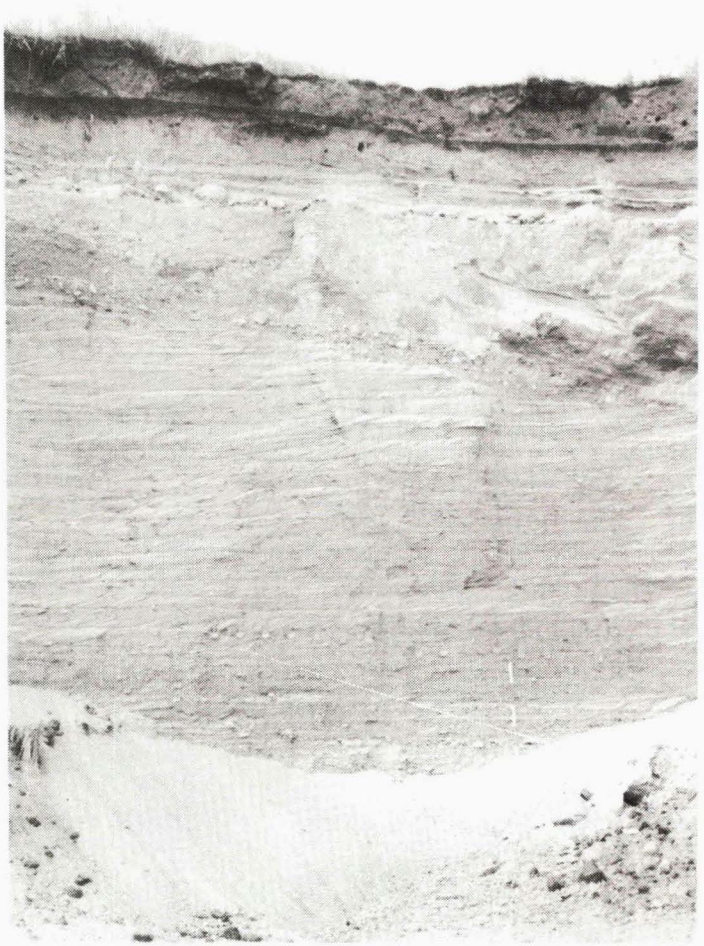

Figure 5: Cosets of cross-stratified pebbly sand overlain by a diamicton which is overlain by horizontally bedded beach sand at site RY114, deposit 10210(e). Survey pole is divided into 0.3 m units.

Outwash deposits east of Notre Dame de Lourdes generally consist of massive fine sand and silt. Several roadcuts through these deposits showed slump structures and contorted bedding interpreted as outwash deposited on stagnant ice. Till lenses in sandy gravel were observed in backhoe test pit BH-08, deposit 10217, indicating deposition close to the ice margin. The large outwash complex north of Pinkerton Lakes showed interbedded fine sand and silt with large areas of massive silt. Roadcuts and backhoe test pits from within this unit show depths of the silt and fine sand to be greater than 6.5 m. One outwash deposit, 10205, is located at the base of the Escarpment. This deposit consists of 3 m of coarse cobble gravel which is rich in shale, overlying till at 3 m.

Lake Agassiz beach and nearshore deposits are located along the Escarpment. Deposits generally consist of horizontally bedded fine sand and pebbly sand with tested depths in excess of 4 m. These deposits mark successively lower levels of Lake Agassiz. At backhoe site BH-03 a discontinuous beach consisted of 1 m pebbly sand overlying till. East of Treherne the beaches merge into a series of offshore bars and spits consisting of fine sand. Only two pits were observed in the beach deposits. At RY131 a pit consisted of 2 m of pebbly sand and a pit at RY133 consisted of 1.5 m pebbly sand overlying fine sand. These pits had a pebble content of 11 and 14 per cent respectively. Beach deposit 10213(d) at backhoe test pit BH-04 showed 3.5 m of pebbly sand with a shale content of 66 per cent. A series of beach ridges overlie glaciofluvial deposit 10210. A backhoe test pit at BH-10 (10210d) exposed 4 m of fine sand. The test pit did not intersect the underlying glaciofluvial deposit.

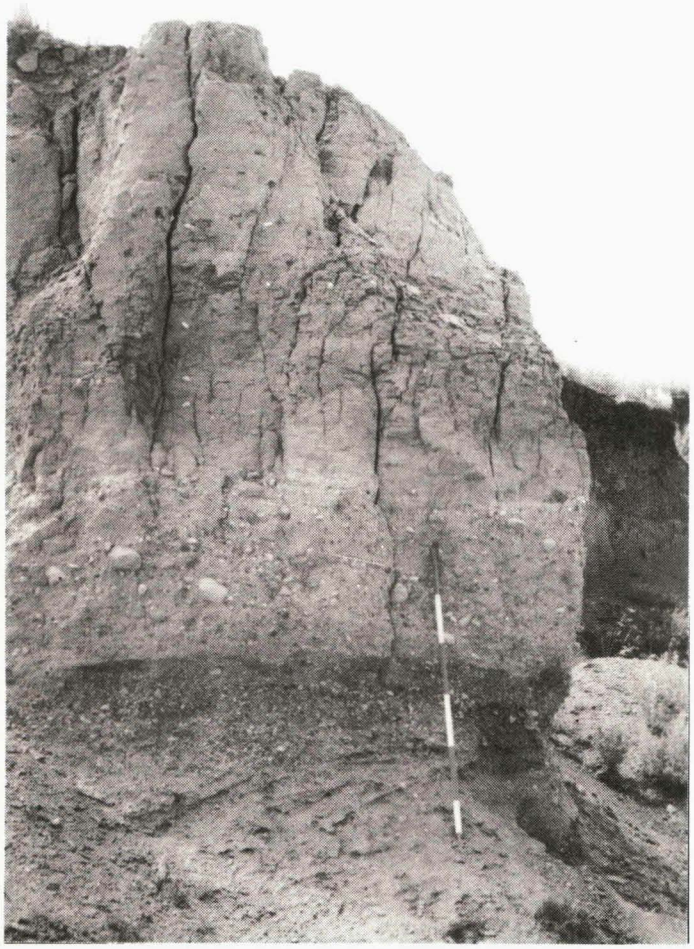

Figure 6: Glaciolacustrine silt overlying buried esker deposits consisting of sandy flow till overlying sand and gravel at site RY125, deposit 10214. Survey rod divided into 0.3 m units.

Eolian deposits are located in the northern and eastern portions of the study area. These deposits are the result of sediment deposition by the Assiniboine Spillway into Lake Agassiz. Subsequent eolian reworking of these deposits has resulted in large areas of fine grained sand dunes. A dune sample at RY138 showed the dune to consist of 94 per cent fine sand and 6 per cent silt/clay. These fine grained deposits are considered to be uneconomical.

Alluvial deposits are confined within the Assiniboine River floodplain. The deposits are variable, consisting of silt, fine sand and pebble gravel with isolated areas of coarse sand and gravel. There were no observed sand and gravel pits within these deposits. Detailed site specific testing is required to identify those areas containing coarser sand and gravel. A section at RY136 showed 1 m of pebbly sand overlain by 2 m of silt.

Sand and gravel reserves

Sand and gravel reserves include glaciofluvial deposits 10206, 10208 and 10212, buried glaciofluvial deposits 10210 (b, d, and e), 10214, and glaciolacustrine deposit 10213(a). Active pits are located in deposits 10208, 10210 (b, d and e), and 10212. Deposit 10206 consists of 3 m of pebbly sand with sand along the flanks of the deposit. Site RY119, deposit 10208, consists of 8 m of interbedded sand and gravel with 37 per cent pebbles, 7 per cent shale and crushable material on site. Site RY113, deposit 10212, consists of 4 m of pebble gravel overlying silt. The pebble gravel consists of 5 per cent shale with crushable material on site. The pit is used for pit run surface gravel for municipal roads.

A series of beach ridges overlie glaciofluvial deposit 10210. At site RY123, deposit 10210(b), the

deposit consists of 3 m of pebbly gravel overlying fine sand. The pebbly gravel consists of 43 per cent pebbles, a shale content of 5 per cent and crushable material within the upper 3 m. Deposit 10210(d) at site RY127 contained a large active pit with 9 m of pebble gravel consisting of 16 per cent pebbles with crushable material on site and a high shale content of 42 per cent. Site RY114 of deposit 10210(e) consists of 12 m of horizontally interbedded sand and gravel with a shale content of 8 per cent. This sample contained 59 per cent pebbles and crushable material. Although the shale content is high for deposit 10210 (d) the deposit contained a large active gravel pit and is classified as a reserve.

The only glaciolacustrine deposit within the reserve classification is deposit 10213(a). At site RY133 the deposit consisted of 1.5 m pebbly sand overlying fine sand. The pebbly sand has a low shale content of 1 per cent.

Supply and demand

The demand for sand and gravel was based on personal communications with the municipality and the Department of Highways. The private sector demand was estimated. Consumption by the Department of Highways fluctuates dependent upon specific road improvement contracts but the value of 6500 m^3 represents an average annual consumption. The estimated annual demand is shown in Table 1.

Estimated remaining reserves for each deposit are shown in Appendix C and D and are summarized in Table 2.

Total estimated supply of aggregate is 84 million cubic metres. Of this supply there are 55 million cubic metres of resource consisting of fine sand, silt and fine sand, and gravel with a high shale content. Estimated higher quality reserves are 29 million cubic metres consisting of pebbly sand and pebble gravel and are located in the southern portion of the municipality.

TABLE 1
ESTIMATED ANNUAL DEMAND FOR SAND AND GRAVEL

('000 cubic metres)

R.M. South Norfolk	8.0
Department of Highways	6.5
Private	5.0
TOTAL :	19.0

TABLE 2
ESTIMATED SUPPLY OF SAND AND GRAVEL

('000 cubic metres)

Estimated Resources	55 188
Estimated Reserves	29 060
TOTAL :	84 248

There are sufficient reserves within the municipality to meet existing road maintenance requirements. Specialized end uses such as concrete and asphalt require importing of shale-free sand and gravel into the municipality.

Conclusion

A total of 19 sand and gravel deposits have been identified within the study area with estimated sand and gravel resources of 84 million cubic metres. The shale content of these resources limits potential end uses. The glaciofluvial deposits have the highest potential for development. Two buried glaciofluvial deposits have been identified but further detailed evaluation would be required to delineate the extent of these deposits.

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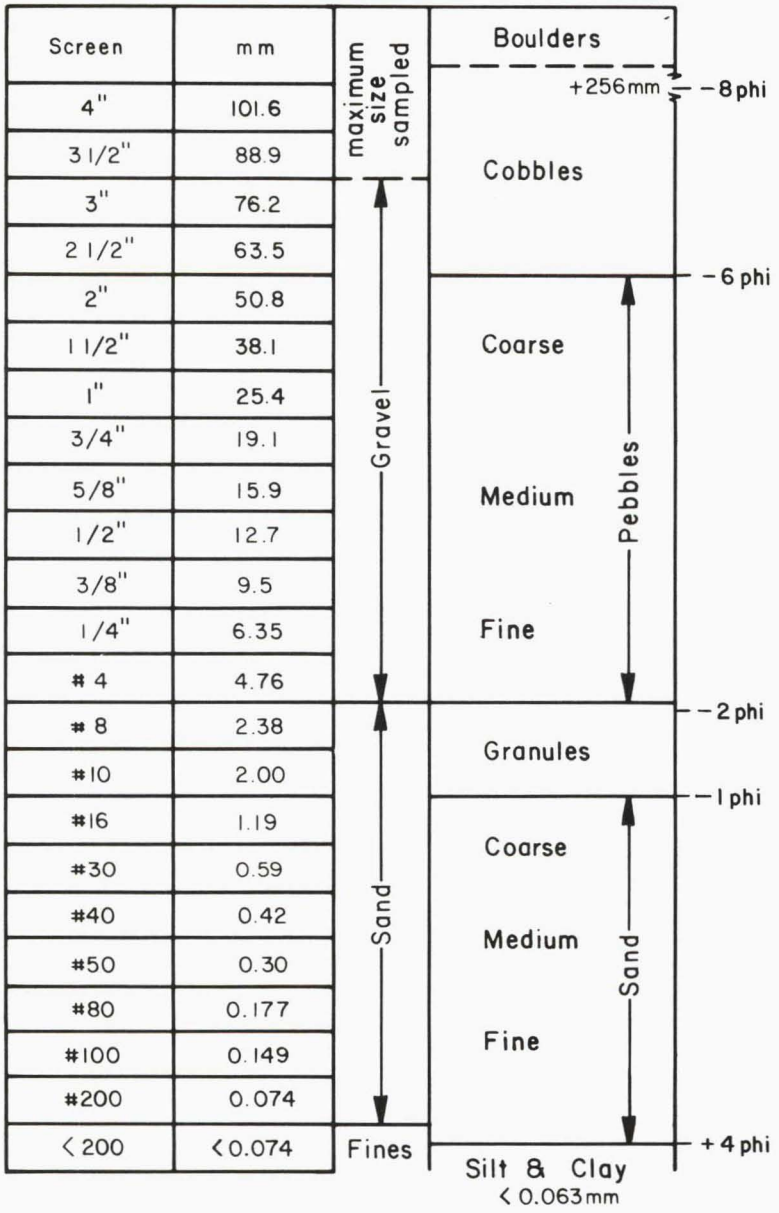
APPENDIX A

GRAIN SIZE CLASSIFICATION



APPENDIX B

GRAIN SIZE DISTRIBUTION

DEPOSIT NUMBER	SAMPLE NUMBER	% PEBBLES 4.76 - 63.5 mm	% GRANULES 2 - 4.76 mm	% SAND 0.074 - 2 mm	% SILT & CLAY < 0.074 mm	CRUSHABLE ON SITE > 15 cm x Yes
10202	RY103	0.4	0.9	62.2	36.3	
10203	RY105	7.7	10.7	69.6	11.7	
	BH-17	10.8	9.4	75.0	4.7	
10204	RY107	23.1	32.7	42.4	1.7	
	RY110	9.0	9.9	75.4	5.5	
	BH-15	32.9	16.5	40.5	10.0	
10205	BH-05	43.1	16.0	27.8	12.9	x
10206	RY106	25.7	15.0	45.7	13.4	
10208	RY119	37.0	12.5	42.8	7.5	x
10210(b)	RY123	43.4	14.0	41.0	1.4	x
(d)	RY127	16.0	20.3	61.2	2.3	x
(e)	RY114	59.1	6.4	31.2	3.2	x
10212	RY113	61.0	17.9	16.0	4.8	x
10213(a)	RY133	14.8	11.6	71.3	2.1	
(d)	BH-04	31.6	11.8	50.0	6.4	
(f)	RY132	1.7	3.1	90.9	4.2	
	RY131	11.3	9.5	78.2	0.8	
10214	RY125	24.8	15.6	45.8	13.5	
10217	BH-08	27.0	19.8	43.8	6.7	x
	RY136	26.5	11.8	59.2	2.3	

APPENDIX C

SAND AND GRAVEL RESOURCES

DEPOSIT NUMBER	SAMPLE NUMBER	DEPOSIT GENETIC TYPE	% PRECAMBRIAN	LITHOLOGY[1] % CARBONATE	% SHALE	AVAILABLE AGGREGATE '000's m^3	COMMENTS
10201		glaciofluvial				1 056	roadcut, 3.5 m pebbly sand
10202	RY103	glaciofluvial	24	39	37	1 600	roadcut sample, 1.5 m fine sand
10203	RY105	glaciofluvial	25	61	14	532	inactive pit
	BH-17	glaciofluvial	25	62	13		
10204	RY107	glaciofluvial	3	1	96	21 486	2 m shale-rich pebbly sand
	RY110	glaciofluvial	22	77	1		small 4 m deep pit
	BH-15	glaciofluvial	25	65	10		
10205	BH-5	glaciofluvial	6	9	85	938	high shale content
10207		glaciofluvial				768	silt and fine sand
10209		glaciofluvial				72	inactive sand pit, untested
10210(a)		glaciofluvial				128	
(c)		glaciofluvial				3 247	
10211		glaciofluvial				3	small pit, 4 m pebbly sand
10213(b)		glaciofluvial				832	
(c)		glaciofluvial				416	
(d)	BH-4	glaciofluvial	18	16	66	4 595	high shale content
(f)	RY132	glaciofluvial	28	31	41	7 379	pebbly sand
	RY131	glaciofluvial	57	29	14		sand pit
(g)						576	
(h)						480	
10215		lacustrine				8 160	beach ridge, fine sand
10216		glaciofluvial				192	esker, poor access
10217	BH-8	glaciofluvial	20	29	50	1 920	sandy gravel, till lenses
10218		glaciofluvial				264	fine sand
10219	BH-9	glaciofluvial				128	pebbly fine
Alluvium	RY136		77	23	0		variable quality
Dune	RY138						fine sand
						TOTAL : 55 188	

[1] 4 - 16 mm size

APPENDIX D

SAND AND GRAVEL RESERVES

DEPOSIT NUMBER	SAMPLE NUMBER	DEPOSIT GENETIC TYPE	% PRECAMBRIAN	LITHOLOGY[1] % CARBONATE	% SHALE	AVAILABLE AGGREGATE '000's m^3	COMMENTS
10206	RY106	glaciofluvial	17	80	3	1 280	inactive 5 m deep pit
10208	RY119	glaciofluvial	53	40	7	576	active 8 m deep pit
10210(b)	RY123	glaciofluvial	49	46	5	1 612	active 4 m deep pit
(d)	RY127	glaciofluvial	36	22	42	590	active commercial 9 m deep pit
(e)	RY114	glaciofluvial	55	37	8	16 667	active commercial pit
10212	RY113	glaciofluvial	58	37	5	358	2 pits, pebble gravel over silt
10213(a)	RY133	lacustrine	51	48	1	172	pebbly sand
10214	RY125	glaciofluvial	53	24	22	2 491	buried esker
						TOTAL : 29 060	

[1] 4 - 16 mm size

GLOSSARY

AGGREGATE

Any inert, construction material (sand, gravel, slag, crushed stone or other mineral material).

AGGREGATE RESERVES

Aggregate in a deposit which is proven and is economically signficiant.

ALLUVIUM

Alluvium is a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during postglacial time by a stream.

BEACH DEPOSITS

These are relatively narrow, linear features formed at the shores of glacial lakes that existed during deglaciation. Well developed beaches are usually less than 6 m (20 feet) thick. The aggregate is well sorted and stratified and sand-sized material commonly predominates.

BEDROCK

In-place pre-Quaternary material exposed at the surface or underlying the surficial material.

BINDER

Material that produces or promotes consolidation in loosely aggregated sediments. Usually mud or clay, sometimes till is used for binder.

CARBONATE ROCKS

A broad term referring to those sedimentary rocks consisting chiefly of carbonate minerals, mainly limestone and dolostone.

CLAST

An individual constituent, grain, or fragment of a sediment or rock, produced by the mechanical weathering of a large rock mass. Synonyms include particle and fragment.

CROWN LAND

Land reserved and administered by the Crown. Sand and gravel usually administered by the Crown.

CROWN SAND AND GRAVEL

Sand and gravel reserved and administered by the Crown.

DELETERIOUS LITHOLOGY

A general term used to designate those rock types which are chemically or physically unsuited for use as construction or road-building aggregates. Such lithologies as chert, shale, siltstone, and sandstone may deteriorate rapidly.

DEPOSIT

An accumulation of sediments left in a new location by a natural transportative agent such as water, wind, ice, or gravity.

An aggregate deposit is a deposit of sand and gravel considered to be of economic significance.

DIRT

See fines.

DOLOMITE (DOLOSTONE)

A carbonate sedimentary rock consisting chiefly of the mineral dolomite and containing relatively little calcite (dolomite is also known as dolostone).

DRIFT

A general term for all unconsolidated rock debris transported from one place and deposited in another; distinguished from underlying bedrock. In North America, glacial activity has been the dominant mode of transport and deposition of drift. Synonyms include overburden and surficial deposit.

DURABLE ROCK

A rock fragment which is hard and inert and can be used as aggregate without breaking, crumbling or reacting with the cementing material.

EOLIAN

Pertaining to wind action.

EPOCH

A geological-time unit longer than an age and a subdivision of a period.

ESKERS

Eskers are narrow, sinuous ridges of sand and gravel. They vary greatly in size. Many eskers consist of a central core of poorly sorted and stratified gravel. The core material is often draped by better sorted and stratified sand and gravel.

FINES

A general term used to describe the size fraction of an aggregate which passes (is finer than) the No. 200 mesh screen (0.074 mm). Also described informally as 'dirt', these particles are in the silt- and clay-size range.

FLUVIAL

Pertaining to rivers or streams.

GLACIOFLUVIAL DEPOSITS

Material deposited by streams flowing from, on, or within melting glacier ice, generally composed of sorted, stratified sand and gravel; includes outwash, kame, esker, etc.

GLACIOLACUSTRINE DELTAS

These features were formed where streams or rivers of glacial meltwater flowed into lakes and deposited their suspended sediment. Such deposits tend to consist mainly of sand and abundant silt. However, in near-ice or ice-contact positions, coarse material may be present.

GLACIOLACUSTRINE DEPOSITS

Material deposited in lakes affected by glacier ice or by meltwater flowing directly from glaciers; composed of well-sorted clay, silt, or sand.

GRANULAR BASE COURSE

Components of a road placed on subgrade and designed to provide strength, stability, and drainage, as well as support for surfacing materials. Several types have been defined: Granular Base Course A consists of crushed and processed aggregate and has relatively stringent quality standards in comparison to Granular Base Course B and C which are usually pit-run or other unprocessed aggregate.

GROUND MORAINE

A deposit of till with a flat or undulating surface.

HOLOCENE

An epoch of the Quaternary period covering the time period from the retreat of the continental glaciers to the present, about 10 000 years.

HUMMOCKY

An irregular or knob and kettle surface.

HUMMOCKY MORAINE

A landscape composed primarily of till with a hummocky surface.

ICE-CONTACT DEPOSIT

Material deposited in contact with glacier ice by meltwater; includes kames, eskers, kame terraces, etc.

ICE-CONTACT TERRACES

These are glaciofluvial features deposited between the glacial margin and a confining topographic high, such as the side of a valley. The structure may be similar to outwash deposits.

KAMES

Kames are mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin. The deposits consist mainly of irregularly bedded and cross-bedded, poorly sorted sand and gravel. Deposits include single mounds, linear ridges (crevasse fillings) or complex groups of landforms.

LACUSTRINE DEPOSIT

Material deposited in a lake.

LITHOLOGY

The description of rocks on the basis of such characteristics as color, structure, mineralogic composition, and grain size. Generally, the description of the physical character of a rock.

MELTWATER CHANNEL

A drainage way produced by water flowing away from a melting glacier margin.

MORAINE

A distinct accumulation of glacial drift. Could represent an ice marginal position.

OUTWASH

Outwash deposits consist of sand and gravel laid down by meltwaters beyond the margin of the ice lobes. They occur as sheets or as terraced valley fills (valley trains) and may be very large in extent and thickness. Well developed outwash deposits have good horizontal bedding and are uniform in grain-size distribution. Outwash deposited near the glacier's margin is much more variable in texture and structure.

PIT RUN

Unprocessed aggregate removed from pit. Generally consists of fine pebble gravel with minor amounts of material coarser than 38 mm (1.5"). It is used for road maintenance, upgrading and resurfacing.

PLEISTOCENE

An epoch of the recent geological past including the time from approximately 1.8 million years ago to 10 000 years ago. Much of the Pleistocene was characterized by extensive glacial activity.

QUATERNARY

The second period of the Cenozoic era, thought to cover the last 2-3 million years. It consists of two epochs: The Pleistocene and the Holocene.

RESOURCE

An aggregate deposit or environment which may or may not be proven and is presently not economically significant.

SHALE

A fine-grained, sedimentary rock formed by the consolidation of clay, silt, or mud and characterized by well developed bedding planes, along which the rock breaks readily into thin layers. The term shale is also commonly used for fissile claystone, siltstone, and mudstone.

SPILLWAY

Large drainage valley formed by meltwater flowing from a glacial lake. Spillways often have gravel terraces.

STONE

That component of aggregate coarser than 4.76 mm or the #4 sieve, includes pebbles, cobbles and boulders.

SURFICIAL GEOLOGY

A form of geological mapping dealing with all materials occurring at surface in an area: unlithified or lithified (sediments or bedrock).

TERRACE

A relatively flat, stair-stepped, depositional or erosional surface bounded by an ascending slope on one side and a descending slope on the other.

TILL

Unsorted and unstratified rock debris, deposited directly by glaciers, and ranging in size from clay to large boulders.

WISCONSINAN

Pertaining to the last glacial stage of the Pleistocene Epoch in North America. It began approximately 100 000 years ago and ended approximately 10 000 years ago. The glacial deposits and landforms of southern Manitoba are predominantly the result of glacial activity during the Winsconsinan Stage.