

Aggregate Resources in the Rural Municipalities of Boulton and Hillsburg

By H. Groom

**Manitoba
Energy and Mines**
Mines Branch



1992

**Manitoba
Energy and Mines
Mines Branch**



Aggregate Report AR92-1

Aggregate Resources in the Rural Municipalities of Boulton and Hillsburg

By H. Groom
Winnipeg, 1992

Energy and Mines

Mines Branch

**Hon. Harold J. Neufeld
Minister**

**A. Ball
Director**

**David Tomasson
Deputy Minister**

This publication is available in large print, audiotape or braille on request

TABLE OF CONTENTS

	Page
Introduction	3
Objectives	3
Location and Access	3
Physiography	3
Methodology	3
Previous Works	3
Acknowledgements	3
Geology	5
Bedrock geology	5
Late glacial history	5
Aggregate Resources	7
Introduction	7
Aggregate reserves	7
Conclusions	7
References	16
Appendix A: Grain Size Classification and Sieve Intervals	17
Appendix B: Detailed Sieve Results	18
Appendix C: Pebble Lithology and Deleterious Content	25
Appendix D: Backhoe Test Pit Logs	27
Appendix E: Block File Information	35
Appendix F: Location of Crown Lands	37
Appendix G: Glossary	39

FIGURES

Figure 1: Location map of the R.M.s of Boulton and Hillsburg	iv
Figure 2: Generalized bedrock geology; after Klassen et al. (1970)	4
Figure 3: Surficial geology of the R.M.s of Boulton and Hillsburg; modified from Klassen (1979)	6
Figure A-1: Grain size classification	17
Figure E-1: Manitoba Highways and Transportation aggregate grade specifications	36
Figure F-1: Crown lands in the R.M. of Boulton	37
Figure F-2: Crown lands in the R.M. of Hillsburg	38

TABLES

Table 1: Aggregate deposits in the R.M.s of Boulton and Hillsburg	8
Table 2: Summary of grain size distribution of gravel samples	13
Table 3: Aggregate reserves in the R.M.s of Boulton and Hillsburg	7
Table 4: Aggregate quality and development potential criteria	15

MAP

Map AR92-1: Surficial geology and aggregate deposits in the R.M.s of Boulton and Hillsburg	In pocket
---------------------------------------------------------------------------------------------------------	-----------

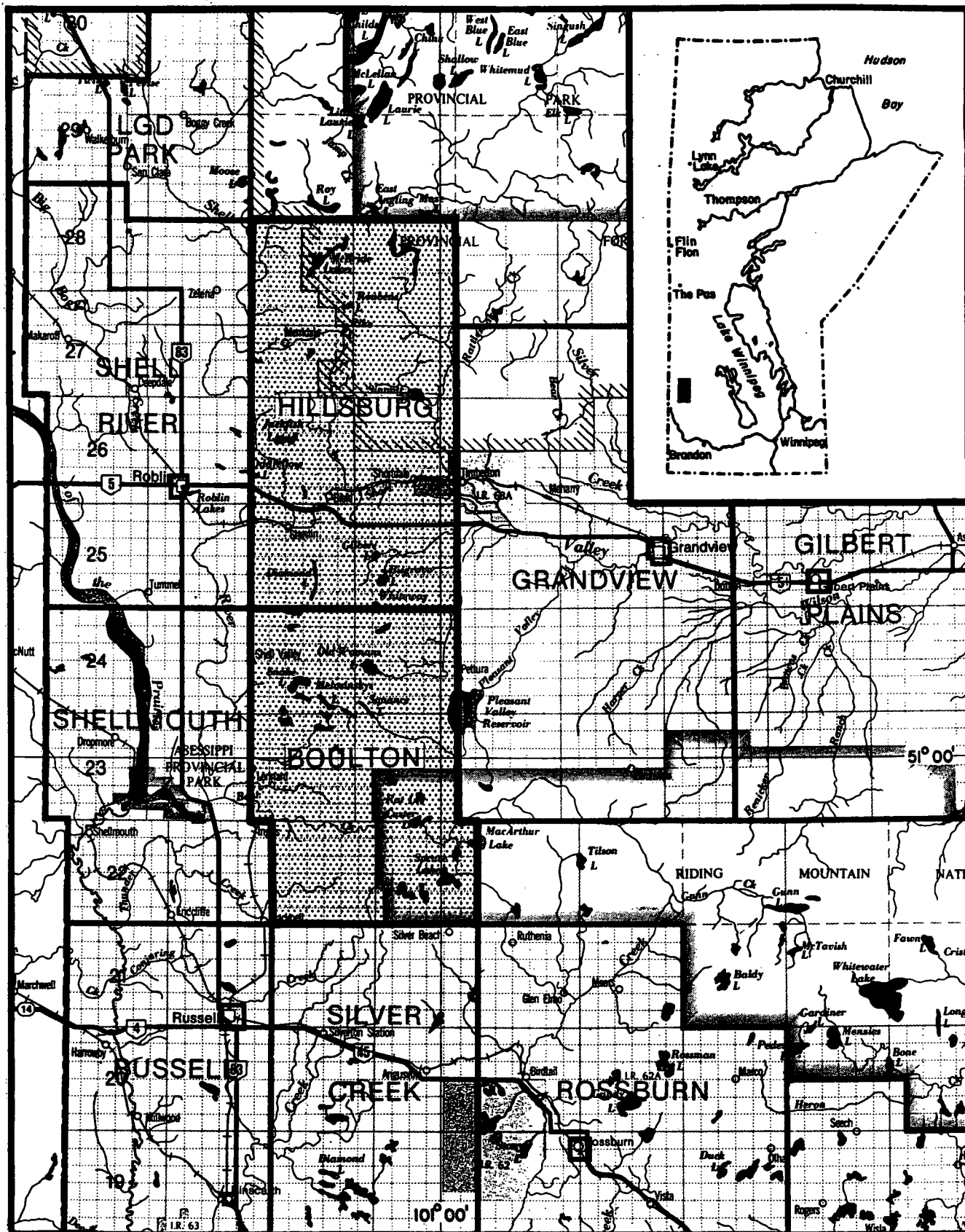


Figure 1: Location map of the R.M.s of Boulton and Hillsburg.

INTRODUCTION

OBJECTIVES

An aggregate resource inventory was carried out during the summer of 1990 in order to:

- 1) delineate the sand and gravel resources at a scale of 1:50 000; and
- 2) provide an estimate of the aggregate reserves in the area.

The information is used to provide aggregate users with resource information for construction needs and to facilitate land-use planning designed to protect high quality aggregate deposits from sterilization.

LOCATION AND ACCESS

The Boulton-Hillsburg area encompasses 1245 km² lying between Townships 22-28 and Ranges 26-27W in western Manitoba (Fig. 1). It includes six 1:50 000 map sheets in NTS areas 62N/2, 3, 6 and 7, and 62K/14 and 15.

The area is primarily a farming district and the town of Roblin is the major service centre. Highway 5 and a network of gravelled Provincial Roads and section roads provide good access to most parts of the district; the exception is within the Duck Mountain Provincial Forest in the north eastern portion of the area.

PHYSIOGRAPHY

The area has three major physiographic divisions: the Duck Mountain uplands in the north, the Riding Mountain uplands in the south and west and the Valley River plain in the centre.

Both the Duck and Riding Mountain uplands rise to elevations of 655 m above sea level (a.s.l.) and comprise bedrock overlain by Quaternary sediments. The drift cover ranges from less than 100 m thick on Riding Mountain to over 200 m on Duck Mountain (Little and Sie, 1976; Sie, 1978). Both upland areas are overlain by hummocky stagnation moraine. The knob and kettle topography consists of till knolls, 5 to 10 m high, separated by sloughs and lakes.

The area between the two uplands is a rolling till plain; the height of the ridges rarely exceeds 3 m. The land slopes gently eastward with elevations falling below 480 m a.s.l. at the municipal boundary.

The Shell River Spillway runs through the western part of the area; the valley is up to 1.5 km wide and from 35 to 40 m deep. The village of Bield marks the approximate position of a drainage divide. East of Bield, water flows through Short Creek and Valley River to the Manitoba Lowlands; on the other side, it flows westward through the Shell Spillway to the Assiniboine River.

METHODOLOGY

Surficial deposits were delineated on 1:50 000 scale airphotos. Airphoto interpretation was based on surficial units outlined by Klassen (1979) and information from Department of Highways and Transportation Service gravel pit inventory files.

Gravel pits, road cuts and natural exposures were examined during the first part of the field investigation. This was followed by a program to test the extent, depth and quality of identified aggregate deposits in backhoe pits.

Aggregate samples were processed in two stages. In the field, samples that weighed between 75 and 100 kilograms were passed through 6" (15cm), 3" (7.5 cm), 1 1/2" (3.8 cm) and 3/4" (1.9 cm) screens. The weights of the 3", 1 1/2", 3/4" and <3/4" fractions were recorded and the relative abundance of the 3-6" and >6" fractions noted. A representative sample of the <3/4" portion was returned to Winnipeg for laboratory sieving. Sieve intervals are shown in Appendix A.

Pebble counts of the 3/4"-1 1/2" fraction were done to determine the content of carbonate, sandstone and Precambrian intrusive volcanic and metamorphic lithologies, as well as the extent of deleterious factors such as shale, chert, concretions, weathering and cementation.

Gravel deposits were delineated on 1:15 840 scale airphotos and transferred to 1:50 000 scale photos for use in production of the 1:50 000 scale map accompanying this report (Map AR92-1, in pocket).

Deposit reserves were obtained by multiplying area by proven aggregate depths; sterilization and depletion factors were taken into account.

PREVIOUS WORKS

The surficial geology of the area has been mapped at a scale of 1:250 000 as part of a regional study of south-western Manitoba - southeastern Saskatchewan (Klassen, 1966; 1979). The evolution of the Shell River spillway and terrace development along the river has also been studied by Klassen (1975). Drift thickness maps are included in ground water studies prepared by Little and Sie (1976) and Sie (1978).

The bedrock geology has been mapped by Wickenden (1945), Bannatyne (1970) and the units further described by McNeil and Caldwell (1981). A map of the bedrock topography at a scale of one inch to eight miles has been produced by Klassen et al. (1970).

ACKNOWLEDGEMENTS

Lauren Haugh provided able field assistance. Chester Wojciechowski drafted the map and figures, Shirley Weselak typed, and D. A. Baldwin edited the manuscript.

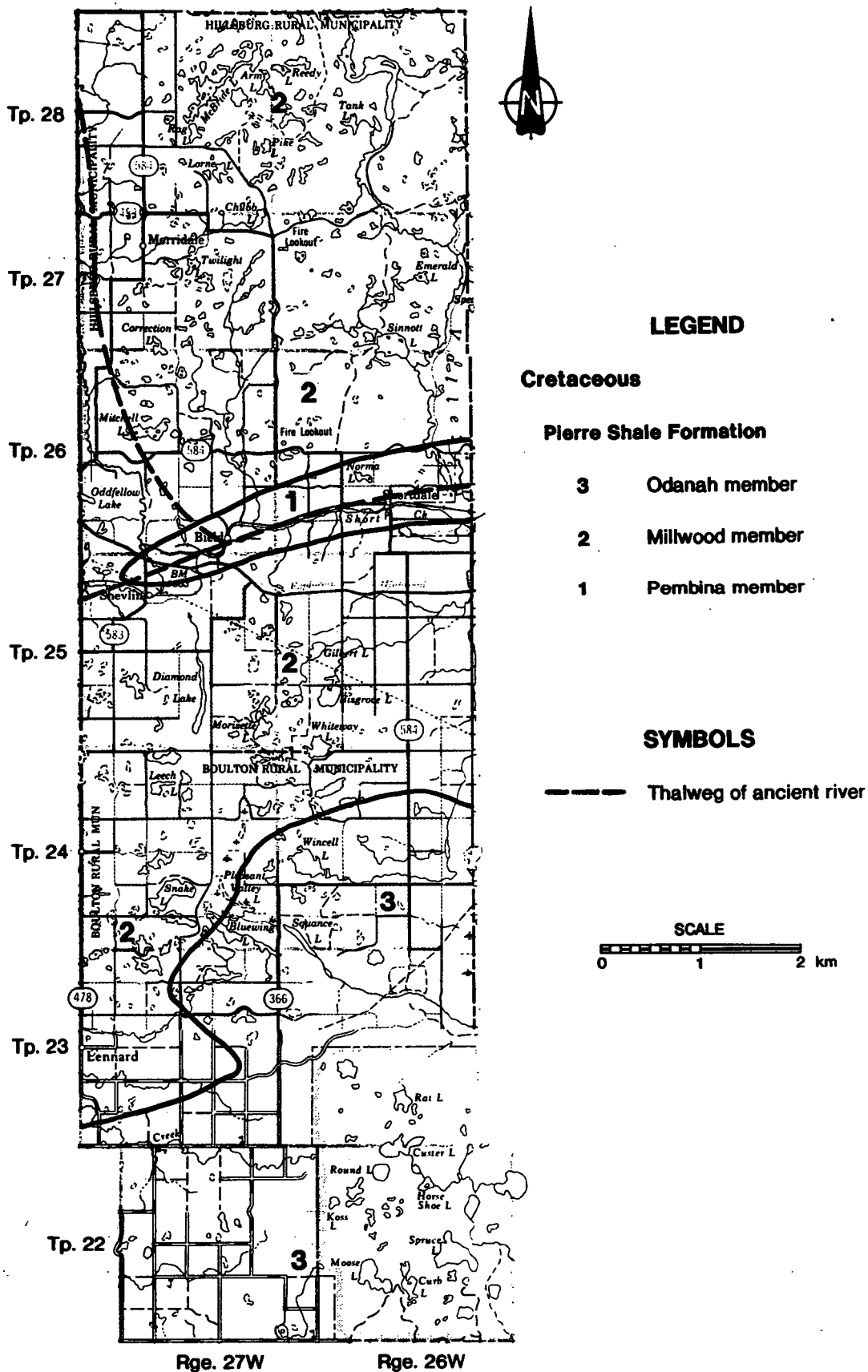


Figure 2: Generalized bedrock geology; after Klassen et al. (1970)

GEOLOGY

BEDROCK GEOLOGY

The area is underlain by three members of the upper Cretaceous Pierre Shale Formation: the Pembina, Millwood and Odanah members.

The bedrock geology of the area (Fig. 2) is taken from Klassen *et al.* (1970); the Millwood and Odanah members were assigned to the Riding Mountain Formation and the Pembina member to the Vermillion River Formation. McNeil and Caldwell (1981) assigned all three members to the Pierre Shale Formation and it is their work that is used for the following description of the units.

The Pembina Member consists of two units, the lower of which is a greyish-black carbonaceous shale characterized by numerous bentonite beds. The upper unit is a yellow-brown shale.

The Millwood Member is an olive-grey clay that passes southeastward to an olive-grey shale. Bentonite beds occur throughout, but particularly in the upper part of the unit.

The Odanah Member is a hard grey siliceous shale with abundant rusty weathered specks. Bentonite beds occur infrequently throughout the unit.

Bedrock in the Boulton-Hillsburg area is overlain by 30 to 200 m of Quaternary sediments and was seen in outcrop at only one location. This is a bedrock ridge in NE 26-23-26W, along the northern edge of Riding Mountain. The rock is a blocky, greyish-black shale that weathers to light grey. Bentonite beds and weathered orange silt concretions

are common in the upper part and the whole has been greatly disturbed by glacial overriding.

LATE GLACIAL HISTORY

A generalized map of the surficial sediments in the region is given in Figure 3.

The surface till was deposited by ice flowing from the northwest (Lennard till) and north (Zelena till) during the Late Wisconsinan (Klassen, 1966; 1979). During deglaciation, the ice overlying the upland areas stagnated and resulted in the present day knob and kettle topography. Active ice remained in the adjacent Assiniboine and Valley River plains, forcing meltwater from Duck Mountain to find its way south through the channel that now contains Bluewing Swamp and Squance Lake.

The upper portion of the Shell River established itself across the stagnant ice on Duck Mountain and deposited the outwash plain that lies north and west of Bield. The plain's elevation and hummocky surface indicate that the sediment was laid down over ice.

Minor wasting of the ice in the Assiniboine River plain allowed the lower portion of the Shell River to form in an ice marginal position (Klassen, 1966). Active ice in the Valley River plain caused meltwater in the Short Creek spillway to flow west across the outwash and into the Shell River channel. As the Valley River ice receded and exposed lower elevations, this flow reversed and water from Short Creek as well as the upper part of the Valley River, took its present course.

AGGREGATE RESOURCES

INTRODUCTION

Sand and gravel resources of the Boulton-Hillsburg area occur in ice-contact, outwash and meltwater stream deposits located primarily in the west and central part of the area.

Deposit and sample locations are shown on Map AR92-1 (in pocket). Information about the deposits is presented in summary tables in the text and in detail in the appendices.

Table 1 (page 8) summarizes pit status, material type, reserves and site specific information for each deposit. Table 2 (page 13) summarizes grain size data for all samples. Detailed sieve results are given in Appendix B. Pebble lithology of the 3/4"-1 1/2" (1.9-3.8 cm) fraction and per cent deleterious in each sample is presented in Appendix C. Appendix D presents logs of the backhoe test pits. Appendix E summarizes aggregate information contained in Manitoba Department of Highways Block Files. Appendix F contains maps showing the location of crown lands in the municipalities and Appendix G is a glossary of relevant terms.

AGGREGATE RESERVES

There are $26\,464 \times 10^3$ cubic metres of aggregate reserves in the Boulton-Hillsburg area. Of these, $5975.1 \times 10^3 \text{ m}^3$ are in the R.M. of Boulton and $20\,488.9 \times 10^3 \text{ m}^3$ in the R.M. of Hillsburg.

Table 3: Aggregate Reserves in the R.M.s of Boulton and Hillsburg
Production Potential

Rural Municipality	High ($'000 \text{ m}^3$)	Medium ($'000 \text{ m}^3$)	Low ($'000 \text{ m}^3$)	Total ($'000 \text{ m}^3$)
Boulton	3 576.3	2 170.9	217.8	5 965.0
Hillsburg	4 991.6	11 622.7	3 884.8	20 499.0
Total	8 567.9	13 793.6	4 102.6	26 464.0

Table 3 shows aggregate reserve figures and Figure 4 the location of deposits classified by production potential within each municipality. Production potential not only depends on quantity and quality of the aggregate in the deposit but also on factors such as hauling distance to the job site, whether or not alternative sources are available and land use pressures that may prevent gravel extraction.

For example, Deposit 14201, despite a large quantity of good quality gravel, has a moderate production potential because there are two large pits nearby that already supply the limited demand for aggregate in that area. On the other hand, the high percentage of shale in Deposit 14229 would indicate a low production potential. However, it has a moderate potential due to the absence of any better, nearby sources.

Table 4 shows the criteria taken into consideration when assigning production potential.

CONCLUSIONS

Aggregate deposits in the R.M.s of Boulton and Hillsburg are associated with the large meltwater channels that run through the west and central parts of the area.

There is an abundance of aggregate of all grain sizes in the R.M. of Hillsburg, concentrated in the western part of the municipality. The Duck Mountain Provincial Forest is in the north east, so that while there is a scarcity of gravel in that area, there is also little demand.

The R.M. of Boulton has an adequate volume of aggregate reserves for the near future. However, these are concentrated in two deposits in the north-central part of the municipality and there is a scarcity of gravel in the southern half of the area. In addition, the unopened part of the major deposit (14225) is generally coarser than the material in the present municipal pit so the volume of pit run reserves is much less than the total reserve figure.

Table 1: Aggregate Deposits in the Rural Municipalities of Boulton and Hillsburg

Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4) (>4.76mm)	Oversize 3-6"/>6"	Estimated Reserves (*000s m3)	Comments
14201	HA330s HA331		65	M / M A / A	1628.2	unopened deposit; test holes indicate >2.5 m of coarse pebble gravel to cobble gravel.
14202	HM377s HA329s	Aband.*	29 45	S / - S / -	199.7	deposit is generally >3 m of interbedded sandy pebble gravel and pebbly coarse sand.
14203	HM379			A / A	248.5	ditch cut shows >2.5 m bouldery, cobble gravel.
14204	HM380As HM380Bs HA322s HA323 HA324 HA325 HA326 HA327 HA328s	Inter.*	47 52 47 44	M / M A / A S / S S / - S / - - / - M / S A / A A / A	190.0	active pit (HM380) is 3-4 m of sandy pebble gravel with minor cobbles; deposit is coarser at north end (>2.5 m sandy coarse pebble gravel with cobbles), fines south (>2.5 m interbeds of pebble gravel and pebbly sand) and shallows to the east (2 m sand over till).
14205A	HM350		32	S / -	6.0	ditch cut in hummock, 3.5 m high.
14205B	HM351	Aband.		M / S	10.5	old pit; 4 m cobbly pebble gravel on west side of road, 2 m sand on east side
14206A	HM376s	Inter.	39	M / -	15.8	roadside pit in hummock; 2.5 m sandy pebble gravel on west side; pit on east side of road is abandoned, shallow and till floored.
14206B	HM375s	Aband.	57	M / M	30.0	old pit; 2.0 m sandy pebble gravel with small cobbles.
14207					236.6	deposit is largely sterilized by road and farm; ditch cuts show sandy pebble gravel at north end and sand or shallow gravel over sand along eastern edge.
14208	HM387 HM388 HA316s HA317 HA318 HA319 HA320 HA321	Aband.	54	M / M A / A S / A S / A	123.1	deposit material is highly variable; ranges from >3 m cobble gravel at HM387 and HA316 to <1 m fine pebble gravel over sand, silt or till in remaining area.
14209	HM384s		48	M / M	79.0	gravel confined to rim of lake.
14210	HM383s	Aband.	32	S / S	5.5	overgrown pit, 2 m deep.
14211	HM396s HM397	Aband.	40	S / S	8.9	deposit is depleted in south and largely sterilized by roads.

Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4) (>4.76mm)	Oversize 3-6"/>6"	Estimated Reserves ('000s m3)	Comments
14212	HM389s	Inter.	43	M / M	1342.1	HM389 is 4 m of high quality gravel, pit recently active; lower terrac levels are mostly sand with localized gravel pockets.
14213	HM390s	Aband. Aband. Inter.	41	S / S	3991.1	deposit is generally sand with local deep pockets of gravel. Most backhoe test pits showed <0.8 m of very sandy fine pebble. gravel over sand. In some areas (eg HM402) sand is of concrete grade.
	HM392s		51	S / S		
	HM393s		36	M / M		
	HM402		1	- / -		
	HA310			- / -		
	HA311			- / -		
	HA312			- / -		
	HA312B			- / -		
	HA313			- / -		
	HA314			- / -		
	HA315s		37	S / -		
14214	HM391	Inter.	51	S / -	4046.7	deposit is primarily sand with localized areas of gravel. Backhoe test pits showed up to 2 m very sandy, fine pebble gravel over fine sand or silt.
	HM399s	Inter.		S / -		
	HM400	Aband.		S / -		
	HA298	Aband.		S / -		
	HA299			S / -		
	HA300s		27	- / -		
	HA301			- / -		
	HA302s		50	- / -		
14215	HA303s		57	A / A	549.3	deposit is very coarse (predominantly cobbles and boulders) in the east and sterilized in the west.
	HA304			A / A		
14216	HM394As	Inter.	56	M / S	1166.9	deposit is generally 2-3 m sandy pebble gravel. HM395 is active and >6 m deep.
	HM394Bs		42	M / S		
	HM395s	Active	45	M / M		
	HA305s		34	S / S		
	HA306s		56	S / -		
	HA307			M / S		
	HA308			S / S		
	HA309s		55	M / S		
14217	HM401	Aband.			69.7	pit varies from 1->3 m gravel; most of deposit is sand.
14218	HM404s	Inter.	68	M / S	1559.8	deposit overall has a high coarse content (HM405 was ballast source); west side is much finer (HM404 is >5 m sandy pebblegravel).
	HM405	Aband.				
	HA210s		61	M / M		
	HA211s		74	M / M		
	HA212			M / M		
	HA213s		44	M / A		
	HA214s		49	M / A		
	HA215s		55	M / A		
	HA216					

Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4) (>4.76mm)	Oversize 3-6"/>6"	Estimated Reserves ('000s m3)	Comments
14219	HA287s HA288 HA290s HA291s HA296s HA297 TR016s		58 46 55 57 44	A / A A / M M / S M / S M / M A / A S / S	1149.6	deposit is cobbly pebble gravel in the north and sterilized in the southern portion.
14220	HM378s HM398As HM398Bs HA289s HA217s HA218s HA219 HA220s HA221 HA222s HA223 HA224s HA225 HA226s HA227 HA228 HA229 HA230s HA231 HA232 HA233s HA234 HA235 HA236s HA237 HA238s HA239	Aband. Inter. Inter.	74 50 47 36 19 48 67 29 42 46 36 53 69 50	A / A M / M M / M S / - - / - M / M S / S M / S S / - S / S S / - M / S - / - A / M S / S - / - S / - S / S A / A S / A A / A S / S S / S M / M A / A A / A A / A	2074.9	deposit becomes progressively finer and sandier from north to south-central area; over most of the southern third of the deposit ~ 2 m sandy pebble gravel overlies cobble beds.
14221	HM374s HA240 HA241s HA242 HA243s HA244 HA245 HA246 HA247 HA248s HA249 HA250 HA251	Inter.	33 49 58 67	M / M A / A M / M M / M M / M A / M M / A A / A M / M A / A M / A A / M A / A	2488.0	variable deposit; some holes show 3 m cobble gravel, others show 2-3 m pebble gravel over till or sand.
14222	HM382s	Aband.	33	S / S	10.1	revegetated roadside pit.
14223	HM373			S / S	6.8	deposit is of very limited extent.

Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4) (>4.76mm)	Oversize 3-6"/>6"	Estimated Reserves ('000s m3)	Comments
14224	HM372As HM372Bs HA252 HA253s HA254s HA255 HA256s	Active	47 46 46 46 44	M / S M / M - / - S / S S / S M / M	1016.4	HM372 is 6 m of sandy pebble gravel; deposit is <2 m gravel over till at western edge.
14225	HM353s HM354s HM355s HM356 HM357s HM358 HM359s HM360s HM361 HA257s HA258 HA259s HA260 HA261s HA262s HA263 HA264 HA265 HA266s HA267s HA268 HA269	Active Active Inter. Aband. Inter. Aband. Active Active Aband.	36 38 75 17 51 48 46 49 55 41 51 54 41	A / S M / M A / A M / M A / A A / A M / S M / S A / M A / A A / A A / A A / A A / A - / - S / - M / M M / M A / A	2559.9	active deposit; in general, lower terraces are coarser than upper levels and are limited by the water table. Upper terraces are >8 m deep. Deposit is coarser in north half.
14226	HM362s	Aband.	38	S / -	8.0	pit is 1 m gravel over sand and revegetated with trees.
14227	HM366s HM367s HA270s HA271 HA272s HA273 HA274s HA275 HA276s HA277s HA278s HA279 HA282s HA283 HA284s HA286	Inter. Aband.	41 1 31 20 29 0 52 47 30 42	S / - - / - S / S - / - S / - - / - S / S - / - - / - A / A M / M - / - - / - - / - S / S S / -	1165.7	deposit is primarily sand with localized areas of gravel; water table at 2 m in northwest portion and deposit overlies till along southern edge.
14228	HA280 HA281s		38	A / A A / A	102.5	unopened deposit; thin cobble gravel deposit.

Deposit Number	Site Number s=sample	Pit Status	Percent Stone (>#4) (>4.76mm)	Oversize 3-6"/>6"	Estimated Reserves ('000s m3)	Comments
14229	HM368s HM369s HM370 HM406s	Aband. Aband.	41 40	M / S S / S M / M S / S	274.2	very high shale.
14230	HM364s HM365s	Aband.	26 32	S / - S / -	97.5	very high shale; 1 m of till overlies the gravel.
14231	HM352s		6	- / -	3.0	road cut; shale and thin till interbeds.
Total Estimated Reserves					26 464.0	

* Aband.=Abandoned; pit is usually revegetated

Inter.=Intermittent; pit generally has been in recent use, portions of pit may be revegetated

Active=Designation reserved for major producers; pits are usually large and in use every summer

Table 2: Summary of Grain Size Distribution of Gravel Samples

Deposit Number	Sample Number	% Gravel (># 4) (>4.76 mm)	% Sand (4.76 mm-) (0.07 mm)	% Silt and Clay (<0.07 mm)	Oversize on Site (3-6"/>6")
14201	HA330	65	32	3	M/M
14202	HM377	29	69	2	S/-
	HA329	45	52	3	S/-
14204	HM380A	47	52	1	M/M
	HM380B	52	47	1	A/A
	HA322	47	51	2	S/S
	HA328	44	54	2	A/M
14205A	HM350	32	62	6	S/-
14206A	HM376	39	58	3	M/-
14206B	HM375	57	40	3	M/M
14208	HA316	54	39	7	A/A
14209	HM384	48	49	3	M/M
14210	HM383	32	64	4	S/S
14211	HM396	40	53	7	S/S
14212	HM389	43	56	1	M/M
14213	HM390	41	53	6	S/S
	HM392	51	47	2	S/S
	HM393	36	62	2	M/M
	HM402	1	98	1	-/-
	HA315	37	61	2	-/-
14214	HM399	51	47	2	S/-
	HA300	27	71	2	S/-
	HA302	50	48	2	-/-
14215	HA303	57	38	5	A/A
14216	HM394A	56	43	1	M/S
	HM394B	42	56	2	M/S
	HM395	45	53	2	M/M
	HA305	34	64	2	S/S
	HA306	56	42	2	S/-
	HA309	55	43	2	M/S
14218	HM404	68	29	3	M/S
	HA210	61	35	4	M/M
	HA211	74	24	2	M/M
	HA213	44	55	1	M/A
	HA214	49	48	3	A/A
	HA215	55	40	5	M/A
14219	HA287	58	39	3	A/A
	HA290	46	49	5	M/S
	HA291	55	39	6	M/S
	HA296	57	39	4	M/M
	TR016D	44	47	9	S/S
14220	HM378	74	23	3	A/A
	HM398A	50	42	8	M/M
	HM398B	47	46	7	M/M
	HA217	19	80	1	-/-
	HA218	48	50	2	M/M
	HA220	67	28	5	M/S
	HA222	29	68	3	S/S
	HA224	42	53	5	M/S
	HA226	46	52	2	A/M
	HA230	36	60	4	S/S
	HA233	53	43	4	A/A
	HA236	69	26	5	M/M

Deposit Number	Sample Number	% Gravel (># 4) (>4.76 mm)	% Sand (4.76 mm-) (0.07 mm)	% Silt and Clay (<0.07 mm)	Oversize on Site (3-6"/>6")
14221	HA238	50	47	3	A/A
	HA289	36	62	2	S/-
	HM374	33	62	5	M/M
	HA241	49	46	5	M/M
	HA243	58	37	5	M/M
14222	HA248	67	29	4	A/A
	HM382	33	64	3	S/S
14224	HM372A	47	50	3	M/M
	HM372B	46	51	3	M/M
14225	HA253	46	52	2	S/S
	HA254	46	47	7	S/S
	HA256	44	53	3	M/M
	HM353	36	62	2	A/S
	HM354	38	60	2	M/M
	HM355	75	22	3	A/A
	HM357	17	81	2	M/M
	HM359	51	45	4	A/A
	HM360	48	46	6	A/A
	HA257	46	52	2	M/S
	HA259	49	48	3	M/M
	HA261	55	42	3	A/A
	HA262	41	56	3	A/A
	HA266	51	45	4	S/-
	HA267	54	43	3	M/M
14226	HM362	38	58	4	S/-
14227	HM366	41	57	2	S/-
	HM367	1	95	4	-/-
	HA270	31	66	3	S/S
	HA272	20	78	2	S/-
	HA274	29	67	4	S/S
	HA276	--	94	6	-/-
	HA277	52	43	5	A/A
	HA278	47	50	3	M/M
	HA282	30	67	3	-/-
	HA284	42	55	3	S/S
14228		HA281	38	56	6A/A
14229	HM368	41	55	4	M/S
	HM369	40	46	14	S/S
	HM406	59	37	4	S/S
14230	HM364	26	69	5	S/-
	HM365	32	63	5	S/-
14231	HM352	6	83	11	-/-
NO DEPOSIT DEFINED					
	HM386	50	43	7	M/S
	HM381	37	59	4	M/M
		HM371	40	58	2M/M

Table 4: Aggregate Quality and Development Potential Criteria

	Criteria	HIGH	MEDIUM	LOW
AGGREGATE QUALITY	Stone %	>30	15-30	0-15
	Sand %	0-35	35-70	>70
	Mud %	0-7	7-17	>17
	Shale %	0-5	5-12	>12
	Thickness	>5 m	2-5 m	<2 m
	Uniformity	high	medium	low
DEPOSIT DEVELOPMENT POTENTIAL	Aggregate Quality	high	medium	low
	<6"	abundant	moderate	minor
	>6"	minor	moderate	abundant
	Overburden	<2 m	2-4 m	>4 m
	Binder	yes	minor	none
	Water Table	>5 m	2-5 m	<2 m
	Geological Potential	good	moderate	low
	Verification	proven	limited	untested
	Local Access	0-1 km	1-5 km	>5 km
	Quarrying Status	active	intermittent	inactive
	Transportation Diff.	high	medium	low
	Planning Constraints	none	conditional	sterilized
	Speciality Material	yes		no
	Aggregate Substitute	none	marginal	proximal

REFERENCES

- Bannatyne, B.B.**
 1970: The clays and shales of Manitoba; Manitoba Mines Branch, Publication 67-1, 107p.
- Folk, R.L.**
 1974: Petrology of sedimentary rocks; Hemphill Publishing Company, Austin, Texas, 185p.
- Hince, T.L., Vogel, C.G. and Barto, W.P.**
 1991: Crown Lands Handbook for Agro-Manitoba; Manitoba Department of Natural Resources.
- Klassen, R.W.**
 1966: The surficial geology of the Riding Mountain area, Manitoba; Ph.D. Dissertation, University of Saskatchewan, 162p.
 1975: Quaternary geology and geomorphology of Assiniboine and Qu'Appelle valleys of Manitoba and Saskatchewan; Geological Survey of Canada, Bulletin 228, 61p.
 1979: Pleistocene geology and geomorphology of the Riding Mountain and Duck Mountain areas, Manitoba-Saskatchewan; Geological Survey of Canada, Memoir 396, 52p.
- Klassen, R.W., Wyder, J.E. and Bannatyne, B.B.**
 1970: Bedrock topography and geology of southern Manitoba; Geological Survey of Canada, Paper 70-51.
- Little, J. and Sie, D.**
 1976: Groundwater availability map series, Duck Mountain area (62N); Manitoba Department of Natural Resources, Water Resources Branch.
- McNeil, D.H. and Caldwell, W.G.E.**
 1981: Cretaceous rocks and their foraminifera in the Manitoba escarpment; Geological Association of Canada Special Paper No.21, 439p.
- Sie, J.**
 1978: Groundwater availability map series, Riding Mountain area (62K); Manitoba Department of Natural Resources, Water Resources Branch.
- Wickenden, R.T.D.**
 1945: Mesozoic stratigraphy of the eastern plains, Manitoba and Saskatchewan; Geological Survey of Canada, Memoir 239, 87p.

APPENDIX A: GRAIN SIZE CLASSIFICATION AND SIEVE INTERVALS

Screen (mm)		Wentworth size class*	
Field Processing	Sample is 100% Passing 6" (152.4mm)	Gravel	Boulders -8 phi (256mm)
	3" (76.1mm)		Cobbles
	1 1/2" (38.1mm)	Pebbles	Coarse -6 phi (64mm)
	3/4" (19.1mm)		Medium
	3/8" (9.5mm)		Fine
Laboratory Processing	#4 (4.8mm)	Sand	Granules -2 phi (4mm)
	#8 (2.4mm)		Sand
	#16 (1.2mm)		Coarse -1 phi (2mm)
	#30 (0.6mm)		Medium
	#50 (0.3mm)		Fine
	#100 (0.15mm)		Silt & Clay < 0.063mm +4 phi (0.063mm)
	#200 (0.07mm)		
	< 200	Fines	

* modified from Folk, 1974

APPENDIX B: SIEVE SAMPLE DATA

Deposit Number Sample Number 3"-6" / >6"		14201 HA330 M/M	14202 HM377 S/-	14202 HA329 S/-	14204 HM380A M/M	14204 HM380B A/A
P A S S I N G	3"	100	100	100	100	99
	1 1/2"	93	99	95	92	85
	3/4"	73	94	79	79	72
	3/8"	54	85	69	65	59
	#4	35	71	55	53	48
	#8	22	55	42	43	33
	#16	11	39	29	29	17
	#30	6	24	18	11	5
	#50	4	8	8	3	2
	#100	3	2	4	2	1
	#200	3	2	3	1	1

Deposit Number Sample Number 3"-6" / >6"		14204 HA322 S/S	14204 HA328 A/M	14205A HM350 S/-	14206A HM376 M/-	14206B HM375 M/M
P A S S I N G	3"	100	98	100	100	100
	1 1/2"	94	86	97	94	87
	3/4"	82	76	88	84	71
	3/8"	69	67	79	76	55
	#4	53	56	68	61	43
	#8	38	46	56	48	34
	#16	23	33	43	34	25
	#30	10	14	28	20	17
	#50	4	4	14	8	9
	#100	3	2	8	4	5
	#200	2	2	6	3	3

Deposit Number Sample Number 3"-6" / >6"		14208 HA316 A/A	14209 HM384 M/M	14210 HM383 S/S	14211 HM396 S/S	14212 HM389 M/M
P A S S I N G	3"	94	100	100	100	100
	1 1/2"	83	96	94	96	92
	3/4"	66	89	87	86	82
	3/8"	57	73	83	74	74
	#4	46	52	68	60	57
	#8	35	33	47	43	39
	#16	25	17	24	27	22
	#30	16	7	15	18	12
	#50	11	4	6	12	5
	#100	9	3	5	9	2
	#200	7	3	4	7	1

Deposit Number		14213	14213	14213	14213	14213
Sample Number		HM390	HM392	HM393	HM402	HA315
3"-6" / >6"		S/S	S/S	M/M	-/-	-/-
	3"	100	100	99	100	100
%	1 1/2"	94	99	96	100	98
	3/4"	81	62	88	100	90
P	3/8"	71	57	77	100	77
A	#4	59	49	64	99	63
S	#8	50	42	54	98	50
S	#16	40	33	40	97	37
I	#30	26	15	18	84	23
N	#50	13	6	4	10	6
G	#100	8	3	2	2	3
	#200	6	2	2	1	2

Deposit Number		14214	14214	14214	14215	14216
Sample Number		HM399	HA300	HA302	HA303	HM394A
3"-6" / >6"		S/-	S/-	-/-	A/A	M/S
	3"	98	100	100	98	99
%	1 1/2"	91	99	98	86	90
	3/4"	78	91	85	64	74
P	3/8"	65	85	66	54	59
A	#4	49	73	50	43	44
S	#8	37	59	37	33	33
S	#16	25	44	22	22	22
I	#30	11	21	9	12	8
N	#50	4	5	4	7	2
G	#100	3	3	2	6	1
	#200	2	2	2	5	1

Deposit Number		14216	14216	14216	14216	14216
Sample Number		HM394B	HM395	HA305	HA306	HA309
3"-6" / >6"		M/S	M/M	S/S	S/-	M/S
	3"	100	100	100	97	99
%	1 1/2"	96	94	94	92	94
	3/4"	85	86	87	79	73
P	3/8"	71	71	78	60	58
A	#4	58	55	66	44	45
S	#8	47	43	54	33	36
S	#16	33	28	39	23	26
I	#30	11	10	16	12	12
N	#50	4	3	4	7	4
G	#100	3	2	3	3	3
	#200	2	2	2	2	2

Deposit Number		14218	14218	14218	14218	14218
Sample Number		HM404	HA210	HA211	HA213	HA214
3"-6" / >6"		M/S	M/M	M/M	M/A	A/A
	3"	100	98	97	97	97
%	1 1/2"	86	89	86	89	89
	3/4"	64	72	64	77	78
P	3/8"	52	54	40	69	65
A	#4	32	39	26	56	51
S	#8	25	29	17	39	39
S	#16	17	21	12	17	26
I	#30	11	13	8	5	15
N	#50	5	6	5	2	6
G	#100	4	5	3	2	4
	#200	3	4	2	1	3

Deposit Number		14218	14219	14219	14219	14219
Sample Number		HA215	HA287	HA290	HA291	HA296
3"-6" / >6"		M/A	A/A	M/S	M/S	M/M
	3"	97	99	98	98	100
%	1 1/2"	88	89	92	94	90
	3/4"	73	73	80	77	70
P	3/8"	58	55	70	61	57
A	#4	45	42	54	45	43
S	#8	31	29	33	31	31
S	#16	19	14	17	21	19
I	#30	11	7	11	14	12
N	#50	7	4	8	10	8
G	#100	6	3	6	8	5
	#200	5	3	5	6	4

Deposit Number		14219	14220	14220	14220	14220
Sample Number		TR016	HM378	HM398A	HM398B	HA217
3"-6" / >6"		S/S	A/A	M/M	M/M	-/-
	3"	100	99	96	96	100
%	1 1/2"	100	87	84	84	100
	3/4"	100	54	72	72	98
P	3/8"	77	37	61	64	96
A	#4	56	26	50	53	81
S	#8	38	19	39	41	51
S	#16	27	13	26	27	21
I	#30	19	11	17	17	7
N	#50	15	7	13	12	3
G	#100	12	5	11	10	2
	#200	9	3	8	7	1

Deposit Number Sample Number 3"-6" / >6"	14220 HA218 M/M	14220 HA220 M/S	14220 HA222 S/S	14220 HA224 M/S	14220 HA226 A/M
3"	100	97	99	95	97
% 1 1/2"	94	85	96	90	90
3/4"	83	63	90	80	78
P 3/8"	69	45	82	71	66
A #4	52	33	71	58	54
S #8	37	26	57	44	38
S #16	28	18	31	28	21
I #30	18	12	8	15	9
N #50	6	7	5	8	4
G #100	3	6	4	6	3
#200	2	5	3	5	2

Deposit Number Sample Number 3"-6" / >6"	14220 HA230 S/S	14220 HA233 A/A	14220 HA236 M/M	14220 HA238 A/A	14220 HA289 S/-
3"	98	97	98	95	100
% 1 1/2"	93	86	89	86	98
3/4"	84	71	59	73	91
P 3/8"	75	58	44	62	79
A #4	64	47	31	50	64
S #8	50	35	23	35	49
S #16	30	21	16	17	37
I #30	12	12	11	7	27
N #50	6	8	8	4	10
G #100	5	6	6	3	3
#200	4	4	5	3	2

Deposit Number Sample Number 3"-6" / >6"	14221 HM374 M/M	14221 HA241 M/M	14221 HA243 M/M	14221 HA248 A/A	14222 HM382 S/S
3"	99	97	100	97	99
% 1 1/2"	94	93	93	83	90
3/4"	86	80	78	61	83
P 3/8"	78	65	59	47	76
A #4	67	51	42	33	67
S #8	55	36	28	23	51
S #16	35	21	19	14	30
I #30	16	14	13	9	10
N #50	8	10	9	6	5
G #100	6	6	6	5	4
#200	5	5	5	4	3

Deposit Number		14224	14224	14224	14224	14224
Sample Number		HM372A	HM372B	HA253	HA254	HA256
3"-6" / >6"		M/M	M/M	S/S	S/S	M/M
	3"	100	100	99	97	99
%	1 1/2"	96	92	94	91	95
	3/4"	82	80	82	79	85
P	3/8"	69	67	69	69	72
A	#4	53	54	54	54	56
S	#8	34	42	41	37	37
S	#16	16	30	29	23	17
I	#30	7	16	20	16	8
N	#50	5	6	8	12	5
G	#100	4	4	3	9	4
	#200	3	3	2	7	3

Deposit Number		14225	14225	14225	14225	14225
Sample Number		HM353	HM354	HM355	HM357	HM359
3"-6" / >6"		A/S	M/M	A/A	M/M	A/A
	3"	98	97	100	98	97
%	1 1/2"	92	92	93	93	83
	3/4"	83	84	69	89	68
P	3/8"	75	75	42	86	57
A	#4	64	62	25	83	49
S	#8	49	48	17	74	42
S	#16	26	23	11	40	31
I	#30	9	8	8	10	18
N	#50	4	4	6	3	9
G	#100	3	3	4	2	5
	#200	2	2	3	2	4

Deposit Number		14225	14225	14225	14225	14225
Sample Number		HM360	HA257	HA259	HA261	HA262
3"-6" / >6"		A/A	M/S	M/M	A/A	A/A
	3"	97	100	97	91	98
%	1 1/2"	90	93	88	82	95
	3/4"	80	83	76	64	84
P	3/8"	69	69	64	54	74
A	#4	52	54	51	45	59
S	#8	39	35	37	33	42
S	#16	24	17	22	20	24
I	#30	14	8	14	11	10
N	#50	10	5	8	6	4
G	#100	8	3	4	4	3
	#200	6	2	3	3	3

Deposit Number		14225	14225	14226	14227	14227
Sample Number		HA266	HA267	HM362	HM366	HM367
3"-6" / >6"		S/-	M/M	S/-	S/-	-/-
	3"	97	78	100	100	100
%	1 1/2"	90	75	98	91	100
	3/4"	79	66	90	82	100
P	3/8"	63	57	76	71	100
A	#4	49	46	62	59	99
S	#8	31	33	48	47	97
S	#16	15	16	32	37	92
I	#30	10	9	14	28	67
N	#50	7	5	6	7	12
G	#100	5	3	5	3	5
	#200	4	3	4	2	4

Deposit Number		14227	14227	14227	14227	14227
Sample Number		HA270	HA272	HA274	HA276	HA277
3"-6" / >6"		S/S	S/-	S/S	-/-	A/A
	3"	99	100	100	100	96
%	1 1/2"	94	100	98	100	86
	3/4"	83	94	91	100	72
P	3/8"	77	88	81	100	59
A	#4	69	80	71	100	48
S	#8	59	69	59	100	37
S	#16	41	52	44	100	27
I	#30	21	26	22	99	19
N	#50	6	6	8	66	10
G	#100	4	2	5	13	6
	#200	3	2	4	6	5

Deposit Number		14227	14227	14227	14228	14229
Sample Number		HA278	HA282	HA284	HA281	HM368
3"-6" / >6"		M/M	-/-	S/S	A/A	M/S
	3"	97	100	100	99	100
%	1 1/2"	92	97	95	91	94
	3/4"	79	90	84	82	83
P	3/8"	66	83	71	74	69
A	#4	53	70	58	62	59
S	#8	43	56	45	53	50
S	#16	31	41	30	43	41
I	#30	15	24	15	31	31
N	#50	7	14	6	18	16
G	#100	4	5	3	9	6
	#200	3	3	3	6	4

Deposit Number Sample Number 3"-6" / >6"		14229 HM369 S/S	14229 HM406 S/S	14230 HM364 S/-	14230 HM365 S/-	14231 HM352 -/-
%	3"	100	100	100	100	100
	1 1/2"	92	77	100	100	99
	3/4"	80	60	97	89	97
	3/8"	67	50	91	79	97
	#4	54	41	74	68	94
	#8	43	31	49	59	85
	#16	32	20	21	49	67
	#30	24	12	9	29	43
	#50	19	8	6	10	20
	#100	16	6	5	6	13
G	#200	14	4	5	5	11

Deposit Number Sample Number 3"-6" / >6"		No Dep HM371 M/M	No Dep HM386 M/S	No Dep HM381 M/M
%	3"	100	92	100
	1 1/2"	96	86	98
	3/4"	84	76	90
	3/8"	71	65	78
	#4	60	50	63
	#8	47	37	50
	#16	32	25	36
	#30	17	17	21
	#50	6	11	10
	#100	3	8	5
G	#200	2	7	4

APPENDIX C: PEBBLE LITHOLOGY AND DELETERIOUS CONTENT OF SAMPLES

Deposit Number	Sample Number	Precambrian crys / vol		% Lithology of 3/4" - 1 1/2" fraction						Encrust/ Cemented
				Carbonate	Sandstone	Chert	Silt/ Shale	Ironstone/ Concretions	Weathered	
14201	HA330	22	14	63						1
14202	HM377	18	10	64	2	1	5			
	HA329	5		31					4	60
14204	HM380A	23	10	50	1					16
	HM380B	16	9	57	1					17
	HA322	23	10	57					6	4
	HA328	19	11	56		1	1	1	7	4
14205A	HM350	24	7	63			1			5
14206A	HM376	9	1	76			1	2		11
14206B	HM375	9	2	82						7
14208	HA316	11	1	67				1	4	16
14209	HM384	1		35				1		63
14210	HM383			12			1			87
14211	HM396	14	5	75			1			5
14212	HM389	13	3	55				1		28
14213	HM390	6	1	48						45
	HM392		3	39						58
	HM393	25	5	70						
	HA315	16	15	58					1	10
14214	HM399	4	1	47			1			47
	HA300	27	5	58	1			1	5	3
	HA302	8	1	49					2	40
14215	HA303	21	8	67		1		2		2
14216	HM394A	25	6	62						7
	HM394B	9	1	30						60
	HM395	10	3	38				2		47
	HA306	19	11	60	1	2	1	1	3	2
	HA309	15	10	71				1	3	
14218	HM404	2	2	38					7	54
	HA210	12	13	66					3	6
	HA211	19	10	45		1		5	1	21
	HA213	26	11	55			2	2	1	3
	HA214	22	15	61		1		1		
	HA215	23	13	59		1	1	1	1	1
14219	HA287	15	15	63			1	2	2	2
	HA290	9	11	67				4	5	4
	HA291	15	8	69				3	4	1
	HA296	9	4	63					6	18
14220	HM378	12	3	44	1		1	1	1	37
	HM398	3	5	57				2		33
	HA289	23	7	68						2
	HA217	18	7	50						25
	HA218	20	13	59				5	1	2
	HA220	19	14	50			1	3	5	8
	HA222	16	5	56	1	2		3	3	14
	HA224	14	11	56		1	2	5	2	9
	HA226	18	11	54				4	3	10
	HA230	15	12	55			1	5		12
	HA233	12	11	59		1		6	7	4
	HA236	14	4	58		1			1	22
	HA238	15	7	76						2
14221	HM374		3	33			2	2		60
	HA241	21	16	53		2	1	1	2	4
	HA243	13	12	64			1	3	3	4

% Lithology of 3/4" - 1 1/2" fraction

Deposit Number	Sample Number	Precambrian crys / vol	Carbonate	Sandstone	Chert	Silt/ Shale	Ironstone/ Concretions	Weathered	Encrust/ Cemented
	HA248	13	8	60				4	15
14222	HM382	22	6	71			1		
14224	HM372A	4	3	76		1			16
	HM372B	2	1	31			3	7	56
	HA253	22	8	62			2	3	3
	HA254	17	13	62	1		4	3	
	HA256	11	13	61		1	4	2	8
14225	HM353	20	12	59		2	1		6
	HM354	23	17	53		1	1		5
	HM355	19	10	63	2	1			5
	HM357	16	5	50		6			23
	HM359	15	12	67		1	2		3
	HM360	11	1	64		2	8		14
	HA257	18	12	58	1	1	1	5	4
	HA259	14	9	60			4	2	9
	HA261	15	9	55			4	6	11
	HA262	20	10	61			5	4	
	HA266	16	10	58	1			1	14
	HA267	17	6	62		1	3	4	7
14226	HM362	15	2	66		4	2		11
14227	HM366	17	6	63		1	2		11
	HA270	7	1	50	1		2	4	35
	HA274	19	3	70	1		2		5
	HA277	10	8	62			15	3	2
	HA278	13	3	72			1	3	8
	HA282	4		36		1	1	3	55
	HA284	19	11	62		2	3	2	1
14228	HA281	26	10	52			7	4	1
14229	HM368	23	11	59		4	1		2
	HM369	7	3	34		56			
	HM406	13	2	51		9	3	4	18
14230	HM364	15	7	76		2			
	HM365	11	2	47		38			2
NO DEPOSIT DEFINED									
	HM371	25	6	52				1	16
	HM381	7	5	41			2	5	40
	HM386	2		50		1			47

APPENDIX D: BACKHOE TEST PIT LOGS

DEPOSIT NUMBER	SITE NUMBER s=sample	LOG
14201	HA330s	0.0 - 1.5M DITCH WALL;SANDY COARSE PEBBLE GRAVEL BACKHOE IN BASE OF DITCH 0.0 ->2.5M SANDY PEBBLE GRAVEL, VERY LITTLE SAND
	HA331	0.0 - 0.8M COBBLY, BOULDER GRAVEL
14202	HA329s	0.0 - 2.8M INTERBEDDED SANDY PEBBLE GRAVEL AND WELL SORTED GRANULES >2.8 COARSE PEBBLE GRAVEL AND WATER
14204	HM380s	PIT FACE 0.0 - 1.5M SANDY PEBBLE GRAVEL, VERY SANDY 1.5 - 4.0 COARSE SAND,PEBBLY; SOME LENSES OF MORE CONCENTRATED STONE BACKHOE IN BASE: 0.0 - 1.0M SANDY PEBBLE GRAVEL; BED OF COBBLES AND BOULDERS AT BASE 1.0 - 1.5 COARSE SAND,SOME PEBBLES 1.5 ->2.5 SANDY COARSE PEBBLE GRAVEL - CAVING
	HA322s	0.0 - 0.2M SOIL 0.2 ->2.6 INTERBEDDED SANDY PEBBLE GRAVEL AND PEBBLY COARSE SAND
	HA323	0.0 - 0.9M PEBBLY COARSE SAND 0.9 - 1.9 SANDY PEBBLE GRAVEL, A FEW SMALL COBBLES 1.9 ->2.5 PEBBLY COARSE SAND
	HA324	0.0 - 0.3M SOIL 0.3 ->3.2 SANDY PEBBLE GRAVEL WITH COBBLES
	HA325	0.0 - 0.2M VERY SANDY, VERY FINE PEBBLE GRAVEL 0.2 - 2.4 SAND, FINES DOWN >2.4 TILL
	HA326	0.0 ->2.6M SANDY COARSE PEBBLE GRAVEL WITH COBBLES
	HA327	0.0 ->1.5M COBBLE GRAVEL WITH BOULDERS
	HA328s	0.0 - 0.2M SOIL 0.2 - 1.8 SANDY COARSE PEBBLE GRAVEL WITH COBBLES 1.8 - 2.2 PEBBLY COARSE SAND 2.2 ->2.6 COBBLE GRAVEL
14208	HA316s	0.0 - 0.5M SILT 0.5 ->2.7 COBBLE GRAVEL, MATRIX IS SANDY COARSE PEBBLE GRAVEL
	HA317	0.0 - 0.3M VERY SANDY, VERY FINE PEBBLE GRAVEL 0.3 - 1.0 SILT >1.0 BOULDER;STOPPED HOLE
	HA318	0.0 - 1.1M COBBLY PEBBLE GRAVEL 1.1 ->1.6 TILL

DEPOSIT NUMBER	SITE NUMBER s=sample	LOG
14213	HA319	0.0 - 0.2M PEBBLE GRAVEL >0.2 TILL
	HA320	0.0 - 0.6M HEAVY BLACK SOIL 0.6 - 0.8 COARSE SAND 0.8 ->1.0 SILT, WET
	HA321	SILT AND CLAY
	HA310	0.0 - 0.2M SOIL 0.2 - 0.4 GRANULES 0.4 ->2.0 MEDIUM TO MEDIUM FINE SAND
	HA311	0.0 ->1.6M COARSE SAND WITH SOME PEBBLES
	HA312	0.0 - 0.7M SOIL 0.7 ->2.0 FINE SAND, STONE FREE
	HA312B	0.0 ->2.0M PEBBLY COARSE SAND
	HA313	0.0 - 0.8M VERY SANDY, VERY FINE PEBBLE GRAVEL >0.8 TILL
	HA314	0.0 - 0.5M VERY SANDY, VERY FINE PEBBLE GRAVEL 0.5 ->1.5 STONE FREE COARSE SAND
	HA315s	0.0 - 1.8M SANDY PEBBLE GRAVEL 1.8 - 2.0 PEBBLY COARSE SAND >2.0 SILT, WET
	HA298	BACKHOE IN BASE OF ABANDONED PIT 0.0 - 0.5M MEDIUM-COARSE SAND >0.5 FINE SAND AND SILT, WET
	HA299	0.0 - 1.8M VERY SANDY, VERY FINE PEBBLE GRAVEL >1.8 FINE SAND AND SILT, WET
	HA300s	0.0 - 1.3M SANDY FINE PEBBLE GRAVEL, HIGH GRANULES 1.3 ->2.8 PEBBLY COARSE SAND
	HA301	0.0 - 1.0M SANDY FINE PEBBLE GRAVEL 1.0 ->2.0 PEBBLY COARSE SAND
14214	HA302s	0.0 - 0.4M GRANULES, WELL SORTED 0.4 - 2.2 SANDY PEBBLE GRAVEL, SAND IS COARSE AND INCREASES DOWN HOLE 2.2 ->2.8 COARSE SAND
	HA303s	0.0 ->2.6M COBBLY PEBBLE GRAVEL
14215	HA304	0.0 - 0.6M SOIL, FINE SAND 0.6 ->0.9 BOULDERS, COBBLE GRAVEL
	HA305s	0.0 - 0.2M SOIL, FINE SAND 0.2 ->2.5 SANDY PEBBLE GRAVEL
14216		

DEPOSIT NUMBER	SITE NUMBER		LOG
	s=sample		
14218	HA306s	0.0 - 0.6M	FINE SAND, LAYER OF CALICHE
		0.6 ->3.0	SANDY PEBBLE GRAVEL
	HA307	0.0 ->3.0M	SANDY COARSE PEBBLE GRAVEL
	HA308	0.0 - 0.2M	SOIL
		0.2 - 2.2	SANDY PEBBLE GRAVEL
		>2.2	PEBBLY COARSE SAND
	HA309s	0.0 ->3.3M	SANDY PEBBLE GRAVEL
	HA210s	0.0 ->3.0M	SANDY PEBBLE GRAVEL WITH COBBLES; SAND INCREASES DOWN HOLE
	HA211s	0.0 - 0.1M	SOIL
		0.1 ->2.8	SANDY PEBBLE GRAVEL WITH COBBLES; MATERIAL COARSENS DOWN HOLE
	HA212	0.0 - 0.2M	SOIL
		0.2 ->2.8	SANDY PEBBLE GRAVEL WITH COBBLES; MORE COARSE MATERIAL THAN HA211
	HA213s	0.0 - 0.1M	SOIL
		0.1 - 1.0	COBBLES, SMALL BOULDERS
		1.0 - 1.8	GRANULES AND FINE PEBBLE GRAVEL
		1.8 ->3.6	SANDY PEBBLE GRAVEL WITH COBBLES
14219	HA214s	0.2 - 0.8M	SANDY FINE PEBBLE GRAVEL
		0.8 ->3.2	COBBLY PEBBLE GRAVEL
	HA215s	0.0 - 0.8M	FINE SAND, UPPER .4M IS SOIL
		0.8 - 2.1	COBBLE GRAVEL
		2.1 ->3.8	SANDY PEBBLE GRAVEL WITH COBBLES
	HA216	0.0 - 1.5M	MEDIUM FINE SAND
		>1.5	INTO COBBLES - STOPPED HOLE
	HA287s	0.0 - 0.4M	SOIL
		0.4 ->3.1	SANDY COARSE PEBBLE GRAVEL, COBBLY
	HA288	0.0 - 0.2M	SOIL
		0.2 - 1.7	SANDY COARSE PEBBLE GRAVEL
		1.7 - 2.0	COBBLES AND BOULDERS
		2.0 - 3.0	SANDY PEBBLE GRAVEL
		>3.0	COBBLES AND BOULDERS
	HA290s	0.0 - 0.2M	SOIL
		0.2 - 1.5	SANDY PEBBLE GRAVEL COARSE SAND MATRIX, SOME COBBLES
		1.5 ->3.3	SANDY PEBBLE GRAVEL, HIGH FINES, TILL BALLS
	HA291s	0.0 - 0.2M	SOIL
		0.2 - 2.6	DIRTY SANDY COARSE PEBBLE GRAVEL WITH COBBLES
	HA296s	0.0 - 0.8M	VERY SANDY FINE PEBBLE GRAVEL
		0.8 ->3.0	COBBLY SANDY PEBBLE GRAVEL
	HA297	0.0 ->2.7M	COBBLY PEBBLE GRAVEL, DIRTY

DEPOSIT NUMBER	SITE NUMBER s=sample		LOG
14220	HA217s	0.0 - 0.2M 0.2 - 1.2 1.2 ->2.5	SOIL VERY SANDY FINE PEBBLE GRAVEL PEBBLY COARSE SAND
	HA218s	0.0 - 0.2M 0.2 - 2.6 2.6 ->3.1	SOIL COBBLY, SANDY PEBBLE GRAVEL SANDY PEBBLY GRAVEL
	HA219	0.0 - 0.2M 0.2 - 0.4 0.4 ->3.0	SOIL COBBLY PEBBLE GRAVEL SANDY PEBBLE GRAVEL, SAND COARSE AND INCREASES DOWN HOLE
	HA220s	0.0 - 0.3M 0.3 - 2.0 2.0 ->3.4	SOIL VERY CLEAN 1 1/2" PEBBLES, ALMOST NO SAND SANDY PEBBLE GRAVEL, VERY DIRTY, SOME COBBLES
	HA221	0.0 - 0.2M 0.2 - 1.0 1.0 ->2.5	SOIL SANDY COARSE PEBBLE GRAVEL, SOME COBBLES SANDY PEBBLE GRAVEL, HIGH COARSE SAND
	HA222s	0.0 - 0.7M 0.7 ->2.8	COBBLY PEBBLE GRAVEL VERY SANDY PEBBLE GRAVEL
	HA223	0.0 - 0.5M 0.5 - 0.8 0.8 - 1.2 1.2 ->2.5	SANDY COARSE PEBBLE GRAVEL MEDIUM-FINE SAND, FEW PEBBLES CLEAN SANDY FINE PEBBLE GRAVEL VERY SANDY FINE PEBBLE GRAVEL
	HA224s	0.0 - 0.2M 0.2 - 1.7 1.7 - 2.5 2.5 ->3.1	SOIL COBBLY PEBBLE GRAVEL SANDY PEBBLE GRAVEL PEBBLY COARSE SAND
	HA225	0.0 - 0.2M 0.2 - 0.5 0.5 - 1.5 1.5 - 1.7 1.7 ->2.2	SOIL SANDY COARSE GRAVEL PEBBLY MEDIUM COARSE SAND BED OF SANDY PEBBLE GRAVEL SAND AS ABOVE
	HA226s	0.0 ->3.2M	SANDY COARSE PEBBLE GRAVEL WITH COBBLES
	HA227	0.0 - 1.3M 1.3 - 2.5 >2.5	SANDY VERY FINE PEBBLE GRAVEL, COBBLE LAG AT SURFACE PEBBLY COARSE SAND MEDIUM FINE SAND
	HA228	0.0 - 0.2M 0.2 - 1.5 1.5 - 2.2 2.2 - 2.5	SOIL SANDY VERY FINE PEBBLE GRAVEL, COARSENS DOWN TO SANDY PEBBLE GRAVEL VERY SANDY FINE PEBBLE GRAVEL PEBBLY SAND -CAVING
	HA229	0.0 - 0.2M 0.2 - 1.5 1.5 - 2.2 2.2 ->2.5	SOIL DIRTY SANDY PEBBLE GRAVEL WITH SOME COBBLES SANDY FINE PEBBLE GRAVEL MEDIUM FINE SAND -CAVING

DEPOSIT NUMBER	SITE NUMBER s=sample	LOG
	HA230s	0.0 - 0.2M SOIL 0.2 - 1.4 SANDY PEBBLE GRAVEL WITH SOME COBBLES 1.4 - 2.2 SANDY FINE PEBBLE GRAVEL, COARSE SAND, SOME LARGE PEBBLES 2.2 ->2.5 SANDY FINE PEBBLE GRAVEL
	HA231	0.0 - 0.2M SOIL 0.2 - 1.0 SANDY PEBBLE GRAVEL 1.0 - 2.2 COARSE PEBBLY SAND >2.2 COBBLES
	HA232	0.0 - 0.3M SOIL 0.3 - 2.2 SANDY PEBBLE GRAVEL >2.2 COBBLES
	HA233s	0.0 - 0.1M SOIL 0.1 ->2.6 COBBLE GRAVEL, GRAVEL FINES DOWN HOLE TO SANDY COARSE PEBBLE GRAVEL WITH COBBLES
	HA234	0.0 - 0.3M SOIL 0.3 - 1.5 SANDY FINE PEBBLE GRAVEL, SOME COBBLES AT SURFACE 1.5 ->2.5 PEBBLY COARSE SAND
	HA235	0.0 - 0.3M SOIL 0.3 ->2.6 COBBLE GRAVEL; UPPER PART VERY COARSE WHILE MATRIX IS MEDIUM FINE SAND, LOWER PART HAS FULLER RANGE OF GRAIN SIZE
	HA236s	0.0 - 0.3M SOIL 0.3 - 0.7 COBBLE GRAVEL 0.7 ->3.3 SANDY COARSE PEBBLE GRAVEL, SOME COBBLES-ESPECIALLY TO BASE, PEBBLES AT BASE ARE TILL COATED >3.0 WATER TABLE
	HA237	0.0 - 0.3M SOIL 0.3 - 1.5 SANDY COARSE PEBBLE GRAVEL 1.5 ->2.0 COBBLE GRAVEL
	HA238s	0.0 - 0.3M SOIL 0.3 - 2.3 SANDY PEBBLE GRAVEL WITH COBBLES >2.3 COBBLES
	HA239	0.0 - 0.3M SOIL 0.3 - 2.3 SANDY PEBBLE GRAVEL >2.3 COBBLES
	HA289s	ABANDONED PIT: 0.0 - 2.5M INTERBEDS OF SANDY PEBBLE GRAVEL, PEBBLY COARSE SAND AND MEDIUM SAND BACKHOE IN BASE: 2.5 - 3.0 PEBBLY SAND 3.0 ->5.5 VERY SANDY FINE PEBBLE GRAVEL
14221	HA240	0.0 ->1.5M BOULDERY COBBLE GRAVEL

DEPOSIT NUMBER	SITE NUMBER	LOG
	s=sample	
	HA241s	0.0 - 0.3M SOIL 0.3 - 1.5 SANDY PEBBLE GRAVEL - FINES DOWN FROM COBBLY PEBBLE GRAVEL AT TOP TO SANDY FINE PEBBLE AT BASE 1.5 - 1.7 MEDIUM FINE GREY SAND 1.7 ->3.2 SANDY PEBBLE GRAVEL, SOME COBBLES
	HA242	0.0 - 0.2M SOIL 0.2 - 3.0 COBBLE GRAVEL 3.0 ->3.2 MEDIUM COARSE SAND, WET
	HA243s	0.0 - 0.3M SOIL 0.3 ->3.4 COBBLY SANDY PEBBLE GRAVEL
	HA244	0.0 - 0.3M SOIL 0.3 ->3.3 COBBLY SANDY PEBBLE GRAVEL
	HA245	0.0 ->2.5M COBBLE GRAVEL
	HA246	0.0 ->1.6M COBBLE GRAVEL
	HA247	0.0 - 0.8M SANDY FINE PEBBLE GRAVEL, FEW COBBLES AT SURFACE 0.8 - 1.1 MEDIUM COARSE SAND, SOME PEBBLES AT BASE 1.1 - 1.7 SANDY PEBBLE GRAVEL, COBBLES AT TOP >1.7 TILL
	HA248s	0.0 ->2.8M INTERBEDS OF COBBLE GRAVEL AND SANDY PEBBLE GRAVEL
	HA249	0.0 ->1.2M BOULDERY COBBLE GRAVEL -HOLE STOPPED DUE TO COARSENESS
	HA250	0.0 - 1.8M COBBLY PEBBLE GRAVEL 1.8 ->3.0 MEDIUM COARSE SAND
	HA251	0.0 ->2.6M COBBLE GRAVEL
14224	HA252	0.0 - 0.5M SANDY COARSE PEBBLE GRAVEL 0.5 - 1.0 VERY SANDY FINE PEBBLE GRAVEL 1.0 ->2.6 COARSE SAND WITH PEBBLES
	HA253s	0.0 - 0.9M VERY SANDY FINE PEBBLE GRAVEL 0.9 ->3.4 INTERBEDS OF PEBBLE GRAVEL AND VERY SANDY FINE PEBBLE GRAVEL
	HA254s	0.0 - 1.5M MEDIUM FINE SAND WITH SOME PEBBLES 1.5 - 3.3 SANDY PEBBLE GRAVEL, SOME COBBLES >3.3 TILL
	HA255	0.0 - 1.8M SANDY COARSE PEBBLE GRAVEL 1.8 ->2.5 TILL
	HA256s	0.0 - 1.0M COBBLE GRAVEL 1.0 - 2.6 SANDY PEBBLE GRAVEL >2.6 COBBLES
14225	HA257s	0.0 - 0.3M SOIL 0.3 ->3.0 SANDY COARSE PEBBLE GRAVEL WITH COBBLES

DEPOSIT NUMBER	SITE NUMBER s=sample	LOG
	HA258	0.0 - 0.3M SOIL 0.3 - 1.3 PEBBLY COARSE SAND 1.3 ->2.8 INTERBEDS OF SANDY PEBBLE GRAVEL AND COBBLY SANDY COARSE PEBBLE GRAVEL
	HA259s	0.0 - 0.3M SOIL 0.3 ->3.3 INTERBEDS OF PEBBLE GRAVEL AND COBBLY PEBBLE GRAVEL AT BASE IS SEAM OF COARSE SAND, THEN BACK INTO COARSE PEBBLE GRAVEL
	HA260	0.0 - 0.2M SOIL 0.2 ->2.5 COBBLY PEBBLE GRAVEL
	HA261s	0.0 ->2.5M COBBLY PEBBLE GRAVEL
	HA262s	0.0 - 1.5M COBBLE GRAVEL 1.5 ->3.0 SANDY PEBBLE GRAVEL WITH SOME SMALL COBBLES
	HA263A	0.0 ->2.5M COBBLY PEBBLE GRAVEL, COARSER DOWN HOLE
	HA263B	0.0 - 0.3M SOIL 0.3 ->1.0 COBBLE GRAVEL, BOULDERS
	HA264	0.0 ->2.0M COBBLE GRAVEL
	HA265	0.0 - 1.5M SANDY FINE PEBBLE GRAVEL 1.5 ->2.5 PEBBLY COARSE SAND - WATER AT BASE
	HA267	0.0 - 0.3M SOIL 0.3 - 0.7 SAND 0.7 ->2.5 SANDY PEBBLE GRAVEL WITH COBBLES
	HA268	0.0 - 0.2M SOIL 0.2 - 2.7 SANDY PEBBLE GRAVEL WITH COBBLES 2.7 ->3.0 SANDY FINE PEBBLE GRAVEL
	HA269	0.0 - 0.3M SOIL 0.3 ->1.5 COBBLES
14227	HA270s	0.0 - 0.2M SOIL 0.2 - 0.6 FINE SAND 0.6 ->2.5 SANDY FINE PEBBLE GRAVEL
	HA271	0.0 - 0.2M SOIL 0.2 - 1.3 SANDY FINE PEBBLE GRAVEL 1.3 ->2.5 PEBBLY SAND (SAND M-MF)
	HA272s	0.0 - 0.2M SOIL 0.2 - 0.7 FINE SAND 0.7 - 1.5 SANDY PEBBLE GRAVEL 1.5 ->3.0 PEBBLY COARSE SAND
	HA273	0.0 - 0.8M SANDY FINE PEBBLE GRAVEL 0.8 - 1.2 FINE SAND, SILTY SEAM 1.2 ->2.8 MEDIUM-FINE SAND, SOME PEBBLES

DEPOSIT NUMBER	SITE NUMBER s=sample	LOG
	HA274s	0.0 - 0.4M SOIL 0.4 - 0.9 FINE SAND 0.9 ->2.8 SANDY PEBBLE GRAVEL
	HA275	0.0 - 3.0M FINE SAND, STONE FREE; FINES DOWN >3.0 TILL
	HA276s	0.0 ->2.5M MEDIUM-FINE SAND, STONE FREE
	HA277s	0.0 ->2.6M SANDY COBBLE GRAVEL, COARSER TO BASE
	HA278s	0.0 ->3.0M INTERBEDS OF PEBBLE GRAVEL, COARSE PEBBLY SAND AND (TO BASE) COBBLY PEBBLE GRAVEL
	HA279	0.0 - 0.5M SANDY FINE PEBBLE GRAVEL 0.5 - 2.5 PEBBLY COARSE SAND 2.5 ->3.0 FINE SAND, BECOMING SILTIER, WET
	HA282s	0.0 - 1.0M SANDY PEBBLE GRAVEL 1.0 - 2.0 MEDIUM SAND >2.0 SANDY PEBBLE GRAVEL, WATER TABLE
	HA283	0.0 - 1.3M VERY SANDY PEBBLE GRAVEL 1.3 ->2.3 MEDIUM COARSE SAND
	HA284s	0.0 - 1.7M SANDY PEBBLE GRAVEL WITH COBBLES, FINES DOWN 1.7 - 3.0 SANDY PEBBLE GRAVEL, TILL BALLS >3.0 MEDIUM COARSE SAND, SOME PEBBLES
	HA286	0.0 - 0.4M SOIL, FINE SAND 0.4 - 0.8 PEBBLY SAND 0.8 - 1.3 VERY SANDY PEBBLE GRAVEL WITH SOME COBBLES 1.3 ->2.2 MEDIUM COARSE SAND, SOME PEBBLES
14228	HA280	0.0 - 1.4M COBBLY PEBBLE GRAVEL 1.4 ->2.3 SILT
	HA281s	0.0 - 2.0M COBBLY PEBBLE GRAVEL

APPENDIX E: INFORMATION FROM DEPARTMENT OF HIGHWAYS BLOCK FILES

Deposit Number	Block File Number	Location	Inventory Type P=pit B=backhoe	Number of Holes /Samples		% Stone >#4	Comments/ End Use
14202	73	NE7-28-27W	P	7	7	30-60	
14208	73	NE19-26-27W		1	1	85	ROAD CUT
14212	73	SE19-26-27W W19-26-27W	P	5 1	5 1	38-62 85	TRAFFIC GRAVEL ROAD CUT
14213	73	LS4-3-26-27W LS13-15-26-27W NE16-26-27W	P	3 2 2	3 2 2	1,5,18 27,28 47,49	ROAD CUTS ROAD CUTS
14214	73	LS6-5-26-27W	P	3	3	2,60	DEP'T PIT
14216	73	LS7+8-4-26-27W LS2-4-26-27W	P P	5 5	5 5	13,30, 53-65 52-68	
14218	73	LS13-28-25-27W SE32-25-27W	P P	5 5	5 5	15,35,50, 74,83 44,58, 76-81	TRAFFIC GRAVEL
14220	73	NW23-25-27W	P	3	3	72-78	
14222	73	LS14-28-25-26W	P	4	4	56-74	
14225	61	NE11-24-27W	P	6	6	28,65, 42-44	C,D TRAFFIC GRAVEL

1988

PROVINCE OF MANITOBA
AGGREGATE GRADING SPECIFICATIONS

*NOTE: N.S. = Not Specified
F.M. = Fineness Modulus

PASSING SIEVE SIZE		BITUMINOUS PLANT MIX			BASE COURSE					GRANULAR FILL	CULVERT GRAVEL	TRAFFIC TYPE						CONCRETE			SEAL COAT COVER				PASSING SIEVE SIZE	
Metric	Imp.	"A"	"B"	"C"	"A"	"A"	"B"	"C"	"C"			"A"	"A"	"B"	"C"	"A"	"B"	Fines	"A"	COURSE	"A"	"B"	Cover "C"	Blotter "D"	Metric	Imp.
50 mm	2"				Gravel	Lime- stone	All	Gravel	Lime- stone	3" 100															50 mm	2"
37.5mm	1½"							100	N.S. 100		100														37.5mm	1½"
25 mm	1"			100										100	100	100				100					25 mm	1"
19 mm	¾"				100	100	100					100	100			85-100	100		100	90-100					19 mm	¾"
16 mm	5/8"		100		80-100																100				16 mm	5/8"
12.5mm	1/2"	100										75-90		70-90	60-95			100			100	80-100	100	100	12.5mm	1/2"
9.5 mm	3/8"	70-95	70-90															96-100	20-55	20-55					9.5 mm	3/8"
4.75mm	#4	55-70	55-70	60-90	40-70	35-70	30-75	25-80	25-80		N.S. 25-80	45-70	35-60	40-70	30-70	35-60	30-60	90-100	0-10	0-10	0-60	0-65			4.75mm	#4
2.00mm	#10	35-55	35-55	35-80	25-55		25-65																		2.00mm	#10
1.18mm	#16																	50-80							1.18mm	#16
600um	#30																	25-60							600um	#30
425um	#40	17-29	17-29	20-50	15-30	10-30	15-35	15-40				10-35		10-35	5-35						0-15	0-15	0-25	0-50	425um	#40
300um	#50																	10-30							300um	#50
180um	#80	N.S. < 10	N.S. < 10																						180um	#80
75 um	#200	3-8	3-8	5-12	8-15	6-17	4-18	8-20 4-20	5-20	0-15	N.S. 4-20	8-15	6-17	0-15	0-15	0-17	0-10	0-3	0-2	0-2	0-4	0-5	0-5	0-10	75um	#200
MINIMUM CRUSH		50%	50%		35%		25%					35%	100%	35%	25%	100%	100%				30%	20%			MINIMUM CRUSH	
MAXIMUM SHALE		T 3% B 7%	T 3% B 7%		12%		12%	12%			N.S. 15%	12%		12%	15%						3%	4%			MAXIMUM SHALE	
MAXIMUM L.A.		35%	35%		35%	35%	35%	35%				45%	45%	45%	45%	45%			28%	28%	35%	35%			MAXIMUM L.A.	
MAXIMUM DELETERIOUS																		7%	1.5%	1.5%					MAXIMUM DELETERIOUS	
MAXIMUM IRONSTONE																		F.M. 2.3-3.5			5%	5%			MAXIMUM IRONSTONE	
MAXIMUM ABSORPTION																			2.25%	2.25%					MAXIMUM ABSORPTION	
SPEC NUMBER		920	920	920	900	900	900	900	900	520		910	910	910	910	910	910	930	930	930	940	940	940	940	SPEC NUMBER	

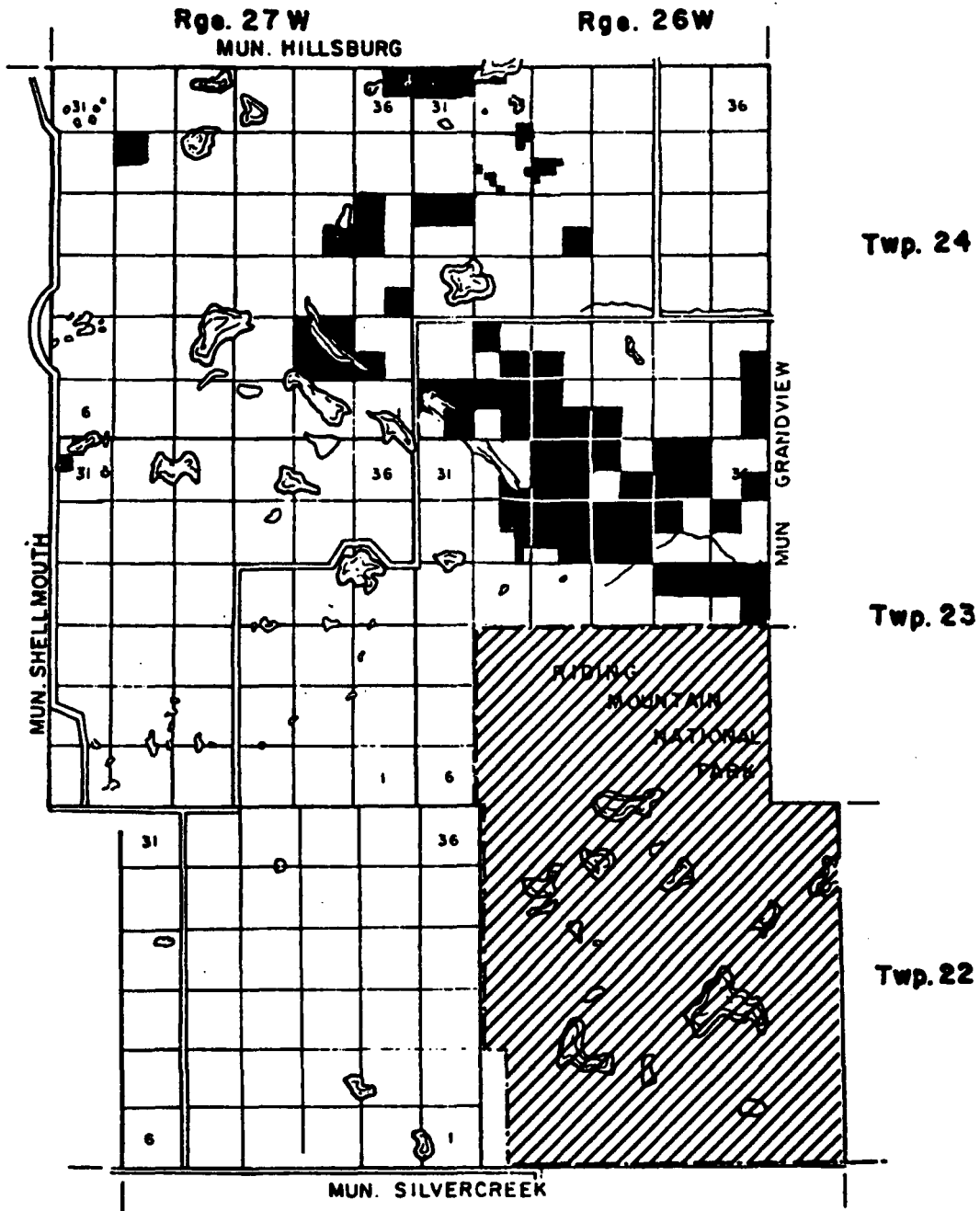
Figure E-1: Manitoba Highways and Transportation aggregate grade specifications.

APPENDIX F: LOCATION OF CROWN LANDS

MUN. OF BOULTON

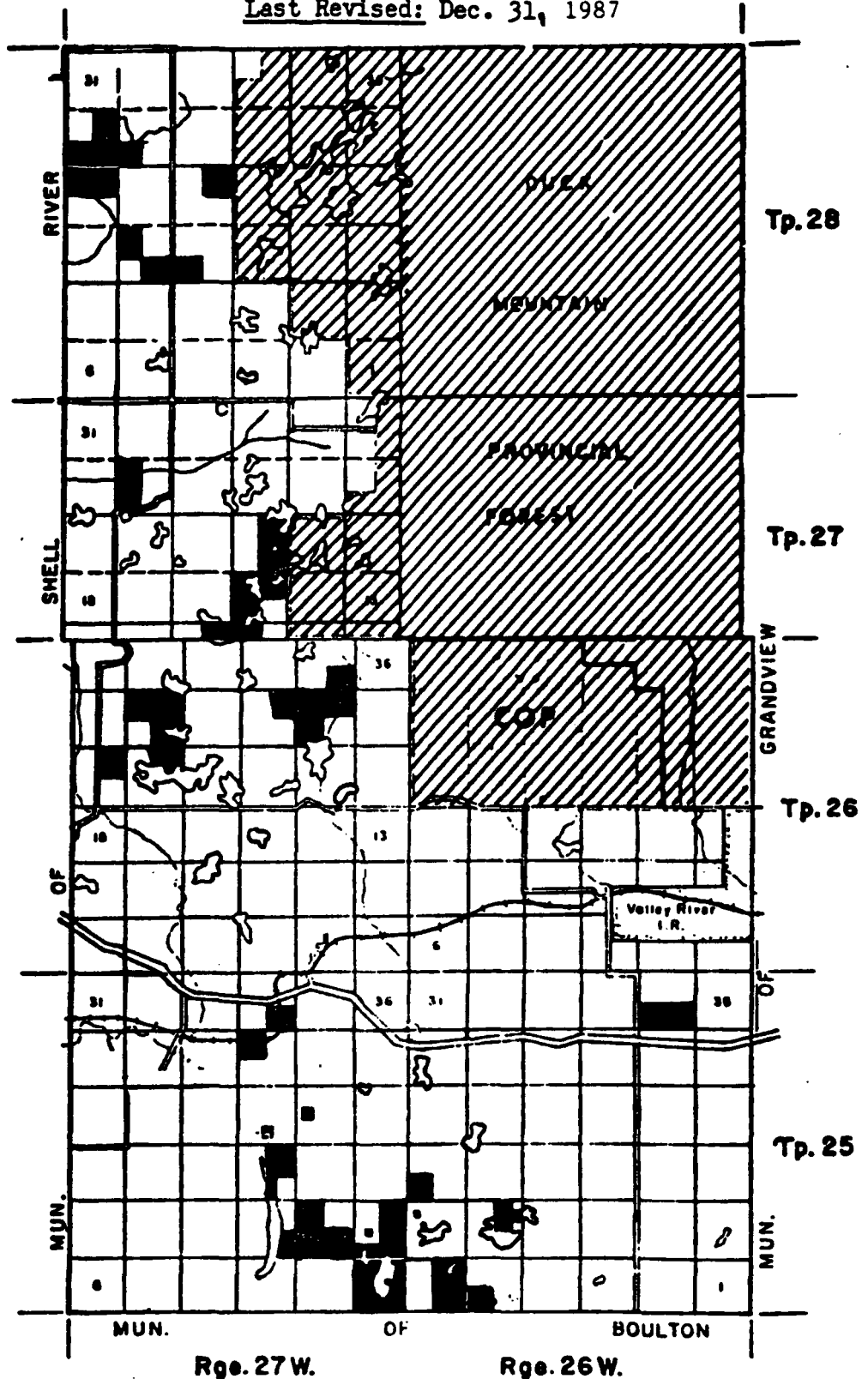
Last Revised: Dec. 31, 1991

SCALE: 1" = 3 MI.



MUN. OF HILLSBURG

Last Revised: Dec. 31, 1987



APPENDIX G: 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 significant.

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 20 feet (6 m) 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 1/2"). 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 Wisconsinan Stage.