Aggregate Report AR87-2

Aggregate Resources and Surficial Geology of the Local Government District of Park North

By MaryAnn Mihychuk

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ABSTRACT

Surficial mapping and an aggregate inventory were carried out in the Local Government District of Park North. Surficial geology and aggregate deposits are delineated on Maps AR87-2-1 and 2 (scale 1:50 000).

Aggregate resources are found in meltwater channels, outwash plains and Shell River spillway. Aggregate reserves are separated into quality and development potential. Quality is based on the physical characteristics of the material, and development potential is based on economic parameters. Shale, often the limiting factor for aggregates, was not observed in the study area.

Total reserves in the L.G.D. of Park North are estimated to be 56 million cubic metres. Deposits in the Shell River valley constitute approximately 30 per cent of the total reserves; however steep valley grades and very coarse aggregate deter utilization of these terrace deposits. The majority of aggregate extraction occurs west of the Shell River valley. The 'Call of the Wild' deposit in the northwest part of township 30-28W is the largest in the study area, containing 23 million cubic metres of high quality aggregate. The deposit remains generally unexploited. Of the total reserves, 42 million cubic metres is considered high quality, of which only 5 million cubic metres is considered to have good development potential. The Tees Lake deposit located primarily in section 36-29-29AW and 11 and 12-30-29AW, contains over 7 million cubic metres of high quality aggregate and is considered to have the greatest potential for development.

Annual local demand is estimated at 23 thousand cubic metres. At this rate there are sufficient reserves to meet projected demands in the foreseeable future.

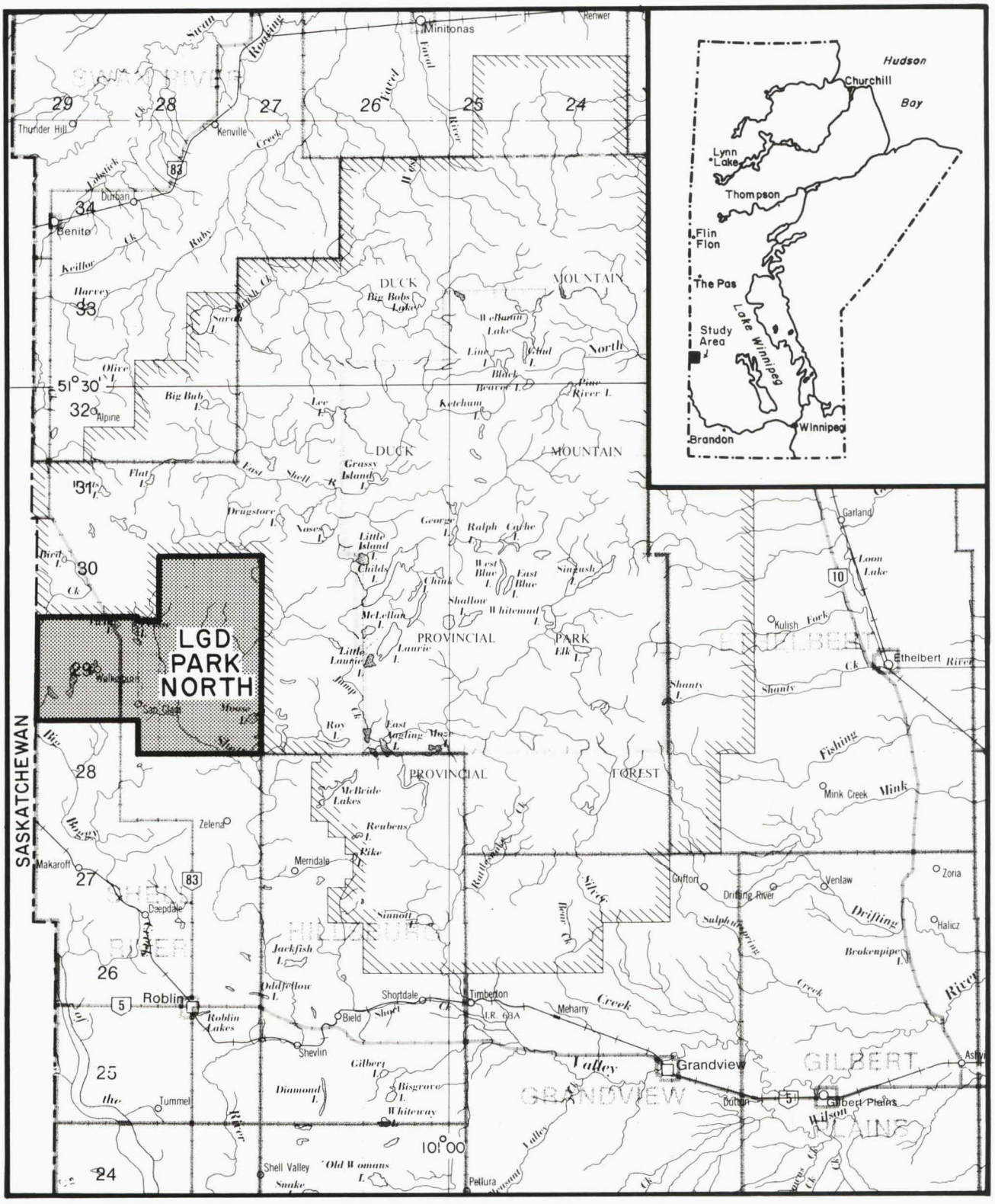

Figure 1: Location of the Local Government District of Park North.

INTRODUCTION

Objectives

An aggregate inventory of the Local Government District of Park North was conducted in 1986 for the purpose of:

1) delineating the sand and gravel resources at a scale of 1:50 000; and 2) providing an estimate of the aggregate reserves in the study area.

The information is used to facilitate land-use planning designed to protect high quality aggregate deposits from sterilization and to provide information to intended users.

Location and Access

The L.G.D. of Park North occupies approximately 30 562 hectares (75 519 acres) in west central Manitoba (Fig. 1), along the Manitoba-Saskatchewan border, 35 km north of Roblin. The L.G.D. consists of three townships between Townships 29 and 30 and Ranges 29, 29A and 28 west, and appears on parts of National Topographic System 1:50 000 map sheets 62N-5, 6, 11 and 12.

The area is primarily an agricultural district. The villages of San Clara and Boggy Creek are the local service centres. Access to the study area is provided by Provincial Trunk Highway 83 and Provincial Roads 367 and 594. Numerous municipal roads in the study area provide easy access.

Physiography

The study area is on the second prairie level, the Saskatchewan Plain, in the Duck Mountain upland physiographic region (Klassen, 1979). Four physiographic units (Fig. 2) consist of lineated till plain, lake plain, sand draped hummocky terrain and spillway valleys. Highest elevations are in the northeast (692 m above sea level) of the study area. Lowest elevations are found in the Shell River valley at 562 m above sea level. The Shell River valley (Fig. 3) is the most prominent geomorphic feature in the area, being 1.2 to 1.8 km wide and 55 to 62 m deep. The Shell River is an underfit stream, relatively slow moving, meandering, with oxbow lakes on the valley floor. Little Boggy Creek also occupies a large spillway channel, and joins the Shell River valley in the centre of the study area. The Little Boggy Creek valley is smaller and the valley walls are less steep than those of the Shell River valley.

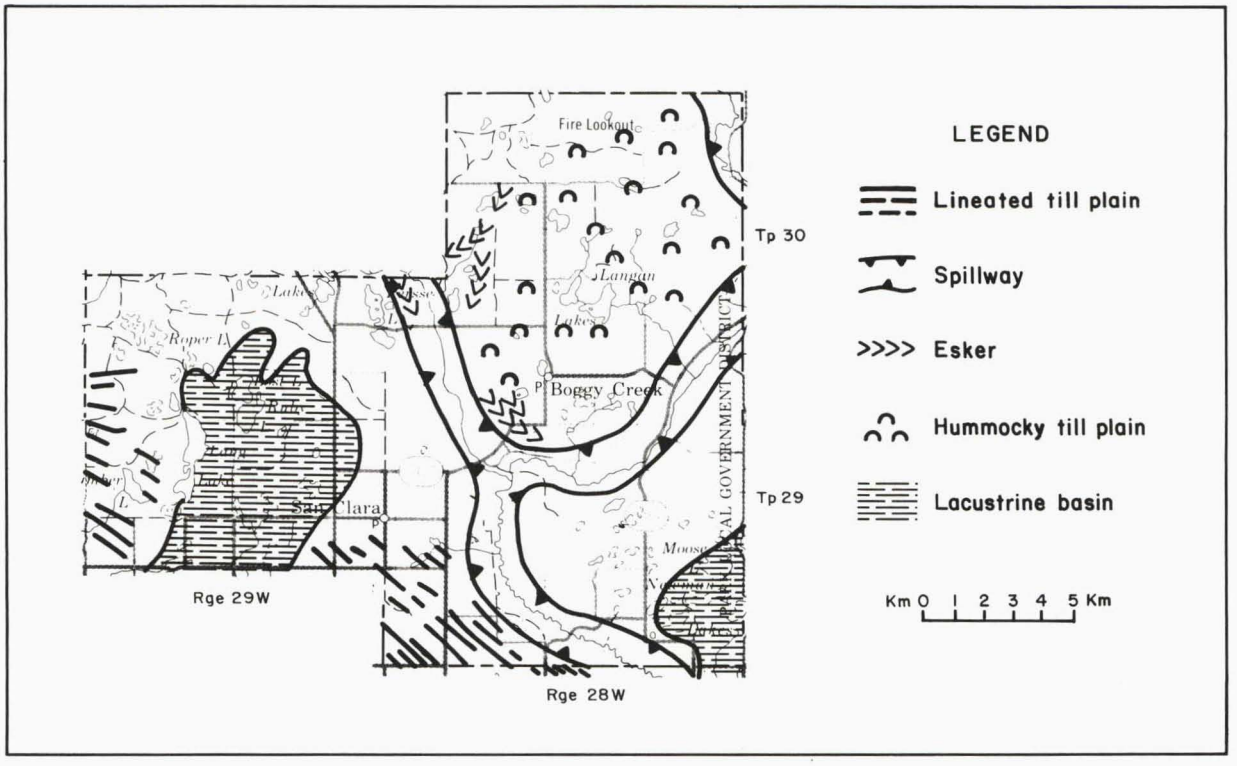

Figure 2: Generalized surficial geology of the L.G.D. of Park North.

Figure 3: View of the Shell River spillway valley, looking east. Location of photo is 29-29-28W.

In the northeast township (30-28W) hummocky topography, ranging from 23 to 31 m in relief, is blanketed by fine lacustrine sediments comprised of silt and sand. The topsoil is susceptible to erosion (Fig. 4) due to steep slopes and the fine grained nature of the sediments.

Total thickness of glacial sediments in the study area ranges from 40 to 182 m (Klassen, 1979), averaging approximately 150 m. Generally the drift cover increases westwards with thickest deposits in the eastern part of the area, near Duck Mountain.

Methodology

Initial information collection phase

The initial phase of report preparation involved the compilation and interpretation of existing geological data including Department of Highways and Transportation Services inventory block files (Department of Highways and Transportation, 1978), water well records (Department of Natural Resources, 1964-1984), and a preliminary airphoto interpretation. A preliminary surficial map was produced using airphotos at a scale of

Figure 4: Soil erosion on glaciolacustrine silt-covered hummock, view to the east (SW 16-30-28W).

1:50 000, to identify potential aggregate sources and locate existing pits.

Field reconnaissance phase

Ground checking of the preliminary map was conducted during the field reconnaissance phase of the study. Field methods include the examination of man-made and natural exposures of surficial sediments, with detailed site investigations at locations of granular material. Sand and gravel pits were visited and sampled; undeveloped aggregate deposits were sampled utilizing backhoe test pits, roadcut exposures and hand-dug holes where access was possible.

Field observations were recorded on the Aggregate Resources Section, Sand and Gravel Inventory, Exposure-Stratigraphic Section Data form 2 (Appendix A). The data collected provide basic information on the site location, thickness of the deposit, general lithologic characteristics and deleterious components. All the information collected is available through the Aggregate Resources Section computer system.

Field testing procedure for aggregate stations includes on-site sieving of the 76.2 to 19.1 mm grain size range (see Appendix B for grain size conversion table); point counting of the material coarser than 76.2 mm, and petrologic examination of the 19.1 to 38.1 mm pebble fraction.

To obtain accurate representation of the coarse gravel fraction and eliminate the difficulties of processing large samples in the laboratory, a 50 to 150 kg sample was sieved through the 76.2 mm, 38.1 mm and 19.1 mm screens in the field based on ASTM specifications (Table 1). A subsample weighing approximately 2 kg of the material finer than 19.1 mm was retained for lab sieving.

Material coarser than 76.2 mm, including cobbles and boulders, was measured using a point count method. This material was divided into three groups: 76.2 to 152.4 mm, 152.4 to 304.8 mm and larger than 304.8 mm. The number of clasts of each group were counted in a 1 m^2 area. The number of 1 m^2 areas counted at a location depends on the variability of the deposit. Up to 11 one metre squares were counted in a deposit that was highly variable. The clasts larger than 304.8 mm were recorded as present or not. Results are shown in Appendix C.

Pebbles were collected from the 19.1 mm screen for petrological examination. Approximately 100 clasts were identified by major rock types and deleterious constituents. Petrological results are given in Appendix D.

TABLE 1
RECOMMENDED SAMPLE SIZE FOR COARSE GRAIN SIZES IN AGGREGATE*

Maximum Nominal Size of Aggregate	Approximate Minimum Mass of Field Sample, kg (lb)
Fine aggregate	
2.36 mm (No.8)	10 (25)
4.75 mm (No.4)	15 (25)
Coarse Aggregate	
9.5 mm (3/8 in.)	10 (25)
12.5 mm (1/2 in.)	15 (35)
19.0 mm (3/4 in.)	25 (35)
25.0 mm (1 in.)	50 (110)
38.1 mm (1 1/2 in.)	75 (165)
50 mm (2 in.)	100 (220)
63 mm (2 1/2 in.)	125 (275)
75 mm (3 in.)	150 (330)
90 mm (3 1/2 in.)	175 (385)

*based on ASTM specification D75-1

Report preparation phase

Preliminary and final maps

Data compilation phase began upon completion of field work. A preliminary map was published concurrently with the annual Report of Field Activities (Mihychuk, 1986).

After the field data were compiled and analyzed the two final maps were produced: a surficial geology map (Map AR87-2-1) and an aggregate deposits map (Map AR87-2-2). The surficial geology map includes the location of proven aggregate deposits and areas which have potential for aggregate based on geological interpretation. Only proven aggregate deposits or reserves are indicated on the aggregate deposits map. Aggregate deposit reserves are separated into aggregate quality, and development potential.

Aggregate quality (Appendix E) is based on grain size distribution, shale content, deposit thickness and uniformity. Aggregate quality is defined as high, medium, and low, and is indicated on Map AR87-2-2.

Development potential refers to the likelihood of a deposit being used in the foreseeable future. Environmental and economic factors (Appendix E), including aggregate quality, access, planning constraints and local supply, were assessed to determine the development potential of each deposit. Economic potential is depicted by the use of tones or shading on Map AR87-2-2.

Mineral ownership and reserve calculations

Mineral ownership and reserve calculations are recorded on the Aggregate Resources Computer Form 1 (Appendix A). Ownership information on surface and sand and gravel rights was obtained from the Manitoba Department of Natural Resources, Crown Lands Registry. Mineral ownership was determined for each deposit on a quarter section basis, and is to be used as a general information base and further verification should be conducted through the Land Titles Office. A generalized ownership diagram is also included on the aggregate deposits Map AR87-2-2.

Reserve calculations are determined by multiplying the planimetered area of the deposit at 1:50 000 scale by the average depth, minus the percentage of the deposit depleted or sterilized. No allowance was made for soil development, which must be stripped before the material can be mined. In general soil development is not excessive on a gravelly base; approximately 10-30 cm of the total thickness should be considered overburden waste.

Integration of point counts, field sieving and laboratory grain size data

Integration of the three methods used in this study to determine grain size - point counts, on site field sieving and laboratory grain size analysis - is described in detail in Appendix F. The result of integration is an apparent coarsening of the overall grain size distribution, reflecting deposit characteristics more accurately. Integrated results are used in this report.

Acknowledgements

The author would like to thank the people of Boggy Creek and San Clara for their friendliness and hospitality, in particular Alex Poitra who provided us with very useful information and put up with us sharing his work office. Appreciation is extended to the Department of Natural Resources for letting us use the Boggy Creek bunkhouse for our field base, which was more than adequate accommodation. The Mortemores at the Boggy Creek general store provided a warm and welcome environment with an abundance of stimulating conversation. To V.J. Starchuk and the Wilgenbuschs, our deepest appreciation for the emergency assistance and hospitality. Rachael Kuropatwa is acknowledged for her field assistance.

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GEOLOGY

Bedrock Geology

The study area is underlain by marine shales of the Upper Cretaceous Riding Mountain Formation. The formation is composed of two Members (Fig. 5); the Odanah, a hard, grey, siliceous shale, and the Millwood, a soft, greenish brown bentonitic shale (Bannatyne, 1970). Most of the study area is covered by thick Quaternary deposits. The Millwood Member was intersected at one locality at a depth of 198 m (Klassen, 1979).

Quaternary Geology

Stratigraphy

Klassen (1966, 1979) mapped the regional surficial geology and described the stratigraphy of the Duck and Riding Mountain areas. Only Klassen's youngest till unit, the Zelena Formation, was observed in the study area. The surficial units overlying the till have not been named and are referred to genetically in this report. The Quaternary stratigraphy is presented in Table 2.

Surficial units

The surficial geology is delineated on Map AR87-2-1 (in pocket) and generalized in Figure 2. Characteristics of the units are discussed below.

Till: unit 1

The Zelena Formation as described by Klassen (1979) is commonly yellowish brown silty, clayey diamicton associated with stagnation deposition on the Duck and Riding Mountain uplands. This formation is thought to be the only till exposed.

Three till landscapes are present (Klassen, 1979). Corrugated moraine is predominant in the western township (29-29W) and south of San Clara (29-28W), and consists of curvilinear aligned ridges with generally low relief of less than 3 m. Hummocky terrain, with relief from 8 to 23 m, is located in the northeast township (30-28W). Most of the hummocky terrain is draped with laminated sand and silt. Locally an isolated hummock of till is exposed in the hummocky terrain. Between the corrugated and hummocky terrains is an

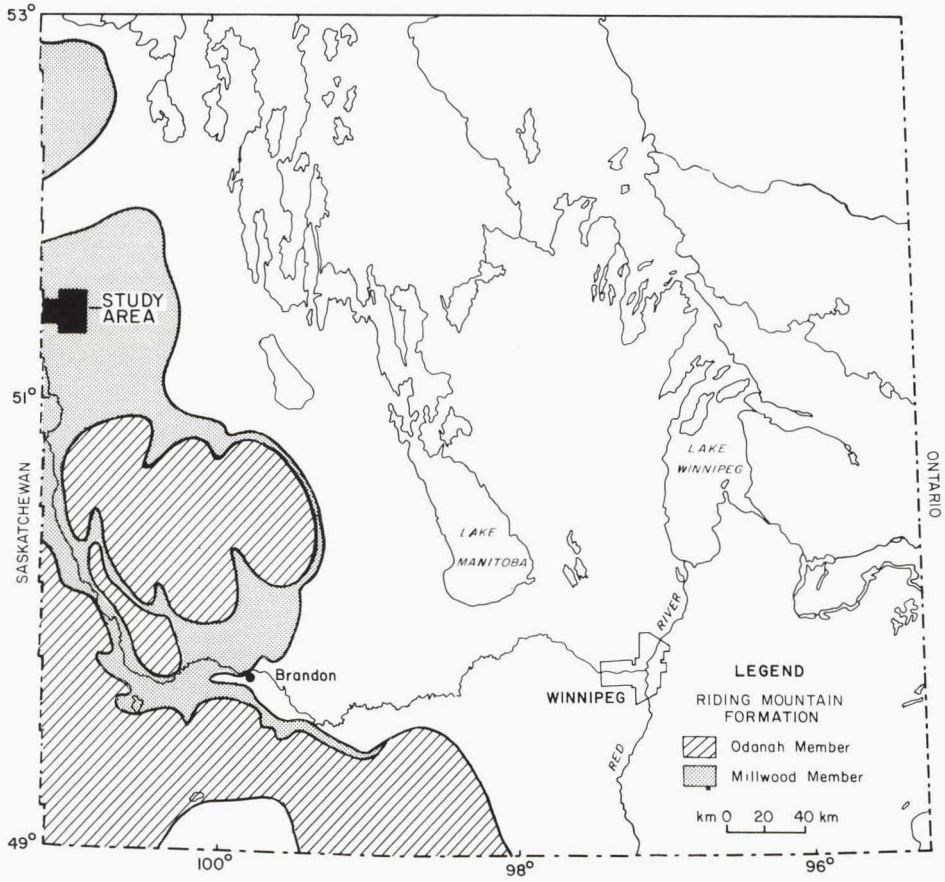

Figure 5: Generalized location map of the Millwood and Odanah Members of the Riding Mountain Formation in western Manitoba.

TABLE 2
TABLE OF FORMATIONS IN THE DUCK MOUNTAIN AREA OF WESTERN MANITOBA

Age	Formation Name	Sediment Type	Depositional Environment	Unit No.	Unit Description
QUATERNARY	unnamed	Organics	Lowlands, swamps	7	dark brown humus and decomposed organics
Holocene	unnamed	Colluvium	Slopes	6	undifferentiated deposits, debris flows, landslide deposits, diamicts, sand
	unnamed	Alluvium	Streams	5	sand and silt, possibly localized pockets of gravel
	unnamed	Terrace	Spillway	4	well sorted, stratified sand and gravel, locally very thin overlying till
	unnamed	Glacio-lacustrine	Glacial Lake	3	laminated silt, fine sand and clay
	unnamed	Outwash	Meltwater	2	well sorted, stratified sand and gravel, generally 0.5 - 2.0 m in thickness and localized
	unnamed	Ice contact	Eskers, kames		
	ZELENA	Till	Glacial ice	1	grey brown, silty clayey, moderate to overconsolidated, fissile, diamicton
Pleistocene	*MINNEDOSA	Till	Glacial ice	-	diamicton
	*ROARING RIVER CLAY	Clay	Lacustrine	-	
	*SHELL	Till	Glacial ice	-	diamicton
	*TEE LAKE				
	*unnamed				
	*LARGS	Till	Glacial ice	-	diamicton
	?				
	?				
CRETACEOUS	*RIDING MOUNTAIN	Shale	Marine		greenish bentonitic shale

*not observed in study area

area of gently rolling till plain. The relief is low, generally less than 3 m.

Till has low sand and gravel potential; however, it can be used for fill or as a source of binder. Binder is basically mud, which acts as a cohesive agent in aggregate products.

Glaciofluvial: unit 2

Glaciofluvial deposits are produced by the meltwaters from the glacier and consist of sand and gravel. Two types of glaciofluvial deposits were identified: eskers and outwash.

Eskers

Several eskers were mapped and indicated symbolically on map AR87-2-1. They are generally associated with the Little Boggy Creek spillway. Eskers are built above the surrounding ground surface and therefore are good extraction sites for sand and gravel. The material in the eskers tends to be sandy and is classified as medium quality.

Outwash

Outwash deposits consist of sand and gravel in sheets or as valley terraces. The deposit is coarser and more variable closer to the ice margin than farther away. The outwash deposits are further subdivided into three depositional environments: ice marginal outwash, meltwater channels, and spillway associated outwash.

Ice marginal outwash plains have generally low to moderate relief. Outwash plains can be very large in extent and thickness. The material is usually well sorted,

sorted, well rounded gravels in planar beds. Only one ice marginal outwash plain occurs in the study area. It is located in the northwest part of 30-28W. The plain, over 2 km wide and 5 km long, is known locally as the 'Call of the Wild' deposit. Ice marginal outwash plains are a high source of sand and gravel because of the abundance of good quality material.

Meltwater channels are formed by localized drainage from melting glacial ice. Channels are short and are locally lined by sand and gravel. Numerous meltwater channels dissect the landscape. Drainage patterns flow towards major spillway systems. Most outwash deposits are found in meltwater channels. Deposits tend to be discontinuous and have variable thickness, from less than 1 m to over 4 m. Meltwater channels are a moderately good source for sand and gravel. The wide distribution of meltwater channels in the study area provides a wide range of potential gravel sources, which may serve local demands.

Spillway associated outwash occurs along the Shell River and Little Boggy Creek valleys. A spillway is a large drainage channel carrying waters from a glacial lake. Outwash occurring along spillways was also noted by Groom (1987) and Underwood McLellan Ltd. (1985) on the Assiniboine and Shell spillway systems. The outwash forms a flat plain. Eskers locally occur within the plain and continue into the spillway valley. The close association of the outwash and eskers with the spillways suggests that the spillways were drainage outlets subglacially as well as ice marginally. Spillway associated outwash deposits consist of well sorted sand and gravel in horizontal or planar beds. Deposit thickness range from 2 m to greater than 5 m. These deposits are good sources of aggregate.

Glaciolacustrine and lacustrine: unit 3

Fine grained sediments, composed primarily of silt, sand and clay, dominate the surficial geology of the study area. These sediments have been divided into two types: glaciolacustrine and lacustrine deposits.

The glaciolacustrine sediments that blanket the hummocky terrain in the northeast township (30-28W) were produced by ponding of glacial water over stagnating ice on Duck Mountain (Klassen, 1979). Lake basinal sediments (unit 3b) or lacustrine deposits were also identified in the west and east townships (Fig. 6). These deposits are found in well defined basins, with a flat, featureless lake bottom. Strandlines are identifiable and mark shoreline positions. Aggregate was not found within the glaciolacustrine or lacustrine sediments; however, the fine grained sediments may be covering economic aggregate deposits.

Valley terrace: unit 4

Valley terrace deposits are found along both the Shell River and the Little Boggy Creek valleys. The deposits are flat terraces along the valley sides of spillway channels. The largest valley terrace deposits are found in the Shell River spillway. The deposits consist of sand and gravel, ranging from bouldery coarse cobble gravel to sand. Most of the terraces are composed of pebble gravel. Spillway terraces are a good source of sand and gravel, but steep valley slopes make transportation difficult out of the spillway.

Figure 6: View westwards across glacial lake basin, Sec. 2-29-29W.

Alluvium: unit 5

Alluvium occurs along the Shell River and Little Boggy Creek as flood deposits. The deposits are composed of fine to medium sand, silt and minor clay and organics. Aggregate was not observed in these deposits.

Colluvium: unit 6

Colluvial deposits are mapped along the steep sides of the spillways. The deposits include diamicton, silt, clay, and organics. Sediments are undifferentiated slope deposits. These deposits have a low potential for sand and gravel.

Organics: unit 7

Organic sediments are common throughout the study area and are most numerous in the western township in the corrugated till area, where drainage patterns are incomplete. The largest organic deposit is found in the northeast township where the hummocky stagnation moraine has produced a closed depression. Where organic sediments overlie sand and gravel, there is usually an associated near-surface water table which prevents extraction of the aggregate.

AGGREGATE DEPOSITS

Introduction

The sand and gravel resources of the L.G.D. of Park North are found primarily in valley terraces, outwash fans, spillway adjacent outwash plains and meltwater channels (Fig. 7). The deposits are summarized in Appendix G. Locations of sand and gravel pits in the L.G.D. and surrounding area are indicated on Figure 8. Grain size, point count data and petrographical analyses are located in tables in Appendices B, C and D.

The study area has been separated into two major zones. Zone I contains those deposits north and west of the Shell River valley, and Zone II those which are either in the valley or east of it. This separation is basically transportation related. Those deposits in the Shell River valley or east of it must be transported out of the valley or across the valley in order to reach the demand areas. Because of very steep grades in the valley transportation costs becomes a deterrent. This has resulted in higher demands for the available deposits in Zone I, leaving major reserves in Zone II generally unexploited.

Zone I deposits

Western township (29-29W)

Two deposits have been identified in the western township. The Laliberte pit deposit (14526) 3 km north of San Clara on Provincial Highway 83 and the Cucumber Lake deposit (14528) 9 km west of the community, near the Saskatchewan-Manitoba provincial boundary.

The Laliberte pit deposit is located primarily in sections 13 and 24-29-29W. The deposit is meltwater channel outwash. Three channels meet in the centre of the deposit and form one channel entering the Little Boggy Creek spillway to the east. Laliberte's pit (site PK020) is located in the central meltwater channel. Exposed in the pit is 2 m of horizontally bedded very sandy fine pebble gravel (Fig. 9), used for winter road sanding. Cross-laminated sand (Fig. 10) is exposed at sites PK056 and PK057. A small revegetated pit (PK058) is located in SE24-29-29W where the sediments consist of sandy pebble gravel, with 3.3% crushable stone. A backhoe pit (PK134) consisted of 2 m of coarse pebble gravel (10.2% crushable) overlying well sorted fine sand. Generally, the Laliberte pit deposit appears to

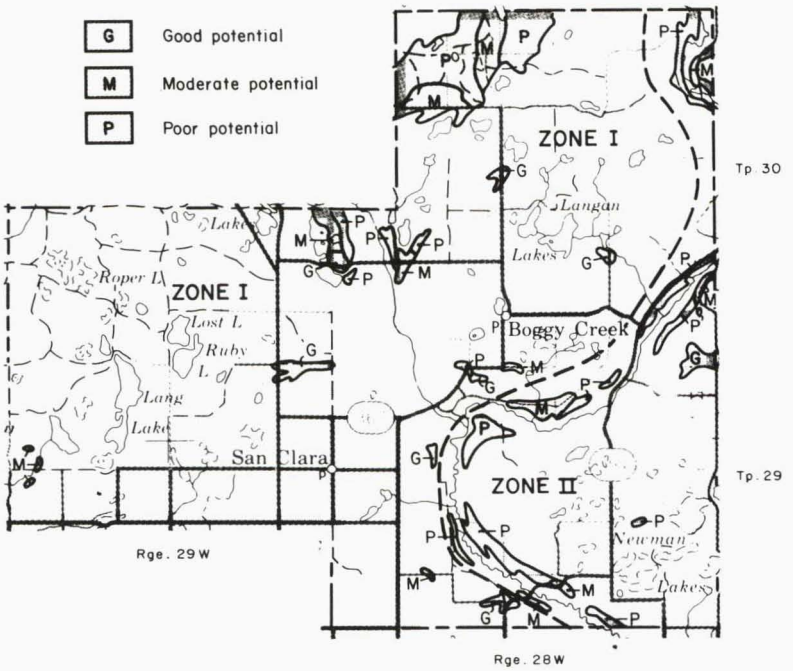

Figure 7: Generalized location of aggregate deposits in the L.G.D. of Park North.

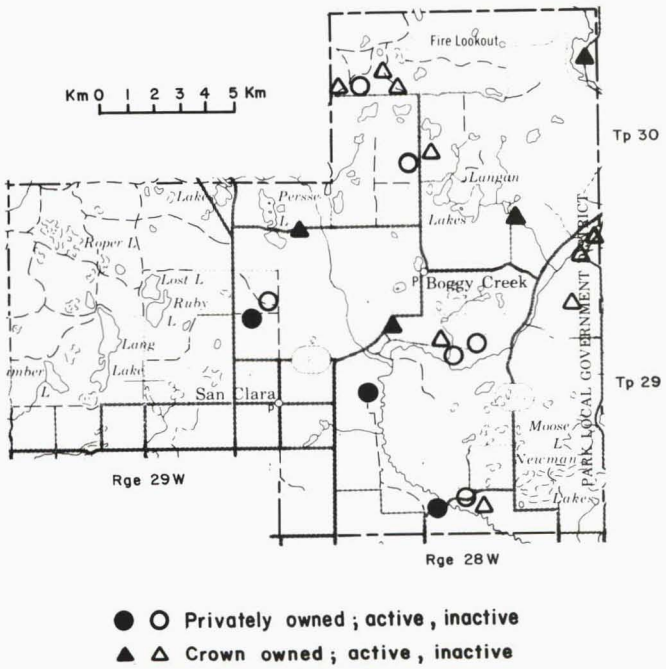

Figure 8: Location of sand and gravel pits in the L.G.D. of Park North.

contain approximately 2 m of aggregate that coarsens eastwards.

The Cucumber Lake deposit actually consists of three small deposits located in sections 06 and 07-29-29W. The deposits are genetically similar to the Laliberte pit deposit in that they are meltwater outwash. At PK048 over 4 m of coarse pebble gravel was observed in an isolated hummock. At PK074, the material is much finer, composed of very sandy fine pebble gravel. Economically, the Cucumber Lake deposit is

Figure 9: Very sandy fine pebble gravel exposed in Laliberte's pit, site PK056, SW 24-29-29W.

Figure 10: Cross-laminated sand with scattered pebbles at site PK056, SW 24-29-29W.

significant because it is the only known aggregate source west of PTH 83 in the study area. The lack of other aggregate deposits in the township suggests these deposits have a moderate to good development potential.

San Clara area

Deposit 14510 is located 2 km east of San Clara (SE19-29-28W) along the edge of the Shell River spillway. The deposit is a spillway-associated outwash plain, approximately 1.0 km long by 0.5 km wide orientated north-south. More than 3.0 m of coarse pebble gravel in planar and cross-stratified beds (Fig. 11) are exposed in Bedu's pit (PK050, PK100). Bedu's pit is approximately 400 by 100 m and is the largest and most active pit in the study area. Deposit reserves probably extend south but the material appears to become finer. This deposit has high potential for continued use.

South of San Clara and west of the Shell River valley are two deposits (14503 and 14504) in meltwater channels. Deposit 14504 in NW06 and SE07-29-28W is located 4 km southeast of San Clara; it is relatively small and occurs on the west side of the meltwater channel. At site PK103 more than 4 m of cobbly coarse pebble gravel with 11% crushable material was encountered. Deposit 14503 is located 6.5 km southeast of San Clara, and is a flat outwash plain consisting of sandy fine pebble gravel. Backhoe testing at PK107 exposed over 4 m of cross-stratified pebbly sand and sandy fine pebble gravel. In 1986 a pit in NW04-29-28W was opened. Even though the sediments in deposit 14503 are sandy, the deposit has a high development

Figure 11: Three metres of pebble gravel exposed in the south wall of Bedu's pit, PK050A, deposit 14510.

potential because of location near transportation routes.

Tees Lake area

The Tees Lake area is located 10.2 km north of San Clara on the west side of the Little Boggy Creek Valley. Deposit 14525 consists of several tributary eskers in an outwash plain. One active pit, Gavin's pit in NW01-30-29AW, is used primarily by the L.G.D. for road maintenance. The material consists of cobbly pebble gravel in planar and cross-stratified beds (Fig. 12). Large unexploited reserves extend northwards, primarily in SW12-30-29AW.

Valley terrace deposit 14524 is in the Little Boggy Creek spillway abutting the east side of deposit 14525. Material in deposit 14524 consists of between 1 and 2 m of pebble gravel ranging from 90.2 to 96.8% freerun. There has been no mining of the deposits in the spillway, and it seems they will generally remain unexploited until the more accessible reserves are mined.

Several terraces in the Little Boggy Creek spillway valley were mapped but were not tested because of the lack of access. A roadcut on Provincial Road 367 crosses a Little Boggy Creek terrace at SE30-29-28W. Where a thin cobbly lag over till is exposed.

Northern township (30-28W)

There are four deposits in the northern township: deposit 14516, deposit 14529, the Happy Lake (14519) deposit, and the 'Call of the Wild' (14520). The Happy Lake deposit is located 4.8 km north of Boggy Creek. Two pits occur in the deposit, one inactive (PK009) and one active (PK010). The pits expose similar material, well sorted cobbly pebble gravel in cross-stratified beds. Screening of the coarse material has resulted in stockpiles of coarse waste left on the pit floor at both locations (Fig. 13). Reserves extend to the south and west, becoming finer southwards.

The 'Call of the Wild' deposit (14520), is located 6.4 km north of Boggy Creek. The deposit is the largest aggregate deposit in the study area. Four small pits exist in the deposit, but overall the deposit is unexploited. The deposit material ranges from sand to very coarse cobble gravel, but generally the sediments are coarse. Remote location and poor access restrict mining.

Deposit 14529 is east of the Little Boggy Creek spillway. The deposit appears to be an esker flanked by outwash sediments. At PK013 and PK014, 5 m of well rounded, well sorted cobbly pebble gravel is exposed. The deposit becomes finer westwards to very fine pebbly sand. An esker has been identified in the southeast portion of the 'Call of the Wild' deposit. This esker appears to be associated with a series of eskers that extends southwards.

The esker system has a good potential as an aggregate source. Due to the abundance of accessible aggregate in the area and the lack of exposures in the esker system, the eskers were not mapped as deposits, but are indicated on the surficial geology map AR87-2-1.

In deposit 14516, 5 km northeast of Boggy Creek, an active pit (SW11-30-28W) is used by the L.G.D. The

Figure 12: Planar beds of cobbly pebble gravel at site PK015, deposit 14525.

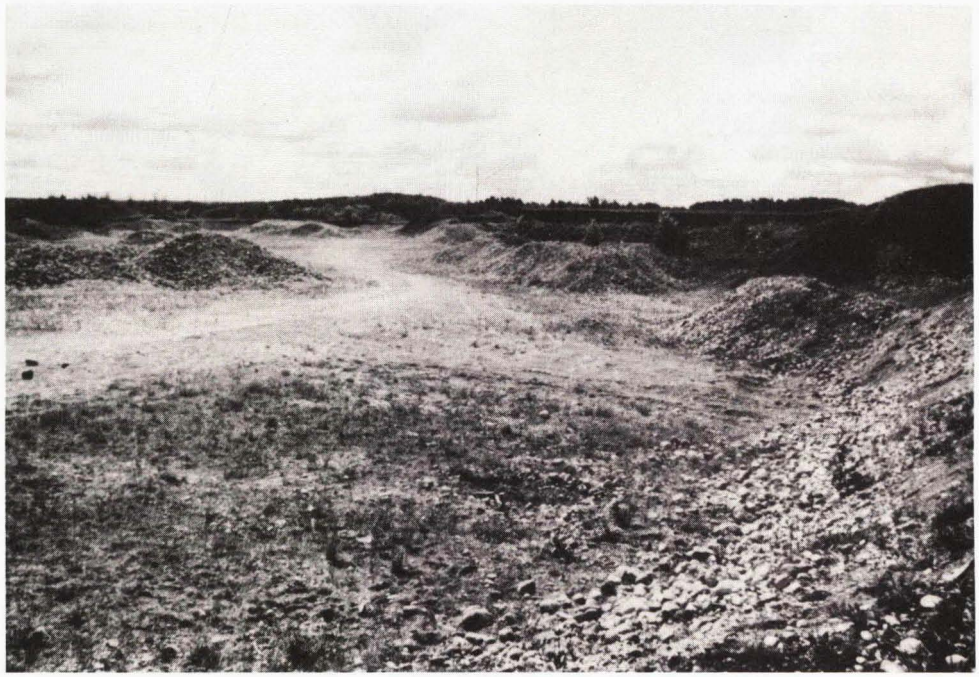

Figure 13: Stockpiles of screened coarse aggregate (larger than 38.1 mm) left as waste in pit PK010, Happy Lake deposit 14519.

deposit consists of very well rounded, coarse pebble gravel with scattered boulders. There has been extensive screening of the crushable material, and stockpiles have been left in the pit. Reserves appear to continue westwards.

Boggy Creek area

Deposit 14518 is situated 2.4 km southwest of the village of Boggy Creek on P.R. 367, the Childs Lake road. The deposit is composed of sandy, pebbly gravel with no material coarser than 76.2 mm. The gravel is well sorted, in cross-stratified uniform horizontal beds. There is one pit, known locally as Pateneaude's Pit (PK038). Deposit reserves appear to continue southward.

Zone II deposits

Shell River Valley terrace deposits

Eleven terrace deposits have been identified in the Shell Valley. One (14511) is being mined for local use. Sediments vary in the terraces. Lower level terraces (14515, 14512, 14505) have 1 to 2 m of sand overlying pebble gravel. The sand is considered overburden and not an economic unit. High level terraces are coarser than the lower terraces. Deposits 14512 and 14506 consist of bouldery cobble gravel with more than 20% crushable. These terraces generally have excess coarse material and are not likely to be mined in the near future.

Southern Township (29-28W)

The Henderson deposit (14513), is the only significant deposit in the southern township east of the Shell River valley. Outwash sediments of more than 5 m are exposed in a Crown pit along the eastern boundary of the L.G.D. The aggregate consists of inclined beds of moderately well sorted, well rounded, coarse pebble gravel. A small inactive pit is located in SW36-29-28W. Large reserves remain in the deposit to the west and south of this pit. The relatively isolated location of the deposit has resulted in very little extraction.

SUPPLY AND DEMAND

Supply

In excess of 56 million m^3 of aggregate resources are present within the study area. Table 3 shows the amounts of aggregate divided into quality and development potential. These figures represent proven or known aggregate reserves only.

More than 75 per cent of the aggregate in the study area is high quality. Deposits generally contain more than sufficient quantities of stone; coarsest aggregate deposits are located in the Shell River terraces. Lithologically, the aggregate consists of approximately 60% carbonate clasts, the remainder being fine grained volcanics and crystalline intrusives, generally granites. Deleterious substances are minor. Shale, usually the limiting factor in quality, especially in Western Manitoba, was not observed in the samples analyzed.

In terms of development it is estimated that 4.7 million m^3 of high quality aggregate has good potential for use in the foreseeable future. The majority of the high quality reserves are found in the Shell River valley where access and tranportation are the major limiting factors. Deposit 14520 contains the largest reserves of aggregate. Reserves in the deposits remain generally unexploited because of location and access. The Tees Lake deposit (14525) seems to have the greatest potential for future development.

TABLE 3
ESTIMATED RESERVE FIGURES FOR THE L.G.D. OF PARK NORTH ('000 000 m^3)

AGGREGATE QUALITY	DEVELOPMENT POTENTIAL			RESERVES BY QUALITY
	GOOD	MOD.	POOR	
HIGH	4.7	15.5	22.3	42.5
MEDIUM	1.0	2.2	8.1	11.3
LOW	1.4	0.0	0.8	2.2
TOTAL*	7.1	17.7	31.2	56.0

*Total reserves based on economic potential

Presently, the major sources of aggregate are deposits 14510, 14516, 14518, 14519 and 14525. Active pits are also present in deposits 14503, 14513, 14522 and 14526.

Demand

The demand for sand and gravel in the L.G.D. of Park North is closely associated with the activity of the construction sector. The majority of the demand for aggregate is for highway and road construction and maintenance.

The estimated demand for aggregate resources is based on:

1. Department of Highways upgrading needs;
2. local requirements of the L.G.D. of Park North;
3. private users.

The estimated annual and projected 25-year demand are presented in Table 4. Based on the 25 year provincial growth rate of 2.4%, consumption will double in 30 years to approximately 45 000 m^3 annually.

There is a good possibility that P.R. 367 from Provincial Trunk Highway 83 to Child's Lake will be paved in the foreseeable future. This would require an additional 95 000 m^3 of high quality aggregate for the 19.2 km of road which passes through the study area.

Total demand for sand and gravel in the L.G.D. of Park North will be 665 000 m^3 (including paving P.R. 367) of reserves for a 25-year period with no increase in consumption.

TABLE 4
ESTIMATED ANNUAL DEMAND FOR SAND AND GRAVEL IN THE L.G.D. OF PARK NORTH (m^3)

CONSUMERS	1 YR.	25 YR.
Department of Highways	14 800	370 000
L.G.D. of Park North	7 000	175 000
Private users	1 000	25 000
TOTAL:	22 800	570 000

CONCLUSIONS

An abundance of high quality aggregate occurs in the L.G.D. of Park North, sufficient to meet the local requirements for the foreseeable future. The method of extraction and processing may have to change to include crushing and more screening. High quality aggregate and large reserves on Crown lands allow for the possibility of exporting aggregates if demand can be found.

The study area has an excess of high quality aggregate, substantially more than the projected demand of the L.G.D. However, deposits in Zone I (west of the Shell River valley) near the communities of San Clara and Boggy Creek are near depletion, particularly on Crown lands. More extensive use of the 'Call of the Wild' (14520) deposit, 6.4 km north of Boggy Creek, can be expected.

Extraction methods are expected to involve more screening and crushing. There are several pits where large quantities of high quality coarse aggregate have been screened. Many deposits have not been mined at all due to the coarseness of the aggregate. This coarse material, if processed, would probably be suitable for railway ballast, A-base or concrete stone.

REFERENCES

American Society for Testing and Materials

1982: Annual Book of ASTM Standards, ASTM, Part 15, D75-71, 1320 p.

Bannatyne, B.B.

1970: The clays and shales of Manitoba; Manitoba Mines Branch Publication 67-1, 107 p.

Department of Highways and Transportation

1978; Material inventory and analysis of sand and gravel deposits; Materials and Research Division, Geotechnical Section, Block File No. 85.

Department of Natural Resources

1964- Manitoba Water Well Drillers Reports;
1984: Water Resources Division, Groundwater Section.

Groom, H.D.

1987: Aggregate resources in the Rural Municipality of Shellmouth; Manitoba Energy and Mines, Aggregate Report AR86-2.

Klassen, R.W.

1966: The surficial geology of the Riding Mountain area, Manitoba; Ph.D. Dissertation, University of Saskatchewan.

1979: Pleistocene geology and geomorphology of the Riding Mountain and Duck Mountain areas, Manitoba-Saskatchewan; Geological Survey of Canada, Memoir 396.

Mihychuk, M.A.

1986: Aggregate resources in the Local Government District of Park (North); in Manitoba Energy and Mines, Report of Field Activities 1986, p. 220-222.

Underwood McLellan and Associates Limited

1985: Surficial geology and aggregate resource inventory of the Rural Municipality of Shell River; Manitoba Energy and Mines, Aggregate Report AR85-4.

APPENDIX A

AGGREGATE INVENTORY COMPUTER CODE SHEET AND FORMS

FORM 1

SAND & GRAVEL INVENTORY

DEPOSIT STATUS

DEPOSIT NO: ______________ ___ SUB

LANDFORM ___ (if K specify landform under depcom field)

DEPOSIT COMMENTS ________________________________

OWNERSHIP & RESERVES

LOCATION							OWNERSHIP				
TWP	RNG	SCT	$\frac{1}{4}$ SCT	APPROXIMATE AREA (HA.)	AVERAGE DEPTH (m.)	% DEPLETED NOT AVAILABLE					

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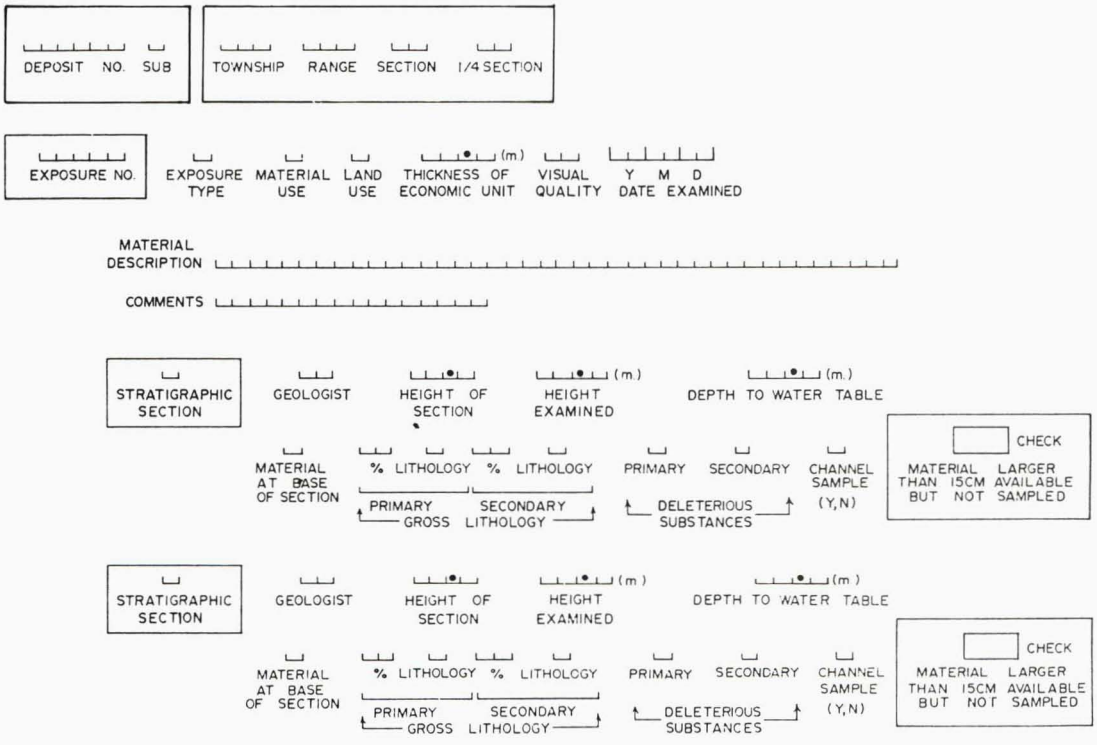
SAND AND GRAVEL INVENTORY

FORM 2

EXPOSURE-STRATIGRAPHIC SECTION DATA



EXPOSURE TYPE CODES (COMPULSORY)

A Sand and Gravel Pit
B Backhoe test pit
C Road cut or ditch section
D Hand dug hole
E Hand/Power auger hole
F Water Resources drill log
G Interpretation or resistivity survey location
H Interpretation of seismic Survey location
I Bulldozer test pit
J Borrow Pit
K Natural exposure

EXPOSURE LAND USE CODES

A Agriculture, haying
B Building site (permanent)
C Cemetary
D Garbage dump-unauthorized, inactive
E Easement-surface, other than roadway e.g. transmission line
F Forest, natural
G Garbage dump - authorized, active
H Highway, roadway, railway
P Pasture, grazing
R Recreation site
S Supervised wildlife habitat
T Timber area
U Underground easement (pipeline, cable)
W Wildlife habitat - natural, unattended
X Active Pit
Y Temporary use
Z Not in Use (commonly revegetated)

SURROUNDING LAND USE CODES

A Agriculture, haying
B Building site (permanent)
C Cemetary
E Easement-surface, other than roadway e.g. transmission line
F Forest, natural
H Highway, roadway, railway
P Pasture, grazing
R Recreation site
S Supervised wildlife habitat
T Timber area
U Underground easement (pipeline, cable)
W Wildlife habitat - natural, unattended

MATERIAL AT BASE OF SECTION CODES

A Bedrock
B Silt
C Sand
D Till
E Clay
F Gravel
G Sand and Gravel
H Permafrost
Z Same as in pit wall

GROSS LITHOLOGY CODES

A Granitic types
B Dioritic types
C Gabbroic types
D Pegmatitic types
E Volcanic types
F Gneisses
G Schists
H General Precambrian crystallines
I General Carbonate
J Limestone
K Shales
L Other sedimentary types
M Ultrabasic types
N Quartzite

DELETERIOUS SUBSTANCES CODES

A Shale
B Organic content
C Carbonate incrustations or concretions
D Iron oxide incrustations or concretions
E Weathered pebbles
F Chert
G Clay lumps

FORM 4

SIEVE ANALYSIS

	DEPOSIT NO.	SUB	TWP.	RNG.	SCT.	1/4 SCT.	EXPOSURE	STRAT. SCT.
SAMPLE NO.								

COMMENT _____ CRUSHABLE MATERIAL ☐ (1 = Yes, 0 = No)

WEIGHT OF FINE FRACTION _____ GMS.

WEIGHT BEFORE WASHING _____ GMS. WEIGHT AFTER WASHING _____ GMS.

Screen	mm	phi Units	Weight on Sieve (Gms.)	
1 1/2"	38.1	-5.25		COARSE FRACTION
3/4"	19.1	-4.25		
3/8"	9.5	-3.25		FINE FRACTION
#4	4.76	-2.25		
#8	2.38	-1.25		
#16	1.19	-0.25		
#30	0.59	+0.75		
#50	0.30	+1.75		
#100	0.149	+2.75		
#200	0.074	+3.75		
< 200				

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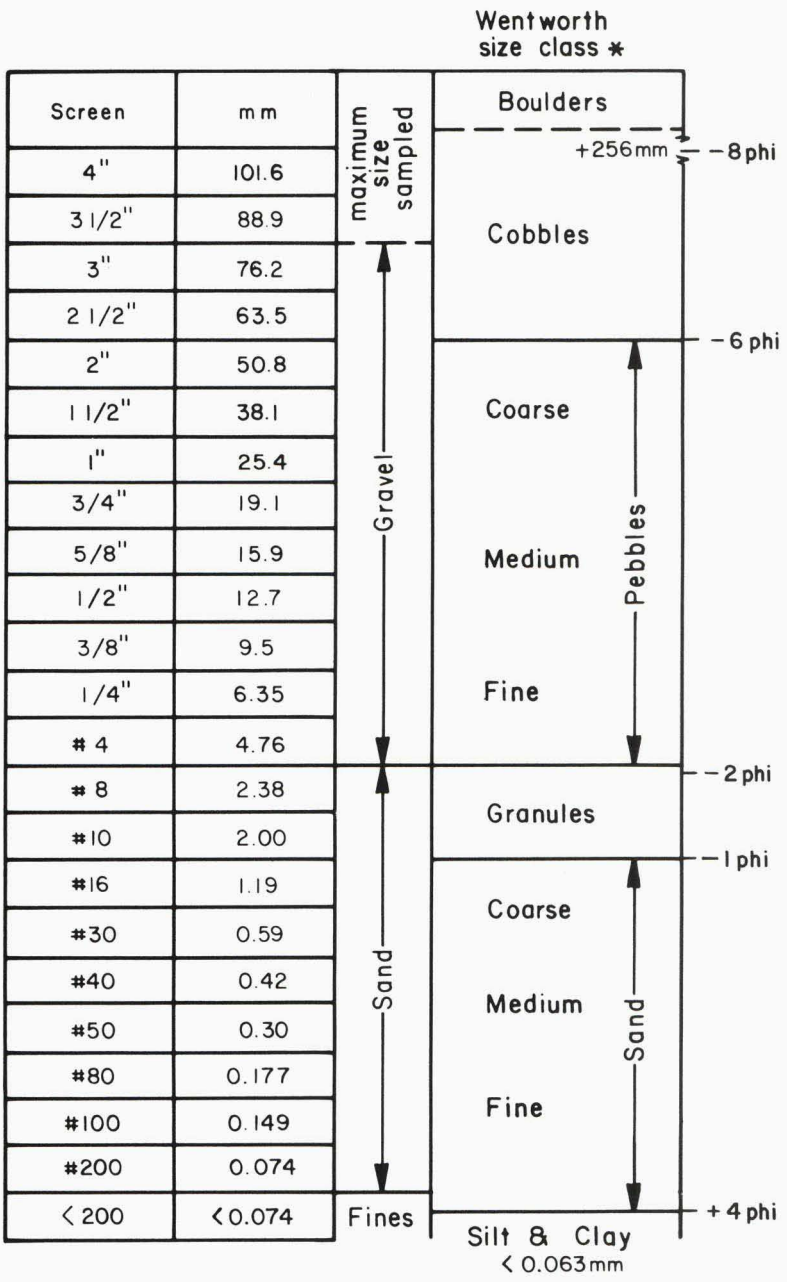
APPENDIX B

GRAIN SIZE CLASSIFICATION



* modified from Folk, 1974

APPENDIX C: POINT COUNT DATA FOR AGGREGATE COARSER THAN 76.2 MM (3") IN THE L.G.D. OF PARK NORTH

Deposit No.	Sample No.	Legal Description	>304.8 mm (>12") X = present	304.8-152.4 (12-6") average	152.4-76.2 (6-3") average	No. m^2 Counted
14502	PK063	SE04-29-28W	X	3.0	6.9	10
14503	PK064	SW04-29-28W	-	-	-	4
14503	PK107	SE05-29-28W	-	-	-	5
14504	PK103	NE06-29-28W	-	-	2.8	5
14505	PK106	SW08-29-28W	-	-	-	5
14506	PK007	NW03-29-28W	X	1.6	1.8	10
14506	PK006	NW04-29-28W	X	0.6	8.6	5
14506	PK109	NE04-29-28W	-	-	3.0	5
14506	PK110	SE09-29-28W	X	0.3	6.8	4
14506	PK111	SW09-29-28W	X	-	1.9	5
14507	PK023	SW14-29-28W	-	0.4	1.2	11
14510	PK050A	SE19-29-28W	-	-	3.2	5
14510	PK050B	SE19-29-28W	-	-	2.7	7
14510	PK050C	SE19-29-28W	-	-	0.8	4
14510	PK100	SE19-29-28W	-	-	-	4
14510	PK101	SE19-29-28W	-	0.3	-	10
14511	PK044	NE21-29-28W	-	-	0.5	11
14511	PK042	SE28-29-28W	X	1.4	3.6	9
14512	PK123	NW26-29-28W	X	4.7	2.7	3
14513	PK116	SE36-29-28W	-	-	1.0	5
14513	PK117	SE36-29-28W	X	1.6	1.9	8
14513	PK118	SE36-29-28W	X	4.0	12.0	3
14513	PK119	SE36-29-28W	-	-	0.4	5
14514	PK028	NE01-30-28W	-	-	-	10
14514	PK029	NE01-30-28W	-	-	-	10
14514	PK121	NE01-30-28W	-	-	0.9	8
14514	PK120	NE01-30-28W	-	-	-	5
14515	PK122	NE35-29-28W	-	0.3	2.0	6
14516	PK126	NW02-30-28W	-	-	0.9	7
14516	PK024	SW11-30-28W	-	0.2	2.3	9
14517	PK070	SE33-29-28W	-	-	-	7
14518	PK133	NE29-29-28W	-	-	-	5
14518	PK038	NW29-29-28W	-	-	-	10
14518	PK039	SW32-29-28W	-	-	-	10
14519	PK010	NW16-30-28W	-	-	2.5	2
14519	PK129	NW16-30-28W	-	-	2.8	4
14519	PK009	NE17-30-28W	-	0.4	3.4	5

APPENDIX C (Cont'd.)

Deposit No.	Sample No.	Legal Description	>304.8 mm (>12") X = present	304.8-152.4 (12-6") average	152.4-76.2 (6-3") average	No. m^2 Counted
14520	PK076	NW29-30-28W	-	-	-	3
14520	PK067	SW29-30-28W	-	0.3	1.0	6
14520	PK071	SE30-30-28W	-	-	1.0	6
14520	PK072	SE30-30-28W	-	0.4	7.3	10
14520	PK131	SE30-30-28W	-	-	-	5
14520	PK068	SW30-30-28W	-	-	-	10
14520	PK130	SW30-30-28W	-	-	-	5
14521	PK077	SE36-30-28W	-	-	-	10
14522	PK075	NE25-30-28W	-	0.2	1.8	6
14523	PK060	SE12-30-29AW	-	-	-	5
14525	PK015	SW12-30-29AW	-	-	3.3	8
14525	PK136	SW12-30-29AW	-	-	-	4
14526	PK134	NE13-29-29W	-	-	-	4
14526	PK058	SE24-29-29W	-	-	-	10
14526	PK057	SW24-20-29W	-	-	-	5
14527	PK137	NE01-30-29W	-	0.4	0.7	7
14528B	PK074	SE07-29-29W	-	-	-	4
14529	PK014	SW07-30-28W	-	-	0.8	10

APPENDIX D: PETROGRAPHIC RESULTS OF THE (16-25 MM) PEBBLE SIZE FRACTION

By Number Percentage

			Nondeleterious			Deleterious				
Sample Number	Deposit Number	Legal Description	Carbonates	Volcanics	Intrusives & Metamorphics	Friable (weathered)	Oxidized (Ironstones)	Chert	Total Delet.	Number Clasts Counted
14502	PK063	SE04-29-28W	64.1	13.0	21.4	0.8	0.8	-	1.6	131
14503	PK064	SW04-29-28W	65.8	6.5	27.6	-	-	-	-	123
14503	PK107	SE05-29-28W	75.2	0.8	22.4	1.6	-	-	1.6	125
14504	PK103	NE06-29-28W	64.8	8.8	19.2	6.4	-	0.8	7.2	125
14505	PK106	SW08-29-28W	61.2	6.1	27.6	2.0	3.1	-	5.1	98
14506	PK007	NW03-29-28W	30.3	-	67.7	-	2.0	-	2.0	99
14506	PK006	NW04-29-28W	58.5	8.5	31.9	1.1	-	-	1.1	94
14506	PK109	NE04-29-28W	75.0	4.6	18.5	0.9	0.9	-	1.8	108
14506	PK110	SE09-29-28W	64.2	8.5	22.6	4.7	-	-	4.7	106
14506	PK111	SW09-29-28W	61.0	6.1	29.3	1.2	1.2	1.2	3.6	82
14507	PK023	SW14-29-28W	51.8	6.1	34.2	1.8	6.1	-	7.9	114
14510	PK050A	SE19-29-28W	53.5	4.6	41.9	-	-	-	-	86
14510	PK050B	SE19-29-28W	66.2	10.5	23.3	-	-	-	-	133
14510	PK050C	SE19-29-28W	64.4	11.1	21.1	3.3	-	-	3.3	90
14511	PK044	NE21-29-28W	60.6	15.4	18.3	4.8	1.0	-	5.8	104
14511	PK042	SE28-29-28W	69.4	6.3	18.1	-	5.6	0.7	6.3	144
14512	PK123	NW26-29-28W	66.1	4.4	25.2	2.6	1.7	-	4.3	115
14513	PK116	SE36-29-28W	72.5	7.8	16.7	2.9	-	-	2.9	102
14513	PK117	SE36-29-28W	70.1	7.2	17.5	2.1	3.1	-	5.2	97
14513	PK118	SE36-29-28W	70.9	5.8	11.6	5.8	2.3	3.5	11.6	86
14513	PK119	SE36-29-28W	60.2	3.9	34.9	1.0	-	-	1.0	103
14514	PK028	NE01-30-28W	52.9	22.3	22.3	1.6	0.8	0	2.4	121
14514	PK029	NE01-30-28W	64.1	11.3	16.9	2.8	4.9	-	7.7	142
14514	PK120	SE01-30-28W	71.3	2.0	23.8	1.0	2.0	-	3.0	101
14514	PK121	NE01-30-28W	56.7	9.6	25.0	8.6	-	-	8.6	104
14515	PK122	NE35-29-28W	50.0	9.4	33.0	2.8	2.8	1.9	7.5	106

APPENDIX D (Cont'd.)

Sample Number	Deposit Number	Legal Description	Nondeleterious			Deleterious			Total Delet.	Number Clasts Counted
			Carbonates	Volcanics	Intrusives & Metamorphics	Friable (weathered)	Oxidized (Ironstones)	Chert		
14516	PK126	NW02-30-28W	68.9	7.8	21.1	2.2	-	-	2.2	90
14516	PK024	SW11-30-28W	55.8	14.7	20.2	4.6	3.1	1.5	9.2	129
14517	PK070	SE33-29-28W	64.3	8.4	19.6	4.2	1.4	2.1	7.7	143
14518	PK133	NE29-29-28W	71.1	4.1	20.6	4.1	-	-	4.1	97
14518	PK038	NW29-29-28W	64.6	11.8	20.8	2.1	0.7	-	2.8	144
14518	PK039	SW32-29-28W	68.2	10.1	14.7	6.2	-	0.8	7.0	129
14518	PK040	SW32-29-28W	61.3	11.7	21.9	2.9	0.7	1.5	4.1	137
14519	PK010	NW16-30-28W	48.7	23.1	20.5	4.3	3.4	-	7.7	117
14519	PK129	NW16-30-28W	55.6	14.8	25.9	2.8	0.9	-	3.7	108
14519	PK009	NE17-30-28W	50.9	8.2	34.6	0.9	3.6	1.8	5.3	110
14520	PK076	NW29-30-28W	66.0	10.7	19.4	2.9	1.0	-	3.9	103
14520	PK067	SW29-30-28W	50.9	17.3	24.6	5.4	-	1.8	7.2	110
14520	PK071	SE30-30-28W	65.6	8.6	25.8	-	-	-	-	93
14520	PK072	SE30-30-28W	61.5	7.7	29.8	0.9	-	-	0.9	104
14520	PK131	SE30-30-28W	54.0	9.7	32.7	2.7	0.9	-	3.6	113
14520	PK132	NE30-30-28W	49.0	9.2	29.6	11.2	1.0	-	12.2	98
14520	PK068	SW30-30-28W	51.8	13.6	32.7	0.9	0.0	0.9	1.8	110
14520	PK130	SW30-30-28W	60.0	7.0	28.0	4.0	-	1.0	5.0	100
14521	PK077	SE36-30-28W	48.0	10.8	37.3	2.9	1.0	-	3.9	102
14522	PK075	NE25-30-28W	58.2	8.7	31.1	-	1.9	-	1.9	103
14523	PK060	SE12-30-29AW	60.5	12.6	24.4	1.7	-	0.8	2.5	119
14524	PK137	NE01-30-29AW	56.7	9.3	33.0	-	-	1.0	1.0	97
14525	PK015	SW01-30-29AW	57.3	12.9	28.2	-	0.8	0.8	1.6	124
14525	PK136	SW01-30-29AW	61.5	11.5	25.0	1.0	-	1.0	2.0	104
14525	PK135	SW01-30-29AW	55.6	9.6	31.3	-	3.5	-	3.5	115
14526	PK134	NE13-29-29W	63.0	5.0	27.0	4.0	1.0	-	5.0	100
14526	PK057	SW24-29-29W	64.2	8.6	17.3	7.4	-	2.5	9.9	81
14526	PK058	SE24-29-29W	68.2	6.4	23.8	-	0.8	0.8	1.6	126
14526	PK020	NW13-29-29W	52.7	17.0	26.8	2.7	-	0.9	3.6	112
14528	PK074	SE07-29-29W	67.3	8.9	20.8	2.0	1.0	-	3.0	101

APPENDIX E: AGGREGATE QUALITY AND DEVELOPMENT POTENTIAL CRITERIA

	Criteria	HIGH	MEDIUM	LOW
	Stone %	+30	15-30	0-15
	Sand %	0-35	35-70	+70
AGGREGATE	Mud %	0-7	7-17	+17
QUALITY	Shale %	0-5	5-12	+12
	Thickness	+5 m	2-5 m	2 m
	Uniformity	high	medium	low
	Aggregate Quality	high	medium	low
	*Crushable	abundant	moderate	minor
	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
DEPOSIT	Verification	proven	limited	untested
DEVELOPMENT	Local Access	0-1 km	1-5 km	+ 5 km
POTENTIAL	Quarrying Status	active	intermittent	inactive
	Transportation Diff.	high	medium	low
	Planning Constraints	none	conditional	sterilized
	Specialty Material	yes		no
	Aggregate Substitute	none	marginal	proximal

*In Park North deposits with abundant crushable are considered to have low economic potential.

APPENDIX F: INTEGRATION OF POINT COUNTS, FIELD SIEVING AND LABORATORY GRAIN SIZE DATA

Grain size distribution information was obtained using three methods due to sampling difficulties as shown in Table 1. Conventionally, most reference to grain size distribution is in terms of weight percentage passing. An attempt here is made to integrate all three methods into a representation of per cent passing. Information for material coarser than 75 mm (3 in.) was divided into two components. The material coarser than 305 mm (12 in.) was recorded as being present or absent, with no attempt to estimate the actual percentage. Material between 305 and 75 mm was divided into two sub-populations and their frequency was determined using the point count method described earlier. The results of the point counts are listed in Appendix A. To convert the point count data to a percentage the following procedure was used:

The median grain size of each population was calculated

Population A = 305-152 mm
median = 241 mm
Population B = 152-76 mm
median = 114 mm

Clasts are assumed to be spherical.

The cross-sectional area of a sphere = πr^2

Then, the area covered by one clast from each population is:

Pop A: r = 12.065 cm Pop B: r = 5.712 cm
r^2 = 145.56 cm r^2 = 32.66 cm
π = 3.1415 π = 3.1415
Pop A = 457.29 cm^2 Pop B = 102.6 cm^2

The area of a 1 metre square = 10 000 cm^2, therefore;

1 clast of Pop A represents 4.573% of the 1 metre square area
and
1 clast of Pop B represents 1.025% of the 1 metre square area

To calculate the percentage represented by population A and B, the averaged value is multiplied by the per cent area of one clast of each population,

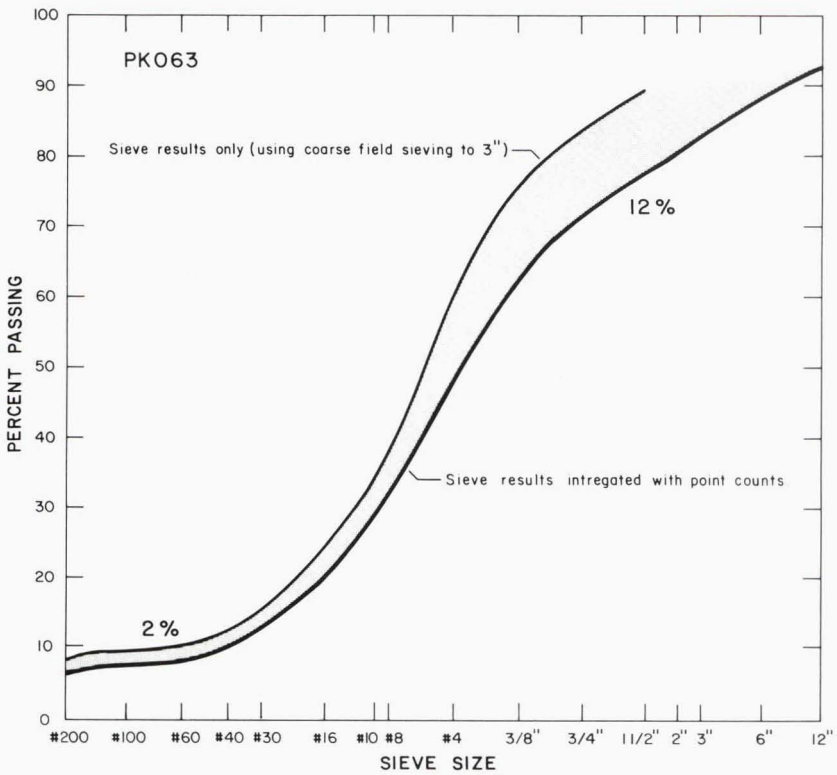
i.e. if there is an average of 8.6 clasts in Pop B (152-76 mm)
then 8.6 x 1.026% = 8.8%

and, 8.8% of the deposit is in the 162 to 73 mm size range.

Point count data of material coarser than 76 mm (medium cobbles) were used with grain size information collected by weighing. The effect of including material coarser than 76 mm is illustrated in the accompanying figure.

Integrating the coarse cobbles and boulders changes the slope of the grading curve. The difference progressively increases with grain size, so that for sample PK063 there is a 2% difference at the 200 mesh increasing to 12% at 3 in. The curve resulting from the sieve information without integration suggests there is no material greater than 3 inches. If a gravel operator uses the curves as indicators for processing management, the difference is significant; using a screening method, the unintegrated sieve line suggests approximately 10% waste, generally considered a manageable amount. The integrated line, however, suggests there could be over 30% waste. This would make the deposit uneconomic because of the amount of waste.

The computer data file is accessible through the Aggregate Resources Section, Mines Branch. The file contains all the geological, reserve, ownership and sieved grain size information. The background data file, including all the working notes, records, maps and airphotos used during the study, is also available at the Aggregate Resources Section.



APPENDIX G: AGGREGATE DEPOSITS IN THE L.G.D. OF PARK NORTH

Deposit Number	Legal Description	Station Number	Crushable % (+35 mm)	Freerun % (-35 mm)	Stone % (+48 mm)	Thickness m	Aggregate Quality*	Development Potential* ('000 m^3)	Reserves ('000 m^3)	Quarrying Status*	Ownership Surface/ Sand and Gravel*	Comments
14501	SW02-29-28W					1.0	M	P	125		P/P	no access, untested, Shell
	SE03-29-28W					1.0	M	P			P/P	Valley terrace
14502	SE03-29-28W					4.0	M	M	1 700		C/C	cobbly, undeveloped, Shell
	NE04-39-28W					4.0	M	M			P/P	Valley terrace
	NW04-29-28W					4.0	M	M			P/P	
	SE04-29-28W	PK063	28	72	39		M	M			P/P	
14503	NW04-29-28W					2.0	M	G	955		P/P	sandy, and shallows eastwards,
	SW04-29-28W	PK064	1	99	24	2.0	M	G		A	P/P	pit opened in 1986
	NE05-29-28W					2.0	M	G			P/P	
	SE05-29-28W	PK107	1	99	24	2.0	M	G			P/P	
14504	NE06-29-28W	PK103	11	90	40	4.0	H	M	275		P/P	variable thickness, undeveloped
	SE07-29-28W					4.0	H	M			P/P	
	SW07-29-28W					4.0	H	M			P/P	
14505	NW08-29-28W					3.8	L	P	1 832		P/P	1.2 m fine sand overburden, poor
	SW08-29-28W	PK106	2	98	31	3.8	L	P			P/P	access, Shell valley terrace
	SW17-29-28W					3.8	L	P			C/C	
	NE18-29-28W					3.8	L	P			P/P	
	SE18-29-28W					3.8	L	P			P/P	
14506	NW03-29-28W	PK007	16	84	39	2.0	M	M	3 530	R	C/C	coarse deposit, water table at
	NW03-29-28W	PK108				2.0	M	M		R	C/C	2.0 m, Shell valley terrace
	NE04-29-28W	PK006	25	75	36	2.0	M	P		I	P/P	
	NE04-29-28W	PK109	15	85	44	2.0	M	P			P/P	
	NE08-29-28W					2.0	M	P			C/C	
	NW08-29-28W					2.0	M	P			C/C	
	SE08-29-28W					2.0	M	P			C/C	
	NW09-29-28W					2.0	M	P			P/P	
	SE09-29-28W	PK110	21	79	46	2.0	M	P			P/P	
	SW09-29-28W	PK111	11	89	25	2.0	M	P			P/P	
	NE17-29-28W					2.0	M	P			C/C	
	NW17-29-28W					2.0	M	P			C/C	
	SE17-29-28W					2.0	M	P			C/C	
	SW17-39-28W					2.0	M	P			C/C	
14507	NW11-29-28W					1.0	L	P	25		P/P	very sandy
	NE11-29-28W					1.0	L	P			P/P	

*Definitions at end of table

APPENDIX G (Cont'd.)

Deposit Number	Legal Description	Station Number	Crushable % (+35 mm)	Freerun % (-35 mm)	Stone % (+48 mm)	Thickness m	Aggregate Quality	Development Potential ('000 m^3)	Reserves ('000 m^3)	Quarrying Status	Ownership Surface/ Sand and Gravel	Comments
14507	SE14-29-28W					1.0	L	P			P/P	
(cont'd.)	SW14-29-28W	PK023	3	97	22	1.0	L	P			P/P	
14509	NE20-29-28W	PK081				2.0	M	P	1 898		P/P	coarse deposit, poor access,
	NW20-29-28W					2.0	M	P			P/P	untested, Shell valley terrace
	SW20-29-28W					2.0	M	P			P/P	
	NW21-29-28W					2.0	M	P			C/C	
	SE29-29-28W					2.0	M	P			C/C	
	SW20-29-28W					2.0	M	P			C/C	
14510	NE18-29-28W					2.5	H	G	196		P/P	Bedu's pit, largest pit in study
	SE19-29-28W	PK050A	7	93	22	2.5	H	G		A	P/P	area, fining southwards, good
	SE19-29-28W	PK050B	9	91	21	2.5	H	G		A	P/P	location and access
	SE19-29-28W	PK050C	4	96	18	2.5	H	G		A	P/P	
	SE19-29-28W	PK100	2	98	25	2.5	H	G		A	P/P	
	SE19-29-28W	PK101	3	97	36	2.5	H	G		Q	P/P	
14511	NE27-29-28W					2.0	H	L	2 252		P/P	large reserves, Shell valley
	SE27-29-28W					2.0	H	L			P/P	terrace, used locally
	SW27-29-28W	PK045				2.0	H	M		I	P/P	
	SE28-29-28W	PK042	17	83	34	2.0	H	M		A	P/P	
	SE28-29-28W	PK044	1	99	10	2.0	H	M		I	P/P	
	SW28-29-28W					2.0	H	M			P/P	
14512	NW26-29-28W	PK034				4.0	L	P	297		P/P	1.0 m sand overburden, bouldery
	NW26-29-28W	PK123	33	67	47	4.0	L	P			P/P	gravel, Shell valley terrace, on
	SW26-29-28W					4.0	L	P			P/P	PR594
14513	NE25-29-28W					5.0	H	M	2 993		P/P	large pit on east of L.G.D.
	NW25-29-28W					5.0	H	M			P/P	boundary road in Forest Reserve
	SE36-29-28W	PK116	4	96	32	5.0	H	M			C/C	(SW31-29-27W)
	SE36-29-28W	PK117	15	85	40	5.0	H	M			C/C	
	SE36-29-28W	PK118	44	56	51	5.0	H	M			C/C	
	SW36-29-28W	PK119	6	94	44	5.0	H	M		I	M/C	
14514	NE35-29-28W					2.5	H	P	870		M/C	good quality, limited deposit
	NE35-29-28W					2.5	H	P			P/P	width, L.G.D. boundary road
	NW36-29-28W					2.5	H	P			M/C	access, Shell valley terrace
	NE01-30-28W	PK028	4	96	30	2.5	H	M			C/C	
	NE01-30-28W	PK029	8	92	41	2.5	H	M		R	C/C	
	NE01-30-28W	PK121	3	97	35	2.5	H	M			C/C	

APPENDIX G (Cont'd.)

Deposit Number	Legal Description	Station Number	Crushable % (+35 mm)	Freerun % (-35 mm)	Stone % (+48 mm)	Thickness m	Aggregate Quality	Development Potential ('000 m^3)	Reserves ('000 m^3)	Quarrying Status	Ownership Surface/ Sand and Gravel	Comments
14515	SE01-30-28W	PK030				2.5	H	M		R	C/C	
(cont'd.)	SE01-30-28W	PK120	4	96	45	2.5	H	M			C/C	
	SW01-30-28W					2.5	H	P			P/P	
14515	NE35-29-28W	PK122	16	84	38	3.0	M	P	1 379		M/C	2.0 m sand overburden, good
	NE01-30-28W					3.0	M	P			C/C	access, deposit on PR 367, Shell
	NW01-30-28W					3.0	M	P			P/P	valley terrace
	SW01-30-28W					3.0	M	P			P/P	
	SE02-30-28W					3.0	M	P			P/P	
	SE12-30-28W					3.0	M	P			C/C	
14516	NE03-30-28W					5.0	H	G	290		P/P	cobbly pebble gravel, water
	SE10-30-28W					5.0	H	G			P/P	table at 2.5 m, deposit
	SW11-30-28W	PK024	15	85	44	5.0	H	G		A	C/C	continues westward
	SW11-30-28W	PK125				5.0	H	G		A	C/C	
	SW11-30-28W	PK126	6	94	25	5.0	H	G			P/P	
14517	NE28-29-28W					1.5	H	M	46		P/P	small deposit, variable gravel
	NW28-29-28W					1.5	H	M			P/P	thickness, good location and
	SW33-29-28W	PK070	11	89	57	1.5	H	M			P/P	access
14518	NE29-29-28W	PK133	4	96	26	3.0	H	G	151		C/C	used as pit run, sandy pebble
	NW29-29-28W	PK038	3	97	46	3.0	H	G		A	C/C	gravel, good location and
	SE32-29-28W					3.0	H	P			P/P	access, reserves continue
	SW32-29-28W	PK039	6	94	32	3.0	H	P			P/P	southwards
	SW32-29-28W	PK040			35	3.0	H	P			P/P	
14519	NW16-30-28W	PK010	12	88	34	3.0	H	G	1 262	A	M/C	cobbly gravel, screened
	NW16-30-28W	PK127				3.0	H	G			M/C	material in stockpiles in pit,
	NW16-30-28W	PK128				3.0	H	G			M/C	reserves to south and west
	NW16-30-28W	PK129	13	87	43	3.0	H	G			M/C	
	SW16-30-28W					3.0	H	G			P/P	
	NE17-30-28W	PK009	15	85	57	3.0	H	G		I	P/P	
	SE17-30-28W					3.0	H	G			P/P	
	SW21-30-28W					3.0	H	G			P/C	
14520	NE19-30-28W					3.0	H	M	22 911		C/C	'Call of the Wild' deposit, large
	NW19-30-28W					3.0	H	M			P/P	extensive deposit, remote
	NW20-30-28W					3.0	H	M			M/C	location
	NE28-30-28W					3.0	H	P			M/C	
	NW28-30-28W					3.0	H	P			P/P	
	SW28-30-28W					3.0	H	P			M/C	

APPENDIX G (Cont'd.)

Deposit Number	Legal Description	Station Number	Crushable % (+35 mm)	Freerun % (-35 mm)	Stone % (+48 mm)	Thickness m	Aggregate Quality	Development Potential ('000 m^3)	Reserves ('000 m^3)	Quarrying Status	Ownership Surface/ Sand and Gravel	Comments
14520	NE29-30-28W					3.0	H	M			C/C	
(cont'd.)	NW29-30-28W	PK076	0	100	29	3.0	H	P		A	C/C	
	SE29-30-28W					3.0	H	P			C/C	
	SW29-30-28W	PK067	8	92	33	3.0	H	M		R	C/C	
	NE30-30-28W	PK132			28	3.0	H	P			C/C	
	NW30-30-28W					3.0	H	P			M/C	
	SE30-30-28W	PK071	4	96	36	3.0	H	M		R	P/P	
	SE30-30-28W	PK072	34	66	60	3.0	H	M			P/P	
	SE30-30-28W	PK131	4	96	29	3.0	H	M			P/P	
	SW30-30-28W	PK068	0	100	29	3.0	H	M		I	M/C	
	SW30-30-28W	PK130	0	100	6	3.0	H	M			M/C	
	NE31-30-28W					3.0	H	P			C/C	
	NW31-30-28W					3.0	H	P			C/C	
	SE31-30-28W					3.0	H	P			P/P	
	SW31-30-28W					3.0	H	P			P/P	
	NE32-30-28W					3.0	H	M			C/C	
	NW32-30-28W					3.0	H	M			C/C	
	SE32-30-28W					3.0	H	M			M/C	
	SW31-30-28W					3.0	H	P			C/C	
	NE33-30-28W					3.0	H	P			C/C	
	NW33-30-28W					3.0	H	P			C/C	
	SE33-30-28W					3.0	H	P			M/C	
	SW33-30-28W					3.0	H	P			M/C	
14521	NE24-30-28W					1.5	H	P	1 357		C/C	remote location, Shell valley
	NW25-30-28W					1.5	H	P			C/C	terrace
	SE25-30-28W					1.5	H	P			C/C	
	SW25-30-28W					1.5	H	P			C/C	
	NE36-30-28W					1.5	H	P			P/C	
	NW36-30-28W					1.5	H	P			P/P	
	SE36-30-28W	PK077	0	100	30	1.5	H	P			C/C	
	SW36-30-28W					1.5	H	P			C/C	
14522	NE25-30-28W	PK075	3	97	21	4.0	H	M	1 184	A	C/C	used locally for road maintenance
	SE25-30-28W					4.0	H	M			C/C	
	SE36-30-28W					4.0	H	M			C/C	
14523	NW06-29-28W					1.5	H	P	521		P/P	Little Boggy Creek terrace,
	SW07-29-28W					1.5	H	P			P/P	undeveloped
	NE12-30-29AW					1.5	H	P			P/P	
	SE12-30-29AW	PK060	3	97	23	1.5	H	P			M/C	

APPENDIX G (Cont'd.)

Deposit Number	Legal Description	Station Number	Crushable % (+35 mm)	Freerun % (-35 mm)	Stone % (+48 mm)	Thickness m	Aggregate Quality	Development Potential ('000 m^3)	Reserves ('000 m^3)	Quarrying Status	Ownership Surface/ Sand and Gravel	Comments
14524	NE12-30-29AW						2.0	M	P			P/PLittle Boggy Creek terrace
	NW12-30-29AW					2.0	M	P	750		C/C	
	SE12-30-29AW					2.0	M	P			M/C	
14525	NW02-30-29AW	PK015	9	91	52	3.0	H	G	7 181	A	C/C	Tees Lake deposit, good access,
	NE02-30-29AW					3.0	H	G			C/C	active pit, large reserves
	NE11-30-29AW					3.0	H	M			C/C	northwards
	SE11-30-29AW					3.0	H	G			C/C	
	NW12-30-29AW					3.0	H	M			P/C	
	SE12-30-29AW					3.0	H	G			P/P	
	SW12-30-29AW	PK059				3.0	H	G			C/C	
	SW12-30-29AW	PK135			31	3.0	H	G			C/C	
	SW12-30-29AW	PK136	2	98	24	3.0	H	G			C/C	
	NE36-30-29AW					3.0	H	P			P/P	
	NW36-30-29AW					3.0	H	P			P/P	
14526	NE13-29-29W	PK134	10	90	29	2.0	L	G	1 386		P/P	Laliberte's pit deposit, very
	NW13-29-29W	PK020			11	2.0	L	G			P/P	sandy pebble gravel, material
	SW13-29-29W					2.0	L	G			P/P	used for winter sanding
	NE14-29-29W					2.0	L	G			P/P	
	SE23-29-29W					2.0	L	G			P/P	
	SE24-29-29W	PK058	3	97	24	2.0	L	G		R	P/P	
	SW24-29-29W	PK056				2.0	L	G			P/P	
	SW24-29-29W	PK057	0	100	26	2.0	L	G			P/P	
	SE35-29-29W					2.0	L	G			P/P	
14527	NE01-30-29AW	PK137	10	90	20	3.0	H	P	781		M/C	poor access
	NW01-30-29AW					3.0	H	P			C/C	
	SE12-30-29AW					3.0	H	P			M/C	
14528A	NW02-29-29W					3.0	H	M	62		P/P	coarse pebble gravel, untested
14528B	SE07-29-29W	PK074	0	100	33	3.0	M	M	62		P/P	poor access, very sandy
14528C	SW07-29-29W					2.0	M	M	46		C/C	no access, untested
14529	NW06-30-28W					2.0	H	M	693		P/P	undeveloped, roadcut exposures
	NE07-30-28W					2.0	H	M			C/C	reserves to northeast, esker
	SE07-30-28W					2.0	H	P			P/P	system

Aggregate Quality
H - High
M - Medium
L - Low

Development Potential
G - Good
M - Moderate
P - Poor

Quarrying Status
A - Active
I - Inactive
R - Revegetated

Ownership Surface/ Sand and Gravel
P - Private
C - Crown
M - Municipal or L.G.D.

APPENDIX H: GRAINSIZE DISTRIBUTION FOR AGGREGATE FINER THAN 305 MM IN THE L.G.D. OF PARK NORTH IN PER CENT PASSING

			Crushable				Freerun		
Deposit No.	Sample No.	Legal Description	Boulder 305 mm 12" X (present)	Boulder 305 mm 12"	Cobble 150 mm 6"	Cobble 75 mm 3"	Pebble 38 mm 1.5"	Sand 4.8 mm #4	Silt/Clay 0.06 mm #200
14502	PK063	SE04-29-28W	X	100.0	86.3	79.2	72.0	48.0	6.4
14503	PK064	SW04-29-28W		100.0	100.0	100.0	98.7	76.0	4.6
14503	PK107	SE05-29-28W		100.0	100.0	100.0	98.7	75.7	2.2
14504	PK103	NE06-29-28W		100.0	100.0	97.1	88.9	57.9	2.9
14505	PK106	SW08-29-28W		100.0	100.0	100.0	97.7	69.1	7.0
14506	PK007	NW03-29-28W	X	100.0	92.7	90.9	83.7	55.7	3.8
14506	PK006	NW04-29-28W	X	100.0	97.4	88.6	75.6	56.9	3.0
14506	PK109	NE04-29-28W		100.0	100.0	97.0	91.2	54.6	5.6
14506	PK110	SE09-29-28W	X	100.0	100.0	91.6	78.0	49.1	4.0
14506	PK111	SW09-29-28W	X	100.0	100.0	98.1	89.5	73.9	3.4
14507	PK023	SW14-29-28W		100.0	98.2	97.0	92.0	87.1	4.9
14510	PK050A	SE19-29-28W		100.0	100.0	96.7	92.5	75.8	1.3
14510	PK050B	SE19-29-28W		100.0	100.0	97.2	91.1	77.1	1.0
14510	PK050C	SE19-29-28W		100.0	100.0	99.2	95.8	80.8	1.8
14510	PK100	SE19-29-28W		100.0	100.0	100.0	97.8	74.7	3.3
14510	PK101	SE19-29-28W		100.0	100.0	98.6	97.2	62.7	1.3
14511	PK044	NE21-29-28W		100.0	100.0	99.5	99.2	89.4	2.0
14511	PK042	SE28-29-28W	X	100.0	93.6	89.9	83.9	58.4	6.9
14512	PK123	NW26-29-28W	X	100.0	78.5	75.7	66.9	39.9	5.6
14513	PK116	SE36-29-28W		100.0	100.0	99.0	97.4	68.5	3.7
14513	PK117	SE36-29-28W	X	100.0	100.0	90.8	85.2	54.6	2.9
14513	PK118	SE36-29-28W	X	100.0	100.0	69.4	56.1	34.2	1.6
14513	PK119	SW36-29-28W		100.0	100.0	99.6	93.8	55.5	1.7
14514	PK028	NE01-30-28W		100.0	100.0	100.0	96.3	70.1	4.2
14514	PK029	NE01-30-28W		100.0	100.0	100.0	91.9	59.1	8.5
14514	PK121	NE01-30-28W		100.0	100.0	99.1	97.5	64.1	5.6
14514	PK120	SE01-30-28W		100.0	100.0	100.0	96.4	54.7	1.2

APPENDIX H (Cont'd.)

Deposit No.	Sample No.	Legal Description	Crushable: Boulder 305 mm 12" X (present)	Crushable: Boulder 305 mm 12"	Crushable: Cobble 150 mm 6"	Crushable: Cobble 75 mm 3"	Freerun: Pebble 38 mm 1.5"	Freerun: Sand 4.8 mm #4	Freerun: Silt/Clay 0.06 mm #200
14515	PK122	NE35-29-28W		100.0	100.0	96.5	84.1	59.8	11.2
14516	PK126	NW02-30-28W		100.0	100.0	99.1	94.2	74.7	3.5
14516	PK024	SW11-30-28W		100.0	99.1	96.7	84.8	54.2	4.2
14517	PK070	SE33-29-28W		100.0	100.0	100.0	88.9	43.3	2.7
14518	PK133	NE29-29-28W		100.0	100.0	100.0	95.9	73.5	2.0
14518	PK038	NW29-29-28W		100.0	100.0	100.0	97.2	54.0	2.0
14518	PK039	SW32-29-28W		100.0	100.0	100.0	94.4	68.2	2.1
14519	PK010	NW16-30-28W		100.0	100.0	97.4	87.9	64.4	2.5
14519	PK129	NW16-30-28W		100.0	100.0	97.1	86.7	55.3	1.8
14519	PK009	NE17-30-28W		100.0	98.2	94.7	85.3	40.7	2.0
14520	PK076	NW29-30-28W		100.0	100.0	100.0	100.0	71.4	2.6
14520	PK067	SW29-30-28W		100.0	98.6	97.6	92.0	65.6	1.6
14520	PK071	SE30-30-28W		100.0	100.0	99.0	96.1	63.6	1.4
14520	PK072	SE30-30-28W		100.0	98.2	90.7	66.2	36.4	2.7
14520	PK131	SE30-30-28W		100.0	100.0	100.0	96.0	71.1	2.4
14520	PK068	SW30-30-28W		100.0	100.0	100.0	100.0	71.1	2.6
14520	PK130	SW30-30-28W		100.0	100.0	100.0	100.0	93.7	2.4
14521	PK077	SE36-30-28W		100.0	100.0	100.0	100.0	70.1	4.3
14522	PK075	NE25-30-28W		100.0	99.1	97.3	97.3	76.6	1.6
14523	PK060	SE12-30-29AW		100.0	100.0	100.0	96.8	76.8	5.1
14525	PK015	NW02-30-29AW		100.0	100.0	96.6	90.6	46.1	1.6
14525	PK136	SW12-30-29AW		100.0	100.0	96.6	90.6	46.1	1.6
14526	PK134	NE13-29-29W		100.0	100.0	100.0	89.8	71.4	5.5
14526	PK058	SE24-29-29W		100.0	100.0	100.0	96.7	76.3	2.6
14526	PK057	SW24-29-29W		100.0	100.0	100.0	99.6	74.2	2.8
14527	PK137	NE01-30-29AW		100.0	100.0	97.5	90.3	77.8	2.4
14528B	PK074	SE07-29-29W		100.0	100.0	100.0	100.0	66.6	1 .1

APPENDIX I: 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 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 Winsconsinan Stage.