Aggregate Report AR85-3

Aggregate Resources in the Rural Municipality of Miniota

By H.D. Groom

Manitoba
Energy and Mines
Mines Branch

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ABSTRACT

The Rural Municipality of Miniota comprises Twps. 13 to 15 and Rges. 25W to 27W in southwestern Manitoba. It is underlain by shale bedrock of the Riding Mountain Formation and glacial sediments predominantly of Late Wisconsinan age. Aggregate deposits in the municipality are associated with the glacial drift and are of four genetic types: 1) eskers, 2) kame moraine, 3) outwash plains and 4) spillway terraces.

Although there is an abundance of aggregate in the municipality — an estimated 41 million m^3 — much of it has limited economic potential due to either a high shale content or poor road access. However, reserves in deposits that are currently being mined, primarily deposits 11504, 11536, 11537 and 11546, are ample to meet the municipality's needs for the foreseeable future.

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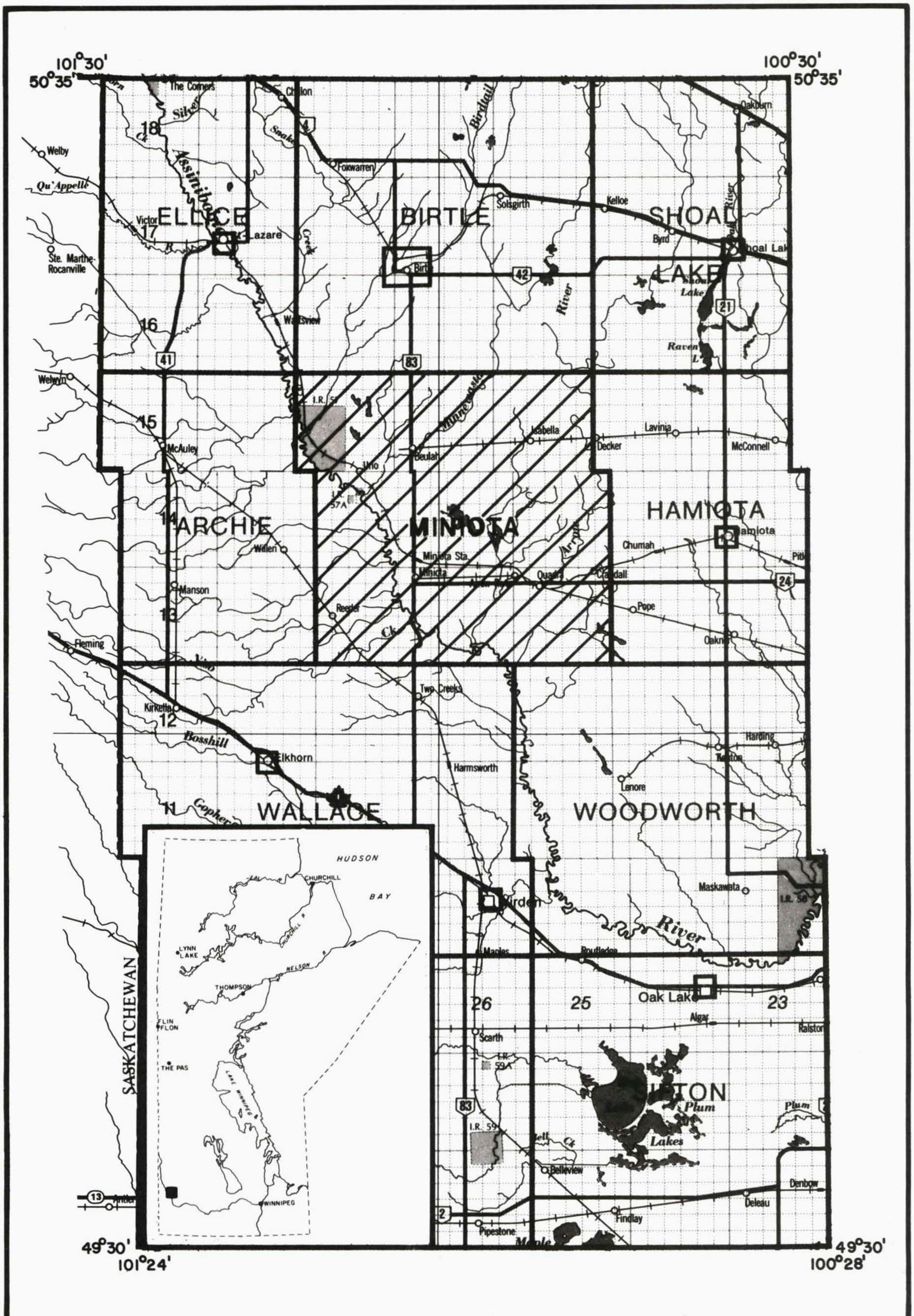

Figure 1: Location map of the Rural Municipality of Miniota.

INTRODUCTION

Objectives

Mapping in the Rural Municipality of Miniota was carried out 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 municipality.

The information is used to facilitate land use planning designed to protect high quality aggregate deposits from sterilization.

Location and Access

The R.M. of Miniota covers 840 km^2, comprising Twps. 13 to 15 and Rges. 25W to 27W (Fig. 1). The area is primarily a farming district and the villages of Miniota and Crandall are the major service centres. A network of paved highways and gravelled section roads provides easy access to most deposits.

Physiography

The municipality lies within the Assiniboine River plain west of the Manitoba Escarpment. Although the land has an overall southeast slope, within the study area contours parallel the Assiniboine Valley; the land rises away from the river on both sides. The highest elevations are in the northeast (530 m above sea level). The elevation decreases to 460 m a.s.l. at the top of the river valley and rises again to the west (485 m a.s.l.).

The Assiniboine River Valley is the most prominent geomorphic feature in the area. The valley is 1 to 2.5 km wide and 45 to 60 m deep (Fig. 2). The river is a meandering, underfit stream and there are numerous oxbow lakes on the valley floor. The valley walls are cut into glacial drift and bedrock; slumping is common particularly where the walls are cut into bedrock.

Birdtail Creek also occupies a major valley. This valley is 0.5 km wide and 50 m deep, and cut into drift and bedrock. Arrow River and Minnewasta and Niso Creeks are the other major drainage channels in the area.

Apart from the river valleys, the greatest relief is in the Arrow Hills area where till and gravel ridges range between 8 and 30 m high. An outwash plain lies along the east side of the Assiniboine River. The surface is flat to gently undulating, except northwest of Birdtail Creek where it is pitted and local relief is between 2 and 5 m (Fig. 3). The rest of the municipality is underlain by a rolling till plain with relief between 2 and 3 m, increasing to 7 m along the southeastern border of the municipality.

Methodology

Surficial deposits were delineated on 1:50 000 scale air photos. Air photo interpretation was based on surficial units delineated at 1:250 000 scale by Klassen (1979) and incorporated information from gravel pit inventory files of the Department of Highways and Transportation Services.

During field mapping, all gravel pits were visited; unopened gravel deposits were backhoed either with the landowner's permission or along public road allowances. Samples were taken from deposits considered to be of economic value and submitted for sieve analysis. All gravel deposits were delineated on 1:15 850 scale photos which were used to calculate reserve estimates on a per quarter section basis.

Previous Work

The surficial geology of the area has been mapped at a scale of 1:250 000 and the glacial history outlined by Klassen (1966, 1979) as part of a regional study of the Riding Mountain-Duck Mountain area of southwestern Manitoba. The evolution of the Assiniboine Spillway and terrace development along the river has also been studied by Klassen (1975).

The soils of the area, including parent material, have been mapped by Ehrlich et al. (1956) at a scale of 1 inch to 2 miles.

The bedrock geology has been described by Wickenden (1945) and Bannatyne (1970). A map of the bedrock topography at a scale of 1 inch to 8 miles has been produced by Klassen et al. (1970).

Figure 2: View of the Assiniboine River Valley, looking southwards; Twp. 13, Rge. 26W.

Figure 3: Pitted outwash plain northwest of Birdtail Creek; Twp. 15, Rge. 27W.

Acknowledgements

Val Erikson provided able field assistance; M. Carvalho and M. Simmons drafted the maps and figures, and the Word Processing Centre typed the manuscript.

GEOLOGY

Bedrock Geology

The study area is underlain by Upper Cretaceous marine shales of the Riding Mountain Formation (Fig. 4). The lower unit, the Millwood Member, is a soft, greenish-brown, bentonitic shale. It outcrops in the lower valley walls of Assiniboine River and Birdtail Creek. The overlying Odanah Member is a hard, grey, siliceous shale that is well exposed in the valley walls of the Assiniboine and Arrow Rivers. The lower part of the Odanah Member is soft with thin interbeds of bentonite 'resembling part of the Millwood when wet' (Bannatyne, 1970). This phase of the Odanah outcrops at several locations along the Assiniboine valley. The rock is black, very soft and clayey. Large calcite concretions (long axis up to 30 cm) are numerous and selenite crystals and bentonite beds are also present.

The depth to bedrock varies considerably throughout the municipality. Southwest of the Assiniboine River, bedrock is within 3 m of the surface in places (Fig. 5). However, water well records in the northeastern portion of the area indicate the bedrock surface is beneath 40 m of drift.

The bedrock topography map of the area (Klassen et al., 1970) depicts the thalweg of several rivers that drained the area in Tertiary and early Pleistocene times. The present-day Assiniboine River occupied the valley of the ancestral Assiniboine from Miniota southwards. Birdtail Creek, the northern portion of Minnewasta Creek and the southern portion of Arrow River also follow ancient river courses.

The bedrock in the municipality has not been exploited commercially. Bannatyne (1970) reports an approximately 60 cm thick bentonite deposit underlying till near Beulah (NE7-15-26W). The distribution and thickness is variable, probably as a result of thrusting of the original bed by over-riding glacial ice. Further testing will have to be done to determine the economic potential of the deposit.

Quaternary Geology and History of Deglaciation

The sequence of events during the deglaciation of the Assiniboine River plain has been described by Klassen (1966, 1979). Figure 6 showing the surficial geology of the R.M. of Miniota has been modified from Klassen (1979).

Tills of the Early Wisconsinan, Minnedosa and the Late Wisconsinan, Lennard Formations are the predominant surficial materials southwest of the Assiniboine River. The till plain covering the northeastern portion of the municipality is composed of the Lennard Formation.

The Arrow Hills, a kame moraine complex covering 20 km^2 south of the town of Arrow River, formed within a narrow re-entrant that developed in the ice sheet during the early stages of deglaciation. The eastern portion of the moraine was built along the ice front and in this area the hills often exceed 25 m in height. The material forming the hills is extremely variable. Till is the major constituent but much of it is interbedded gravels, sands and diamicton beds. Isolated hills of shale rubble, resulting from ice-thrust, are present and much of the gravel, up to cobble size, is shale.

The western edge of the moraine is formed of southwest oriented ridges that are 10 m high and extend discontinuously for over 1.5 km. Although the material is variable in grain size, ranging from sand to cobble gravel and rare diamicton beds, overall it is finer, better sort-

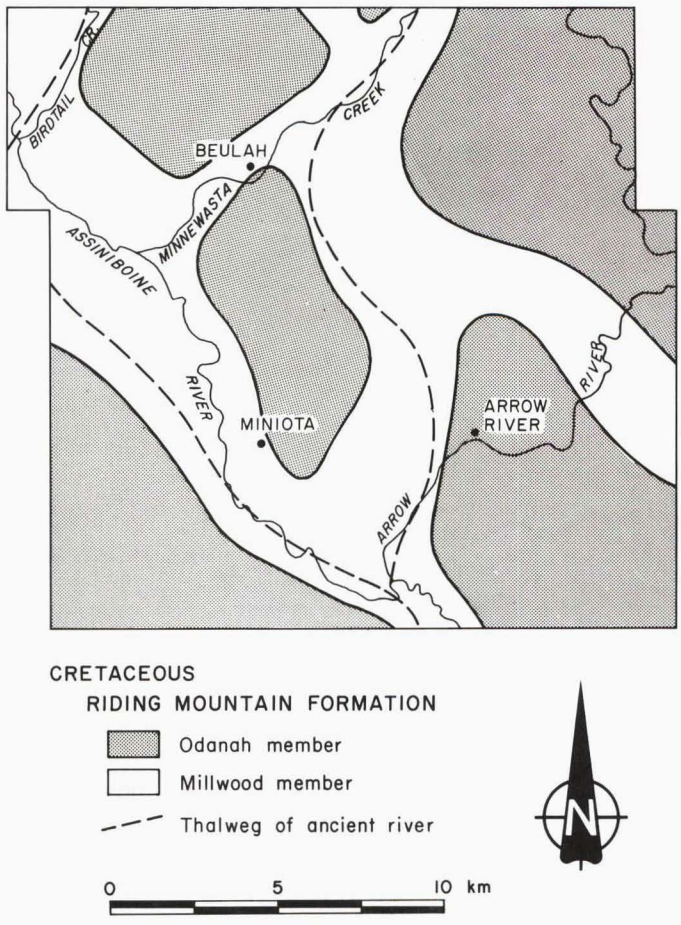

Figure 4: Bedrock geology of the Rural Municipality of Miniota.

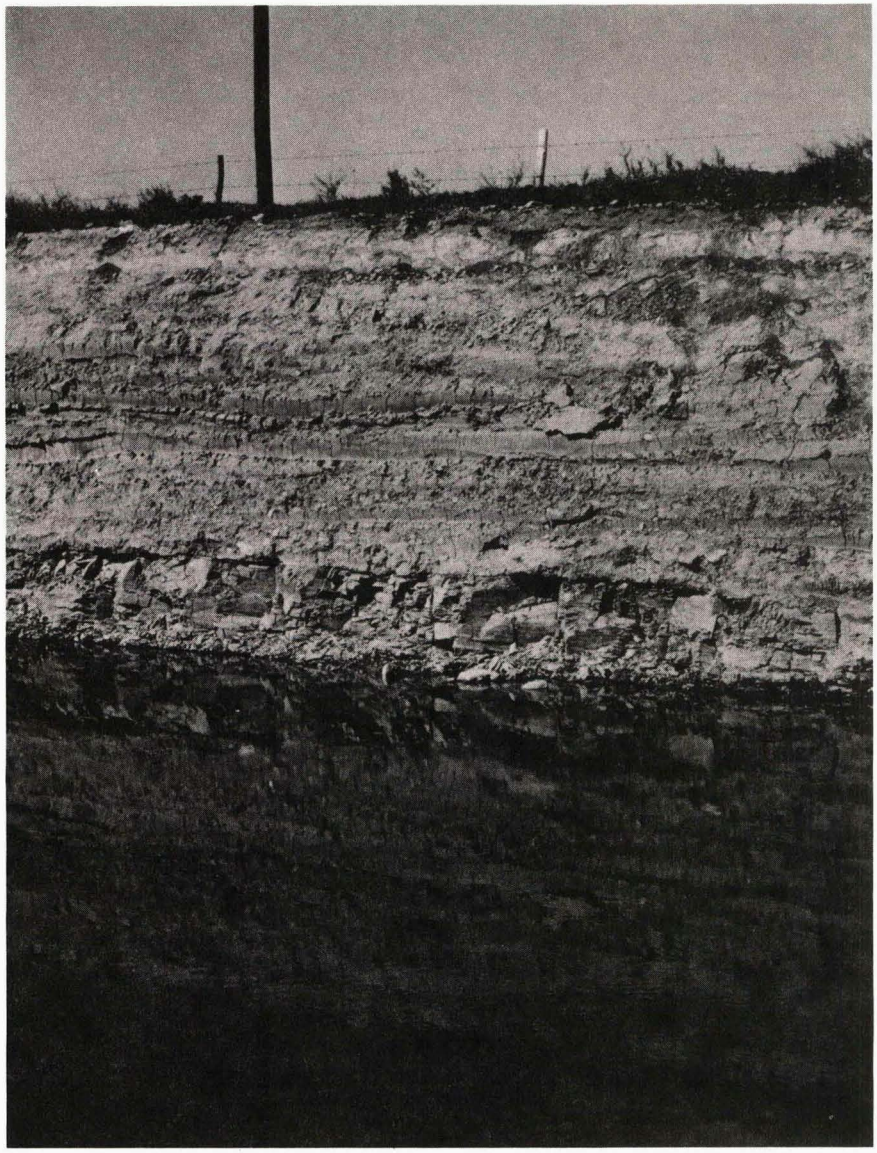

Figure 5: Dugout (SW29-13-27W) showing bedrock underlying 3 to 4 m of glacial sediment.

ed and lower in shale than the gravels in the eastern portion of the moraine. The ridges are formed predominantly of interbedded sand and pebble gravel and are generally coarser at the northern ends. Paleocurrent directions measured at SE24-13-26W were southwesterly (200°-220°).

The southern edge of the moraine complex is an outwash plain. Most backhoe test sites exposed 2 to 3 m of crossbedded sand overlying till. The paleoflow in the sand is southwesterly.

The outwash lying along the edge of the Assiniboine River was deposited sequentially into the re-entrant as the ice front retreated northwards up the valley, (Phase No. 6 of Klassen, 1966). Minor pauses during the retreat of the ice are marked by coarse gravel deposited at Beulah, west of the river at Miniota, and immediately north of Birdtail Creek. The width of the plain on the east side of the river ranges from 9 km at Hooper Lake to 4.5 km at Miniota; depths range from over 9 m in the north to 5 m in the south (Klassen, 1979). The outwash is primarily medium to fine sand with local beds of pebbly sand. The sand is often parallel bedded but is more commonly planar or trough crossbedded (Fig. 7). Paleoflow was southerly between 160° and 220°. The eastern edge of the outwash plain between Birdtail and Minnewasta Creeks was deposited in a channel. At least 4 m of well sorted, sandy, fine to coarse pebble gravel overlies sand. The gravel is crossbedded and paleoflow (152° to 180°) was along the channel axis.

The Assiniboine River and Birdtail Creek valleys were major spillways for the meltwater accompanying deglaciation. The Assiniboine Spillway is 60 m deep and from 1.5 to 2 km wide along its course through the municipality. The Assiniboine carried meltwater from a large portion of southeastern Saskatchewan, via its tributary, the Qu'Appelle River Spillway, as well as from western Manitoba.

Birdtail Creek carried a much smaller volume of water as it drained only a portion of the Riding Mountain uplands. Terrace levels in the Birdtail Creek valley are at least 30 m higher than those in the Assiniboine indicating it had ceased acting as a spillway while the Assiniboine River continued to carry meltwater as the glacial ice retreated northwards.

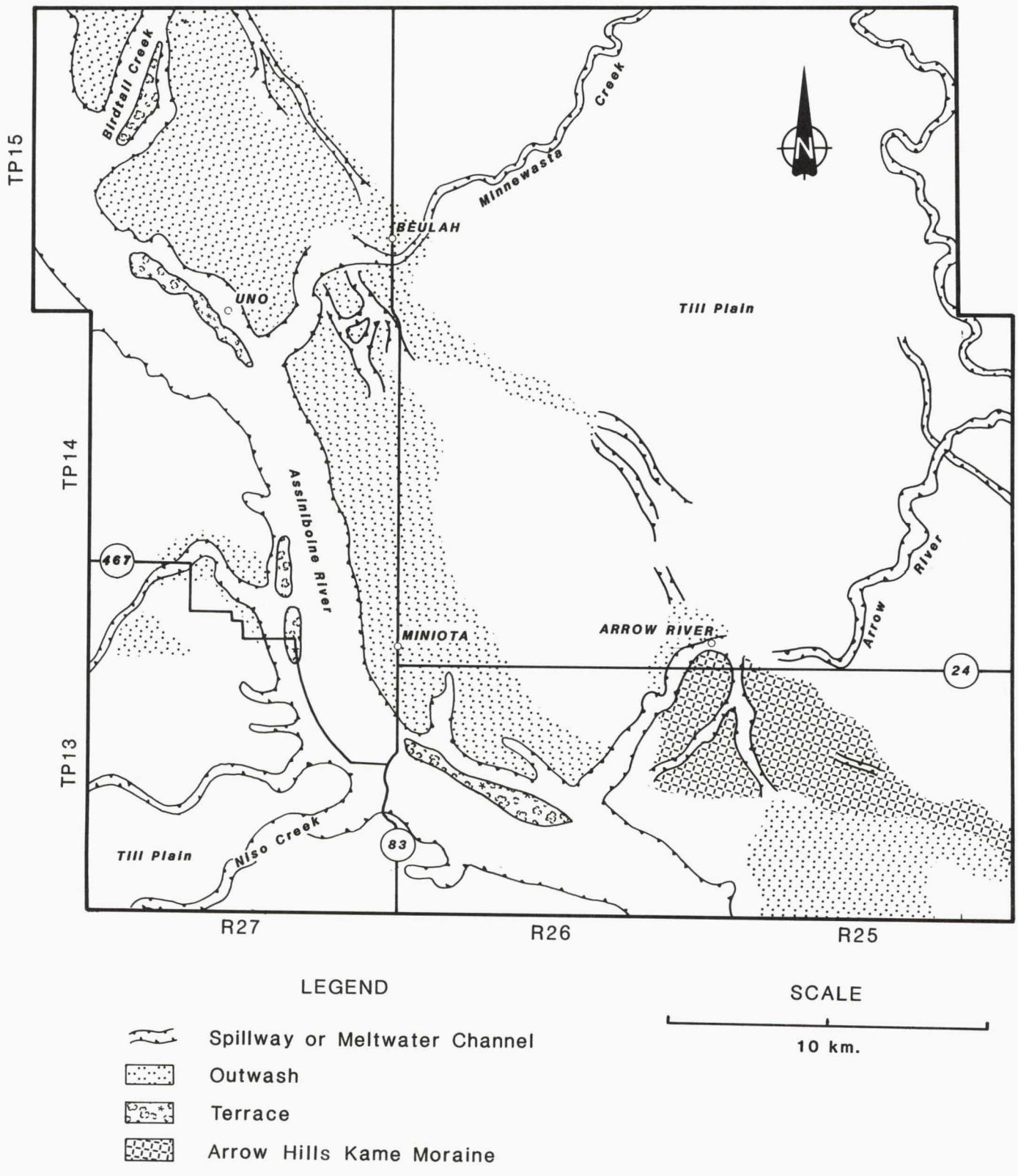

Figure 6: Generalized surficial geology of the Rural Municipality of Miniota.

Figure 7: Crossbedded sand facies of the outwash plain; NW32-25-27W.

AGGREGATE DEPOSITS

There are 41 million m^3 of granular material in the Rural Municipality of Miniota and an additional 3 million m^3 on the Birdtail Creek Indian Reserve. The aggregate deposits are of four genetic types: 1) eskers, 2) kame moraine, 3) outwash plains and 4) spillway terraces. Deposit locations are shown on Map AR85-3 (in pocket). The table in Appendix I summarizes relevant information for each of the deposits.

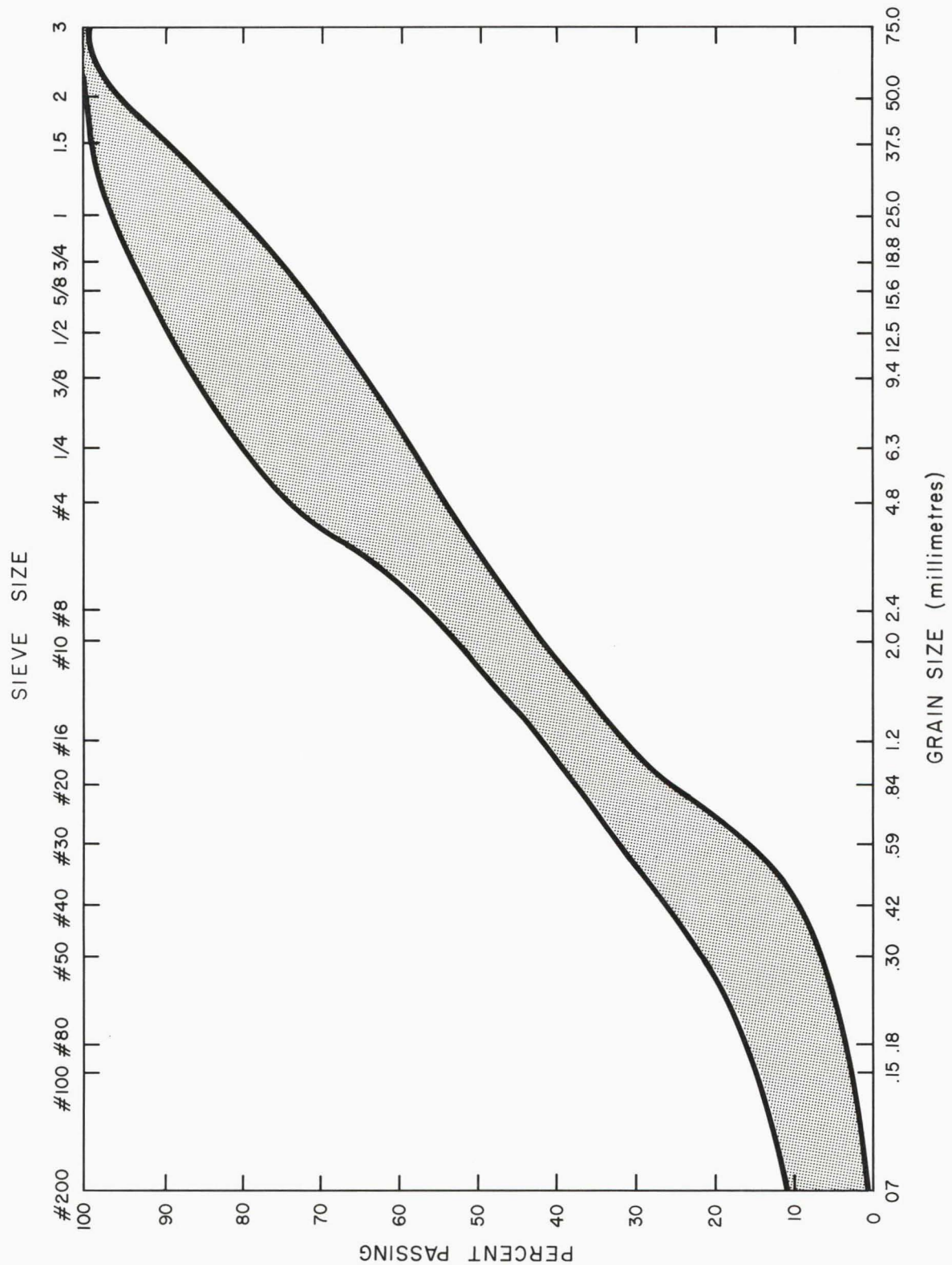

Figure 8: Range of grain size distribution in eskers; 6 samples.

Grain size data are given in Appendix II. The size limits of granular descriptive terms (e.g. sandy fine pebble gravel) used throughout the text are given in Appendix III.

Eskers

Eskers form a very minor component of the aggregate reserves in the municipality. There are six deposits scattered throughout the area and they account for less than 1% of total aggregate reserves. Most

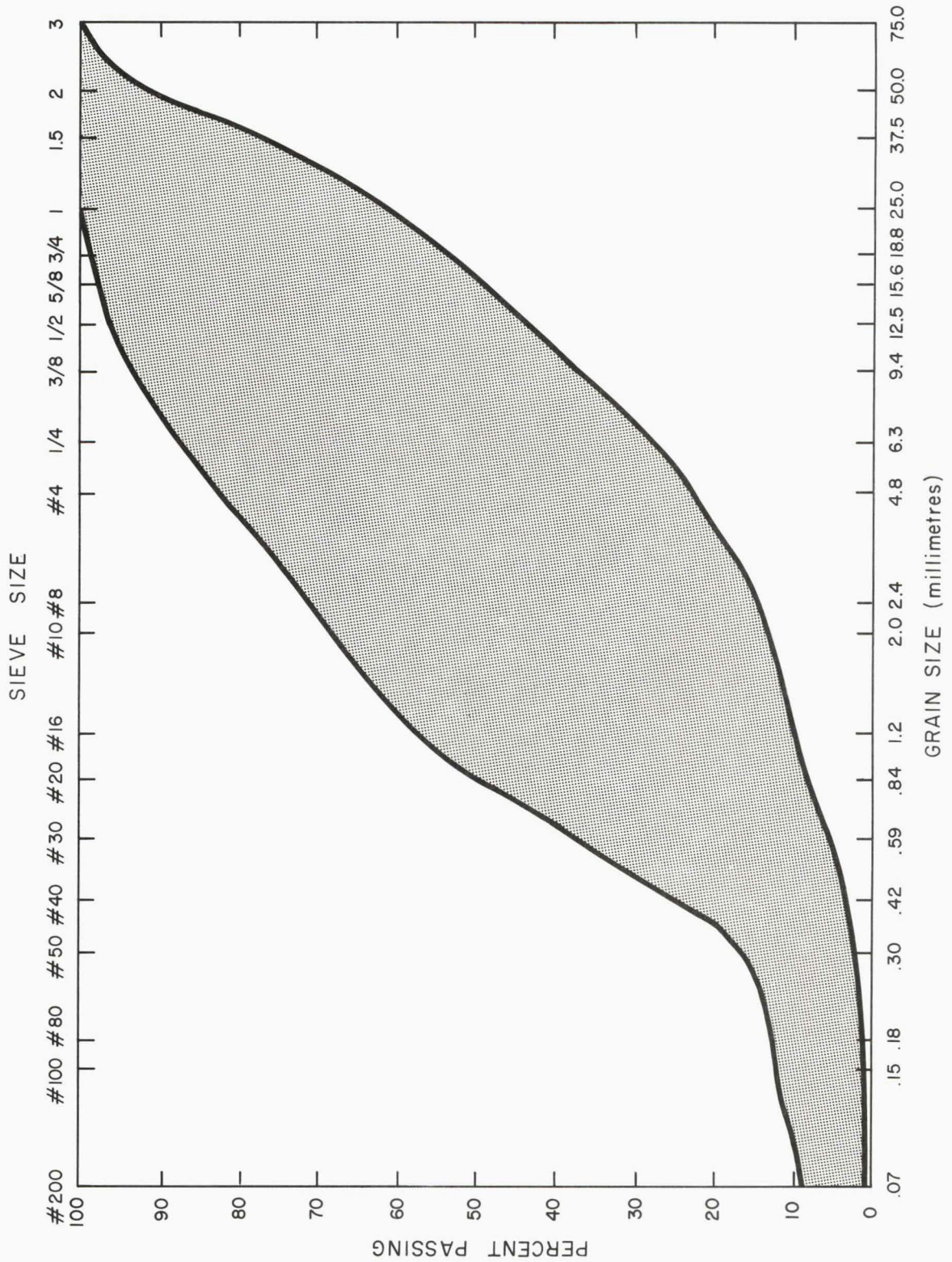

Figure 9: Range of grain size distribution of gravel samples from the Arrow Hills Moraine; 22 samples.

of the ridges consist of 2 to 3 m of very sandy, fine pebble gravel (Fig. 8) with a medium shale content. Deposit 11504 is an exception as it is 4 m high and composed of cobbly coarse pebble gravel at its northern end. Deposit 11561 has a minimum of 3.5 m of sandy pebble gravel and could be exploited as the terrace deposits along Arrow River are nearing depletion.

Arrow Hills Kame Moraine

Areas within the Arrow Hills moraine that are predominantly gravel have been delineated on the accompanying map but local pockets of gravel occur throughout the moraine complex. Gravel quality varies considerably within the moraine complex. Shale content ranges from low (deposits 11536 - 11538) to extremely high (deposit 11539) and per cent gravel content is also variable. Figure 9 shows the range of grain size distribution of 22 gravel samples taken from moraine deposits.

Deposits 11536, 11537 and 11538 are the most extensively mined in the area. Deposit 11536 has two active pits (NW19-13-25W) both showing 4 to 5 m of sandy coarse pebble gravel interbedded with pockets of sand and silt (Fig. 10). Deposit 11537 has several gravel pits used on an intermittent basis; one in SE24-13-25W was active in the summer of 1984. This pit has a minimum depth of 4 m of crossbedded sandy fine pebble gravel although beds of coarser material as well as of silt and sand occur. The other pits in the north and central portions of this deposit consist of 3 to 4 m of interbedded sand and sandy fine pebble gravel; they are inactive and some have begun to revegetate. The two pits in the south end of the deposit (14-13-26W) are each 1.5 m deep and are revegetated. The material is sandy pebble gravel. A backhoe site in NW13-13-26W exposed 3 m of similar material.

Deposit 11538 has been extensively mined in the past. The pits in the east half of the deposit expose 4 to 5 m of very sandy pebble gravel. The gravel in E24-13-26W has been stockpiled and no pit remains.

Deposits 11539 and 11540 are primarily pebbly sand with some gravel interbeds. However, at the northern end of 11539 (SW21-13-25W) 3 m of sandy pebble gravel overlies sand; at the southern end there is 4 to 5 m of cobbly pebble gravel which is not economic due to an extremely high shale content.

Deposits 11541 and 11543 have not been opened but backhoe pits in 11541 showed a minimum of 3 to 4 m of sandy pebble gravel with a fairly high shale content.

Outwash Plains

Sand is the major constituent of the outwash plains in the municipality but areas that are primarily gravel have been delineated on map AR85-3. Outwash gravels account for two-thirds of the aggregate reserves in the municipality — 27 out of 41 million m^3.

Deposit 11501 contains over half of the outwash gravels in the municipality — 14 out of 27 million m^3. This is a minimum figure as most backhoe pits ended in gravel. The deposit is composed mainly of cobbly, sandy, coarse pebble gravel. The range of grain size distribution is shown in Figure 11; cobbles were not included in the sampling. Two backhoe sites just north of the Birdtail Indian Reserve (SW29-15-27W) showed 3 m of coarse sand and indicate the deposit may be fining to the southwest. Although grain size distribution, shale content and reserve estimates indicate this is a moderately high quality deposit, there is only one small pit (SW31-15-27W) due to the deposit's isolated location.

Deposit 11504 is a major source of aggregate for the municipality. The active pit in SW35-15-27W shows 3 m of sandy fine pebble gravel over pebbly sand. The water table is 1 m below the pit floor. Backhoe pits along the western edge of the deposit showed 3 to 4 m of similar material and ended in gravel. At the south end of the deposit, a revegetated pit (NW24-15-27W) shows 3 m of pebble gravel overlying till. The range of grain size distribution of samples from this deposit is shown in Figure 12.

The outwash gravel at Beulah, deposits 11512 and 11513, is variable in depth, grain size and shale content. The deposit is coarsest in the northeast (S 1/2 8-15-26W) where 5 m of cobbly sandy coarse pebble gravel is exposed in the town garbage dump. The deposit fines to the south and west where pebbly sand and fine pebble gravel overlie sand. The major part of the reserves in this deposit has been sterilized by the townsite and Hwy. 83.

Local gravel pockets in the outwash south of Miniota have been extensively mined. Deposit 11527 is used on an intermittent basis. The

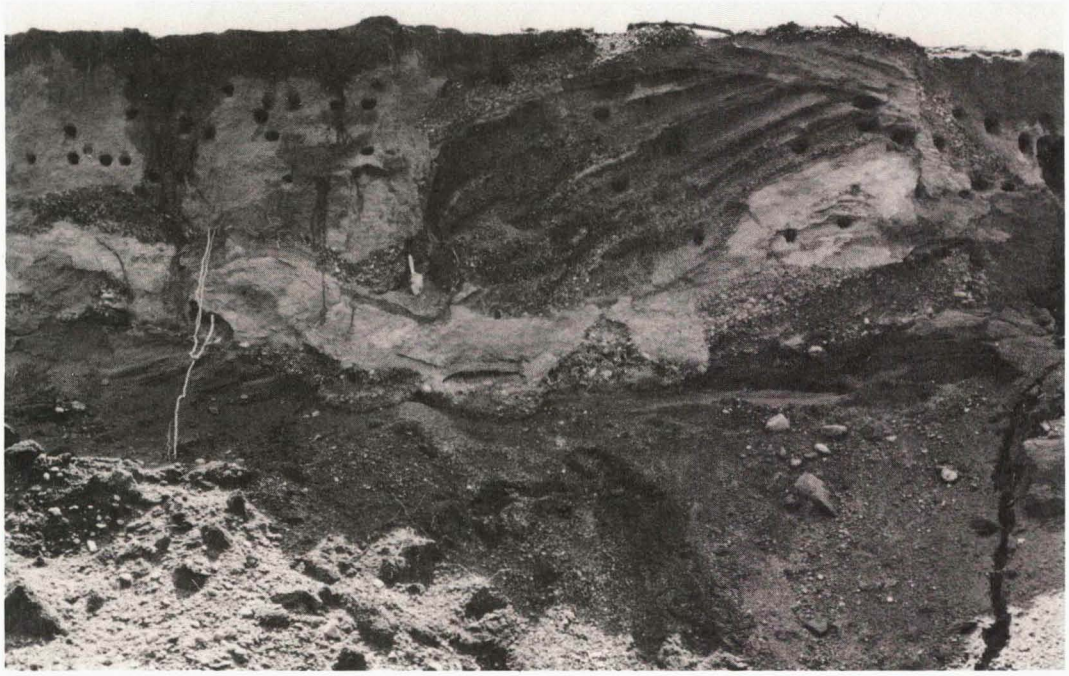

Figure 10: Gravel pit (NW19-13-25W) in Arrow Hills Moraine, showing interbedding of gravel, sand and silt.

pit in NE25-13-27W is predominantly sand and is revegetated at the south end but the north pit face shows 4 m of fine pebble gravel and has been recently worked. The pits at the northern end of the deposit are sandy and depleted. Deposit 11529 has an active pit (NW19-13-26W) exposing a minimum of 3 m of sandy fine pebble gravel with a medium low shale content. The deposit is depleted to the northwest but good gravel continues to the southeast.

Three outwash deposits lie west of the Assiniboine River. Deposit 11526 is underlain by a minimum of 3 m of sandy fine pebble gravel. The deposit is largely sterilized by a farmstead although a small road-

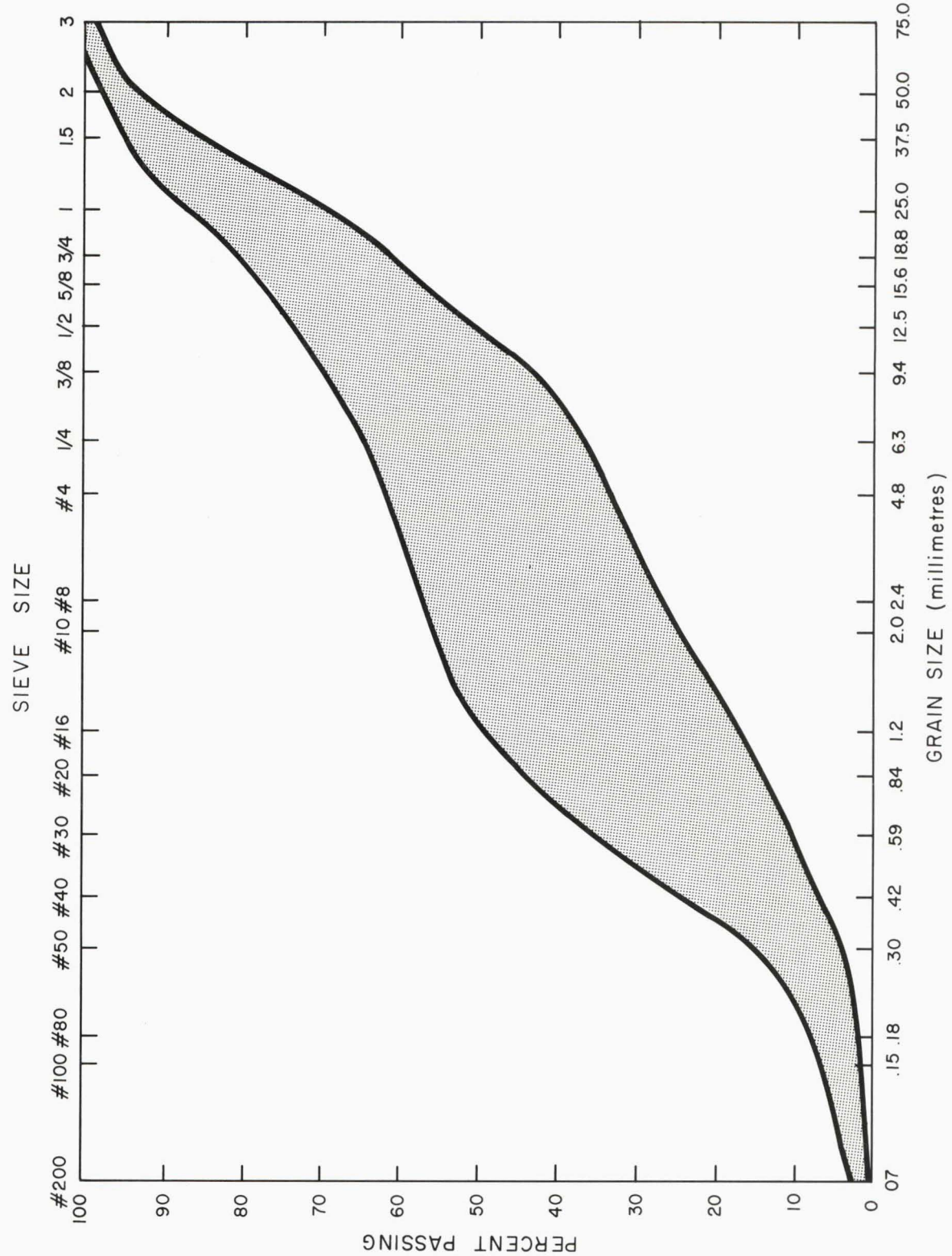

Figure 11: Range of grain size distribution of Deposit 11501; 13 samples.

side pit (SW32-13-27W) has been used on a temporary basis. Backhoe pits in deposit 11524 show 4 m of sandy coarse pebble gravel with a moderate shale content. However, the deposit has not been exploited as it is isolated from road access by a creek valley 30 m deep. Deposit 11525 is a medium quality deposit, presently being mined. The active pit in SE8-14-27W shows 11 m of sandy fine pebble gravel and cross-bedded sand. The extensive pits in NW4-13-27W expose 5 m of sandy coarse pebble gravel; the pits are inactive and beginning to revegetate but there are substantial reserves remaining in the quarter section. At the south end of the deposit, three roadside pits show pebble gravel

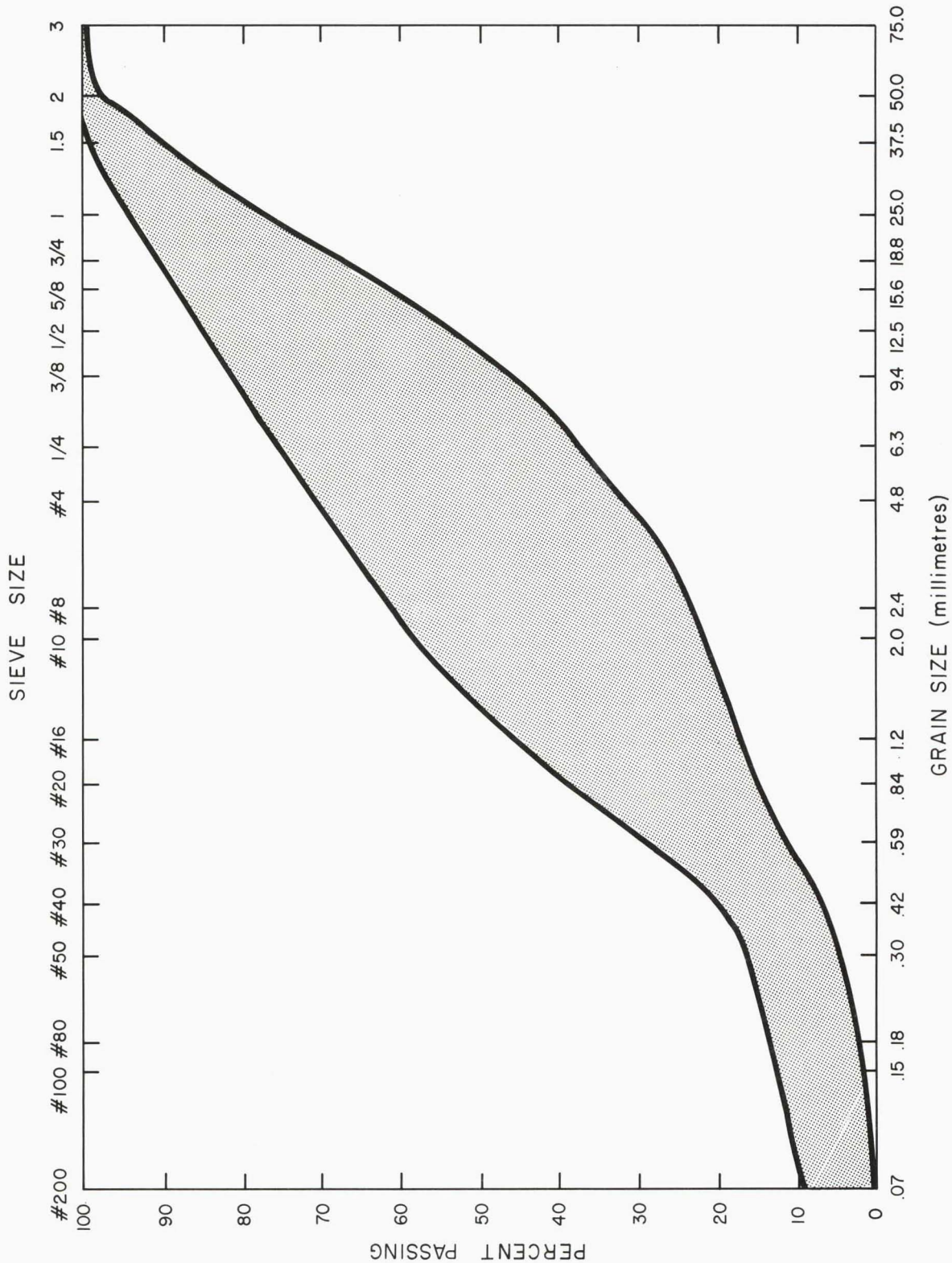

Figure 12: Range of grain size distribution of Deposit 11504; 6 samples.

overlain by sand with some pebble beds. Figure 13 shows the range of grain size distribution of samples from Deposit 11525.

Spillway Terraces

Three terrace deposits occur along the Assiniboine River within the area. Deposit 11515 is underlain by minimum of 3 m of well sorted fine pebble gravel. A small pit in NW27-14-27W is used on an intermittent basis. The terrace west of the river at Miniota is overlain by sand of alluvial fan and slope wash origin except at the northern end (NE10-14-27W) where a 5 m deep pit shows interbedded pebble gravel and sand. Deposit 11546, southeast of Miniota, is 0.5 km wide and over 3 km long. It is underlain by at least 6 m of gravel for most of its length

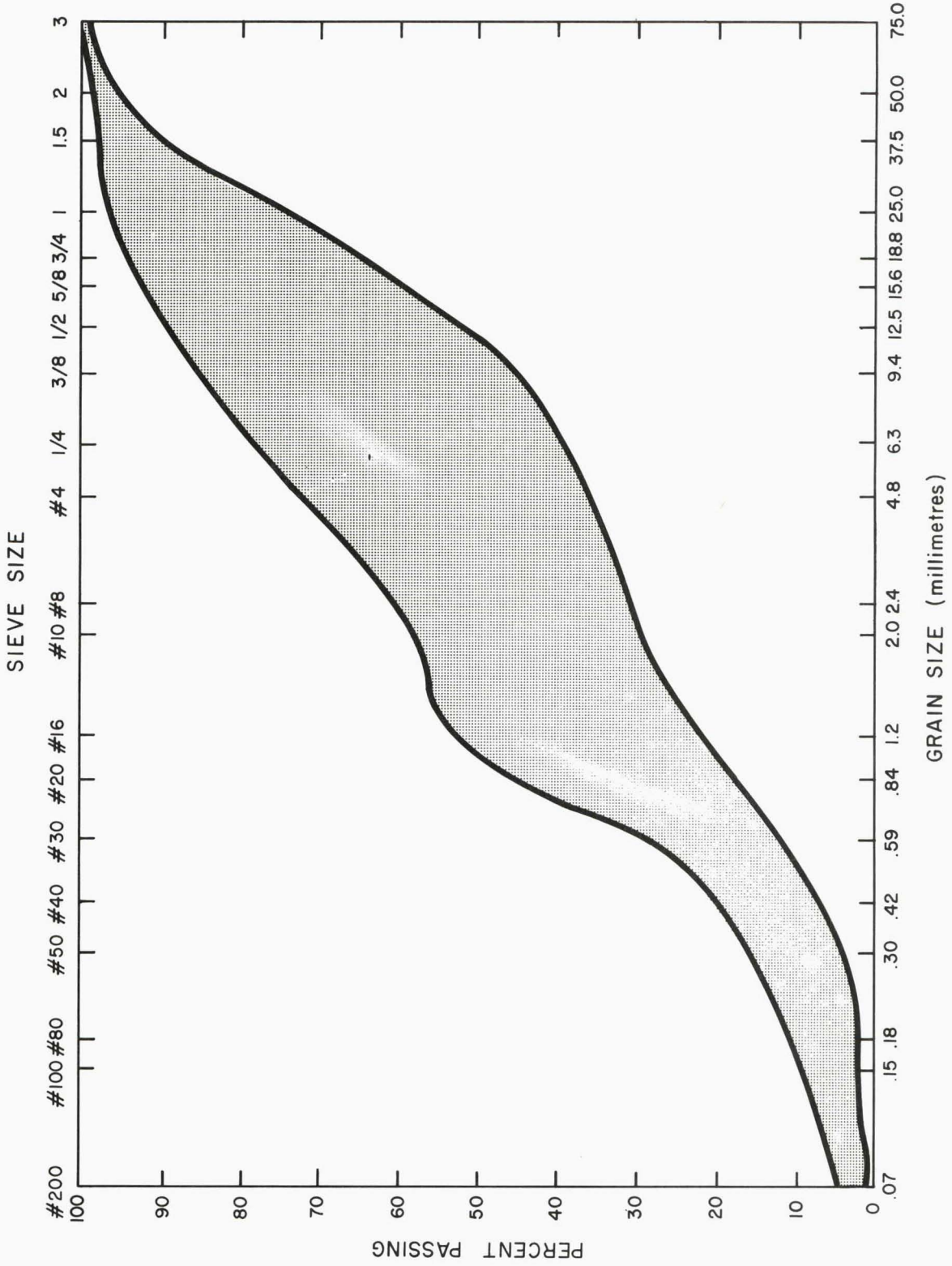

Figure 13: Range of grain size distribution of Deposit 11525; 8 samples.

and is overlain by sand and silt of slope wash origin along the valley edge. The aggregate is massive cobble gravel and crossbedded pebble gravel (Fig. 14). A low percentage of shale and good road access makes this one of the best sources of aggregate in the municipality. Several small pits have been opened in the deposit; the one in SE17-13-26W has been active recently (Fig. 15).

Deposit 11502 along Birdtail Creek is composed of coarse gravel (Fig. 16) similar to that of the outwash lying across the creek. Pits have not been opened in this deposit.

Arrow River and Minnewasta Creeks are both meltwater channels that have small terrace deposits associated with them. The deposits along Arrow River consist of 2 to 3 m of very sandy gravel overlying

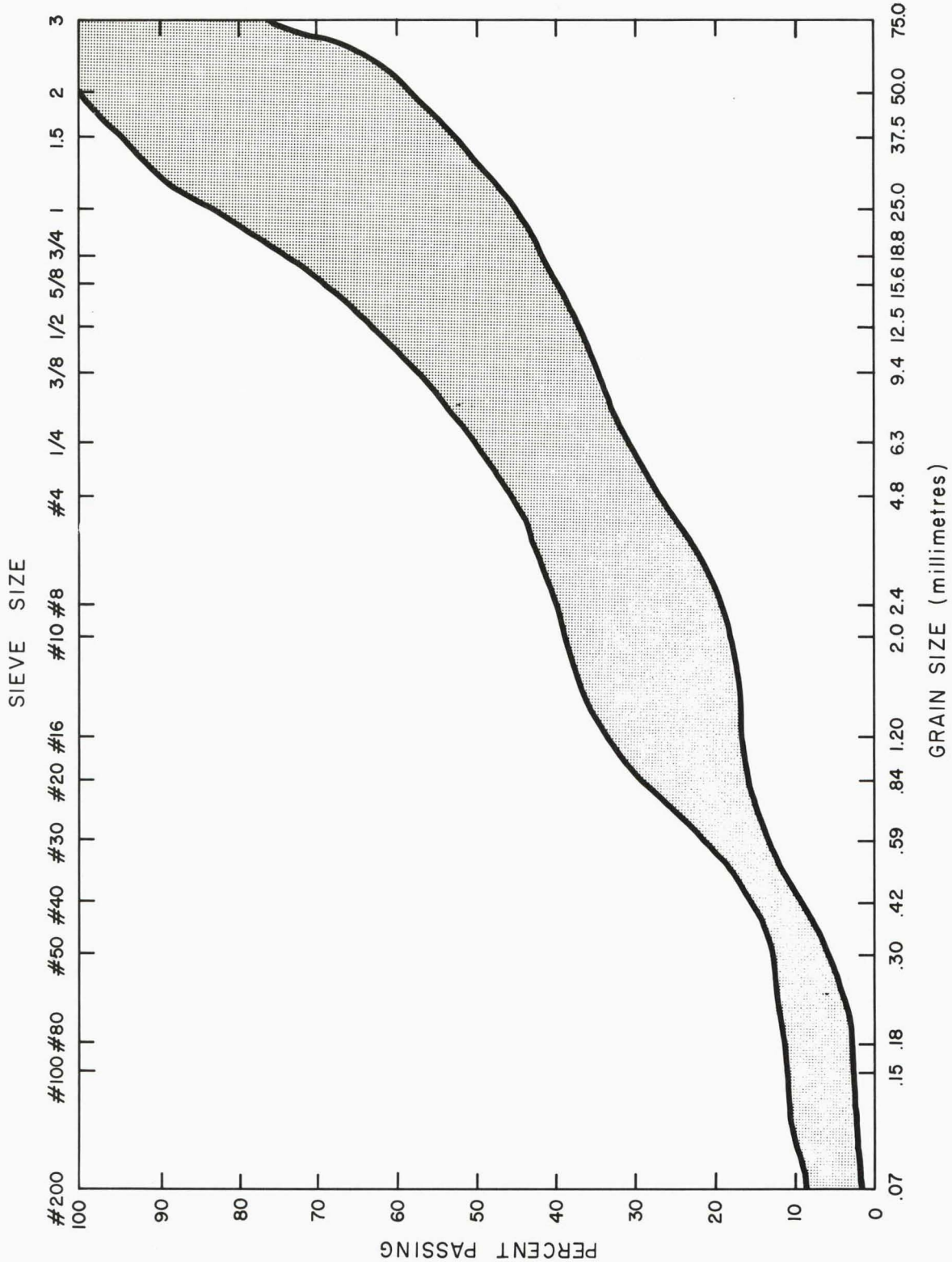

Figure 14: Range of grain size distribution of Deposit 11546; 6 samples.

till. They have been extensively mined and most are near depletion. The terraces along Minnewasta Creek comprise 2 to 4 m of poorly sorted, coarse pebble to cobble gravel. All have pits used on an intermittent basis, but none have been active recently.

Demand for Sand and Gravel

The estimated annual demand for aggregate in the R.M. of Miniota is 20 000 m^3. Of this, the Manitoba Department of Highways is the largest user, consuming 14 500 m^3 yearly.

The estimated reserves in the municipality are 41 million m^3. However, the varying percentage of shale in the gravel makes much of it of marginal quality. At present, the most important sources of gravel are Deposits 11504, 11523, 11525, 11529, 11536, 11537 and 11546. These deposits contain 14 million m^3 of sand and gravel, ensuring no shortage of aggregate in the municipality for the foreseeable future.

Figure 15: Gravel pit in Assiniboine River terrace deposit; (SW17-13-26W).

Figure 16: Cobble gravel exposed in Birdtail Creek terrace deposit (NW28-15-27W).

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APPENDIX I
Table A-1: Aggregate Deposits in the R.M. of Miniota

Deposit Number	Genetic Type	Site Number	% Stone (+ #4) (+ 4.76 mm)	Lithology[1] 4-16 mm % Precambrian	Lithology[1] 4-16 mm % Carbonate	Estimated[2] Shale Content	Estimated[3] Reserves 000's m³	Comments
11501	Outwash plain	HG743	48	48	52	mh	14 443	— unopened deposit, isolated location; deposit continues into Birdtail Creek Indian Reserve
		HB215	54	51	49	h	[579]	
		HB216	64	44	56	mh		
		HB217	47	53	47	mh		
		HB218	56	50	50	mh		
		HB219	43	57	43	mh		
		HB222	51	55	45	mh		
		HB224	39	49	51	m		
		HB225	66	54	46	l		
		HB226	58	60	40	m		
		HB229	44	60	40	h		
		HB231	47	51	49	mh		
		HB234	—	47	53	m		
11502	Fluvial terrace	HG744	47	51	49	m	1 534	— unopened deposit; south half in Birdtial Creek Indian Reserve
		HG745	30	59	41	l	[1 695]	
		HB258	68	56	44	l		
		HB259	—	48	36	ml		
		HB260	58	53	47	mh		
		HB261	46	52	48	mh		
		HB262	49	55	45	mh		
		HB264	64	55	45	ml		
11503	Esker	HG746	33	51	49	m	159	— unopened deposit
		HB236	45	51	49	ml		
11504	Outwash plain	HG747	68	53	47	l	5 242	— 1 active pit, limited by water table
		HG748	36	54	46	mh		
		HB234	29	47	53	m		
		HB245	55	48	52	m		
		HB246	40	49	51	ml		
		HB250	35	50	50	h		
11505	Fluvial terrace	HG704	51	39	51	ml	108	— 2 large pits, intermittent usage, both beginning to revegetable
11506	Fluvial terrace	HG700	9	38	62	h	14	— 1 large pit, intermittent usage
11507	Fluvial terrace	HG702	22	47	53	ml	19	— 1 revegetated pit; shallow, sandy deposit
11508	Fluvial terrace	HG706	—	—	—	—	24	— sandy fine pebble gravel and cobbles

APPENDIX I (cont.)
Table A-1: Aggregate Deposits in the R.M. of Miniota

Deposit Number	Genetic Type	Site Number	% Stone (+ #4) (+ 4.76 mm)	Lithology[1] 4-16 mm % Precambrian	Lithology[1] 4-16 mm % Carbonate	Estimated[2] Shale Content	Estimated[3] Reserves 000's m³	Comments
11509	Fluvial terrace	HG708	47	—	—		157	— Extensive pit; intermittent usage
11510	Fluvial terrace	HG749 HB271	58	52	48	ml	39	— deposit sand on north side of road; pit on south side of road is revegetated
11511	Fluvial terrace	HB278	—	—	—	—	3	— pit revegetated; deposit very sandy
11512	Outwash plain	HB269 HB280 HB284	42 34 —	39 45 —	61 55 —	l ml —	966	— largely sterilized by rail line, highway and town; deposit shallow west of highway
11513	Outwash plain	HB709 HB750 HB283 HB285 HB286	31 30 — — —	38 41 — — —	62 59 — — —	h h — — —	2 577	— deposit sandy in south, coarsest in northeast portion. 1 pit intermittent usage, 2 revegetated pits
11514	Esker	—	—	—	—	—	32	— 1 pit, revegetated
11515	Fluvial terrace	HB275	—	—	—	—	171	— 1 pit, intermittent usage; sandy fine pebble gravel
11516	Esker	HG710	—	—	—	—	37	— sandy fine pebble gravel interbedded with till
11517	Fluvial terrace	HG716	—	—	—	h	7	— 1 pit, near depletion
11518	Fluvial terrace	HG715	26	40	60	h	20	— 1 pit, intermittent usage
11519	Fluvial terrace	HG714	—	—	—	—	11	— 1 pit, near depletion
11520	Fluvial terrace	HG718	15	42	58	ml	15	— 1 large pit, revegetated
11521	Fluvial terrace	HG717	—	—	—	h	15	— 1 large pit, revegetated
11522	Fluvial terrace	HG719	15	53	47	mh	85	— deposit sandy to south; limited by water table

APPENDIX I (cont.)
Table A-1: Aggregate Deposits in the R.M. of Miniota

Deposit Number	Genetic Type	Site Number	% Stone (+ #4) (+ 4.76 mm)	Lithology[1] 4-16 mm % Precambrian	Lithology[1] 4-16 mm % Carbonate	Estimated[2] Shale Content	Estimated[3] Reserves 000's m³	Comments
11523	Fluvial terrace	HG755	61	53	47		80	— 1 pit; intermittent usage
11524	Outwash plain	HB348	37	66	34	l	1 702	— deposit unopened due to isolated location
		HB349	39	46	54	l		
		HB354	62	63	37	m		
11525	Outwash plain	HG771	25	45	55	ml	1 263	— 1 large, active pit; several small inactive ones
		HB209	37	50	50	ml		
		HB209A	46	60	40	l		
		HB211	26	54	46	l		
		HB212	29	48	52	ml		
11526	Outwash plain	HG700	29	41	59	l	177	— 2 small pits, intermittent usage
		HB206	10	49	51	h		
11527	Outwash plain	HB765	55	52	48	l	171	— deposit sandy to north
11528	Outwash plain	—	—	—	—	—	16	— untested
11529	Outwash plain	HG760	45	62	39	ml	256	— 1 active pit; deposit depleted west of highway
11530	Outwash plain	HG757	—	—	—	—	24	— 1 small pit; intermittent usage
11531	Fluvial terrace	HG722	46	52	48	—	71	— 1 small pit, intermittent usage; deposit sterilized south of highway
11532	Fluvial terrace	HB316	—	—	—	—	154	— largely sterilized by highway
11533	Fluvial terrace	HG720	12	—	—	h	29	— very shaly gravel over shale bedrock
11534	Fluvial terrace	HB306	—	—	—	—	19	— 2 depleted pits
11535	Moraine	HG730	29	38	62	h	127	— variable material
11536	Moraine	HG731	51	52	48	l	615	— active pits
		HG732	39	48	52	l		
		HG733	44	54	46	mh		

APPENDIX I (cont.)
Table A-1: Aggregate Deposits in the R.M. of Miniota

Deposit Number	Genetic Type	Site Number	% Stone (+ #4) (+ 4.76 mm)	Lithology[1] 4-16 mm % Precambrian	Lithology[1] 4-16 mm % Carbonate	Estimated[2] Shale Content	Estimated[3] Reserves 000's m³	Comments
11537	Moraine	HG735	36	54	46	l	1 686	— variable material; several pits, intermittent usage
		HG736	24	56	44	m		
		HG738	47	53	47	l		
		HB739	40	55	45	l		
		HG742	29	47	53	l		
		GH752	26	50	50	m		
		HG753	54	48	52	l		
		HB310	30	53	47	l		
		HB315	28	47	53	l		
11538	Moraine	HG740	17	54	46	l	961	— variable material; sandy
11539	Moraine	HG723	—	—	—	h	849	— deposit very shaly in south; sandy to north
		HG724	39	74	26	h		
		HG725	33	53	47	h		
		HB317	57	45	55	ml		
		HB320	28	54	46	h		
11540	Moraine	HB318	—	—	—	—	402	— interbedded sand and sandy fine pebble gravel
11541	Moraine	HB311	32	70	30	h	716	— unopened deposit
11542	Outwash plain	HG728	—	—	—	h	687	— shaly; variable material
11543	Moraine	—	—	—	—	—	230	— unopened deposit; untested
11544	Fluvial terrace	—	—	—	—	—	90	— revegetated pit
11545	Fluvial terrace	HG778	—	52	48	h	75	— very coarse deposit
11546	Fluvial terrace	HG756	72	57	43	l	4 774	— several pits, intermittent usage
		HG758	53	73	27	h		
		HG782A	44	58	42	l		
		HG782B	67	61	39	l		
		HB337	56	64	36	ml		
11547	Fluvial terrace	HG761	36	44	56	h	9	— deposit sterilized by farmstead
11548	Fluvial terrace	HG767	10	46	54	m	41	— pit revegetated

APPENDIX I (cont.)
Table A-1: Aggregate Deposits in the R.M. of Miniota

Deposit Number	Genetic Type	Site Number	% Stone (+ #4) (+ 4.76 mm)	Lithology[1] 4-16 mm % Precambrian	Lithology[1] 4-16 mm % Carbonate	Estimated[2] Shale Content	Estimated[3] Reserves 000's m^3	Comments
11549	Fluvial terrace	HG768	36	45	55	h	134	— deposit shallow
11550	Fluvial terrace	HB200	—	—	—	h	56	— small deposit, very high shale content
11551	Fluvial terrace	—	—	—	—	—	10	— no site, very sandy
11552	Fluvial terrace	HB208	24	46	54	h	26	— shallow deposit over till
11553	Fluvial terrace	HG759	31	66	34	l	24	— small deposit; 1 pit, intermittent usage
11554	Esker	HG711	40	39	61	ml	13	— unopened deposit
11555	Fluvial terrace	HG703	—	—	—	—	21	— 1 pit, stockpiles
11556	Fluvial terrace	HG701	27	42	58	l	9	— deposit near depletion
11557	Fluvial terrace	HG754	33	54	46	l	130	
11558	Outwash	—	—	—	—	—	18	— very sandy deposit
11559	Esker	HG705	25	42	58	m	21	— very sandy deposit
11560	Fluvial terrace	HB267	—	—	—	—	[670]	— on Birdtail Creek Indian Reserve
11561	Esker	HB305	34	47	53	ml	30	— 1 revegetated test pit
11562	Fluvial terrace	—	—	—	—	—	18	— 2 m sandy fine pebble gravel

APPENDIX I (cont.)
Table A-1: Aggregate Deposits in the R.M. of Miniota

Deposit Number	Genetic Type	Site Number	% Stone (+ #4) (+ 4.76 mm)	Lithology[1] 4-16 mm % Precambrian	Lithology[1] 4-16 mm % Carbonate	Estimated[2] Shale Content	Estimated[3] Reserves 000's m³	Comments
TOTAL							41 445 [2 944]	— R.M. Miniota — Birdtail Creek Indian Reserve
11563	Fluvial terrace	—	—	—	—	—	22	— untested
11564	Outwash	HB241	—	—	—	—	11	— 1 revegetated pit

1 excluding shale

2 Shale content estimated visually, by volume in the 4-16 mm fraction:

high (h)	— greater than 30%
medium high (mh)	— 20 to 30%
medium (m)	— 15 to 20%
medium low (ml)	— 10 to 15%
low	— less than 15%

3 Estimated reserves for deposits in Birdtail Creek Indian Reserve are given in brackets [ ].

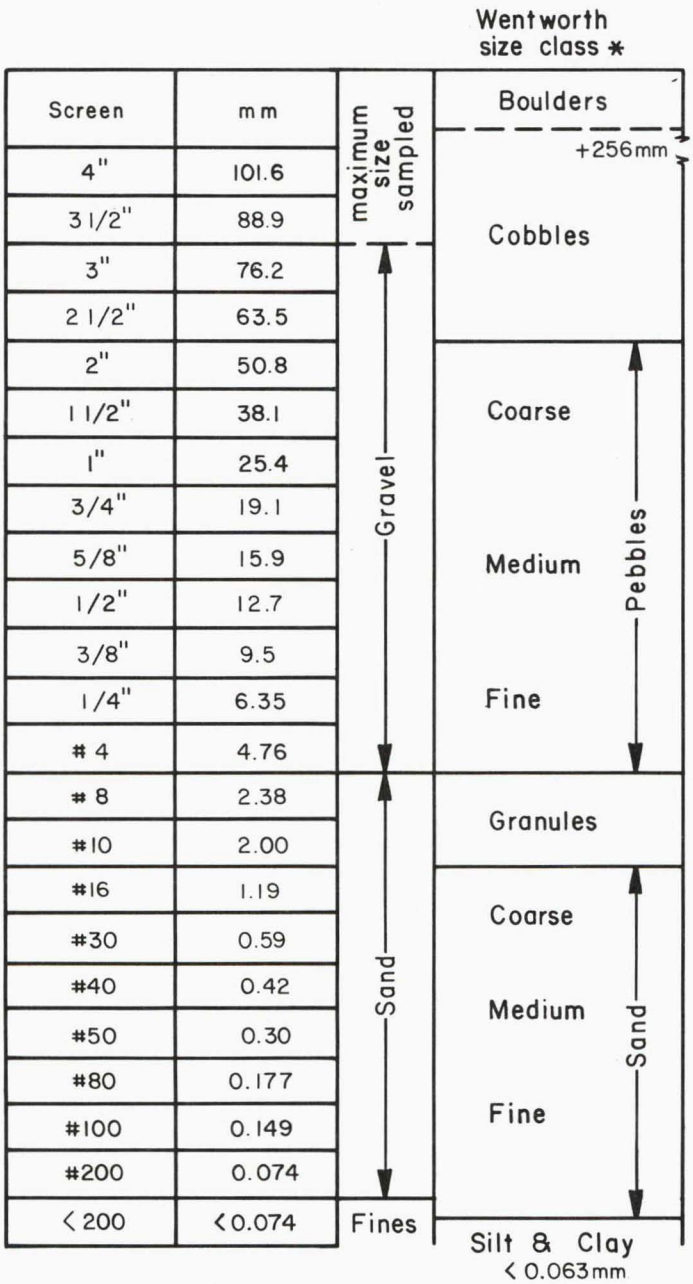
APPENDIX II
Table A-2: Grain size distribution of Aggregate Samples

Deposit Number	Sample Number	% Pebbles 4-64 mm	% Granules 2-4 mm	% Sand 0.07-2 mm	% Silt and Clay <0.07 mm	Crushable on site >15 cm x Yes
11501	HG743	47.8	11.0	38.6	2.6	x
	HG775	62.9	10.8	24.0	2.3	x
	HB215	54.3	11.3	32.0	2.4	x
	HB216	64.4	10.5	22.8	2.3	x
	HB217	47.0	13.0	37.7	2.3	x
	HB218	56.4	8.6	32.9	2.1	x
	HB219	43.4	12.7	41.4	2.5	x
	HB222	50.7	10.8	37.7	0.8	x
	HB224	38.9	6.8	50.5	3.8	
	HB225	66.2	8.4	23.2	2.2	x
	HB226	57.8	14.1	25.3	2.8	
	HB229	44.5	9.1	45.4	1.0	
	HB231	46.5	13.0	39.2	1.3	x
11502	HG744	46.9	11.2	36.8	5.1	x
	HG745	30.0	23.3	35.0	11.7	x
	HB258	68.0	5.8	21.6	4.6	x
	HB260	58.5	23.1	16.2	2.2	x
	HB261	46.1	25.5	25.3	3.1	x
	HB262	49.0	12.0	37.9	1.1	x
	HB264	64.5	7.6	25.0	2.9	x
11503	HG746	32.9	13.5	51.7	1.9	
	HB236	45.1	12.0	41.5	1.4	x
11504	HG747	67.7	10.9	19.0	2.4	x
	HG748	36.1	13.6	46.3	4.0	
	HB234	28.7	12.9	56.8	1.6	
	HB245	54.9	13.2	30.2	1.7	
	HB246	40.1	11.1	38.7	10.1	x
	BH250	35.2	12.2	49.4	3.2	
11505	HG704	53.4	14.7	21.2	10.8	x
11506	HG700	8.6	22.9	64.8	3.7	
11507	HG702	22.2	21.3	49.8	6.7	
11509	HG708	47.2	12.0	32.9	7.9	x
	HB281	47.9	21.0	27.3	3.8	
11510	HG749	58.1	11.2	28.1	2.6	x
11512	HB269	42.1	21.3	32.0	4.6	
	HB280	33.6	17.0	43.0	6.4	
11513	HG709	30.6	16.7	48.6	4.1	
	HG750	30.0	18.7	48.3	3.0	x
11518	HG715	26.2	18.8	49.0	6.0	
11520	HG718	15.4	22.7	56.7	6.2	x
11522	HG719	15.2	22.3	60.5	2.0	
11523	HG755	61.5	11.8	22.4	4.3	x
11524	HB348	36.7	4.3	55.3	1.6	x
	HB349	39.2	25.2	33.6	2.0	x
	HB354	61.7	7.5	29.1	1.7	

APPENDIX II (cont.)
Table A-2: Grain size distribution of Aggregate Samples

Deposit Number	Sample Number	% Pebbles 4-64 mm	% Granules 2-4 mm	% Sand 0.07-2 mm	% Silt and Clay <0.07 mm	Crushable on site >15 cm x Yes
11525	HG771	25.8	17.9	56.0	0.3	x
	HG209A	37.1	27.8	34.7	0.4	
	HG209B	46.1	23.0	30.1	0.8	
	HB211	26.4	35.9	33.1	4.6	
	HB212	28.6	22.2	48.4	0.8	
11526	HG770	29.2	22.3	40.3	8.2	
	HB206	9.6	11.1	71.6	7.7	
11527	HG765	54.7	19.9	23.3	2.1	
11529	HG760	44.6	17.6	34.0	3.8	
11531	HG722A	45.6	20.1	28.9	5.4	x
	HG722B	45.8	20.8	31.4	2.0	x
11533	HG720	12.4	14.0	67.2	6.4	x
11535	HG730	29.3	22.2	42.8	5.7	x
11536	HG731	50.9	22.4	21.6	5.1	x
	HG732	39.4	17.6	39.8	3.2	x
	HG733	43.8	27.4	26.4	2.4	
11537	HG735	35.8	34.7	28.0	1.5	x
	HG736	24.5	24.2	48.7	2.6	
	HG738	47.2	25.0	22.8	5.0	x
	HG739	40.2	24.3	30.9	4.6	x
	HG742	29.3	31.5	37.7	1.5	x
	HG752	26.1	20.5	51.1	2.3	
	HG753	53.8	13.1	29.6	3.5	
	HB310	29.8	29.2	40.6	0.4	
	HB315	28.0	23.3	40.6	8.1	
11538	HG740	16.9	15.8	62.6	4.7	x

APPENDIX III



* modified from Folk, 1974

Figure A-1: Grain size classification.