016950

FEASIBILITY STUDY OF THE SUBSURFACE CONDITIONS, CONSTRUCTION AND CONCRETE AGGREGATES AND MINE WASTE MANAGEMENT ASPECTS AT THE GRUM DEPOSIT, FARO, YUKON

Y/FA/GT/RPT. Dean
SDM RCK

FOR

CYPRUS ANVIL MINING COMPANY

August 1979

By

Montreal Engineering Company, Limited

DRAFT

MONTREAL ENGINEERING COMPANY, LIMITED

2045 STANLEY ST., MONTREAL, CANADA
CORRESPONDENCE:
P.O. Box 6088, Station "A", Montreal H3C 3Z8

Tel: (514)286-3636
Telex: 055-60735
Cables: "Monenco"

15 August, 1979

Mr. Peter Taggart
Manager, Feasibility and
Development Group
Cyprus Anvil Mining Company
330-335 Burrard
Vancouver, B.C.

Dear Mr. Taggart,

We are pleased to submit our report on the feasibility study of the subsurface conditions, construction and concrete aggregates and mine waste management aspects of the proposed Grum Mine near Faro, Yukon. The report formally presents some of the work that was performed for Kerr Addison Mines, the previous manager and joint-owner of the Grum deposit, as part of an overall feasibility study for the complete proposed Grum Development.

The report recommends preliminary slopes that could be used for initial mine planning, outlines and estimates locations and quantities of granular material suitable for construction and concrete aggregates and also develops a mine waste management plan.

The original study envisaged a mill for processing the mined ore to be located adjacent to the proposed open pit. It is realized that this is not your present plan and further, because your present plans have not been completed, you asked us not to take them into account. Once your present plans are completed we would welcome the opportunity of reviewing them with you in light of the work presented in this report.

It has been a pleasure to complete this study and we look forward to working further with you on the development of this most interesting project.

Yours very truly,

J. Barter, P.Eng.
Project Manager

If phoning on this matter

please call .....

at .....

PREFACE

In 1977 Kerr Addison Mines as one of the joint venture owners and manager of the Grum development commissioned Montreal Engineering Company, Limited to perform a feasibility study of the following aspects associated with the proposed Grum development:

- Water Supply,
- Tailings Disposal,
- Power Supply,
- Mine Geotechnical Aspects,
- Construction and Concrete Aggregates, and
- Mine Waste Management.

Just before the feasibility study was to be completed in March 1977 a decision was made by Kerr Addison Mines, to stop all work on the feasibility study. All work was thus stopped immediately, and all the relevant documents filed for future use.

In May 1979 Cyprus Anvil Mining Company bought the Grum deposit and requested Montreal Engineering Company to complete the later three elements of the feasibility study which are mentioned above. It was noted before the recent study commenced that Cyprus Anvil did not intend to mill the ore at Grum but rather ship the ore from Grum to the Anvil mill. It is possible that a crushing plant could be constructed at Grum. Because of the preliminary nature of

the revised proposed development at Grum it was assumed for purposes of completing this study that neither a mill or crushing plant will be built at Grum. Once the final plans for development of Grum have been made then the results of this report should be reviewed.

To conclude, this report presents the results of a feasibility study performed for the proposed Grum development dealing with the mine geotechnical aspects, construction and concrete aggregates and mine waste management.

PRINCIPAL FINDINGS AND CONCLUSIONS

1. Glacial till was found overlying phyllitic bedrock in thicknesses of 33 to over 61 m.

2. The glacial till has a high density and low plasticity, the plastic limit ranging from 15 to 21% and the plasticity index from 10 to 16%.

3. The phyllitic bedrock is extremely fissile and ready to break along foliation planes. It is expected to deteriorate rapidly upon exposure.

4. An estimated total of 77,800 m^3 of exploitable aggregates was found. Of this amount 30,000 m^3 could be used as concrete aggregates.

5. The 75 x 10^6 tonnes of waste rock and 25 x 10^6 tonnes of overburden that will be stripped from the mine can be placed in two dumps, with several lifts in each.

6. Soil conditions in the area indicate that a high runoff condition exists.

7. The design storm sequence used in this study was a storm which builds to a peak intensity at 30 minutes after the storm starts and subsequently decays.

8. The mine water and surface runoff from the waste rock dump would require treatment only for the removal of suspended solids

and turbidity to meet the effluent water quality requirements as stipulated by the Federal Government.

RECOMMENDATIONS

The following recommendations are made to enable initial mine planning to proceed and to continue into final mine development.

1. In the glacial till a maximum long term slope angle of the order of 30° is recommended provided seepage is minimal. This angle may have to be reduced to 25° or less where significant seepage occurs. For individual benches of up to 12 m height, a short term slope of 55° may be used although local flattening must be expected where seepage occurs and the till is more granular.

2. For long-term, drained conditions, slopes in the range of 33° to 37° are required where the foliation plane dips into the pit. Maximum slopes of 45° are recommended where the foliation dips into the pit walls with a transition zone of about 40° between the above two zones. Individual bench slopes of 1H:2V should prove satisfactory, though it is recommended that confirmatory structural analyses be performed.

3. For rock spoil, the overall slope angle should not exceed 28° while the till spoil should be sloped at not more than 23°. Where rock and till are placed in the same dump then the latter slope angle should be adopted.

4. The provision of a drain layer of some 5 m thickness beneath the dumps employing the sounder bedrock or preferably sand and gravel, is recommended as it would be most beneficial in maintaining stability.

5. Before detailed mine and mine waste management planning is commenced it is recommended that a more exhaustive geotechnical field investigation should be performed to confirm the preliminary recommendations given above.

6. After determining the amount of concrete and construction aggregates required the four sources of granular material that are considered more promising should be further investigated and detailed laboratory testing should be performed on bulk samples, including sodium sulphate soundness, Los Angeles abrasion, alkali reactivity, specific gravity and petrographic examination for unstable minerals.

7. It is recommended that further studies be performed to determine the optimum way to reclaim the waste dumps and disturbed lands.

8. It is recommended that a program of site investigations be carried out for the sedimentation pond to determine the characteristics of the dam foundation.

TABLE OF CONTENTS

	PAGE
Letter of Transmittal	(i)
Preface	(iii)
Principal Findings and Conclusions	(v)
Recommendations	(vii)
Table of Contents	(ix)
PART ONE GEOTECHNICAL ASPECTS	
PART TWO CONSTRUCTION AND CONCRETE AGGREGATES	
PART THREE MINE WASTE MANAGEMENT	
APPENDIX A - LABORATORY TEST RESULTS FOR BOREHOLE SAMPLES AT THE PROPOSED OPEN PIT MINE SITE	
APPENDIX B - BOREHOLE LOGS	
APPENDIX C - TEST PIT LOGS	
APPENDIX D - LABORATORY TEST RESULTS OF TEST PIT SAMPLES	

PART 1

MINE GEOTECHNICAL ASPECTS

PART 1 - GEOTECHNICAL ASPECTS

CONTENTS

		PAGE
1.1	INTRODUCTION	1-1
1.2	DESCRIPTION OF INVESTIGATION	1-1
121	VISIT TO ANVIL MINE	1-1
122	GEOTECHNICAL REPORT ON THE ANVIL MINE	1-3
123	SUBSURFACE CONDITIONS AT GRUM	1-4
.1	Soil Overburden	1-5
.2	Bedrock	1-5
1.3	PRELIMINARY SLOPE RECOMMENDATIONS	1-7
131	GENERAL	1-7
132	TILL	1-7
133	BEDROCK	1-8
134	SPOIL	1-8

DRAWINGS

DRAWING NO.		
X 66888	Geotechnical Investigation - Location Plan Sheet 2 of 2	In Pocket at End of This Part

1.1 INTRODUCTION

Limited geotechnical studies were performed to provide preliminary recommendations for operating and ultimate pit slopes in soils and bedrock. These studies included: a visit to the nearby Cyprus Anvil Mine, a review of the 1976 report of Piteau Gadsby MacLeod Limited on the geotechnical features of the Cyprus Anvil Mine, a study of the subsurface information in cross-sectional form, provided by Kerr Addison; and a limited drilling program to evaluate the characteristics of soil overburden.

1.2 DESCRIPTION OF INVESTIGATION

121 VISIT TO ANVIL MINE

A visit to the open pit was made in the company of Cyprus Anvil personnel on June 21, 1977.

The pit had been developed to a depth of about 170 m in successive benches of some 12 m height. The pit slopes exposing the predominantly phyllitic and schistose bedrock appeared to be on the order of 45°, and possibly somewhat steeper locally. Several outstanding features relating to slope stability were noted.

Most of the berms, originally of some 7 m width, were full of debris material that had fallen from the overlying slopes. This surface deterioration is attributable to the susceptibility of the fissile and jointed rock to deteriorate on exposure. Such deterioration has a minimal affect on overall slope stability.

The berms must be regularly cleared to accommodate further falling debris.

Evidence of slope instability was observed in the upper part of the slopes, most notably to the north where pit slopes were established in the thick soil deposits present in the valley of Faro Creek. This instability had apparently occurred as a slow creep with corresponding vertical movements on the order of 2 m, and was considered to be in large measure attributable to the pronounced seepage related to Faro Creek. Remedial measures had subsequently been undertaken which comprised removal of soil overburden on wider berms and diversion of surface runoff in steel flumes installed on a berm. The latter measure apparently proved somewhat ineffective as a significant proportion of the surface runoff entering the pit was believed to be seeping into the slopes.

Instability was also observed to the northeast in the upper part of the slopes formed in phyllitic bedrock. Large tension cracks and vertical movements of 2 to 3 m had developed slowly, indicative of a progressive failure along rock foliation planes.

The remnants of a slump failure were noted along the east wall where sliding of soil overburden and gneiss was apparently caused by a combination of toe undercutting and seepage. The mass has since remained stable.

With the exception of surface water flowing across the north wall and groundwater flow through the soil overburden in Rose Creek Valley, groundwater was encountered only in limited quantities during mining operations and did not constitute a significant problem.

In summary, relatively steep pit slopes have been developed at Cyprus Anvil Mine. To the northeast, the slopes may be considered somewhat excessive as they undercut the foliation plane which constitutes a major weakness inherent in the nature of the rocks. The likelihood of mass movements is further compounded by a high water table and seepage conditions observed in the slopes. In the areas of the pit where the foliation dips into the walls, the slope angles may be considered satisfactory provided adversely oriented faults and joints sets are not present.

122 GEOTECHNICAL REPORT ON THE ANVIL MINE

Extensive geotechnical investigations were performed by Piteau Gadsby MacLeod Limited to provide slope stability recommendations for the existing Cyprus Anvil Mine. The studies included: thorough geological mapping of mine benches, surface outcrops and open trenches with a geotechnical assessment of lithology and discontinuities; examination of rock cores from selected diamond drill holes with emphasis on evaluating the competency of the rocks; hydrological investigations to locate the groundwater table; and testing to determine the strength of selected material.

The studies indicated that the orientation of the foliation plane in respect to the attitude of the pit slopes is the most significant single factor affecting slope stability, owing to the low shear strength that can be mobilized along the foliation. Fault zones filled with low strength gouge also constituted major adverse

discontinuities where unfavourably oriented in respect to pit slopes. Joint sets were found to be poorly defined and consequently not expected to significantly affect overall slope stability. On the basis of rock structure analyses and strength measurements, the pit was divided into areas within which the geological structure, rock strengths and orientation of pit slopes are similar. Slope stability analyses were performed for each design sector using corresponding design criteria, and several failure modes were evaluated for alternative slope designs both for overall slopes and individual benches. The influence of factors such as blasting and groundwater were also included. Consideration was also given to past performance of pit slopes to evaluate in-situ strength and rock mass behaviour.

Instability involving foliation and/or faults was found to be the predominent failure mode for overall slopes while wedge or toppling failures involving joint sets were expected in benches. In the former case, recommended slopes ranged from 36 1/2 to 43° with high groundwater levels and 39 1/2 to 47° with dewatered slopes. In bench design recommendations included slopes of 70 to 80° with bench widths of 8 to 11 m.

123 SUBSURFACE CONDITIONS AT GRUM

Significant drilling programs totalling in excess of 150 diamond drill holes were performed during the exploration stage of the Grum deposit prior to our involvement. While only scanty information had been gained on the nature of the soil overburden, sufficient data had been obtained for the bedrock, such as the types

of rock forming the footwalls and hanging walls and the attitude of foliation and faults. This enabled the formulation (when compared with that from the nearby Cyprus Anvil Mine) of preliminary recommendations for the proposed open pit development. A limited soil sampling program was performed during this study to evaluate the characteristics of the soil overburden.

.1 Soil Overburden

Three boreholes numbered BH-77-1, 12 and 13 were drilled in deep soil overburden at the locations shown on Drawing X-66888 at the end of this part. The results of the laboratory testing are included in Appendix A. Glacial till was found overlying phyllitic bedrock in thicknesses of 33 to over 61 m. It was found to have similar gradation characteristics to the tills encountered at other sites investigated in the area, consisting of a gravelly sandy silt containing some clay with occasional partings of sands and gravels. A typical grain size analysis shows a content of 18% gravel, 37% sand and 45% fine sizes (finer than No. 200 mesh openings). The till has a high density and low plasticity, the plastic limit ranging from 15 to 21% and the plasticity index from 10 to 16%.

Detailed logs for the three holes are included in Appendix B.

.2 Bedrock

Based on an examination of cross-sections provided by Kerr Addison Mines Ltd., the deposit consists of bands of sulphides enclosed in marine sediments that were metamorphosed to phyllites. It is expected that the open pit slopes will be established mainly in these phyllites.

Structurally, the phyllites are characterized by the foliation which occurred during metamorphism. These rocks, which appear to be compact, are extremely fissile and readily break along their foliation planes. Owing to their clayey constituents, they must be expected to be susceptible to rapid deterioration upon exposure.

In the Piteau geotechnical report on Cyprus Anvil Mines, it was concluded that the attitude of the foliation plane was the most important single factor in regard to slope stability. It was also considered that joint sets were significantly less important structural features, generally being poorly defined and showing considerable local variations in attitude. While these conclusions may not entirely apply to the subject area, they were considered adequate for preliminary planning purposes.

While the foliation plane dips in a westerly direction, the long axis of the pit will be oriented northwest-southeast. This implies that the foliation plane will slope into the excavation along the footwall and into the rock face on the hanging wall. On the basis of the above geotechnical considerations, the footwall slope angle will be essentially controlled by the foliation plane. A review of the foliation attitude shown on the cross-sections indicates that the foliation angles vary in the range from about 31 to 40°, averaging 35° along the footwall.

The presence of several faults is noted in the open pit area. These faults are generally oriented favourably to slope stability.

1.3 PRELIMINARY SLOPE RECOMMENDATIONS

131 GENERAL

The following recommendations are based on the foregoing preliminary investigation and should therefore be used only for preliminary mine and waste management studies. It is recommended that for detailed mine and mine waste management planning, a more exhaustive geotechnical field investigation should be performed.

132 TILL

The open pit mining method proposed by Kerr Addison Mines implies that slopes have to be developed which will be required to stand for long periods of time. As established in subsurface studies, slopes of significant heights (up to 60 m) will be formed in till.

A maximum long term slope angle of the order of 30° is recommended provided seepage is minimal. This angle may have to be reduced to 25° or less where significant seepage occurs.

For individual benches of up to 12 m heights, a short term slope of 55° may be used although local flattening must be expected where seepage occurs and the till is more granular.

133 BEDROCK

For long-term, drained conditions, slopes in the range of 33 to 37° are recommended where the foliation plane dips into the pit and consequently controls the stability. Maximum slopes of 45° are recommended where the foliation dips into the pit walls with a transition zone of about 40° between the above two zones.

Individual bench slopes of 1H:2V should prove satisfactory, though it is recommended that confirmatory structural analyses be performed.

134 SPOIL

The spoil will be subject to progressive deterioration and must be considered, from the viewpoint of long term stability, to attain a uniformly deteriorated condition. The use of flat slopes is necessary to avoid massive slides. For rock spoil, the overall slope angle should not exceed 28° while the till spoil should be sloped at not more than 23°. Where rock and till are placed in the same dump then the latter slope angle should be adopted.

The pile slopes may be benched. In that case, the bench slope adopted may be taken as that achieved naturally by dumping. It must nevertheless be understood that material so placed on a bench slope face will eventually slump to give overall slopes corresponding to those quoted above.

It is important to minimize the ingress of surface water into the pile and certainly ensure that the pile in no way acts to dam water in any adjoining depression. The provision of a drain layer of some 5 m thickness beneath the pile, employing the sounder bedrock or preferably sand and gravel, is recommended as it would be most beneficial in maintaining stability.

PART 2

CONSTRUCTION AND CONCRETE AGGREGATES

PART 2 - CONSTRUCTION AND CONCRETE AGGREGATES

CONTENTS

		PAGE
2.1	INTRODUCTION	2-1
2.2	CONCRETE AGGREGATES	2-1
2.3	ROAD CONSTRUCTION MATERIAL AND GRANULAR BACKFILL	2-7

TABLES

TABLE		
2-1	Construction Aggregates Summary of Laboratory Testing	2-2
2-2	Construction Aggregates Characteristics of Composite Samples	2-4
2-3	Construction Aggregates Sources and Quantities	2-5
2-4	Construction Aggregates Content of Fine and Large Sizes	2-9

DRAWINGS

DRAWING		
X-66887	Geotechnical Investigation Location Plan Sheet 1 of 2	In Pocket at End of This Part

2.1 INTRODUCTION

Searches were performed in the project area to locate natural deposits suitable for concrete, road construction and granular backfill. It was not known at the time of the investigation how much construction and concrete aggregates would be required and therefore the consultant attempted to be as exhaustive as possible in his preliminary search. A total of 62 backhoe test pits designated 57 to 60 and 100 to 157 were excavated in several areas. The locations of the pits are shown on drawing 66887 located at the end of this part of the report and drawing X-66888 located at the end of Part 1. Detailed logs are included in Appendix C. Several selected samples were subject to laboratory testing including grain size and organic impurities with a visual inspection of particle shape and material soundness.

2.2 CONCRETE AGGREGATES

The results of tests on some 32 samples from 20 test pits are presented in Appendix D and summarized in Table 2-1.

ASTM standards state that the fineness modulus of fine concrete aggregates should be within the range of 2.3 and 3.1 while gradation characteristics should conform to the grain size envelope shown on Plates 30 through 60 (Appendix D). The organic impurities index should not exceed 3 to insure adequate concrete quality.

TABLE 2-1

Construction Aggregates

Summary of Laboratory Testing

Test Pit No.	Depth	Organic Impurities Index	Fineness Modulus	% wt retained on No. 4 sieve *
	(m)			%
101	0.61 - 1.83	4	3.2	26.5
	1.83 - 3.08	2	1.4	0
108	0.34 - 2.59	3	3.2	48.7
114	0.67 - 1.92	3	3.4	55.5
	1.92 - 3.35	1	3.1	12.7
122	1.01 - 1.65	2	2.9	68.3
	1.65 - 3.23	3	1.9	2.1
	3.23 - 4.27	1	0.42	0.2
123	0.61 - 3.81	2	1.8	5.9
128	1.49 - 3.23	0 - 1	3.2	45.3
130	1.46 - 3.54	0 - 1	3.6	60.4
133	1.74 - 2.47	2	3.6	60.6
	2.47 - 2.99	0 - 1	2.7	1.4
136	1.28 - 1.77	0 - 1	2.9	53.9
	1.77 - 3.60	0 - 1	1.1	11.5
137	0.49 - 1.83	3	1.0	2.2
	1.83 - 3.75	0 - 1	2.1	30.6
139	1.01 - 3.81	0 - 1	3.2	62.9
142	1.74 - 2.80	1	1.1	25
	2.80 - 4.02	1	2.9	34.5
148	0 - 1.68	1	2.1	34.6
	1.68 - 3.93	1	0.8	7.6
149	0 - 1.4	1	1.5	11.4
	1.4 - 3.08	1	2.7	17.6
152	0 - 2.44	1	3.6	49.8
156	0 - 1.71	0 - 1	1.7	14
	1.71 - 3.29	1	3.5	37.7
57	1.5 - 1.75	2	0.13	0.6
59	2 - 3	1	0.25	1.1
	3	1	1.0	11.5
	3.5	1	1.3	22.4
58 & 60	1.0 - 3.0	-	2.9	44.5

* Corrected for cobble and boulder sizes

Table 2-1 indicates that the latter requirement causes the rejection of only one sample (a portion of the oxidized layer was included in the sample). However only 7 samples appeared to have a suitable fineness modulus for fine aggregates. In this study, some marginal values (2.2 and 3.2) were subsequently included because of the preliminary nature of the information and the sparsity of apparently suitable aggregate sources. Gradation data indicates that about 40% of the samples could be classified as coarse, using a cut-off value of 35% weight retained on No. 4 sieve.

A listing of all the pits possessing potential aggregate is presented in Table 2-2. Samples from the same pit have been combined, while consideration has been given to both No. 4 and 3/8 parting sieves to maximize potential. Included in this table are some pits for which no testing was performed but which appeared on visual inspection to constitute potential sources of coarse aggregate. Quantities of fine and coarse aggregate are presented in Table 2-3 for the nine potential zones located on Drawings X-66887 and X-66888. It should be noted that these quantities were based on a maximum pit depth of about 4 m attained in the test pitting, and may, therefore be considered as conservatively low.

Zones 1 and 2 are located at the mine site in an area characterized by a kame and kettle topography. Based on the information obtained from Pits 108, 109, 111 and 114, some 8800 m^3 of fine and coarse aggregates were estimated to be present. The aggregates, especially in Zone 2, may well extend to more considerable depths than were reached in the investigation.

TABLE 2-2

Construction Aggregates

Characteristics of Composite Samples

Type of Aggregate	Test Pit No.	Depth (m)	Parting Sieve No.	Fineness Modulus	% wt retained on parting sieve	% wt passing parting sieve (1)
Fine & Coarse	58 & 60	1.0 - 3.0	4	2.9	44.5	55.5
"	108	0.34- 2.59	4	3.2	48.7	51.3
"	114	0.67- 3.35	4	3.2	32.6	67.4
"	128	1.49- 3.23	4	3.2	45.3	54.7
"	133	1.74- 2.99	4	3.0	36.1	63.9
Fine	101	0.61- 3.08	3/8	2.4	7.3	92.7
"	122	1.01- 3.23	3/8	2.2	17.3	82.7
"	123	0.61- 3.81	3/8	2.3	2.3	97.7
"	149	1.40- 3.08	4	2.7	17.6	82.4
Coarse	130	1.46- 3.54	4		60.4	
"	139	1.01- 3.81	4		62.9	
"	152	0 - 2.44	4		49.8	
"	107	0.55- 2.68	Visual Estimation (2)			
"	109	0.49- 2.53				
"	111	0.91- 2.44				
"	126	0.49- 3.60				
"	129	1.01- 3.14				
"	132	1.22- 3.66				
"	135	1.01- 3.35				
"	138	0.82- 2.96				
"	140	1.31- 3.69				
"	141	1.04- 3.63				
"	150	0 - 3.05				
"	153	0 - 2.29				
"	156	1.71- 3.29				

Notes: (1) Corrected for cobble and boulder sizes

(2) A test pit was considered as a possible source of coarse aggregate when the visual description revealed a gravelly sand fraction or a bed of sand and gravel. No till blanket should underly the granular material and the water table should be located below the deposit.

TABLE 2-3

Construction Aggregates

Sources and Quantities

Zone No.	Total Volume from ground level	Volume of surface stripping required	Exploitable volume	Parting Sieve No.	Aggregate Type	
					Fine % wt passing parting sieve	Coarse % wt retained on parting sieve
	m^3	m^3	m^3			
1	7,600	1,900	5,700	4	65	35
2	3,700	600	3,100	4	55	45
3	14,500	7,500	7,000	4	60	40
4	17,700	5,800	11,900	4	60	40
5	3,100	1,300	1,800	4	-	60
6	16,400	3,200	13,200	3/8	85	-
7	6,700	2,000	4,700	4	-	35
8	18,800	5,500	13,300	4	-	45
9	17,100	-	17,100	4	-	45

Zones 3 to 6 are located in close proximity to the previously-proposed Middle Vangorda Creek dam site in an area where kames, kettles and eskers abound. The presence of some 34,000 m^3 of aggregate, of which about 65% is fine aggregate, has been estimated in these sources. It was assumed, though solely on the basis of visual descriptions, that Zone 4 (test pits 129 and 139) has similar material characteristics to Zone 3. On the basis of laboratory data, Zone 6 appeared marginally acceptable because of its pronounced fineness, and may well require mixing with the coarser aggregate observed in adjacent Pit 126.

Zones 7 and 8 are located some 1300 m downstream from the above-mentioned damsite on the south bank of Vangorda Creek and contain a majority of coarse aggregates. The estimate of material larger than No. 4 sieve size shown in Table 2-3 is essentially based on visual examination and is considered conservative. The estimate of exploitable aggregate is similarly approximate owing to the locally steep grades, particularly in Zone 7, which limited the extent of the investigation.

Zone 9 is located on the Cyprus Anvil road and includes a previously-exploited gravel pit. The extent of the investigation was limited by access problems due to steep grades. The exploitable volume estimated is therefore very conservative and may well be several times larger.

To summarize, searches for concrete aggregates were limited by the type of equipment utilized and the material suitability was essentially evaluated on the basis of two characteristics (i.e. content of organic impurities and gradation). This study is therefore considered preliminary and is basically aimed at determining the potential of several sources. As shown in Table 2-3, five sources are small and contain only minimal quantities. The other four sources may be considered more promising and should be further investigated. After estimating the sizes of these sources more accurately, detailed laboratory testing should be performed on bulk samples, including sodium sulphate soundness, Los Angeles abrasion, alkali reactivity, specific gravity and petrographic examination for unstable minerals.

2.3 ROAD CONSTRUCTION MATERIAL AND GRANULAR BACKFILL

Northern climatic conditions dictate the need for strict construction criteria, particularly to avoid frost heave problems in fill placement. It was deemed advisable that the percentage of fines (smaller than No. 200 mesh size) should be in the range of 2 to 10% for road base course and sub-base material construction, and up to 5 to 15% for road surfacing. The amount of fines was limited to 5% with a maximum particle size of 76 mm (3 inches) for granular backfill.

It can be seen in Table 2-3 that most of the aggregate sources investigated could supply coarse fill, with the exception of Zone 6. The content of fine and large sizes determined in each potential zone is listed in Table 2-4. On this basis, only Zone 8 would be rejected because of its fines content.

TABLE 2-4

Construction Aggregates

Content of fine and large sizes

Zone No.	% Particle Size	
	finer than No. 200 mesh size	coarser than 76 mm
1	1.4	8
2	2.1	10
3	2.2	5
4	-	11
5	3.5	16
7	-	7
8	6.4	12
9	0.7	13

PART 3

MINE WASTE MANAGEMENT

PART 3 - MINE WASTE MANAGEMENT

CONTENTS

		PAGE
3.1	INTRODUCTION	3-1
3.2	REGULATORY REQUIREMENTS	3-1
3.3	HYDROLOGY OF THE AREA	3-2
	331 GENERAL	3-2
	332 RUNOFF POTENTIAL	3-4
	333 DESIGN STORM	3-5
	334 UNIT HYDROGRAPHS	3-6
	335 DESIGN FLOODS	3-6
3.4	SOURCES OF WASTES	3-11
	341 MINE SPOIL	3-12
	.1 Location of Dumps	3-12
	342 MINE WATER	3-16
	343 SURFACE DRAINAGE	3-20
3.5	WASTE MANAGEMENT	3-22
3.6	RECLAMATION OF WASTE DUMPS	3-25
3.7	COST ESTIMATES	3-27

TABLES

TABLE		
3-1	Exploration Phase Settling Pond Effluent Water Quality Limits	3-2
3-2	Metal Mining Effluent Authorized Levels of Substances	3-3

		PAGE
3-3	Flood Discharge Hydrographs	3-8
3-4	Dump Parameters	3-14
3-5	Dump Volumes	3-15
3-6	Cyprus Anvil Grum Deposit Water Quality Data From the Discharge From the Settling Pond (1976-1977)	3-18
3-7	Dissolved and Extractable Metal Concentrations[a]	3-19
3-8	Summary of Existing Water Quality of Vangorda Creek	3-26

FIGURES

FIGURE		
3-1	Flood Discharge Hydrograph - 25 year recurrence for Area Number 2	3-10
3-2	Drainage Pond Reservoir Volume vs Dam Volume & Height	3-24

PLATES

PLATE		
3-1	Location of Overburden and Waste Dumps	3-13
3-2	Drainage Layout	3-21

3.1 INTRODUCTION

Mine Waste Management as described in this report involves the design of mine spoil dumps and the drainage associated with the complete mine and associated mine spoil dumps. Consideration has not been given at this time to any wastes associated with a milling or existing camp at Grum because such a mill has not been proposed or defined.

3.2 REGULATORY REQUIREMENTS

Application to the Yukon Territory Water Board will be required to obtain approval for the proposed waste management measures and discharge of effluents from the mine site. The Board, administered by the Department of Indian Affairs and Northern Development, has the authority to specify "the quantity and types of wastes that may be deposited in any waters by the licensee and the conditions under which any such wastes may be so deposited" (Section 10(2), Northern Inland Water Act, 1969-70, c66). Also, since a representative of the Environmental Protection Service (EPS) sits on the Board, it is generally understood that any requirements of the EPS with respect to the Fisheries Act would be channelled through the Board. Limits specified by the Board for the discharge of settling pond effluent during the underground exploration phase carried-out in 1977 are given in Table 3-1. The settling pond received minewater and runoff from the ore storage area.

TABLE 3-1

Exploration Phase Settling Pond Effluent
Water Quality Limits

Parameter	Effluent Water Quality Limit[a]
Suspended solids (mg/l)	25
pH	>6.5
Lead (mg/l)	0.2
Zinc (mg/l)	0.3

[a]Monthly sample

The Metal Mining Liquid Effluent Regulations (Environment Canada, 1977), administered by EPS, specify water quality limits for the discharge of effluents from new mines. The limits, given in Table 3-2, would likely form a basis for the specification of effluent quality applicable to the proposed mining operation at the Grum deposit.

3.3 HYDROLOGY OF THE AREA

331 GENERAL

Basic hydrologic studies were described in the Preliminary Engineering report of January, 1978 and the Interim Report on Water Supply of October, 1977. These studies resulted in the selection of the Pelly River as the source of water supply for the mine and mill. Subsequently, studies of flood potential in the project area were made to determine ditch capacities and culvert sizes for the mine waste management plant.

TABLE 3-2

Metal Mining Effluent

Authorized Levels of Substances

Substance	Column I Maximum[1] Authorized Arithmetic Monthly Mean Concentration	Column II Maximum[1] Authorized Concentration in a Daily Composite Sample	Column III Maximum[1] Authorized Concentration in other samples
Arsenic	0.5 mg/1	0.75 mg/1	1.0 mg/1
Copper	0.3 mg/1	0.45 mg/1	0.6 mg/1
Lead	0.2 mg/1	0.3 mg/1	0.4 mg/1
Nickel	0.5 mg/1	0.75 mg/1	1.0 mg/1
Zinc	0.5 mg/1	0.75 mg/1	1.0 mg/1
Suspended Solids	25.0 mg/1	37.5 mg/1	50.0 mg/1
Radium 226	10.0 pCi/1	20.0 pCi/1	30.0 pCi/1
pH	6.0 mg/1	5.5 mg/1	5.0 mg/1

[1] Except for pH which is the minimum authorized value

Note: The concentrations are given as total values with the exception of Radium 226 which is a dissolved value after filtration of the sample through a 3 micron filter.

The only measured flood data in the region are for relatively large drainage areas within the Pelly River system, ranging in area from 7250 to 51000 square kilometers. Estimates of floods based upon data from these large and diverse watersheds cannot be considered accurate for the very small watersheds in the project area because of the extreme difference in the time taken for run-off to occur following precipitation.

Nevertheless, for the project under study at that time, flood peaks and hydrographs were needed for the design of a large number of culverts along the water supply pipeline, the tailings disposal pipeline and the attendant access roads. Procedures devised for the solution of such problems are presented in the United States Bureau of Reclamation publication entitled Design of Small Dams. That proposed by the Soil Conservation Service (SCS) applied in this study.

332 RUNOFF POTENTIAL

Analysis of the drainage basins shows that soil conditions in the area are favorable for a high runoff. In the upper reaches of the basins, rock outcrops are extensive while the lower portions of the basins are underlain by either permafrost or relatively impervious tills. There is very little topsoil or organic litter.

Tree cover is sparse at lower levels except in areas immediately bounding well-defined drainage paths. At higher elevations, in excess of 1220 meters AMSL, there is virtually no tree cover.

Based upon this descriptive information, two basic soil and cover complexes were defined for purposes of estimating runoff potential for the various watersheds. The area above 1220 m AMSL was classified as having an SCS runoff curve number of 90, indicating a very high runoff potential. Characteristics below 1220 m AMSL were assumed to be less favourable to high runoff due to somewhat greater extent of soil cover and somewhat more permeable underlying. Accordingly, an SCS curve number of 80 was selected for this area. Runoff curve numbers were then selected for each of the study watersheds based upon a judgment as to the proportions of each falling within each of these two major classifications.

333 DESIGN STORM

Intensity-duration-frequency relationships developed in this region are for the meteorological stations at Carmacks, Fort Selkirk and Whitehorse. Regional information is presented in the Atlas of Rainfall Intensity-Duration-Frequency Data for Canada, a publication of Department of Transport, Meteorological Branch, produced in 1968. Based upon this information, an upper envelope containing the Whitehorse and Carmacks relationships was developed and used in this study.

The design storm sequence used in this study was a storm which builds to a peak intensity 30 minutes after the storm starts and subsequently decays. Storm volumes indicated by the intensity-duration-frequency curves were derived for 15 minute increments. These data were then arranged in the sequence 3, 2, 1, 4, 5, 6, etc., where 1 represents the largest 15 minute rainfall increment, 2 represents the next largest and so on.

The possible contribution of snowmelt to a maximum runoff event was studied by reference to the observed snow course at Whitehorse. It quickly became evident that snowmelt only becomes a dominant factor in runoff for drainage areas large enough for the critical duration to exceed 150 hours. It was therefore excluded from further consideration.

334 UNIT HYDROGRAPHS

The dimensionless unit hydrograph developed by SCS, presented in Design of Small Dams, was used to develop hydrograph shapes for the storm runoff.

335 DESIGN FLOODS

The design storm information was combined with the runoff curve numbers for each of the watersheds to develop incremental net storm rain values. This net storm rainfall was used in conjunction with the associated unit hydrographs to produce surface runoff hydrographs. Base flow was neglected due to the short duration of the floods and the relatively low base flow component expected on these drainage areas.

A summary of the calculated floods for the six areas considered significant to the present study is presented in Table 3-3. Figure 3-1 illustrates the design storm and resultant flood hydrograph for a 25-year recurrence on Area Number 2, where calculated hydrographs are compared to hydrographs approximated by straight lines. This random sample is typical of the accuracy of the proposed method of approximation.

TABLE 3-3

Flood Discharge Hydrographs (1/s)

Area Number		1				Area Number		2			
Return Period (yrs)		10	25	50	100	Return Period (yrs)		10	25	50	100
Length of Time Step (min)		2.0	2.0	2.0	2.0	Length of Time Step (min)		2.0	2.0	2.0	2.0
Time to First Runoff (min)		30.0	30.0	30.0	30.0	Time to First Runoff (min)		30.0	30.0	30.0	30.0
		Flood Discharge (1/s)						Flood Discharge (1/s)			
Step:	1	8	23	51	74	Step:	1	3	11	25	37
	2	51	136	275	399		2	25	71	142	207
	3	181	456	833	1172		3	93	232	428	600
	4	479	1093	1858	2515		4	241	549	926	1252
	5	1005	2110	3370	4417		5	490	1014	1589	2064
	6	1764	3426	5182	6569		6	818	1546	2268	2832
	7	2684	4842	6966	8608		7	1169	2022	2809	3398
	8	3625	6116	8467	10194		8	1464	2345	3115	3681
	9	4446	7051	9401	11100		9	1645	2466	3171	3653
	10	4984	7504	9741	11327		10	1699	2415	3030	3455
	11	5210	7532	9571	10958		11	1645	2240	2769	3115
	12	5154	7192	8976	10222		12	1515	2005	2452	2750
	13	4899	6626	8212	9259		13	1351	1753	2132	2381
	14	4502	5975	7362	8268		14	1189	1521	1843	2047
	15	4078	5352	6541	7334		15	1045	1320	1591	1761
	16	3681	4757	5805	6484		16	917	1147	1379	1523
	17	3341	4247	5154	5748		17	807	997	1198	1320
	18	3030	3823	4616	5125		18	699	858	1031	1133
	19	2755	3455	4163	4616		19	589	722	864	949
	20	2523	3143	3766	4163		20	481	589	705	773
	21	2305	2832	3398	3794		21	385	467	561	614
	22	2093	2574	3086	3426		22	300	365	439	481
	23	1872	2296	2738	3058		23	232	283	340	374
	24	1637	2005	2384	2653		24	181	221	266	292
	25	1399	1710	2030	2260		25	142	173	207	227
	26	1169	1427	1693	1889		26	110	133	161	176
	27	963	1175	1393	1555		27	85	105	125	136
	28	784	957	1185	1266		28	65	79	96	105
	29	637	776	928	1028		29	51	62	74	79
	30	578	631	750	835		30	40	45	54	57
	31	419	513	609	680		31	28	34	40	42
	32	343	416	496	552		32	20	25	28	31
	33	278	337	402	447		33	14	17	20	20
	34	224	275	326	362		34	11	11	14	14
	35	181	221	258	286		35	8	8	11	11
	36	144	173	201	221		36	6	6	6	8
	37	113	133	156	170		37	3	6	6	6
	38	88	102	119	130		38	3	3	3	3
	39	68	79	91	102		39	3	3	3	3
	40	54	62	71	79		40	0	0	3	3
	41	40	45	54	59		41	0	0	0	0
	42	31	37	42	45						
	43	25	28	34	37	Total Flood Volume (m^3)		2350	3341	4304	4984
	44	20	23	25	28						
	45	14	17	20	23						
	46	11	14	14	17						
	47	8	8	11	11						
	48	6	8	8	8						
	49	3	6	6	6						
	50	3	3	3	3						
	51	3	3	3	3						
	52	0	0	0	0						
Total Flood Volume (m^3)		8863	12459	15942	18434						

NOTE: See Plate 3-2 for location and numbering of drainage areas.
See Figure 3-1 for illustration of design storm and resultant flood hydrograph (25 year recurrence, Area 2).

Flood Discharge Hydrographs (1/s)

Area Number		4				Area Number		5			
Return Period (yrs)		10	25	50	100	Return Period (yrs)		10	25	50	100
Length of Time Step (min)		2.0	2.0	2.0	2.0	Length of Time Step (min)		1.0	1.0	1.0	1.0
Time to First Runoff (min)		30.0	30.0	30.0	30.0	Time to First Runoff (min)		30.0	30.0	30.0	30.0
		Flood Discharge (1/s)						Flood Discharge (1/s)			
Step:	1	6	17	34	51	Step:	1	0	3	11	20
	2	34	93	190	275		2	6	25	62	102
	3	125	311	569	799		3	25	88	201	303
	4	323	739	1252	1690		4	74	221	459	648
	5	668	1388	2195	2860		5	164	433	818	1102
	6	1138	2175	3228	4078		6	300	708	1220	1566
	7	1668	2945	4134	5040		7	476	1002	1586	1948
	8	2152	3511	4757	5663		8	668	1263	1855	2206
	9	2500	3851	5012	5833		9	844	1458	2016	2333
	10	2667	3879	4927	5663		10	985	1580	2084	2364
	11	2659	3709	4616	5239		11	1082	1634	2084	2330
	12	2515	3370	4163	4701		12	1130	1631	2030	2251
	13	2291	3002	3681	4134		13	1133	1583	1937	2129
	14	2044	2645	3228	3596		14	1104	1492	1804	1971
	15	1812	2316	2812	3115		15	1053	1382	1651	1798
	16	1606	2030	2455	2718		16	991	1260	1492	1620
	17	1416	1773	2138	2362		17	915	1135	1337	1450
	18	1240	1538	1852	2039		18	833	1014	1186	1286
	19	1062	1311	1577	1736		19	742	892	1042	1127
	20	889	1093	1314	1447		20	648	773	903	977
	21	725	892	1073	1178		21	563	668	779	841
	22	580	714	858	943		22	490	578	677	731
	23	462	566	680	748		23	428	504	592	637
	24	362	4474	538	589		24	382	447	527	566
	25	289	354	425	467		25	345	405	473	513
	26	229	280	337	371		26	314	368	433	467
	27	181	221	266	292		27	292	340	399	430
	28	142	176	210	229		28	272	317	374	402
	29	113	139	167	181		29	258	297	351	377
	30	88	108	130	144		30	244	283	331	357
	31	71	85	102	110		31	232	266	314	337
	32	54	65	79	82		32	218	249	294	314
	33	42	48	57	59		33	195	227	266	286
	34	31	34	40	42		34	170	195	232	249
	35	20	23	28	31		35	142	161	193	207
	36	14	17	20	23		36	113	130	153	164
	37	11	11	14	17		37	88	99	119	127
	38	8	8	11	11		38	68	76	91	96
	39	6	6	8	8		39	51	59	71	74
	40	3	6	6	6		40	40	45	54	57
	41	3	3	3	3		41	31	34	40	45
	42	3	3	3	3		42	23	25	31	34
	43	0	0	0	3		43	17	20	23	25
	44	0	0	0	0		44	14	14	17	20
							45	11	11	14	14
							46	8	8	11	11
							47	6	6	8	8
							48	6	6	6	6
							49	3	3	6	6
							50	3	3	3	3
							51	3	3	3	3
							52	0	3	3	3
							53	0	0	0	0
Total Flood Volume (m^3)		3879	5522	7107	8212	Total Flood Volume (m^3)		1093	1526	1960	2217

NOTE: See Plate 3-2 for location and numbering of drainage area.
See Figure 3-1 for illustration of design storm and resultant flood hydrograph (25 year recurrence, Area 2).

TABLE 3-3

Flood Discharge Hydrographs (1/s)

Area Number		6				Area Number		19			
Return Period (yrs)		10	25	50	100	Return Period (yrs)		10	25	50	100
Length of Time Step (min)		1.0	1.0	1.0	1.0	Length of Time Step (min)		2.0	2.0	2.0	2.0
Time to First Runoff (min)		30.0	30.0	30.0	30.0	Time to First Runoff (min)		30.0	30.0	30.0	30.0
		Flood Discharge						Flood Discharge			
					(1/s)						(1/s)
Step:	1	3	11	31	51	Step:	1	3	31	93	159
	2	17	71	173	275		2	40	212	549	892
	3	71	238	538	810		3	198	779	1829	2781
	4	195	569	1167	1640		4	617	2064	436	6258
	5	411	1059	1943	2557		5	1481	4304	8212	11185
	6	716	1614	2662	3313		6	2860	7362	12827	16735
	7	1068	2118	3171	3794		7	4701	10732	17245	21634
	8	1402	2478	3455	3993		8	6683	13705	20614	25003
	9	1662	2679	3511	3993		9	8467	15687	22313	26363
	10	1832	2755	3483	3879		10	9684	16424	22398	25995
	11	1909	2738	3370	3709		11	10222	16084	21266	24324
	12	1906	2639	3200	3483		12	10052	14979	19368	21974
	13	1838	2461	2945	3200		13	9458	13507	17216	19397
	14	1727	2237	2642	2860		14	8608	11978	15093	16933
	15	1600	2005	2350	2540		15	7787	10562	13224	14781
	16	1470	1790	2084	2248		16	7022	9344	11610	12912
	17	1331	1583	1838	1979		17	6286	8212	10166	11270
	18	1172	1376	1591	1713		18	5550	7164	8835	9741
	19	1005	1169	1354	1455		19	4785	6116	7504	8297
	20	849	985	1141	1229		20	3993	5097	6230	6881
	21	719	835	968	1042		21	3256	4134	5069	5578
	22	620	719	838	903		22	2597	3285	4021	4446
	23	549	634	742	799		23	2050	2599	3171	3511
	24	493	572	668	716		24	1611	2039	2498	2750
	25	450	521	609	654		25	1269	1606	1965	2166
	26	419	481	563	606		26	997	1266	1549	1707
	27	394	453	530	569		27	782	991	1218	1339
	28	374	430	504	544		28	614	782	957	1053
	29	357	411	484	521		29	484	614	753	830
	30	345	396	467	501		30	382	481	586	640
	31	331	379	447	481		31	300	374	445	481
	32	306	351	416	447		32	232	280	328	351
	33	266	306	362	388		33	176	204	238	255
	34	215	246	292	314		34	127	142	167	178
	35	164	190	224	241		35	91	102	122	130
	36	122	139	164	176		36	65	74	88	93
	37	88	102	119	127		37	45	51	59	65
	38	62	74	88	93		38	31	37	45	48
	39	45	54	62	68		39	23	25	31	34
	40	34	40	45	48		40	17	17	23	23
	41	25	28	34	37		41	11	11	14	14
	42	17	20	25	25		42	6	6	8	8
	43	14	142	17	20		43	3	3	3	3
	44	8	113	14	14		44	0	0	0	0
	45	6	8	8	8						
	46	6	6	6	6	Total Flood Volume (m^3)		14781	23220	31714	37095
	47	3	3	6	6						
	48	3	3	3	3						
	49	3	3	3	3						
	50	0	0	0	0						
Total Flood Volume (m^3)		1716	2401	3086	3483						

NOTE: See Plate 3-2 for location and numbering of drainage areas.
See Figure 3-1 for illustration of design storm and resultant flood hydrograph (25 year recurrence, Area 2).

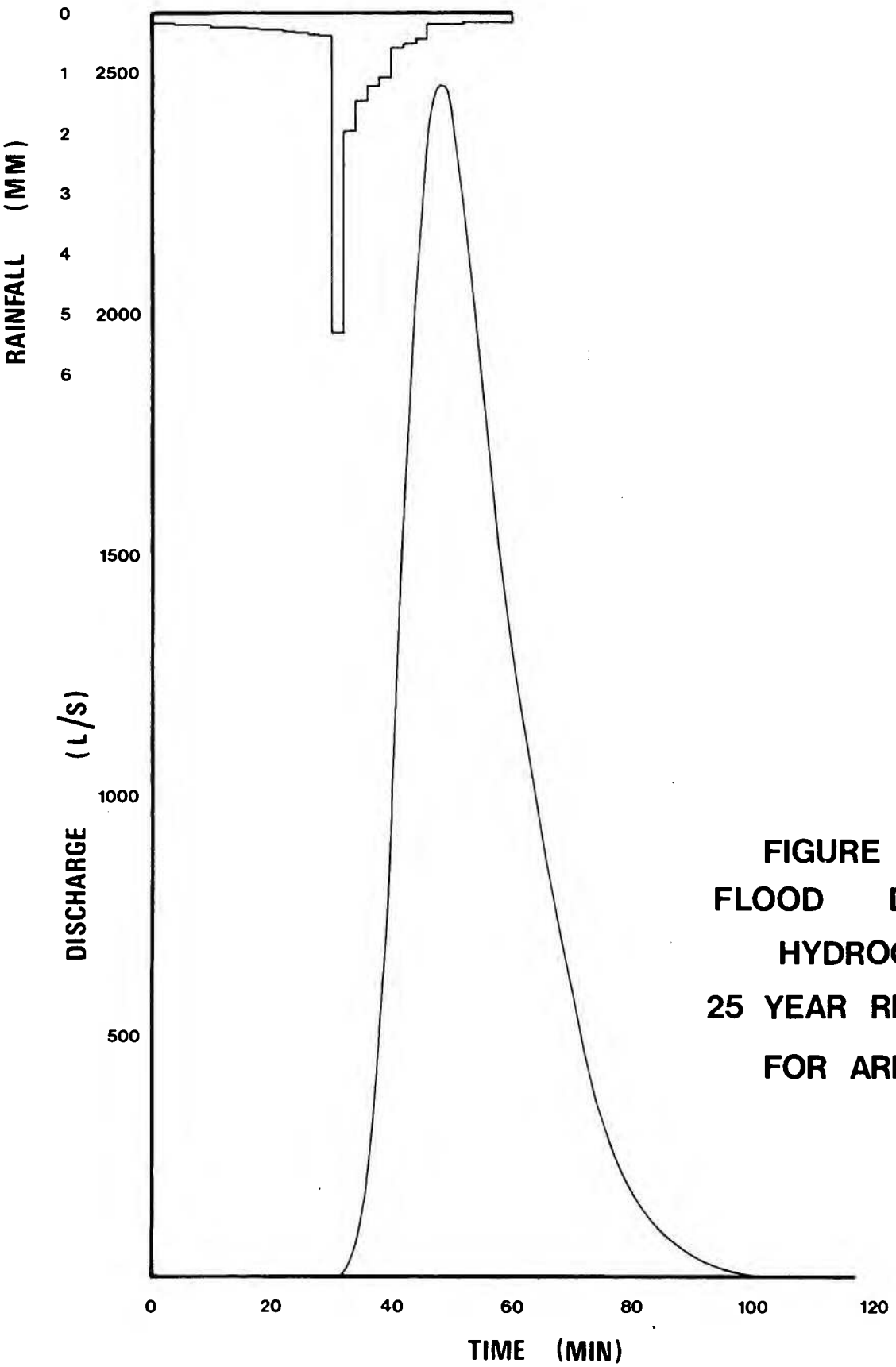


FIGURE 3 -1
FLOOD DISCHARGE
HYDROGRAPH
25 YEAR RECURRENCE
FOR AREA No. 2

Runoff volumes at various points where these sub-basins combine can be approximated by adding components of the flood. It should be noted that peak discharges may not be additive as peak flows on all areas do not occur simultaneously.

3.4 SOURCES OF WASTES

The primary sources of wastes from the open pit mining operation would include mine spoil, mine water pumped from the pit, and surface drainage in contact with the mining operations area. This would include general site runoff, and runoff from the overburden and waste rock dump sites.

Domestic wastes and sewage associated with mining operation would require conventional treatment to meet regulatory criteria and are not considered further in this report.

In addition to aqueous wastes the mining operation would also result in fugitive dust emissions and noise. Due to the isolation of the site, these aspects would be of limited concern as regards environmental impact. Fugitive dust emissions and noise should be controlled to meet industrial hygiene or working environment requirements. These aspects are not considered further in this report.

The quantity/quality, and treatment requirements with respect to the major sources of wastes are considered below.

341 MINE SPOIL

.1 Location of Dumps

The possible locations for the overburden and waste dumps are shown in Plate 3-1. It was necessary to determine dump volumes for 75×10^6 tonnes of waste material and for 25×10^6 tonnes of overburden considering the following constraints.

- Ultimate pit limits as shown in Plate 3-1.

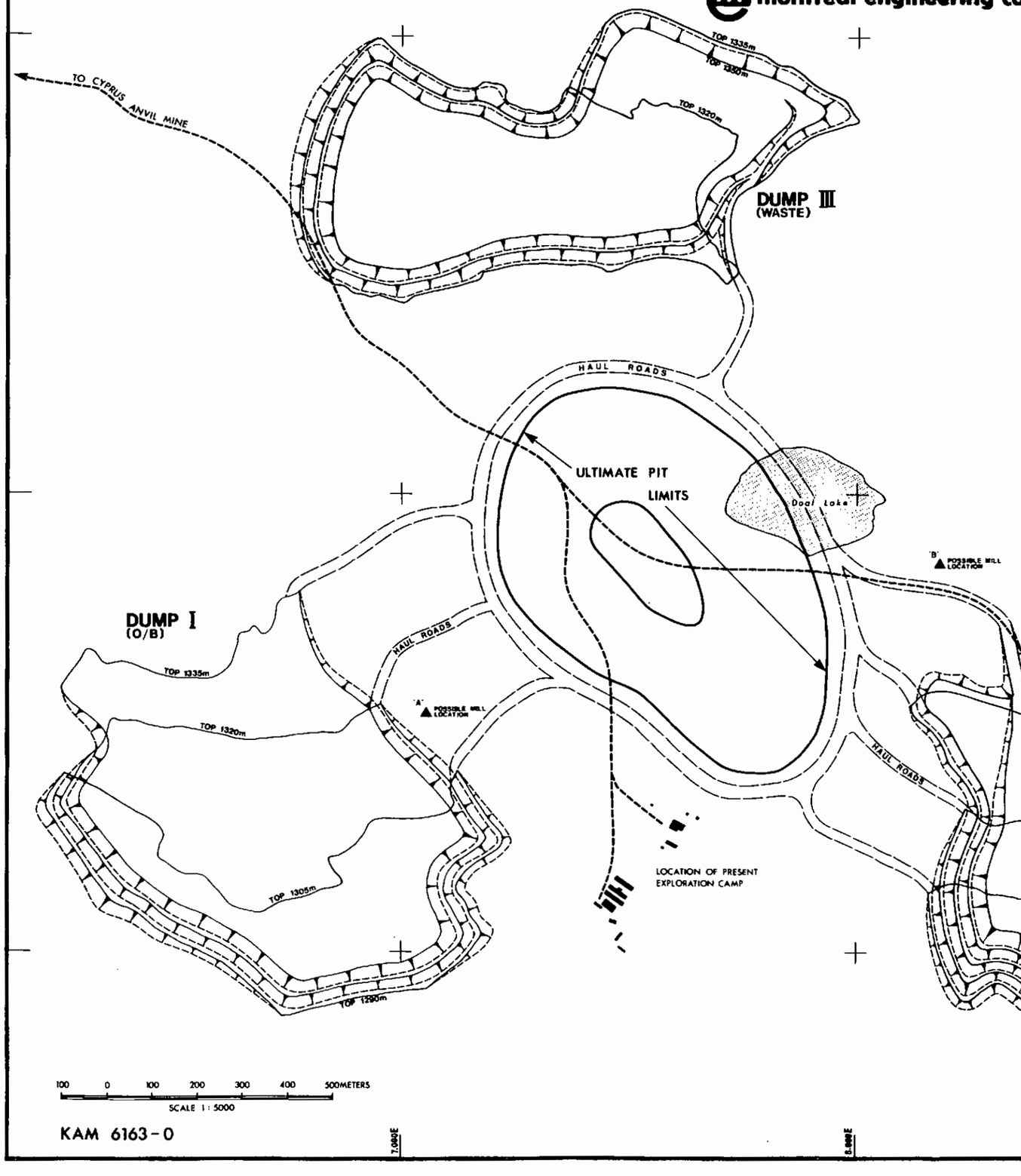
- Diamond drill exploration holes which indicate ore reserves north of the ultimate pit limits shown (towards Dump III) and also south of the pit in the area immediately east of the present exploration camp.

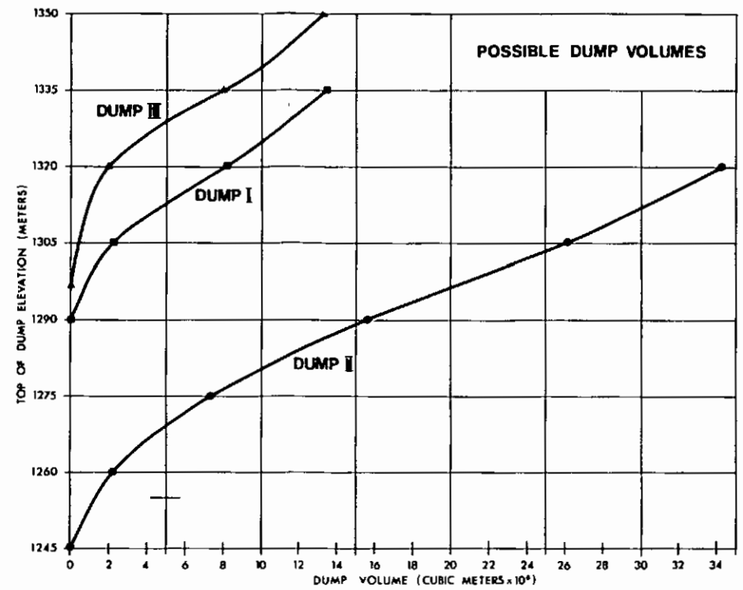
- Possible mill or crusher location west of the pit and indicated as A site on Plate 3-1. A further mill or crusher site being considered is denoted as B site but this had no constraints on dump location.

- Based on geotechnical information available at this time it was considered advisable to separate the waste and the overburden into discrete dumps. The possibility of combining waste and overburden within a single dump should be explored further as this could reduce haul distance and therefore reduce costs.

- Dump locations and designs are independant of pit design.

The parameters used are shown below in Table 3-4.





KAM 6163-0

PLATE 3-1

LOCATION OF OVERBURDEN AND WASTE DUMPS

TABLE 3-4

Dump Parameters

	Overburden	Waste Rock
Ultimate volume (x 10^6 tonnes)	25	75
(x 10^6 m^3)	10.6	26.6
In-situ density (tonnes/m^3)	2.3	2.8
Swell factors (%)	25	30
Loose density (tonnes/m^3)	1.9	2.2
Dump Lifts (meters)	15	15
Width of berm (meters)	15	10
Slope angle (degrees)	35	40

Note: Quantity calculations were made on the basis of preliminary geotechnical parameters outlined above. Depending on the number of lifts, overall slope, based on these parameters, may slightly exceed subsequent recommendations outlined on Page . It was considered that the differences would be minor and accordingly dumps were not redesigned. As a result of further geotechnical work, the above parameters may be revised or confirmed.

Due to the present knowledge of the differing inherent and weathering characteristics of the waste and overburden, it was decided to segregate them into separate dumps. To minimize the risk of dump failure the dumps were constructed on the areas having the least slope. The steep slopes are particularly noticeable in the south and southwest areas, shown on Plate 3-1, as the land drops to Vangorda Creek.

The initial pit digging will involve the removal of the overburden and this will be placed in Dump I, southwest of the pit. The first lift will have a foot elevation of approximately 1290 meters and a top elevation of 1305 meters. The volumes estimated in each of the lifts are shown in Table 3-5. Prior to dumping, provision must be made to divert surface drainage around the dump area as run-off entering the dump could cause erosion and subsequent dump failure.

TABLE 3-5

Dump Volumes

Top of Dump Elevation (meters)	Accumulative Volume in Cubic Meters x 10^6		
	Dump I	Dump II	Dump III
1245	-	0	-
1260	-	2.1	-
1275	-	7.3	-
1290	0	15.7	-
1297	0.7	20.3	-
1305	2.2	26.1	0
1320	8.2	34.6	2.0
1335	13.5	-	8.0
1350	-	-	13.3
Total	13.5	34.6	13.3

Successive lifts will then be constructed after allowing a berm width of 15 meters from the crest of the underlying lift. Three lifts with a top elevation of 1335 meters will accommodate 13.5 x 10^6 cubic meters of overburden. Assuming all of the 25 x 10^6 tonnes at a loose density of 1.88 then the volume required is 13.3 x 10^6 cubic meters, and will therefore be of an adequate capacity.

Dump II located southeast of the pit is designated for waste disposal. It also will be constructed in a similar manner to that of the overburden dump described starting with the lowest lift first, and then building the dump with 10 meters berms. With 5 lifts each of 15 meters and with the dimensions shown on Plate 3-1 this dump will hold 34.6×10^6 cubic meters which will be sufficient to accommodate the design volume. Again, it must be stressed that surface run-off must be diverted around the dump area before, during and after construction to reduce the risk of dump failure.

Dump III to the north of the pit is superfluous to design volume requirements but the haulage cost will be less for this dump than for the eastern limits of dump II due to haul distance involved. This dump III area must be considered again in the light of economics of ore mineral extension and waste haul costs.

342 MINE WATER

The quantity of mine water that would be produced from the open pit operation has not been established. During the underground exploration phase the quantity of mine water produced was not monitored. It was estimated to be less than 2 l/s. Indications such as shortage of drinking water and low flows at Cyprus Anvil's pit, were obtained during the exploration phase, that the mining operation would be relatively "dry". For the purpose of this assessment a mine water flowrate of 7 l/sec has been assumed with allowance provided for significantly greater flow rates.

The quality of the mine water produced during the underground exploration phase was monitored during the period from November 1975 to December 1977. The mine water, as shown by the data given in Table 3-6 was consistently alkaline with pH varying from 7.5 to 9.0 and bicarbonate alkalinity ranging from 87 to 238 mg/l as calcium carbonate. The extractable concentrations of metals detected in the water can be related to the presence of mineralized particulates in the mine water (turbidity and suspended solids) resulting from mining activity. The dissolved concentration of metals would be anticipated to be minimal due to its alkaline characteristics. This, as indicated by the data given in Table 3-7, was confirmed by measuring both dissolved and extractable concentrations of metals in a sample of mine water collected during the exploration phase. Thus, on this basis mine water would require treatment only for the removal of suspended solids and turbidity to meet the effluent water quality requirements referred to in Section 3.2.

It should be noted that ore from the Grum deposit has a positive potential for the generation of acid through sulphide oxidation. This was confirmed in tests carried-out by B.C. Research to determine the acid generation potential of the ore. The absence of acidity in the mine water has been attributed to climatic conditions and the presence of alkaline host rock, and alkaline ground and surface waters which do not favour the development of acid generating conditions.

TABLE 3-6

Cyprus Anvil Grum Deposit
Water Quality Data From the Discharge From The Settling Pond (1976-1977)

Date of Sampling	Sodium MG/L	Potassium MG/L	pH MG/L	Sulphate MG/L	Conductivity micromhos N21°C	Turbidity FTU	TSS MG/L	Total Hardness EDTA MG/L C_aCo_3	Colour APHA MG/L	Total Alkalinity MG/L C_aCo_3	Copper MG/L	Iron MG/L	Lead MG/L	Manganese MG/L	Nickel MG/L	Zinc MG/L	Cadmium MG/L	Arsenic MG/L	Mercury MG/L	Cobalt MG/L	Chromium MG/L
Nov. 9, 75	24	8.8	7.68	95	600	47	69	269	<5	226	0.009	2.80	0.98	0.077	0.012	1.00	0.005	0.118	0.78	0.01	
Dec. 1, 75	25	9.6	8.99	90	395	160	340	142	5	138	0.013	5.50	1.89	0.124	0.012	2.80	0.006	0.201	1.08	<0.01	-
Dec. 14, 75	-	-	7.63	93	450	46	59	191	<5	175	0.011	0.178	0.51	0.040	-	0.549	0.002	0.132	0.36	-	-
Jan. 6, 76	-	-	7.92	96	640	52	73	263	<5	231	0.018	0.151	0.70	0.094	0.013	1.015	0.004	0.112	0.97	0.02	-
Jan. 14, 76	-	-	8.45	90	520	48	58	240	<5	210	0.016	0.193	0.67	0.070	0.014	0.775	0.001	0.109	0.56	0.02	-
Jan. 16, 76	-	-	9.48	92	360	140	2161	118	<5	238	0.011	14.1	9.0	0.36	0.023	9.50	0.013	-	3.3	0.02	-
Jan. 22, 76	-	-	7.91	103	495	145	166	161	5	121	0.055	4.40	2.70	0.094	<0.005	4.10	0.007	0.168	1.70	0.028	0.010
Jan. 26, 76	-	-	7.70	123	680	37	43	255	5	208	0.019	1.80	0.75	0.086	0.018	1.40	0.003	0.185	0.80	0.013	0.008
Feb. 1, 76	-	-	7.76	103	610	35	37	249	5	210	0.012	1.20	0.50	0.062	0.022	1.00	0.011	0.080	0.57	0.011	0.005
Feb. 7, 76	-	-	7.52	120	560	62	80	213	<5	161	0.004	2.30	0.495	0.043	0.032	1.489	0.004	0.168	0.97	<0.01	0.007
Feb. 14, 76	-	-	7.53	125	590	43	49	227	<5	174	0.003	1.66	0.305	0.033	0.047	0.775	0.005	0.060	0.48	<0.01	0.010
Feb. 21, 76	-	-	7.58	127	630	59	108	255	<5	204	0.005	0.48	0.137	0.029	0.037	0.116	0.004	0.065	0.86	<0.01	0.010
Feb. 28, 76	-	-	7.62	54	640	39	44	273	<5	205	0.001	2.088	0.420	0.078	0.052	0.699	0.004	0.099	0.38	<0.01	0.006
Mar. 7, 76	-	-	8.28	56	440	95	133	143	<5	91	0.001	0.080	0.111	0.018	0.033	0.151	0.003	0.042	0.70	<0.01	0.007
Mar. 14, 76	-	-	7.93	61	590	52	54	251	<5	200	0.001	0.030	0.111	0.039	0.066	0.237	0.002	0.064	0.96	<0.01	0.007
Mar. 21, 76	-	-	7.88	135	485	58	71	197	<5	133	0.001	0.02	0.08	0.020	<0.01	0.119	0.001	0.055	0.41	<0.01	<0.005
Mar. 28, 76	-	-	8.02	128	565	85	140	211	<5	165	0.001	<0.01	0.11	0.026	<0.01	0.122	0.003	0.058	0.62	<0.01	<0.005
Apr. 4, 76	-	-	8.01	120	610	42	56	219	<5	165	0.001	<0.01	0.09	0.024	<0.01	0.108	0.002	0.063	0.39	<0.01	<0.005
Apr. 11, 76	-	-	7.86	128	610	52	90	240	<5	176	0.005	0.010	0.09	0.025	0.05	0.179	0.003	0.108	1.64	<0.01	0.006
Apr. 18, 76	-	-	8.39	141	520	96	160	157	<5	110	0.005	0.025	0.14	0.025	0.01	0.201	0.001	0.176	1.63	<0.01	0.007
Apr. 25, 76	-	-	8.78	132	500	82	116	167	<5	127	0.005	0.030	0.07	0.016	0.01	0.079	0.004	0.080	1.31	<0.01	0.005
May 2, 76	-	-	7.96	140	640	110	176	233	<5	164	0.006	0.01	0.02	0.022	<0.05	0.25	0.003	0.080	1.36	<0.02	-
May 9, 76	-	-	8.05	140	650	180	478	230	<5	170	0.008	0.01	0.02	0.030	<0.05	0.59	0.003	0.095	3.00	<0.02	-
May 16, 76	-	-	8.32	116	540	57	72	206	<5	159	0.008	0.01	0.03	0.027	<0.05	0.14	0.004	0.076	1.04	<0.02	-
May 23, 76	-	-	7.37	130	660	70	112	235	<5	148	<0.02	0.920	0.34	0.032	<0.02	0.430	0.006	0.006	0.75	<0.02	-
May 29, 76	-	-	7.93	129	610	42	55	225	<5	170	<0.02	3.25	0.50	0.061	0.04	0.764	0.006	0.080	0.32	<0.02	-
June 6, 76	-	-	7.68	138	600	210	1421	220	<5	178	0.05	2.16	0.48	0.140	0.02	1.40	0.007	<0.005	5.12	<0.02	-
June 12, 76	-	-	7.92	125	640	67	105	215	<5	162	0.07	5.49	1.35	0.099	0.02	1.74	0.014	0.075	0.96	<0.02	-
June 20, 76	-	-	7.55	148	520	280	479	176	<5	82	0.07	10.54	3.83	0.211	0.05	4.54	0.007	1.250	2.52	<0.02	-
June 27, 76	-	-	8.02	136	700	31	35	262	<5	206	0.05	2.95	0.50	0.134	0.03	0.905	0.003	0.100	0.64	<0.02	-
July 4, 76	-	-	7.79	128	710	32	35	274	<5	167	0.022	3.38	0.41	0.125	<0.05	0.960	0.003	0.047	0.33	-	-
July 11, 76	-	-	8.06	101	610	34	43	245	<5	191	0.005	1.25	0.25	0.050	<0.05	0.317	0.001	0.024	0.22	-	-
July 18, 76	-	-	8.42	105	530	36	33	196	<5	142	0.010	0.88	0.26	0.017	<0.05	0.291	0.001	0.025	0.22	-	-
Aug. 22, 76	50	6.6	9.15	121	440	48	67	115	<5	98	0.005	0.043	<0.05	0.028	<0.02	0.122	<0.005	0.032	0.34	-	-
Aug. 29, 76	43	5.3	9.12	113	440	28	26	135	<5	97	0.005	0.323	<0.05	0.017	<0.02	0.103	0.005	0.030	0.44	-	-
Sept. 5, 76	34	4.3	8.58	109	150	22	9	192	<5	150	0.005	0.020	<0.05	0.031	<0.02	0.033	<0.005	0.039	0.33	-	-
Sept. 12, 76	32	2.8	8.39	96	500	5.1	22	193	<5	158	0.002	0.010	<0.05	0.016	0.01	0.088	0.004	0.032	0.27	-	-
Sept. 19, 76	34	3.1	8.41	101	470	3.9	14.4	174	<5	137	0.001	0.090	<0.05	0.014	0.02	0.090	0.003	0.025	0.12	-	-
Sept. 26, 76	34	3.3	8.42	113	540	3.8	5.8	213	<5	168	0.001	0.005	<0.05	0.014	0.01	0.061	0.003	0.040	0.07	-	-
Oct. 3, 76	30.4	3.3	7.92	98	590	3.0	6.8	245	<5	189	0.002	0.014	<0.05	0.012	0.04	0.066	0.001	0.018	0.08	-	-
Oct. 10, 76	26.4	3.2	8.03	95	550	8.5	26	215	<5	163	0.004	0.087	<0.05	0.022	0.04	0.145	0.001	<0.005	0.23	-	-
Oct. 18, 76	32	2.9	8.28	96	650	22	34	255	<5	215	0.004	0.015	<0.05	0.023	0.04	0.108	0.001	0.006	0.19	-	-
Oct. 25, 76	27	2.7	8.10	97	580	1.9	2.4	240	<5	210	0.007	0.025	<0.05	0.012	0.03	0.061	0.001	0.037	0.01	-	-
Oct. 31, 76	27	2.6	8.08	88	610	9.0	9.6	237	<5	210	0.003	0.016	0.05	0.015	0.02	0.062	0.001	0.022	0.01	-	-
Nov. 7, 76	27	3.0	8.32	103	600	8.3	9.6	237	<5	205	0.005	0.009	0.06	0.014	0.02	0.058	0.002	0.022	0.10	-	-
Nov. 14, 76	29	2.6	8.18	100	510	9.5	11.6	230	<5	163	0.005	0.019	<0.02	0.015	0.02	0.090	0.003	0.017	0.43	-	-
Nov. 21, 76	28	2.5	7.98	101	545	8.6	11.8	230	<5	202	0.002	0.035	<0.02	0.021	0.02	0.152	0.004	0.017	0.34	-	-
Nov. 28, 76	29	2.5	8.32	100	525	18	14.4	215	<5	189	0.012	0.40	<0.02	0.020	0.03	0.150	0.003	0.017	0.42	-	-
Dec. 5, 76	27	2.4	7.77	91	620	7.3	11.0	235	<5	187	0.010	0.020	<0.02	0.020	0.01	0.192	0.001	0.022	0.21	-	-
Dec. 12, 76	24	2.4	8.20	85	480	5.3	7.4	265	<5	193	0.010	0.020	<0.02	0.020	0.01	0.136	0.003	0.040	0.07	-	-
Dec. 19, 76	25	2.4	8.22	93	510	3.3	4.0	235	<5	193	0.010	0.015	<0.02	0.010	0.01	0.148	0.002	0.036	0.06	-	-
Dec. 26, 76	26	2.3	9.00	82	610	2.7	2.8	219	<5	198	0.038	0.01	<0.02	0.016	0.01	0.10	0.002	0.032	0.20	-	-
Jan. 1, 77	25	2.7	9.00	90	610	7.2	10.0	229	<5	195	0.035	0.02	<0.02	0.122	0.01	0.235	0.002	0.023	0.11	-	-
Jan. 30, 77	24	2.3	9.00	80	535	3.1	4.6	239	<5	202	0.034	0.01	<0.02	0.119	0.01	0.078	0.002	0.020	0.07	-	-
Feb. 27, 77	23	2.1	9.00	78	435	0.61	0.6	224	<5	189	0.017	0.02	<0.02	0.019	0.01	0.163	0.003	0.042	0.08	-	-
Mar. 27, 77	24	2.2	-	85	525	2.7	2.8	210	<5	191	0.01	<0.01	0.06	0.020	0.01	0.215	0.009	0.017	0.08	-	-
April 24, 77	23	1.9	-	89	580	5.7	7.0	223	<5	184	0.01	0.02	0.02	0.026	<0.01	0.280	<0.001	0.031	0.10	-	-
May 29, 77	20.2	1.8	9.00	83	530	4.2	6.8	233	<5	188	<0.01	0.06	<0.01	0.02	<0.01	0.104	<0.001	0.007	0.29	-	-
June 26, 77	21.7	2.0	9.00	81	580	2.3	2.8	228	<5	126	<0.01	0.01	0.03	0.014	<0.01	0.131	<0.001	<0.005	0.04	-	-
July 31, 77	18.3	2.2	8.22	76	510	9.8	13.6	252	<5	218	0.001	2.22	0.11	0.025	<0.01	0.242	0.002	<0.002	0.05	-	-
Aug. 31, 77	18	2.0	7.83	75	470	3.1	4.8	229	<5	183	<0.01	0.06	<0.02	0.035	<0.01	0.244	<0.002	0.002	0.05	-	-
Oct. 17, 77	20	1.4	7.90	76	465	0.18	0.6	228	<5	149	<0.005	0.01	<0.02	0.009	<0.05	0.320	<0.005	0.025	0.03	-	-
Oct. 30, 77	20	1.7	8.18	73	490	0.72	1.6	228	<5	191	<0.005	0.02	<0.02	0.015	0.02	0.398	<0.005	0.049	0.01	-	-
Dec. 12, 77	19	2.0	7.98	75	490	0.15	1.4	237	<5	208	<0.005	0.01	<0.02	0.019	<0.02	0.428	<0.005	0.048	0.01	-	-

TABLE 3-7

Dissolved and Extractable Metal Concentrations[a]

Parameter		Mine Water Quality
Suspended solids (mg/l)		2.9
Turbidity (FTU)		1000
pH		8.6
Alkalinity (mg/l as $CaCO_3$)		109
Metals (mg/l)		
Iron	extra	14.3
	diss	0.02
Manganese	extra	0.50
	diss	0.01
Cadmium	extra	0.04
	diss	0.01
Copper	extra	0.05
	diss	0.01
Lead	extra	11.1
	diss	0.05
Zinc	extra	6.30
	diss	0.01

Sample filtered with 0.45μ millipore filter prior to dissolved metals analysis

Extra - extractable
Diss - dissolved

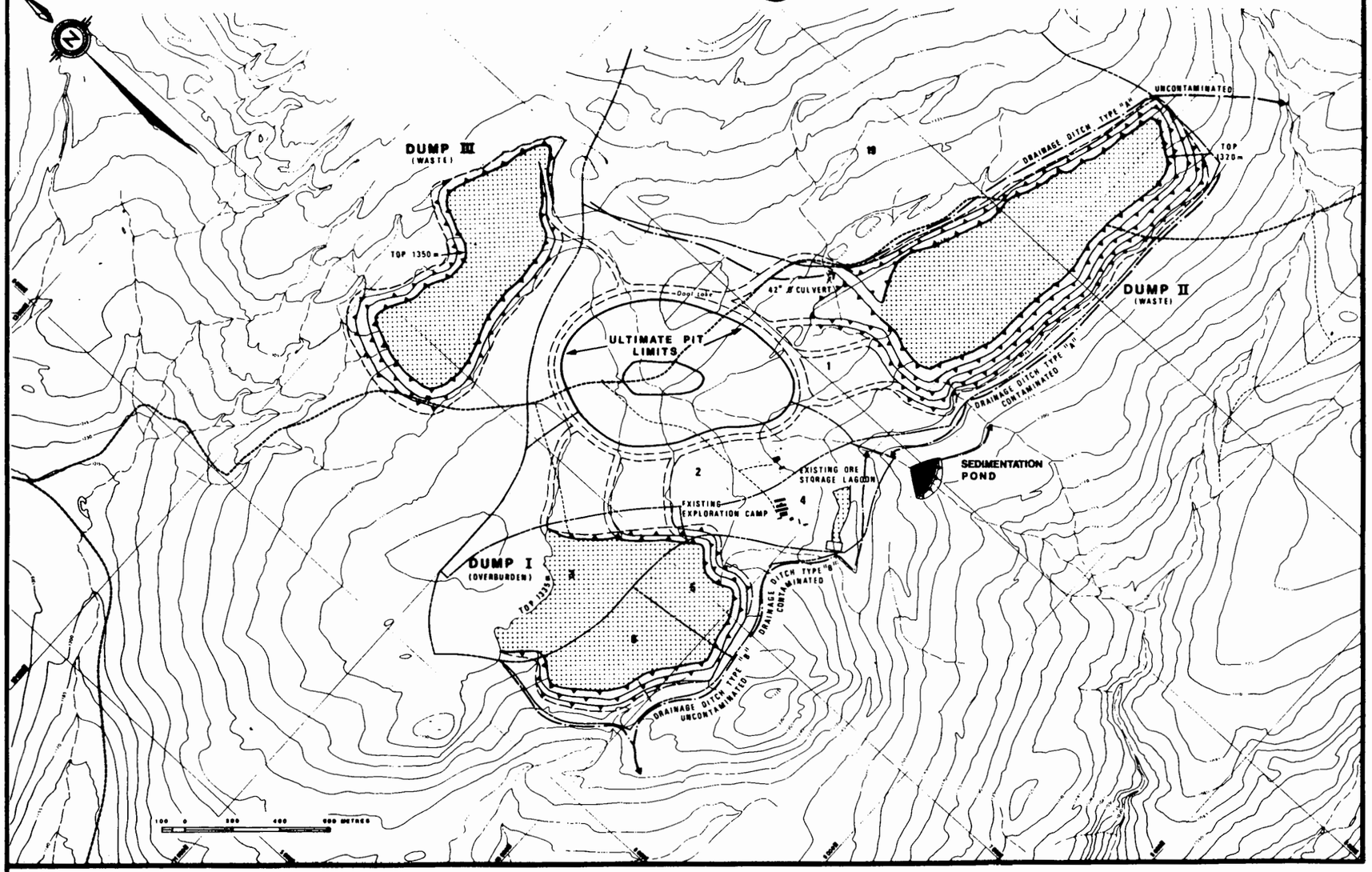
343 SURFACE DRAINAGE

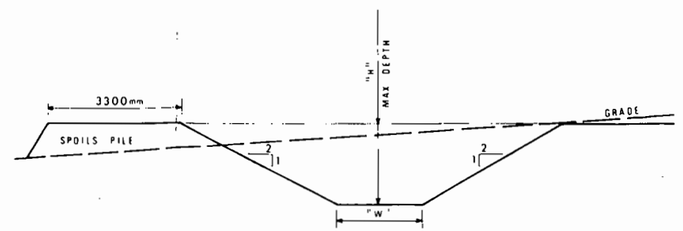
The quantity of uncontaminated surface drainage that contacts the mine site would be minimized by diversion ditches located along the perimeter of the site as shown in Plate 3-2. Surface drainage from the mine site would be anticipated to contain suspended solids and turbidity due to erosion of disturbed areas, in particular the overburden and waste rock dumps.

The waste rock dump would contain some mineralized material and hence drainage from this area could potentially contain extractable concentrations of metals due to the presence of suspended solids and turbidity in the runoff. The overburden dump would contain unmineralized surface material scraped from the pit and waste rock dump areas. This dump would be anticipated to revegetate by natural means within a relatively short period of time, and hence provision for the removal of sediment from the runoff from this area has not been considered. The faces of the overburden dump should be gently graded and if necessary seeded to minimize erosion and loss of sediment.

Thus, surface runoff from the waste rock dump and general mine site active area, located between the overburden and waste rock dumps, would require treatment for the removal of suspended solids and turbidity prior to discharge from the site. The average rate of surface runoff from this area of 290 ha would be approximately 23 l/sec.

montreal engineering company, limited





DESCRIPTION	BOTTOM WIDTH "W"	MAX DEPTH "H"
TYPE "A"	4000mm	1200mm
TYPE "B"	3000mm	1000mm

TYPICAL SURFACE DRAINAGE DITCH
N.T.S

LEGEND:

PROPOSED DRAINAGE DITCH

EXISTING ROAD

DRAINAGE AREA BOUNDARIES

PLATE 3-2
DRAINAGE LAYOUT

3.5 WASTE MANAGEMENT

The general layout of the proposed mine water and surface drainage control scheme with respect to the ultimate open pit and waste dump limits is shown in Plate 3-2. It should be pointed out that there would be some economy in staging the construction of these works. This should be reviewed at the same time that the detailed mine planning is being performed. Uncontaminated drainage would be diverted from the mine site by means of ditching constructed on the perimeter of the open pit and waste dump areas. Surface drainage from the drainage area of approximately 370 ha east of the pit and waste Dumps II and III shown in Plate 3-2 would be diverted around the north side of waste Dump II into Vangorda Creek. Surface drainage from the approximately 28 ha area, south and west of overburden Dump I, would be diverted directly into Vangorda Creek. Drainage from the waste dump area (Dump II, Plate 3-2) and the mining operations area, south of the open pit, would be conveyed into a sedimentation pond for the removal of suspended solids. The diversion and contaminated water ditches would be designed for a peak storm runoff with a return period of 10 years and would be fused to overflow for storm of 1 in 25 year return. The general layout and cross section of the diversion and collection ditches are given in Plate 3-2.

Both mine water and contaminated surface drainage would be discharged into a 0.38 ha sedimentation pond for the removal of suspended solids. While the design of the ditches leading water to this pond is

based on short-duration, high-intensity flood flows as just described, the design of the pond is based on providing adequate detention time for sedimentation and adequate volume for the runoff from a storm of 24 hours duration. For this study the pond was designed to limit the applied overflow rate to 24.5 $m^3/m^2/d$ (0.283 mm/s) for the 24 hour storm runoff with a return period of 10 years. The applied overflow rate under average runoff rates would be approximately 0.52 $m^3/m^2/d$ (0.006 mm/s) in order to ensure efficient removal of suspended solids.

Figure 3-2 shows the drainage pond volume vs. dam volume and height. At the overflow design rate of 24.5 $m^3/m^2/d$ for the 1 in 10 year, 24 hour storm runoff, the pond would have a live storage of approximately 19,000 m^3 at an elevation of 1214.5 m. This would provide an average of 5 hrs detention for the 1 in 10 year, 24 hour storm runoff. The spillway would be located at 1214.5 m elevation and would be sized for the 1 in 25 year return period drainage flow from the overburden and No. II waste dump area. The crest of the dam would be at 1217 m. The spillway would discharge through a sidehill canal, cut in bedrock, to an existing stream bed located approximately 300 m due east of the proposed sedimentation pond. It is recommended that a program of site investigations be carried out for the sedimentation pond to determine the characteristics of the dam foundation.

The mine water would be anticipated to require treatment for the removal of turbidity as well as suspended solids in order to meet effluent criteria for extractable metals concentrations. Treatment, as applied during the underground exploration phase, would involve the addition of flocculant to the mine water prior to discharge into the sedimentation pond. The effectiveness of this method for the removal

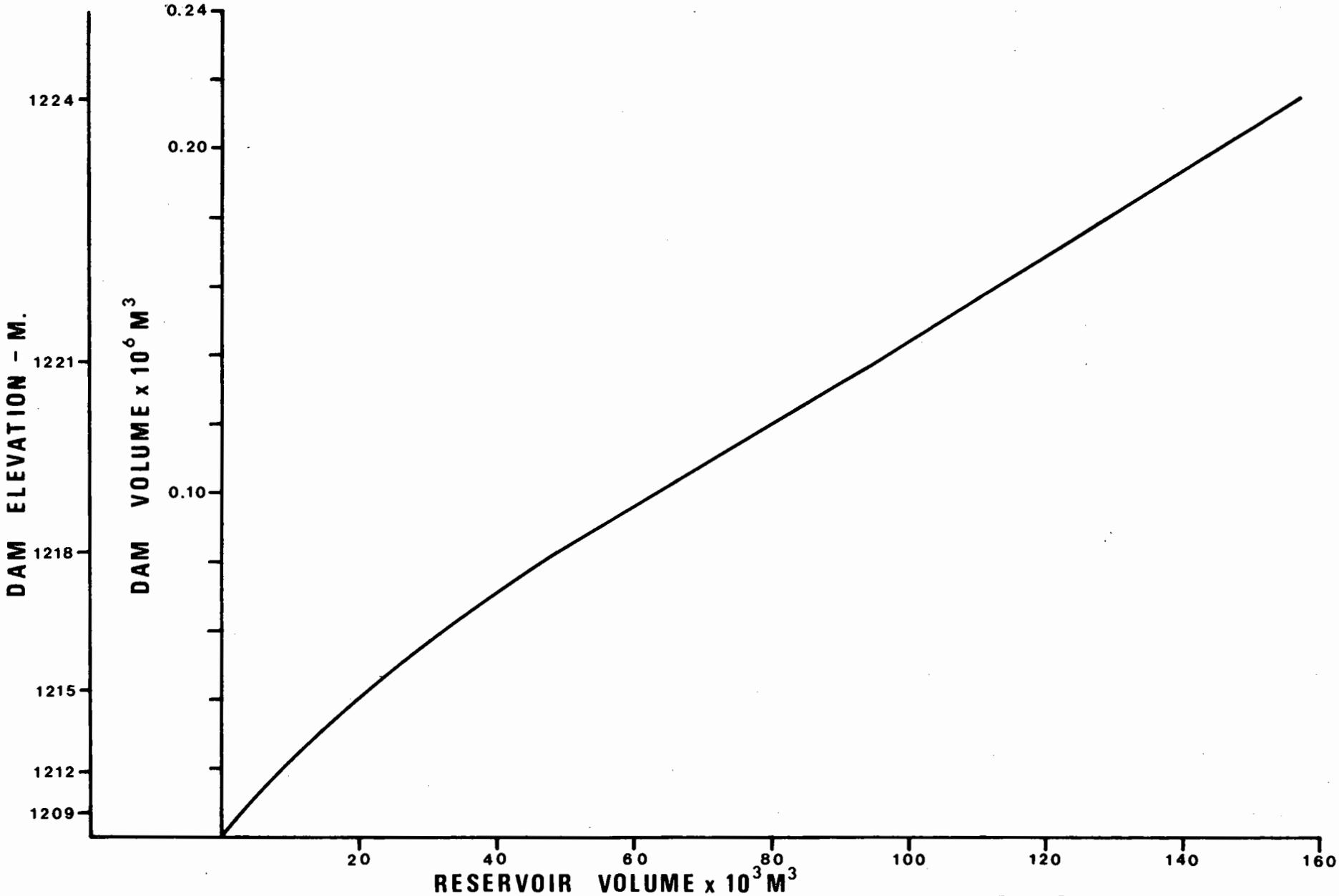


FIGURE 3-2

DRAINAGE POND

RESERVOIR VOLUME VS. DAM VOLUME & HEIGHT

of turbidity and reduction of extractable metal concentrations is indicated by the mine water quality data (Table 3-6) recorded after the month of August, 1976. The flocculant addition system was installed in August, 1976.

Overflow from the sedimentation pond would be discharged into Vangorda Creek. The water of Vangorda Creek, as shown by the water quality data given in Table 3-8 is generally alkaline with pH varying from 6.8 to 8.2 and bicarbonate alkalinity ranging from 83 to 270 mg/l as calcium carbonate. The conductance of this water is similar to that recorded for the mine water during the underground mining phase. Discharge of alkaline overflow from the sedimentation pond would not be expected to alter the chemical quality of water in Vangorda Creek.

However, effective removal of suspended solids and turbidity from the contaminated mine water and surface drainage would be required to minimize the discharge of mineralized particulate into the Creek.

3.6 RECLAMATION OF WASTE DUMPS

Stabilization of dump areas will be required at the completion of mining activity and may also be required during prolonged shutdowns to minimize the potential for adverse environmental effects. Primary concerns with respect to waste dump stabilization would include structural integrity of the dumps, the potential for generation of acidic drainage and contamination of ground and surface water, and reclamation of the

TABLE 3-8

Summary of Existing Water Quality of Vangorda Creek

Parameter	Range
Suspended solids (mg/l)	<1.0-7.6
Turbidity (FTU)	0.2-2.1
Colour (ADHA)	<5-55
pH	6.8-8.2
Conductance (µmho/cm)	18-500
Alkalinity (mg/l as $CaCO_3$)	5.6-143
Hardness (mg/l as $CaCO_3$)	8.3-270

Source: MECo 1977 - Environmental Baseline Investigation - 1976 Program

dump area to an acceptable state. Minimal studies have been performed to date on mine and waste dump reclamation and therefore it is recommended that further studies be performed to determine the optimum way to reclaim the mine, waste dumps, and disturbed areas.

3.7 COST ESTIMATES

To give an order of magnitude of the costs associated with the proposed mine drainage plan an estimate has been produced as shown below. It has been assumed that the cost of dumping mine spoil will be included in the mine planning costs.

Generally the unit prices used are based on contract unit prices for work at Charlot River in northern Saskatchewan. These unit prices have been adjusted where considered necessary to allow for the difference in the volume of work involved at the two sites and for conditions peculiar to the Charlot River site.

The unit prices are estimated contractor's selling price in mid-1979 dollars and are based on the following assumptions:

1. The work will be done as part of a mine development contract and equipment brought in for the mine development contract will be available for the Mine Waste Management work.

2. Work will be done during the summer construction period. No allowance has been made for winter works.

MONTREAL ENGINEERING COMPANY, LIMITED

ESTIMATE OF Cyprus Anvil - Grum Deposit

FILE CAM 7194-4 DATE August 1979 ESTIMATED BY A.H. Somani/I. Jordan PAGE 1 OF 1

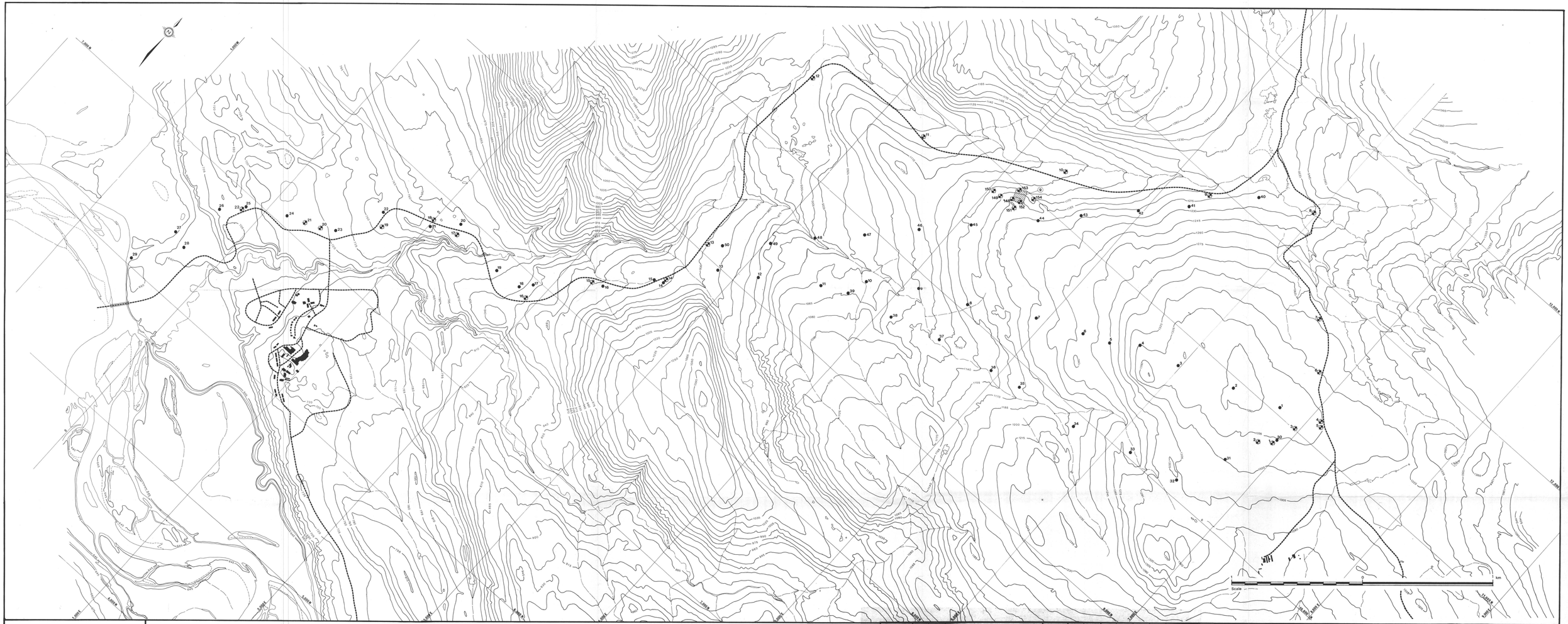
ACCOUNT NO.			DESCRIPTION	UNIT COST	TOTALS IN: DOLLARS	
			SURFACE DRAINAGE POND DAM			
	3500	m^2	Surface Preparation	20.00	70,000	
	20,000	m^3	Borrow Material	5.75	115,000	
						185,000
			MINE WATER TREATMENT			
			Treatment Facility	L.S.	10,000	10,000
			SURFACE DRAINAGE DITCH			
	22,300	m^3	Overburden Excavation Ditch Type 'A'	5.00	111,000	
	2,500	m^3	Rock Excavation Ditch Type 'A'	20.00	50,000	
	7,900	m^3	Overburden Excavation Ditch Type 'B'	5.00	40,000	
	900	m^3	Rock Excavation Ditch Type 'B'	20.00	18,000	
						219,000

MONTREAL ENGINEERING COMPANY, LIMITED

ESTIMATE OF Cyprus Anvil - Grum Deposit

FILE CAM 7194-4 DATE August 1979 ESTIMATED BY R. Hutt/I. Jordan PAGE 1 OF 1

ACCOUNT NO.			DESCRIPTION	UNIT COST	TOTALS IN: DOLLARS	
			SPILLWAY			
	130	m^3	Reinforced concrete	800.00	104,000	
	1500	m^3	Overburden excavation	5.00	8,000	
	3500	m^3	Rock excavation	20.00	70,000	
						182,000
			20% Contingency			119,000
			Total Estimated Cost			715,000



REFERENCE DRAWINGS
0324-001 TAILINGS DISPOSAL SYST. LOCN PLN & SECTIONS
0324-0014 STRATIGRAPHIC PROFILES SHEET 2 OF 2
0324-0015 STRATIGRAPHIC PROFILES SHEET 1 OF 2
0324-0004 GEOTL INVESTIGATION LOCN PLAN SH. 2 OF 2

LEGEND:

- AUGER HOLE
- TEST PIT
- SOURCES OF AGGREGATES (B)

MICROFILM NO.	REV.	DATE	DESCRIPTION	LOC'N	MADE BY	CHK'D BY	CIVIL	ELEC.	MECH.	CONS.	APPR.
							APPROVALS				
	1	14-3-78	SOURCES OF AGGREGATES		T.H.M.	D.L.					
	0	17-2-78	PRELIMINARY		T.H.M.	D.L.					
REVISIONS					ORIGINAL PREPARED IN: MONTREAL						

This reference scale was correct when the original of this work was plotted. If the scale on the image, therefore it can be used as a reference.

SCALE: AS NOTED
DESIGNED: D. LEMELIN
DATE: FEB. 1978
DRAWN: T.H. M'NAUGHTON
DATE: FEB. 1978
SUPV. D.R.J. THOMPSON
DATE: FEB. 1978
PASSED:
DATE:
APPROVED:
DATE:

KERR ADDISON MINES LIMITED
KERR-CNRL GRUM JOINT VENTURE
GEOTECHNICAL INVESTIGATION
LOCATION PLAN
SHEET 1 OF 2
MONTREAL ENGINEERING CO., LTD.

W.O.Nº K,A,M,6,1,6,3,-,0
SYS.Nº 0,3,2,4, ,0,0,1,3,
DWG. Nº X 6,6,8,8,7

Dogi Lake

Shrimp Lake

A — A

B — B

C — C

D — D

E — E

SCALE 1 0 1 km

0324-0016	STRATIGRAPHIC PROFILES SH. 2 OF 2.
0324-0015	STRATIGRAPHIC PROFILES SH. 1 OF 2.
0324-0017	TAILINGS DISPOSAL SYST. LOCN PLN & SECTS.
0324-0013	GEOT. INVESTIGATION LOCN PLN. SH. 1 OF 2

REFERENCE DRAWINGS

LEGEND:

- AUGER HOLE
- TEST PIT
- BOREHOLE
- SOURCES OF AGGREGATES (1)

REVISIONS

MICROFILM NO.	REV.	DATE	DESCRIPTION	LOC'N	MADE BY	CHK'D BY
	1	14-3-78	SOURCES OF AGGREGATES		T.H.M.	D.L.
	0	17-2-78	PRELIMINARY		T.H.M.	D.L.

APPROVALS: CIVIL | ELEC. | MECH. | CONS. | | APPR.

ORIGINAL PREPARED IN MONTREAL

This reference scale bar was measured on the original image. It will scale at the same rate as the image when it can be used as a reference for the original size.

YUKON GEOLOGICAL SURVEY

SCALE: AS NOTED

DESIGNED: J. LEMIEUX
DATE: FEB. 1978

DRAWN: T.H. McLAUGHLIN
DATE: FEB. 1978

SUPV.: DR. W.J. THOMSON
DATE: FEB. 1978

PASSED:
DATE:

APPROVED:
DATE:

KERR ADDISON MINES LIMITED

KERR - CNRL GRUM JOINT VENTURE

GEOTECHNICAL INVESTIGATION
LOCATION PLAN

SHEET 2 OF 2

MONTREAL ENGINEERING CO., LTD.

W.O.Nº K,A,M,6,1,6,3,-,0,

SYS.Nº 0,3,2,4, 0,0,1,4,

DWG.Nº X 6,6,8,8,8,

APPENDIX A

LABORATORY TEST RESULTS

FOR BOREHOLE SAMPLES AT THE PROPOSED OPEN PIT MINE SITE

Montreal Engineering - Kerr Addison Mines

Moisture Content Determination

Samples Received August 31/77

Bore Hole	Sample Type	Bottom Depth (m)	Moisture Content (%)	Comments
BH-77-1	SS-1	1.77	11.0	
	SS-2	2.71	14.3	
	SS-3	3.96	11.8	
	SS-4	5.40	10.7	
	SS-7	9.05	8.0	
	SS-8	10.76	8.1	
	SS-9	13.90	10.0	
	SS-11	17.16	9.5	
	SS-12	19.45	10.3	
	SS-18	28.87	10.6	
	SS-19	31.95	10.0	
	SS-21	37.23	1.6	
	DC-22	38.17	1.7	
BH-77-12	SS-1	1.28	6.2	Sand
	SS-3	2.80	12.3	
	SS-5	5.12	9.6	
	SS-6	6.55	8.8	
	SS-7	8.35	13.1	
	SS-9	10.88	15.1	
	SS-10	13.17	11.1	
	SS-12	16.07	16.8	
	SS-13	18.05	16.4	
	SS-14	20.34	16.0	
	SS-15	22.84	20.9	
	SS-20	29.18	9.3	
	SS-22	32.47	11.1	
	SS-23	34.45	10.7	
	SS-24	36.74	11.8	
	SS-29	40.88	11.2	
BH-77-13	SS-1	1.31	5.0	Sand
	SS-2	2.59	15.7	
	SS-3	4.36	13.0	
	SS-6	7.59	11.8	
	SS-7	9.76	14.8	
	SS-8	11.89	11.3	
	SS-9	14.18	12.4	
	SS-10	16.10	13.3	
	SS-11	18.05	11.1	
	SS-12	20.30	17.2	
	SS-15	24.18	11.2	
	SS-16	26.16	10.4	
	SS-17	27.77	11.1	

.....2

Bore Hole	Sample Type	Bottom Depth (m)	Moisture Content (%)	Comments
BH-77-13 (Cont'd)	SS-18	30.18	10.7	
	SS-19	32.13	10.9	
	SS-20	34.30	8.9	
	SS-21	36.77	9.8	
	SS-22	39.60	9.8	
	SS-23	42.35	10.3	
	SS-24	44.27	10.6	
	SS-25	46.92	6.9	
	SS-26	48.75	8.1	
	SS-31	53.87	10.0	
	SS-33	55.70	10.9	
	SS-35	57.53	10.7	
	SS-37	59.54	8.8	

Results

A. Unit Weight

Bore Hole	Sample	Depth (m)	Wet Unit Wt. (t/m^3)	Dry Unit Wt. (t/m^3)	Moisture Content (%)
BH 77-12	SS-20	28.69-29.18	2.34	2.15	8.6
BH 77-13	SS-8	11.43-11.89	2.32	2.10	10.7
	SS-15	23.72-24.18	2.44	2.23	9.2
	SS-20	33.87-34.30	2.36	2.18	8.5
	SS-35	57.13-57.53	2.35	2.15	9.2

B. Atterberg Limits

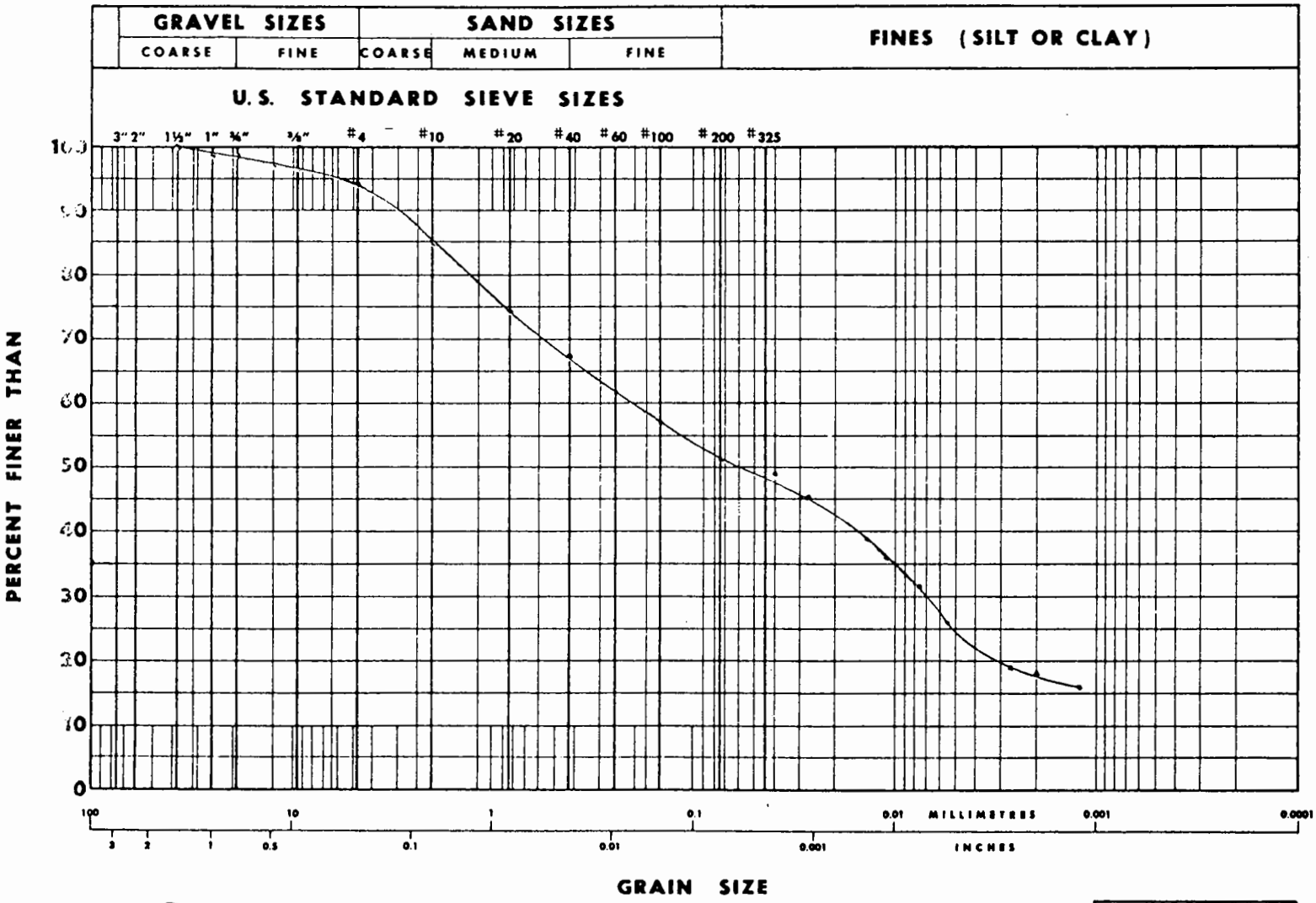
Bore Hole	Sample	Depth (m)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
BH 77-12	SS-3	2.50-2.80	25.8	15.5	10.3
	SS-9	10.40-10.88	36.2	21.3	14.9
	SS-24	36.16-36.74	25.2	15.6	9.6
BH 77-13	SS-2	1.98-2.59	28.9	15.4	13.5
	SS-8	11.43-11.89	33.5	17.0	16.5
	SS-15	23.72-24.18	27.4	15.4	12.0

GU202-0373

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S-2687
CLIENT B-4017
SAMPLE SEE REMARKS
SOURCE
HOLE BH77-1 DEPTH
DATE REC'D.
TECHNICIAN
DATE TESTED



REMARKS: COMBINED BH77-1 SS-1 @ 1.77 m
" SS-2 @ 2.71
" SS-3 @ 3.96

D_{10} = _____ mm.
D_{30} = _____ mm.
D_{60} = _____ mm.
C_u _____
C_c _____

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

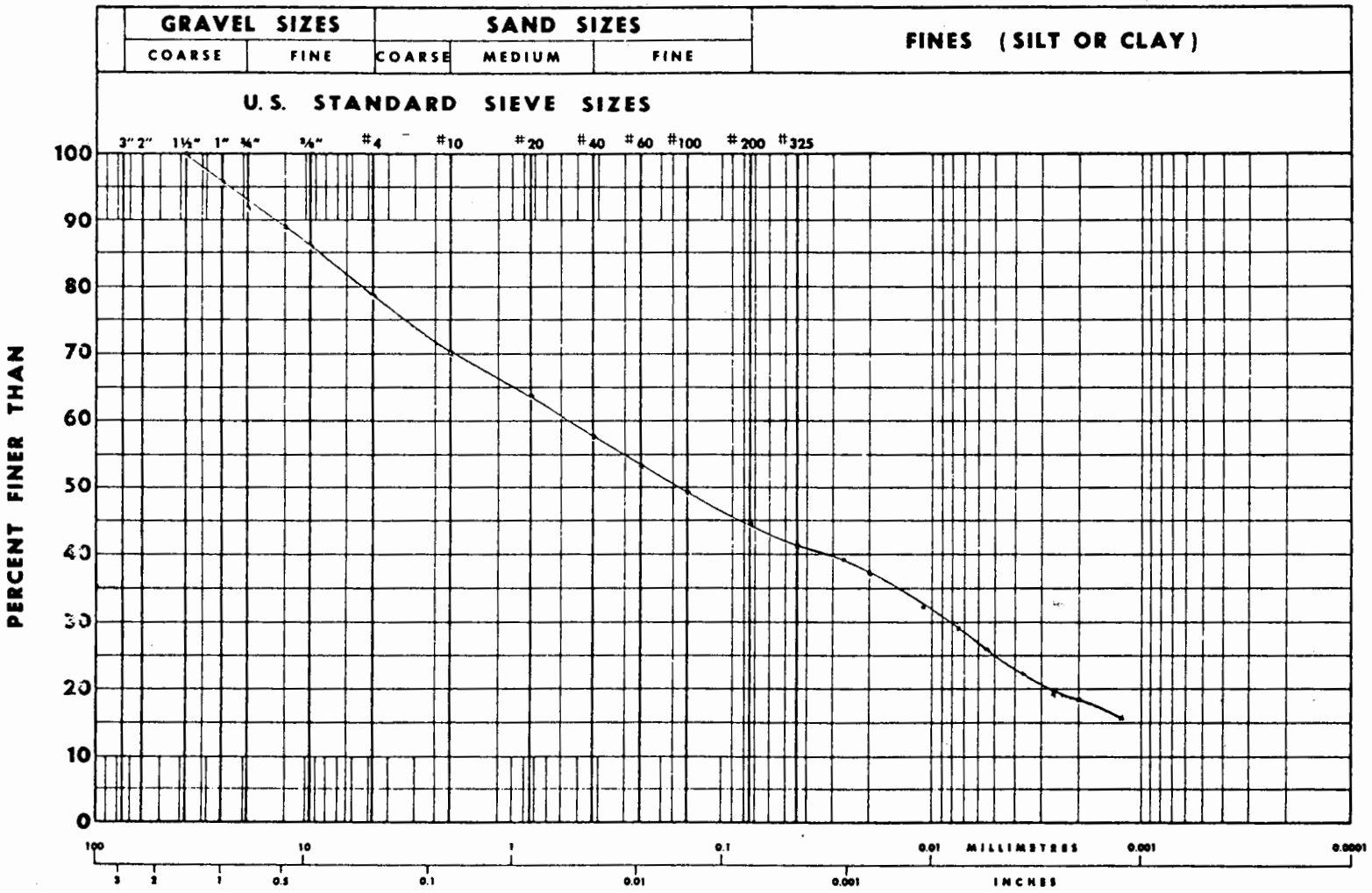
PLATE 1

J202-0373

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S-7687
CLIENT B-4017
SAMPLE SEE REMARKS
SOURCE
HOLE BH77-1 DEPTH DATE REC'D.
TECHNICIAN GFHH DATE TESTED 3/10/77



REMARKS: Combined BH77-1 SS-7 @ 9.05 m
SS-8 @ 10.76
SS-9 @ 13.90

D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_U _____
C_C _____

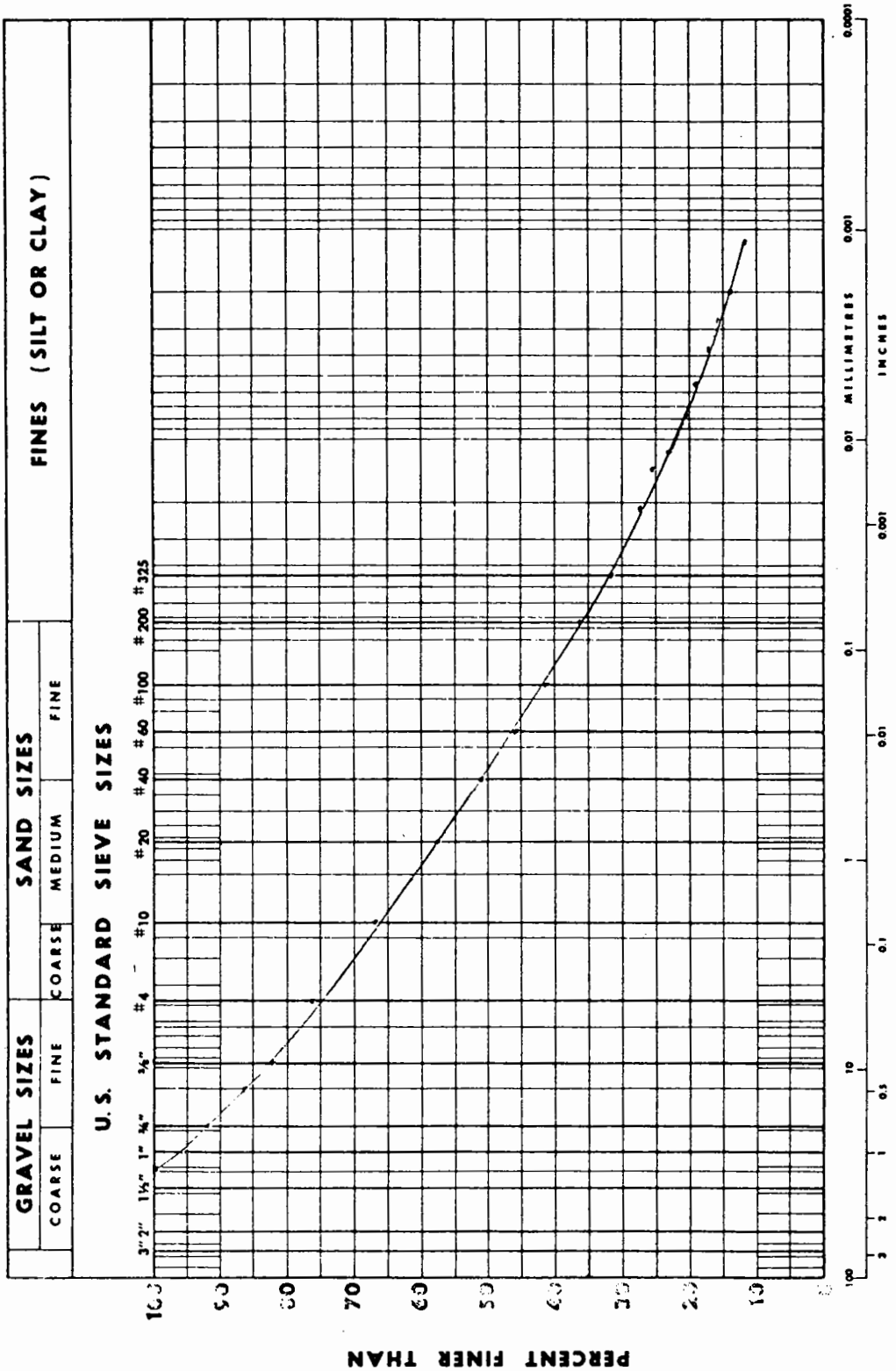
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

2

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO.	S-7687
CLIENT	B-4017
SAMPLE	SEE REMARKS
SOURCE	
HOLE DEPTH	DATE REC'D.
TECHNICIAN HH	DATE TESTED 4/10/77



D_{10} = ____ MM.
D_{30} = ____ MM.
D_{60} = ____ MM.
C_u = ____
C_c = ____

GRAIN SIZE

REMARKS: COMBINE: BH77-1 SS 18 @ 28.32 - 28.87
SS 19 @ 31.46 - 31.95

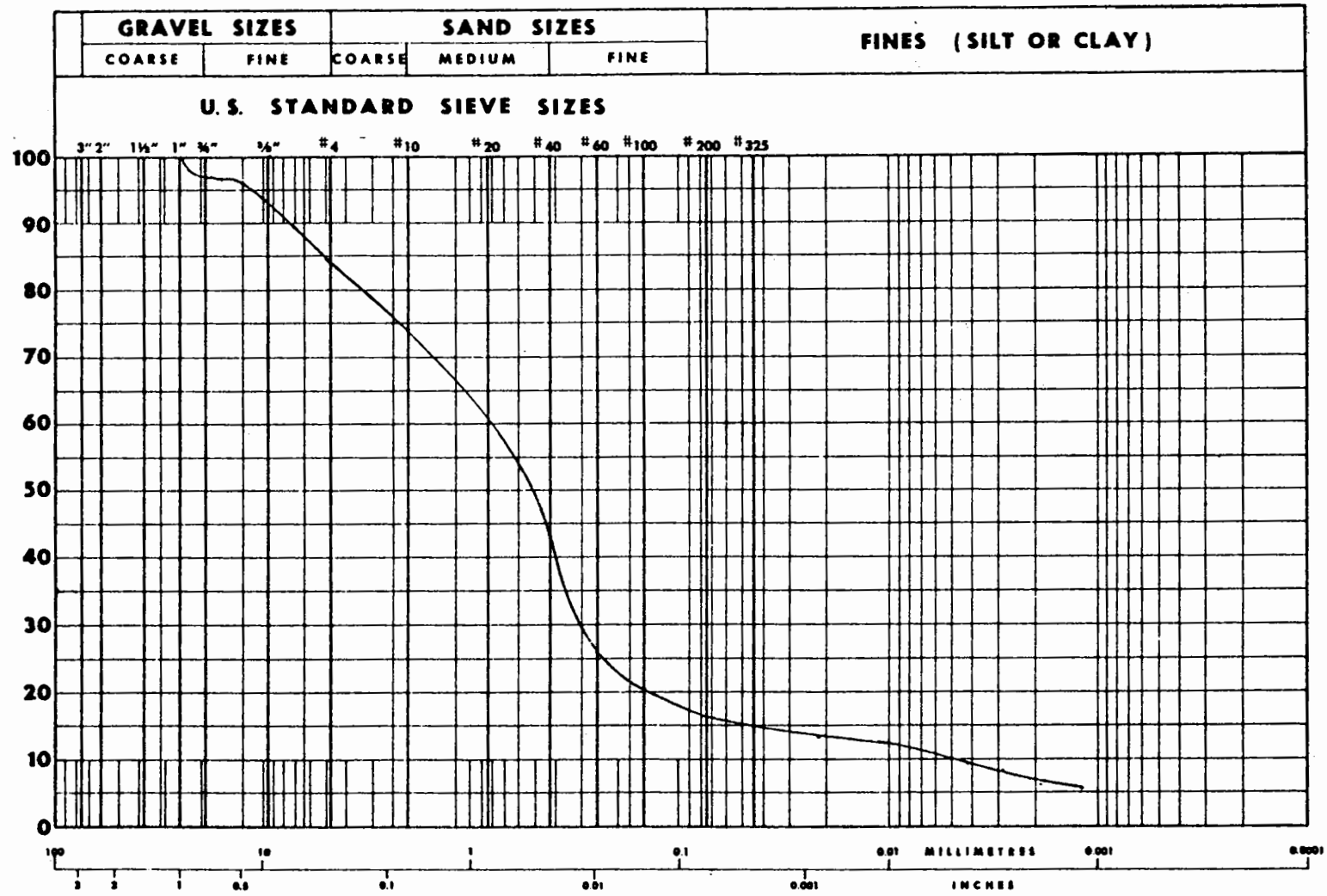
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 3

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. 52781
CLIENT B4017
SAMPLE SS-1
SOURCE BH77-12
HOLE DEPTH 0.67 - 1.28
TECHNICIAN AC/AD DATE TESTED 6/11/77



REMARKS: _____

D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_U = _____
C_C = _____

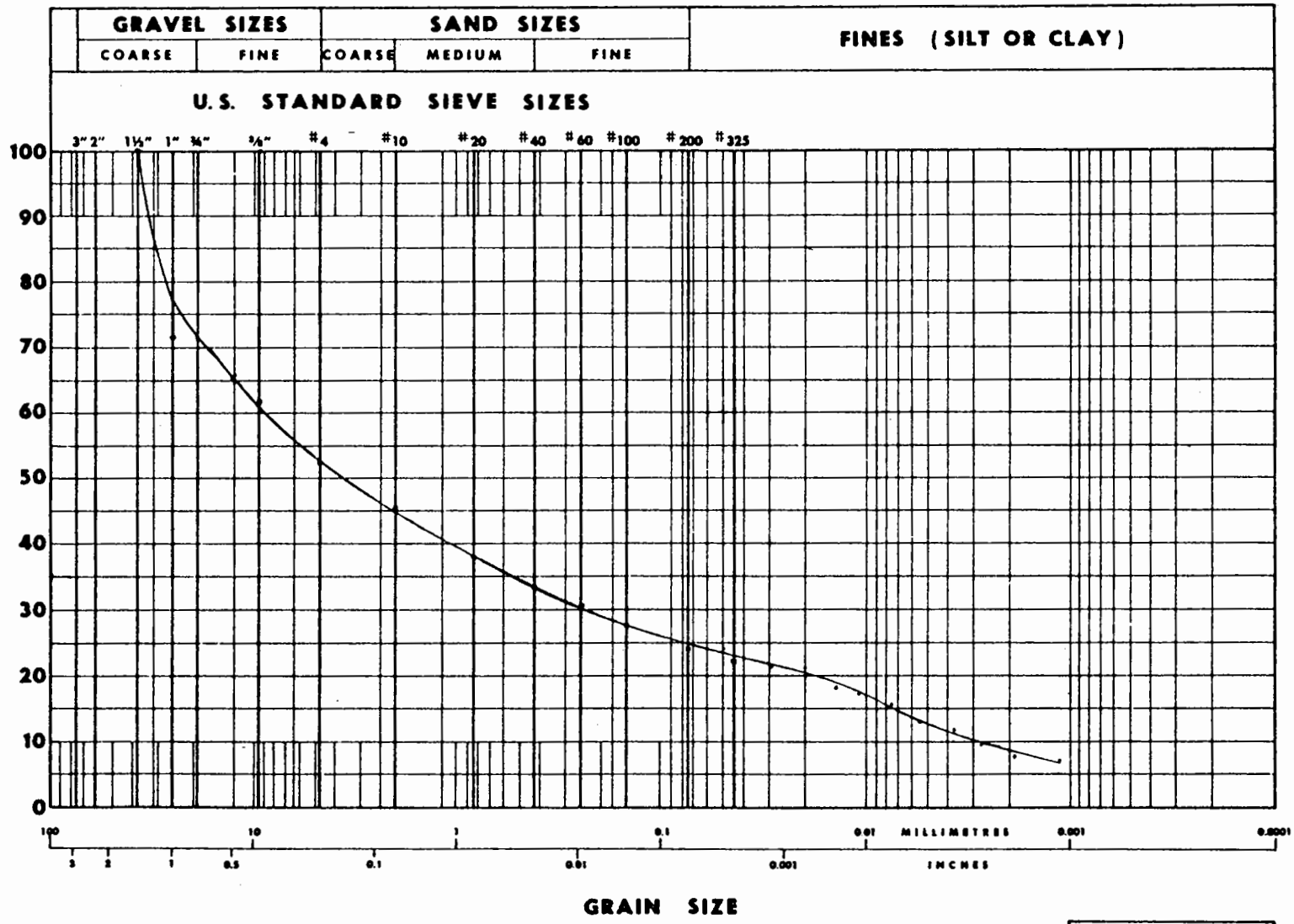
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 1

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S-2781
CLIENT B-4017
SAMPLE SS-3
SOURCE
HOLE BH77-12 DEPTH 2.50 - 2.80
TECHNICIAN AC Exp AD DATE TESTED NOV 16 77

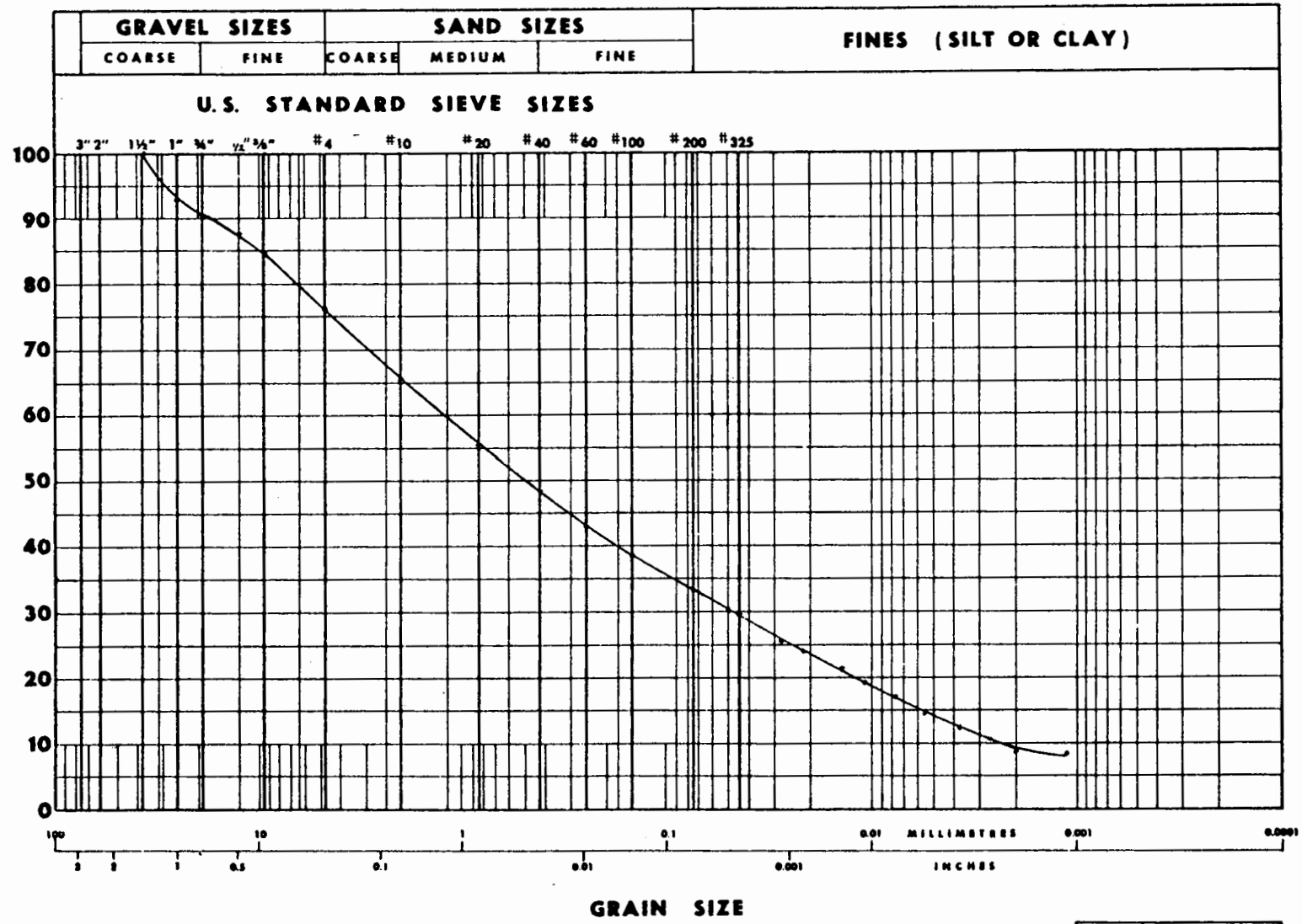


REMARKS: _____

D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_U _____
C_C _____

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 2



REMARKS: ss #5 @ 4.66 - 5.12 m
6 @ 5.95 - 6.55
7 @ 7.44 - 8.35

D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_U = _____
C_C = _____

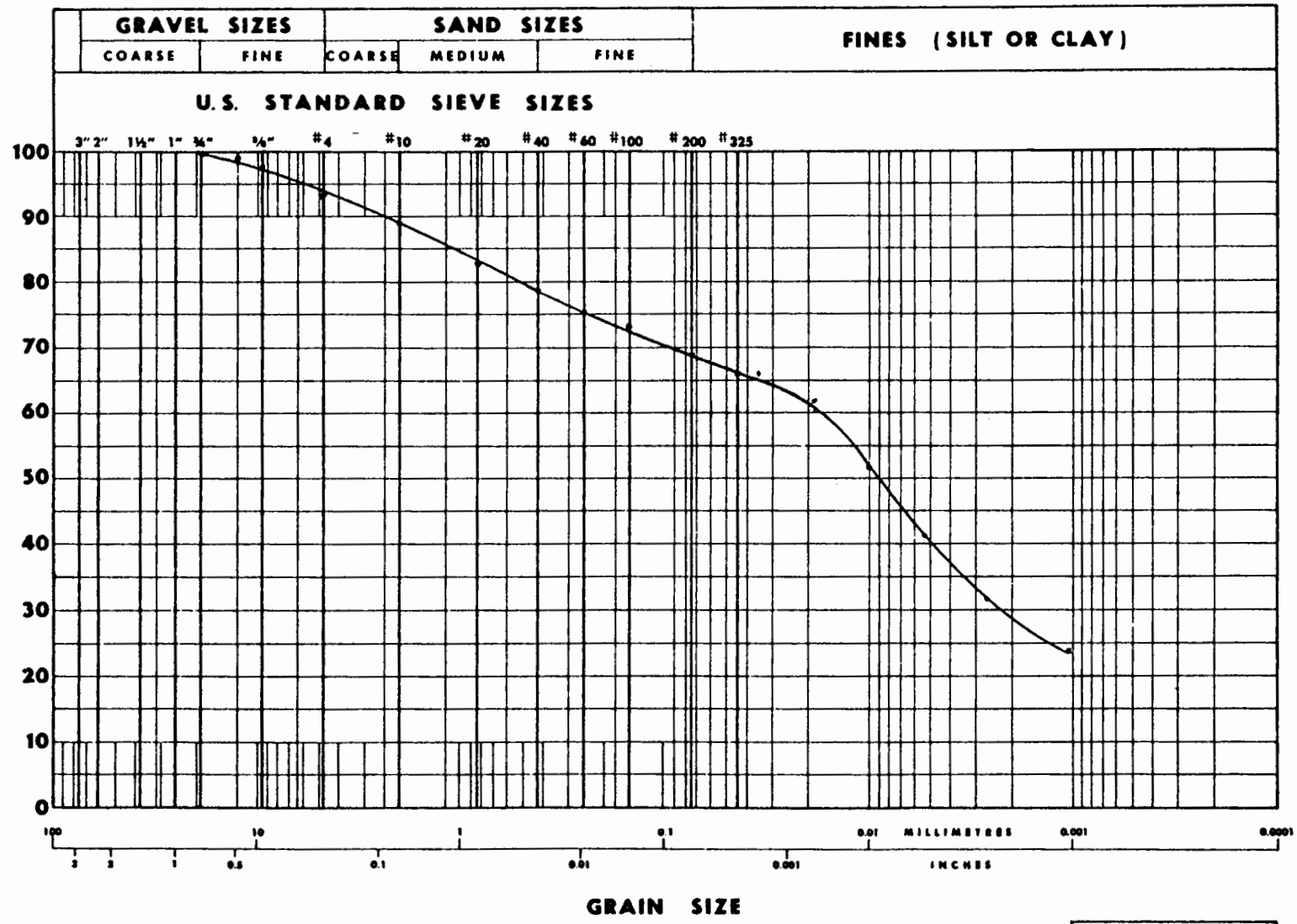
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 3

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S2781
CLIENT B4017
SAMPLE SEE REMARKS
SOURCE
HOLE BH 77-12 DEPTH DATE REC'D.
TECHNICIAN FJ/HH DATE TESTED NOV. 28/77



REMARKS: COMBINED SAMPLE:

(1) SS#9 @ 10.40 - 10.88 m

(2) SS#10 @ 12.56 - 13.17

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

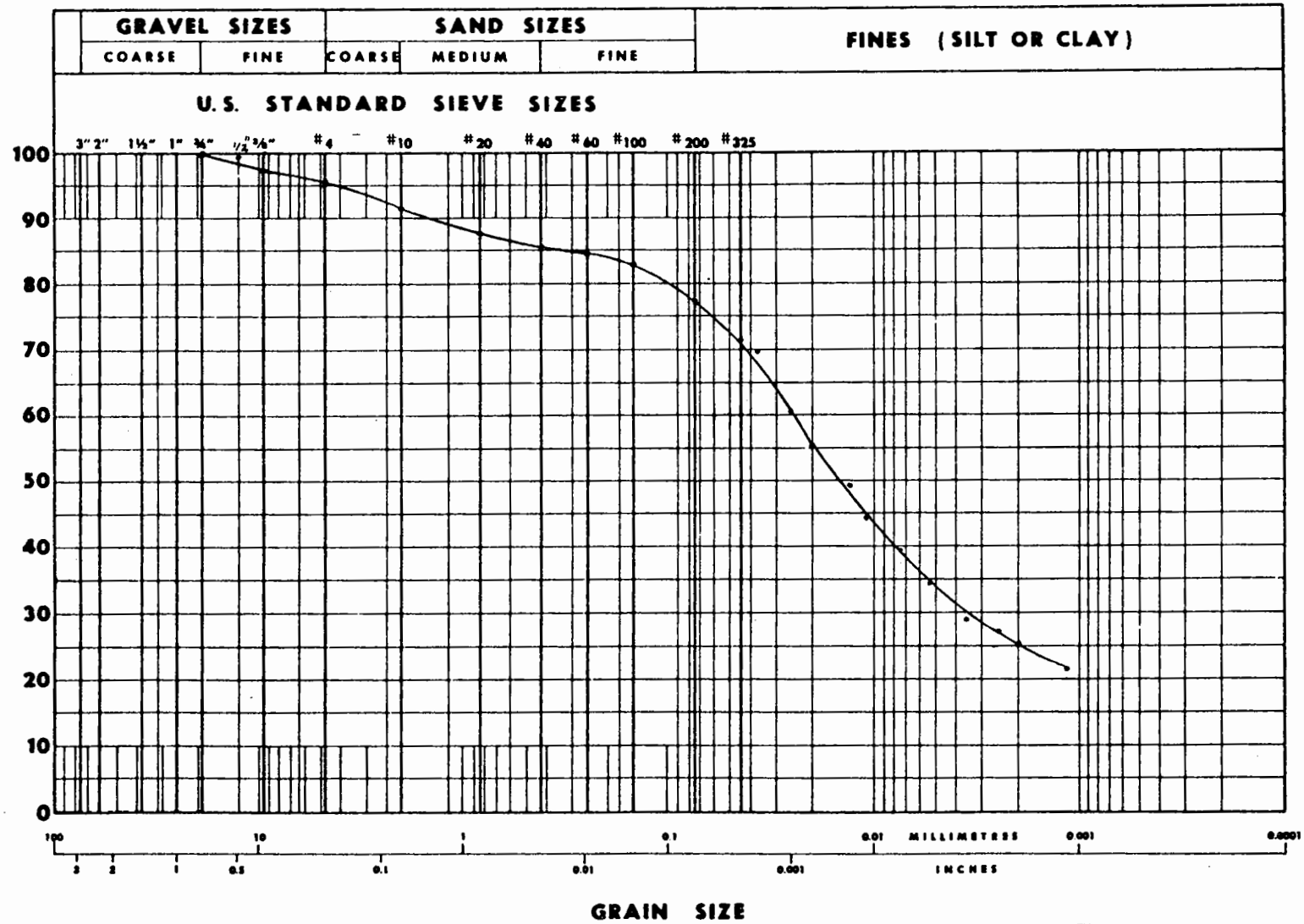
D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_U _____
C_C _____

PLATE 4

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S-2781
CLIENT B4017
SAMPLE SEE REMARKS
SOURCE BH 77-12
HOLE DEPTH DATE REC'D.
TECHNICIAN GF DATE TESTED 25/11/77



REMARKS: SS-12 @ 15.52 - 16.07 m
SS-13 @ 17.53 - 18.05
SS-14 @ 19.94 - 20.34 COMBINED SAMPLE
SS-15 @ 22.50 - 22.84

D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_U _____
C_C _____

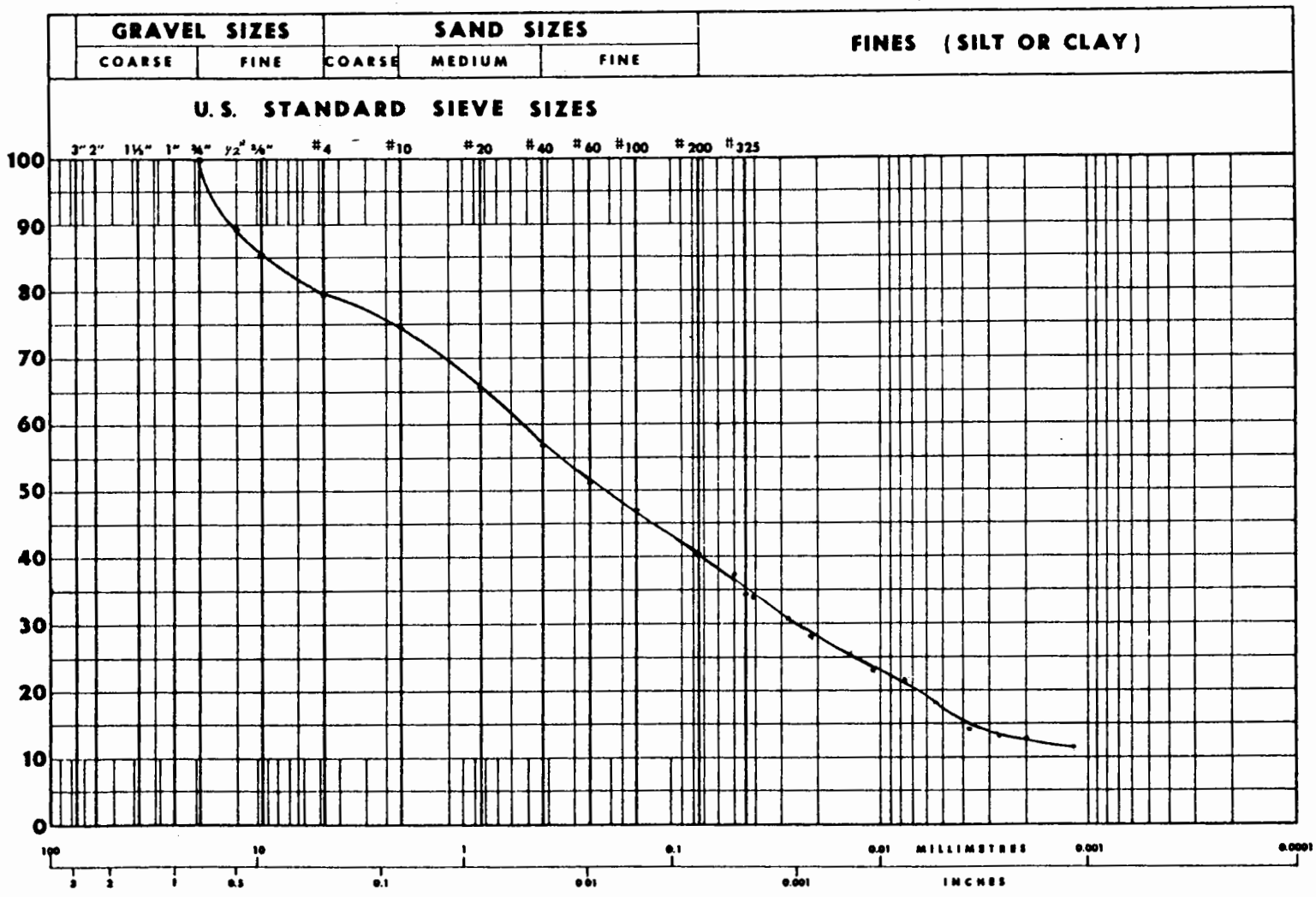
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 5

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S-2781
CLIENT B 4017
SAMPLE SEE REMARKS.
SOURCE
HOLE BH77-12 DEPTH DATE REC'D.
TECHNICIAN FJ/HH DATE TESTED NOV. 28/77



REMARKS: COMBINED SAMPLE:

SS-20 @ 28.69 - 28.69 - 29.18m

SS-22 @ 31.86 - 32.47

SS-23 @ 33.84 - 34.45

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_U _____
C_C _____

PLATE 6

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S 2781
CLIENT B 4017
SAMPLE SEE REMARKS.
SOURCE BH 77-12
HOLE DEPTH DATE REC'D.
TECHNICIAN FJ/HH DATE TESTED Nov. 28/77

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO.	S-2781
CLIENT	B-4017
SAMPLE	SS-24
SOURCE	BH77-12
HOLE DEPTH	36.16 - 36.74
TECHNICIAN AC	CK'D. DATE TESTED NOV 16, 1977

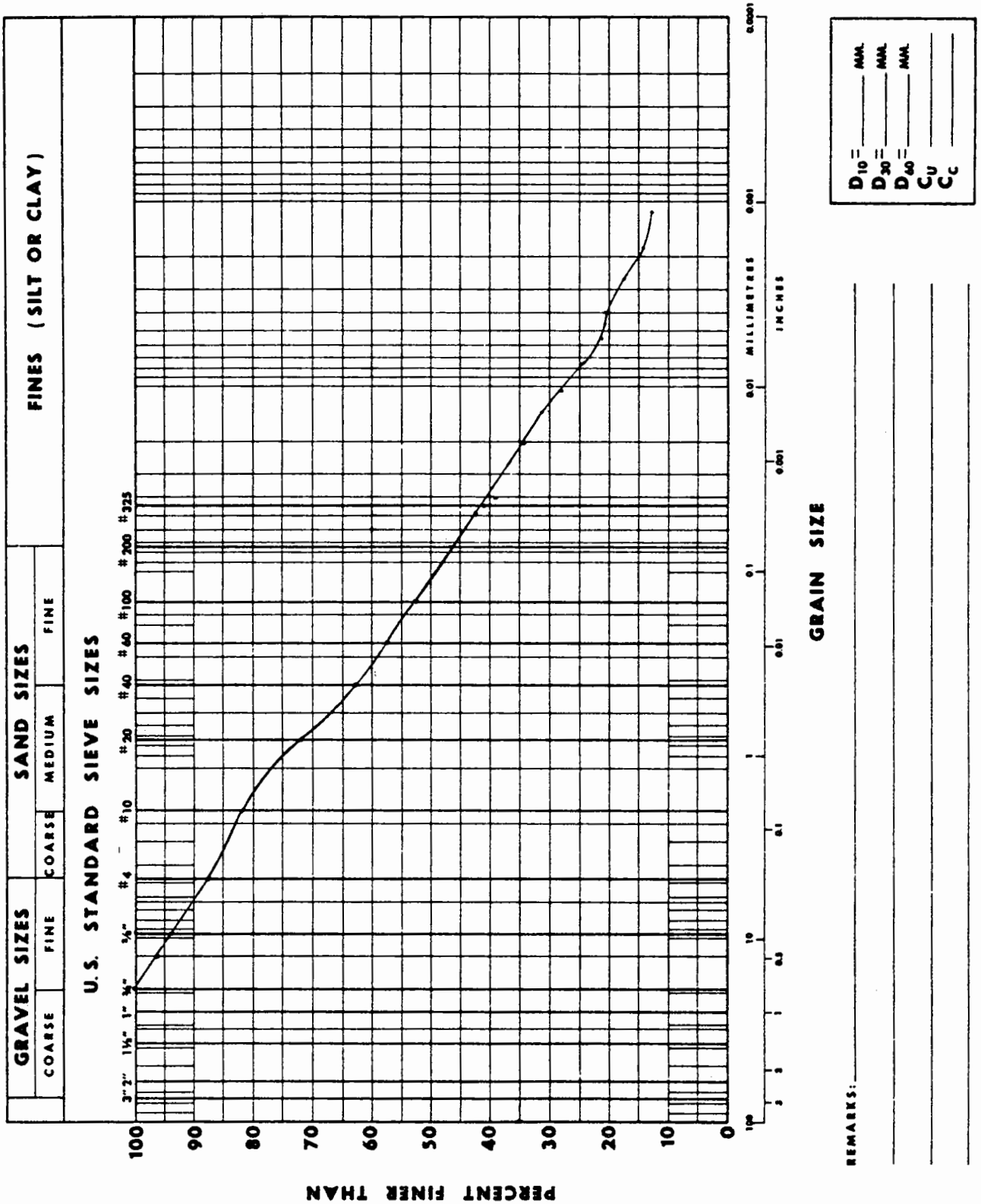


PLATE 7

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO.	S-2781
CLIENT	B-4017
SAMPLE	SS-29
SOURCE	BH77-12
HOLE DEPTH,	40.49 - 40.88
TECHNICIAN AD	DATE TESTED 17/11/77

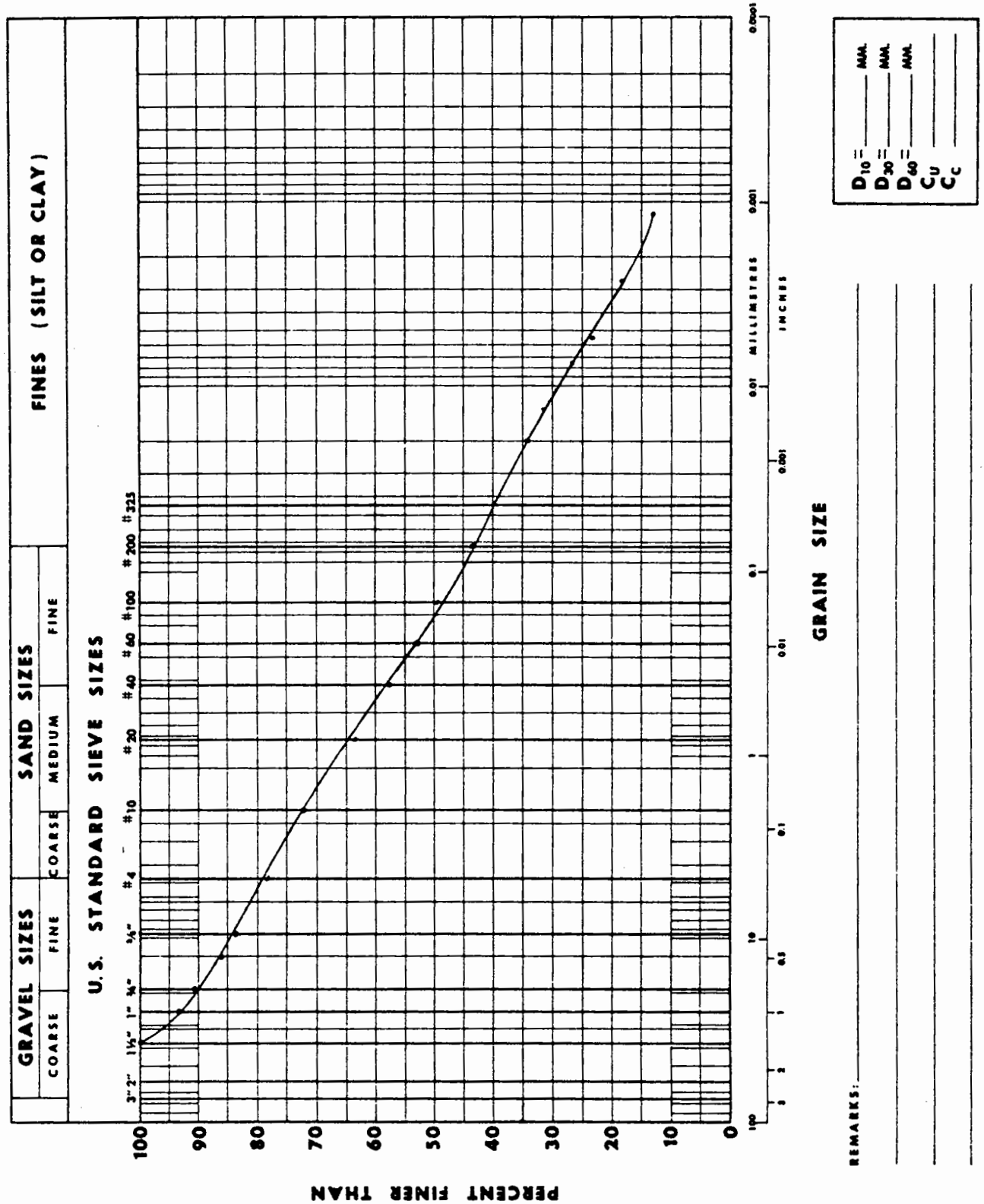
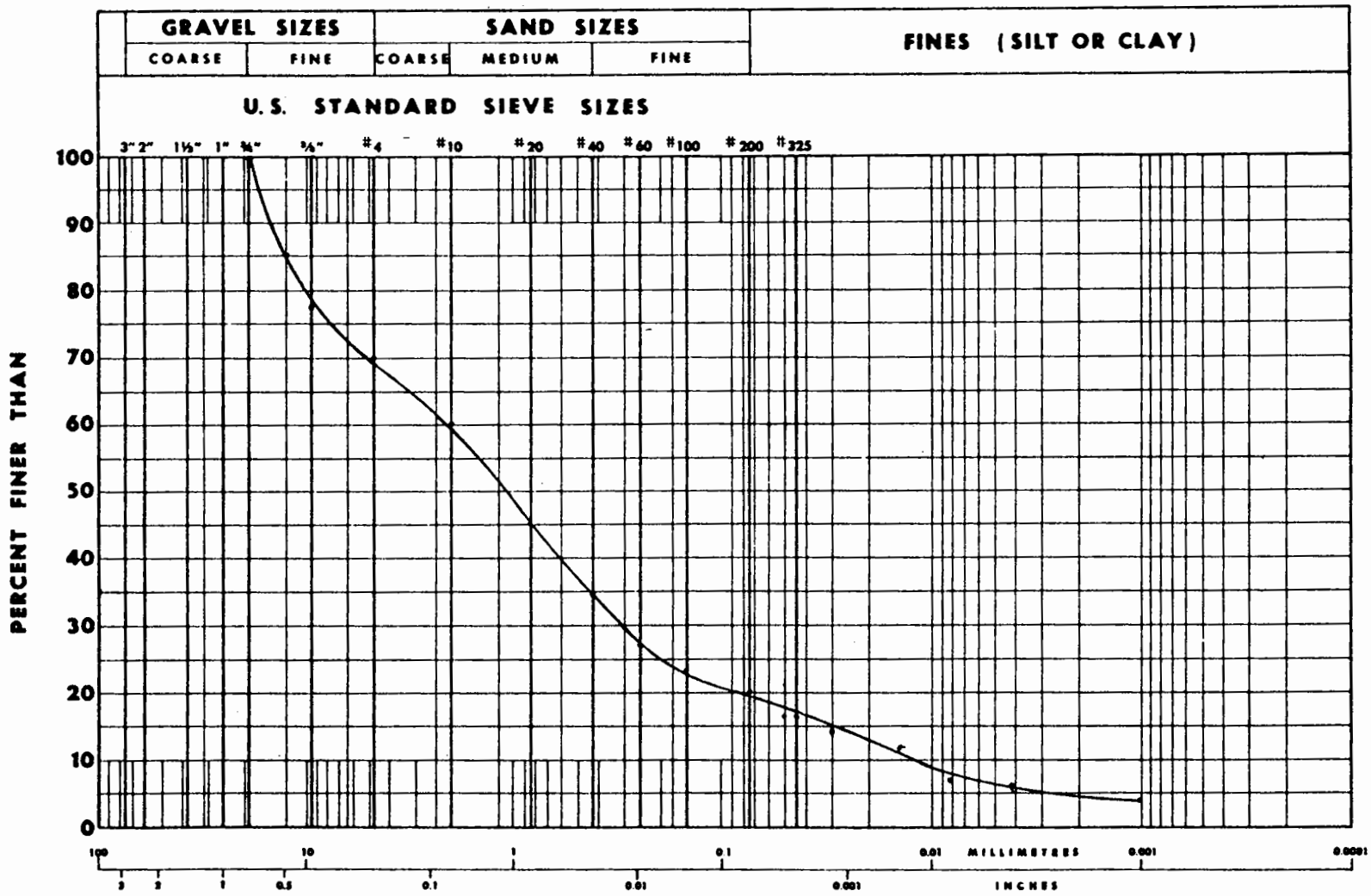


PLATE 8

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S-2781
CLIENT B4017
SAMPLE SS#1
SOURCE BH77-13
HOLE DEPTH 0.70 - 1.31
TECHNICIAN GF DATE TESTED 25/11/77

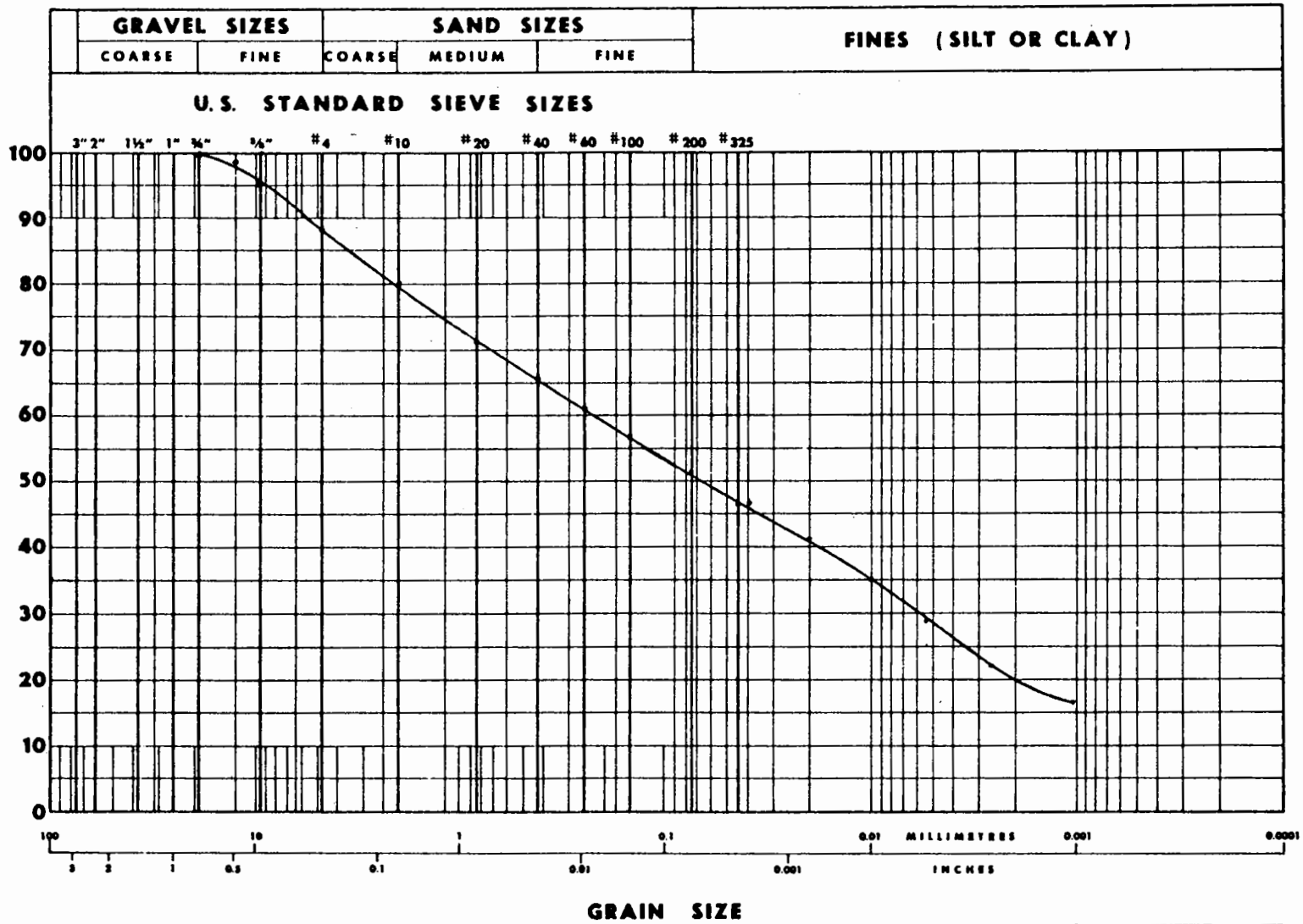


D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_u _____
C_c _____

REMARKS: _____

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 9



REMARKS: COMBINED SAMPLE;

(1) 55# 2@ 2.59 PL

(2) 55# 3@ 4.36

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_U _____
C_C _____

PLATE 10

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S-2781
CLIENT B4017
SAMPLE SEE REMARKS
SOURCE B77-13
HOLE DEPTH DATE REC'D.
TECHNICIAN GF DATE TESTED 25/11/77

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. 52781
CLIENT B4017
SAMPLE SS-6
SOURCE BH 77-13
HOLE DEPTH 7.13 - 7.59
TECHNICIAN GF/AD/NS DATE TESTED 7/11/77

GRAVEL SIZES		SAND SIZES			FINES (SILT OR CLAY)
COARSE	FINE	COARSE	MEDIUM	FINE	

U.S. STANDARD SIEVE SIZES

3" 2" 1½" 1" ¾" ⅜" #4 #10 #20 #40 #60 #100 #200 #325

PERCENT FINER THAN

100 90 80 70 60 50 40 30 20 10 0

100 10 1 0.1 0.01 MILLIMETRES 0.001 0.0001

3 2 1 0.5 0.1 0.01 0.001 INCHES

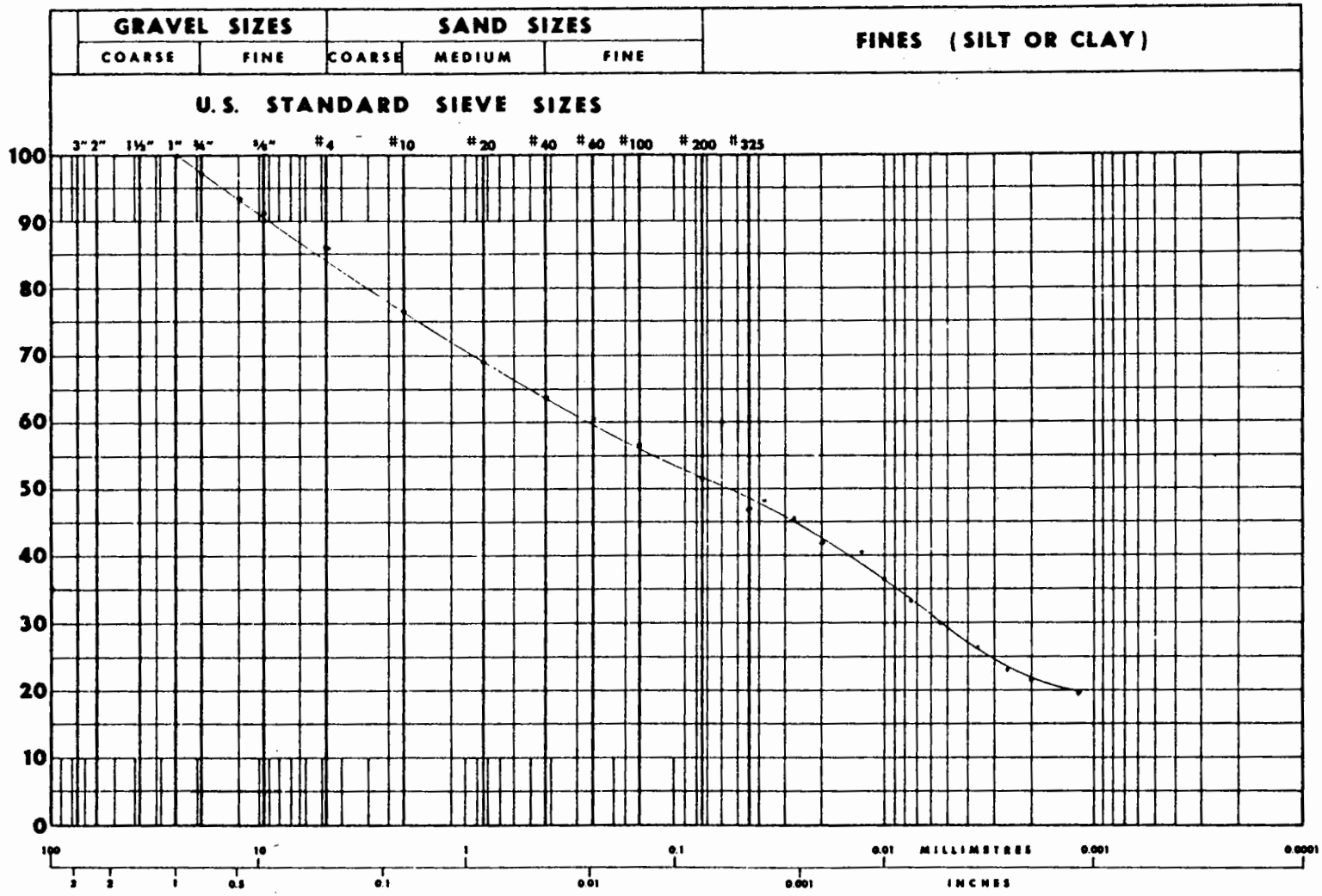
GRAIN SIZE

REMARKS: _____

D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_U = _____
C_C = _____

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 11



REMARKS: COMBINED SAMPLE SS7 @ 9.30-9.76m.
SS8 @ 11.43-11.89
SS9 @ 13.57-14.18

D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_U _____
C_C _____

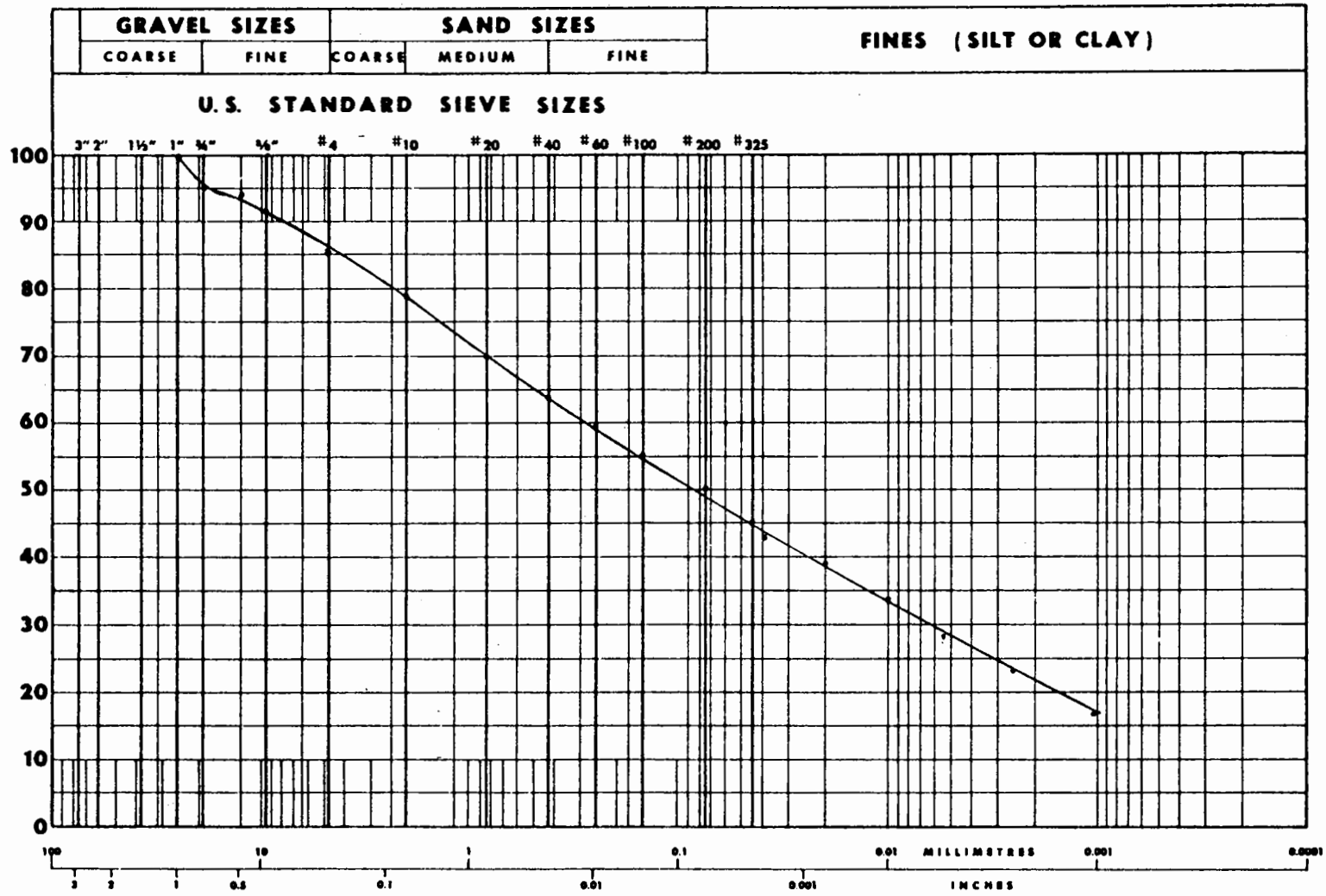
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 12

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. R 4017
CLIENT S 2781
SAMPLE SEE REMARKS
SOURCE BH77-13
HOLE DEPTH DATE REC'D.
TECHNICIAN AD:HH DATE TESTED Nov 23/77



REMARKS: COMBINED SAMPLE:

(1) SS#10 @ 15.49 - 16.10 m

(2) SS#11 @ 17.44 - 18.05

(3) SS#12 @ 19.70 - 20.30

D_{10} = _____ mm

D_{30} = _____ mm

D_{60} = _____ mm

C_U _____

C_C _____

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 13

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S-2781
CLIENT B4017
SAMPLE SEE REMARKS
SOURCE BH77-13
HOLE DEPTH DATE REC'D.
TECHNICIAN GF DATE TESTED 25/11/77

R.M. HARDY & ASSOCIATES LTD.

CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S-2781

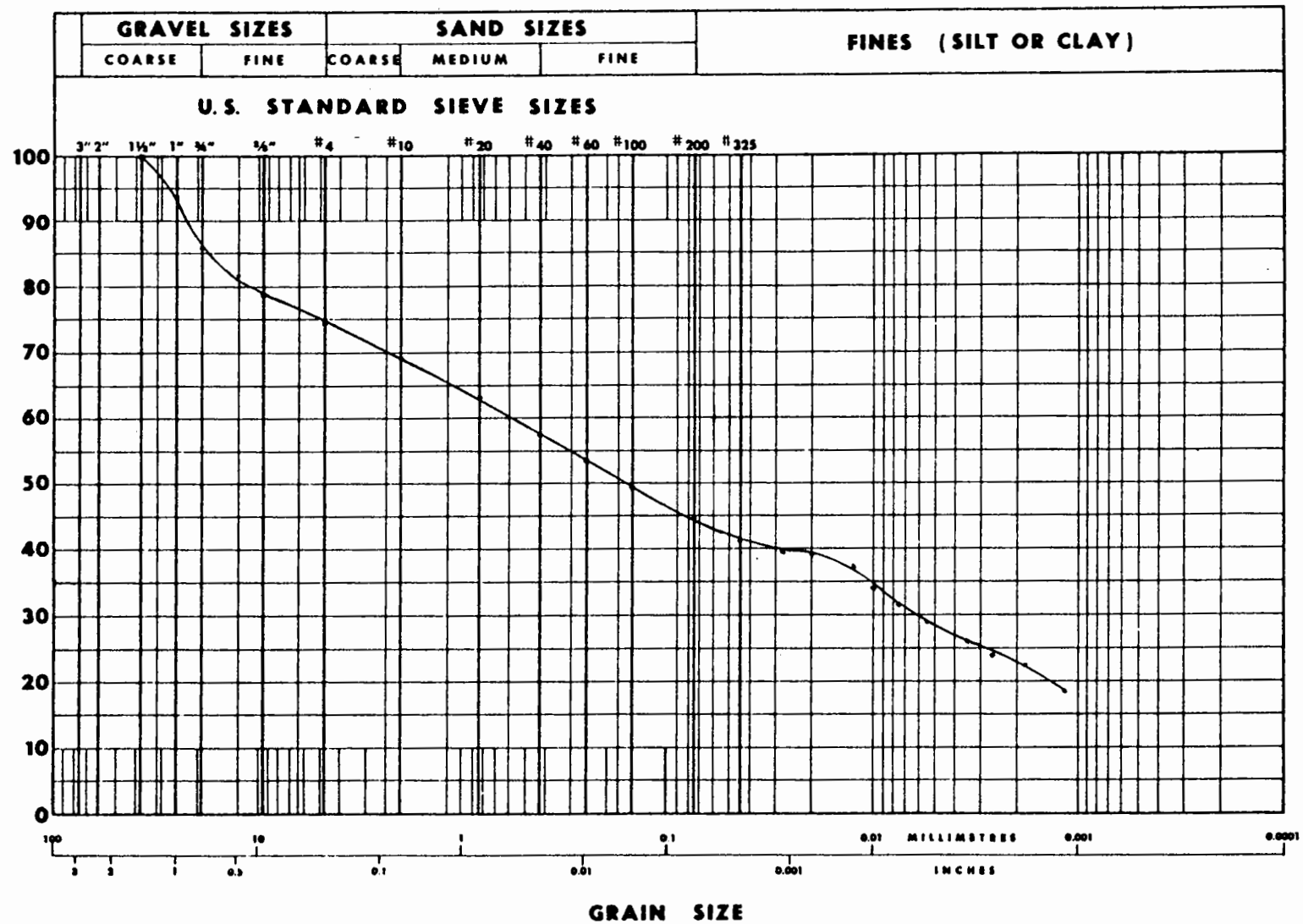
CLIENT B-4017

SAMPLE SEE REMARKS

SOURCE

HOLE BH77-13 DEPTH DATE REC'D.

TECHNICIAN HH CKD'D. DATE TESTED 17/11/77



REMARKS: SS-15 23.72 - 24.18 m

SS-16 25.70 - 26.16

COMBINED SAMPLE

D_{10} = _____ MM.

D_{30} = _____ MM.

D_{60} = _____ MM.

C_U _____

C_C _____

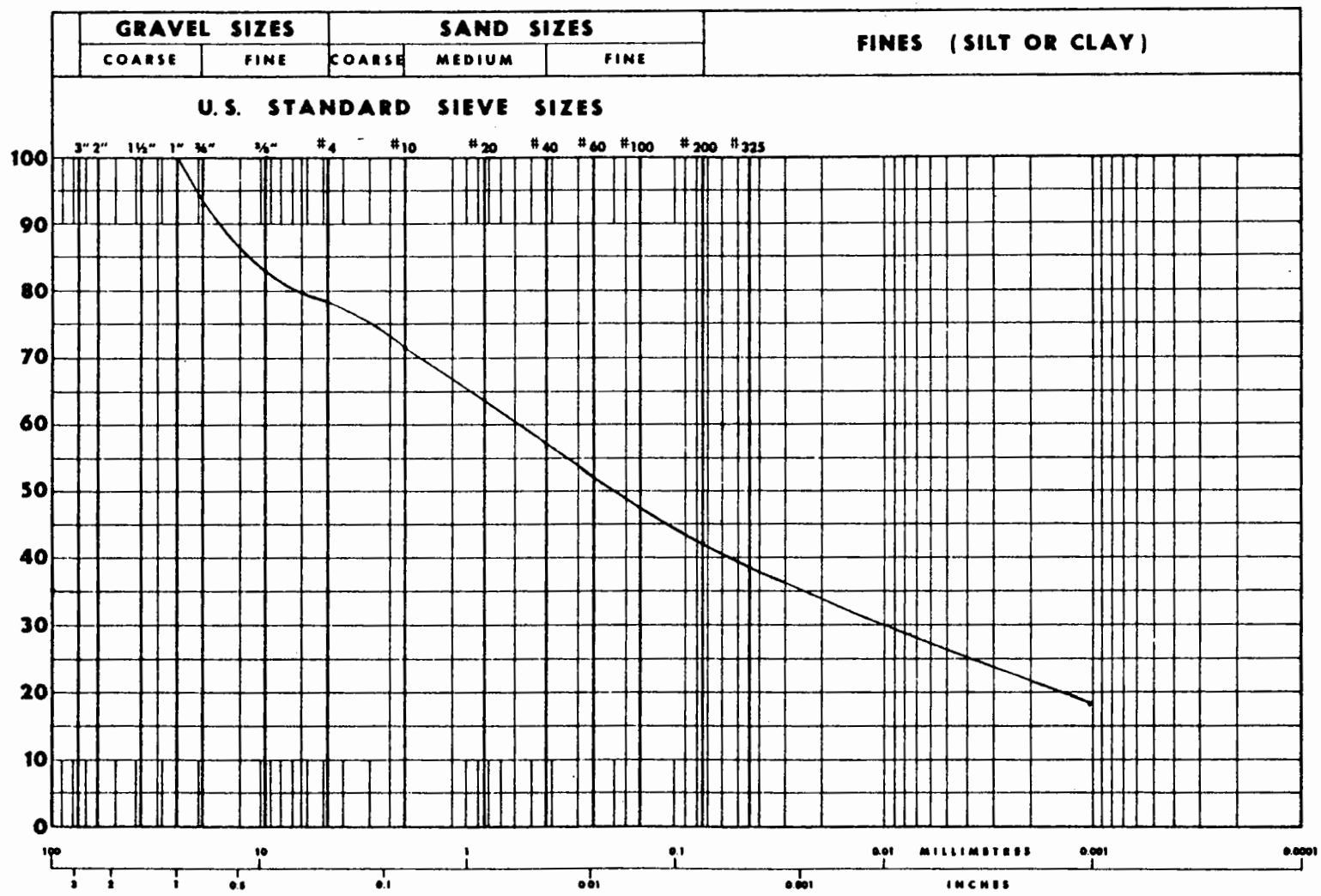
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 14

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S-2781
CLIENT B4017
SAMPLE SEE REMARKS
SOURCE BH77-13
HOLE DEPTH DATE REC'D.
TECHNICIAN GF DATE TESTED 25/11/77

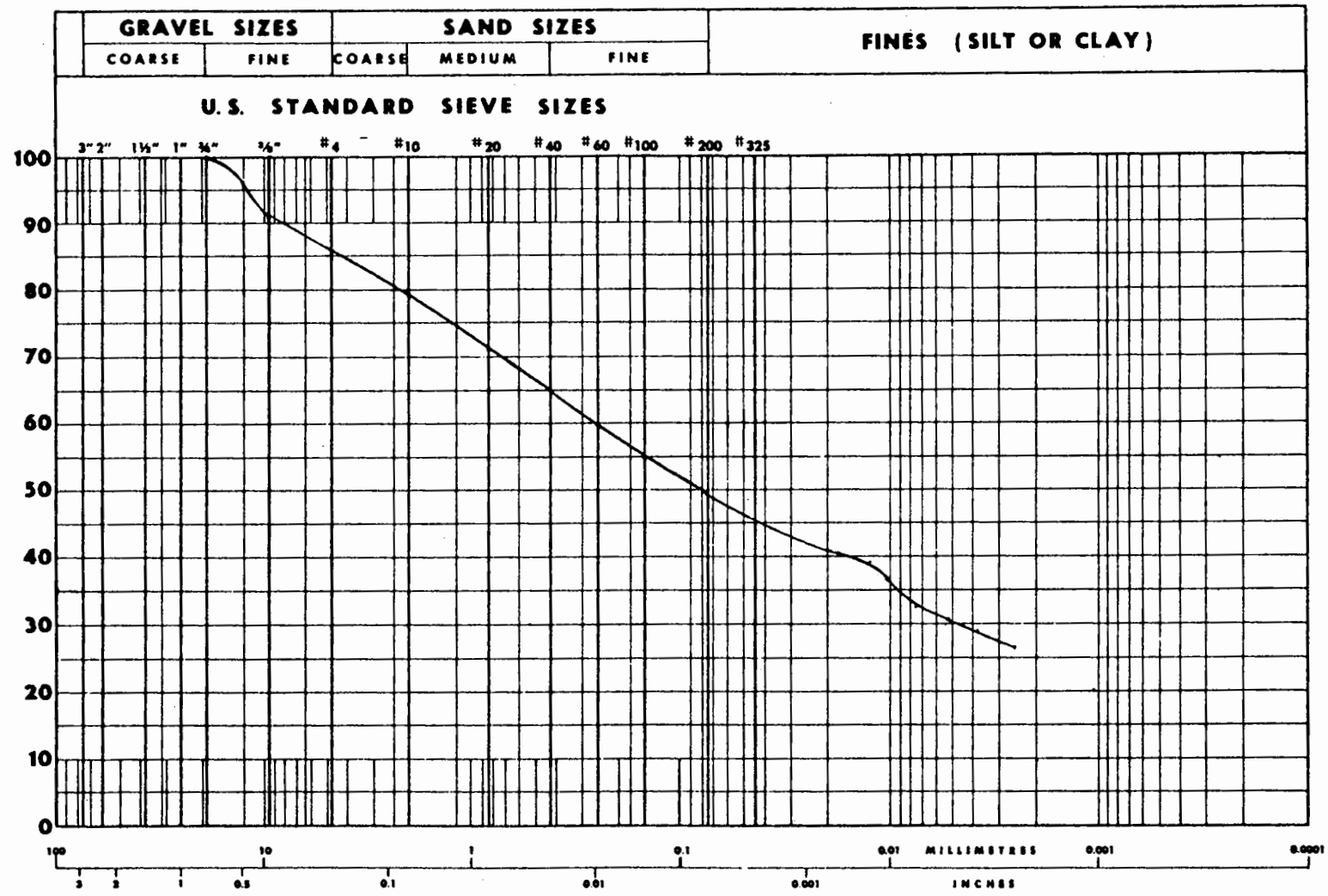


REMARKS: COMBINED SAMPLE: SS 19 @ 31.83 - 32.13 m
SS 20 @ 33.87 - 34.30
SS 21 @ 36.31 - 36.77
SS 22 @ 39.42 - 39.60

D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_U _____
C_C _____

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 15



REMARKS: COMBINED SAMPLE:

5523 @ 41.92 - 42.35 m

5524 @ 43.90 - 44.27

5525 @ 46.90 - 46.92

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

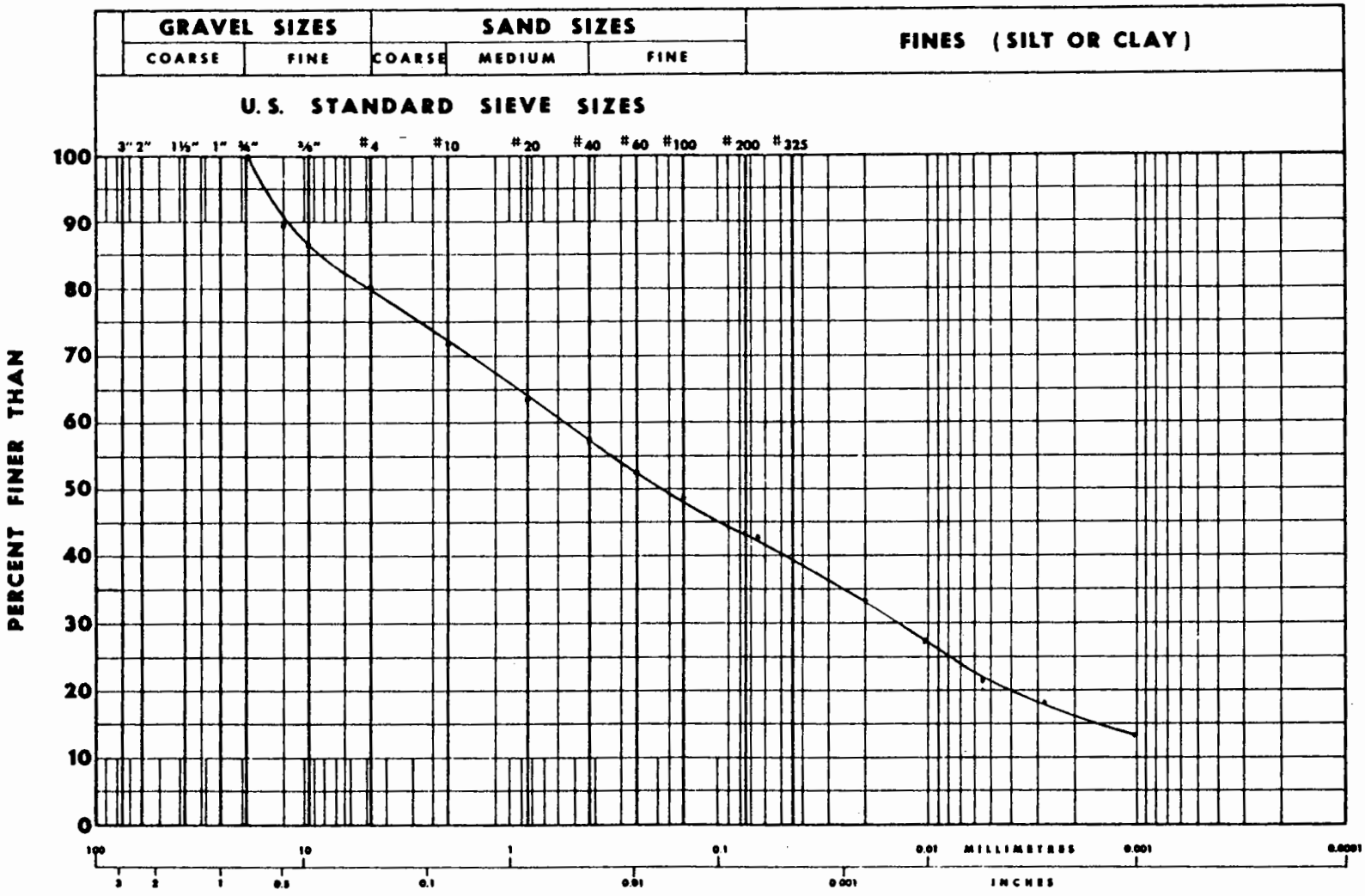
D_{10} = _____ MM.
D_{30} = _____ MM.
D_{60} = _____ MM.
C_U _____
C_C _____

PLATE 16

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. 52781
CLIENT B4017
SAMPLE SEE REMARKS
SOURCE BH77-13
HOLE DEPTH DATE REC'D.
TECHNICIAN GF/KA DATE TESTED 25/11/77



REMARKS: COMBINED SAMPLE:

(1) SS #35 @ 57.13 - 57.53

(2) SS #37 @ 59.24 - 59.54

D_{10} = _____ MM.

D_{30} = _____ MM.

D_{60} = _____ MM.

C_U _____

C_C _____

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 17

R.M. HARDY & ASSOCIATES LTD.

CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO. S-2781

CLIENT B4017

SAMPLE SEE REMARKS

SOURCE BH77-13

HOLE DEPTH DATE REC'D.

TECHNICIAN GF DATE TESTED 25/11/77

APPENDIX B

BOREHOLE LOGS

PROPOSED OPEN PIT MINE SITE

montreal engineering company, limited

BOREHOLE LOG

SHEET 1 OF 4

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0

HOLE Nº BH-77-1 — EQUIPMENT Longyear 34

LOCATION Faro, Yukon.

DATUM Ground — COORDINATES: N E

DATE: START 12th July '77 — GROUND ELEV.

FINISH 16th July '77 — DIP 90° — BEARING

SAMPLE CONDITIONS: DISTURBED ⊠ | UNDISTURBED ▨ | NOT RECOVERED ▧

SS SPLIT SPOON 51 mm O.D.
DC DIAMOND CORE BQ SIZE
ST SHELBY TUBE mm O.D.
AS AUGER SAMPLE
WS WASH SAMPLE
DO DRIVE OPEN

γ BULK DENSITY (t/m³)
K PERMEABILITY (cm/sec)
V IN-SITU VANE (kg/cm²)
q_u UNCONFINED COMPRESSION (kg/cm²)
PP POCKET PENETROMETER (kg/cm²)
C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N' (BLOWS/30cm)
⊢▲ PLASTIC & LIQUID LIMITS
⊙ WATER CONTENT (w%)
▽ WATER LEVEL

DEPTH ft	DEPTH m	ELEV. m	GEOLOGIC PROFILE: DESCRIPTION	STRAT.	GROUND WATER	SAMPLES: COND.	Nº	TYPE	REC. %	TESTS	TEST RESULTS: 10 20 30 40 50 60 70 80 N W	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
0															
			Till: Greenish-grey silt and sand with traces of gravel and cobbles.			⊠	1	SS	85	N=22	⊕				
2			Some oxidized gravel observed throughout the soil. Thin layers of oxidized till noted in SS sample #4.			⊠	2	SS	90	N=22	⊙	18	33	43	6
					▽										
						⊠	3	SS	75	N=53	⊕				
4			Compact to very dense material, well graded, sub-angular to sub-rounded particles.			⊠	4	SS	100	N=102	⊙				
6			Till: Dark grey silty and gravelly sand with traces of clay. Very dense material of low plasticity. Cobbles and boulders noted.			⊠	5	SS	45	N=147					
8						▬	6	SS	0	N=145/ 3 cm					
						⊠	7	SS	100	N=111	⊙				
10						⊠	8	SS	100	N=165	⊙	18	26	34	22

montreal engineering company, limited

BOREHOLE LOG

SHEET 2 OF 4

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0

HOLE Nº BH-77-1 — EQUIPMENT Longyear 34

LOCATION Faro, Yukon.

DATUM Ground — COORDINATES: N E

DATE: START 12th July '77 — GROUND ELEV.

FINISH 16th July '77 — DIP 90° — BEARING

SAMPLE CONDITIONS

DISTURBED ⊠ UNDISTURBED ◪ NOT RECOVERED ⧅

SS SPLIT SPOON 51 mm O.D. — γ BULK DENSITY (t/m³) — X PENETRATION 'N'

DC DIAMOND CORE BQ SIZE — K PERMEABILITY (cm/sec) — PLASTIC & LIQUID LIMITS

ST SHELBY TUBE mm O.D. — V IN-SITU VANE (kg/cm²) — WATER CONTENT (w%)

AS AUGER SAMPLE — q_u UNCONFINED COMPRESSION (kg/cm²) — WATER LEVEL

WS WASH SAMPLE — PP POCKET PENETROMETER (kg/cm²)

DO DRIVE OPEN — C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

DEPTH ft	DEPTH m	ELEV. m	DESCRIPTION	STRAT.	GROUND WATER	SAMPLES COND.	Nº	TYPE	REC. %	TESTS	TEST RESULTS 10 20 30 40 50 60 70 80 N W	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
12															
						⊠	9	SS	90	N=137	⊙				
14															
			Till: Dark grey sandy silt and gravel with some clay. Medium plasticity.			⧅	10	SS	0	N=121/ 9 cm					
						⊠	11	SS	100	N=115	⊙				
16															
18															
			Till: Dark grey clayey silt and gravel with some sand. Medium plasticity.			⊠	12	SS	100	N=109/ 18 cm	⊙				
20															
			Till: Olive green sandy silt and gravel with some												

montreal engineering company, limited

BOREHOLE LOG

SHEET 3 OF 4
PROJECT Nº KAM 6163-0

PROJECT Kerr-CNRL Grum Joint Venture
HOLE Nº BH-77-1 EQUIPMENT Longyear 34
LOCATION Faro, Yukon.
DATUM Ground COORDINATES: N E
DATE: START 12th July '77 GROUND ELEV.
FINISH 16th July '77 DIP 90° BEARING

SAMPLE CONDITIONS

DISTURBED ⊠ UNDISTURBED ◪ NOT RECOVERED ⊘

SS SPLIT SPOON 51 mm O.D.
DC DIAMOND CORE BQ SIZE
ST SHELBY TUBE mm O.D.
AS AUGER SAMPLE
WS WASH SAMPLE
DO DRIVE OPEN

γ BULK DENSITY (t/m³)
K PERMEABILITY (cm/sec)
V IN-SITU VANE (kg/cm²)
q_u UNCONFINED COMPRESSION (kg/cm²)
PP POCKET PENETROMETER (kg/cm²)
C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N'
PLASTIC & LIQUID LIMITS
⊙ WATER CONTENT (w%)
▽ WATER LEVEL

GEOLOGIC PROFILE				GROUND WATER	SAMPLES				TESTS	TEST RESULTS	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
DEPTH ft m	ELEV. m	DESCRIPTION	STRAT.		COND.	Nº	TYPE	REC. %		10 20 30 40 50 60 70 80 N W				
		clay. A few cobbles and boulders. Some oxidized and altered gravel. Slightly plastic.			⊠	13	SS	100	N=247/ 21 cm					
					◪	14	SS	0	N=75/ 0 cm					
24		Till: Dark grey sandy silt and gravel with some clay. A few cobbles and boulders.			▮	15	DC	62						
					▮	16	DC	42						
					⊠	17	SS	18	N=75/ 3 cm					
26														
28		Till: Olive green gravelly and silty sand with traces of clay. Cobbles and boulders in traces. Low plasticity, well graded, sub-angular particles.			⊠	18	SS	83	N=187	⊙				
30											14	22	39	25
					⊠	19	SS	75	N=256	⊙				
32														

montreal engineering company, limited

BOREHOLE LOG

SHEET 4 OF 4

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0

HOLE Nº BH-77-1 — EQUIPMENT Longyear 34

LOCATION Faro, Yukon.

DATUM Ground — COORDINATES: N E

DATE: START 12th July '77 — GROUND ELEV.

FINISH 16th July '77 — DIP 90° BEARING

SAMPLE CONDITIONS

DISTURBED ⊠ UNDISTURBED ◪ NOT RECOVERED ▨

SS SPLIT SPOON 51 mm O.D. — γ BULK DENSITY (t/m³) — X PENETRATION 'N'

DC DIAMOND CORE BQ SIZE — K PERMEABILITY (cm/sec) — ⊢▲ PLASTIC & LIQUID LIMITS

ST SHELBY TUBE mm O.D. — V IN-SITU VANE (kg/cm²) — ⊙ WATER CONTENT (w%)

AS AUGER SAMPLE — q_u UNCONFINED COMPRESSION (kg/cm²) — ▽ WATER LEVEL

WS WASH SAMPLE — PP POCKET PENETROMETER (kg/cm²)

DO DRIVE OPEN — C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

DEPTH ft	DEPTH m	ELEV. m	GEOLOGIC PROFILE DESCRIPTION	STRAT.	GROUND WATER	SAMPLES COND.	Nº	TYPE	REC. %	TESTS	TEST RESULTS 10 20 30 40 50 60 70 80 N W	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
			Approximate bedrock surface.												
34			Phyllite: Soft, highly altered, decomposed and fractured. Dark toned rock with brownish red rust zones.			⊠	20	SS	100	N=214/9 cm					
36						⊠	21	SS	100	N=230/15 cm	⊙				
							22	DC	81		⊙				
38			Bleached phyllite; Buff to yellow-grey earthy lustre in spots. Fine to medium grained, foliation ~ 45°. Microfolding, extremely altered by oxidation. Chlorite in stringers with disseminated calcite throughout rock. Highly sheared from 37.38-37.56 m, probable fault gouge from 40.3-40.7 m.				23	DC	86						
40							24	DC	60						
							25	DC	74						
42			Massive sulphide: Reddish hued rock, fine grained foliation ~ 50° to 70° but not well developed. Sphalerite and galena are the major constituants of the ore.				26	DC	78						
			END OF HOLE AT 42.10 m												

montreal engineering company, limited

BOREHOLE LOG

SHEET 1 OF 5

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0

HOLE Nº BH-77-12 — EQUIPMENT Longyear 34

LOCATION Faro, Yukon.

DATUM Ground — COORDINATES: N E

DATE: START 10th Sept. '77 — GROUND ELEV.

FINISH 18th Sept. '77 — DIP 90° — BEARING

SAMPLE CONDITIONS

DISTURBED ⊠ UNDISTURBED ◪ NOT RECOVERED ⊘

SS SPLIT SPOON 51 mm O.D.
DC DIAMOND CORE BQ SIZE
ST SHELBY TUBE mm O.D.
AS AUGER SAMPLE
WS WASH SAMPLE
DO DRIVE OPEN

γ BULK DENSITY (t/m³)
K PERMEABILITY (cm/sec)
V IN-SITU VANE (kg/cm²)
q_u UNCONFINED COMPRESSION (kg/cm²)
PP POCKET PENETROMETER (kg/cm²)
C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N' (BLOWS/30 cm)
⊢△ PLASTIC & LIQUID LIMITS
⊙ WATER CONTENT (w%)
▽ WATER LEVEL

DEPTH ft	DEPTH m	ELEV. m	DESCRIPTION	STRAT.	GROUND WATER	SAMPLES COND.	Nº	TYPE	REC. %	TESTS	TEST RESULTS (10 20 30 40 50 60 70 80 W / N)	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
0															
			Sand, brown with some silt and some gravel. Slight oxidation proven to a depth of 1.28m. Sub-angular to sub-rounded particles. Compact.			⊠	1	SS	55	N=24	⊙	7	9	68	16
2						◪	2	SS	0	N=11					
			Till: Brownish green sandy gravel with some silt and some clay. Well graded, good plasticity, sub-angular to sub-rounded particles.			⊠	3	SS	60		⊢△ ⊙	8	17	27	48
4						⊠	4	SS	10	N=46					
			Till: Olive green gravelly and silty clay with some sand. Highly plastic, dense.			⊠	5	SS	47		⊙				
6						⊠	6	SS	55	N=147	⊙	9	24	43	24
			Till: Olive green gravelly and silty sand. Some cobbles and traces of boulders. Very dense.			⊠	7	SS	45	N=88	⊙				
8															
			Till: Olive green to dark grey silty clay with some sand and traces of gravel. Plastic, black streaks of organic material in traces.			◪	8	SS	0						
10						⊠	9	SS	75	N=90	⊢△ ⊙				

montreal engineering company, limited

BOREHOLE LOG

SHEET 2 OF 5

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0

HOLE Nº BH-77-12 — EQUIPMENT Longyear 34

LOCATION Faro, Yukon.

DATUM Ground — COORDINATES: N E

DATE: START 10th Sept. '77 — GROUND ELEV.

FINISH 18th Sept. '77 — DIP 90° — BEARING

SAMPLE CONDITIONS: DISTURBED ⊠ — UNDISTURBED ◪ — NOT RECOVERED ⊘

SS SPLIT SPOON 51 mm O.D. — DC DIAMOND CORE BQ SIZE — ST SHELBY TUBE mm O.D. — AS AUGER SAMPLE — WS WASH SAMPLE — DO DRIVE OPEN

γ BULK DENSITY (t/m³) — K PERMEABILITY (cm/sec) — V IN-SITU VANE (kg/cm²) — q_u UNCONFINED COMPRESSION (kg/cm²) — PP POCKET PENETROMETER (kg/cm²) — C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N' — PLASTIC & LIQUID LIMITS — ⊙ WATER CONTENT (w%) — ▽ WATER LEVEL

DEPTH ft	DEPTH m	ELEV. m	GEOLOGIC PROFILE: DESCRIPTION	STRAT.	GROUND WATER	SAMPLES: COND.	Nº	TYPE	REC. %	TESTS	TEST RESULTS: N (10 20 30 40 50 60 70 80) W	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
			Some cobbles and boulders up to a depth of 9.8 m.		▽										
												29	40	25	6
12			Till: Dark grey sandy silt with some clay and some gravel. Slight plasticity, very dense.			⊠	10	SS	100	N=67	⊙				
14			Till of a higher clay content, high plasticity, sandy silt partings.			⊘	11	SS	0	N=351/24 cm					
						⊠	12	SS	94	N=138	⊙				
16															
18						⊠	13	SS	71	N=156	⊙				
												25	52	18	5
20			Sandy silt: Dark grey colour, uniform with a trace of gravel. Sandy partings, thinly laminated structure.			⊠	14	SS	77	N=204	⊙				
22			Clayey silt with some sand and traces												

BOREHOLE LOG

SHEET 3 OF 5

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0
HOLE Nº BH-77-12 — EQUIPMENT Longyear 34
LOCATION Faro, Yukon,
DATUM Ground — COORDINATES: N E
DATE: START 10th Sept. '77 — GROUND ELEV.
FINISH 18th Sept. '77 — DIP 90° — BEARING

SAMPLE CONDITIONS: DISTURBED ⊠ | UNDISTURBED ◪ | NOT RECOVERED ▨

SS SPLIT SPOON 51 mm O.D.
DC DIAMOND CORE BQ SIZE
ST SHELBY TUBE mm O.D.
AS AUGER SAMPLE
WS WASH SAMPLE
DO DRIVE OPEN

γ BULK DENSITY (t/m³)
K PERMEABILITY (cm/sec)
V IN-SITU VANE (kg/cm²)
q_u UNCONFINED COMPRESSION (kg/cm²)
PP POCKET PENETROMETER (kg/cm²)
C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N' (BLOWS/m)
⊡—△ PLASTIC & LIQUID LIMITS
⊙ WATER CONTENT (W%)
▽ WATER LEVEL

DEPTH ft	DEPTH m	ELEV. m	GEOLOGIC PROFILE DESCRIPTION	STRAT.	GROUND WATER	SAMPLES COND.	Nº	TYPE	REC. %	TESTS	TEST RESULTS 10 20 30 40 50 60 70 80 N W	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
			of gravel, interlayered with a sand and silt. Dark grey colour.			⊠	15	SS	73	N=218	⊙				
24	7.3		Till: Dark grey gravelly and sandy silt. Well graded, very dense, subangular to subrounded particles. Traces of cobbles and boulders.			▬	16	SS	0	N=101/3 cm					
						⊠	17	SS	14	N=116					
26	7.9		Till: Olive green gravelly and silty sand with some clay. Very dense, well graded, low plasticity, subangular to subrounded particles. Traces of cobbles and boulders.			▬	18	SS	0	N=125/3 cm					
28	8.5					◪	19	SS	0	N=286					
						⊠	20	SS	75	N=345 γ=2.34	⊙				
30	9.1														
						▬	21	SS	0	N=201/9 cm					
32	9.8					⊠	22	SS	45	N=158	⊙				T327 4020

MECO 26 001

BOREHOLE LOG

SHEET 4 OF 5

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0
HOLE Nº BH 77-12 — EQUIPMENT Longyear 34
LOCATION Faro, Yukon.
DATUM Ground — COORDINATES: N E
DATE: START 10th Sept. '77 — GROUND ELEV.
FINISH 18th Sept. '77 — DIP 90° — BEARING

SAMPLE CONDITIONS

DISTURBED ⊠ UNDISTURBED ◪ NOT RECOVERED ⊘

SS SPLIT SPOON 51 mm O.D.
DC DIAMOND CORE BQ SIZE
ST SHELBY TUBE mm O.D.
AS AUGER SAMPLE
WS WASH SAMPLE
DO DRIVE OPEN

γ BULK DENSITY (t/m³)
K PERMEABILITY (cm/sec)
V IN-SITU VANE (kg/cm²)
q_u UNCONFINED COMPRESSION (kg/cm²)
PP POCKET PENETROMETER (kg/cm²)
C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N'
⊕—△ PLASTIC & LIQUID LIMITS
⊙ WATER CONTENT (w%)
▽ WATER LEVEL

DEPTH ft	DEPTH m	ELEV. m	DESCRIPTION	STRAT.	GROUND WATER	SAMPLES COND.	Nº	TYPE	REC. %	TESTS	TEST RESULTS 10 20 30 40 50 60 70 80 N W	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
34							23	SS	70	N=65					
36			Till: Olive green silty and clayey sand with some gravel, high plasticity.				24	SS	100	N=63		15	31	41	13
38							25	SS	0	N=200/ 6 cm					
							26	SS	0	N=130/ 6 cm					
40							27	SS	0						
							28	DC	57						
			Till: Olive green to dark grey gravelly silt and sand. Some cobbles and traces of boulders. Very dense, well graded, sub-angular to sub-rounded particles with a preponderance of altered phyllite.				29	SS	100	N=110		16	27	36	21
							30	DC	38						
42							31	SS	33						
							32	DC	29						
			Bedrock at 42.29 m				33	DC	11						
44															

BOREHOLE LOG

SHEET 5 OF 5

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0
HOLE Nº BH 77-12 — EQUIPMENT Longyear 34
LOCATION Faro, Yukon.
DATUM Ground — COORDINATES: N E
DATE: START 10th Sept. '77 — GROUND ELEV.
FINISH 18th Sept. '77 — DIP 90° — BEARING

SAMPLE CONDITIONS

DISTURBED ⊠ UNDISTURBED ◪ NOT RECOVERED ▨

SS SPLIT SPOON 51 mm O.D.
DC DIAMOND CORE BQ SIZE
ST SHELBY TUBE mm O.D.
AS AUGER SAMPLE
WS WASH SAMPLE
DO DRIVE OPEN

γ BULK DENSITY (t/m³)
K PERMEABILITY (cm/sec)
V IN-SITU VANE (kg/cm²)
q_u UNCONFINED COMPRESSION (kg/cm²)
PP POCKET PENETROMETER (kg/cm²)
C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N'
⊕—▲ PLASTIC & LIQUID LIMITS
⊙ WATER CONTENT (w%)
▽ WATER LEVEL

DEPTH ft	DEPTH m	ELEV. m	GEOLOGIC PROFILE DESCRIPTION	STRAT.	GROUND WATER	SAMPLES COND.	Nº	TYPE	REC. %	TESTS	TEST RESULTS 10 20 30 40 50 60 70 80 N W	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
			Quartz sericite phyllite: grey, fine grained. Silvery sheen on cleavage planes, some white quartz present in bands up to a thickness of 5cm. Foliation ≈65° to 75°, microfolding noted, alterations not prominent although slight epidotisation. Fault gouge from 53.3 to 54.6m. Most of the fractures in the recovered core are due to foliation.			⊠	34	SS	56	N=295/27 cm					
46						⊠	35	SS	75	N=167/24 cm					
							36	DC	10						
48							37	DC	18						
							38	DC	19						
50							39	DC	50						
							40	DC	29						
							41	DC	55						
52							42	DC	80						
							43	DC	81						
							44	DC	69						
54			END OF HOLE AT 54.57 m				45	DC	53						

Thurber Engineering Company, Limited

BOREHOLE LOG

SHEET 1 OF 6

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT No KAM 6163-0
HOLE No BH-77-13 — EQUIPMENT Longyear 34
LOCATION Faro, Yukon.
DATUM Ground — COORDINATES: N E
DATE: START Sept. 19th '77 — GROUND ELEV.
FINISH Oct. 4th '77 — DIP 90° — BEARING

SAMPLE CONDITIONS

DISTURBED ⊠ UNDISTURBED ◪ NOT RECOVERED ⊘

SS SPLIT SPOON 51 mm O.D.
DC DIAMOND CORE BQ SIZE
ST SHELBY TUBE mm O.D.
AS AUGER SAMPLE
WS WASH SAMPLE
DO DRIVE OPEN

γ BULK DENSITY (t/m³)
K PERMEABILITY (cm/sec)
V IN-SITU VANE (kg/cm²)
q_u UNCONFINED COMPRESSION (kg/cm²)
PP POCKET PENETROMETER (kg/cm²)
C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N' (BLOWS/30 cm)
⊟—⊠ PLASTIC & LIQUID LIMITS
⊙ WATER CONTENT (w%)
▽ WATER LEVEL

DEPTH ft	DEPTH m	ELEV. m	GEOLOGIC PROFILE DESCRIPTION	STRAT.	GROUND WATER	SAMPLES COND.	SAMPLES No	SAMPLES TYPE	SAMPLES REC. %	TESTS	TEST RESULTS 10 20 30 40 50 60 70 80 N W	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
0															
			Sand, brown, gravelly with some silt. Compact, sub-angular to sub-rounded particles.			⊠	1	SS	40	N=60	⊙	5	15	49	31
2			Till: Brown silt and sand with some clay and some gravel. Traces of cobbles and boulders. Well graded, sub-angular to sub-rounded particles, compact.			⊠	2	SS	50	N=21	⊟—⊠ ⊙				
												20	31	37	12
4						⊠	3	SS	65	N=27	⊙				
6			Till: Grey silty and clayey sand with some gravel. Highly plastic, angular to sub-rounded particles, dense. Traces of cobbles.		▽	◪	4	SS	0	N=30					
						◪	5	SS	0	N=31					
8						⊠	6	SS	60		⊙	17	29	40	14
			Till: Olive green sandy clay with some gravel. Slightly plastic, very dense. Traces of cobbles.			⊠	7	SS	80		⊙				
10															

BOREHOLE LOG

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0
HOLE Nº BH-77-13 — EQUIPMENT Longyear 34
LOCATION Faro, Yukon.
DATUM Ground — COORDINATES N E
DATE: START Sept. 19th '77 — GROUND ELEV.
FINISH Oct. 4th '77 — DIP 90° — BEARING

SAMPLE CONDITIONS: DISTURBED ⊠ | UNDISTURBED ◪ | NOT RECOVERED ⊘

SS SPLIT SPOON 51 mm O.D.
DC DIAMOND CORE BQ SIZE
ST SHELBY TUBE mm O.D.
AS AUGER SAMPLE
WS WASH SAMPLE
DO DRIVE OPEN

γ BULK DENSITY (t/m³)
K PERMEABILITY (cm/sec)
V IN-SITU VANE (kg/cm²)
q_u UNCONFINED COMPRESSION (kg/cm²)
PP POCKET PENETROMETER (kg/cm²)
C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N'
⊢△ PLASTIC & LIQUID LIMITS
⊙ WATER CONTENT (w%)
▽ WATER LEVEL

DEPTH ft	DEPTH m	ELEV. m	DESCRIPTION	STRAT.	GROUND WATER	SAMPLES COND.	Nº	TYPE	REC. %	TESTS	TEST RESULTS 10 20 30 40 50 60 70 80 N W	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
						⊠	8	SS	80	γ=2.32	⊢△ ⊙	22	30	32	16
12															
						⊠	9	SS	50	N=106	⊙				
14															
						⊠	10	SS	50	N=119	⊙				
16															
						⊠	11	SS	75	N=96	⊙	22	27	37	14
18															
						⊠	12	SS	75	N=85	⊙				
20															
						⊘	13	SS	0	N=163					
22															

montreal engineering company, limited

BOREHOLE LOG

SHEET 3 OF 6

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0

HOLE Nº BH-77-13 — EQUIPMENT Longyear 34

LOCATION Faro, Yukon.

DATUM Ground — COORDINATES: N E

DATE: START Sept. 19th'77 — GROUND ELEV.

FINISH Oct. 4th'77 — DIP 90° — BEARING

SAMPLE CONDITIONS

DISTURBED ⊠ UNDISTURBED ◪ NOT RECOVERED ⊘

SS SPLIT SPOON 51 mm O.D.
DC DIAMOND CORE BQ SIZE
ST SHELBY TUBE mm O.D.
AS AUGER SAMPLE
WS WASH SAMPLE
DO DRIVE OPEN

γ BULK DENSITY (t/m³)
K PERMEABILITY (cm/sec)
V IN-SITU VANE (kg/cm²)
q_u UNCONFINED COMPRESSION (kg/cm²)
PP POCKET PENETROMETER (kg/cm²)
C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N'
⊢△ PLASTIC & LIQUID LIMITS
⊙ WATER CONTENT (w%)
▽ WATER LEVEL

DEPTH ft	DEPTH m	ELEV. m	GEOLOGIC PROFILE DESCRIPTION	STRAT.	GROUND WATER	SAMPLES COND.	Nº	TYPE	REC %	TESTS	TEST RESULTS 10 20 30 40 50 60 70 80 N W	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
			More significant gravel content.												
							14	SS	0	N=271					
24							15	SS	100	γ=2.44					
												23	21	31	25
26							16	SS	100						
28							17	SS	100						
30							18	SS	100						
32							19	SS	100						

montreal engineering company, limited

BOREHOLE LOG

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0
HOLE Nº BH-77-13 — EQUIPMENT Longyear 34
LOCATION Faro, Yukon.
DATUM Ground — COORDINATES: N E
DATE: START Sept. 19th '77 — GROUND ELEV.
FINISH Oct. 4th '77 — DIP 90° — BEARING

SAMPLE CONDITIONS

DISTURBED ⊠ UNDISTURBED ◢ NOT RECOVERED ⊘

SS SPLIT SPOON 51 mm O.D.
DC DIAMOND CORE BQ SIZE
ST SHELBY TUBE mm O.D.
AS AUGER SAMPLE
WS WASH SAMPLE
DO DRIVE OPEN

γ BULK DENSITY (t/m³)
K PERMEABILITY (cm/sec)
V IN-SITU VANE (kg/cm²)
q_u UNCONFINED COMPRESSION (kg/cm²)
PP POCKET PENETROMETER (kg/cm²)
C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N'
⊕—▲ PLASTIC & LIQUID LIMITS
⊙ WATER CONTENT (w%)
▽ WATER LEVEL

DEPTH ft	DEPTH m	ELEV. m	DESCRIPTION	STRAT.	GROUND WATER	SAMPLES COND.	Nº	TYPE	REC. %	TESTS	TEST RESULTS (N: 10 20 30 40 50 60 70 80 W)	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
34						⊠	20	SS	100	γ=2.36	⊙				
												22	20	36	22
36						⊠	21	SS	100		⊙				
38															
						⊠	22	SS	83	N=406/18 cm	⊕				
40			Predominantly silt and sand sizes with some clay and some gravel.												
42						⊠	23	SS	100	N=251	⊕				
44						⊠	24	SS	100	N=152		25	25	36	14

montreal engineering company, limited

BOREHOLE LOG

SHEET 5 OF 6

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0

HOLE Nº BH 77-13 — EQUIPMENT Longyear 34

LOCATION Faro, Yukon.

DATUM Ground — COORDINATES: N E

DATE: START Sept.19th '77 — GROUND ELEV.

FINISH Oct. 4th '77 — DIP 90° — BEARING

SAMPLE CONDITIONS

DISTURBED ⊠ UNDISTURBED ◢ NOT RECOVERED ⧅

SS SPLIT SPOON 51 mm O.D.
DC DIAMOND CORE BQ SIZE
ST SHELBY TUBE mm O.D.
AS AUGER SAMPLE
WS WASH SAMPLE
DO DRIVE OPEN

γ BULK DENSITY (t/m³)
K PERMEABILITY (cm/sec)
V IN-SITU VANE (kg/cm²)
q_u UNCONFINED COMPRESSION (kg/cm²)
PP POCKET PENETROMETER (kg/cm²)
C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N'
⊢△ PLASTIC & LIQUID LIMITS
⊙ WATER CONTENT (w%)
▽ WATER LEVEL

DEPTH ft	DEPTH m	ELEV. m	GEOLOGIC PROFILE DESCRIPTION	STRAT.	GROUND WATER	SAMPLES COND.	Nº	TYPE	REC. %	TESTS	TEST RESULTS 10 20 30 40 50 60 70 80 N W	% CLAY	% SILT	% SAND	% GRAVEL & LARGER
46							25	SS	65	N=243	⊙				
48							26	SS	100	N=312/ 15 cm	⊙				
50			Variable clay content, slight to medium plasticity.				27	SS	100	N=250/ 6 cm					
52							28	SS	0	N=150/ 6 cm					
							29	DC	24						
							30	SS	25	N=269/ 24 cm					
54							31	SS	83	N=226/ 18 cm	⊙				
			Till: Greyish green gravelly silt with				32	DC	28						

montreal engineering company, limited

BOREHOLE LOG

SHEET 6 OF 6

PROJECT Kerr-CNRL Grum Joint Venture — PROJECT Nº KAM 6163-0

HOLE Nº BH-77-13 — EQUIPMENT Longyear 34

LOCATION Faro, Yukon.

DATUM Ground — COORDINATES: N E

DATE: START Setp. 19th '77 — GROUND ELEV.

FINISH Oct. 4th '77 — DIP 90° — BEARING

SAMPLE CONDITIONS

DISTURBED ⊠ UNDISTURBED ◪ NOT RECOVERED ⊘

SS SPLIT SPOON 51 mm O.D.
DC DIAMOND CORE BQ SIZE
ST SHELBY TUBE mm O.D.
AS AUGER SAMPLE
WS WASH SAMPLE
DO DRIVE OPEN

γ BULK DENSITY (t/m³)
K PERMEABILITY (cm/sec)
V IN-SITU VANE (kg/cm²)
q_u UNCONFINED COMPRESSION (kg/cm²)
PP POCKET PENETROMETER (kg/cm²)
C_u UNDRAINED SHEAR STRENGTH (kg/cm²)

X PENETRATION 'N'
⊞—▲ PLASTIC & LIQUID LIMITS
⊙ WATER CONTENT (w%)
▽ WATER LEVEL

DEPTH ft	DEPTH m	ELEV. m	GEOLOGIC PROFILE DESCRIPTION	STRAT.	GROUND WATER	SAMPLES COND.	Nº	TYPE	REC. %	TESTS	TEST RESULTS 10 20 30 40 50 60 70 80 N w	% CLAY	% SILT	% SAND	% GRAVEL & % LARGER
			some sand and some clay. Slightly plastic. Some cobbles.			⊠	33	SS	94	N=224	⊕				
56							34	DC	13						
			Predominantly silt and sand with some gravel and traces of clay.			⊠	35	SS	85	N=268 γ=2.35	⊕				
58							36	DC	9			16	27	37	20
						⊠	37	SS	80	N=286	⊕				
60															
			END OF HOLE AT 61.34 m			⊠	38	SS	0						

MECO 26 001

APPENDIX C

TEST PIT LOGS

CONSTRUCTION MATERIALS

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.5

DEPTH TO WATER LEVEL (m) Not achieved

DATE 12.8.77

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
0.15				Organic cover						
			1	Oxidized organic silt that passes to a sandy gravel with traces of cobbles. Rust colour, loose, well graded, rounded to sub-angular particles.				⊙		
1.0										
1.4			2	Uniform brown sandy silt. Dense, moist material.	0.6	32.5	66.9	⊙		
2.0										
3.0										
3.5				END OF HOLE						
4.0										

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 57

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.0

DEPTH TO WATER LEVEL (m) Not achieved

DATE 12.8.77

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
0.02				Moss
0.15				Beige fine and uniform sand
				Oxidized gravelly sand. Well graded, loose material.
0.8				
1.0			#1	Brown sand and gravel. Well graded, very loose, rounded to sub-angular particles.
2.0				
3.0				END OF HOLE
4.0				

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 58

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.6

DEPTH TO WATER LEVEL (m) Not achieved

DATE 12.8.77

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
0.2				Moss and fine beige sand.						
0.8				Oxidized rusty coloured organic silt and sand.						
1.0			1	Brown medium grained sand with a trace of gravel and boulders. Uniform distribution, loose material.				⊙		
2.0			2	Brown uniform silt and sand with traces of gravel. Dense, moist, angular and subangular particles.	1.1	39.2	59.7	⊙		
3.0			3		11.5	34.2	54.3	⊙		
3.35			4	Till: Gravelly and silty sand. High water content, average plasticity, compact.	22.4	47.3	30.3	⊙		
3.60										
4.0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 59

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.0

DEPTH TO WATER LEVEL (m) Not achieved

DATE 12.8.77

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
0				Moss and fine washed out sand.
0.25				Oxidized rusty coloured organic silt and sand.
1·0			1	Sand and gravel with a trace of cobbles and boulders. Well graded, loose, dry, rounded to sub-angular particles.
3·0				END OF HOLE
4·0				

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

⊙ at 2·0 m

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 60

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.68

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 3, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
0				Brown oxidized layer: sand and gravel with traces of silt. Roots and organic material present, average density. Traces of cobbles ≃ 8%.
1·0			#1	Brown gravelly medium to coarse grained sand. Well graded, average density, moist, sub-angular to sub-rounded particles. Coarse sand and gravel noted in layers of 30 cm thickness.
2·0			#2	Brown medium grained sand with traces of gravel. Moist, uniform, average density. Gravel in layers ≃ 10 cm thick.
				END OF HOLE
3·0				
4·0				

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY

NOTE: Granitic particles constitute a majority of the fraction > 6 mm although phyllite is present (20 to 30%).

TEST TYPE

MOISTURE CONTENT % 20 40 60 80

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 100

montreal engineering company, limited

PROJECT: Kerr-CNRL GRUM JOINT VENTURE

PROJECT Nº KAM 6163-0 — APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION BACKHOE — DEPTH (m) 3.08

PURPOSE Search for Concrete Aggregate — DEPTH TO WATER LEVEL (m) Not Achieved

DATE Oct. 3/77

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Organic material, black earth, beige outwashed silty sand, brown to grey sandy silt with some gravel.						
1·0			#1	Brown gravelly medium to coarse grained sand. Traces of cobbles ≃ 3%. Average density, subangular to sub-rounded particles. Gravel and coarse sand in layers of variable thickness. Oxidation and roots up to a depth of 1.04 m.	24.2	75	0.8	⊙		
2·0			#2	Brown fine to medium grained sand. Uniform distribution, moist, average density.		98.2	1.8	⊙		
3·0				End of hole.						
4·0										

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 101

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.35

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 3, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, outwashed beige silty sand, white volcanic ash.
1·0				Brown till: Gravelly and sandy silt. Well graded, very dense, average water content, angular to sub-rounded particles. 5 to 10% cobbles, 10% boulders.
2·0				
3·0				→END OF HOLE
4·0				

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY

TEST TYPE

MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 102

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 1.8

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 3, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth.
1·0				Brown till: sandy and gravelly silt. Very dense, well graded, angular to sub-rounded particles, average water content, 10% cobbles and 5% boulders.
				END OF HOLE
2·0				
3·0				
4·0				

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 103

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.68

DEPTH TO WATER LEVEL (m) 2.50

DATE October 3, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth.
				Brown silt and sand.
				Outwashed beige silty sand, black organic material.
1·0				Brown sandy silt with some clay. Plastic in spots.
			#1	Brown sand and gravel with some cobbles (15%) and some boulders (15%). Loose material, moist, sub-angular to sub-rounded particles mostly of granitic origin, well graded. Roots up to a depth of 1.22 m.
2·0				Brown till: gravelly silt and clay with some sand. Highly plastic, high water content, well graded, dense, angular to sub-rounded particles.
3·0				END OF HOLE
4·0				

DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m³	OTHER TESTS
GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 104

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.71

DEPTH TO WATER LEVEL (m) 2.32

DATE October 4, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
0				Dark brown passing to a light brown sand and silt with some gravel and traces of cobbles ≃ 1%. Black earth, organic material, roots present.
1·0				Oxidized layer: sand and gravel with traces of cobbles ≃ 4%. Brown to reddish brown. Roots noted.
			#1	Brown medium to coarse grained sand and gravel. Loose material, average water content, sub-angular to sub-rounded particles of essentially granitic origin. Well graded. 5% cobbles.
2·0				Brown till with green overtones: gravelly silt and clay with some sand, traces of cobbles and boulders. Highly plastic, well graded, moist, compact, sub-angular to sub-rounded particles.
3·0				
4·0				END OF HOLE

NOTE: Depth of till is a rough approximation due to the water level.

DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m³	OTHER TESTS
GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 105

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.54

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 4, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % 20 40 60 80	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
1·0				Gravelly brown sand with a pocket of coarse sand and gravel from 0.27 to 0.46 m on the SW wall. Oxidized up to a depth of 0.55 m. Average water content, compact, sub-angular to sub-rounded particles. 2% cobbles, 1% boulders. Roots up to a depth of 0.49 m.						
2·0				Olive green till: gravelly and clayey silt with some sand. Traces of cobbles ≅ 8% and boulders ≅ 1%. Well graded, plastic in spots, average moisture, sub-angular to sub-rounded particles. The clay content augments with depth while the sand content diminishes.						
3·0										
4·0				END OF HOLE						

NOTE: Vegetation and topsoil previously stripped from site.

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 106

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.68

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 4, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth, outwashed beige silty sand.
				Oxidized layer: brownish red sand with some gravel. Roots present.
1·0			#1	Brown medium to coarse sand and gravel. Cobbles ≃ 3%, boulders < 1%. Loose material, moist, sub-angular to sub-rounded particles of essentially granitic origin. Well graded, roots up to a depth of 0.76 m. The cobbles and boulders are mainly concentrated between 0.55 and 1.01 m.
2·0				
3·0				END OF HOLE
4·0				

NOTE: The pit was dug by trenching along the slope of the hillock.

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 107

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0 — APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe — DEPTH (m) 2.59

PURPOSE Search for concrete aggregate — DEPTH TO WATER LEVEL (m) Not achieved

DATE October 4, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m³	OTHER TESTS
				Moss, organic material, white volcanic ash.						
				Oxidized layer: Reddish brown sand and gravel with some silt. Traces of cobbles ≃ 1%.						
1·0			#1	Brown sand and gravel. The sand is medium to coarse grained; cobbles ≃ 8%, boulders ≃ 1%. Compact, average water content, angular to rounded particles essentially igneous, well graded, roots to a depth of 0.52 m. The cobbles and boulders are mostly situated from 1.46 m on down. Gravel beds (≃ 30 cm thick) have a slight dip.	43.6	54.3	2.1	⊙		
2·0										
3·0				END OF HOLE						
4·0										

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 108

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.53

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 4, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth, off white outwashed silty sand.
				Oxidized layer: Brownish red gravelly sand.
1·0			#1	Brown medium to coarse sand and gravel. Cobbles ≃ 10%, boulders < 1%. Compact, average water content, angular to sub-rounded particles of essentially igneous origin although some phyllite present. Well graded, roots up to a depth of 1.07 m. Layer of moist, uniform, light brown silt and sand from 1.19 - 1.28 m. The concentration of cobbles augments as of a depth of 1.37 m.
2·0				
3·0				END OF HOLE
4·0				

DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m³	OTHER TESTS
GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		
			End of hole at 2.53 m due to instability of pit walls.		

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 109

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.44

DEPTH TO WATER LEVEL (m) 2.44

DATE October 5, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % 20 40 60 80	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Moss, organic material, black earth, leached light grey zone.						
				Oxidized layer: Brown to reddish brown sandy silt with some clay and traces of gravel passes to a sand and gravel with traces of cobbles ≃ 2%.						
1·0			#1	Brown medium to coarse grained sand and gravel. Loose, well graded, average moisture, sub-angular to sub-rounded particles of predominantly granitic origin. Roots up to a depth of 1.22 m. Cobbles ≃ 10%, boulders ≃ 1% with average ϕ = 8-10 cm and maximum ϕ = 30 cm.						
2·0										
				Olive green till: gravelly and sandy silt with some clay. Plastic in spots, well graded, some cobbles and boulders. Sub-angular to sub-rounded particles.						
3·0				END OF HOLE						
4·0										

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 110

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.44

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 5, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth, leached, light grey zone.
				Oxidized layer: Reddish brown sand with some gravel passes to a sand and gravel with 8% cobbles and < 1% boulders.
1·0			#1	Brown medium to coarse sand and gravel. Well graded, moist, sub-angular to sub-rounded particles of granitic origin. Roots up to a depth of 1.28 m. 5% cobbles and < 1% boulders; average φ = 8 cm, maximum φ = 27 cm.
2·0				
				END OF HOLE
3·0				
4·0				

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m³

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 111

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.05

DEPTH TO WATER LEVEL (m) 2.62

DATE October 5, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth, leached light grey zone.
				Oxidized layer: Reddish brown gravelly silt and sand passes to a sand and gravel with traces of cobbles ≃ 8%.
1·0			#1	Brown sand and gravel with traces of oxidation up to a depth of 1.31 m. Well graded, average moisture, sub-angular to sub-rounded particles of mostly granitic origin, loose, roots attain a depth of 0.91 m. 6% cobbles, <1% boulders with an average φ = 9 cm and maximum φ = 30 cm.
2·0				
3·0				Brownish green till: gravelly and clayey silt with some sand. Good plasticity, well graded, sub-angular particles. Some cobbles and boulders.
				END OF HOLE
4·0				

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY

NOTE: The depth of till is a rough approximation due to water level.

TEST TYPE — MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 112

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.11

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 5, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, leached light grey zone, black earth.
				Brownish red to faintly oxidized sand and gravel. Cobbles ≃ 8%, boulders ≃ 1%.
1·0			#1	Brown medium to coarse grained sand and gravel. Average moisture, well graded, sub-angular to sub-rounded particles mostly of granitic origin. Loose, roots up to a depth of 1.92 m. 12% cobbles, 2% boulders with an average ϕ = 10 cm and a maximum ϕ = 46 cm.
2·0				
3·0				Olive green till: gravelly and clayey silt with some sand. Good plasticity, well graded, average water content. Traces of cobbles and boulders.
				END OF HOLE
4·0				

DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 113

montreal engineering company, limited

PROJECT: Kerr -CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for Concrete Aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.35

DEPTH TO WATER LEVEL (m) Not Achieved.

DATE Oct. 6/77

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m³	OTHER TESTS
				Moss, organic material, black earth, leached light grey soil						
				Oxidized layer: Reddish brown sand & gravel with traces of cobbles ≃ 1%.						
1·0			#1	Brown medium to coarse grained sand & gravel. Average water content, well graded, sub-angular to sub-rounded particles mostly granitic, loose, roots attain a depth of 0.82 m. Layers of brown medium grained sand with traces to some gravel notably from 0.88 to 0.98 m.	48.8	49.8	1.4	⊙		
2·0				10% cobbles, 3% boulders: average Ø = 10 cm, maximum Ø = 30 cm. The cobbles & boulders are essentially concentrated from 1.31 - 1.92 m.						
3·0			#2	Brown fairly uniform medium grained sand with some gravel. Compact, subangular particles. Gravel in layers of variable thickness.	12.7	85.9	1.4	⊙		
4·0				End of hole.						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 114

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.78

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 6, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, leached light brown soil, black earth.
				Oxidized layer: Reddish brown sand and gravel with some cobbles ≃ 15% and traces of boulders ≃ 10%.
1·0				Olive green till: Clayey and gravelly silt with some sand. Well graded, variable clay content, plastic in spots, average moisture, sub-angular to sub-rounded particles. Traces of cobbles ≃ 3% and boulders ≃ 1%. Maximum φ = 36 cm.
2·0				
3·0				
4·0				END OF HOLE

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY

TEST TYPE

MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 115

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0 — APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe — DEPTH (m) 3.51

PURPOSE Search for concrete aggregate — DEPTH TO WATER LEVEL (m) Not achieved

DATE October 6, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % 20 40 60 80	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Moss, organic material, leached light grey soil, black earth.						
				Oxidized layer: Reddish brown sand with some gravel.						
1·0				Brown medium grained sand with traces of gravel interbanded with brown silty sand with traces of gravel.						
2·0				Brown medium to coarse grained sand and gravel. Loose, moist, traces of oxidation, roots up to a depth of 1.10 m. Cobbles ≃ 8%, boulders ≃ 3%, sub-angular to sub-rounded particles of mostly granitic origin. Well graded, average ϕ = 13 cm, maximum ϕ = 36 cm.						
3·0				Olive green till: gravelly and sandy silt. Well graded, low water content, sub-angular to sub-rounded particles. Traces of cobbles and boulders.						
4·0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 116

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.29

DEPTH TO WATER LEVEL (m)

DATE October 6, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
0				Brown medium to coarse grained sand and gravel with traces of oxidation. Loose, very moist, 10% cobbles and 4% boulders, sub-angular to sub-rounded particles mostly of granitic origin though some phyllite, average ϕ = 10 cm, maximum ϕ = 33 cm. Well graded.
1.0				Brown till: gravelly and sandy silt with some clay. Slight plasticity, well graded, angular to sub-rounded particles. Average moisture, 8% cobbles and 2% boulders.
2.0				
3.0				END OF HOLE
4.0				

NOTE: Surface run-off at contact between gravel and till.

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 117

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.68

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 7, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY
				Oxidized layer: Brown sand and gravel. Traces of cobbles ≃ 5% and boulders < 1%			
1·0			#1	Brown medium to coarse grained sand and gravel. Well graded, moist, loose, sub-angular to sub-rounded particles mostly of granitic origin though some 30% phyllite chips. 4% cobbles and < 1% boulders with an average φ = 8 cm and a maximum φ = 28 cm. Traces of oxidation.			
2·0				Brownish green till: gravelly and sandy silt with traces of clay. Low plasticity, well graded, average moisture, sub-angular to sub-rounded particles. 5% cobbles and 1% boulders.			
3·0				END OF HOLE			
4·0							

TEST TYPE — MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 118

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Evaluate depth of bedrock

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.96

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 7, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth, leached light grey soil.
				Brown silt and sand with traces of gravel, organic material present, traces of cobbles ≃ 3% and boulders ≃ 2%.
1·0			#1	Brown till: gravelly silt and sand with traces of cobbles ≃ 3%. Moist, well graded, sub-angular to sub-rounded particles, dense. Thin layers of medium grained sand from 0.55-0.64 and 0.82-0.88m
2·0			#2	Grey to olive green till: Gravelly and clayey silt with some sand. Well graded, compact to dense, moist, traces of oxidation up to a depth of 1.83 m, sub-angular to sub-rounded particles, 4-5% cobbles and 1-2% boulders. One thin layer of brown medium grained sand from 1.40-1.52 m.
3·0				
4·0				END OF HOLE

DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m³	OTHER TESTS
GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 119

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0 — APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe — DEPTH (m) 3.66

PURPOSE Evaluate depth of bedrock — DEPTH TO WATER LEVEL (m) Not achieved

DATE October 7, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % 20 40 60 80	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Moss, organic material, black earth.						
1·0			#1	Brown to olive green till: Gravelly and sandy silt with some clay. The clay content is variable for plasticity soars from low to high. Well graded, sub-angular to sub-rounded particles. Traces of oxidation throughout, black organic material up to a depth of 1.22 m. Very moist, thin layers of brown saturated medium grained sand with some gravel ≃ 5 cm thick noted. 5% cobbles and 3% boulders.						
2·0										
3·0			#2	Grey till: Gravelly clay and silt with some sand. Highly plastic.						
4·0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 120

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.93

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 8, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, leached light grey soil.
				Brown silt and sand with some gravel.
1·0				Oxidized layer: Reddish brown medium to coarse grained sand and gravel. 12% cobbles and 2% boulders, dry, well graded, loose, roots up to a depth of 1.59 m.
2·0				
3·0			#1	Light brown uniform silty sand with traces of gravel. 1% cobbles and boulders< 1%. Average moisture, compact, sandy partings, thinly layered ≃ 1 mm. Bed of reddish brown medium grained oxidized sand with traces of gravel from 2.44-2.71. Some layers of uniform grey clayey silt noted due to good plasticity.
4·0				END OF HOLE

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY

TEST TYPE

MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 121

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 4.27

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 8, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % 20 40 60 80	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Moss, organic material, leached light grey soil, black earth.						
				Reddish brown to brown medium grained sand with some gravel and traces of cobbles <1%. Oxidation in traces.						
1·0			#1	Oxidized layer: Reddish brown to brown sandy gravel. 12% cobbles and 1% boulders. Loose, low water content, well graded. Sub-angular to sub-rounded particles, truly oxidized up to 1.01 m, roots attain a depth of 0.91 m.	63.6	34.5	1.9	⊙		
2·0			#2	Brown medium and fine grained uniform sand with traces of gravel. Compact, interbands of coarser grained sand with traces of gravel (3 to 15 cm thickness). The gravel is essentially found in the coarser beds.	2.1	92.9	5.0	⊙		
3·0			#3	Fine uniform silty sand with traces of gravel. Compact material.	0.2	66.8	33	⊙		
4·0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 122

montreal engineering company, limited

PROJECT: Kerr - CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for Concrete Aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.81

DEPTH TO WATER LEVEL (m) Not Achieved

DATE Oct. 8/77

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth, leached light grey soil
				Oxidized layer: Reddish brown medium grained sand with traces of gravel.
1·0				Brown fine and medium grained sand with traces of gravel interbanded with layers of brown medium to coarse grained sand with some gravel and traces of cobbles ≃ 1%.
2·0			#1	Thin layers of reddish-brown oxidized sand notably from 0.82-0.88 m and 1.49-1.55 m. Traces of cobbles ≃ 1% in 1.49 -1.55m layer. Coarse beds notably from 1.83-2.87 m.
3·0				Loose to compact, average moisture, more or less uniform, roots attain a depth of 1.43 m.
4·0				End of hole.

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY
4.9	91.4	3.7

TEST TYPE

MOISTURE CONTENT % (20 40 60 80)

⊙ at #1

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 123

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.84

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 8, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, leached light grey soil.
				Oxidized layer: Reddish brown gravelly sand with traces of cobbles ≃ 2%.
1·0				Brown till with greenish overtones: Gravelly and sandy silt. Well graded, dense, average water content, sub-angular to sub-rounded particles. 4% cobbles and 2% boulders, average φ = 10 cm, maximum φ = 30 cm.
2·0				
3·0				Bedrock: Grey quartz sericite phyllite, fine grained, platy, tender, silvery sheen on cleavage planes.
				END OF HOLE
4·0				

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 124

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0 — APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe — DEPTH (m) 3.41

PURPOSE Search for concrete aggregate — DEPTH TO WATER LEVEL (m) Not achieved

DATE October 9, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, leached light grey soil.
				Oxidized layer: Reddish brown sand with some silt and traces of gravel. Cobbles ≃ 2%.
1·0				Medium to fine grained sand with traces to some gravel. Reddish brown to brown, well oxidized, low water content, compact.
2·0				Olive green till: Gravelly silt, passes from sandy to clayey with depth. Well graded, platy appearance, dense, sub-angular to sub-rounded particles, moist, variable plasticity. Cobbles ≃ 4%, boulders ≃ 2% with a maximum φ = 28 cm. Roots attain a depth of 1.71 m.
3·0				
4·0				END OF HOLE

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY

TEST TYPE

MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 125

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.60

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 9, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, leached white soil.
				Brownish red sand with some silt and some gravel.
1·0			#1	Brown gravelly sand with traces of cobbles ≏ 1%. Compact, low water content, maximum φ = 15 cm, sub-angular to sub-rounded particles. Roots attain a depth of 1.07 m.
2·0			#2	Medium to coarse grained brown sand and gravel. 20% cobbles and 8% boulders, sub-angular to sub-rounded particles mostly of granitic origin, well graded, low water content, loose. Average φ = 10 cm, maximum φ = 30 cm. Traces of oxidation throughout.
3·0				
4·0				END OF HOLE

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 126

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.84

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 9, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, leached light grey soil, black earth.
				Greenish grey sandy and gravelly silt.
1·0				Oxidized layer: Reddish brown sand and gravel. Cobbles ≃ 5%.
2·0				Olive green till: Gravelly and sandy silt with some clay. Well graded, high water content, variable plasticity, platy appearance, sub-angular to sub-rounded particles. 5% cobbles and 2% boulders with a maximum φ = 61 cm.
3·0				
4·0				END OF HOLE

DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- ✖ OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 127

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0 APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe DEPTH (m) 3.23

PURPOSE Search for Concrete Aggregate DEPTH TO WATER LEVEL (m) Not Achieved.

DATE Oct. 9/77.

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Moss, organic material, leached light grey soil.						
1·0				Oxidized layer: Rusty brown sand and gravel. Cobbles ≃5%.						
2·0			#1	Brown medium to coarse grained sand & gravel. Cobbles ≃ 5% with an average ϕ of 8 cm & a maximum ϕ = 15 cm. Well graded, loose, average moisture, sub-angular to sub-rounded particles mostly igneous though a good percentage of phyllitic chips ≃30%. Traces of oxidation throughout.	42.4	55.0	2.6	⊙		
3·0				End of hole.						
4·0										

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 128

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.14

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 10, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material leached light grey soil.
				Oxidized layer: Reddish brown to brown gravelly sand with traces of cobbles ≃ 3%.
1·0			#1	Brown medium to coarse grained sand and gravel. Loose, well graded, low water content. 10% cobbles and< 1% boulders with an average φ = 10 cm and a maximum φ=23 cm. Sub-angular to sub-rounded particles mostly of igneous origin. Traces of oxidation throughout. Roots attain a depth of 3.05 m. Cobbles essentially concentrated as of 1.37 m depth.
2·0				
3·0				END OF HOLE
4·0				

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY

TEST TYPE

MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- ✖ OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 129

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0 — APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe — DEPTH (m) 3.54

PURPOSE Search for concrete aggregate — DEPTH TO WATER LEVEL (m) Not achieved

DATE October 10, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % 20 40 60 80	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Moss, organic material, leached light grey soil.						
1·0				Oxidized layer: Reddish brown to brown sand and gravel. Cobbles ≃ 8% and boulders ≃ 1%. Well graded, loose, low water content.						
2·0			#1	Brown medium and coarse grained sand and gravel. Cobbles ≃ 15% and boulders < 1% with an average φ = 10 cm and a maximum φ = 33 cm. Well graded, loose, low water content, sub-angular to sub-rounded particles mostly of granitic origin. Traces of oxidation and rust. % of cobbles and boulders augments at 1.83 m.	52.9	43.6	3.5	⊙		
3·0				END OF HOLE						
4·0										

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 130

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.11

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 10, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, leached light grey soil.
1·0				Brown till: Gravelly sand and silt with 2% cobbles and <1% boulders. Roots and black organic material prominent. Well graded, compact to dense, average moisture, sub-angular to sub-rounded particles with a maximum ϕ = 28 cm. Pockets of gravelly sand noted.
2·0				Horizon of black organic material and reddish brown organic silt, with some sand and some gravel.
3·0			#1	Brown medium to coarse grained sand and gravel. Well graded, loose, average moisture. Sub-angular to sub-rounded particles mostly of granitic origin. Cobbles ≃ 5% and boulders ≃ 5%, with an average ϕ = 13 cm and a maximum ϕ = 46 cm. Traces of oxidation, roots attain a depth of 1.83 m.
4·0				END OF HOLE

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 131

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.66

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 10, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, leached light grey soil.
				Oxidized layer: Reddish brown to brown sand and gravel. Cobbles ≃ 20% and boulders ≃ 2% with a maximum φ = 33 cm. Well graded, loose, sub-angular to sub-rounded particles, low water content.
1·0				
			#1	Brown medium to coarse grained sand and gravel. Cobbles ≃ 10% and boulders ≃ 1% with an average φ = 10 cm and a maximum φ = 33cm. Well graded, low water content, compact, sub-angular to sub-rounded particles mostly of granitic origin. Traces of oxidation and rust, roots attain a depth of 1.92 m.
2·0				
3·0				
4·0				END OF HOLE

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 132

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.99

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 11, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Moss, organic material, leached light grey soil.						
1·0				Oxidized layer: Reddish brown sand and gravel. 10% cobbles and < 1% boulders. Average φ = 10 cm, maximum φ = 23 cm. Loose, well graded, low water content, sub-angular to sub-rounded particles mostly granitic.						
2·0			#1	Brown medium and coarse grained sand and gravel. 8% cobbles with an average φ = 8 cm and a maximum φ = 18 cm. Well graded, loose, low water content, sub-angular to sub-rounded particles mostly granitic. Traces of oxidation.	57.2	41.5	1.3	⊙		
			#2		1.4	96.6	2.0	⊙		
3·0				Brown uniform sand with traces of gravel. Average moisture, loose.						
				END OF HOLE						
4·0										

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 133

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 1.8

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 12, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, leached light grey soil.
1·0				Oxidized layer: Reddish brown gravelly silt and sand passes to a reddish brown sand and gravel, low water content, well graded, loose to compact. 4% cobbles and < 1% boulders. Angular to sub-rounded particles.
2·0				Brown medium to coarse grained sand and gravel. 10% cobbles, 1% boulders. Average φ = 10 cm, maximum φ = 38 cm. Well graded, loose, sub-angular to sub-rounded particles, average moisture. Roots attain a depth of 0.82 m. Traces of oxidation.
3·0				END OF HOLE, REFUSAL ON BEDROCK
4·0				

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

NOTE: Bedrock description: Black, fine grained graphite phyllite.

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 134

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.35

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 13, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth, leached light grey soil.
				Reddish brown sand with some silt and some gravel. Cobbles ≃ 2%.
1·0			#1	Oxidized layer: Brown silt, sand and gravel. Cobbles ≃ 5%. Compact, low water content, well graded. Roots plentiful, traces of oxidation.
2·0			#2	Brown medium to coarse grained sand and gravel. Cobbles ≃ 3%, boulders < 1%, sub-angular to sub-rounded particles mostly granitic, average φ = 8 cm and a maximum φ = 23 cm. Loose, low water content, fairly well graded. Roots attain a depth of 1.31 m.
3·0				Brown gravelly medium to coarse grained sand. Cobbles ≃ 5-10%, boulders < 1% with an average φ=13 cm and a maximum φ = 38 cm. Well graded, loose, low water content, angular to sub-rounded particles mostly igneous though some phyllite ≃ 15%. Traces of oxidation, roots to a depth of 1.92 m.
4·0				

DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

END OF HOLE

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 135

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.60

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 14, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Moss, organic material, black earth, leached light grey soil.						
				Reddish to light brown silt and sand with traces of gravel ≃ 2%.						
1·0				Oxidized layer: Reddish brown sand and gravel. Cobbles ≃ 8%, boulders < 1%.						
			#1	Brown sand and gravel. Cobbles ≃ 10%, boulders ≃ 1%. Average φ = 8 cm and a maximum φ = 25 cm. Interbanded with layers of brown fine silty sand ≃ 13cm thickness.	48.2	47.7	4.1	⊙		
2·0			#2	Brown sand with some silt and traces of gravel. Cobbles ≃ 4%, boulders < 1% with an average φ = 15 cm and a maximum φ = 33 cm, sub-angular to sub-rounded particles mostly granitic though traces of phyllite. Compact, roots attain a depth of 2.62 m though few. Layer of brown silt and sand from 1.77 - 2.01 m, sandy partings noted. Some thin layers of coarse grained sand 5 cm thickness observed.	6.8	73.7	19.5	⊙		
3·0										
4·0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 136

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.75

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 14, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % 20 40 60 80	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Moss, organic material, black earth, leached light grey soil.						
				Oxidized layer: Reddish brown to brown sand with some silt and traces of gravel. Uniform, average water content, compact.						
1·0			#1	Brown sand with some silt and traces of gravel. Uniform, compact, average water content.	2.2	81.2	16.6	⊙		
				Horizon of brown uniform sand and silt. Compact, average water content.						
2·0				Brown gravelly sand with some silt. Cobbles ≃ 4%, boulders < 1%, average φ = 10 cm, maximum φ = 25 cm. Sub-angular to sub-rounded particles essentially granitic, very few phyllite chips. Compact, fairly well graded, average moisture. Roots attain a depth of 2.68 m though not prominent. From 1.92-1.95 m layer of brown sand with some silt. From 2.41-2.53 m, layer of brown silt and sand with uniform distribution and sandy partings.						
3·0			#2		26.9	60.4	12.7	⊙		
4·0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 137

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.96

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 14, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth, leached light grey soil.
			#1	Oxidized layer: Reddish brown silty sand with traces of gravel. Cobbles ≃ 1%.
1·0				Light brown silt and sand with traces of gravel. Uniform, compact, average moisture.
2·0			#2	Medium to coarse grained brown gravelly sand passes to sand and gravel with depth. Cobbles ≃ 8%, boulders ≃ 1%, average φ = 13 cm, maximum φ = 28 cm. Sub-angular to sub-rounded particles mostly granitic although 15% phyllite and schist. Well graded, moist, loose to compact. Traces of oxidation up to 1.83 m. Roots attain a depth of 1.55 m. Lenses of silt and sand noted but few.
3·0				END OF HOLE
4·0				

DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 138

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.81

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 15, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m³	OTHER TESTS
				Moss, organic material, black earth, leached light grey soil.						
				Oxidized layer: From reddish brown to brown passing to a light green sandy silt with traces to some gravel. Cobbles ≃ 3%, compact, fairly uniform, low water content, roots present.						
1·0										
			#1	Brown gravel and sand with traces of silt. Cobbles ≃ 15%, boulders < 1%, angular to sub-rounded particles mostly granitic though a good percentage of phyllite ≃ 20%, average φ = 13 cm, maximum φ = 23 cm. Well graded, compact, low water content. Traces of oxidation and rust. Traces of silt noted in the matrix and on particle coatings. Lens of silty brown sand from 3.51-3.81 m (dimension 30 cm x 70 cm).	55.8	37.8	6.4	⊙		
2·0										
3·0										
4·0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 139

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.69

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 15, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth, leached light grey to white soil.
1·0				Oxidized layer: Reddish brown to burnt orange well calibrated sand and gravel. Cobbles ≃ 20%, boulders ≃ 15%, average φ = 15 cm, maximum φ = 46 cm. Sub-angular to sub-rounded particles, well graded, loose to compact, low moisture content.
2·0			#1	Brown medium to coarse grained gravelly sand. Cobbles ≃ 10%, boulders ≃ 3%, average φ = 10 cm, maximum φ = 64cm. Well graded, sub-angular to sub-rounded particles mostly granitic, traces of phyllite ≃ 5%. Average moisture, loose. Very little oxidation, roots attain a depth of 2.59 m though not a prominent feature. Gravel in layers.
3·0				
4·0				END OF HOLE

DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 140

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.63

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 15, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth, leached light grey soil.
				Reddish brown to brown silt and sand, gravelly to some. Cobbles ≃ 2%.
1·0				Oxidized layer: Reddish brown sand and gravel. Cobbles ≃ 20%, boulders ≃ 10%, average φ = 15 cm, maximum φ = 84 cm, sub-angular to sub-rounded particles, well graded, loose, low moisture content.
2·0			#1	Grey medium to coarse grained gravelly sand. Cobbles ≃ 8%, boulders < 1%, average φ = 10 cm, maximum φ = 23 cm. Sub-angular to sub-rounded particles mostly granitic. High phyllite content in coarse sand and gravel ≃ 30%. Well graded, average moisture, loose to compact. Traces of silt on particle coatings. Roots attain a depth of 1.22 m, oxidation in traces though not prominent.
3·0				
4·0				END OF HOLE

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m³

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- ✖ OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 141

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0 — APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe — DEPTH (m) 4.02

PURPOSE Search for concrete aggregate — DEPTH TO WATER LEVEL (m) Not achieved

DATE October 16, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m³	OTHER TESTS
				Moss, organic material, black earth, leached light grey to white soil.						
				Reddish brown silty sand with traces to some gravel.						
1·0				Brown medium grained sand with some gravel. Fairly oxidated.						
				Horizon of greenish brown silt and sand.						
2·0				Oxidized layer: Reddish brown gravelly sand. Cobbles ≃ 3%, average φ = 8 cm, maximum φ = 15 cm. Well graded, loose, low water content, sub-angular to sub-rounded particles						
			#1	Brown gravelly sand and silt. Cobbles ≃ 2%, sub-angular to sub-rounded particles, maximum φ = 13 cm. Compact. Gravel essentially concentrated from 1.74-2.29 m.	23.5	41.4	35.1	⊙		
3·0										
			#2	Brown gravelly well calibrated sand. Cobbles < 1%, maximum φ = 10 cm, sub-angular particles with some phyllite ≃ 15%. Well graded, loose to compact. The gravel content diminished with depth. Irregular contact with overlying bed (dip=20°S).	33.8	64.8	1.4	⊙		
4·0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 142

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.41

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 16, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth.
1·0				Brown till: Sandy silt, gravelly to some. Cobbles ≃ 5%, boulders ≃ 1%, average φ = 13 cm, maximum φ = 46 cm. Well graded, low water content, platy appearance up to a depth of 1.52 m. Layer of medium grained sand with some coarse from 1.68 - 1.77 m. Roots attain a depth of 2.90 m.
2·0				
3·0				
				END OF HOLE
4·0				

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 143

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.08

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 16, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Moss, organic material, black earth, leached light grey soil.
1·0				Reddish brown gravelly sand. Cobbles ≃ 5%, boulders < 1%, maximum φ = 25 cm, sub-angular to sub-rounded particles. Well graded, compact, low moisture content.
			#1	Light brown silt with some sand and some gravel. Uniform distribution. End of oxidated zone.
2·0				Brown medium to coarse grained gravelly sand. Cobbles ≃ 4%, average φ≃8 cm, maximum φ = 15 cm. Well graded, loose, low water content, sub-angular to sub-rounded particles with ≃ 20% phyllite chips. Some oxidation, roots attain a depth of 1.62 m. Layer of sand and gravel from 1.13-1.89 m.
3·0				Brownish green till: Gravelly and sandy silt. Cobbles ≃ 8%, boulders ≃ 1%, average φ = 13 cm, maximum φ = 33 cm. Well graded, dense, average moisture content, sub-angular particles.
4·0				END OF HOLE

DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 144

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0 APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe DEPTH (m) 0.61

PURPOSE Search for concrete aggregate DEPTH TO WATER LEVEL (m) 0.40

DATE October 17, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Brown medium to coarse grained sand with some gravel. Cobbles ≏ 3%, boulders ≏ 1%, sub-angular to sub-rounded particles. Uniform distribution, moist, loose.
1·0				END OF HOLE
2·0				
3·0				
4·0				

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m³

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 145

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 0.46

DEPTH TO WATER LEVEL (m) 0.37

DATE October 17, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % 20 40 60 80	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Brown medium to coarse grained gravelly sand. Cobbles ≃ 5%, boulders < 1%, sub-angular to sub-rounded particles. Moist, loose to compact, well graded.						
1·0				END OF HOLE						
2·0										
3·0										
4·0										

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- ✖ OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 146

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.41

DEPTH TO WATER LEVEL (m)

DATE October 17, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Brown silty sand passes at 9 cm depth to an oxidized reddish brown gravelly sand. Cobbles ≃ 4% with a maximum φ = 15 cm, sub-angular particles. Moist, well graded, loose.
1·0				Greenish brown till: Gravelly and sandy silt. Cobbles ≃ 8%, boulders ≃ 1%, average φ = 13 cm, maximum φ = 23 cm, sub-angular to sub-rounded particles. Well graded, dense, average moisture.
2·0				
3·0				END OF HOLE
4·0				

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY

NOTE: Surface run-off at 0.43 m, contact between granular material and till.

TEST TYPE

MOISTURE CONTENT % 20 40 60 80

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 147

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0 — APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe — DEPTH (m) 3.93

PURPOSE Search for concrete aggregate — DEPTH TO WATER LEVEL (m) Not achieved

DATE October 17, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
0			#1	Brown gravelly sand with traces of silt. Cobbles ≃ 5%, average φ = 10 cm, maximum φ = 15 cm. Sub-angular to sub-rounded particles mostly granitic though ≃ 10% phyllitic. Interbanded with layers of brown silty sand notably from 0.82 - 0.88, 1.22 - 1.31 and 1.43 - 1.49 m. Sandy partings observed. Well graded, compact, average moisture, traces of oxidation.	31.2	60.1	8.7	⊙		
1.0										
2.0				Brown silty sand with traces of gravel. Uniform, compact, some sandy partings observed. Thin layers of medium grained sand present notably from 2.5 - 2.59 and 2.96 - 3.08 m.						
			#2		7.6	68.4	24.0	⊙		
3.0										
4.0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 148

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for Concrete Aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.08

DEPTH TO WATER LEVEL (m) Not Achieved

DATE Oct. 18/77

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
0			#1	Interbanded layers of green tinted brown sand & silt, brown silty sand, brown medium grained sand & medium to coarse grained sand & gravel. Sandy partings noted in silty beds, cobbles ≃ 1%, compact, sub-angular particles. Some gravel in total description.	10.5	72.7	16.8	⊙		
1.0			#2	Brown well calibrated sand with some gravel. Uniform distribution, compact, low water content, sub-angular particles. Some gravelly layers present. Cobbles ≃ 1%.	16.8	81.5	1.7	⊙		
2.0										
3.0				End of hole.						
4.0										

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 149

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0 — APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe — DEPTH (m) 3.05

PURPOSE Search for concrete aggregate — DEPTH TO WATER LEVEL (m) Not achieved

DATE October 18, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % 20 40 60 80	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
0			#1	Brown medium to coarse grained gravelly sand. Cobbles ≃ 5%, sub-angular particles mostly granitic with an average φ = 6 cm and a maximum φ = 15 cm. Well graded, compact, low water content. Roots attain a depth of 1.37 m. Some oxidation from 0.0 to 0.21 m with traces only, thereafter. From 0.7 - 1.01 m horizon of greenish brown sand and silt with some gravel. Cobbles ≃ 3% with a maximum φ = 15 cm. Some oxidation spots noted, traces of wood and leached light grey soil, roots prominent. Dense, average moisture.	NOTE: Sand and silt horizon not sampled.					
1.0										
2.0										
3.0				END OF HOLE						
4.0										

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 150

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 1.83

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 18, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
				Organic material, black earth, leached light grey soil.
				Brown medium to coarse grained sand with some gravel.
1·0				Olive green till: Gravelly and sandy silt with traces of clay. Fragmented bedrock (quartz sericite phyllite) dispersed throughout. Dense, average moisture, well graded.
2·0				Bedrock: Grey fine grained quartz sericite phyllite. Platy, silvery sheen on cleavage planes, quartz veined.
				END OF HOLE
3·0				
4·0				

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY

TEST TYPE

MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 151

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for Concrete Aggregate.

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.44

DEPTH TO WATER LEVEL (m) Not Achieved

DATE Oct. 18/77

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % 20 40 60 80	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
1·0			#1	Brown medium to coarse grained sand and gravel. Cobbles ≃ 8-10% with an average φ = 8 cm and a maximum φ = 18 cm. Well graded, loose, low moisture content, sub-angular particles mostly igneous though some phyllite chips ≃ 15% specifically in gravel and coarse sand fractions. Traces of oxidation observed though not prominent. Gravel in layers ≃ 10cm to 15 cm thickness.	44.8	54.5	0.7	⊙		
2·0										
3·0				End of hole.						
4·0										

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 152

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0 APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe DEPTH (m) 2.29

PURPOSE Search for concrete aggregate DEPTH TO WATER LEVEL (m) Not achieved

DATE October 18, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
0			#1	Brown medium to coarse grained sand and gravel from 0.0 to 1.22 m passes to a gravelly medium grained sand with a lens of gravel 28 cm thick from 1.22 - 2.29 m. Cobbles ≃ 15%, boulders ≃ 2%: essentially concentrated from 0 - 1.22 m. Average φ = 10 cm maximum φ = 25 cm. Well graded, loose, low water content, sub-angular particles mostly granitic though some phyllite ≃ 25% specifically in gravel and coarse sand fractions.
1·0				
2·0			#2	
				END OF HOLE
3·0				
4·0				

DISTRIBUTION OF MATERIALS %: GRAVEL | SAND | SILT / CLAY

TEST TYPE: MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 153

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.74

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 19, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
0			#1	Brown medium to coarse grained sand and gravel passes with depth to a gravelly sand. Cobbles ≃ 10%, boulders < 1%, average φ = 10cm maximum φ = 23 cm. Cobbles and boulders mainly situated between 0.0 and 0.98 m. Sub-angular particles essentially granitic though some phyllite ≃ 15% prominent in the coarse sand fraction. Well graded, loose, average moisture.
1.0				Olive green till: Gravelly and sandy silt with traces of clay. Well graded, compact to dense, average moisture. Cobbles ≃ 4%, boulders < 1%, average φ = 10 cm, maximum φ = 28 cm. Sub-angular particles.
2.0				
3.0				END OF HOLE
4.0				

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY

TEST TYPE

MOISTURE CONTENT % (20, 40, 60, 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 154

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.66

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 19, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
1·0				Brown uniform silty sand with traces of gravel. Thinly layered ≃ 1 mm with sandy partings. Compact, low water content. Cobbles ≃ 1%.
2·0			#1	Thin horizons of grey silt with some sand observed. Thin layers ≃ 13 cm and less of brown sand and gravelly sand noted.
3·0				
4·0				END OF HOLE

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY

TEST TYPE

MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m³

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- ✖ OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 155

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº: KAM 6163-0

METHOD OF EXCAVATION: Backhoe

PURPOSE: Search for Concrete Aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m): 3.29

DEPTH TO WATER LEVEL (m): Not Achieved

DATE: Oct. 19, 1977.

GEOLOGIC PROFILE					DISTRIBUTION OF MATERIALS %			TEST TYPE		
DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Brown medium to fine grained sand with traces of gravel and traces of silt. Fairly uniform, average moisture, compact.						
1·0			#1	Lens of medium to coarse grained gravelly brown sand with some silt in the matrix. Covers three of the four walls.	13.1	73.5	13.4	⊙		
				Thinly layered uniform brown silt and sand. Compact, average moisture, sandy partings noted.						
2·0			#2	Brown sand and gravel. Cobbles ≃ 3%, boulders ≃ 1%, average φ = 8 cm, maximum φ = 30 cm. Well graded, loose to compact, low water content, sub-angular particles mostly granitic though ≃ 15% phyllite essentially in gravel and coarse sand fractions. Gravel in layers.	35.1	64.2	0.7	⊙		
3·0										
4·0				End of hole. Note: Cobbles ≃ 1% from 0.0 to 1.71 m with a maximum φ of 10 cm.						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- ✕ OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 156

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 2.68

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 19, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS
0			#1	Brown silt and sand with traces of gravel interbanded with brown fine grained sand. Uniform, compact, low moisture content. Sandy partings noted in silt and sand beds. Cobbles ≃ 1%.
1·0				Olive green till: Gravelly and sandy silt. Cobbles ≃ 8%, boulders ≃ 1%, average φ = 10 cm, maximum φ = 30 cm. Well graded, low moisture content, sub-angular to sub-rounded particles, dense material.
2·0				
3·0				END OF HOLE
4·0				

DISTRIBUTION OF MATERIALS %

GRAVEL	SAND	SILT / CLAY

TEST TYPE

MOISTURE CONTENT % (20 40 60 80)

MAXIMUM DRY UNIT WEIGHT t/m3

OTHER TESTS

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- ◬ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 157

APPENDIX D

LABORATORY TESTING

CONSTRUCTION MATERIALS

Moisture Content Determination

November 8, 1977 Samples

Hole No.	Sample	Bottom Depth (m)	Moisture Content (% Dry Wt.)	Comments
TP57	S-1/2	1.0	5.5	Gravel
	S-2/2	1.75	18.5	Sand
TP58	Auger	3.0	3.9	
TP59	S-1/4	1.0	5.2	Sand
	S-2/4	2-3	20.9	Silt
	S-3/4	3.0	16.2	
	S-4/4	3.5	12.8	
TP60	Auger	3.0	3.8	
TP101	S-1/2	1.83	3.9	Gravel
	S-2/2	3.08	7.3	Sand
TP108	S-1/1	2.59	3.9	Gravel
TP114	S-1/2	1.92	4.2	Gravel
	S-2/2	3.35	3.6	Sand
TP122	S-1/3	1.65	3.4	Gravel
	S-2/3	3.23	4.3	Sand
	S-3/3	4.27	7.6	Sand
TP123	S-1/1	3.81	5.1	Sand
TP128	S-1/1	3.23	4.2	Gravel
TP130	S-1/1	3.54	3.6	Gravel
TP133	S-1/2	2.47	2.9	Gravel
	S-2/2	2.99	3.6	Gravel
TP136	S-1/2	1.77	2.9	Gravel
	S-2/2	3.60	7.4	Sand
TP137	S-1/2	1.83	6.6	Gravel
	S-2/2	3.75	6.4	Sandy Gravel
TP139	S-1/1	3.81	3.5	
TP142	S-1/2	2.80	10.1	Silt
	S-2/2	4.02	3.2	Sand

.....2

Hole No.	Sample	Bottom Depth (m)	Moisture Content (% Dry Wt.)	Comments
TP148	S-1/2	1.68	4.7	
	S-2/2	3.93	8.9	Sand
TP149	S-1/2	1.40	12.3	
	S-2/2	3.08	2.7	
TP152	S-1/1	2.44	2.4	
TP156	S-1/2	1.71	5.7	
	S-2/2	3.29	2.1	

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#57 @ 1.5 - 1.75 TYPE OF SAMPLE S 2/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"		
¾"		
½"		
⅜"		
No. 4	100.0	100.0
No. 8		
PAN		

FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	0.7	0.7
No. 16	0.5	1.2
No. 30	0.3	1.5
No. 50	0.6	2.1
No. 100	5.1	7.2
No. 200	25.5	32.7
PASS No. 200	67.3	100.0
F.M.		.13

SHAPE 100% angular and subangular.

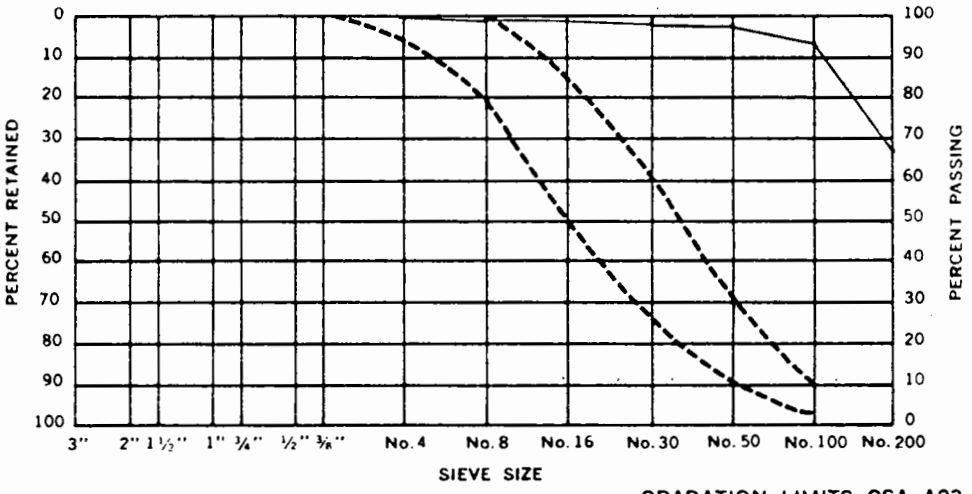
PERCENT CRUSH
SOUNDNESS (VISUAL INSPECTION)

COAL CONTENT
COMMENTS Some elongated and flat stones.

F.M. RANGE 2.2-2.6 FINE SAND; 2.6-2.9 MEDIUM SAND; 2.9-3.2 COARSE SAND

PERCENT SAND 99.4
PERCENT FINER NO. 200 67.3
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 2.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 57

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

GRAIN SIZE CURVE

LAB ORDER NO.	S 2687
CLIENT	34017
SAMPLE	TP58 & TP-60
SOURCE	
HOLE	DEPTH 3 M DATE REC'D.
TECHNICIAN HH	DATE TESTED 3/10/77

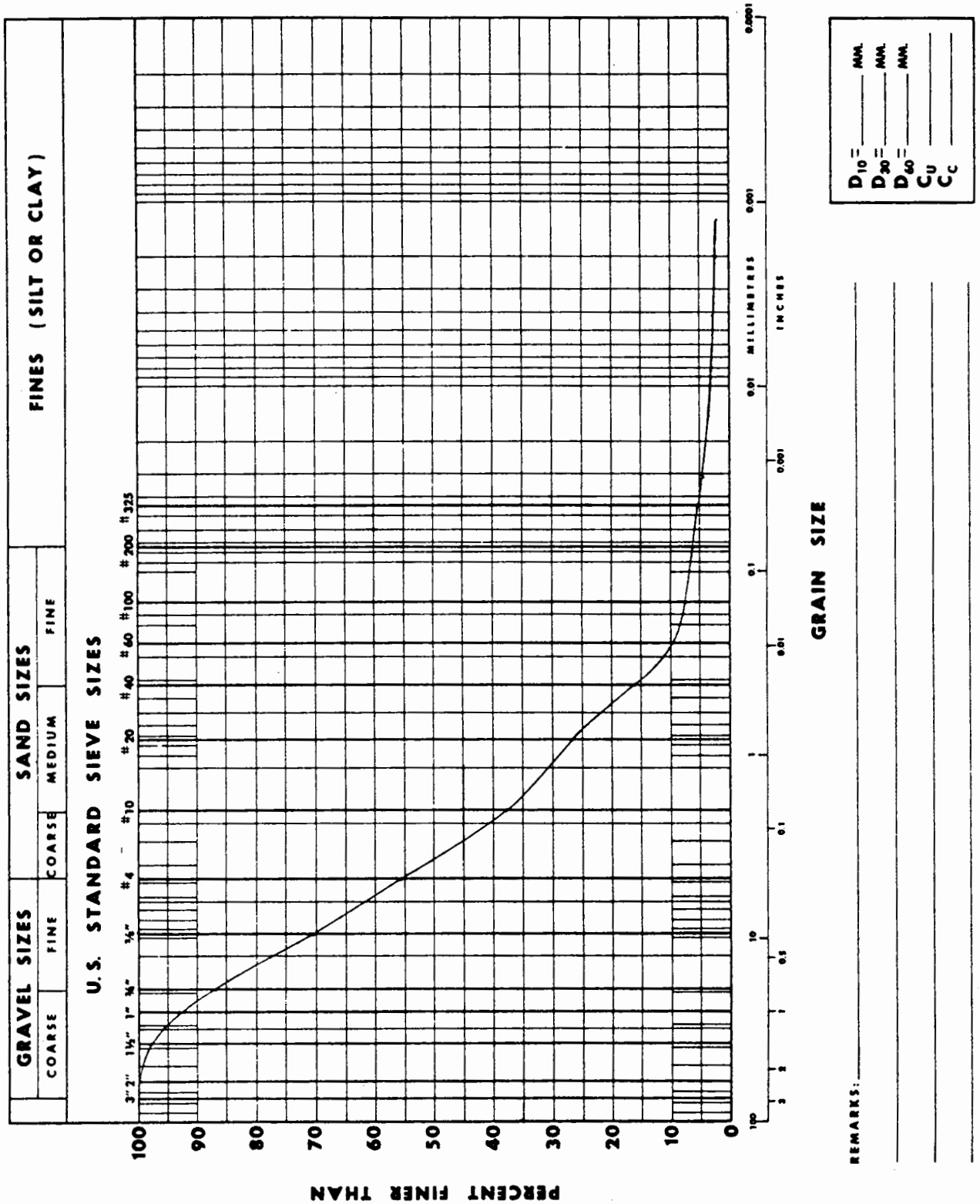


PLATE 12

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#59@ 2 - 3M TYPE OF SAMPLE S 2/4 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"		
¾"		
½"		
⅜"		
No. 4	100.0	100.0
No. 8		
PAN		

FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	0.7	0.7
No. 16	0.6	1.3
No. 30	0.6	1.9
No. 50	2.2	4.1
No. 100	12.9	17.0
No. 200	22.6	39.6
PASS No. 200	60.4	100.0
F.M.		.25

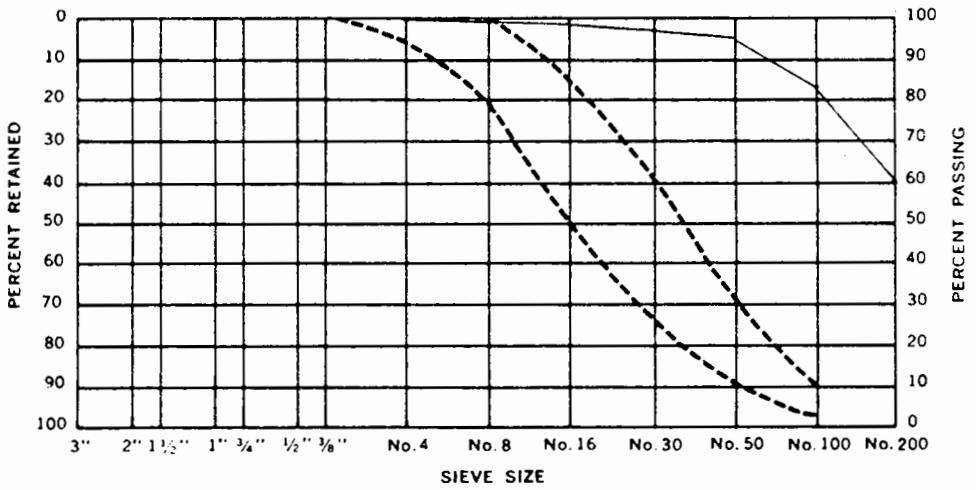
SHAPE 97% angular and subangular.
3% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS

F.M. RANGE		
	2.2-2.6	FINE SAND
	2.6-2.9	MEDIUM SAND
	2.9-3.2	COARSE SAND

PERCENT SAND 98.9
PERCENT FINER NO. 200 60.4
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 58

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#59 @ 3m — TYPE OF SAMPLE S 3/4 — SAMPLED BY
DATE SAMPLED — DATE RECEIVED — DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"	21.6	21.6
¾"	5.8	27.4
½"	17.8	45.2
⅜"	18.6	63.8
No. 4	36.2	100.0
No. 8		
PAN		

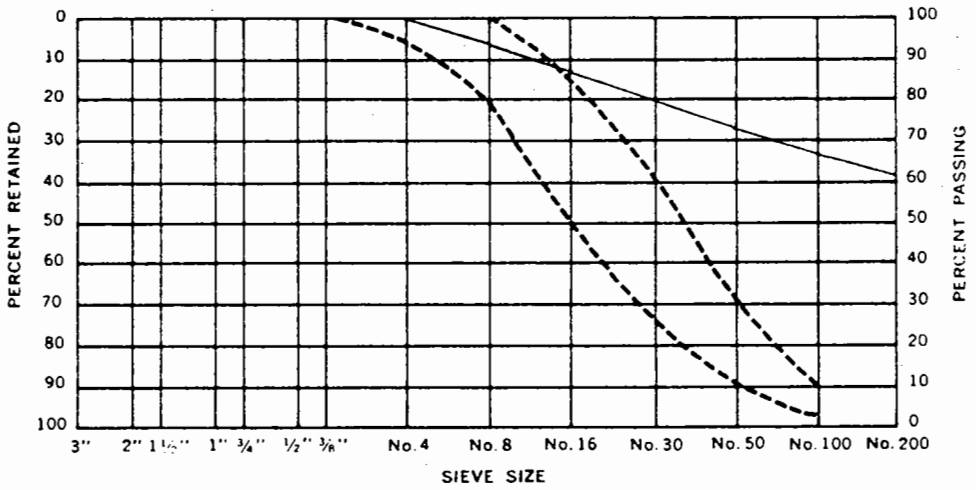
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	6.9	6.9
No. 16	6.7	13.6
No. 30	6.4	20.0
No. 50	6.8	26.8
No. 100	5.5	32.3
No. 200	6.3	38.6
PASS No. 200	61.4	100.0
F.M.		1.0

SHAPE 96% angular and subangular.
4% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS

F.M. RANGE 2.2-2.6 FINE SAND; 2.6-2.9 MEDIUM SAND; 2.9-3.2 COARSE SAND
PERCENT SAND 88.5
PERCENT FINER NO. 200 61.4
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED — TECHNICIAN — GRADATION LIMITS CSA A23

PLATE 59

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#59 @ 3.5M TYPE OF SAMPLE S 4/4 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"	26.6	26.6
¾"	13.8	40.4
½"	15.9	56.3
⅜"	11.7	68.0
No. 4	32.0	100.0
No. 8		
PAN		

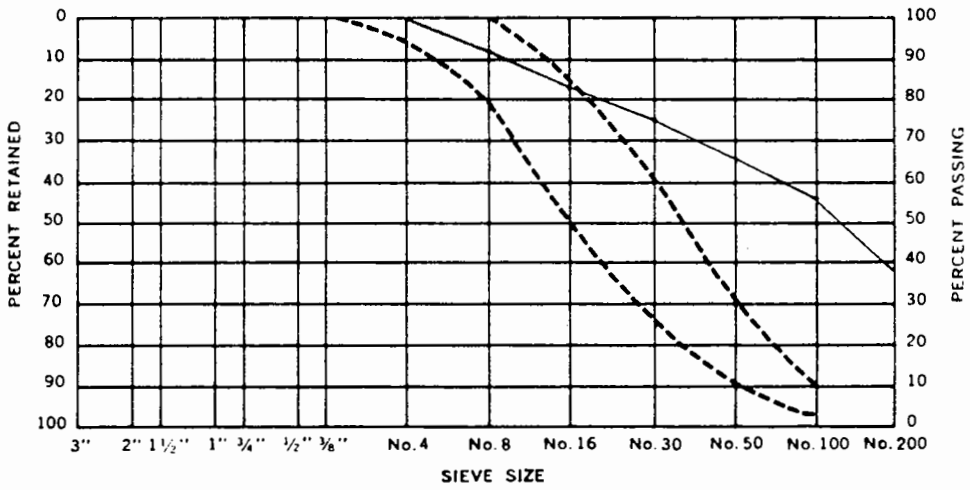
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	8.8	8.8
No. 16	8.2	17.0
No. 30	7.9	24.9
No. 50	8.9	33.8
No. 100	9.6	43.4
No. 200	17.5	60.9
PASS No. 200	39.1	100.0
F.M.		1.3

SHAPE 98% angular and subangular.
2% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 77.6
PERCENT FINER NO. 200 39.1
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED TECHNICIAN GRADATION LIMITS CSA A23

PLATE 60

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#101 @ 0.61 - 1.83 TYPE OF SAMPLE S 1/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"	9.4	9.4
¾"	11.4	20.8
½"	12.1	32.9
⅜"	17.4	50.3
No. 4	49.7	100.0
No. 8		
PAN		

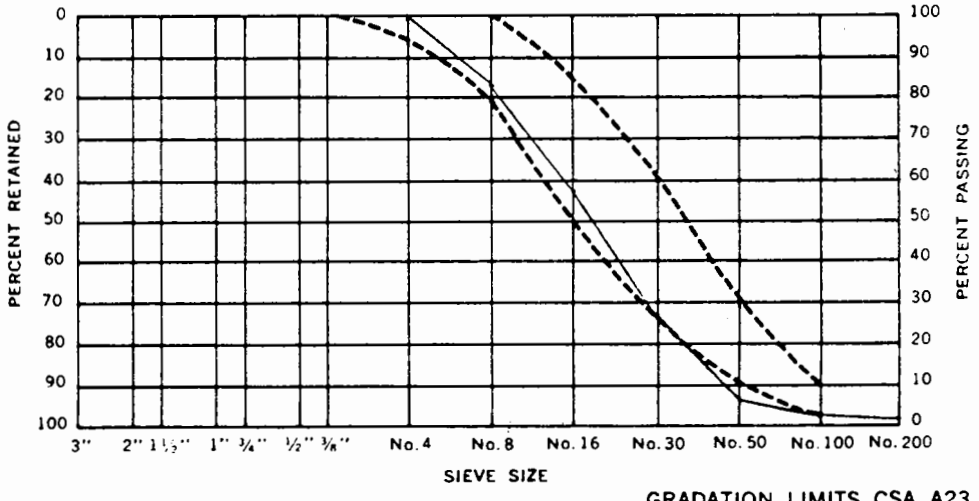
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	17.8	17.8
No. 16	24.1	41.9
No. 30	28.4	70.3
No. 50	22.8	93.1
No. 100	5.0	98.1
No. 200	0.8	98.9
PASS No. 200	1.1	100.0
F.M.		3.2

SHAPE 94% angular and subangular.
6% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Some flat and elongated stones, occasional mica stone (poor).

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 75.8
PERCENT FINER NO. 200 1.1
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 4.0 COAL REMOVED
COAL CONTENT
COMMENTS No coal test done.

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 30

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#101 @ 1.83 - 3.08 TYPE OF SAMPLE S 2/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"		
¾"		
½"		
⅜"		
No. 4		
No. 8		
PAN		

FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	0.1	0.1
No. 16	0.1	0.2
No. 30	2.3	2.5
No. 50	44.3	46.8
No. 100	45.4	92.2
No. 200	6.0	98.2
PASS No. 200	1.8	100.0
F.M.		1.4

SHAPE

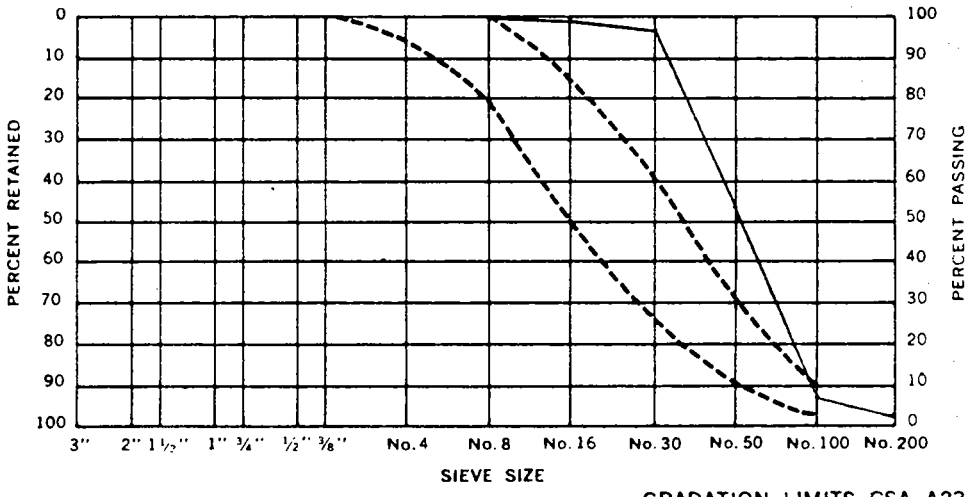
PERCENT CRUSH
SOUNDNESS (VISUAL INSPECTION)

COAL CONTENT
COMMENTS

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND

PERCENT SAND 100.0
PERCENT FINER NO. 200 1.8
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 2.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 31

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#108 @ 0.34 - 2.59 TYPE OF SAMPLE S 1/1 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"	25.1	25.1
¾"	16.1	41.2
½"	20.0	61.2
⅜"	11.5	72.7
No. 4	27.3	100.0
No. 8		
PAN		

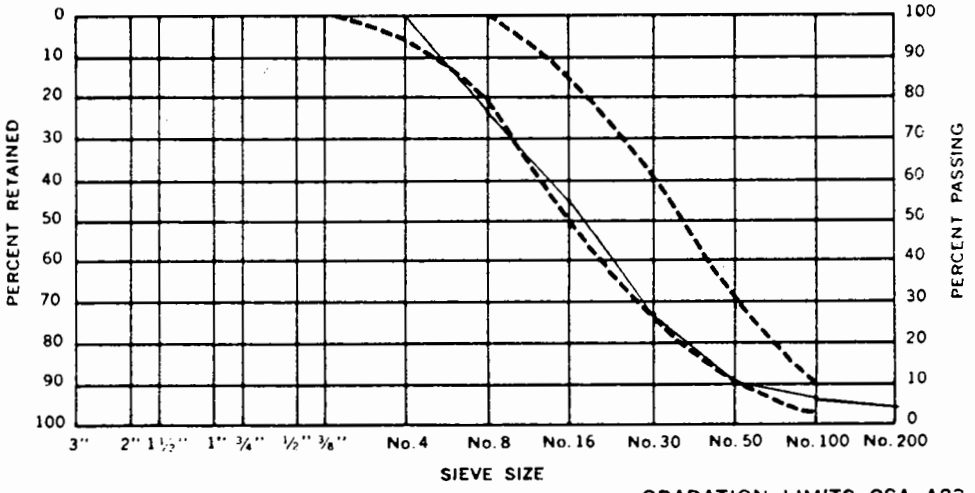
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	22.5	22.5
No. 16	23.9	46.4
No. 30	25.4	71.8
No. 50	17.9	89.7
No. 100	4.5	94.2
No. 200	2.0	96.2
PASS No. 200	3.8	100.0
F.M.		3.2

SHAPE 95% angular and subangular.
5% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Several elongated and flat stones.

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 3.3 COARSE SAND
PERCENT SAND 56.4
PERCENT FINER NO. 200 3.8
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 3.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 32

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#114 @ 0.67 - 1.92 TYPE OF SAMPLE S 1/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"	13.4	13.4
¾"	12.1	25.5
½"	15.8	41.3
⅜"	17.7	59.0
No. 4	41.0	100.0
No. 8		
PAN		

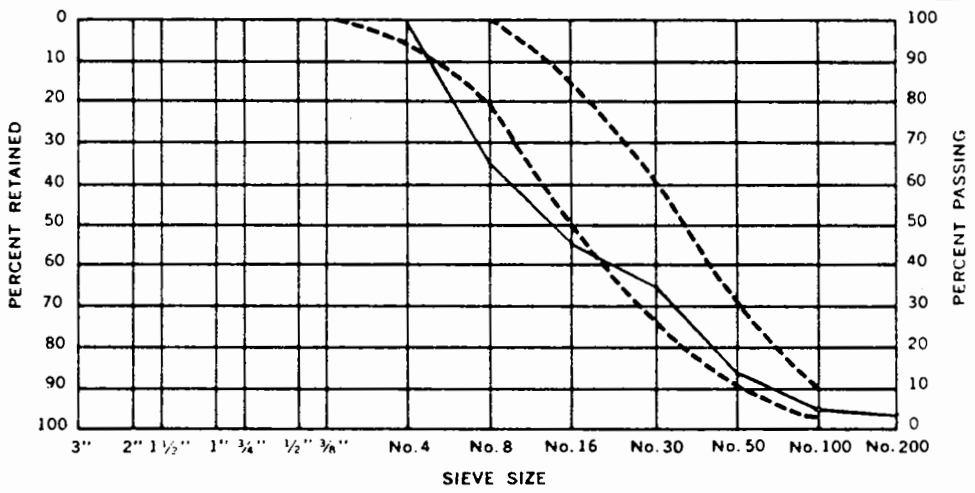
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	34.8	34.8
No. 16	19.2	54.0
No. 30	12.5	66.5
No. 50	20.6	87.1
No. 100	7.8	94.9
No. 200	2.3	97.2
PASS No. 200	2.8	100.0
F.M.		3.4

SHAPE Angular and subangular = 80%.
Rounded and subrounded = 20%.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION)

COAL CONTENT
COMMENTS Some elongated and flat stones, soft stones (poor).

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 51.2
PERCENT FINER NO. 200 2.8
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 3.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 33

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#114 @ 1.92 - 3.35 TYPE OF SAMPLE S 2/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

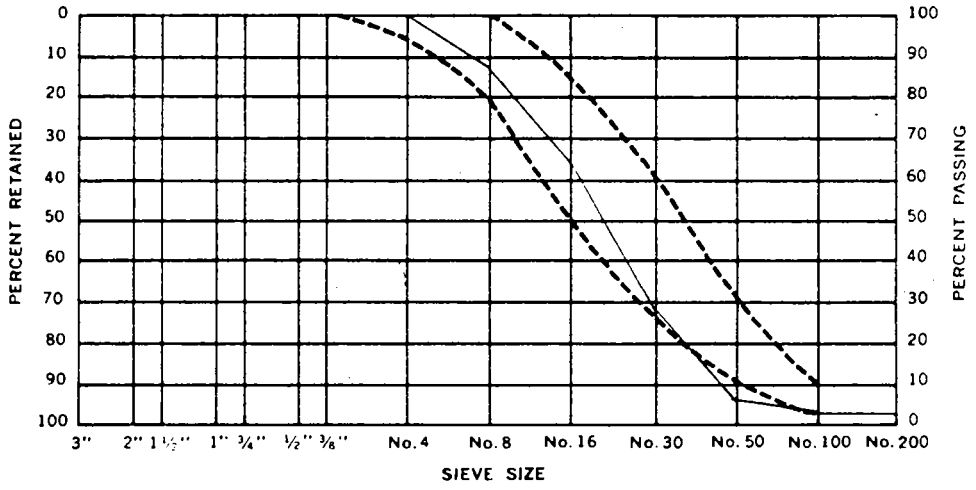
COARSE AGGREGATE			FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED		SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE		INDIVIDUAL	CUMULATIVE
3"			No. 4		
2"			No. 8	11.9	11.9
1½"			No. 16	23.7	35.6
1"			No. 30	36.1	71.7
¾"	14.4	14.4	No. 50	21.8	93.5
½"	15.7	30.1	No. 100	4.0	97.5
⅜"	22.1	52.2	No. 200	0.4	98.4
No. 4	47.8	100.0	PASS No. 200	1.6	100.0
No. 8			F.M.		3.1
PAN					

SHAPE Angular and subangular = 95%.
Rounded and subrounded = 5%.
PERCENT CRUSH Nil
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 3.1 COARSE SAND
PERCENT SAND 87.3
PERCENT FINER NO. 200 1.6
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 34

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#122 @ 1.01 - 1.65 TYPE OF SAMPLE S 1/3 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"	9.5	9.5
1½"	7.6	17.1
1"	23.2	40.3
¾"	10.2	50.5
½"	18.7	69.2
⅜"	11.8	81.0
No. 4	19.0	100.0
No. 8		
PAN		

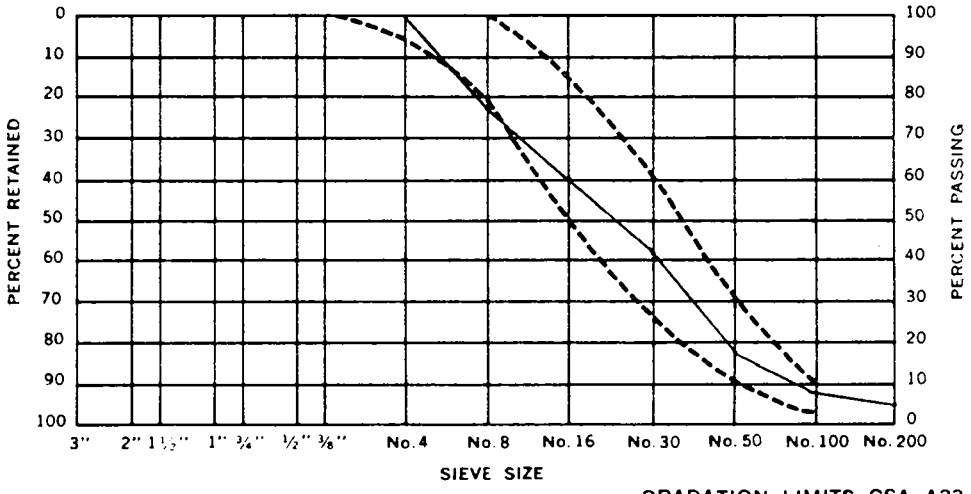
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	21.5	21.5
No. 16	18.3	39.8
No. 30	19.1	58.9
No. 50	22.9	81.8
No. 100	10.0	91.8
No. 200	3.0	94.8
PASS No. 200	5.2	100.0
F.M.		2.9

SHAPE Angular and subangular = 90%.
Rounded and subrounded = 10%.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 36.4
PERCENT FINER NO. 200 5.2
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 2 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 35

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#122 @ 1.65 - 3.23 TYPE OF SAMPLE S 2/3 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

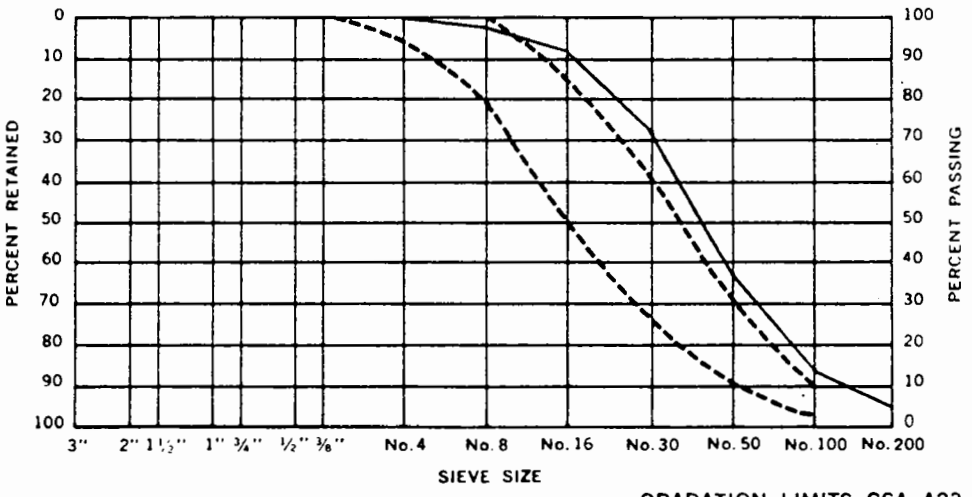
COARSE AGGREGATE			FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED		SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE		INDIVIDUAL	CUMULATIVE
3"			No. 4		
2"			No. 8	1.7	1.7
1½"			No. 16	7.4	9.1
1"			No. 30	20.1	29.2
¾"			No. 50	34.4	63.6
½"	13.2	13.2	No. 100	22.5	86.1
⅜"	28.9	42.1	No. 200	8.8	94.9
No. 4	57.9	100.0	PASS No. 200	5.1	100.0
No. 8			F.M.		1.9
PAN					

SHAPE Angular and subangular = 90%.
Rounded and subrounded = 10%.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 97.9
PERCENT FINER NO. 200 5.1
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 3 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED TECHNICIAN

GRADATION LIMITS CSA A23

PLATE 36

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#122 @ 3.23 - 4.27 TYPE OF SAMPLE S 3/3 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"		
¾"		
½"		
⅜"		
No. 4	100.0	100.0
No. 8		
PAN		

FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	.5	.5
No. 16	.5	1.0
No. 30	.8	1.8
No. 50	3.2	5.0
No. 100	28.8	33.8
No. 200	33.1	66.9
PASS No. 200	33.1	100.0
F.M.		.42

SHAPE 100% angular and subangular.

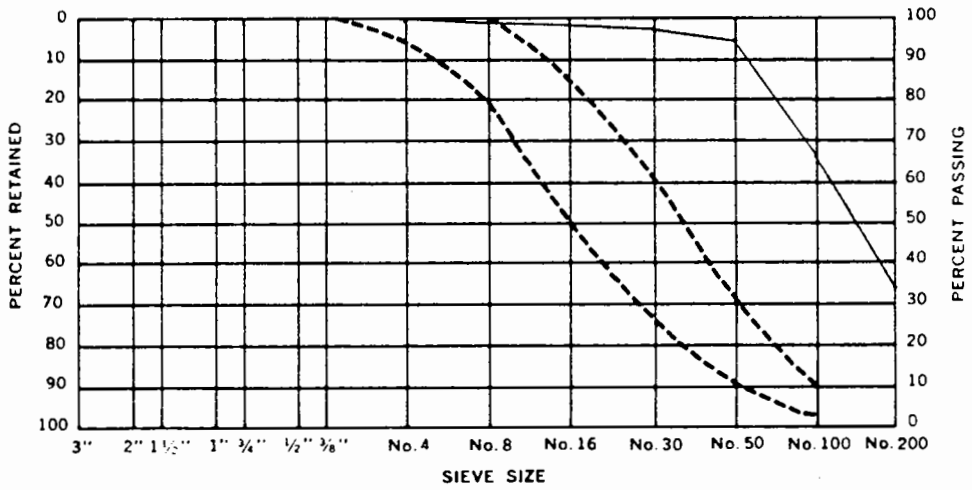
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND

PERCENT SAND 99.8
PERCENT FINER NO. 200 33.1
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23

PLATE 37

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#123 @ 0.61 - 3.81 TYPE OF SAMPLE S 1/1 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"		
¾"		
½"	15.1	15.1
⅜"	10.8	25.9
No. 4	74.1	100.0
No. 8		
PAN		

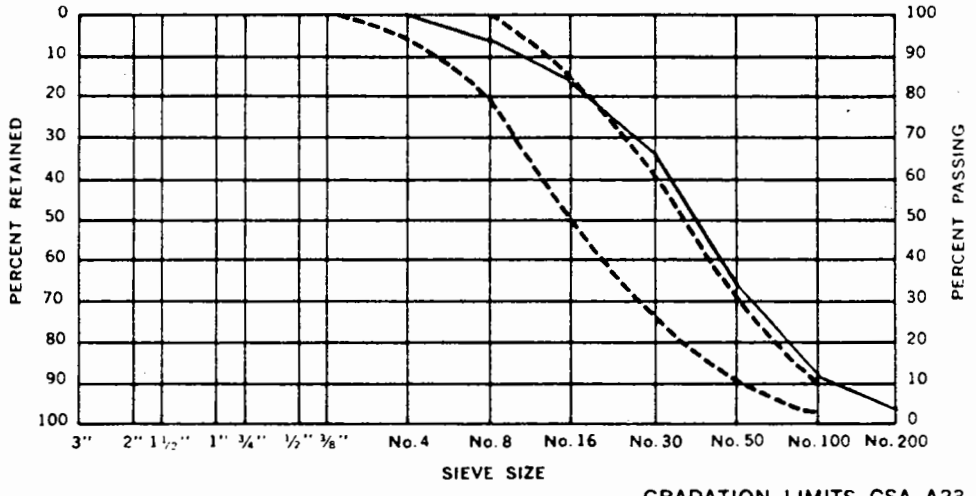
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	5.8	5.8
No. 16	10.5	16.3
No. 30	17.8	34.1
No. 50	33.2	67.3
No. 100	21.5	88.8
No. 200	7.3	96.1
PASS No. 200	3.9	100.0
F.M.		1.8

SHAPE Angular and subangular = 95%.
Rounded and subrounded = 5%.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Some elongated stones.

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 95.1
PERCENT FINER NO. 200 3.9
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 2 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23

PLATE 38

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#128 @ 1.49 - 3.23 TYPE OF SAMPLE S 1/1 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"	18.2	18.2
1"	20.3	38.5
¾"	8.8	47.3
½"	15.3	62.6
⅜"	10.0	72.6
No. 4	27.4	100.0
No. 8		
PAN		

FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	21.9	21.9
No. 16	24.7	46.6
No. 30	23.6	70.2
No. 50	17.7	87.9
No. 100	5.6	93.5
No. 200	1.9	95.4
PASS No. 200	4.6	100.0
F.M.		3.2

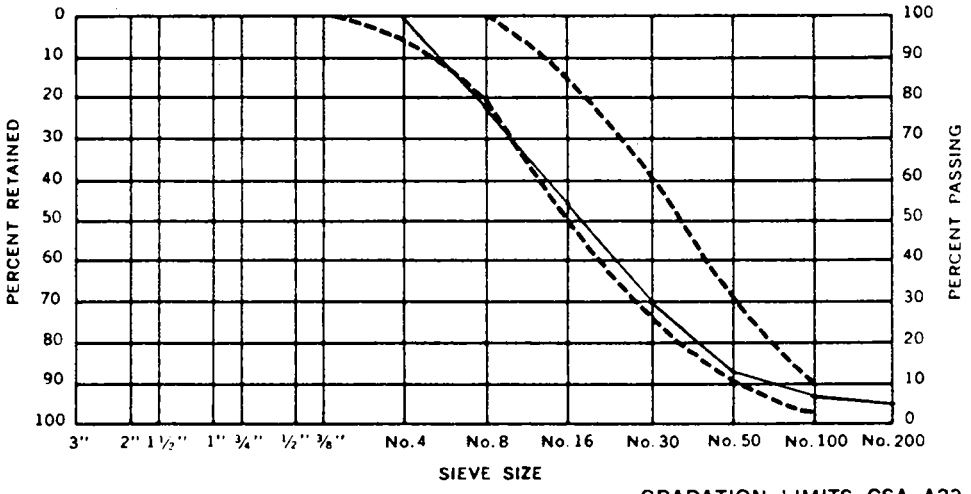
SHAPE 96% angular and subangular.
4% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Several elongated and flat stones.

F.M. RANGE		
	2.2-2.6	FINE SAND
	2.6-2.9	MEDIUM SAND
	2.9-3.2	COARSE SAND

PERCENT SAND 57.6
PERCENT FINER NO. 200 4.6
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 0-1 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 39

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client.

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#130 @ 1.46 - 3.54 TYPE OF SAMPLE S 1/1 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"	3.3	3.3
1"	16.1	19.4
¾"	15.6	35.0
½"	17.1	52.1
⅜"	13.5	65.6
No. 4	34.4	100.0
No. 8		
PAN		

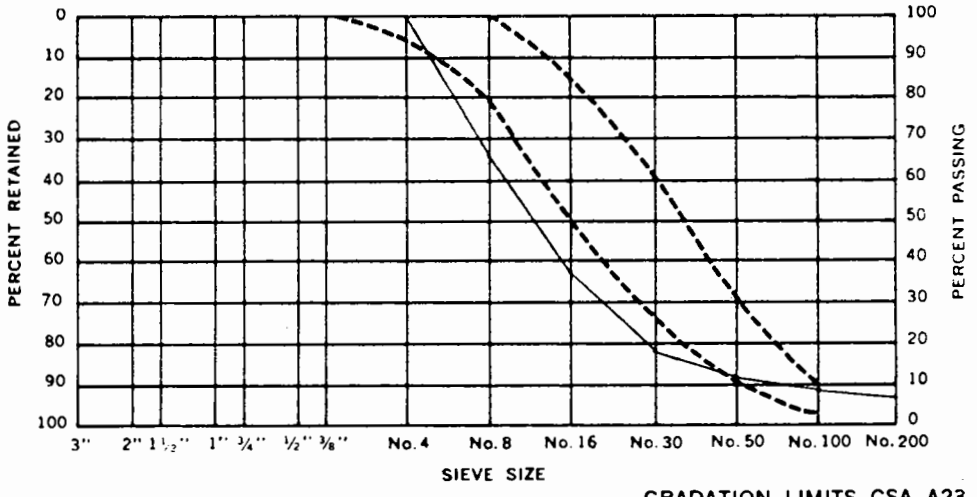
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	33.9	33.9
No. 16	28.2	62.1
No. 30	18.5	80.6
No. 50	8.5	89.1
No. 100	2.3	91.4
No. 200	1.2	92.6
PASS No. 200	7.4	100.0
F.M.		3.6

SHAPE 96% angular and subangular.
4% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Several elongated and flat stones.

F.M. RANGE 2.2-2.6 FINE SAND; 2.6-2.9 MEDIUM SAND; 2.9-3.2 COARSE SAND
PERCENT SAND 47.1
PERCENT FINER NO. 200 7.4
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 0-1 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 40

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#133 @ 1.74 - 2.47 TYPE OF SAMPLE S 1/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"	3.9	3.9
1"	16.1	20.0
¾"	18.0	38.0
½"	18.6	56.6
⅜"	14.2	70.8
No. 4	29.2	100.0
No. 8		
PAN		

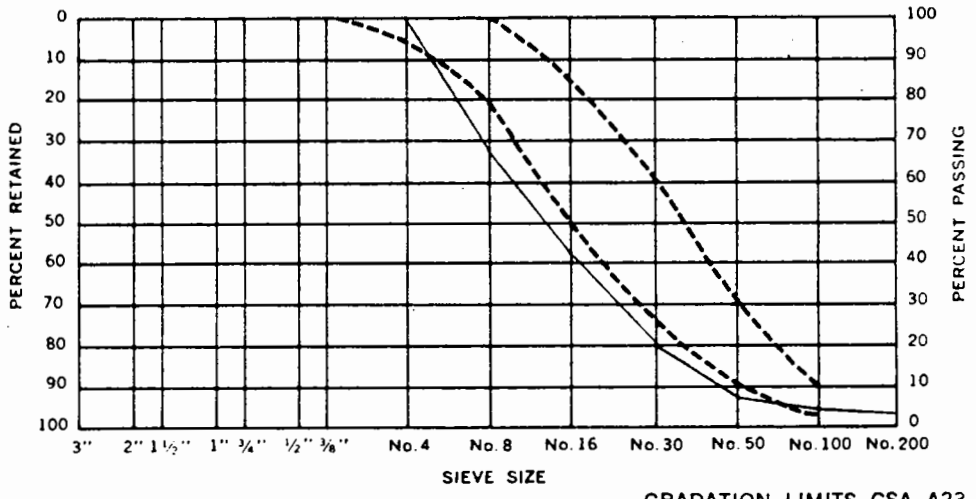
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	32.3	32.3
No. 16	26.0	58.3
No. 30	21.2	79.5
No. 50	12.7	92.2
No. 100	3.4	95.6
No. 200	1.4	97.0
PASS No. 200	3.0	100.0
F.M.		3.6

SHAPE 96% angular and subangular.
4% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Some flat and elongated stones.

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 42.8
PERCENT FINER NO. 200 3.0
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 2.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23

PLATE 41

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#133 @ 2.47 - 2.99 TYPE OF SAMPLE S 2/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"		
¾"		
½"	11.1	11.1
⅜"	7.1	18.2
No. 4	81.8	100.0
No. 8		
PAN		

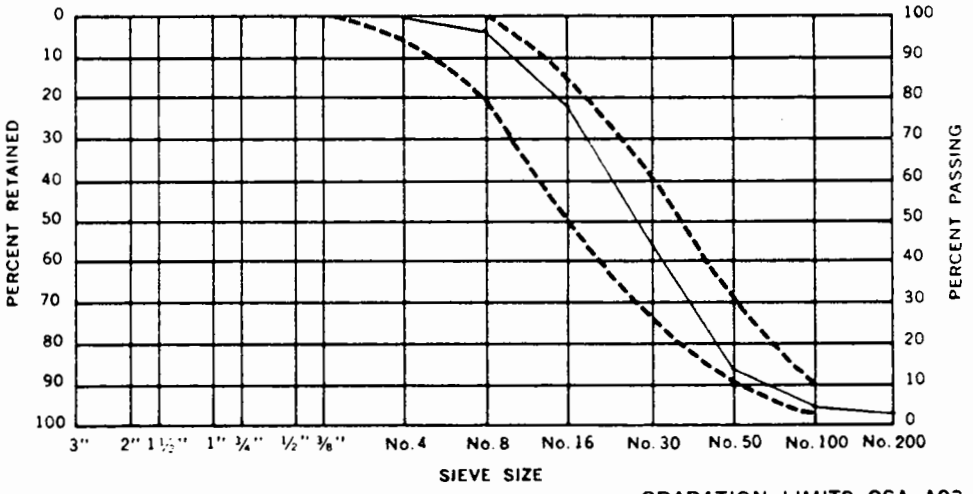
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	4.3	4.3
No. 16	17.3	21.6
No. 30	35.5	57.1
No. 50	31.2	88.3
No. 100	7.8	96.1
No. 200	1.9	98.0
PASS No. 200	2.0	100.0
F.M.		2.7

SHAPE 98% flat and angular-elongated.
2% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Poor.

COAL CONTENT
COMMENTS

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 98.6
PERCENT FINER NO. 200 2.0
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 0-1 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23

PLATE 42

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP #136 @ 1.28 - 1.77 TYPE OF SAMPLE S 1/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"	11.1	11.1
1"	33.3	44.4
¾"	15.7	60.1
½"	12.6	12.7
⅜"	9.4	82.1
No. 4	17.9	100.0
No. 8		
PAN		

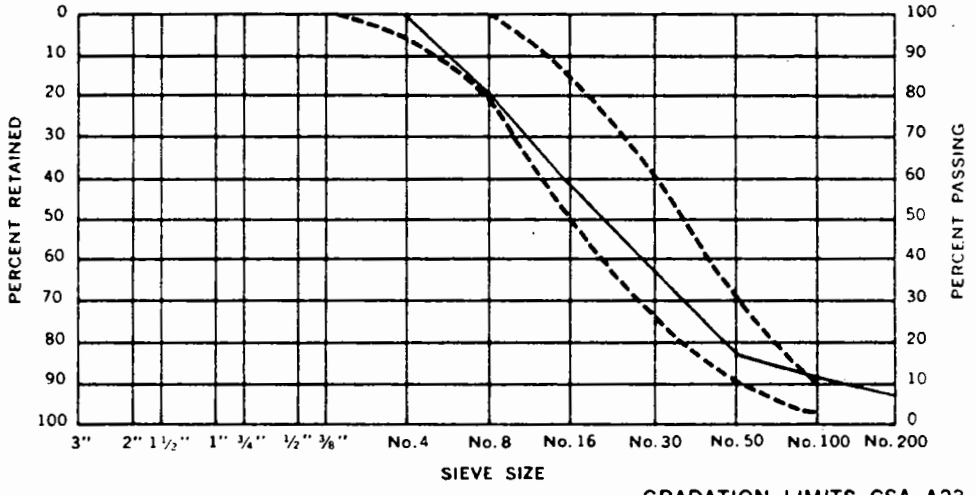
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	19.8	19.8
No. 16	20.7	40.5
No. 30	22.6	63.1
No. 50	19.1	82.2
No. 100	6.3	88.5
No. 200	3.5	92.0
PASS No. 200	8.0	100.0
F.M.		2.9

SHAPE 96% angular and subangular.
4% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Some flat and elongated stones.

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 51.8
PERCENT FINER NO. 200 8.0
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 0-1 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 43

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#136 @ 1.77 - 3.60 TYPE OF SAMPLE S 2/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"	35.5	35.5
¾"	4.4	39.9
½"	14.4	54.3
⅜"	16.8	71.1
No. 4	28.9	100.0
No. 8		
PAN		

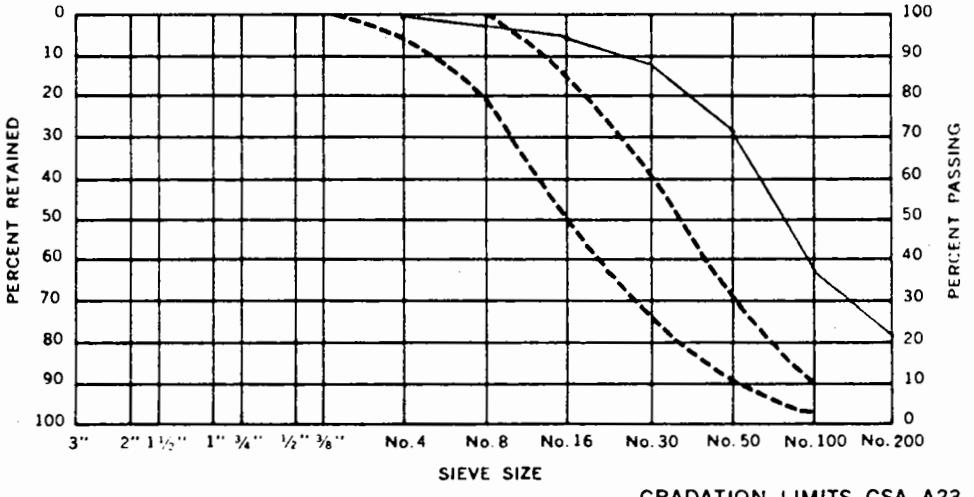
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	2.7	2.7
No. 16	3.1	5.8
No. 30	4.8	10.6
No. 50	18.5	29.1
No. 100	32.5	61.6
No. 200	17.5	79.1
PASS No. 200	20.9	100.0
F.M.		1.1

SHAPE 97% angular and subangular.
3% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Some flat and elongated stones (poor).

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 93.2
PERCENT FINER NO. 200 20.9
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 0-1 COAL REMOVED
COAL CONTENT
COMMENTS Silt FM (1.10)

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23

PLATE 44

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#137 @ 0.49 - 1.83 TYPE OF SAMPLE S 1/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"		
¾"		
½"	31.8	31.8
⅜"	17.9	49.7
No. 4	50.3	100.0
No. 8		
PAN		

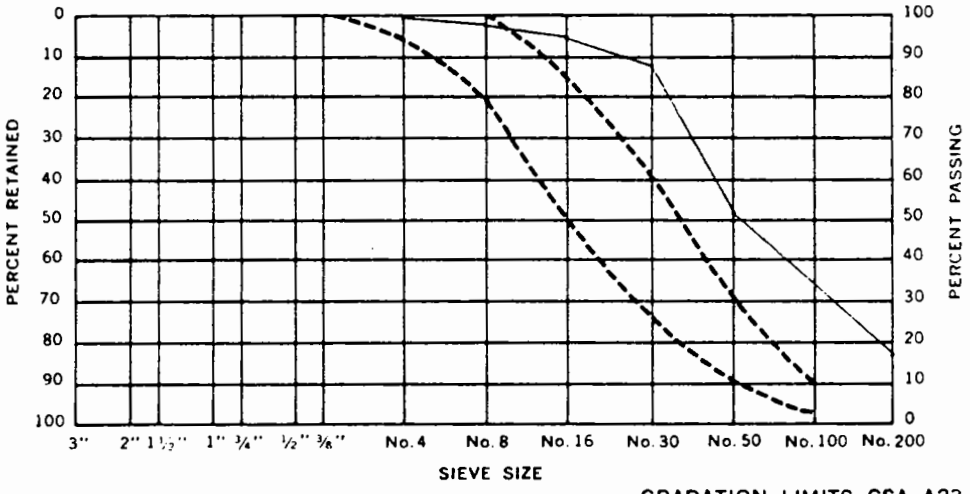
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	1.7	1.7
No. 16	3.4	5.1
No. 30	5.8	10.9
No. 50	17.7	28.6
No. 100	29.0	57.6
No. 200	25.4	83.0
PASS No. 200	17.0	100.0
F.M.		1.0

SHAPE 98% angular and subangular.
2% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS A few flat and elongated stones.

2.2-2.6 FINE SAND
F.M. RANGE 2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 97.8
PERCENT FINER NO. 200 17.0
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 3.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23

PLATE 45

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#137 @ 1.83 - 3.75 TYPE OF SAMPLE S 2/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"	15.2	15.2
1"	14.1	29.3
¾"	10.8	40.1
½"	14.2	54.3
⅜"	13.2	67.5
No. 4	32.5	100.0
No. 8		
PAN		

FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	11.8	11.8
No. 16	12.5	24.3
No. 30	14.4	38.7
No. 50	22.6	61.3
No. 100	14.2	75.5
No. 200	7.2	82.7
PASS No. 200	17.3	100.0
F.M.		2.1

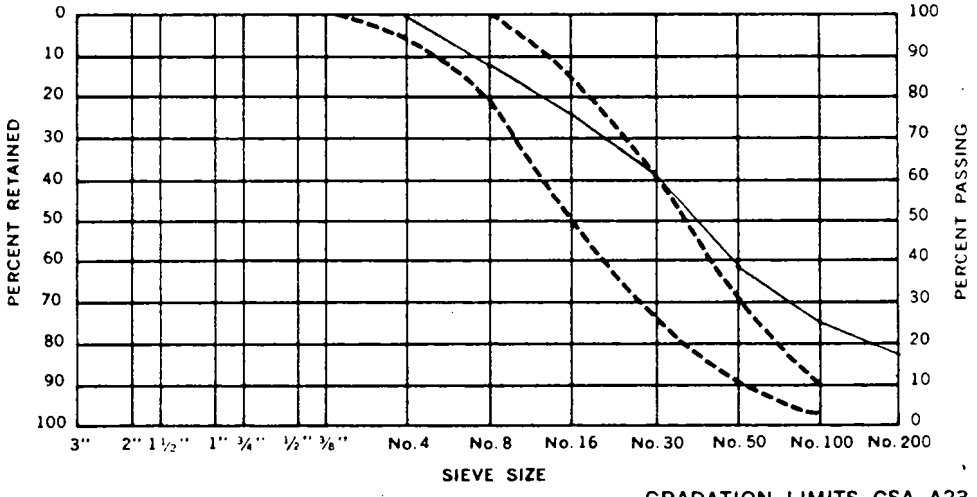
SHAPE 95% angular and subangular.
5% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Some elongated and flat stones (poor).

F.M. RANGE	2.2-2.6	FINE SAND
	2.6-2.9	MEDIUM SAND
	2.9-3.2	COARSE SAND
PERCENT SAND	73.1	
PERCENT FINER NO. 200	17.3	

ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 0-1 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 46

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#139 @ 1.01 - 3.81 TYPE OF SAMPLE S 1/1 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"	4.6	4.6
1"	15.9	20.5
¾"	17.3	37.8
½"	18.7	56.5
⅜"	13.1	69.6
No. 4	30.4	100.0
No. 8		
PAN		

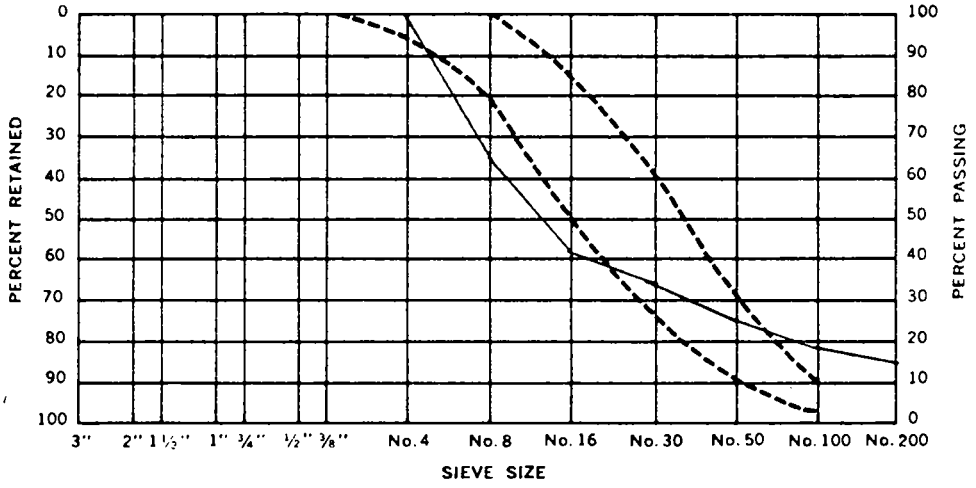
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	36.5	36.5
No. 16	22.7	59.2
No. 30	8.0	67.2
No. 50	8.0	75.2
No. 100	6.0	81.2
No. 200	4.3	85.5
PASS No. 200	14.5	100.0
F.M.		3.2

SHAPE 95% angular and subangular.
5% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Several elongated and flat stones (poor).

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 44.2
PERCENT FINER NO. 200 14.5
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 0-1 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23

PLATE 47

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#142 @ 1.74 - 2.80 TYPE OF SAMPLE S 1/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"	27.3	27.3
¾"	16.6	43.9
½"	14.4	58.3
⅜"	12.6	70.9
No. 4	29.1	100.0
No. 8		
PAN		

FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	7.6	7.6
No. 16	7.8	15.4
No. 30	6.3	21.7
No. 50	5.8	27.5
No. 100	8.5	36.0
No. 200	18.1	54.1
PASS No. 200	45.9	100.0
F.M.		1.1

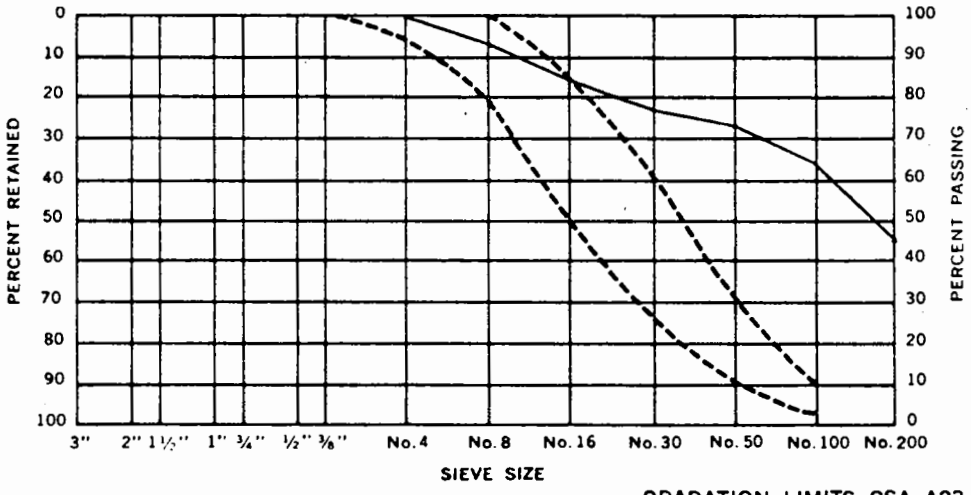
SHAPE 95% angular and subangular.
5% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Some elongated and flat stones. Very silty and clayey material.

F.M. RANGE		
	2.2-2.6	FINE SAND
	2.6-2.9	MEDIUM SAND
	2.9-3.2	COARSE SAND

PERCENT SAND 76.5
PERCENT FINER NO. 200 45.9
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 48

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#142 @ 2.80 - 4.02 TYPE OF SAMPLE S 2/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"	31.2	31.2
¾"	9.1	40.3
½"	17.5	57.8
⅜"	14.1	71.9
No. 4	28.1	100.0
No. 8		
PAN		

FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	16.1	16.1
No. 16	21.2	37.3
No. 30	23.5	60.8
No. 50	24.1	84.9
No. 100	10.3	95.2
No. 200	2.7	97.9
PASS No. 200	2.1	100.0
F.M.		2.9

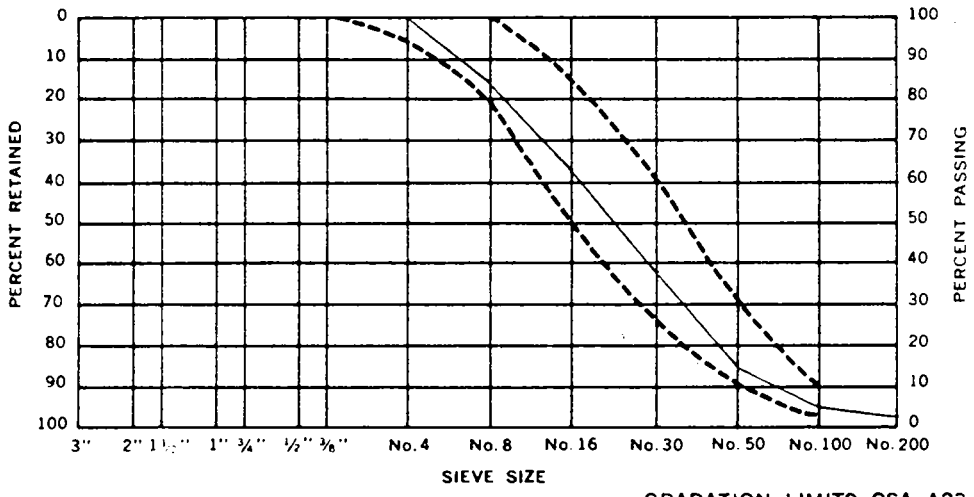
SHAPE 80% angular and subangular.
20% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Numerous elongated stones.

F.M. RANGE	2.2-2.6	FINE SAND
	2.6-2.9	MEDIUM SAND
	2.9-3.2	COARSE SAND

PERCENT SAND 66.2
PERCENT FINER NO. 200 2.1
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 49

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP #148 @ 0 - 1.68 TYPE OF SAMPLE S 1/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"	9.9	9.9
1"	16.1	26.0
¾"	24.0	50.0
½"	13.8	63.8
⅜"	13.3	77.1
No. 4	22.9	100.0
No. 8		
PAN		

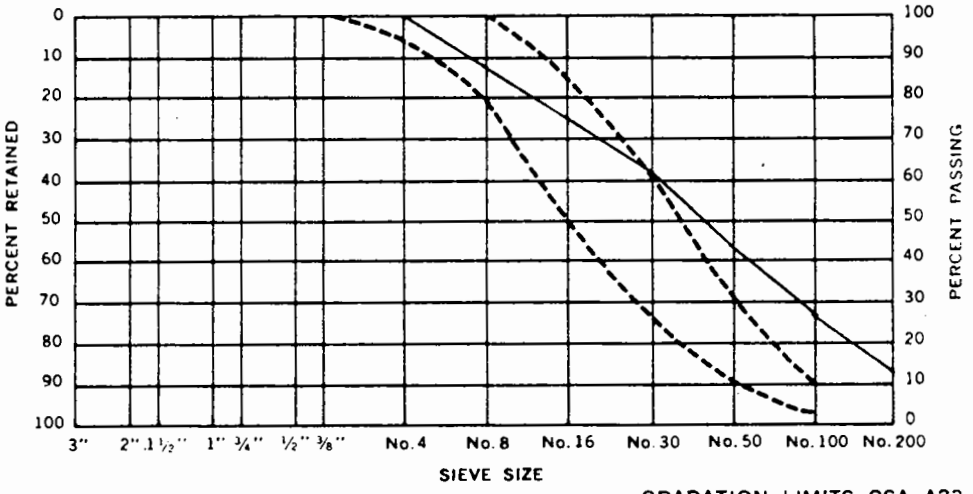
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	12.3	12.3
No. 16	12.1	24.4
No. 30	14.4	38.8
No. 50	19.6	58.4
No. 100	14.7	73.1
No. 200	14.3	87.4
PASS No. 200	12.6	100.0
F.M.		2.1

SHAPE 80% angular and subangular.
20% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION)

COAL CONTENT
COMMENTS

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 68.8
PERCENT FINER NO. 200 12.6
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 50

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

3

PROJECT Kerr Addison Mines

SOURCE TP#148 @ 1.68 - 3.93 TYPE OF SAMPLE S 2/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

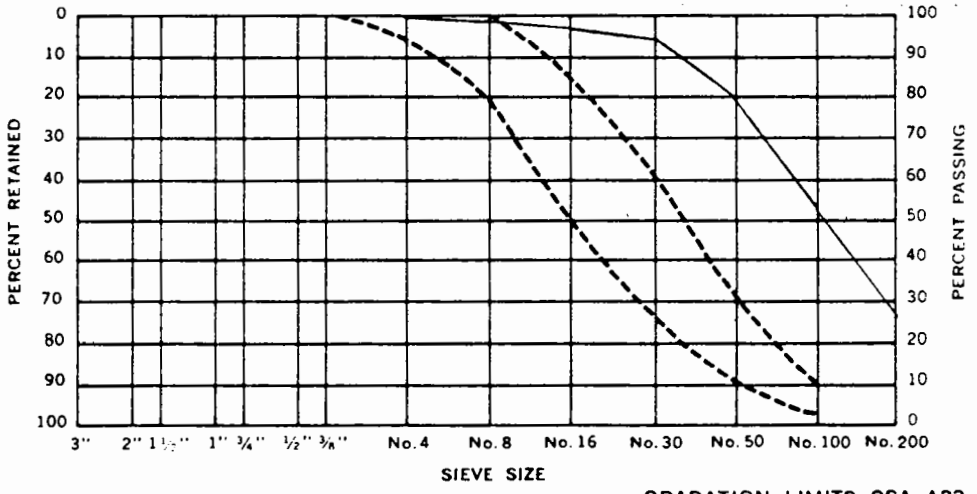
COARSE AGGREGATE			FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED		SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE		INDIVIDUAL	CUMULATIVE
3"			No. 4		
2"			No. 8	1.5	1.5
1½"			No. 16	1.5	3.0
1"	41.9	41.9	No. 30	3.3	6.3
¾"	7.6	49.5	No. 50	13.8	20.1
½"	14.9	64.4	No. 100	27.0	47.1
⅜"	12.4	76.8	No. 200	26.9	74.0
No. 4	23.2	100.0	PASS No. 200	26.0	100.0
No. 8			F.M.		.8
PAN					

SHAPE 95% angular and subangular.
5% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS A few flat and elongated stones.

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 92.4
PERCENT FINER NO. 200 26.0
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 51

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP #149 @ 0 - 1.40 TYPE OF SAMPLE S 1/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"	21.7	21.7
¾"	8.0	29.7
½"	12.5	42.2
⅜"	14.3	56.5
No. 4	43.5	100.0
No. 8		
PAN		

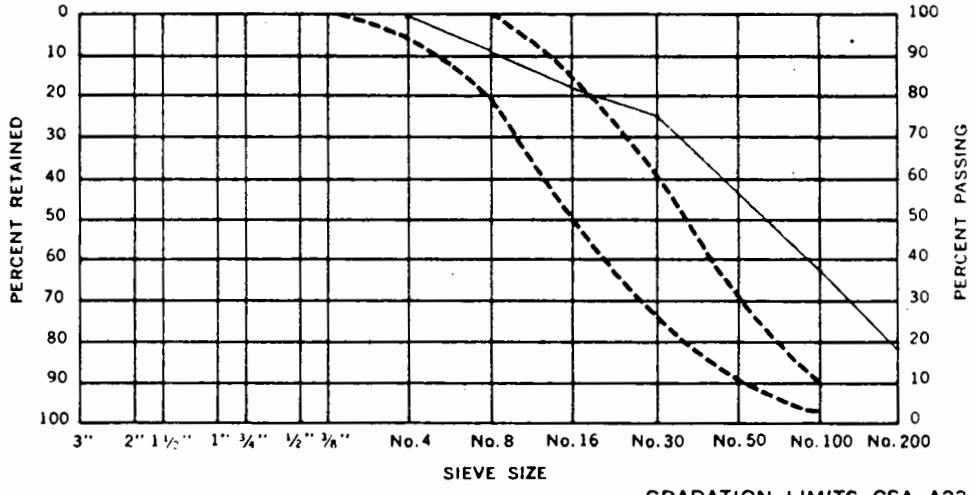
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	8.7	8.7
No. 16	9.4	18.1
No. 30	7.7	25.8
No. 50	13.0	38.8
No. 100	24.1	62.9
No. 200	18.3	81.2
PASS No. 200	18.8	100.0
F.M.		

SHAPE 97% angular and subangular.
3% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Several flat and elongated stones.

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 89.5
PERCENT FINER NO. 200 18.8
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1.0 COAL REMOVED
COAL CONTENT
COMMENTS Fair amount of flaky mica chips.

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED TECHNICIAN GRADATION LIMITS CSA A23

PLATE 52

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#149 @ 1.40 - 3.08 TYPE OF SAMPLE S 2/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"	15.8	15.8
1"	4.5	20.3
¾"	12.8	33.1
½"	4.5	37.6
⅜"	12.6	50.2
No. 4	49.8	100.0
No. 8		
PAN		

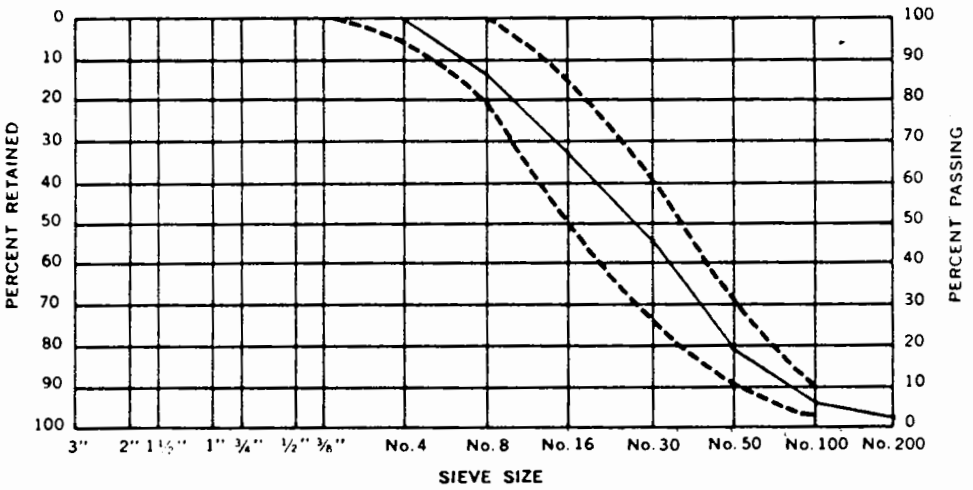
FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	13.1	13.1
No. 16	19.5	32.6
No. 30	21.0	53.6
No. 50	26.6	80.2
No. 100	13.5	93.7
No. 200	4.3	98.0
PASS No. 200	2.0	100.0
F.M.		2.7

SHAPE 80% angular and subangular.
20% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND
PERCENT SAND 83.2
PERCENT FINER NO. 200 2.0
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 53

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP#152 @ 0 - 2.44 TYPE OF SAMPLE S 1/1 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"	3.1	3.1
1"	7.4	10.5
¾"	12.1	22.6
½"	16.0	38.6
⅜"	19.0	57.6
No. 4	42.4	100.0
No. 8		
PAN		

FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	29.1	29.1
No. 16	26.6	55.7
No. 30	22.7	78.4
No. 50	16.0	94.4
No. 100	3.8	98.2
No. 200	1.1	99.3
PASS No. 200	0.7	100.0
F.M.		3.6

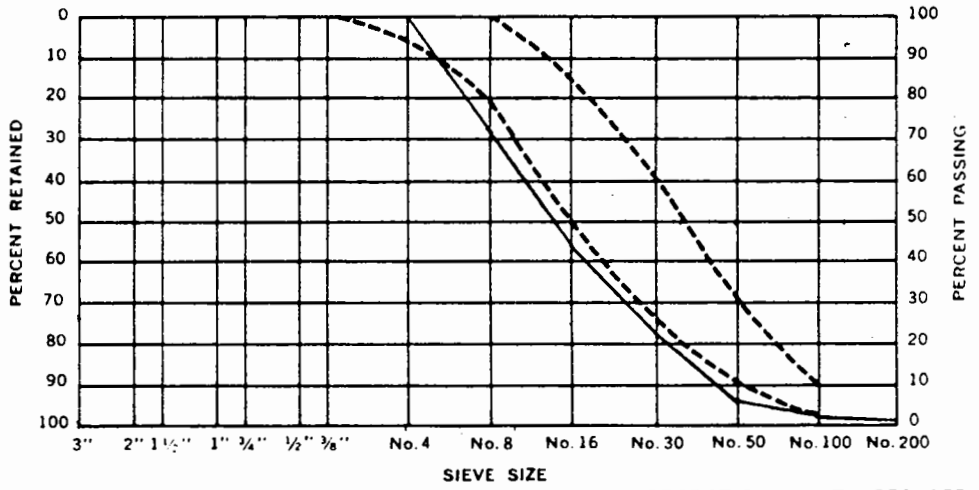
SHAPE 80% angular and subangular.
20% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS

F.M. RANGE 2.2-2.6 FINE SAND
2.6-2.9 MEDIUM SAND
2.9-3.2 COARSE SAND

PERCENT SAND 55.2
PERCENT FINER NO. 200 1.2
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 54

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP #156 @ 0 - 1.71 TYPE OF SAMPLE S 1/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"		
¾"	17.2	17.2
½"	20.8	38.0
⅜"	16.9	54.9
No. 4	45.1	100.0
No. 8		
PAN		

FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	9.0	9.0
No. 16	10.1	19.1
No. 30	10.4	29.5
No. 50	17.9	47.4
No. 100	19.3	66.7
No. 200	17.9	84.6
PASS No. 200	15.4	100.0
F.M.		1.7

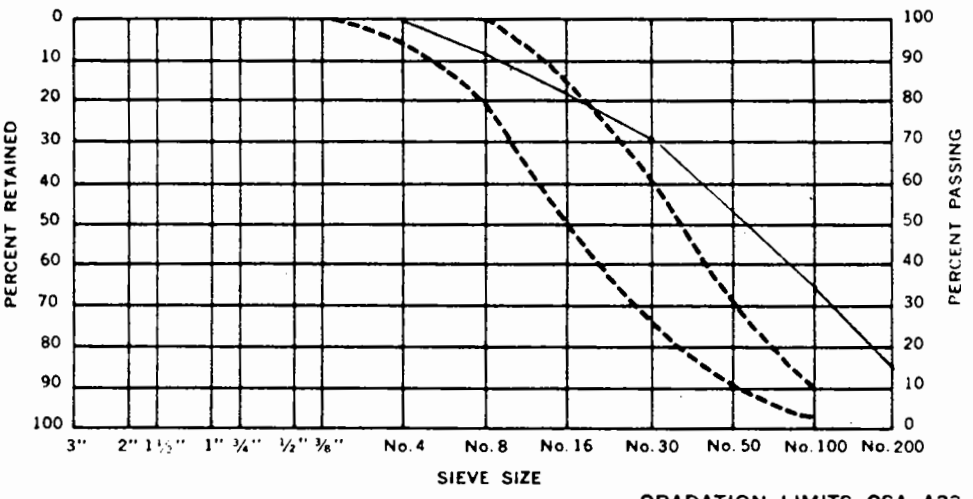
SHAPE 96% angular and subangular.
4% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Some flat and elongated stones.

F.M. RANGE	2.2-2.6	FINE SAND
	2.6-2.9	MEDIUM SAND
	2.9-3.2	COARSE SAND

PERCENT SAND 86.9
PERCENT FINER NO. 200 15.4
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 0-1 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 55

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

CONCRETE AGGREGATE REPORT

OFFICE Edmonton
FILE B-4017
DATE November 30, 1977
CLIENT P.O.
3 C.C. Client

TO Montreal Engineering Company Ltd.,
P.O. Box 777,
Place Bonaventure,
MONTREAL, Quebec
H5A 1E3

PROJECT Kerr Addison Mines

SOURCE TP #156 @ 1.71-3.29 TYPE OF SAMPLE S 2/2 SAMPLED BY
DATE SAMPLED DATE RECEIVED DATE TESTED

COARSE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
3"		
2"		
1½"		
1"	15.6	15.6
¾"	14.3	29.9
½"	18.4	48.3
⅜"	16.6	64.9
No. 4	35.1	100.0
No. 8		
PAN		

FINE AGGREGATE		
SIEVE SIZE	PERCENT RETAINED	
	INDIVIDUAL	CUMULATIVE
No. 4		
No. 8	23.5	23.5
No. 16	26.6	50.1
No. 30	28.1	78.2
No. 50	17.1	95.3
No. 100	3.0	98.3
No. 200	0.7	99.0
PASS No. 200	1.0	100.0
F.M.		3.5

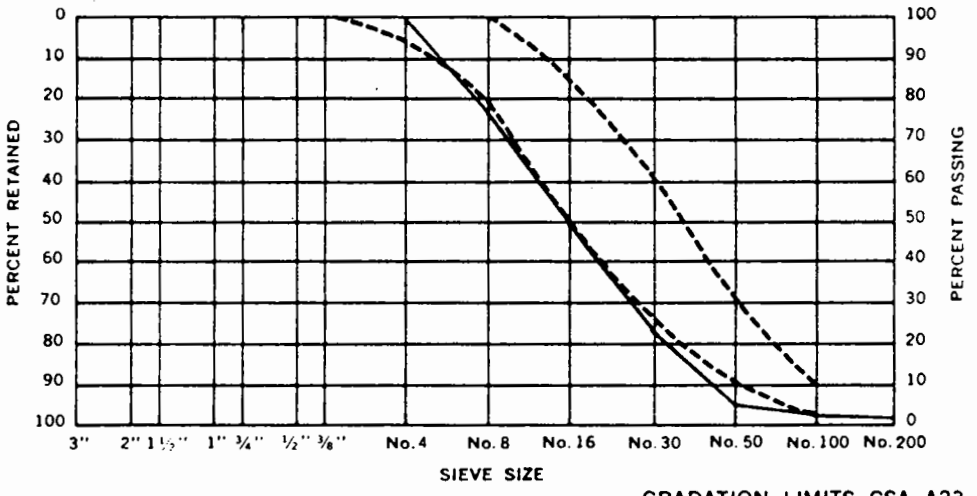
SHAPE 90% angular and subangular.
10% rounded and subrounded.
PERCENT CRUSH Nil.
SOUNDNESS (VISUAL INSPECTION) Good.

COAL CONTENT
COMMENTS Numerous elongated rocks.

F.M. RANGE		
	2.2-2.6	FINE SAND
	2.6-2.9	MEDIUM SAND
	2.9-3.2	COARSE SAND

PERCENT SAND 64.9
PERCENT FINER NO. 200 1.0
ORGANIC IMPURITIES NO. (COLOR RANGE 1-5)
AS IS 1.0 COAL REMOVED
COAL CONTENT
COMMENTS

COARSE AGGREGATE GRADATION LIMITS PERCENT RETAINED			
	1½"-4	1"-4	¾"-4
2"	0		
1½"	0-5	0	
1"		0-5	0
¾"	30-65		0-10
½"		40-75	
⅜"	70-90		45-80
4	95-100	90-100	90-100
8		95-100	95-100



REPORT CERTIFIED

TECHNICIAN

GRADATION LIMITS CSA A23
PLATE 56