GEOTECHNICAL INVESTIGATION OF POTENTIAL SAND AND GRAVEL RESERVES INUVIALUIT SETTLEMENT REGION 155 SOUTH DEPOSIT TUKTOYAKTUK, NORTHWEST TERRITORIES

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Prepared for:

Indian and Northern Affairs Canada

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EXECUTIVE SUMMARY

Indian and Northern Affairs Canada is carrying out detailed assessments of selected granular resource deposits in the Inuvialuit Settlement Region. As a part of this assessment, the present report describes the findings of the recent geotechnical investigation at the 155 South deposit near Tuktoyaktuk, which had previously been identified as a potential source of granular material for this community.

A field drilling program was carried out at the 155 South deposit to delineate areas containing extractable granular materials. Laboratory and office studies followed the drilling program to establish the suitability of the borrow for different uses, to quantify potentially extractable volumes, and to discuss development considerations.

A proven volume of 632 000 m^3 of Class 2 to 4 granular materials was delineated during this investigation, with corresponding estimates of 1 879 000 m^3 and 2 132 000 m^3 for probable and prospective reserves. For each reserve subclass the properties of Classes 2,3 and 4 were evenly divided (29 - 38%). These materials are spread among 12 separate areas comprising the 155 South Site.

Previous work by Hardy BBT Limited (June, 1987) had delineated 388 000 m^3 of proven reserves in the 155 North deposit. These reserves included 47 000 m^3 of Class 2, 312 000 m^3 of Class 3, and 29 000 m^3 of Class 4 materials. No estimates of probable or prospective reserves were presented separately. Total deposit reserves were estimated to be about 860 000 m^3 of fair to good quality granular materials. This present study has confirmed the quality assessment and increased the total prospective reserves to over 2.5 million m^3.

The volumes of proven reserves delineated are in excess of the expected requirements for the Tuktoyaktuk region up until at least the year 2006 for Classes 2, 3 and 4 (EBA, 1987). Although no Class 1 reserves were identified, by further

processing of Class 2 reserves, it should be feasible to meet the Class 1 requirements.

Development of the Site 155 South deposits investigated in this study should proceed from north to south within these deposits, as an extension of current operations in the 155 North deposits. A winter extraction operation, similar to that used at the 155 North Site is considered to be the most appropriate. Commonly, the upper 2.5 to 3 m of these deposits are not strongly ice bonded, and ripping operations should be feasible, although slow progress may be encountered in some areas. In order to reduce the potential for melting of massive ice and the creation of thaw ponds, it is recommended that active pit areas be minimized and that extraction to the full depth of available granular materials should take place during a single extraction season.

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1.0 INTRODUCTION

1.1 GENERAL

Hardy BBT Limited (HBT) of Calgary, Alberta were contracted by Supply and Services Canada (SSC) to carry out a geotechnical investigation of potential sand and gravel reserves for portions of the 155 South deposit near Tuktoyaktuk, in the Inuvialuit Settlement Region. The Scientific Authority for the project was Mr. R.J. Gowan, Geotechnical Advisor, Land Management Division, Indian and Northern Affairs Canada (INAC).

The study, which was partially funded by the Inuvialuit Final Agreement (IFA) Implementation Program, Task 7 - "Sand and Gravel Inventory", was authorized under Contract No. A7134-8-0053/01ST, dated March 8, 1989.

The Inuvialuit Final Agreement provided that the Federal Government grant to the Inuvialuit people title to some 90 650 square kilometers (35 000 square miles) in the Western Arctic. These lands are subdivided into two categories, with and without subsurface rights, referred to as 7 (1)(a) and 7 (1)(b), respectively. The location of these lands is shown on Figure 1, following the text. Granular materials are considered part of the surface estate, consequently, they are owned by the Inuvialuit on both 7 (1)(a) and 7 (1)(b) lands.

The study included the preparation of a multi-year, geotechnical investigation plan for the detailed assessment of granular resources in the Inuvialuit Settlement Region, specifically near the communities of Inuvik, Aklavik, Tuktoyaktuk, Sachs Harbour, Paulatuk and Holman. In March, 1989, HBT

submitted a proposed program, and as a first phase of this plan, three sites were investigated in the late winter of 1989; the 467 Site near Aklavik, the I407 Site near Inuvik and the 155 South Site near Tuktoyaktuk.

The following report discusses the investigation of the 155 South Site which is located approximately 40 km to the southwest of Tuktoyaktuk as shown on Figure 2. The report combines the findings of previous investigations at this site, to provide a comprehensive assessment of granular resource quality and quantity. A Glossary of Terms is provided at the conclusion of the text.

1.2 PREVIOUS WORK

The initial identification of the 155 North and South deposit areas, see Figure 3, by airphoto interpretation and limited geotechnical investigation, was carried out by Ripley, Klohn and Leonoff International Ltd. in 1972. This study provided a preliminary estimate of the quality and quantity of granular materials at this site and concluded that development might be difficult and expensive due to access limitations.

Between 1987 and 1989, additional exploration of this site was undertaken by Hardy BBT Limited on behalf of the Government of the Northwest Territories (GNWT) Department of Public Works. The early phases of that study included further definition of the potential resource areas within the 155 deposits from airphoto interpretation, additional test pitting and laboratory testing during the fall of 1986. From this work, the existence of some high quality gravels was indicated in the 155 North deposit and the need for further work at the 155 South site was noted.

During the spring of 1987, HBT carried out more extensive field investigations for the GNWT (but partially funded by INAC, under the IFA Implementation Program - Task 7), of the 155 South deposit, including 22 boreholes with representative sampling of granular materials. From these, 33 grain size distribution tests were carried out, four composite samples were analyzed for petrographic numbers and two composite samples were analyzed for Los Angeles abrasion values. The results of this investigation indicated that substantial quantities of Class 2 and Class 3 granular material were contained in the 155 South deposit. A total volume of about 860 000 m^3 of fair to good quality material was estimated in the 155 North and South deposits combined, with the possibility of a further 200 000 to 300 000 m^3 of granular material being present within the 155 South deposit. The HBT (1987c) report also provided development recommendations for management of the 155 North deposit, including reservation of specific material types for community use.

The interim HBT geotechnical investigation plan of March, 1989, noted that the 155 North and South sites comprised the potential source of all Class 1 to 4 granular materials for the community of Tuktoyaktuk for the next 20 years. The 155 North site is presently being developed, and the report recommended that additional data would be required for proper development planning of the 155 South deposits.

The reference section of this report lists previous studies that contain information relating to the 155 North and South deposits.

1.3 SCOPE OF WORK

The scope of work for the present investigation was defined in the contract document as follows:

1) Briefly review available information for those sources on Inuvialuit and adjacent lands that have been recommended for further investigation.

2) Prepare a phased, multi-year site investigation plan for review and acceptance by representatives of the Inuvialuit Land Administration (ILA), the Government of the Northwest Territories (GNWT) and INAC.

3) Organize and conduct a winter field program to complete the site investigation work approved for the fiscal year 1988/89.

4) Conduct laboratory testing of samples obtained during the field investigation and analyze the field and laboratory data.

5) Prepare a comprehensive granular source evaluation report describing the site investigation work undertaken and the results of the laboratory testing and data analysis.

Tasks 1 and 2 above were completed and presented in the HBT interim report entitled: "Proposed Geotechnical Investigation Plan, Potential Sand and Gravel Reserves, Inuvialuit Settlement Region", March, 1989. This proposed investigation plan report was finalized in May, 1990.

Specifically, it is the scope of the following report to describe the field and laboratory geotechnical investigations carried out during March through May of 1989, for the 155 South deposit, and to integrate the results of this work with the findings of previous investigations in order to delineate and characterize the potential sand and gravel reserves available.

2.0 INVESTIGATION METHODOLOGY

2.1 PRELIMINARY WORK

A comprehensive selection of reports, studies and publications was reviewed during the preparation of the geotechnical investigation plan. In addition, the INAC computerized granular resources borehole and test pit log data base was consulted.

Following this review of existing information, a proposed, phased, multi-year program of geotechnical site investigation, was presented to INAC and the ILA at a meeting in Inuvik on March 7, 1989. In this program, sites requiring more precise definition of granular reserves were identified.

2.2 FIELD INVESTIGATION

A drilling program was carried out from March 13 to March 21, 1989, using a Nodwell-mounted CME 750 auger drill rig operated by Midnight Sun Drilling Ltd., of Whitehorse, Yukon. The field work was under the full-time supervision of members of the HBT geotechnical staff.

Site personnel on each shift included a driller, a driller's helper, a bear monitor and a geologist or engineer. A drill supervisor for Midnight Sun Drilling Ltd. was responsible for scouting access routes and moving equipment between sites. Crew changes from the base of field operations in Inuvik were normally made by (206B) helicopter. A detailed summary of the field operations is included in Appendix B. Various aspects of equipment

and field operations are illustrated in Photos 1 to 4 of Appendix D.

Drilling or moving was maintained 24 hours per day in two 12-hour shifts. Twelve boreholes were drilled using 150 or 200 mm diameter solid-stem flight augers, and in two of these, a 150 mm diameter CRREL core barrel was used to obtain undisturbed samples. Auger cuttings and core runs were visually logged on site.

Samples of representative materials were taken at regular intervals from the auger returns. These were sealed in labelled plastic bags and transported to the HBT Yellowknife soil testing laboratory. All suitable CRREL core samples of massive ice were sent to the Inuvik Research Laboratory. These ice core samples were for use in a separate INAC cooperative research program with the Geological Survey of Canada.

Boreholes were located in six of the potential granular resource areas, designated as J, L, M, N, O, and P of the 155 South deposit. One borehole had been drilled at Area P during the 1987 survey, and one additional hole was added as part of the present investigation. The other five had not been explored in the 1987 program. Boreholes were extended to depth ranging between 2.4 and 10.0 m.

The borehole logs with explanatory sheets are presented in Appendix A, with the locations shown on Figure 4. In addition, Table 1 presents a summary of the field work undertaken in terms of distribution of boreholes, depths and numbers of samples.

TABLE 1

SUMMARY OF 1989 FIELD WORK

155 SOUTH DEPOSIT TUKTOYAKTUK

Area	Hole Number	Depth of Hole (m)	Number of Samples	
			Grab	Core
J	155SB023	3.8	1	
	155SB024	3.8	1	
	155SB025	7.0	1	1
L	155SB026	5.0	2	
	155SB027	4.0	2	
	155SB028	10.0	3	1
	155SB029	9.5	3	
M	155SB030	4.0	1	
N	155SB031	5.0	1	
O	155SB032	2.4	2	
	155SB033	3.0	2	
P	155SB034	2.6	1	

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Borehole elevations were obtained by hand level methods and, accordingly, are relative elevations only with a maximum error of up to 2 m (i.e. ± 1 m). Relative distances between boreholes were chained and are considered to have a maximum error of 0.5 m. Boreholes within the deposit were located with respect to identified landmarks on airphotos and photomosaics. UTM grids were superimposed on the site plan from a 1:50 000 scale photomosaic. UTM grid references for boreholes are considered to have an absolute error in the range of 100 m.

2.3 LABORATORY TESTING

Conventional laboratory testing for classification purposes was carried out on selected samples in the HBT Yellowknife soils laboratory. This testing included: grain size analyses, moisture content determinations, and petrographic analyses.

Several samples from each area were forwarded to the HBT Calgary testing laboratory for concrete aggregate suitability testing. This work included Los Angeles Abrasion tests, sulphate soundness determinations, specific gravity tests, water absorption tests and alkali-aggregate reactivity tests. The laboratory test results are presented in Appendix C.

Table 2 presents a summary of the different laboratory test procedures undertaken, along with the appropriate ASTM and CSA standards for test procedures and the numbers and purpose of each test type carried out.

The Unified Soil Classification system symbol is used on the borehole logs to identify each soil unit and any significant changes within the unit. The

TABLE 2

TEST SPECIFICATIONS AND PURPOSE

	Test Designation	Method	Number Done	Rationale For Test
Geotech-nical	Soil Moisture Content	ASTM D 2216	21	Basic material property; can indicate thaw pond potential and material workability
	Particle-Size Distribution	ASTM D 422 with sample preparation by ASTM D 421	17	Indicator of whether deposit meets gradation criteria for various uses (i.e. concrete); determines frost susceptibility
Lithology	Petrographic Analysis	ASTM C 295 CSA Can 3-A23.1, Clause 5.5	3	Identifies particle types; specifically, determines any deleterious materials
Concrete Aggregate Suitability Analysis	Bulk Specific Gravity and Absorption	ASTM C 127 - C 128	2 2	Minimum specific gravity required for some uses (eg. concrete, riprap); absorption results indicate susceptibility to freeze - thaw degradation
	Los Angeles Abrasion	CSA A23.2-M77-16A and 17A	2	Determines resistance to physical wear
	Sulphate Soundness	CSA A23.2-M77-9A	2	Evaluates resistance to weathering
	Alkali-Aggregate Reactivity	ASTM C 289	2	Determines potential for adverse reactions between cement and aggregate

symbol is expressed in capitals where the classification is supported by laboratory test data, and in lower case letters when the identification is estimated from field logs (e.g. SW, gp). Whenever the nature of the fines content has not been determined, it is designated by the letter "F" (or f); e.g. sf is an estimated classification of sand with silt and/or clay.

3.0 SITE DESCRIPTION

The 155 South Site comprises some 12 separate, but genetically similar, areas of potential granular deposits, situated about 15 km to the south and southeast of the abandoned settlement of Kittigazuit, on the mainland coast about 30 km west of Tuktoyaktuk, as shown on Figure 2.

The deposits, as shown on Figure 3, occur adjacent to and west of Kittigazuit Creek. The topography of the area is typical of arctic tundra lowlands, with gently undulating and hummocky terrain including numerous small lakes and meandering stream channels, many of which exhibit obvious thermokarst features. The 155 South site area comprises a number of broad, often flat-topped, ridges which occur on either side of a drowned meltwater channel, aligned northwest-southeast, sub-parallel to Kittigazuit Creek. Their location suggests that these granular deposits represent either remnants of glaciofluvial terraces associated with the meltwater channel, or kame terraces deposited from melting glacial ice bordering the meltwater channel. Appendix D includes photographs typifying the site topography (Photos 5 and 6).

There are distinct morphologic differences between the 155 North and South deposits. The 155 North deposits are generally flat-lying with minimal surface

relief, while the 155 South deposits are hummocky with, in places, several metres of relief. It would appear that ponding of glacial meltwaters in the area of the 155 North Site may have resulted in the accumulation of silts and clays that infilled any hummocky terrain, creating a more level surface expression than the 155 South Site. Similar lacustrine silts and clays are rare within the 155 South deposits.

4.0 DESCRIPTION OF MATERIALS

4.1 GENERAL

The following section provides detailed descriptions for each of the principal material types identified at the 155 South Site, including the following:

- Surficial Deposits
- Sandy Gravels
- Gravelly Sands
- Fine Sand
- Massive Ice

Five schematic geological cross-sections; J1-J1', LI-LI', L2-L2', O1-O1', and P1-P1' summarizing the findings of the present investigation are presented in Figures 7 to 11. Cross-section locations are shown on Figure 4. Four additional cross-sections from the 1987 HBT report on the 155 Site are included in Appendix E.

In summary, the stratigraphy of the 155 South Site consists of relatively thin peat deposits over most of the area, with localized deeper pockets of silt and

clay, also included as surficial deposits. With one exception, from the HBT 1987 investigation, all boreholes encountered granular deposits underlying these surficial materials. The granular deposits typically are mostly sandy gravels and gravelly sands, overlying fine sands, but exceptions to this simplified scenario are quite common.

Approximately one third of the boreholes from the two investigations were terminated in massive ice underlying the granular deposits.

4.2 SURFICIAL DEPOSITS

The present investigation encountered thin peat deposits of less than 0.3 m overlying granular materials in most of the boreholes. However, while the 1987 investigations also found generally thin peat deposits throughout the site, it also identified localized deposits of peat of up to 1.0 m in thickness. In addition, several of the holes of the 1987 survey, particularly in area "I", encountered greater thicknesses (up to 1.5 m) of surficial silt, clay and ice, overlying granular materials.

Table 3 summarizes the nature and thickness of the surficial materials found throughout the 155 South Site, and Figure 5 presents a plan showing the thickness of overburden materials at the borehole locations.

4.3 SANDY GRAVELS

Figure 12 presents a composite grading curve for 12 samples of coarse granular materials tested during the current investigation. These range from a very poorly graded gravel to a very silty, sandy gravel, both of which are

TABLE 3
SOURCE 155S: SUMMARY OF SURFICIAL DEPOSITS

Area	Borehole	Thickness (m)	Material
E	155SB001	0.1) 0.8 m	Peat
		0.7) total	Silt
	155SB002	0.2) 0.6 m	Peat
		0.4) total	Sand
	155SB003	0.2	Peat
	155SB004	0.15) 0.45 m	Peat
		0.30) total	Clay
F	155SB005	0.10	Peat
	155SB006	0.15	Peat
	155SB007	No sand or gravel encountered in this borehole	
	155SB008	0.10	Peat
	155SB009	0.15	Peat
G	155SB010	1.10	Peat
	155SB011	1.10	Peat
	155SB012	1.10	Peat
	155SB013	1.10	Peat
	155SB014	0.10) 1.5 m	Peat
		1.40) total	Silt
	155SB015	0.50) 1.5 m	Peat
		1.00) total	Ice
	155SB016	1.10	Peat
H	155SB017	1.10	Peat
	155SB018	1.10	Peat
I	155SB019	1.00) 2.0 m	Peat
		1.00) total	Sand and Silt
	155SB020	0.15) 1.45 m	Peat
		1.30) total	Silt

Table 3 (cont'd)

Area	Borehole	Thickness (m)	Material
	155SB021	0.20) 0.20) 1.4 m 0.50) total 0.50)	Peat Silt Sand Sand
	155SB022	0.15) 0.8 m 0.65) total	Peat Silt
J	155SB023 155SB024 155SB025	0.00 0.00 0.00	– – –
L	155SB026 155SB027 155SB028 155SB029	0.30 0.20 0.20 0.30	Peat Peat Peat Peat
M	155SB030	0.20	Peat
N	155SB031	0.20	Peat
O	155SB032 155SB033	0.30 0.30	Peat Peat
P	155SB034	0.20	Peat

shown by dashed lines on the composite envelopes (Figure 12). Excluding the two anomalous samples, the remainder fall within a much narrower range, which can be further defined by grouping the six samples with greater than 50% gravel and the four obtaining less than 50% gravel. These groups are represented by the two differently shaded areas in Figure 12. For the purposes of the following descriptions, these coarse granular materials have been divided broadly into sandy gravels and gravelly sands. While the correlation is not precise, it is noted that the sandy gravels fall mostly within granular materials quality Classes 1 and 2, as described in Section 5, and the gravelly sands tend to be Classes 3 or 4 granular materials.

The occurrences of sandy gravels in each borehole of both the 1987 and 1989 surveys are summarized in Table 4, which includes the modified Unified Soil Classification (U.S.C.) designation for the material along with the depth limits at which it was encountered.

Sandy gravels were encountered in all but six of the boreholes. In most cases, they were identified as clean gravels with GW or GP classifications, although some silty and occasionally clayey gravels were noted in Areas "E" and "L". Individual grading curves are presented in Appendix C, and the typical sandy gravel materials would fall within the lower/coarser branch of the envelope of Figure 12.

The thickness recorded for the sandy gravel ranged between 0.25 m and 4.4 m, with an average thickness of about 1.8 m.

Table 5 summarizes the percentages of gravel, sand and fines, as well as moisture contents, for all 39 samples of coarse granular material tested in

TABLE 4

SUMMARY OF SANDY GRAVEL DEPOSITS
SOURCE 155 SOUTH

AREA	BOREHOLE NUMBER	UNIFIED SOIL CLASSIFICATION **	DEPTHS OF SANDY GRAVEL DEPOSITS		
			From		To (m)
E	155SB001	GM-GC	0.8		1.8
	155SB002	GP-GM	0.6		1.5
		GP-GM	and 2.0		3.8*
	155SB003	GP-GM	0.2		0.9
		GW-GP	and 1.25		1.5
	155SB004		None		
F	155SB005	GW-GP	0.15		2.4
	155SB006	GW-GP	0.1		1.8
	155SB007		None		
	155SB008	GW-GP	0.15		2.4
	155SB009	GW-GP	0.15		1.8
G	155SB010	GW-GP	0.15		1.4
	155SB011	GW-GP	0.1		2.0
	155SB012	GP	0.1		1.7
	155SB013	GW-GP	0.1		1.5
	155SB014		None		
	155SB015		None		
P	155SB016	GW-GP	0.1		2.0
H	155SB017	GW-GP	0.1		2.45
	155SB018	GW-GP	0.1		2.45
I	155SB019	GW-GP	2.1		2.9
	155SB020		None		
	155SB021	GW-GP	1.4		1.8
		GW-GP	and 2.9		3.7
	155SB022		None		
J	155SB023	GP	0		1.8
	155SB024		None		
	155SB025	GW-GF	0		4.4
L	155SB026	GP	0.3		3.0
		GP	and 4.2		4.6
	155SB027		None		
	155SB028	GF	0.2		2.9
	155SB029	GP-GF	0.3		0.8
M	155SB030	GW	0.2		1.5
N	155SB031	GW	0.2		1.7
		GP-GF	and 1.7		2.5
O	155SB032	GP	0.3		0.9
	155SB033	GW-GF	0.3		1.5
P	155SB034	GP-GF	0.2		2.1

* Deposit only partially penetrated
** Symbols include both laboratory-data-supported classifications and estimated classifications

TABLE 5

COMPONENT PERCENTAGES OF
COARSE GRANULAR DEPOSITS
SOURCE 155 SOUTH

AREA	BOREHOLE NUMBER	SAMPLE INTERVAL (m)	COMPONENT PERCENTAGE			MOISTURE CONTENT(%)
			GRAVEL	SAND	FINES	
E	155SB001	0.7 – 1.5	39	33	28	22
	155SB002	2.4 – 3.7	52	31	17	10
	155SB003	1.5 – 1.8	15	73	12	17
		2.4 – 2.7	16	75	9	16
	155SB004	0.9 – 1.2	35	49	16	10
		2.1 – 2.4	33	57	10	12
F	155SB005	0.6 – 0.9	66	27	7	4
		2.4 – 2.7	35	53	12	8
	155SB006	1.2 – 1.5	60	33	7	4
		2.1 – 2.3	21	67	12	12
	155SB008	0.2 – 1.1	55	38	7	5
		1.2 – 2.3	50	42	8	8
	155SB009	0.3 – 1.5	50	42	8	7
G	155SB010	0.3 – 1.5	71	25	4	5
		1.5 – 2.75	40	52	8	9
	155SB011	0.3 – 1.5	55	38	7	7
		2.1 – 2.6	29	61	10	11
	155SB012	0.6 – 0.9	88	8	4	3
	155SB013	0.6 – 1.2	62	32	6	4
P	155SB016	0.5–0.8 & 1.2–1.5	65	31	4	3
H	155SB017	0.6 – 2.1	61	34	5	4
	155SB018	0.3 – 2.1	60	35	5	4
I	155SB019	2.1 – 2.3	57	35	8	6
	155SB021	0.9 – 1.4	19	70	11	18
		1.5 – 1.7	79	15	6	12
		2.1 – 2.4	21	54	25	8
		3.0 – 3.4	54	39	7	6
	155SB022	1.1–1.4 & 1.8–2.4	25	60	9	13
J	155SB024	0.0 – 0.8	31	27	42	12
	155SB025	0.8 – 2.3	60	34	6	2
L	155SB026	1.5 – 2.1	93	5	2	2
	155SB027	1.2 – 1.8	44	48	8	7
	155SB028	1.5 – 2.1	48	38	14	19
	155SB029	0.3 – 0.8	48	42	10	5
	155SB029	0.8 – 1.5	42	42	16	10
M	155SB031	1.7 – 2.2	63	31	6	4
O	155SB032	0.3 – 0.9	70	30	0	4
	155SB033	0.6 – 1.2	62	33	5	12
P	155SB034	1.0 – 1.5	65	28	7	4
	Stockpile		75%	24%	1%	5%

both investigations. A bulk sample from a stockpile located in Area H falls along the lower, coarser limit of the sandy gravels.

4.4 GRAVELLY SANDS

Gravelly sands represent a smaller component of the coarse granular deposits than do the sandy gravels. The typical grading for these materials is represented by the upper finer branch of the envelope shown in Figure 12.

The occurrences of gravelly sands are summarized in Table 6. These materials were identified in half of the boreholes from both surveys. U.S.C. classification varied between SW, SP, and SM indicating a range between well graded, poorly graded, and silty sands. Individual grading curves are presented in Appendix C. As for the sandy gravel deposits, percentages of gravel, sand, fines and moisture are included in Table 5.

The thickness recorded for these deposits ranged between 0.35 m and 3.1 m, with an average thickness of around 1.5 m.

4.5 FINE SANDS

Figure 13 presents a composite grading curve for five samples of fine sands from the present study, indicating a markedly uniform material. These fine sands typically underlie the coarser granular sediments, but occasionally occur as layers within the gravels.

Fine sands were encountered in most of the boreholes. The thicknesses recorded ranged between 0.25 m and 6.7 m, with an average value of about

TABLE 6

SUMMARY OF GRAVELLY SAND DEPOSITS
SOURCE 155 SOUTH

AREA	BOREHOLE NUMBER	UNIFIED SOIL CLASSIFICATION **	DEPTH OF GRAVELLY SAND DEPOSITS		
			From (m)		To (m)
E	155SB001			None	
	155SB002			None	
	155SB003	SP	0.9		1.25
		SP-SM	and 1.5		4.0
	155SB004	SP-SM	0.45		2.7
F	155SB005	SP-SM	2.4		2.75
	155SB006	SP-SM	1.8		2.6
	155SB007			None	
	155SB008			None	
	155SB009			None	
G	155SB010	SW-SP	1.4		2.75
	155SB011	SW-SP	2.0		2.6
	155SB012			None	
	155SB013			None	
	155SB014			None	
	155SBO15			None	
P	155SB016	SP	2.0		2.4
H	155SB017			None	
	155SB018			None	
I	155SB019	SP	2.9		3.5
	155SB020			None	
	155SB021	SP-SM	0.9		1.4
		SP-SM	and 1.8		2.95
	155SB022	SP-SM	0.8		2.4
J	155SB023			None	
	155SB024	SF	0.0		3.1
	155SB025	SW	4.4		7.0*
L	155SB026	SF	3.0		4.2
		SF	and 4.6		5.0*
	155SB027	SP-SF	0.2		1.8
	155SB028	SW	2.9		4.4
	155SB029	SF	0.8		2.8
M	155SB030			None	
N	155SB031			None	
O	155SB032	SP	0.9		1.3
	155SB033			None	
P	155SB034			None	

* Deposit only partially penetrated

** Symbols include both laboratory-data-supported classifications and estimated classifications

1.6 m. However, in the majority of the holes, this unit was not fully penetrated. Table 7 presents a summary of the occurrence of the fine sands and Table 8 represents the component percentages of gravel, sand and fines, and also moisture contents, for samples tested from both the 1987 and 1989 investigations.

The fine sands fall either within the poorly graded (SP) or silty sand (SM) categories of the U.S.C., depending on silt content. With regard to the quality classification of granular materials (see Section 5), the fine sands tend to fall within Classes 3 or 4, depending primarily on silt content.

4.6 MASSIVE ICE

Massive ice with inclusions of silt and sand was encountered in twelve boreholes, or approximately one-third of the boreholes completed at the site in 1987 and 1989.

Those areas where massive ice was identified included; E, F, G, I, and J. Within these areas, 55% of the holes encountered massive ice bodies. Of the areas investigated in the present study, only one encountered massive ice.

In all cases, the massive ice underlies granular deposits. Since all 12 boreholes were terminated in massive ice, its thickness is not known, but proven minimum thicknesses of up to 3.7 m were observed.

5.0 CLASSIFICATION OF GRANULAR MATERIALS

The quality of granular materials encountered during the field program has

TABLE 7

SUMMARY OF FINE SAND DEPOSITS
SOURCE 155 SOUTH

AREA	BOREHOLE NUMBER	UNIFIED SOIL CLASSIFICATION **	DEPTH OF FINE SAND DEPOSITS From (m)	To (m)
E	155SB001	SP	1.8	2.3
	155SB002	SP	1.5	2.0
	155SB003		None	
	155SB004		None	
F	155SB005	SP	2.75	4.6*
	155SB006	SP	2.6	3.8*
	155SB007		None	
	155SB008		None	
	155SB009	SP	1.8	3.4
G	155SB010	SP	2.75	3.0*
	155SB011	SP	2.6	4.6*
	155SB012	SP	1.7	2.4*
	155SB013	SP	1.5	3.4*
	155SB014		None	
	155SB015	SP	1.5	2.0
P	155SB016	SP	2.4	3.7*
H	155SB017	SP	2.45	4.3*
	155SB018	SP	2.45	4.3*
I	155SB019	SM	1.0	2.1
	155SB020	SP	1.4	2.0*
	155SB021	SP	0.45	0.9
	155SB022	SP	2.4	3.5*
J	155SB023	SF	1.8	3.0
	155SB024		None	
	155SB025		None	
L	155SB026		None	
	155SB027	SF	1.8	4.0*
	155SB028	SF	4.4	9.5*
	155SB029	SP-SF	2.8	9.5
M	155SB030	SF	1.5	4.0*
N	155SB031	SF	2.5	5.0*
O	155SB032	SF	1.3	2.4*
	155SB033	SF	1.5	3.0*
P	155SB034	SF	2.1	2.6*

* Deposit only partially penetrated
** Symbols include both laboratory-data-supported classifications and estimated classifications.

TAB10

TABLE 8

COMPONENT PERCENTAGES OF
FINE SAND DEPOSITS
SOURCE 155 SOUTH

AREA	BOREHOLE NUMBER	SAMPLE INTERVAL(m)	COMPONENT PERCENTAGE			MOISTURE CONTENT (%)
			GRAVEL	SAND	FINES	
E	155SB001	1.8 – 2.3	0	84	16	24
F	155SB005	3.5 – 4.0	0	88	12	23
	155SB006	2.6 – 2.7	0	94	6	27
G	155SB011	2.6 – 3.0	0	92	8	31
I	155SB022	2.4 – 2.6	7	86	7	22
L	155SB027	2.7 – 3.3	2	82	16	18
	155SB028	4.4 – 5.0	2	83	15	16
		7.2 – 7.8	2	76	22	17
	155SB029	2.8 – 3.1	0	91	9	17
O	155SB032	1.2 – 1.8	4	75	21	16

been evaluated primarily according to gradation. Each sample subjected to a grain size analysis has been categorized according to the modified Unified Soil Classification (U.S.C.) scheme. This has then been related to a classification scheme developed by INAC for regional granular resource evaluations. The INAC scheme has been developed to reflect the general requirements of the AASHTO specifications for soils and soil aggregate mixtures for highway construction purposes, i.e. embankments, subgrades, sub-base, base and surface courses. A summary of the adapted classification scheme used in this study is presented in Table 9. In addition to the gradation of the granular materials, attention has also been given to other factors such as moisture and ice content, and petrography.

Four classes of granular material relevant to this study are described as follows:

Class 1 Granular Material

Class 1 material is well-graded with a low fines content, and comprises hard and durable particles, which meet the following criteria; a maximum petrographic number (PN) of 160, a maximum L.A. Abrasion loss of 35%, and a maximum magnesium sulphate soundness loss of 12%. Consequently, it is considered suitable for use as concrete or asphalt aggregate after minimal processing. Sources of Class 1 material are relatively scarce in the Tuktoyaktuk region and consequently should be reserved specifically as a source of high quality aggregate. A PN specification of 160 is somewhat higher than might be expected. For concrete aggregates, specifications limit the PN for excellent, good, fair and poor aggregates to 110, 125, 140, and 155, respectively. Specifically, aggregates with high PN values may contain chert

TABLE 9

Quality Classification of Granular Materials

Granular Material Class	General Description of Material	Minimum Technical Indentification Parameters	Suggested Uses of Material
(1) Excellent	Well graded gravels and sands suitable for use as aggregates with a minimum of processing. <5% fines.	Petrographic Number - 160 max. Los Angeles Abrasion Loss - 35% max. Soundness Loss (Magnesium Sulphate) - 12% max. and meeting other requirements other requirements of CSA A23.1 - 1973.	Portland Cement Concrete, Asphaltic Concrete, Masonry Sand, Concrete Block, Surface Treatment and Roofing Aggregate.
(2) Good	Well graded sands and gravels with varying quantities of silt. <10% fines	Petrographic Number - 200 max. Los Angeles Abrasion Loss - 60% max. Fines greater than 10% passing the 200 sieve can be removed with minimum of processing.	Granular base and sub-base. Winter sand backfill for trenches and slabs. Pads for structures.
(3) Fair	Poorly graded sands and gravels with or without substantial silt content. <20% fines	Petrographic Number - 250 max. Can be processed to meet local frost susceptibility criteria.	Granular sub-base. General backfill material, pads for equipment.
(4) Poor	Poorly graded granular soils of high silt content, possibly containing very weak particles and deleterious materials. >20% fines.	Nil	General non-structural fill.

NOTE: Based on classification developed by INAC

Moisture content ideally <10%; if moisture content 10 - 20%, requires drying before use.

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components which may react with the alkali in normal Portland cements. An alkali-aggregate reactivity test should also be performed and evaluated before using these materials as concrete aggregates.

Class 2 Granular Material

Class 2 material is similar to Class 1, except that it is of lower quality due to somewhat poorer grading, a higher fines content and less durable particles, which meet the following criteria; a maximum PN of 200, and a maximum L.A. Abrasion loss of 60%. With processing, it may be upgraded to concrete aggregate quality. Class 2 materials may be used in highway construction as granular base and sub-base material, but may be prudently reserved as a source of lower quality aggregate or structural fill.

Class 3 Granular Material

Class 3 material generally comprises poorly graded sands and gravels with low to high fines content of up to 20% and with particles meeting the durability criterion of a maximum PN of 250. It can be processed to meet local frost susceptibility criteria. The presence of moderate amounts of fines makes it ideal as a surface course material which requires the presence of a binding component. In addition, this material may be used as general fill for embankment construction.

Class 4 Granular Material

Class 4 material comprises poorly graded granular soils with a substantial fines content of more than 20%. There is no durability criteria for this class

of granular material. Class 4 material is generally acceptable only for use as non-structural fill.

6.0 GRANULAR BORROW QUANTITIES

Each of the twelve areas defined within the 155 South Site has been evaluated in terms of quantities and quality of granular reserves. All of the above data have been integrated to provide an evaluation of the quality classification for each deposit of granular material as recorded on the borehole logs. Figure 6 presents a plan delineating the interpreted extent of the different quality classes of granular material within the 155 South deposits. Table 10 presents quantities of material, by quality class, for each of the 12 areas within this deposit. Three confidence levels of reserves are presented, and defined in Table 10 including proven, probable and prospective. These confidence levels represent increasing certainty moving from prospective to proven.

Proven quantities of granular borrow within the 155 South deposit are calculated to be about 632 000 m^3 of which 38% is Class 2, 30% is Class 3 and 32% is Class 4. No Class 1 material was identified.

Probable and prospective material quantities are calculated to have similar proportions of these three classes with a total probable volume of about 1 879 000 m^3 and a total prospective volume of about 2 132 000 m^3. These volumes were based on the criteria presented in Table 10.

TABLE 10

DEPOSIT 155 SOUTH SUMMARY OF GRANULAR RESERVES

AREA	GRANULAR MATERIAL CLASS	AVERAGE THICKNESS (m)	RESERVES		
			Proven (1) (m^3)	Probable (2) (m^3)	Prospective (3) (m^3)
E	3	1.5	35 000	134 000	140 000
	4	1.5	12 000	13 000	16 000
F	2	2.0	47 000	80 000	80 000
	3	2.5	20 000	20 000	20 000
G	2	2.0	47 000	132 000	132 000
	3	1.5	12 000	33 000	33 000
H	2	2.0	31 000	56 000	56 000
I	2	1.0	8 000	15 000	15 000
	3	2.0	31 000	54 000	54 000
J	2	2.0	26 000	51 000	51 000
	3	2.6	16 000	66 000	66 000
	4	1.4	19 000	36 000	36 000
K	2	1.5*	0	0	110 000
	3	2.0*	0	0	150 000
	4	1.5*	0	0	110 000
L	2	0.8	24 000	95 000	95 000
	3	2.4	74 000	286 000	286 000
	4	3.4	106 000	405 000	405 000
M	2	1.3	104 000	20 000	20 000
	4	2.5	20 000	38 000	38 000
N	2	2.3	18 000	67 000	67 000
	4	2.5	20 000	73 000	73 000
O	2	0.8	12 000	28 000	28 000
	4	1.6	24 000	55 000	55 000
P	2	2.0	16 000	98 000	98 000
	4	0.5	4 000	24 000	24 000
Totals (%)	2		239 000 (38%)	642 000 (34%)	752 000 (35%)
	3		188 000 (30%)	593 000 (32%)	623 000 (29%)
	4		205 000 (32%)	644 000 (34%)	757 000 (36%)
	2+3+4		632 000	1 879 000	2 132 000

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DEFINITIONS OF RESERVE SUBCLASSES

[1] Material in each class whose occurrence, distribution, thickness and quality is supported with a high degree of confidence by ground truth information such as geotechnical drilling, test pitting, and/or exposed stratigraphic sections. The thickness of material encountered in a borehole is usually extrapolated to a radius not exceeding 50 metres around the hole, with adjustments applied by assessing landform type and anticipated or known deposit homogeneity.

[2] Material in each class whose existence and extent is inferred on the basis of several types of direct and indirect evidence, including topography, landform characteristics, airphoto interpretation, extrapolation of stratigraphy, geophysical data and/or limited sampling. Additional investigation is needed to determine a reliable material volume. The volume is estimated by projecting known parameters (typically those of proven resources) over the entire deposit, with adjustments for landform type, anticipated homogeneity and other site characteristics such as ice content and drainage.

[3] Material in each class whose existence is merely speculated on the basis of limited indirect evidence, such as airphoto interpretation and/or general geological considerations. The volume is typically estimated from the maximum areal extent of the deposit and the estimated relief of the geomorphic feature, with adjustments for anticipated site and deposit characteristics.

By convention, the quantities in each confidence level are cumulative; i.e. PROBABLE includes PROVEN, PROSPECTIVE includes PROBABLE and PROVEN quantities.

Previous work by Hardy BBT Limited (June, 1987) had delineated 388 000 m^3 of proven reserves in the 155 North deposits. These reserves included 47 000 m^3 of Class 2, 312 000 m^3 of Class 3, and 29 000 m^3 of Class 4 materials. No estimates of probable or prospective reserves were presented separately. Total deposit reserves were estimated to be about 860 000 m^3 of fair to good quality granular materials. This present study has confirmed the quality assessment and increased the total prospective reserves to over 2.5 milion m^3.

Some Class 2 materials occur in all of the areas except Area E. Class 3 materials were recorded in Areas; E, F, G, I, J and L, and Class 4 materials recorded in Areas E, J, L, M, N, O, and P.

It should be noted that while some materials otherwise meet the INAC classification criteria for consideration as Class 1 material, chert exists in sufficiently high concentrations, that if reactive, could render the aggregates unsuitable for use with high alkali cements. More detailed testing would be required if any of these materials were to be developed as a concrete aggregate source, particularly in view of the poor alkali-aggregate reactivity test results reported (see Table 11).

The anticipated total required volumes of granular materials for the Tuktoyaktuk region, excluding speculative projects, up until the year 2006 are as follows (from EBA 1987):

Class 1	30 400 m^3
Class 2	137 300 m^3
Class 3	88 200 m^3
Class 4	40 000 m^3

The volumes of proven reserves delineated in the present report for Class 2, 3 and 4 were 239 000 m^3, 188 000 m^3 and 205 000 m^3 respectively, indicating that the 155 South Site should provide an adequate resource for these three classes of material.

With regard to Class 1 requirements, no suitable deposits were identified in the present study. However, by further processing of Class 2 reserves, it should be feasible to meet a significant proportion of the Class 1 demand.

Table 11 presents the results of concrete aggregate suitability tests performed as part of this study on one combined sample from Boreholes 155SB026 to 155SB029 and one sample from a stockpile of material at the site, as well as the results of petrographic analyses.

In general, the 155 South deposit should be rated as fair to poor with respect to suitability for the production of concrete aggregate. As shown on Table 11, the petrographic numbers (PNs) calculated from petrographic analyses all exceeded the "poor" classification as defined by CSA A23.2 and the alkali reactivity potential gave "deleterious" results from three out of four tests. Magnesium sulphate soundness and Los Angeles abrasion tests, however, gave acceptable results with regard to aggregate durability. L.A. abrasion losses ranged from 18% to 20% with excellent defined as less than 35% losses, while soundness losses were between 1% to 4% where 12% is the maximum allowable.

TABLE 11

SUMMARY OF CONCRETE AGGREGATE SUITABILITY DATA
SOURCE 155 SOUTH

SAMPLE	LOS ANGELES ABRASION LOSS AT 500 REVOLUTIONS (%)	SPECIFIC GRAVITY	ABSORPTION (%)	SULPHATE SOUNDNESS LOSS (%)	ALKALI REACTIVITY POTENTIAL		PETROGRAPHIC NUMBER (PN)
					FINE FRACTION	COARSE FRACTION	
COMBINED SAMPLE FROM BOREHOLES 155SB026 TO 155SB029	20.2	2.62	1.21	3.6	DELETERIOUS	DELETERIOUS	
SAMPLE FROM STOCKPILE AT 155 SOUTH SITE	18.1	2.60	1.43	1.62	INNOCUOUS	DELETERIOUS	
155SB028 1.5 – 2.1 m							164
155SB031 1.7 – 2.2 m							159
155SB034 1.0 – 1.5							176

7.0 DEVELOPMENT CONSIDERATIONS

7.1 GENERAL DEVELOPMENT STRATEGY

Most areas investigated within the 155 South Site do not have massive ice at depths shallower than 3.0 m. A favourable combination of material types and topography has generally prevented the formation of thick ice units within about 2.5 to 3 m of the ground surface. Massive ice is restricted to the fine sand units. With the exception of Area I and portions of Areas E and G, organic deposits overlying the granular materials are 0.3 m or less in thickness.

As the majority of materials in the 155 South deposits are distributed evenly between Class 2,3 and 4, there is no preferred order of development based solely upon granular materials quality. Accordingly, since access will be from the north through the 155 North Site, extraction operations should reasonably begin at the north end of the 155 South Site and work southward through areas E, F, M, I and J.

7.2 DEVELOPMENT METHODOLOGY

It is assumed that a similar methodology to the 155 North Site will be used in the development of this deposit. That is, a winter operation with access along an ice road from Tuktoyaktuk. A winter operation would involve ripping the overburden where encountered, pushing the overburden to the edges of the area to be developed, ripping the granular material, pushing the ripped material into temporary stockpiles, loading and trucking the granular

material to stockpile sites at the community, and, upon completion of extraction, spreading the stockpiled overburden on the slopes of the completed excavation and/or other disturbed areas such as access roads. The stockpiled frozen granular material would then be available for community use during the following summer as thawing of the stockpile progressed.

Access to all potential borrow areas would be available predominantly across ice, together with short snow roads from the shore to the development sites. The major problem anticipated with a winter operation will be the rippability of the materials encountered and a relatively low level of productivity might be anticipated in this regard. However, the subsurface conditions identified comprise a relatively high component of poorly bonded, granular materials devoid of overburden, that should be easily rippable. A thin organic cover above granular materials should not present major ripping problems.

Following the extraction of granular materials, thawing of the underlying massive ice may be initiated. Therefore, the area of the pit should be minimized during an extraction season. In addition, excavation during any season should be carried to the maximum extent of recoverable materials since unextracted granular materials may become submerged in thaw ponds during the following summer as the underlying massive ice thaws.

7.3 ABANDONMENT AND RECLAMATION

Since thaw of massive ice may follow extraction of granular materials, thaw ponds may occur in some worked areas. Ponds and small lakes are common in the general area, thus, the formation of the additional ponds is considered an environmentally acceptable end result. The perimeters of the worked

areas will be unstable initially if underlain by massive ice. However, these areas can be expected to stabilize naturally over a few years, without excessive regression. The time to stabilize and the amount of regression likely to occur along the boundaries of depleted borrow areas will be dependent on soil type, ice content, vegetation cover and depth to massive ice.

In preparation for abandonment, the area should be cleaned of all debris, and topographic irregularities associated with pit operations, such as ridges and mounds, should be removed. No significant terrestrial disturbances are anticipated during winter operations for areas outside the pit limits.

Disturbed areas which are not expected to become flooded should be smoothly graded, and previously stockpiled overburden should be mixed into the abandoned surfaces in preparation for establishing a seeded plant cover.

Prior to seeding, the site should be deeply ripped with a caterpillar mounted ripping tool. This will serve to mix some native topsoil, high in organic content with the compacted layer of coarse material remaining on the pit floor after cleanup, thereby improving fertility and the moisture holding capacity of the surface materials. This operation would be most successful when done in late fall after frost has penetrated 100 to 150 mm into the surface but before the entire active layer is frozen. Clods of soil generated by ripping at this time would provide a roughened surface that would reduce the potential of wind erosion and provide protected microsites for the establishment of seeded and native species.

Seed and fertilizer should be applied by broadcast in late fall, immediately following ripping. The recommended seed mixture includes Boreal creeping

red fescue, Nugget Kentucky bluegrass, Fairway crested wheatgrass and Engmo timothy in a 2:2:1:1 ratio, by weight, applied at 56 kg/ha (50 lb/ac). Fertilization should be with a 14-28-14 mix of N, P_2O_5 and K_2O, applied at 440 kg/ha (400 lb/ac) at the time of seeding, and again at the beginning of the second growing season. Annual monitoring of revegetation success for the first two years is recommended. Although the seed mix includes species that are winter hardy and species with moderate tolerance to saline soil conditions, harsh climatic and site conditions may require that portions of the site be reseeded or that fertilization be continued for more than two years.

8.0 CLOSURE

A field drilling program was carried out at the 155 South deposit at Kittigazuit Creek to delineate areas containing potentially extractable granular materials. Laboratory and office studies followed the drilling program to establish suitability of granular materials for various uses, to quantify potentially extractable volumes and to discuss development considerations.

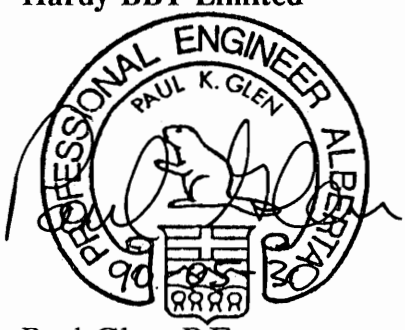
An estimated 2 132 000 m^3 of Class 2 to 4 granular materials was delineated during this investigation, being equally distributed within each class. These materials are spread among 12 separate areas comprising the 155 South Site. The proven reserves at this site should meet the projected demand up until the year 2006 assuming that Class 2 material will be processed to satisfy the Class 1 demands.

Development should proceed from north to south within these deposits. A winter extraction operation, similar to that used at the 155 North Site, is

considered to be the most appropriate. Commonly, the upper 2.5 to 3 m of these deposits are not strongly ice bonded, and ripping operations should be feasible, although slow progress may be encountered in some areas. In order to reduce the potential for melting of massive ice and the creation of thaw ponds, it is recommended that active pit areas be minimized and that extraction to the full depth of available granular materials should take place during a single extraction season.

Respectfully submitted,

Hardy BBT Limited



PERMIT TO PRACTICE
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GLOSSARY OF TERMS

Absorption

The moisture contained in saturated and surface-dry aggregate, as a percentage of the dry weight.

AASHTO Specifications

A set of specifications for the testing of soil and soil aggregate mixtures for highway construction purposes, as formulated by the American Association of State Highway and Transportation Officials.

Active Layer

In permafrost regions, the active layer is that surface layer of ground which thaws annually. The active layer may be up to several metres in thickness. Granular material in the active layer which is ice-bonded during the winter may become loose and workable after thawing.

Aggregate

An assemblage of different sized particles of natural granular material or crushed rock used in the manufacture of concrete, mortar and asphalt. These materials are also used with or without additional processing for road construction, drainage works and construction fills.

Alkali

In the context of concrete aggregate testing, alkali refers to trace amounts of alkali metals, such as sodium and potassium, that may occur in cement. When cement and aggregate are mixed to produce concrete adverse reactions may occur between certain aggregates and the alkali component of the cement (see "Alkali-Aggregate Reactivity").

Alkali-Aggregate Reactivity

The potential of an aggregate to adversely react with the alkali component of cement, so leading to problems such as swelling and slaking of the concrete.

Alluvial Fan

A low, outspread, relatively flat to gently sloping mass of detritus, shaped like an open fan or a segment of a cone, deposited by a stream where it issues from a narrow mountain valley upon a plain or broad valley.

ASTM Standards

Test specifications of the American Society for Testing Materials, in this report referring to testing of soil and concrete aggregate.

Borrow

Any natural material, such as clay, silt, sand, gravel or bedrock, which is extracted from its original location for engineering construction purposes elsewhere (see "Fill").

Chert

A micro-crystalline form of silica which may be of organic or inorganic origin. While normally a physically sound component in aggregates, chert is considered deleterious because of its high degree of potential reactivity with the alkali content of cement. (see "Alkali-Aggregate Reactivity").

Colluvial

Pertaining to any loose, heterogeneous and incoherent mass of soil material and/or rock fragments deposited by rainwash, sheetwash or slow continuous downslope creep, usually collecting at the base of gentle slopes or hillsides.

Concrete Aggregate Suitability Testing

A set of tests, the results of which when taken together are used to determine the suitability of gravel deposits for concrete production. Individual tests include petrographic analysis, the Los Angeles abrasion test, sulphate soundness analysis, alkali reactivity determination, specific gravity determination and water absorption testing.

Conglomerate

A coarse-grained clastic sedimentary rock, composed of rounded to subangular fragments larger than 2 mm in diameter cemented in a fine-grained matrix of sand, silt or clay.

CRREL Coring

This is a method of obtaining cores of frozen soil or ice as developed by the Cold Regions Research and Engineering Laboratory. A specifically designed coring bit is used in conjunction with a hollow-stem auger barrel, so that the latter acts as the core barrel. Following drilling, the cores are extruded horizontally by a piston into suitable containers.

CSA Standards

Test specifications of the Canadian Standards Association, in this report referring to testing of soil and concrete aggregate.

Drowned Meltwater Channel

A meltwater channel is a drainage course specifically formed by erosion due to glacial meltwater flow. When such a channel is subsequently occupied by a branch of either a lake or the sea, it is referred to as a drowned meltwater channel.

Fault Controlled Escarpment

An escarpment is a long, more or less continuous cliff or relatively steep slope facing in one general direction, breaking the continuity of the land by separating two level or gently sloping surfaces. An escarpment may have been formed by differential vertical movement along a fault line, in which case it is said to be "fault controlled".

Fill

Artificially placed deposits of natural earth materials (soil or rock) and/or waste materials (see "Borrow").

Fines

All material passing the #200 U.S. Standard sieve size, including both silt and clay, having grain sizes of less than 75 microns.

Flood Plain

The surface or strip of relatively smooth land adjacent to a river channel, constructed by the present river in its existing regimen and covered with water when the river overflows its banks. It is formed by alluvium carried by the river during floods and deposited in the sluggish water beyond the influence of the swiftest current.

Frost Susceptible Soil

Soil in which significant ice-segregation will occur, resulting in frost heave, or heaving pressures, when the requisite moisture and freezing conditions exist. Silts or soils with appreciable fines content are considered to be frost susceptible.

Geotechnical

Pertaining to the application of scientific methods and engineering principles to the acquisition, interpretation and use of knowledge of materials of the earth's crust for the solution of engineering problems.

Glaciofluvial Terraces

Terraces formed by the deposition of material carried by meltwater streams flowing from wasting glacier ice.

Grab Sample

A disturbed sample of soil collected from drill cuttings, as from the flights of an auger drill.

Grading Curve

A plot showing the results of a grain size analysis. For each size tested, the proportion by weight of the total sample which is less than that size is plotted. The grading curve is formed by joining successive points.

Grading Envelope

A plot describing the range of gradings of any composite set of soils. The envelope includes two separate grading curves marking the upper and lower size limits of the material described.

Grain Size Analysis

A test for determining the distribution of particles of defined size fractions of a given soil or aggregate sample.

Granular Material

Any material not passing the #200 U.S. Standard sieve size, including sand, gravel and cobble sizes. Boulder sized material, in excess of 1000 mm diameter, would not normally be included as granular material.

Hollow-Stem Auger

A borehole drilling technique in which the rotation of spiral shaped flanges, or flights, serve to raise soil material to ground surface, having firstly been loosened or broken up by a cutting bit at the base of the auger. The central stem of the auger is hollow to enable sampling and testing of undisturbed soil at the base of the hole.

Indurated

Pertaining to a rock or soil hardened or consolidated by pressure, cementation, or heat.

Interstitial

Pertaining to the voids within a host rock or soil assemblage, geologically the term is specifically applied to a mineral deposit filling such voids, in this case it is used specifically with reference to ice-filled voids.

Isopach

A line on a map drawn through points of equal thickness of a designated stratigraphic unit, or group of units.

Kame Terrace

A terrace consisting of stratified sand and gravel formed as a glaciofluvial deposit between a melting glacier or a stagnant ice lobe and a higher valley wall or lateral moraine, and left standing after the disappearance of the ice.

Lacustrine

Pertaining to, produced by, or formed in a lake or lakes.

Lithology

The mineralogical composition and physical characteristics of a rock.

Los Angeles Abrasion Test

This is a laboratory test of the durability of aggregate particles. It uses standardized equipment to test the resistance to wear of gravel particles. A weighed amount of sieved gravel is loaded into the test instrument with a set of grinding spheres, and is then subjected to a set number of rotations (e.g. 500). The grinding spheres are then removed and the gravel and sand content separated and weighed. The percentage decrease in the amount of gravel is a measure of the durability of the aggregate.

Moisture Content

The amount of water in a given soil mass expressed as a percentage of the weight of the soil after it has been dried to constant weight at 105° to 110°C.

Morainal

Pertaining to accumulations of unsorted, unstratified glacial drift, predominantly till.

Mudstone

A blocky or massive, nonfissile, fine-grained sedimentary rock in which the proportions of clay and silt are approximately equal.

Normal Portland Cement

This is the cement which is normally supplied by a manufacturer unless another type is specifically called for. Having a medium rate of hardening, it is suitable for most kinds of concrete construction.

Overburden

Unconsolidated natural soil or fill material overlying either bedrock or an unconsolidated borrow deposit.

Oversized Material

Any granular material with a diameter in excess of 76 mm. In normal granular resource processing such material must be wasted. However, it may be of use as rip-rap material in erosion control.

Permafrost

Any soil, subsoil, or other surficial deposit, including bedrock, in which a temperature below 0°C has existed continuously for more than two years.

Petrographic Analysis

The determination of the percentage content of different rock type groupings in a sample of aggregate. This analysis is carried out in order to determine the overall quality of a sample, in terms of its Petrographic Number (PN).

Petrographic Number, PN

This number is the measure of the overall quality of a gravel sample. It reflects the amount of physically unsound or potentially chemically reactive particles in a sample. Rock and mineral constituent types are rated between 1 and 20, for excellent to very

deleterious respectively. The total weight percentage for each rock type is then multiplied by its soundness rating, and the resulting values are summed to give the overall PN for the sample. Poorer quality aggregates thus would have higher PN values.

Poorly Graded

A soil assemblage is said to be poorly graded when all of the constituent particles are of about the same size, or when a continuous distribution of particle sizes from the coarsest to the finest is lacking.

Quartzitic Sandstone

A medium-grained clastic sedimentary rock composed of sand sized quartz grains, set in a silica cement.

Sheet Glacier

A glacier of considerable thickness and areal extent, forming a continuous cover of ice and snow over a land surface, spreading outward in all directions, and not confined by the underlying topography.

Solid-Stem Auger

As for hollow-stem auger, but the auger stem is solid, not allowing for undisturbed sampling and testing with the auger in place in the hole.

Specific Gravity

The ratio of the weight in air of a given volume of soil particles to the weight in air of an equal volume of distilled water at a temperature of 4°C.

Sulphate Soundness Test

This test is used to estimate the ability of a sample of aggregate to resist excessive changes in volume as a result of changes in physical conditions, that is, its ability to resist physical weathering. The sample is subjected alternately to immersion in a saturated solution of sodium or magnesium sulphate and drying in an oven. The formation of salt crystals in the pores of the aggregate tends to disrupt the particles, similarly to the action of ice. The reduction in size of the particles, as shown by a sieve analysis, after a number of cycles of exposure, denotes the degree of unsoundness.

Surficial Deposits

Unconsolidated and residual, alluvial, or glacial deposits lying on bedrock or occurring on or near the earth's surface; they are generally unstratified and represent the most recent of geologic deposits.

Terrace Remnant

A terrace is any long, narrow, relatively level or gently inclined surface, bounded along one edge by a steeper descending slope and along the other by a steeper ascending slope. Where a relatively small section of terrace formation is separated by erosion from the remainder of the original feature, then, it is referred to as a "terrace remnant".

Tertiary

The first period of the Cenozoic era, following the Cretaceous period of the Mesozoic era and preceding the Quaternary. The Tertiary is believed to have covered the span of time between 65 and 2 million years ago.

Thaw Pond Potential

The probability of ponds forming within a granular borrow area as the active layer thaws.

Thermokarst

Karstlike topographic features produced in a permafrost region by the local melting of ground ice and the subsequent settling of the ground. The irregular karst topography is normally associated with the dissolution of limestone by groundwater, rather than with thawing of permafrost terrain.

Tundra

A treeless, level or gently undulating plain characteristic of arctic or subarctic regions. It usually has a marshy surface, which supports a growth of mosses, lichens and low shrubs and is underlain by permafrost.

Unified Soil Classification (U.S.C.)

A standard soil classification system developed by the U.S. Bureau of Reclamation and the Corps of Engineers in 1952, and is intended for use in all engineering problems involving soils. A more recent, modified version of the U.S.C. is presented following the borehole logs in Appendix A of this report.

Universal Transverse Mercator (UTM) Co-ordinates

A geographical reference system for determining locations. It is based on the division of a sphere into UTM zones, each six degrees of longitude wide and numbered consecutively in each Hemisphere (East or West) from the International Dateline (180th Meridian); and each with an overlying metric grid, centered parallel to the Central Meridian of the zone and the Equator, such that North America is largely within Zones 2W to 22W, and the grid co-ordinates 500,000 m E; 0,000,000 m N represent the intersection of the zones Central Meridian and the Equator.

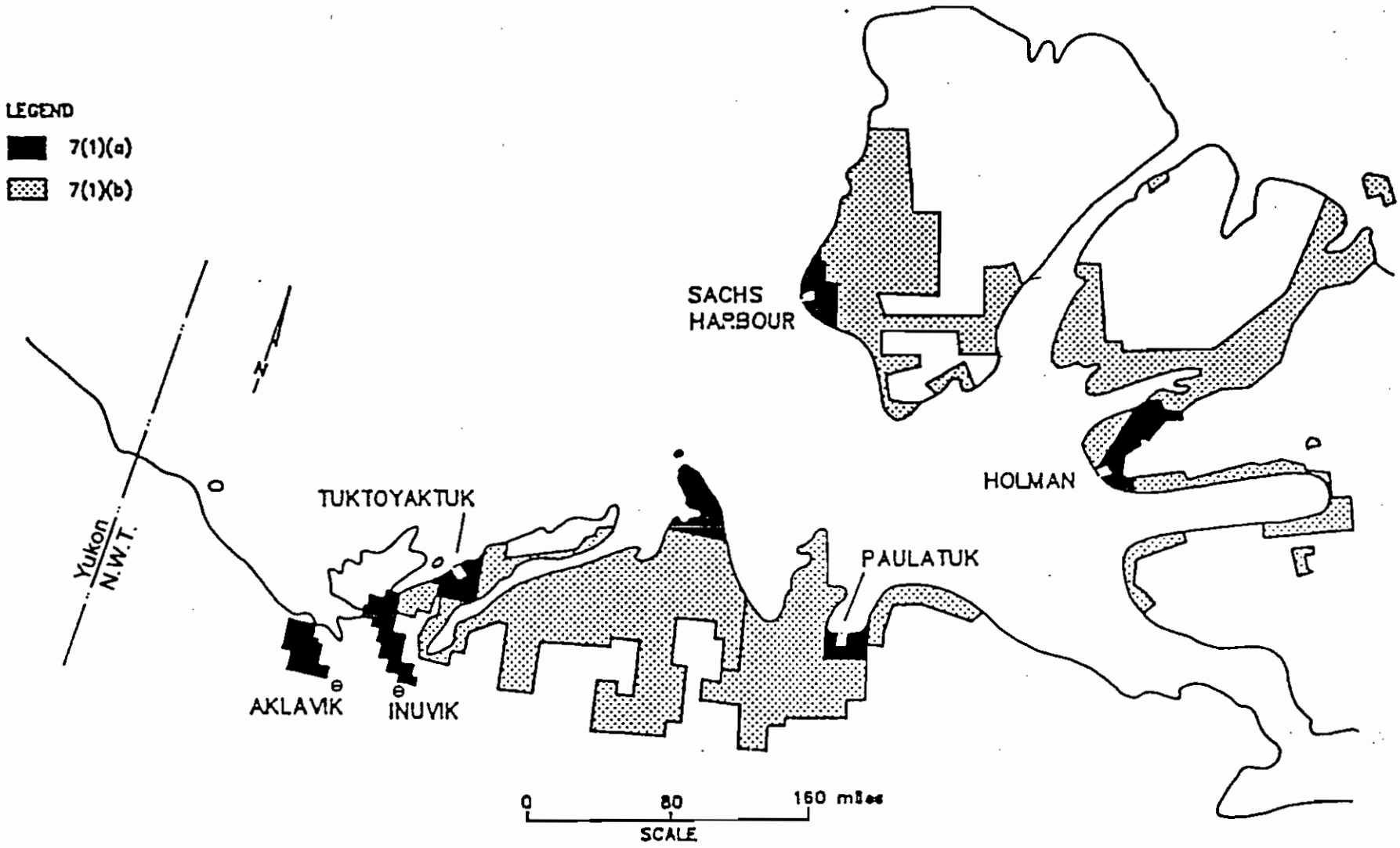
Water Absorption Test

A test to estimate the capacity of an aggregate sample to absorb water into pore spaces. The procedure consists of soaking the sample in distilled water for 24 hours, surface-drying and weighing in air, and then oven-drying and weighing in air again. The water absorption is obtained by expressing the difference between the weights of the saturated and the oven-dried sample in air, as a percentage of the latter.

Well Graded

A soil assemblage is said to be well graded when there is a continuous distribution of particle sizes from the coarsest to the finest, in such proportions that the successively smaller particles almost completely fill the spaces between the larger particles.

PG/rb
CG10346.GLS
Eng_Geo



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CONSULTING ENGINEERING & PROFESSIONAL SERVICES

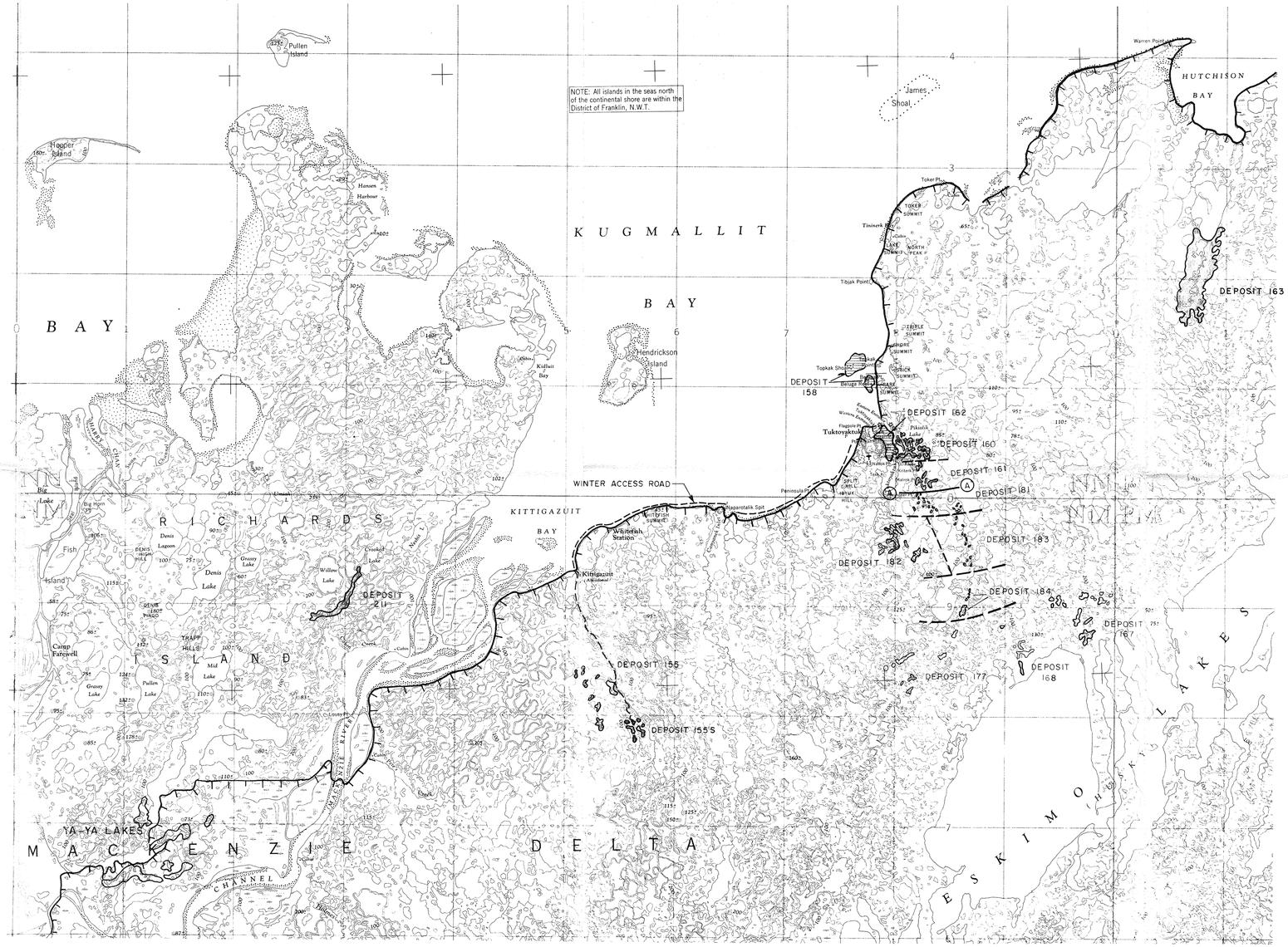
GEOTECHNICAL INVESTIGATION OF POTENTIAL SAND AND GRAVEL RESERVES
INUVIALUIT SETTLEMENT REGION
155 SOUTH DEPOSIT, TUKTOYAKTUK N.W.T

INUVIALUIT LANDS LOCATION PLAN

CG10346

Figure 1

HBLT 15 - 87.05



LEGEND

- Deposits investigated during this study and/or previously, and considered favourable
- Offshore deposits investigated previously considered favourable
- Deposits investigated during this study and considered unsuitable
- Deposits identified during this study but not ground-truthed
- Inuvialuit lands
- (A—A) Demarcation line agreed upon during Phase I, development of granular deposits south of this line allowed

Scale 1:250,000 Échelle

Miles 5 0 5 10

Kilometres 5 0 5 10 15

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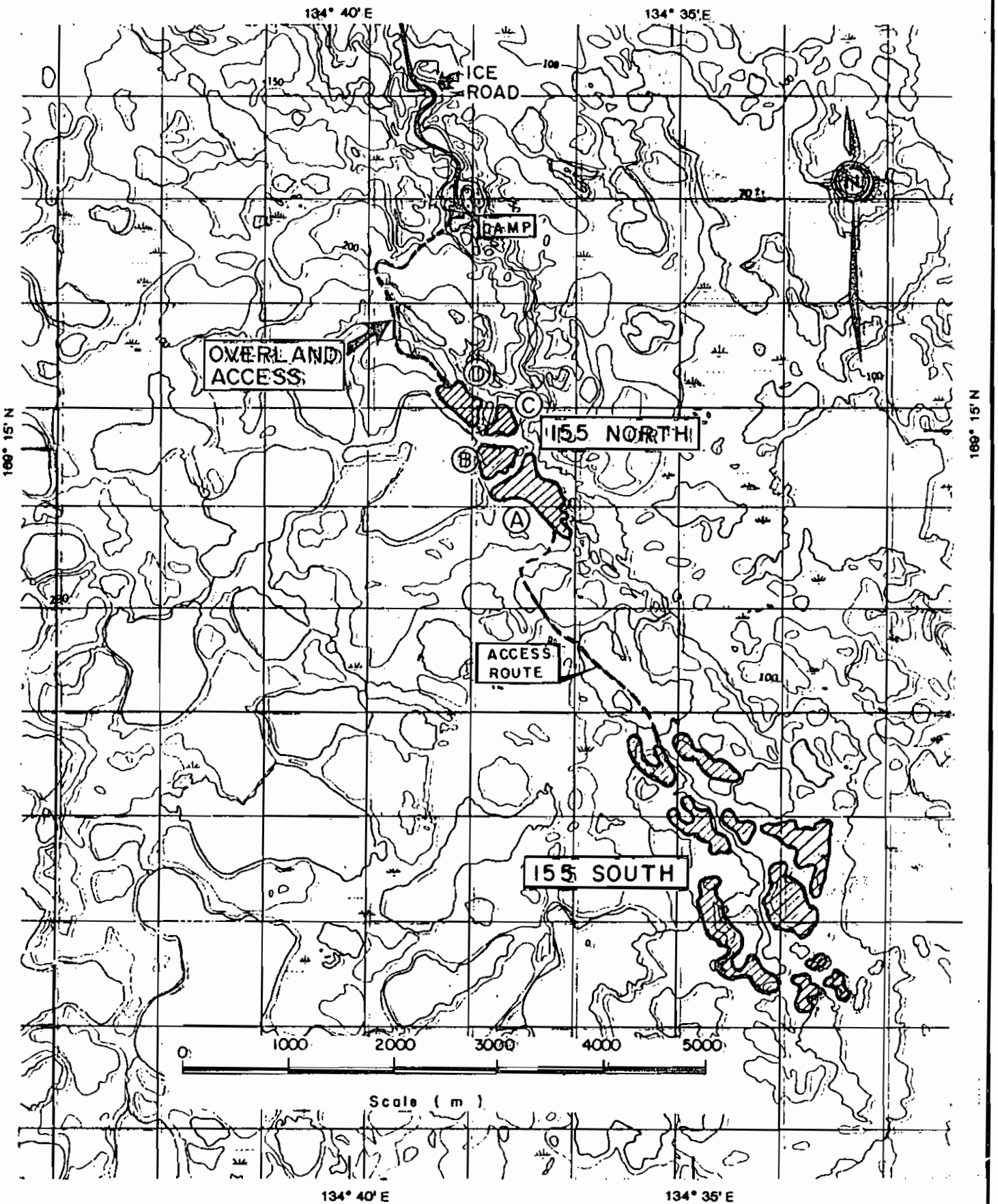
COMMUNITY GRANULAR MANAGEMENT PLAN
TUKTOYAKTUK N.W.T

SITE LOCATION PLAN
POTENTIAL BORROW SOURCES FOR COMMUNITY SUPPLY (1986 STUDY)

DATE Nov. / 86 DWN YK CHKD. NM APPD AH

CG10346 | FIGURE 2



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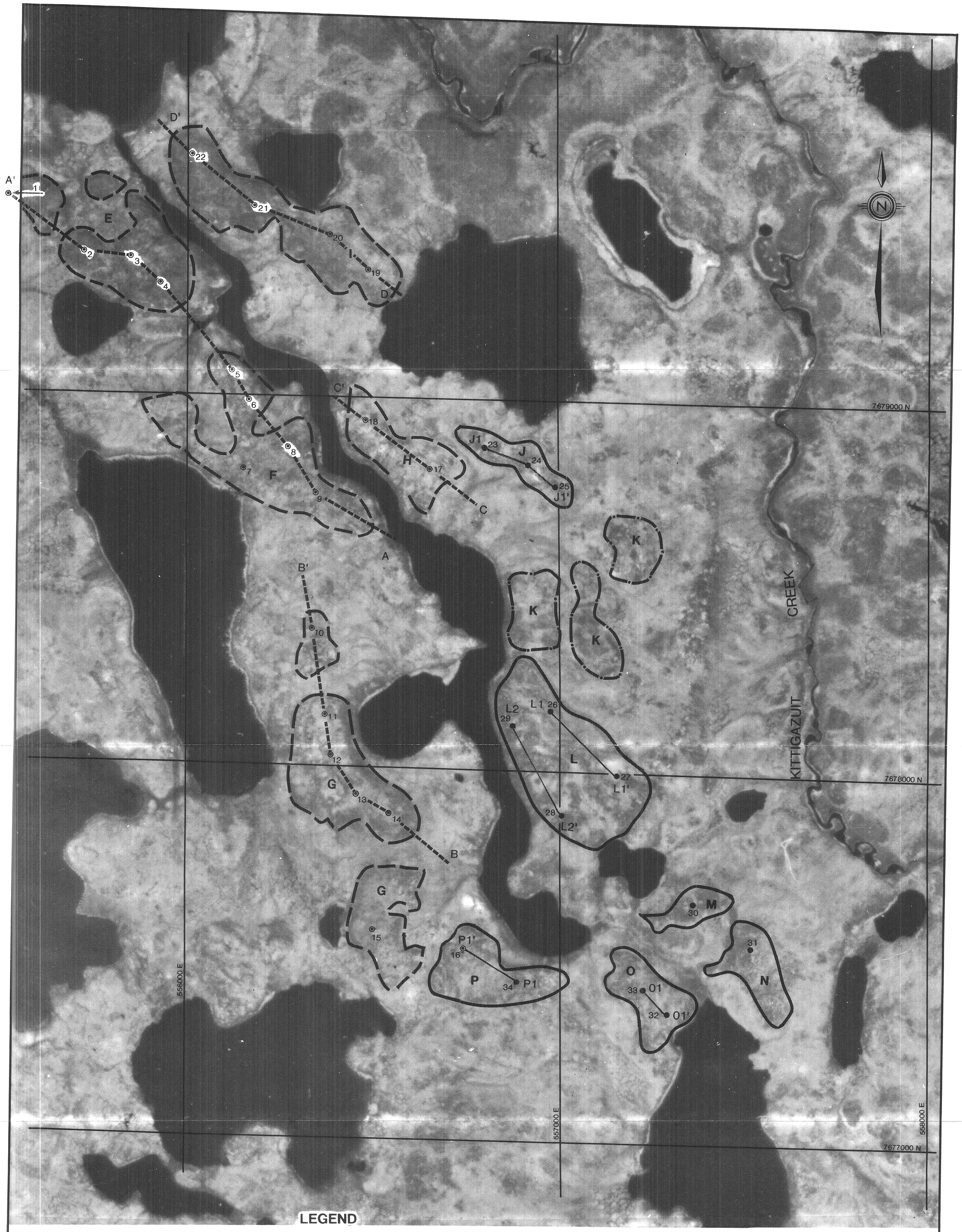
GEOTECHNICAL INVESTIGATION OF
POTENTIAL SAND AND GRAVEL RESERVES
INUVIALUIT SETTLEMENT REGION, TUKTOYAKTUK N.W.T

LOCATION OF DEPOSITS, 155 NORTH AND 155 SOUTH

CG10346

FIGURE 3



LEGEND

- Cross Sections (1987 Program)
- J1 — J1' Cross-Sections (1989 Program)
- Deposits Drilled During 1987 Program
- Small Deposits – Undrilled During 1987/1989 Program
- Deposit Drilled During 1989 Program
- ● 23* Drilling Location with Borehole Number (1989 Program)
- ◉ 1* Drilling Location with Borehole Number (1987 Program)

NOTE: Geodetic control based on
107 C/2 West Provisional Map
U.T.M. Grid Zone 8

Air Photo #A26749-120

* Abbreviated borehole numbers
eg. 23=155SB023

SCALE (m)
0 100 200 300 400 500

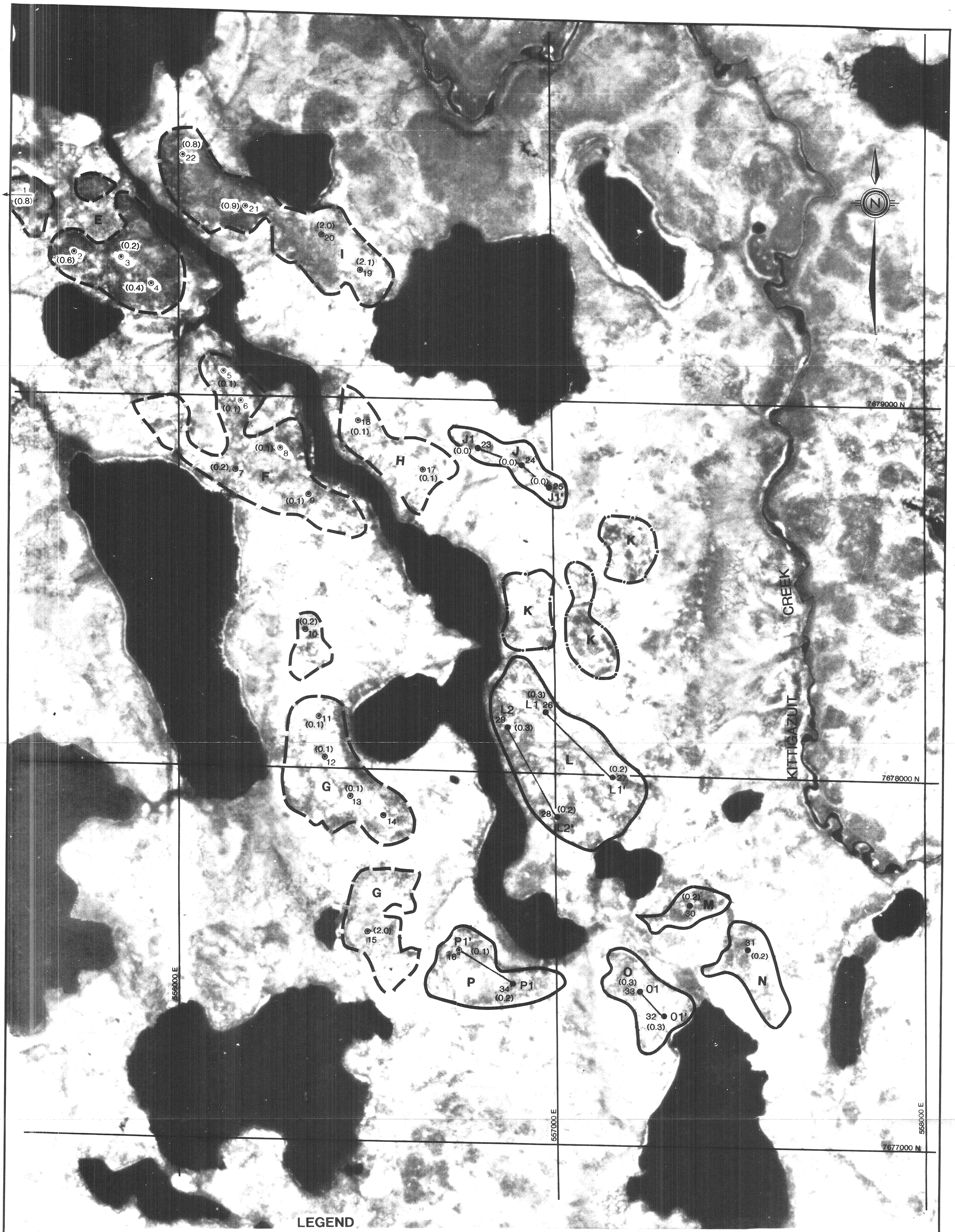
REFERENCES

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

INUVIALUIT SETTLEMENT REGION
GRANULAR RESOURCES EVALUATION

DEPOSIT 155 SOUTH
BOREHOLE LOCATIONS AND
GEOLOGICAL CROSS - SECTIONS

SCALE	As Shown	DATE	OCT/89	MADE	YK	CHKD	BW	APPD	PG
JOB No.	CG10346					FIGURE 4		REV.	1



LEGEND

(0.2) Overburden Thickness at Borehole (in metres)

J1 — J1' CROSS SECTIONS

Deposits Drilled During 1987 Program

Small Deposits – Undrilled During 1987/1989 Program

Deposit Drilled During 1989 Program

● 23* Drilling Location with Borehole Number (1989 Program)

⊙ 1* Drilling Location with Borehole Number (1987 Program)

NOTE: Geodetic control based on 107 C/2 West Provisional Map U.T.M. Grid Zone 8

Air Photo #A26749-120

* Abbreviated borehole numbers eg. 23=155SB023

SCALE (m)
0 100 200 300 400 500

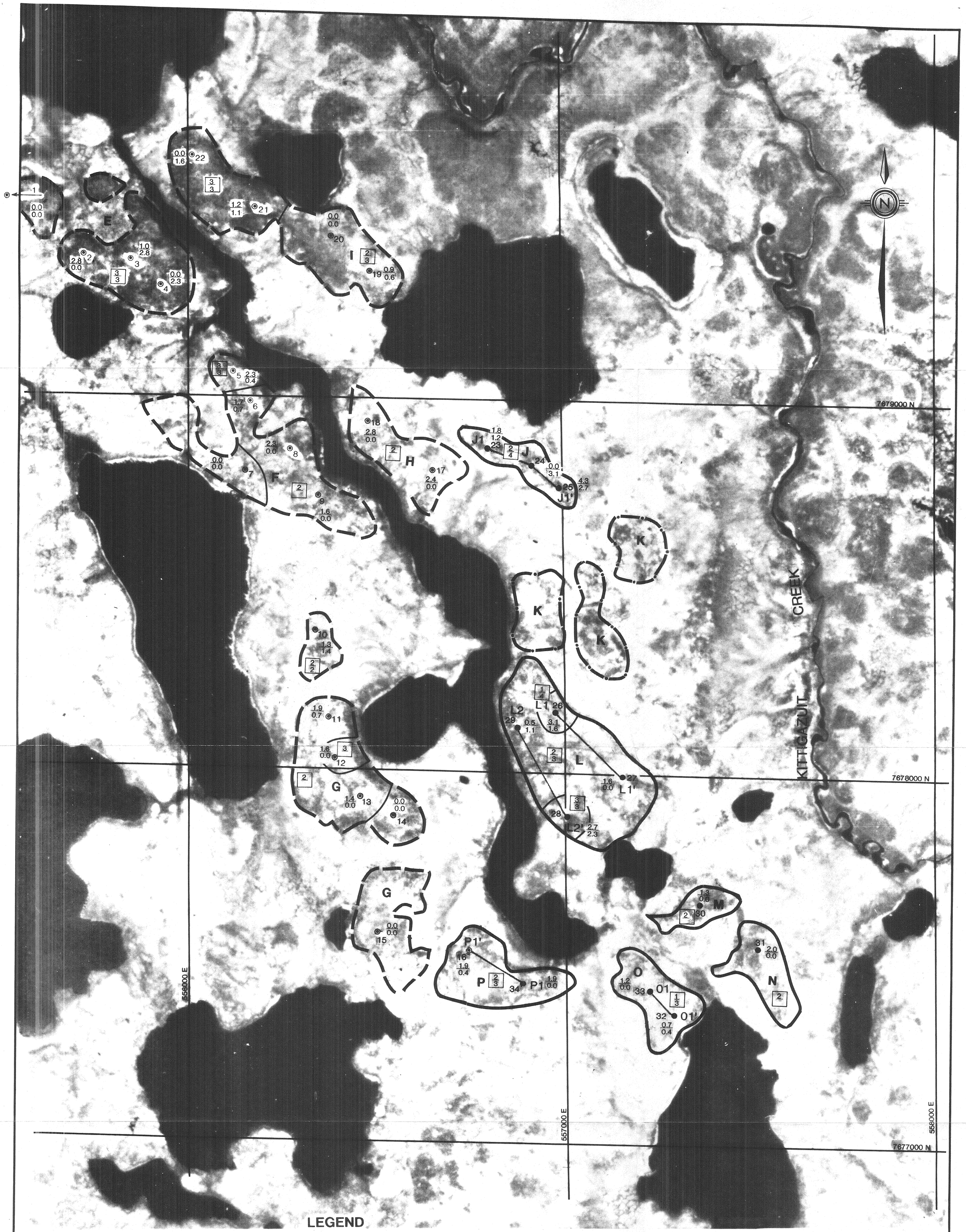
REFERENCES

Hardy BBT Limited
CONSULTANTS IN PROFESSIONAL SERVICES

INUVIALUIT SETTLEMENT REGION
GRANULAR RESOURCES EVALUATION

DEPOSIT 155 SOUTH
OVERBURDEN THICKNESS

SCALE	As Shown	DATE	OCT/89	MADE	YK	CHKD	BW	APPD	PG	
JOB No	CG10346							FIGURE	5	REV 1



LEGEND

Thickness at Borehole (in metres)

$\frac{1.2}{0.9}$ = Gravel – Sandy Gravel / Gravelly Sand – Medium Grained Sand

$\frac{1}{2}$ = Quality of Gravel–Sand Gravel / Quality of Gravelly Sand–Medium Grained Sand

Source Quality Classes

1. Excellent
2. Good
3. Fair
4. Poor

J1 — J1' CROSS SECTIONS

Deposits Drilled During 1987 Program

Small Deposits – Undrilled During 1987/1989 Program

Deposit Drilled During 1989 Program

● 23* Drilling Location with Borehole Number (1989 Program)

⊙ 1* Drilling Location with Borehole Number (1987 Program)

NOTE: Geodetic control based on 107 C/2 West Provisional Map U.T.M. Grid Zone 8

Air Photo #A26749–120

* Abbreviated borehole numbers eg. 23=155SB023

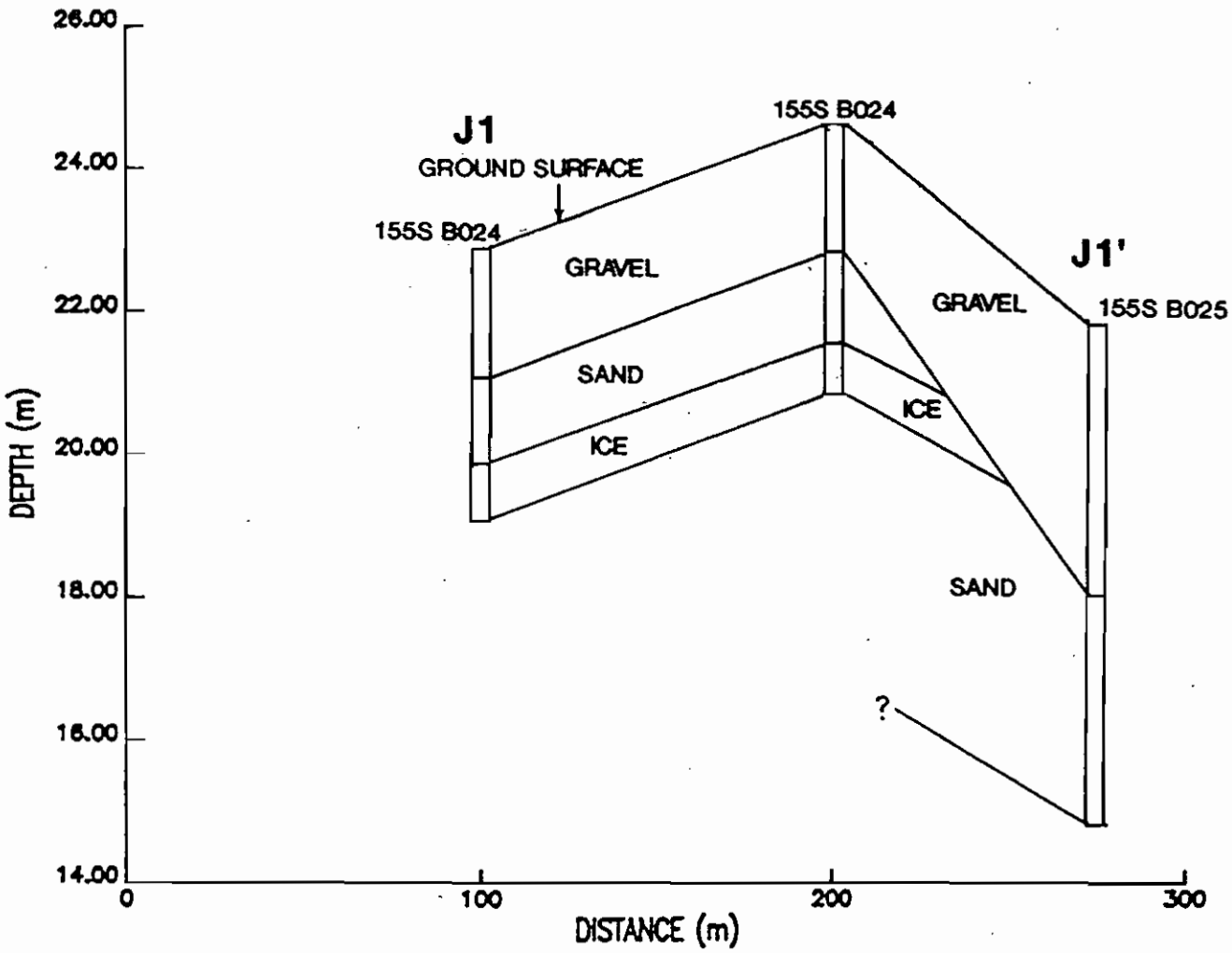
SCALE (m)
0 100 200 300 400 500

REFERENCES

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

INUVIALUIT SETTLEMENT REGION
GRANULAR RESOURCES EVALUATION
DEPOSIT 155 SOUTH
SOURCE QUALITY CLASS
GRANULAR MATERIAL THICKNESS

SCALE	As Shown	DATE	OCT/89	MADE	YK	CHKD	BW	APPD	PG
JOB No.	CG10346					FIGURE	6	REV	1



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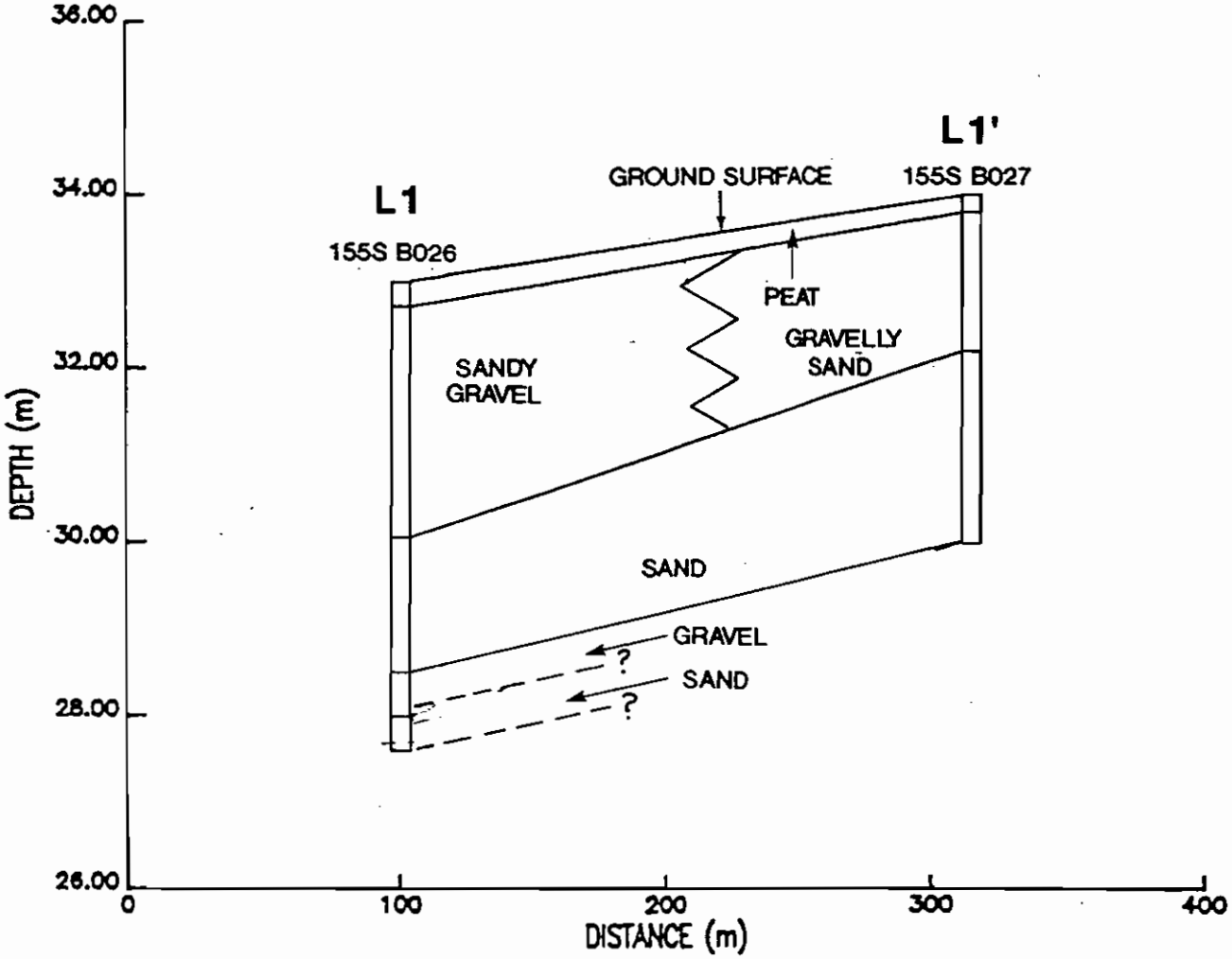
KITTIGAZUIT CREEK (155S)
CROSS-SECTIONAL PLOT J1 - J1'

Figure 7

HBLT 15 - 87/05



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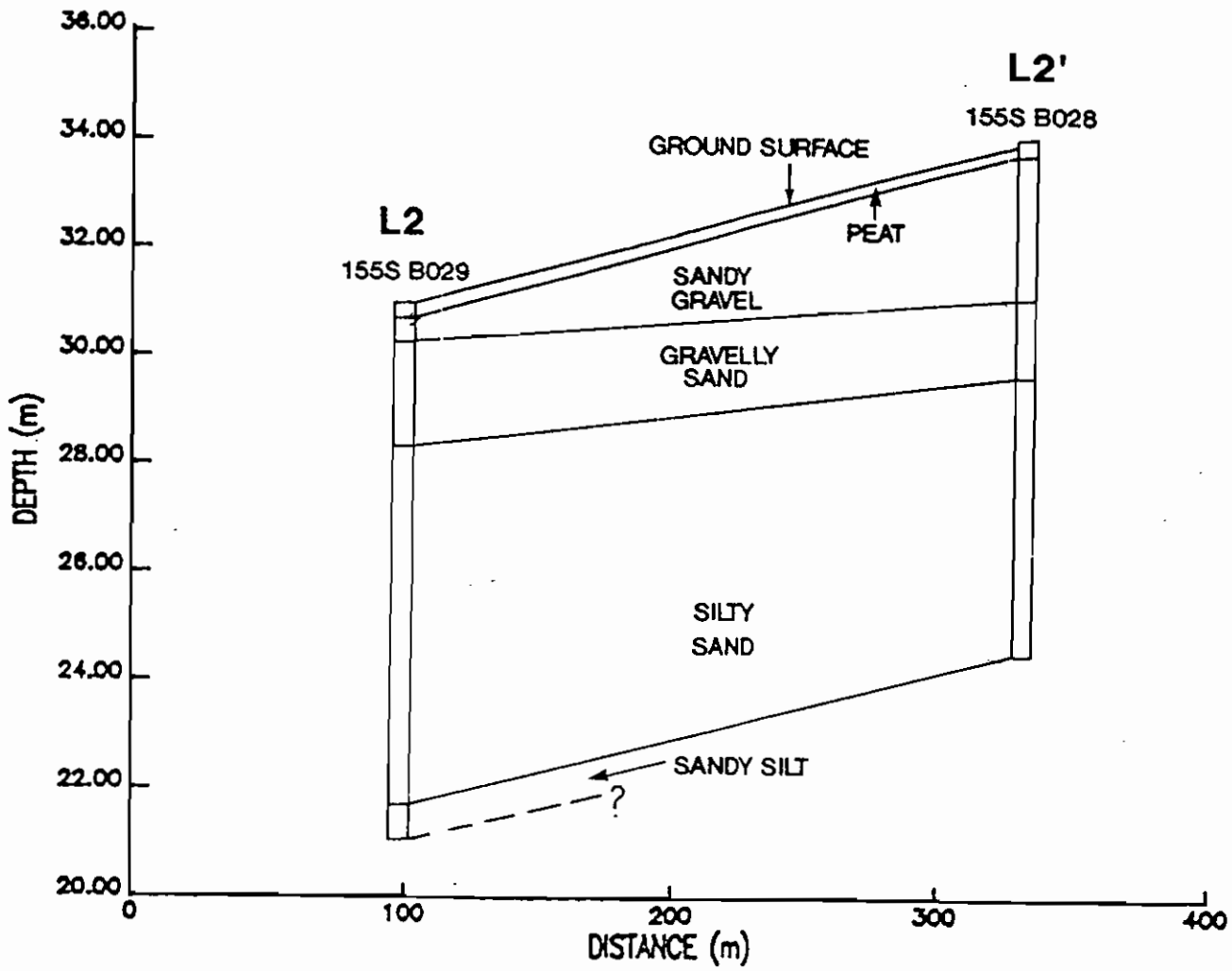
KITTIGAZUIT CREEK (155S)
CROSS-SECTIONAL PLOT L1 - L1'

Figure 8

HBLT 15 87/05



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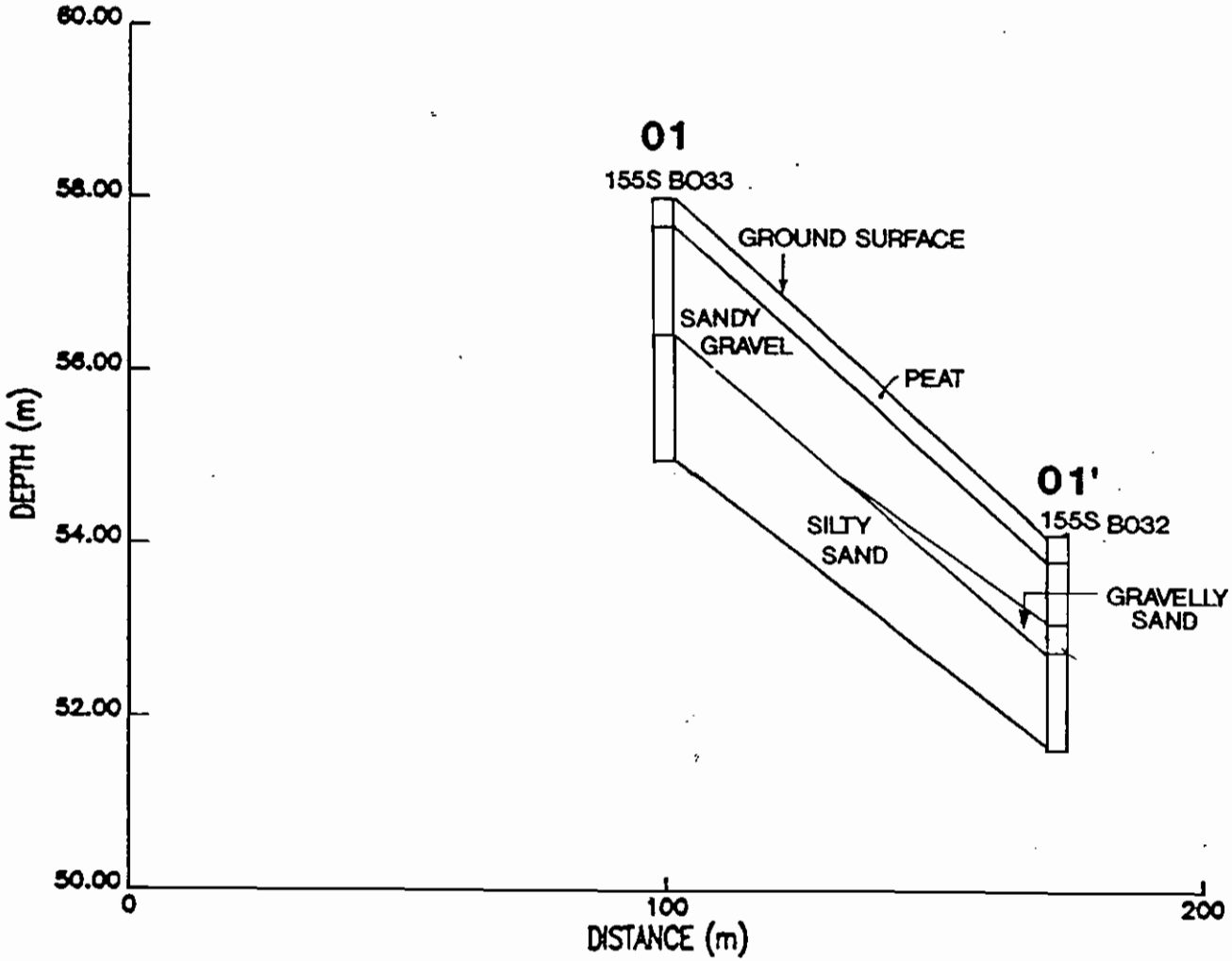
KITTIGAZUIT CREEK (155S)
CROSS-SECTIONAL PLOT L2 - L2'

Figure 9

HBLT 15 87/05



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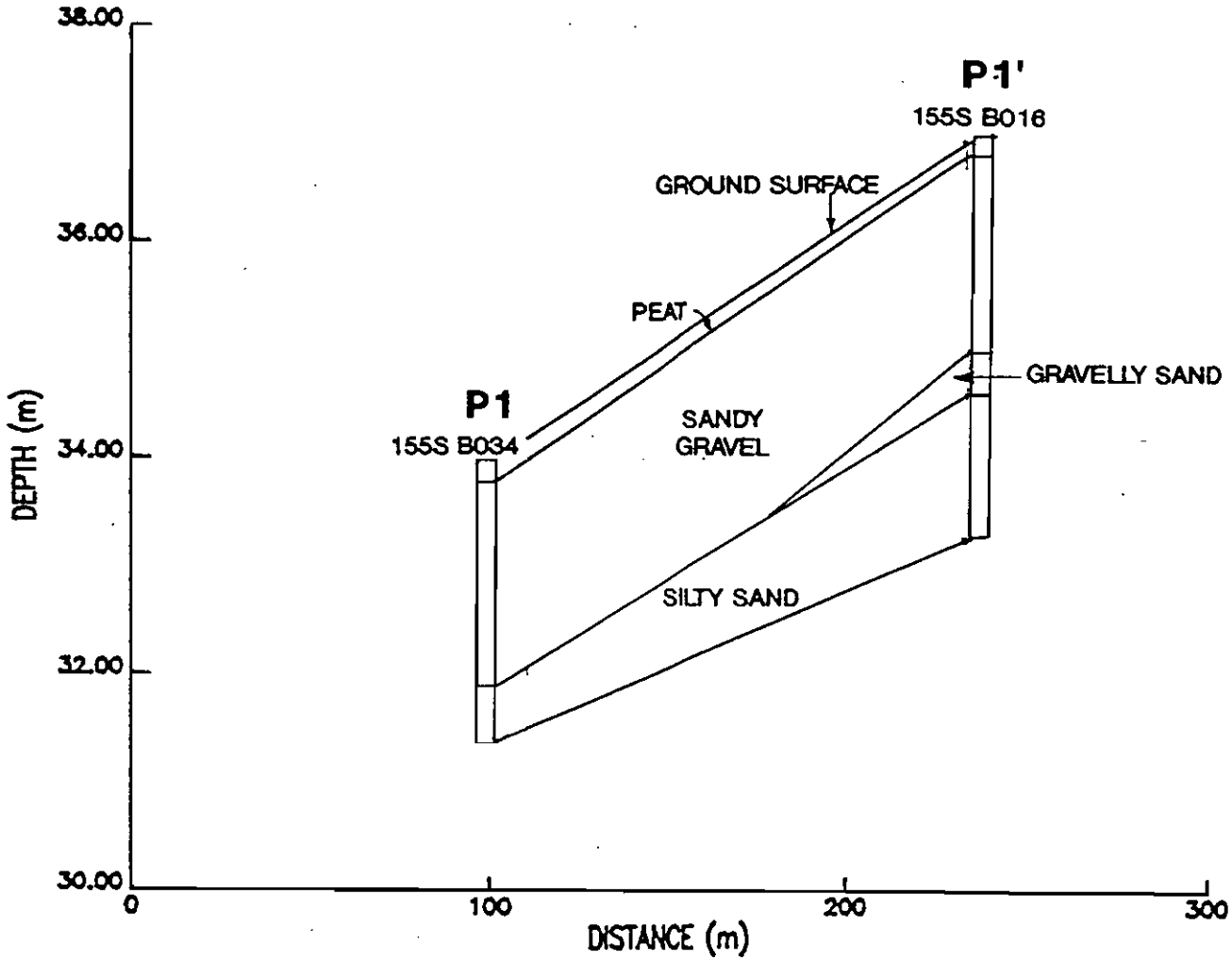
KITTIGAZUIT CREEK (155S)
CROSS-SECTIONAL PLOT 01 - 01'

Figure 10

HBLT 15 - 87/05



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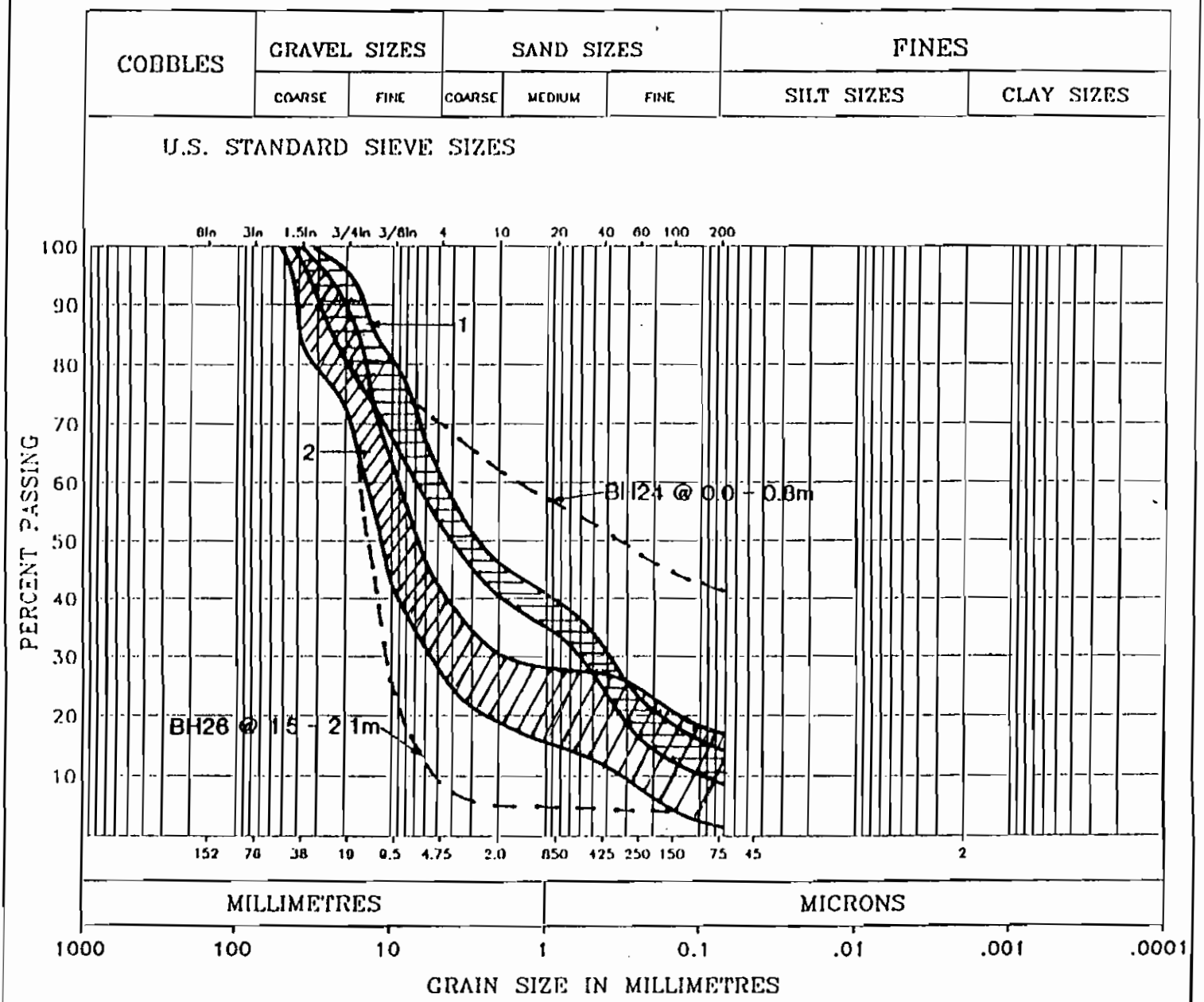
KITTIGAZUIT CREEK (155S)
CROSS-SECTIONAL PLOT P1 - P1'

Figure 11

HBLT 15 - 87/05



REMARKS:

(1) Upper/Finer Branch: 4 samples with < 50% grave
- well-graded gravelly sand.

(2) Lower/Coarser Branch: 6 samples with > 50% gravel
- poorly-graded sandy gravel.

Anamolous samples shown with dashed lines.

SUMMARY

D_{10} =	mm	GRAVEL
D_{30} =	mm	SAND
D_{60} =	mm	FINES
C_U =		
C_C =		

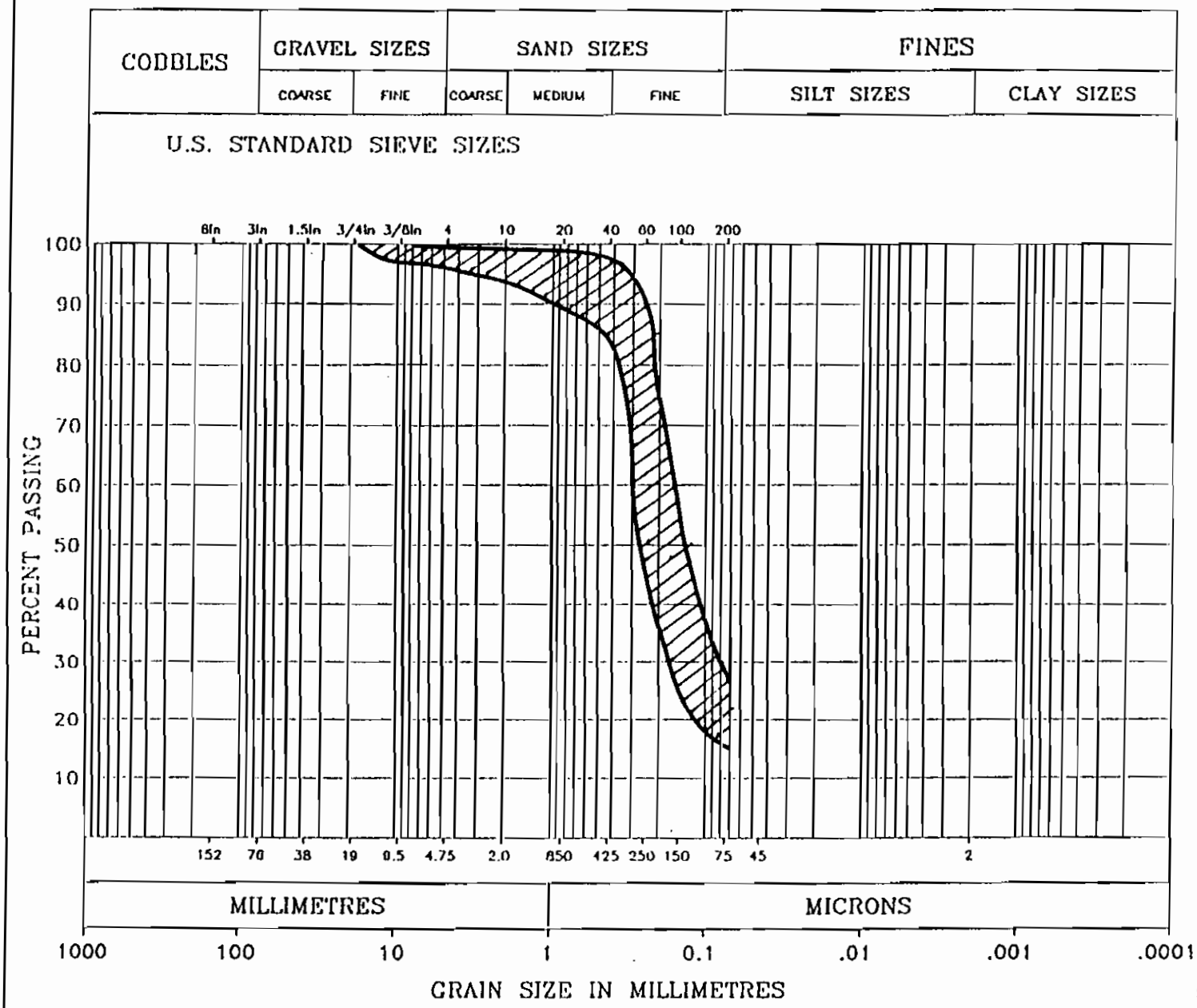
Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE:
DEPTH:
TECHNICIAN:

FIGURE 12

COMPOSITE GRADING CURVE
FOR COARSE GRANULAR DEPOSITS



REMARKS: 155 South. Fine-grained unit

Grain-Size envelope (based on 5 samples taken during the 1989 program.)

SUMMARY		
D_{10} =	mm	GRAVEL
D_{30} =	mm	SAND
D_{60} =	mm	FINES
C_U =		
C_C =		

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE:
DEPTH:
TECHNICIAN:

FIGURE 13

COMPOSITE GRADING CURVE FOR FINE SAND DEPOSITS

APPENDIX A

Borehole Logs and Explanatory Sheets

N.B. The 1987 borehole numbering system has been revised: i.e. 155-S-1 (1987 HBT report)
155SB001 (1989 HBT report)

Grain size analyses have been added to borehole logs

GMC - Granular Materials Classification

GROUND ICE CLASSIFICATIONS

CATEGORY	GROUP SYMBOL	SUBGROUP SYMBOL	DESCRIPTION
		F	UNDIFFERENTIATED
NON-VISIBLE ICE	N	Nf	POORLY BONDED OR FRIABLE FROZEN SOIL
		Nbn	WELL BONDED FROZEN SOIL WITH NO EXCESS ICE
		Nbe	WELL BONDED FROZEN SOIL WITH EXCESS ICE. FREE WATER PRESENT WHEN SAMPLE THAWED.
VISIBLE ICE LESS THAN 25mm THICK	V	Vx	INDIVIDUAL ICE CRYSTALS OR INCLUSIONS
		Vc	ICE COATINGS ON PARTICLES
		Vr	RANDOM OR IRREGULARLY ORIENTED ICE FORMATIONS
		Vs	STRATIFIED OR DISTINCTLY ORIENTED ICE FORMATIONS
VISIBLE ICE GREATER THAN 25mm THICK	ICE	ICE + Soil Type	ICE GREATER THAN 25mm THICK WITH SOIL INCLUSIONS
		ICE	ICE GREATER THAN 25mm THICK WITHOUT SOIL INCLUSIONS

NOTE: 1. UF signifies unfrozen ground.

2. F? or UF? indicates likely thermal condition not obvious during drilling.

ADAPTED FROM NRC 7576

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EXPLANATION OF TERMS AND SYMBOLS

The terms and symbols used on the borehole logs to summarize the results of field investigation and subsequent laboratory testing are described in these pages.

It should be noted that materials, boundaries and conditions have been established only at the borehole locations at the time of investigation and are not necessarily representative of subsurface conditions elsewhere across the site.

TEST DATA

Data obtained during the field investigation and from laboratory testing are shown at the appropriate depth interval.

Abbreviations, graphic symbols, and relevant test method designations are as follows:

*C	Consolidation test	*ST	Swelling test
D_R	Relative density (formerly specific gravity)	TV	Torvane shear strength
Fines	Percentage by weight smaller than #200 sieve	VS	Vane shear strength (undisturbed-remolded)
k	Permeability coefficient	w	Natural moisture content (ASTM D 2216)
*MA	Mechanical grain size analysis and hydrometer test	w_l	Liquid limit (ASTM D 423)
		w_p	Plastic limit (ASTM D 424)
N	Standard penetration test (CSA A119.1-60)	ε_f	Unit strain at failure
N_d	Dynamic cone penetration test	γ	Unit weight of soil or rock
NP	Non plastic soil	γ_d	Dry unit weight of soil or rock
pp	Pocket penetrometer strength	ρ	Density of soil or rock
*q	Triaxial compression test	ρ_d	Dry density of soil or rock
q_u	Unconfined compressive strength		
*SB	Shearbox test	→	seepage
SO_4	Concentration of water-soluble sulphate	▼	observed water level

**The results of these tests usually are reported separately*

SOIL CLASSIFICATION AND DESCRIPTION

Soils are classified and described according to their engineering properties and behaviour.

The soil of each stratum is described using the Unified Soil Classification System[1] modified slightly so that an inorganic clay of "medium plasticity" is recognized.

The use of modifying adjectives may be employed to define the actual or estimated percentage range by weight of minor components. This is similar to a system developed by D.M. Burmister.[2]

The soil classification system is shown in greater detail on page 2.

SAMPLE TYPE — The type of sample is shown at the appropriate depth interval using the following abbreviations:

- A auger sample
- B block sample
- C rock core, or frozen soil core
- D drive sample
- P pitcher tube sample
- U tube sample (usually thin-walled)
- W wash or air return sample
- O other (see report text)
- ⊠ indicates no sample recovery

1. "Unified Soil Classification System", Technical Memorandum 3-357 prepared for Office, Chief of Engineering, by Waterways Experiment Station, Vicksburg, Mississippi, Corps of Engineers, U.S. Army, Vol 1, March 1953.
2. American Society for Testing and Materials, Procedures for Testing Soils, "Suggested Methods of Testing for Identification of Soils", 4th Ed; pp 221-233, Dec. 1964.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	COLOR CODE	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 200 SIEVE)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW		RED	WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 4$ $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			GP		RED	POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME FINES)	GM		YELLOW	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			GC		YELLOW	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
	SANDS MORE THAN HALF FINE GRAINS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW		RED	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 6$ $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			SP		RED	POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME FINES)	SM		YELLOW	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE P.I. LESS THAN 4
			SC		YELLOW	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES 200 SIEVE)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 50\%$	ML		GREEN	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (see below)	
		$W_L > 50\%$	MH		BLUE	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS		
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART NEGLIGIBLE ORGANIC CONTENT	$W_L < 30\%$	CL		GREEN	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS		
		$30\% < W_L < 50\%$	CI		GREEN-BLUE	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50\%$	CH		BLUE	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS BELOW "A" LINE ON CHART	$W_L < 50\%$	OL		GREEN	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	WHENEVER THE NATURE OF THE FINE CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER "F", E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		$W_L > 50\%$	OH		BLUE	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt		ORANGE	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE	

SPECIAL SYMBOLS

BEDROCK (Undifferentiated)

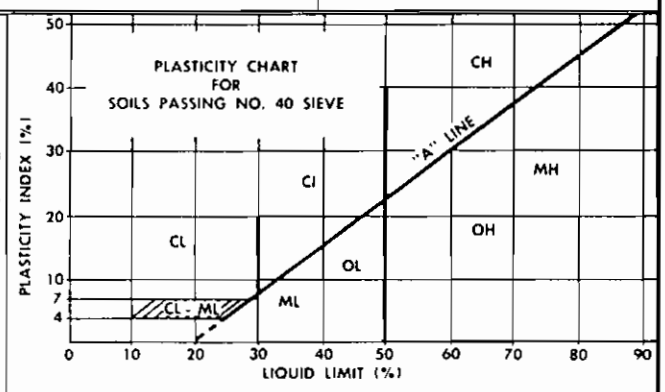
VOLCANIC ASH

SOIL COMPONENTS

FRACTION	U S STANDARD SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
	PASSING	RETAINED	PERCENT	DESCRIPTOR
GRAVEL			50 - 35	and
coarse	76 mm	19 mm		
fine	19 mm	No 4	35 - 20	some
SAND				
coarse	4.75 mm	2.00 mm	20 - 10	little
medium	2.00 mm	425 μm		
fine	425 μm	75 μm	10 - 1	trace
SILT (non plastic) or CLAY (plastic)	75 μm			

OVERSIZE MATERIAL

Rounded or subrounded	Not rounded
COBBLES 76 mm to 203 mm	ROCK FRAGMENTS > 76 mm
BOULDERS > 203 mm	ROCKS > 0·76 cubic metre in volume



1. ALL SIEVE SIZES MENTIONED ON THIS CHART ARE U.S. STANDARD, A.S.T.M. E.11.
2. BOUNDARY CLASSIFICATIONS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE GIVEN COMBINED GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL SAND MIXTURE WITH CLAY BINDER BETWEEN 5% AND 12%.

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

GRANULAR MATERIALS CLASSES (GMC)[1]

Class 1 Granular Material

Class 1 material is well-graded with a low fines content, and comprises hard and durable particles, which meet the following criteria, a maximum petrographic number (PM) of 160, a maximum L.A. Abrasion loss of 35%, and maximum magnesium sulphate soundness loss of 12%. Consequently, it is suitable for use as concrete or asphalt aggregate after minimal processing. Sources of Class 1 material are relatively scarce in the Inuvik region and are considered to be of too high quality for use in highway construction, and should be reserved specifically as a source of high quality aggregate. A PN of 160 is somewhat higher than might be expected for excellent aggregates, particualarly for concrete aggregates. Specifically, chert components of these aggregates may cause acceptable reactions with the alkali in Normal Portlan cements. An alkali-aggregate reactivity test should also be performed and evaluated before using these materials as concrete aggregates.

Class 2 Granular Material

Class 2 material is similar to Class 1 except that it is of lower quality due to somewhat poorer grading, a higher fines content and less durable particles, which meet the following criteria; a maximum PM of 200 and a maximum L.A. Abrasion loss of 60%. With processing, it may be upgraded to concrete aggregate quality. Class 2 materials may be used in highway construction as granular base and sub-base material, but may be more prudently reserved as a source of lower quality aggregate or structural fill.

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[1] Refer to GMC column on borehole logs.

Class 3 Granular Material

Class 3 material generally comprises poorly graded sands and gravels with low to high fines content of up to 20%, and with particles meeting the durability criterion of a maximum of PN of 250. It can be processed to meet local frost susceptibility criteria. The presence of moderate amounts of fines makes it ideal as a surface course material, which requires the presence of a binding component. In addition, this material may be used as general fill for embankment construction.

Class 4 Granular Material

Class 4 material comprises of poorly grade granular soils with a substantial fines content of more than 20%. There is generally durability criteria for this class of granular material. Class 4 material is generally acceptable only for use as non-structural fill.

Class 5

Class 5 material comprise fair to excellent quality bedrock, felsenmeer, talus or similar extremely coarse granular material, suitable for quarrying and processing to produce potentially excellent construction materials ranging from general fill, to concrete aggregate, building stone, and erosion control materials such as rip rap or armour stone.

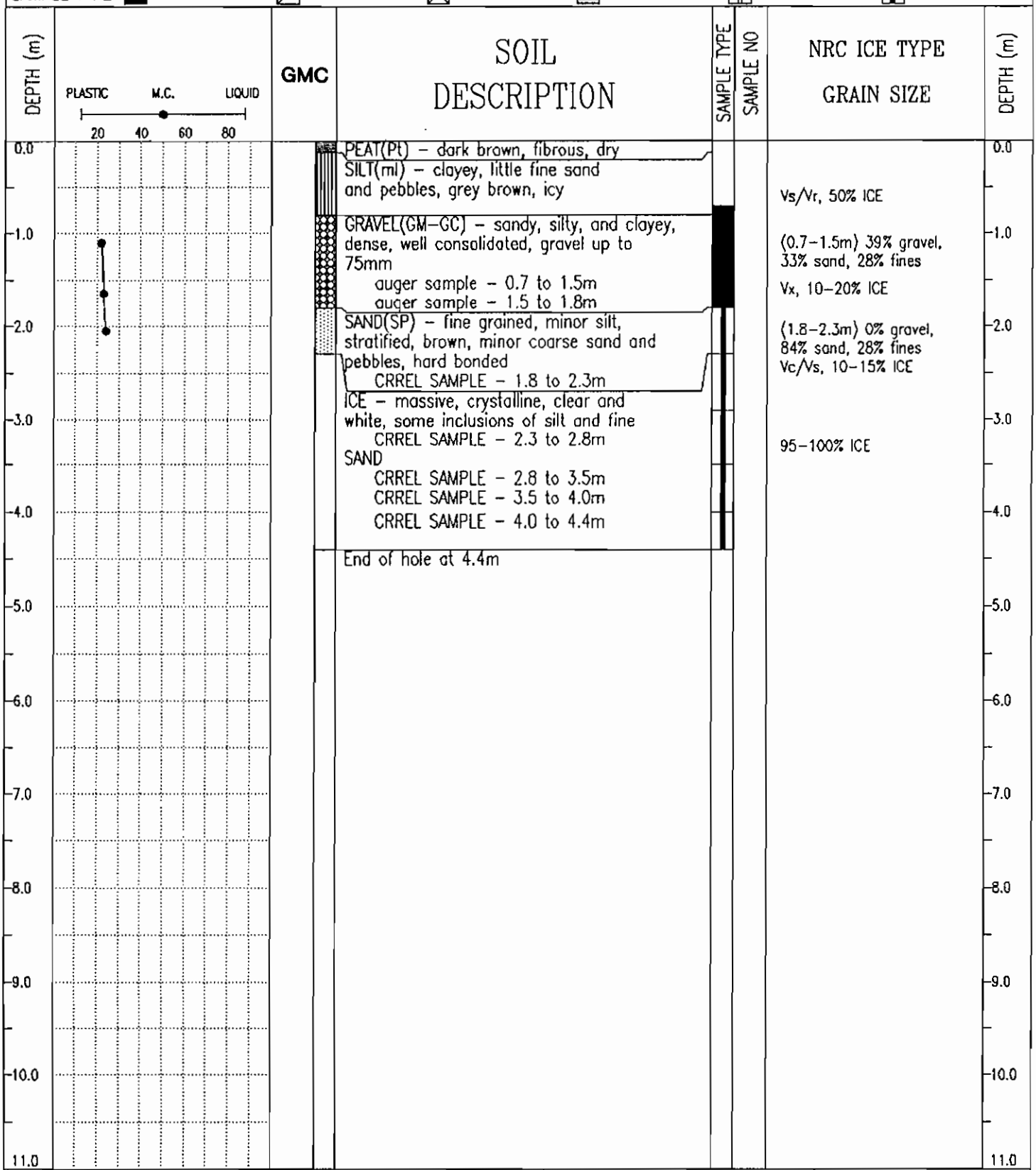
Class 7 - Organic

I - Ice

U - Unusable Materials

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB001
UTM ZONE: 8 N7679550.00 E555530.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ⊠ ▤ ▯ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.4 m		COMPLETE 19/03/87
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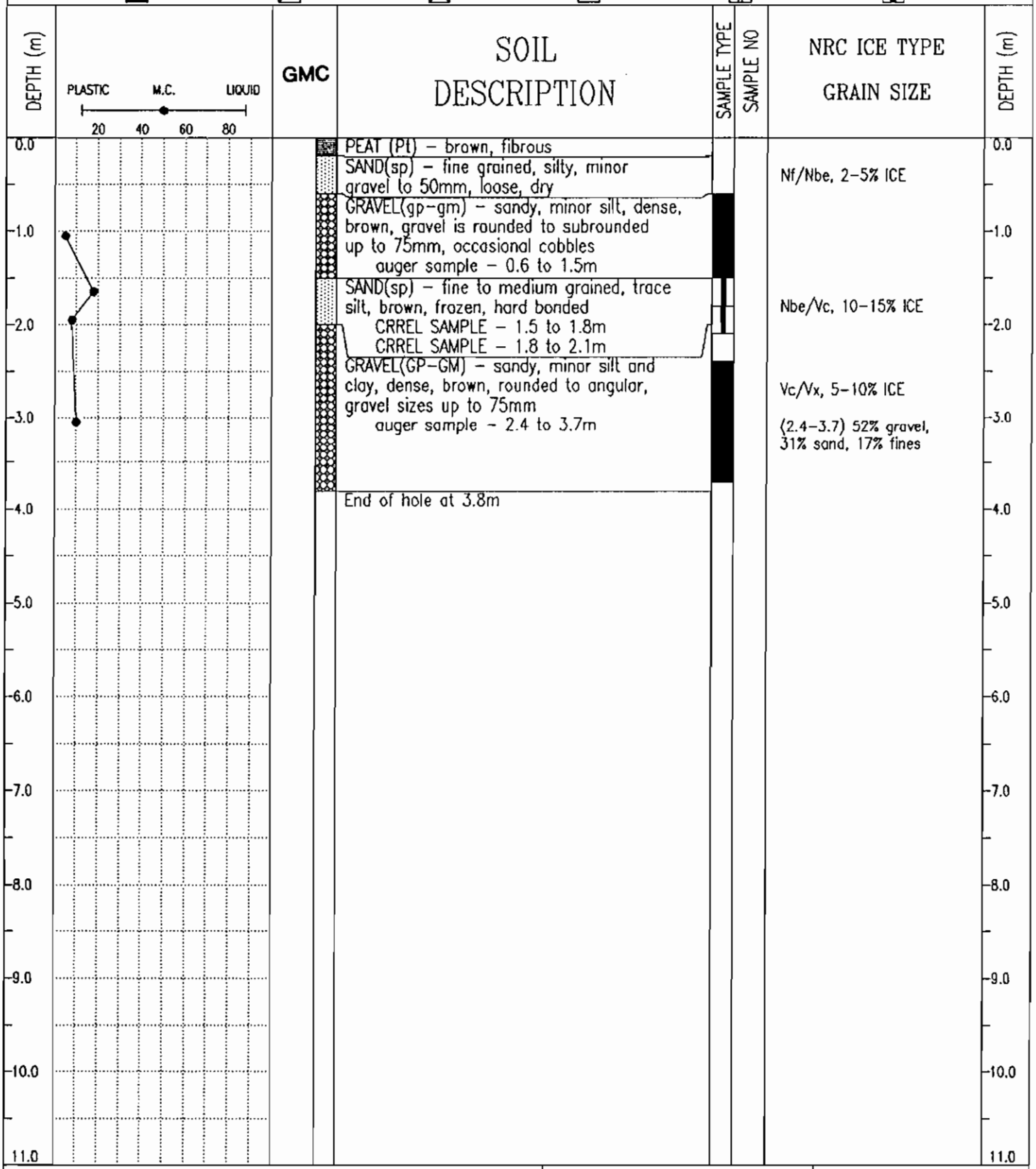
ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB002
UTM ZONE: 8 N7679390.00 E555720.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ▩ ▤ ▥ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 3.8 m	COMPLETE 19/03/87
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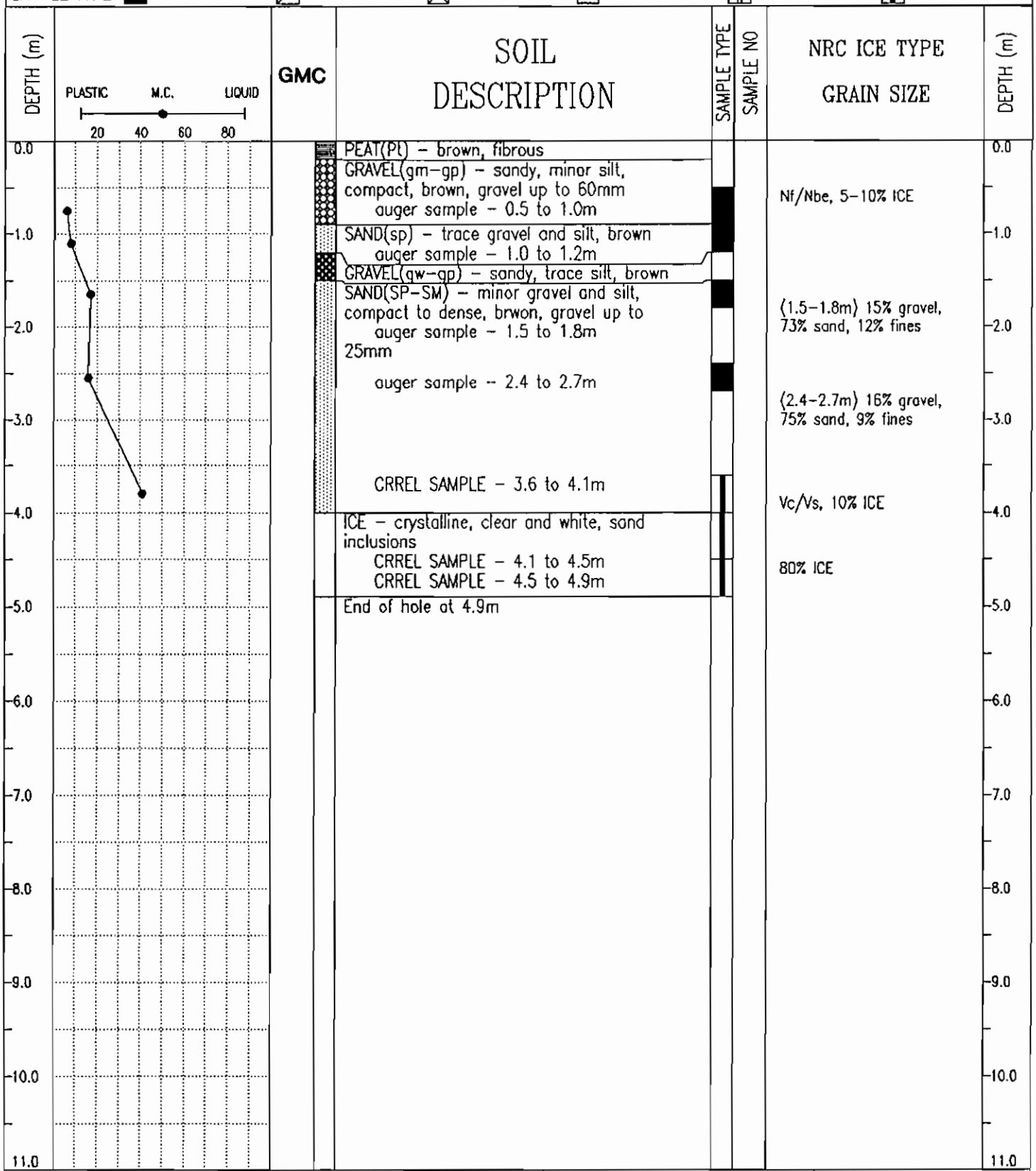
ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB003
UTM ZONE: 8 N7679370.00 E555850.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ⊠ ▤ ▥ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.9 m		COMPLETE 19/03/87
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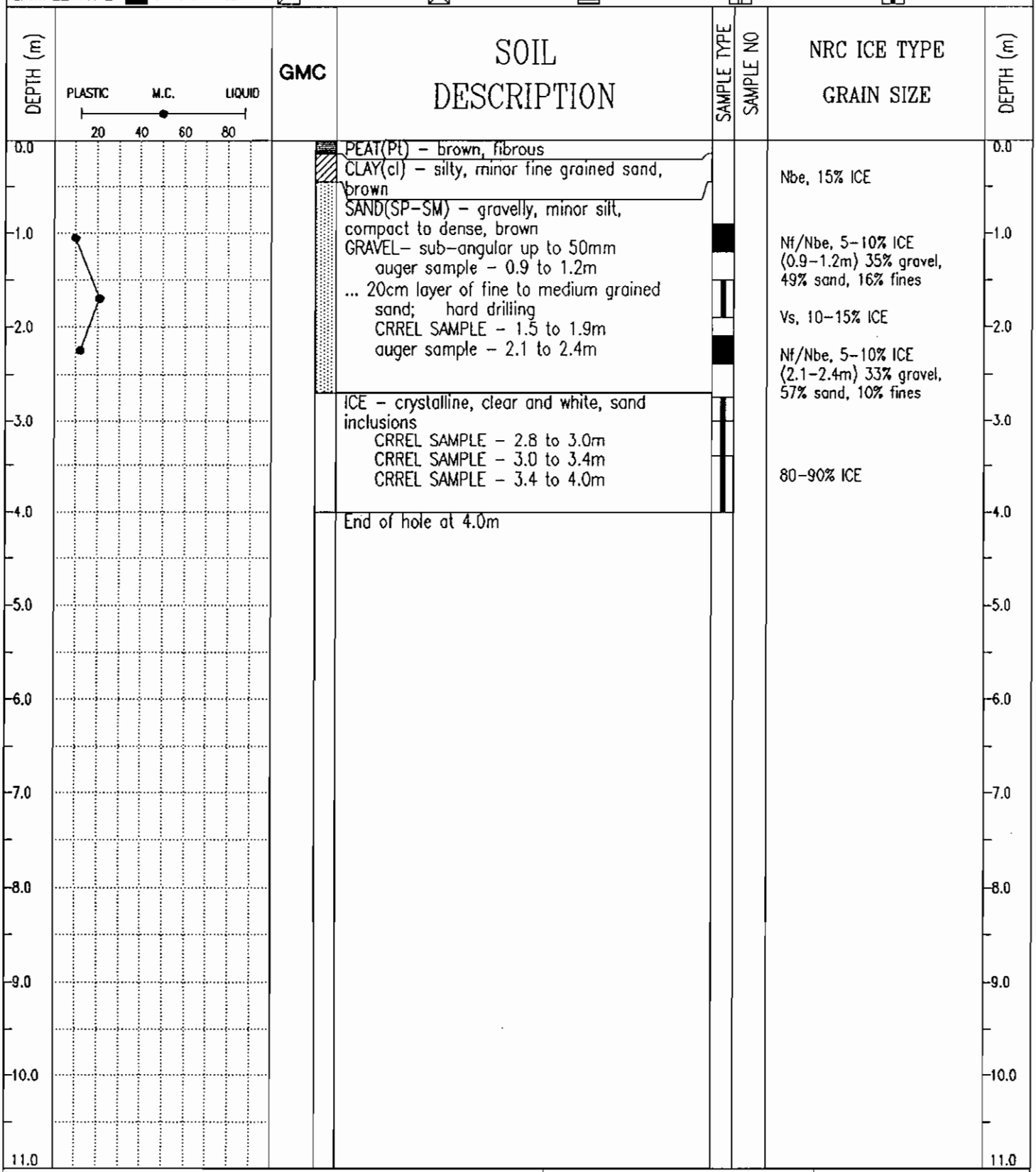
ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB004
UTM ZONE: 8 N7679300.00 E555850.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ▩ ▤ ▥ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.0 m		COMPLETE 19/03/87
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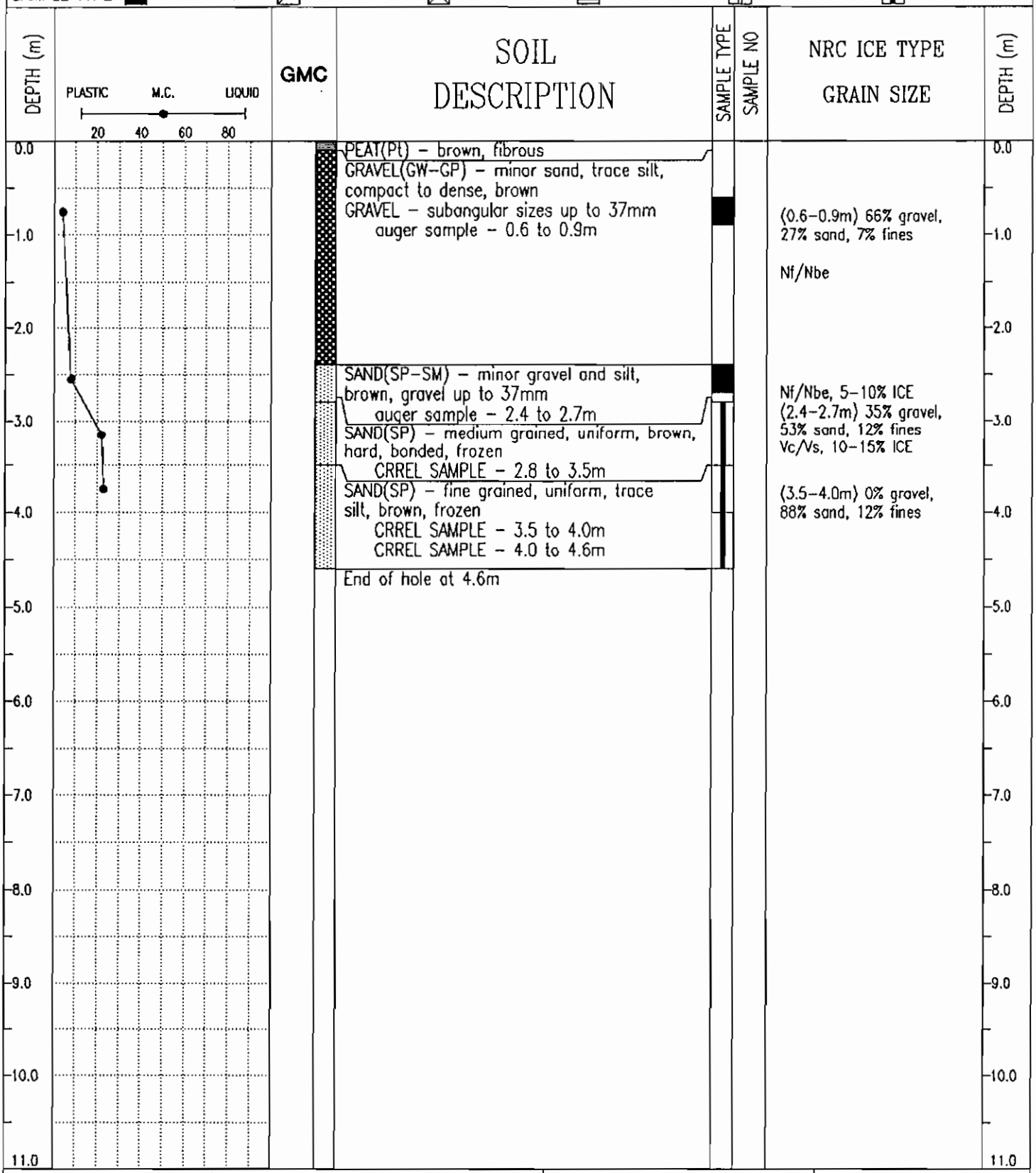
ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB005
UTM ZONE: 8 N7679060.00 E556120.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ▩ ▤ ▥ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.6 m		COMPLETE 20/03/87
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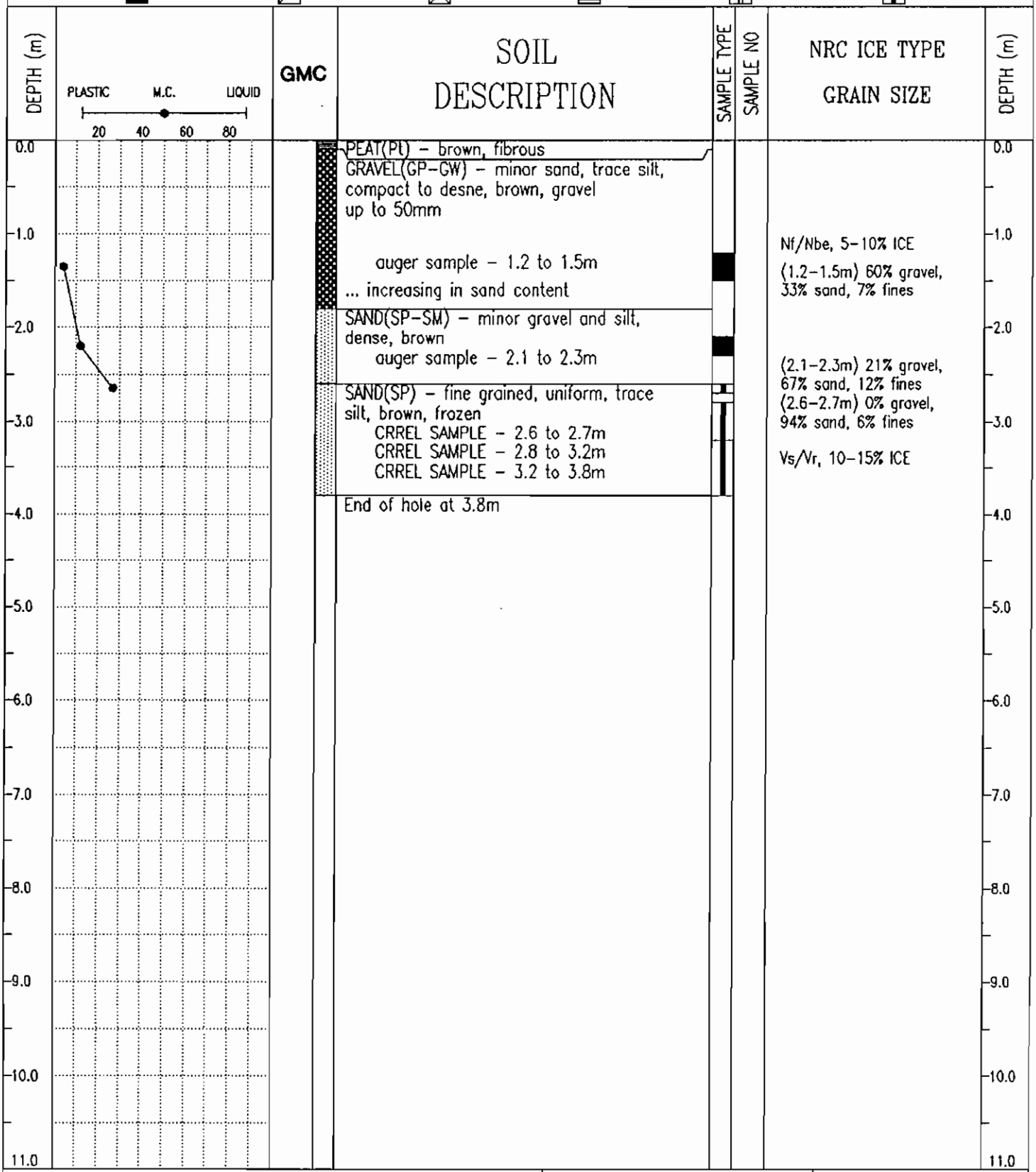
ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB006
UTM ZONE: 8 N7678980.00 E556160.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ☒ ▤ ▥ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 3.8 m	COMPLETE 20/03/87
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ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB007
UTM ZONE: 8 N7678800.00 E556150.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ▩ ▤ ▥ CRREL CORE

DEPTH (m)	PLASTIC M.C. LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE	DEPTH (m)
0.0			PEAT(Pt) – brown, fibrous, icy				0.0
			CRREL SAMPLE – 0.3 to 1.0m			Vx, 70% ICE	
			.. interlayered with silt and ice				
1.0			SILT(ml) – sandy, minor gravel			Vc/Vr, 20–30% ICE	1.0
			.. becoming very gravelly				
			ICE – crystalline, clear and white, sand inclusions				
2.0							2.0
						80–90% ICE	
3.0							3.0
4.0							4.0
			End of hole at 4.6m				
5.0							5.0
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.6 m	COMPLETE 20/03/87
	LOGGED BY CA	DWG NO.
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ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB008
UTM ZONE: 8 N7678850.00 E556270.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ▩ ▤ ▥ CRREL CORE

DEPTH (m)	PLASTIC — M.C. — LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE / GRAIN SIZE	DEPTH (m)
0.0			PEAT(Pt) – brown, fibrous				0.0
			GRAVEL(GP-GW) – sandy, trace silt, compact to dense, brown, gravel – rounded to subangular, gravel up to 75mm			Nf (0.2–1.1m) 55% gravel, 38% sand, 7% fines	
1.0			auger sample – 0.2 to 1.1m				1.0
			... 15cm layer of fine to medium grained sand				
2.0			auger sample – 1.2 to 2.3m			Nbe/Vx, 5% ICE (1.2–2.3m) 50% gravel, 42% sand, 8% fines	2.0
3.0			ICE – crystalline, clear and white, occasional inclusions of sand				3.0
4.0							4.0
5.0						95% ICE	5.0
6.0			End of hole at 6.1m				6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 6.1 m	COMPLETE 20/03/87
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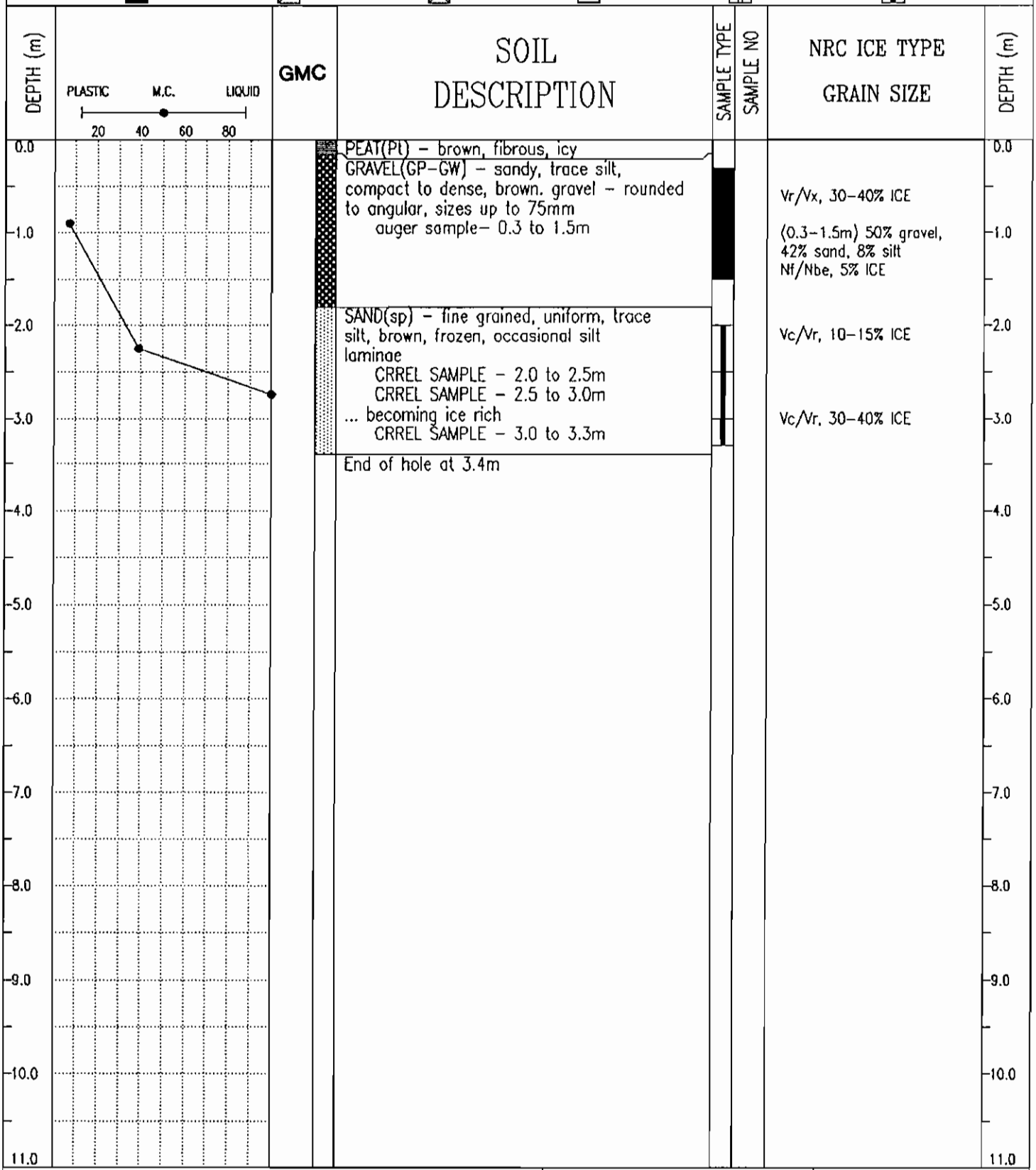
ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB009
UTM ZONE: 8 N7678740.00 E556350.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ⊠ ▤ ▥ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 3.4 m	COMPLETE 20/03/87
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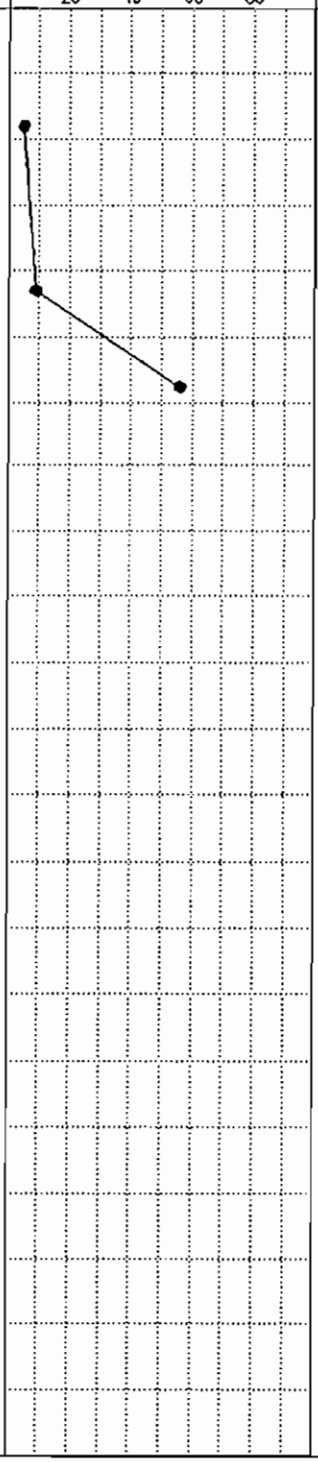
ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB010
UTM ZONE: 8 N7678370.00 E556340.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)
SAMPLE TYPE ■ GRAB SAMPLE	⊠	CRREL CORE



GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE	DEPTH (m)
	PEAT(Pt) – brown, fibrous				0.0
	GRAVEL(GP-GW) – minor silt and sand, compact to dense, brown, rounded to subrounded auger sample – 0.3 to 1.5m			Nf (0.3–1.5m) 71% gravel, 25% sand, 4% fines	1.0
	SAND(SW-SP) – gravelly, trace silt, compact to dense, brown, gravel up to 75mm auger sample – 1.5 to 2.8m			Nf/Nbe, 5% ICE (1.5–2.8m) 40% gravel, 52% sand, 8% fines	2.0
	SAND(sp) – fine grained, uniform, trace silt, brown, icy CRREL SAMPLE – 2.8 to 3.0m			Vs, 40–50% ICE	3.0
	ICE– crystalline, clear and white, sand inclusions			80–90% ICE	4.0
	End of hole at 5.3m				5.0
					6.0
					7.0
					8.0
					9.0
					10.0
					11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 5.3 m	COMPLETE 20/03/87	
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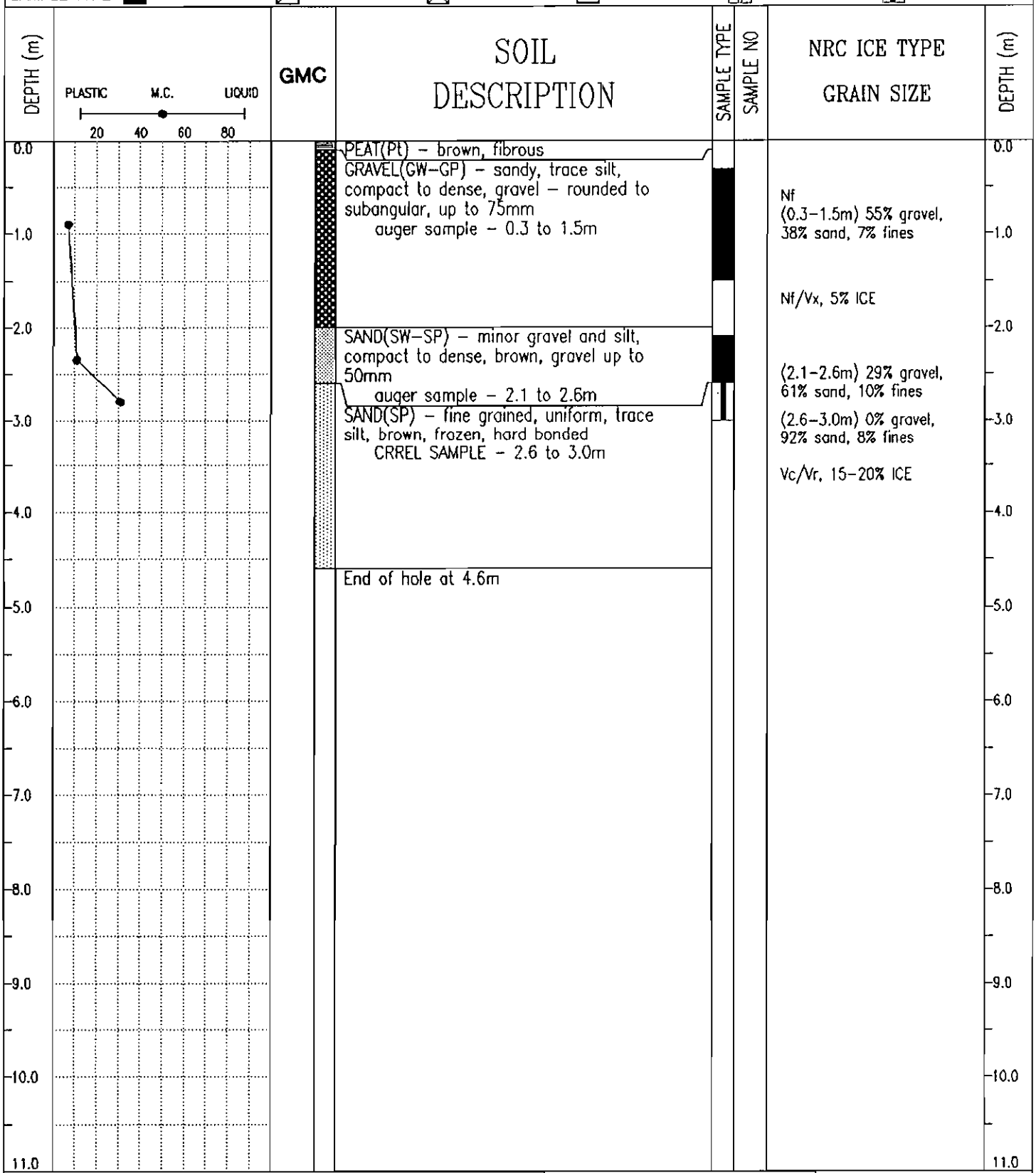
ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB011
UTM ZONE: 8 N7678140.00 E556370.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.6 m		COMPLETE 20/03/87
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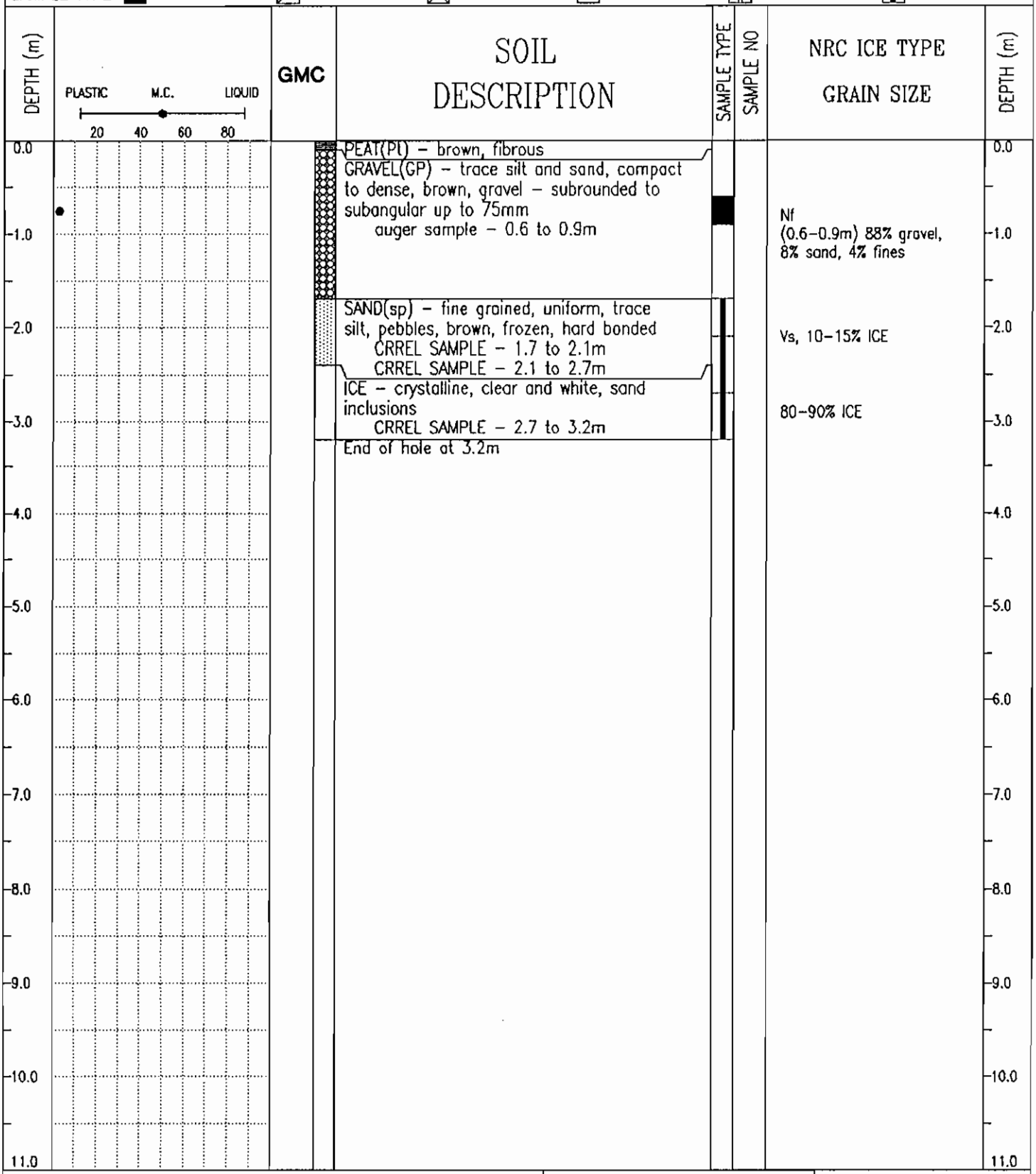
ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB012
UTM ZONE: 8 N7678030.00 E556390.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ⊘ ⊠ ▤ ◫ ◧ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 3.2 m		COMPLETE 20/03/87
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ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB013
UTM ZONE: 8 N7677930.00 E556460.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ⊘ ⊠ ▤ ▯ ▮ CRREL CORE

DEPTH (m)	PLASTIC M.C. LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE	DEPTH (m)
0.0			PEAT(Pt) – brown, fibrous, icy			Vx, 70% ICE	0.0
1.0	•		GRAVEL(GP-GW) – minor sand and silt, compact to dense, brown, gravel – subangular up to 50mm auger sample – 0.9 to 1.2m	■		Nf/Nbe, 5% ICE (0.9–1.2m) 62% gravel, 32% sand, 6% fines	1.0
2.0			SAND(sp) – fine grained, uniform, trace silt, brown, frozen, hard bonded CRREL SAMPLE – 1.7 to 2.0m CRREL SAMPLE – 2.0 to 2.5m CRREL SAMPLE – 2.5 to 2.9m				2.0
3.0			... 10cm layer of ice CRREL SAMPLE – 2.9 to 3.4m			Vs/Vr, 10–15% ICE	3.0
4.0			End of hole at 3.4m				4.0
5.0							5.0
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 3.4 m		COMPLETE 20/03/87
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ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB014
UTM ZONE: 8 N7677880.00 E556540.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ⊘ ⊠ ▤ ◫ ◫ CRREL CORE

DEPTH (m)	PLASTIC M.C. LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE	DEPTH (m)
0.0			PEAT(Pt) – dark brown, fibrous				0.0
			SILT(ml) – trace fine sand, brown, hard bonded, icy with depth			Nb, 15% ICE	
1.0			CRREL SAMPLE – 0.6 to 1.0m			Vs, 20–30% ICE	1.0
			CRREL SAMPLE – 1.0 to 1.5m			Vs/Vr, 20–30% ICE	
2.0			SAND(sm) – fine grained, interbedded with silt, brown, hard bonded, icy			Vs/Vr, 15–20% ICE	2.0
			CRREL SAMPLE – 1.5 to 1.8m				
			CRREL SAMPLE – 1.8 to 2.0m				
			End of hole at 2.0m				
3.0							3.0
4.0							4.0
5.0							5.0
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 2.0 m	COMPLETE 20/03/87
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ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB015
UTM ZONE: 8 N7677570.00 E556500.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ▩ ▤ ▥ CRREL CORE

DEPTH (m)	PLASTIC – M.C. – LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE / GRAIN SIZE	DEPTH (m)
0.0			PEAT(Pt) – dark brown, fibrous, becoming interbedded with silt				0.0
			CRREL SAMPLE – 0.2 to 0.8m			Vs/Vr, 40–50% ICE	
1.0			ICE – laminated inclusions of silt and fine sand			80% ICE	1.0
			SAND(sp) – fine grained, uniform, trace silt, brown, frozen, hard bonded			Vs/Vr, 10–15% ICE	
2.0			CRREL SAMPLE – 1.5 to 1.8m				2.0
			CRREL SAMPLE – 1.8 to 2.6m			60% ICE	
			ICE – fine sand and silt inclusions				
			End of hole at 2.6m				
3.0							3.0
4.0							4.0
5.0							5.0
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 2.6 m	COMPLETE 20/03/87
	LOGGED BY CA	DWG NO.
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ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB016
UTM ZONE: 8 N7677520.00 E556750.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ▩ ▤ ▥ CRREL CORE

DEPTH (m)	PLASTIC — M.C. — LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE / GRAIN SIZE	DEPTH (m)
0.0			PEAT(Pt) – brown, fibrous			Vr, 50% ICE	0.0
			GRAVEL(GW–GP) – minor sand and silt, compact to dense, brown, gravel up to 50mm				
1.0			auger sample – 0.5 to 0.8m			Nf/Nbe (0.5–0.8/1.2–1.5m) 65% gravel, 31% sand, 4% fines	1.0
			auger sample – 1.2 to 1.5m				
2.0			SAND(sp) – medium to coarse grained, minor gravel, trace silt, brown			Nf, 5–10% ICE	2.0
			CRREL SAMPLE – 2.0 to 2.3m				
			CRREL SAMPLE – 2.3 to 3.2m			Vs/Vr, 15–30% ICE	
3.0			SAND(sp) – fine grained, uniform, trace silt, brown, hard bonded				3.0
			... 25–50mm ice layers				
			CRREL SAMPLE – 3.2 to 3.7m			Vs/Vr, 20–50% ICE	
4.0			End of hole at 3.7m				4.0
5.0							5.0
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 3.7 m	COMPLETE 21/03/87
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ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB017
UTM ZONE: 8 N7678810.00 E556650.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ☒ ▤ ◫ CRREL CORE

DEPTH (m)	PLASTIC — M.C. — LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE / GRAIN SIZE	DEPTH (m)
0.0			PEAT(Pt) – brown, fibrous				0.0
			GRAVEL(GW-GP) – minor sand and silt, compact to dense, rusty-brown, gravel – rounded to subangualr up to 75 mm, occasional cobbles			Nf	
1.0			auger sample – 0.6 to 2.1m			(0.6–2.1m) 61% gravel, 34% sand, 5% fines	1.0
			... hard drilling @ 1.05m			Nbe	
2.0							2.0
			SAND(sp) – fine grained, uniform, trace silt, brown, frozen, hard bonded				
3.0			CRREL SAMPLE – 2.5 to 3.5m				3.0
			CRREL SAMPLE – 3.5 to 3.8m			Vc/Vr, 15–25% ICE	
4.0			CRREL SAMPLE – 3.8 to 4.3m				4.0
			End of hole at 4.3m				
5.0							5.0
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.3 m	COMPLETE 21/03/87
	LOGGED BY NM	DWG NO.
		Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB018
UTM ZONE: 8 N7678940.00 E556480.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ☒ ▤ ▯ CRREL CORE

DEPTH (m)	PLASTIC M.C. LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE / GRAIN SIZE	DEPTH (m)
0.0			PEAT(Pt) – brown, fibrous				0.0
			GRAVEL(GW–GP) – minor sand and silt, compact to dense, rusty–brown, gravel – rounded to subangular up to 75mm, occasional cobbles			Nf	
1.0	●		auger sample – 0.3 to 2.1m			(0.3–2.1m) 60% gravel, 35% sand, 5% fines	1.0
						Nbe/Vx, 5% ICE	
2.0							2.0
			SAND(sp) – fine grained, uniform. trace silt, brown, frozen, hard bonded				
3.0			CRREL SAMPLE – 2.8 to 3.2m			Vc/Vr, 15–20% ICE	3.0
			CRREL SAMPLE – 3.2 to 3.8m				
			... numerous ice lenses and random veins up to 25mm thick			Vs/Vr, 20–30% ICE	
4.0			CRREL SAMPLE – 3.8 to 4.3m				4.0
			End of hole at 4.3m				
5.0							5.0
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.3 m	COMPLETE 21/03/87
	LOGGED BY NM	DWG NO.
		Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB019
UTM ZONE: 8 N7679340.00 E556490.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ⊠ ▤ ▥ ▮▯ CRREL CORE

DEPTH (m)	PLASTIC M.C. LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE	DEPTH (m)
0.0			PEAT(Pt) – dark brown, fibrous, becoming amorphous below 0.2m, occasional pebbles				0.0
			CRREL SAMPLE – 0.5 to 1.0m			Vx, 20% ICE	
1.0			SAND(sm) – fine grained, interlayered with silt, brown, frozen, hard bonded, 5–15cm thick layers				1.0
			CRREL SAMPLE – 1.0 to 1.7m			Vs, 20–30% ICE	
			CRREL SAMPLE – 1.7 to 2.1m				
2.0			GRAVEL(GW–GP) – minor sand, trace silt, dense, brown, up to 50mm in size				2.0
			auger sample – 2.1 to 2.3m			(2.1–2.3m) 57% gravel, 35% sand, 8% fines Nf/Nbe	
3.0			SAND(sp) – minor gravel, trace silt, dense, brown				3.0
			CRREL SAMPLE – 3.3 to 4.0m			Vx/Vr, 10% ICE	
			ICE – crystalline, clear and white				
4.0			CRREL SAMPLE – 4.0 to 4.3m			100% ICE	4.0
			End of hole at 4.3m				
5.0							5.0
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.3 m	COMPLETE 21/03/87
	LOGGED BY CA	DWG NO.
		Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB020
UTM ZONE: 8 N7679430.00 E556380.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

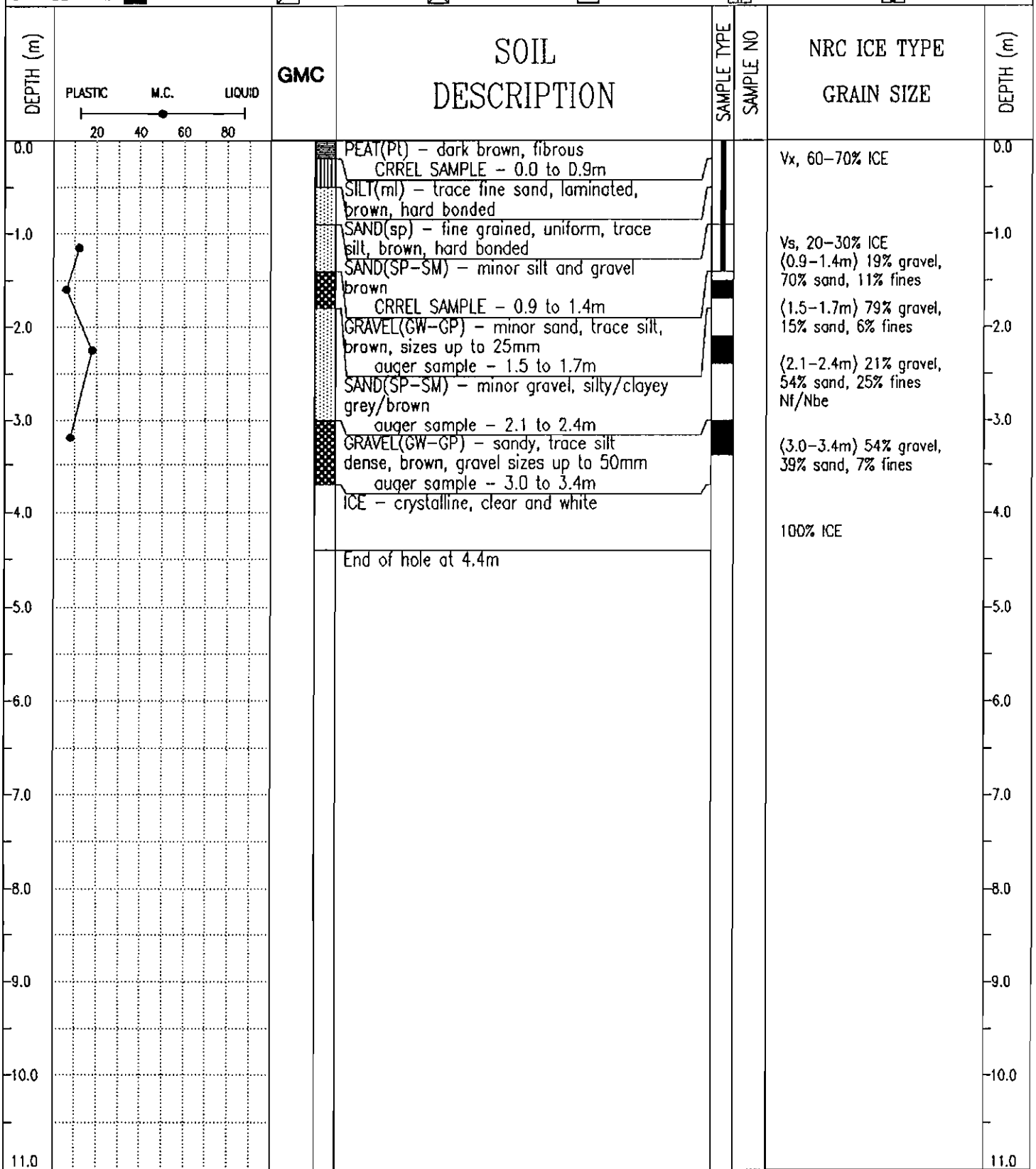
SAMPLE TYPE ■ GRAB SAMPLE ▨ ▩ ▤ ▥ CRREL CORE

DEPTH (m)	PLASTIC — M.C. — LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE / GRAIN SIZE	DEPTH (m)
0.0			PEAT(Pt) – dark brown, fibrous			Vx, 50% ICE	0.0
			SILT(ml) – brown, interlayered with black peat, brown, hard bonded, icy CRREL SAMPLE – 0.3 to 0.8m			Vx/Vr, 40–60% ICE	
1.0			SAND(sm) – fine grained, interlayered with silt, brown, hard bonded CRREL SAMPLE – 0.8 to 1.0m CRREL SAMPLE – 1.0 to 1.7m			Vs, 20–30% ICE	1.0
2.0			SAND(sp) – fine grained, uniform, trace silt, brown, hard bonded CRREL SAMPLE – 1.7 to 2.0m				2.0
			End of hole at 2.0m				
3.0							3.0
4.0							4.0
5.0							5.0
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 2.0 m		COMPLETE 21/03/87
	LOGGED BY CA	DWG NO.	Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB021
UTM ZONE: 8 N7679510.00 E556180.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

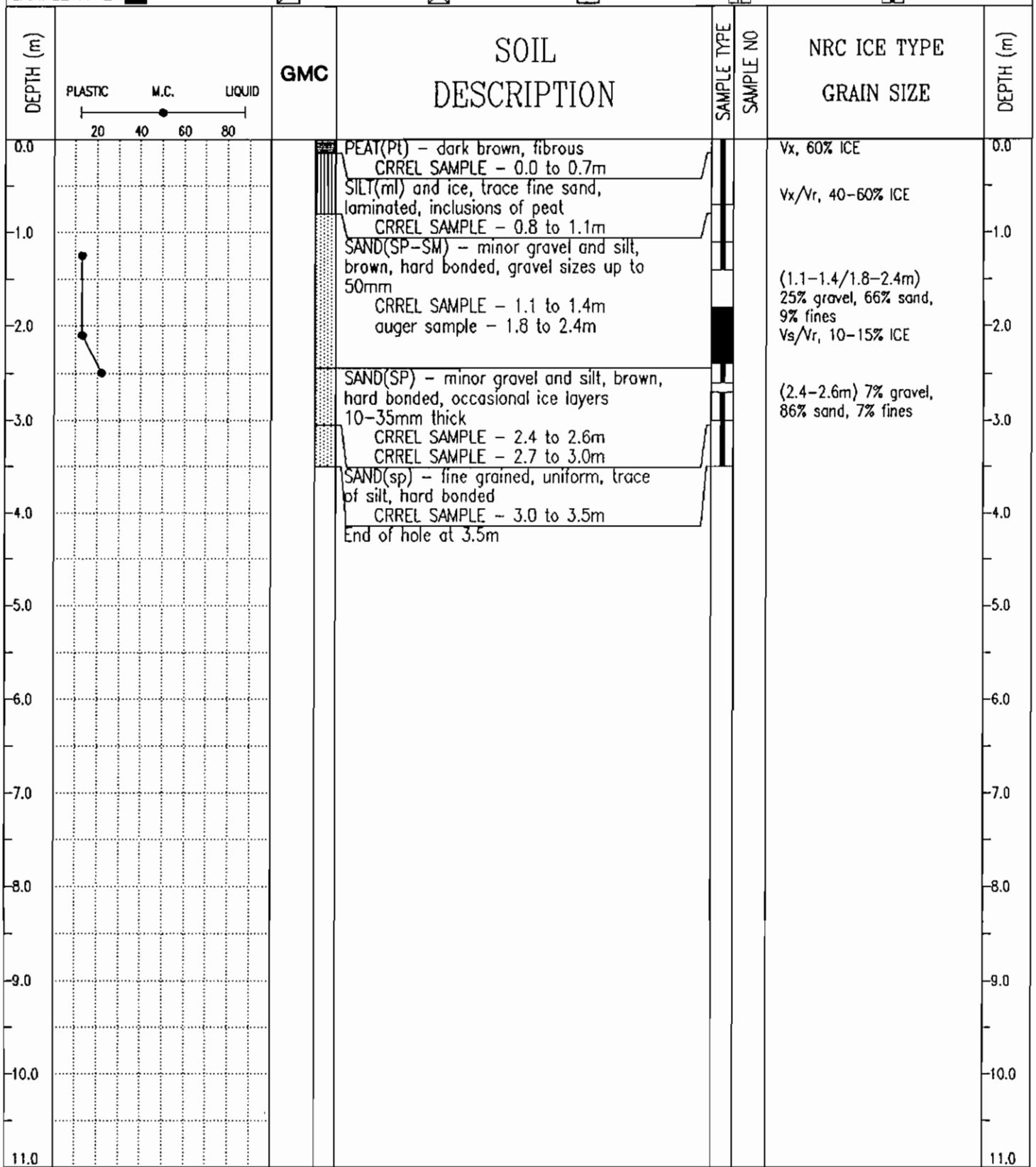
SAMPLE TYPE ■ GRAB SAMPLE ⊠ ▤ ◫ ◫ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.4 m		COMPLETE 21/03/87
	LOGGED BY CA	DWG NO.	Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB022
UTM ZONE: 8 N7679640.00 E556010.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

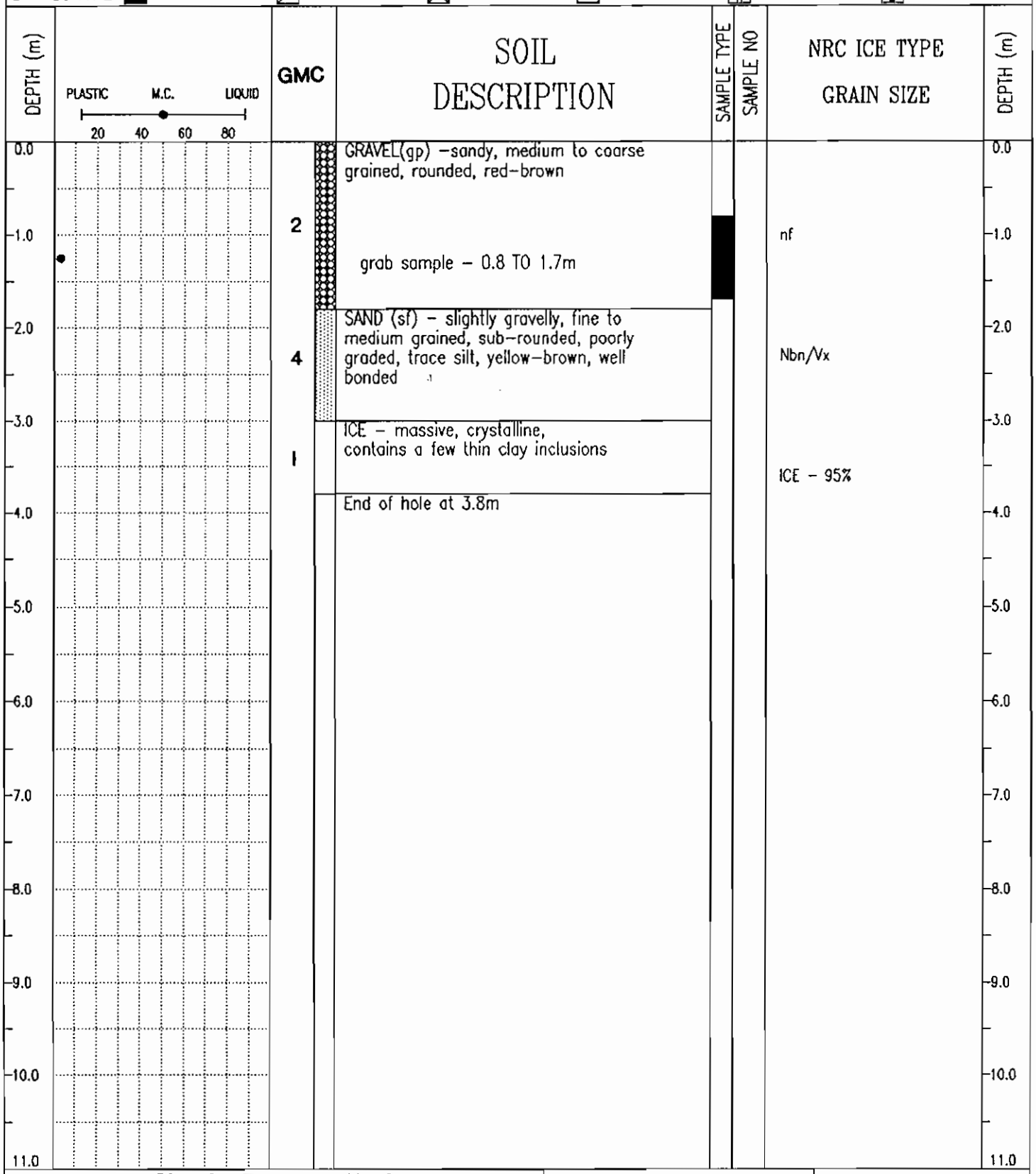
SAMPLE TYPE ■ GRAB SAMPLE ▨ ▩ ▤ ▥ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 3.5 m	COMPLETE 21/03/87
	LOGGED BY CA	DWG NO.
		Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CREEK)	BOREHOLE No. 155SB023
UTM ZONE: 8 N7678870.00 E556800.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 22.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ⊠ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 3.8 m	COMPLETE 17/03/89
	LOGGED BY BW	DWG NO.
		Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CR)	BOREHOLE No. 155SB024
UTM ZONE: 8 N7678830.00 E556920.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 24.70 (m)

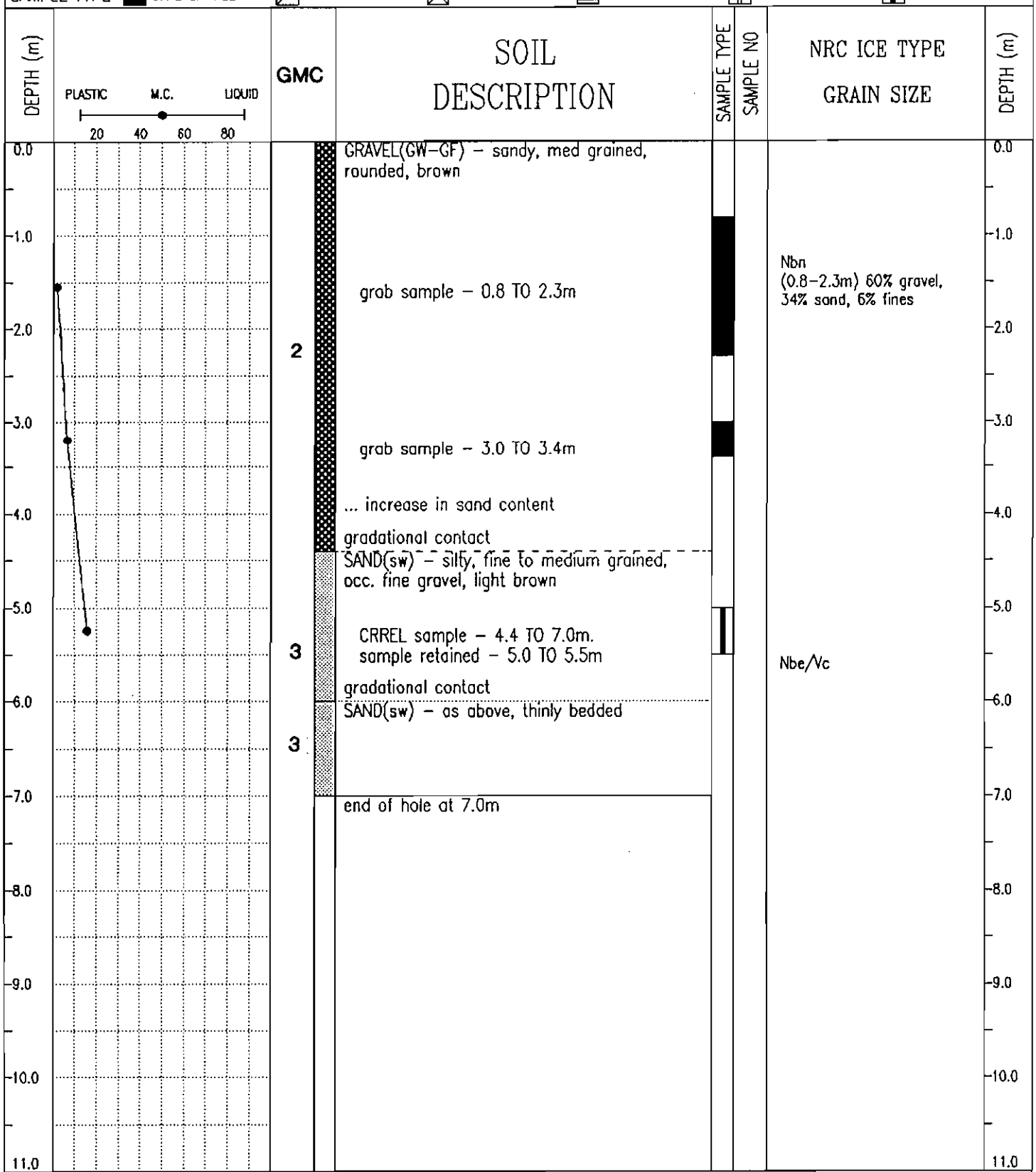
SAMPLE TYPE ■ GRAB SAMPLE ▨ ▩ ▤ ▥ CRREL CORE

DEPTH (m)	PLASTIC M.C. LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE	DEPTH (m)
0.0			GRAVEL(GF) – sandy, silty, medium to coarse grained, rounded, brown grab sample – 0.0 TO 1.8m	■			0.0
1.0		4				Nbn (0.0–0.8m) 31% gravel, 27% sand, 42% fines	1.0
2.0		4	SAND(sf) – gravelly with traces of silt, fine to medium grained, sub-rounded, well graded, grey-brown, interstitial ice			Nbn/Vx	2.0
3.0		1	ICE– ice with soil inclusions, hard, colourless, clear, contains sand inclusions			95% ICE – SANDY	3.0
4.0			end of hole at 3.8m				4.0
5.0							5.0
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 3.8 m	COMPLETE 17/03/89
	LOGGED BY BW	DWG NO.
		Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CR)	BOREHOLE No. 155SB025
UTM ZONE: 8 N 767877.00 E556990.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 21.90 (m)

SAMPLE TYPE ■ GRAB SAMPLE ☒ ▤ ▯ ▮ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 7.0 m		COMPLETE 17/03/89
	LOGGED BY BW	DWG NO.	Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CR)	BOREHOLE No. 155SB026
UTM ZONE: 8 N7678160.00 E556970.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 33.00 (m)

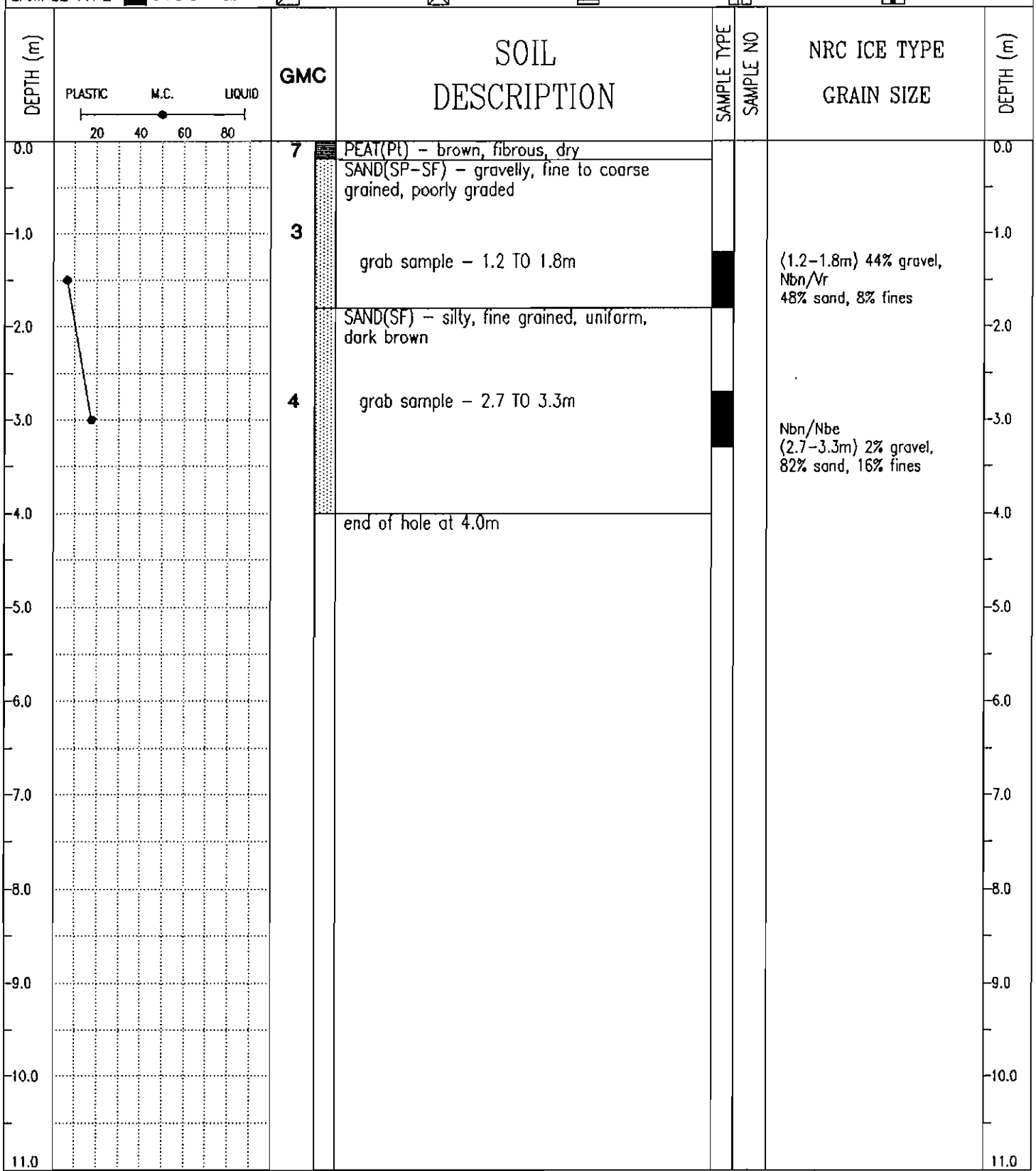
SAMPLE TYPE ■ GRAB SAMPLE ▨ CRREL CORE

DEPTH (m)	PLASTIC M.C. LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE	DEPTH (m)
0.0		7	PEAT(Pt) – brown, fibrous, dry				0.0
1.0			GRAVEL(GP) – sandy, rounded to sub-rounded, fine to medium grained, poorly graded, occasional cobbles, medium brown				1.0
2.0	•	2	grab sample – 1.5 TO 2.1m	■		Nbn/Vr (1.5–2.1m) 92% gravel, 5% sand, 3% fines	2.0
3.0			SAND(sf) – gravelly, medium grained, silty, brown				3.0
		3	grab sample – 3.8 TO 4.4m	■		Nbn	
4.0		2	GRAVEL(gp) – as above				4.0
5.0		4	SAND(sf) – silty, fine grained, uniform, dark brown			Vx	5.0
			... ice crystals from 4.8 TO 5.0m				
			END OF HOLE AT 5.0m				
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 5.0 m	COMPLETE 17/03/89
	LOGGED BY GB	DWG NO. Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CR)	BOREHOLE No. 155SB027
UTM ZONE: 8 N7678000.00 E557150.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: 5G10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 34.00 (m)

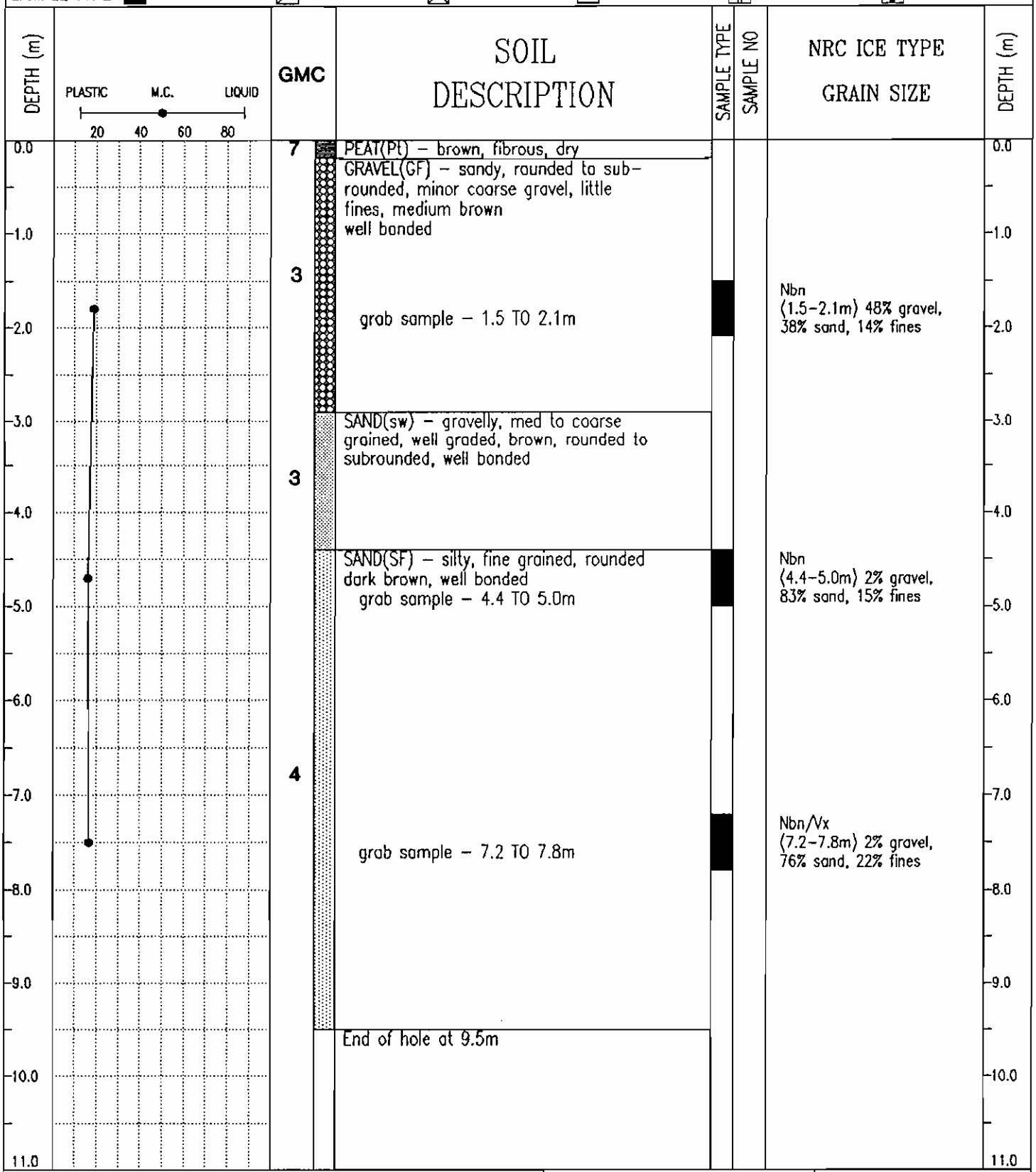
SAMPLE TYPE ■ GRAB SAMPLE ⊠ ▤ ◫ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.0 m		COMPLETE 17/03/89
	LOGGED BY GB	DWG NO.	Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CR)	BOREHOLE No. 155SB028
UTM ZONE: 8 N7678120.00 E557870.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: 5G10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 34.00 (m)

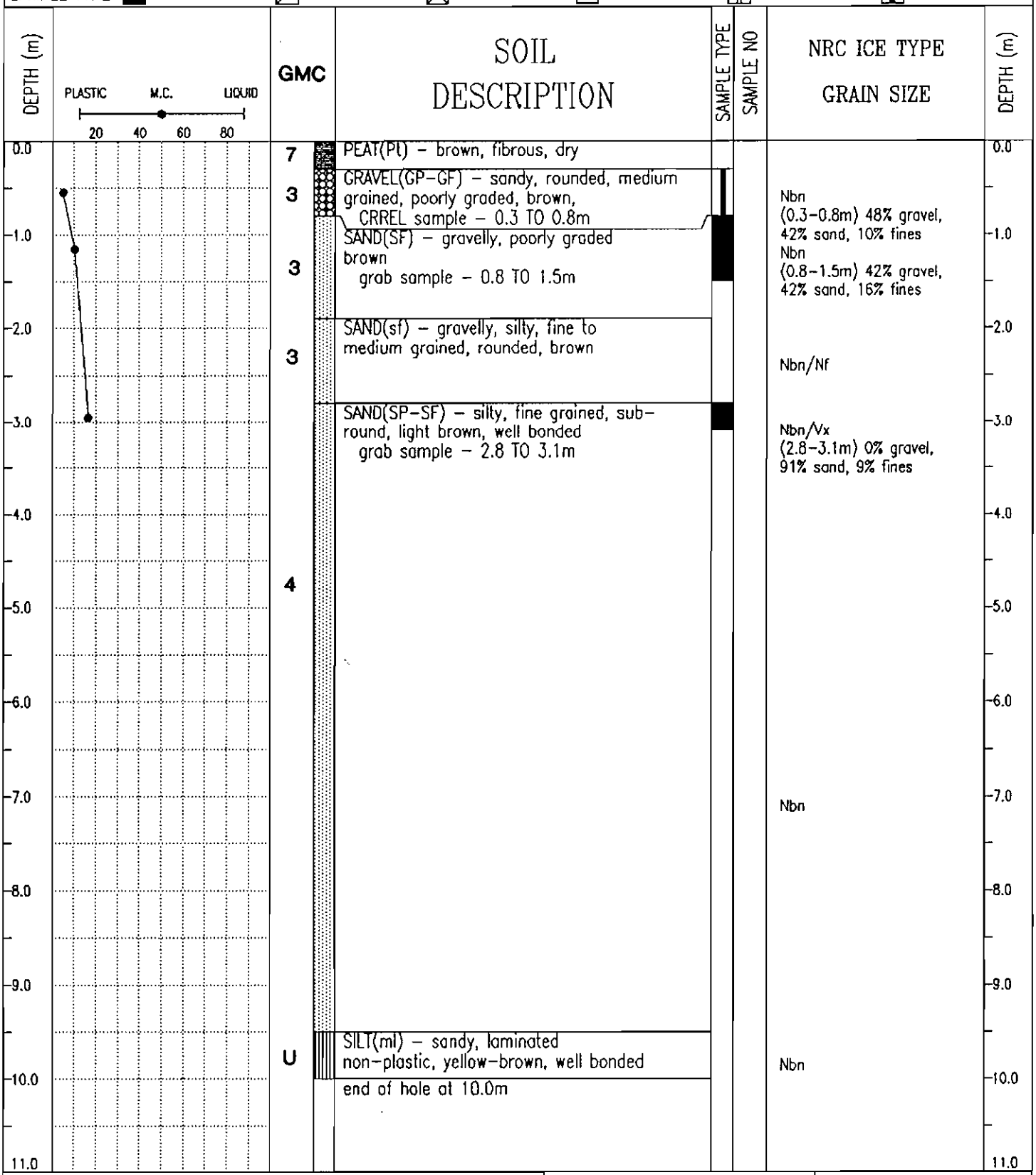
SAMPLE TYPE ■ GRAB SAMPLE ☒ ▤ ▯ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 9.5 m		COMPLETE 18/03/89
	LOGGED BY GB	DWG NO.	Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CR)	BOREHOLE No. 155SB029
UTM ZONE: 8 N7677890.00 E556000.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 31.00 (m)

SAMPLE TYPE ■ GRAB SAMPLE ☒ ▤ ▯ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 10.0 m		COMPLETE 18/03/89
	LOGGED BY BW	DWG NO.	Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CR)	BOREHOLE No. 155SB030
UTM ZONE: 8 N7677650.00 E557360.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 26.00 (m)

SAMPLE TYPE ■ GRAB SAMPLE ⊠ ▤ ▯▯ ▮▯ CRREL CORE

DEPTH (m)	PLASTIC M.C. LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE	DEPTH (m)
0.0		7	PEAT(Pt) – brown, fibrous, dry				0.0
		2	GRAVEL(GW) – sandy, coarse to medium grained, rounded, clean, well graded brown			Nbn/Nf	
1.0			grab sample – 0.9 TO 1.5m	■		Nbn	1.0
		4	SAND(sf) – med grained, minor clay rounded			Nbn	
2.0							2.0
		4	SAND (sf) – silty, fine to medium grained, rounded, brown			Nbn	
3.0							3.0
4.0			End of hole at 4.0m				4.0
5.0							5.0
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.0 m		COMPLETE 18/03/89
	LOGGED BY BW	DWG NO.	Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CR)	BOREHOLE No. 155SB031
UTM ZONE: 8 N7677530.00 E557520.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 24.00 (m)

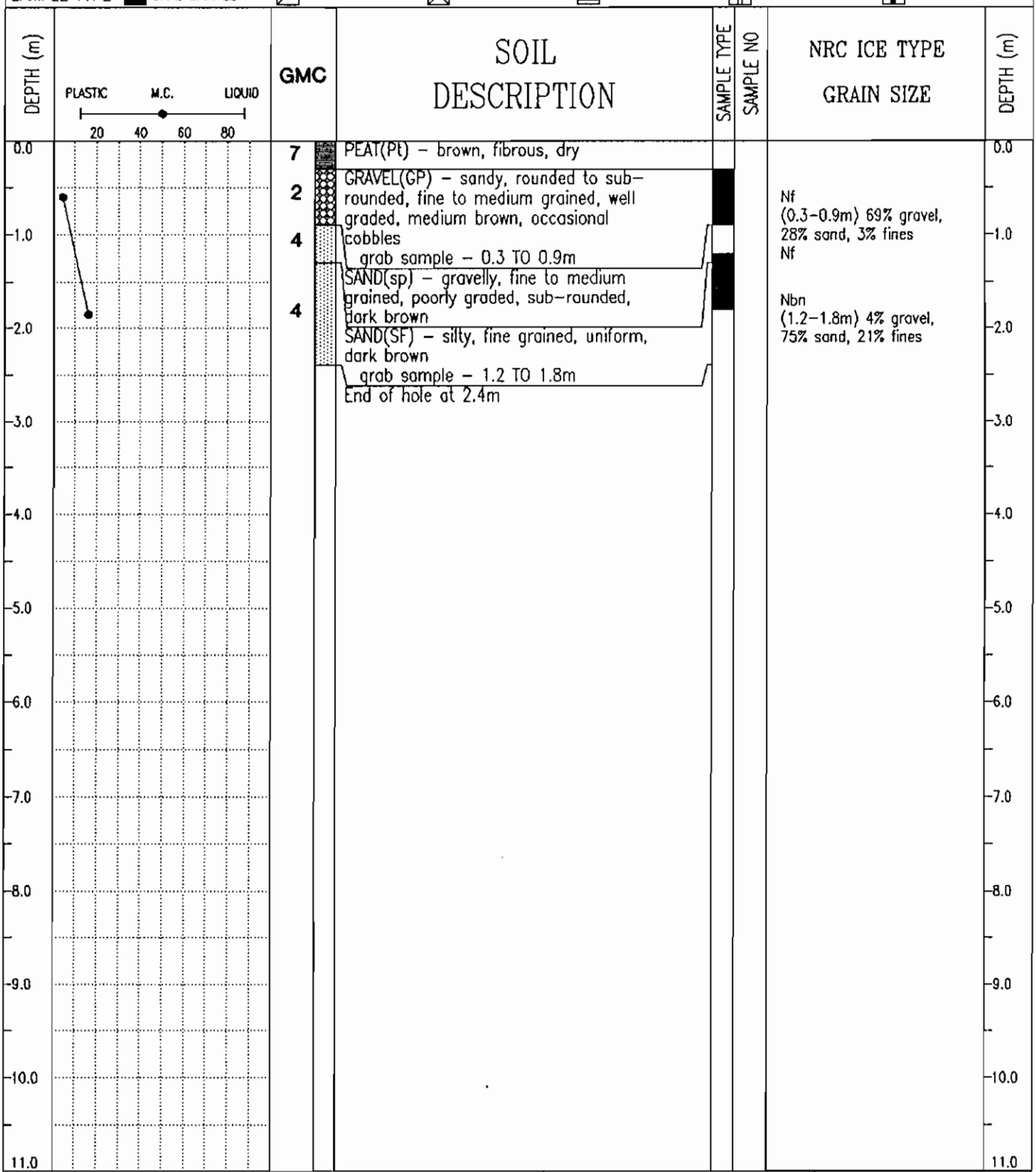
SAMPLE TYPE ■ GRAB SAMPLE ☒ ▤ ▯ CRREL CORE

DEPTH (m)	PLASTIC — M.C. — LIQUID (20 40 60 80)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE / GRAIN SIZE	DEPTH (m)
0.0		7	PEAT(Pt) – brown, fibrous, dry				0.0
			GRAVEL(gw) – coarse grained, rounded brown, well graded			Nf	
1.0		2					1.0
						Nbn	
2.0	•	2	GRAVEL(GP-GF) – sandy, fine to medium grained grab sample – 1.7 TO 2.2m	■		(1.7-2.2m) 63% gravel, 31% sand, 6% fines	2.0
3.0			SAND(sf) – silty, fine grained, medium brown				3.0
		4				Nbn	
4.0							4.0
5.0			End of hole at 5.0m				5.0
6.0							6.0
7.0							7.0
8.0							8.0
9.0							9.0
10.0							10.0
11.0							11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 5.0 m	COMPLETE 18/03/89
	LOGGED BY BW	DWG NO.
		Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CR)	BOREHOLE No. 155SB032
UTM ZONE: 8 N7677350.00 E557280.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 54.00 (m)

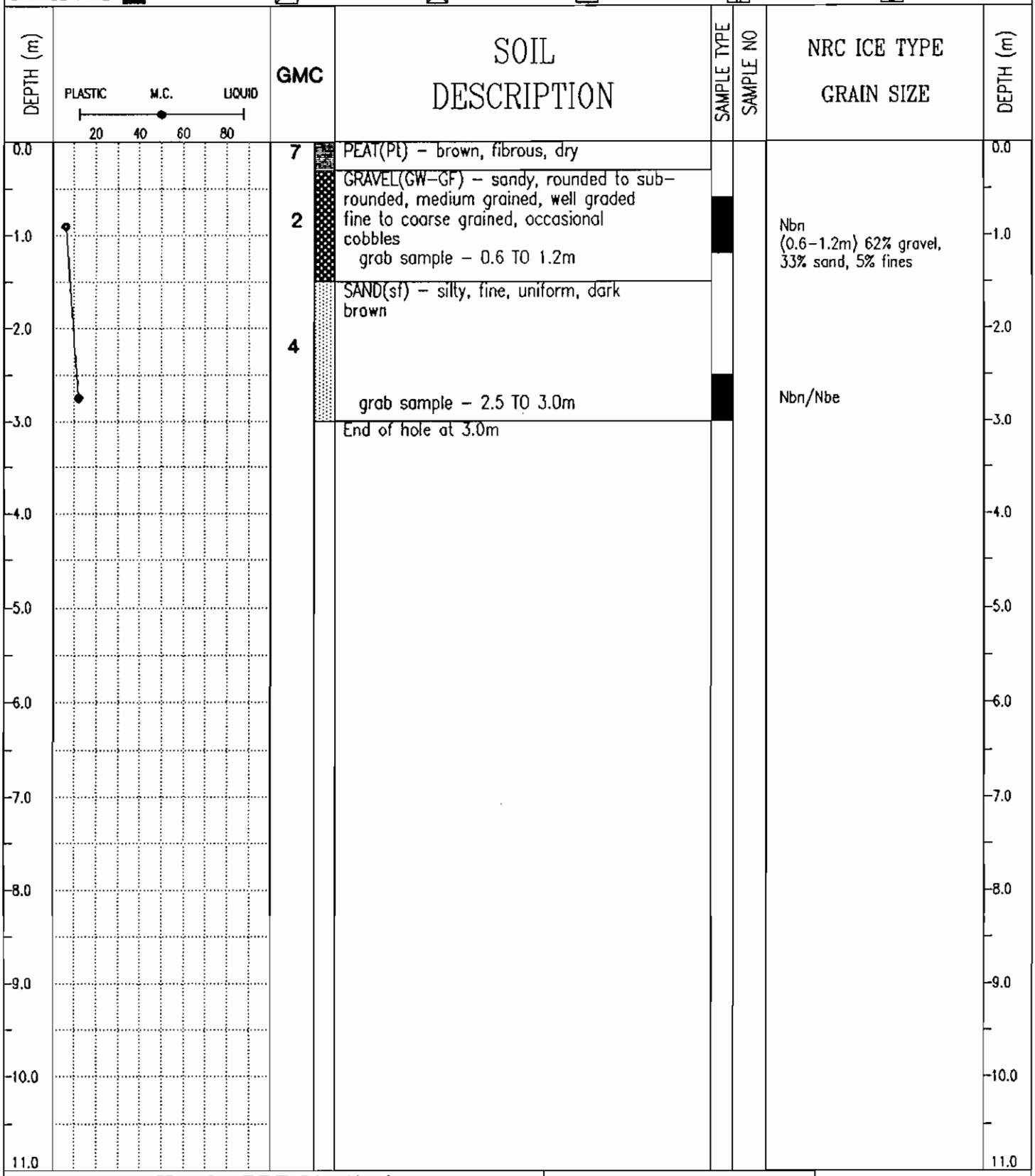
SAMPLE TYPE ■ GRAB SAMPLE ⊠ ▤ ▥ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 2.4 m	COMPLETE 18/03/89
	LOGGED BY GB	DWG NO.
		Page 1 of 1

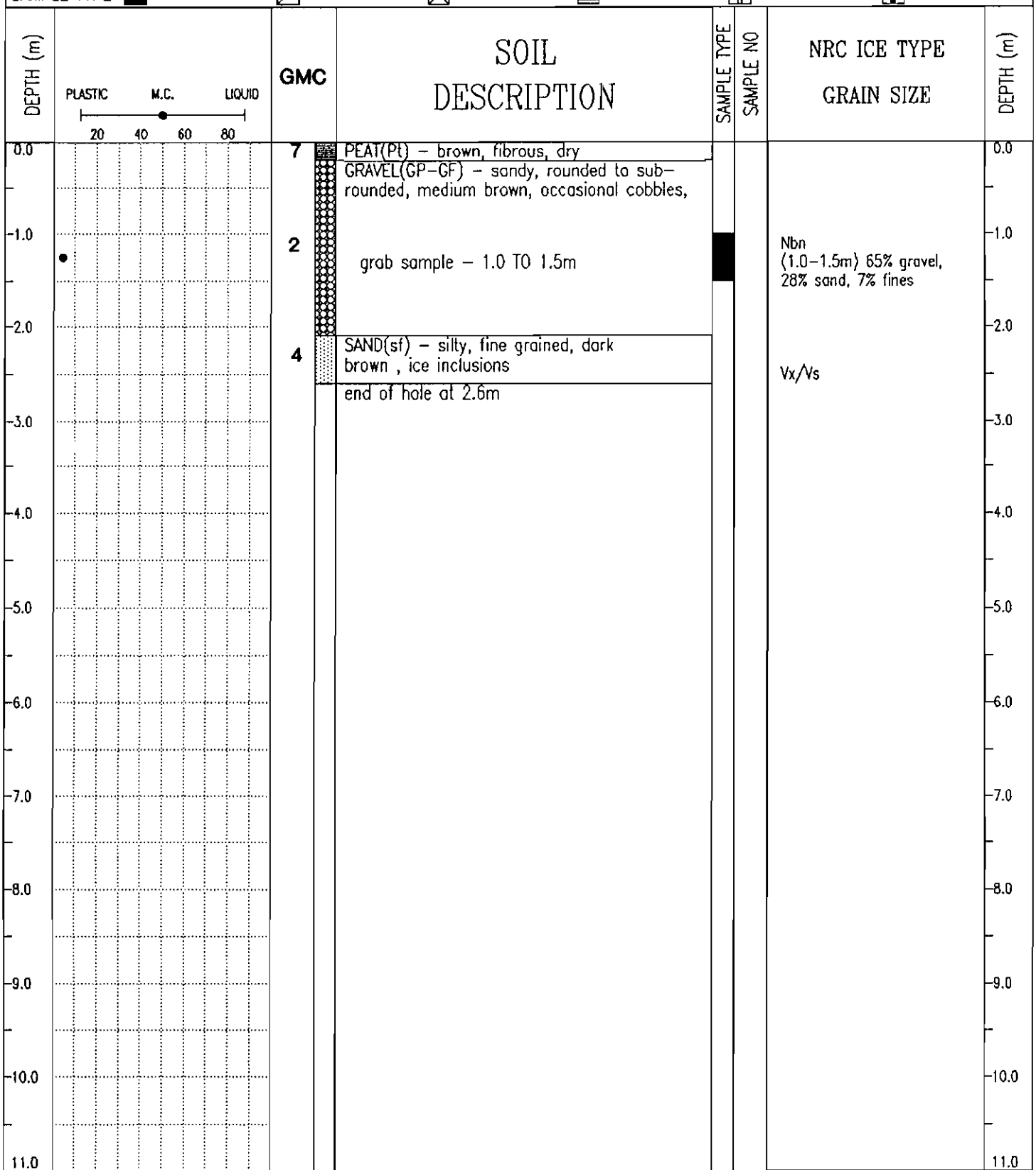
ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CR)	BOREHOLE No. 155SB033
UTM ZONE: 8 N7677420.00 E 55723.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 58.00 (m)

SAMPLE TYPE ■ GRAB SAMPLE ☒ ▤ ◫ CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 3.0 m		COMPLETE 18/03/89
	LOGGED BY GB	DWG NO.	Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	155S (KITTIGAZUIT CR)	BOREHOLE No. 155SB034
UTM ZONE: 8 N7677430.00 E556880.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 34.00 (m)
SAMPLE TYPE ■ GRAB SAMPLE		CRREL CORE



Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 2.6 m		COMPLETE 19/03/89
	LOGGED BY GB	DWG NO.	Page 1 of 1

APPENDIX B

Operational Calendar - INAC Inuvialuit

Granular Resource Investigations, March 1989

Operational Calendar - INAC INUVIALUIT
Granular Resource Investigation

March 10 to 12, 1989

Midnight Sun Drilling Ltd. mobilized from Whitehorse. All drilling and accessory equipment in Inuvik by the morning of March 13, 1989. The field program was carried out in two 12 hour shifts per day.

March 12, 1989

HBT staff mobilized from Calgary.

March 13, 1989

Site investigation program begins. Midnight Sun Drilling Ltd. personnel fly to I-407 site to check access route conditions.

Move equipment on-site and open access to the I-407 primary drilling site.

March 14, 1989

00:00 - 11:00	Continue to move equipment to-site.
11:00 - 12:00	Drill and sample Borehole I407B001 to a completed depth of 6.7 m.
12:00 - 13:45	Drill and sample Borehole I407B002 to a completed depth of 7.9 m.
13:45 - 15:30	Drill and sample Borehole I407B003 to a completed depth of 7.9 m.
15:30 - 17:00	Drill and sample Borehole I407B004 to a completed depth of 7.1 m.
17:00 - 16:30	Drill and sample Borehole I407B005 to a completed depth of 7.0 m.

March 14, 1989

16:30 - 18:00	Drill and sample Borehole I407B006 to a completed depth of 3.3 m.
18:00 - 19:30	Drill and sample Borehole I407B007 to a completed depth of 5.8 m.
19:30 - 21:30	Drill and sample Borehole I407B008 to a completed depth of 6.3 m.
21:30 - 23:00	Drill and sample Borehole I407B009 to a completed depth of 5.3 m.
23:00 - 24:00	Commenced drilling and sampling of Borehole I407B010.

March 15, 1989

00:00 - 02:00	Continue Borehole I407B010 to a completed depth of 5.6 m.
02:00 - 04:30	Drill and sample Borehole I407B011 to a completed depth of 6.0 m.
04:30 - 07:00	Drill and sample Borehole I407B012 to a completed depth of 6.0 m.
07:00 - 10:30	Drill down. Canadian Helicopter crew fails to show up at the in-town helipad. Change of shift has to be accomplished by truck.
10:30 - 15:00	Re-drill Borehole I407B003 and take CRREL ice core samples. Complete borehole at a depth of 8.2 m.
15;00 - 19:00	Re-drill Borehole I407B011 and take CRREL ice core samples. Complete borehole at a depth of 9.8 m.
19:00 - 20:00	Drill and sample Borehole I407B013 to a completed

depth of 5.2 m.

20:00 - 21:00 — Re-drill Borehole I407B013 and take CRREL ice core samples. Complete borehole at a depth of 5.2 m.

21:00 - 24:00 — Drill and sample Borehole I407B014 to a completed depth of 4.0 m. Cat employed to back-blade a trail to secondary drilling area on tip of the Caribou Hills escarpment.

March 16, 1989

00:00 - 03:00 — Drill and sample Borehole I407B015 to a completed depth of 3.9 m. Cat continues to back-blade a trail.

03:00 - 08:30 — Move rig to site of Borehole I407B016, prepare to drill

08:30 - 14:00 — Drill Borehole I407B016 and take CRREL ice core samples. Complete borehole at a depth of 8.8 m.

14:00 - 24:00 — Move drill and accessory equipment to the 155 South site at Kittigazuit Creek. The Cat begins ploughing out access route at approximately 18:00 hours.

March 17, 1989

00:00 - 09:30 — Continue move to Kittigazuit Creek. Access trail ploughed out as far as the stockpiles at 155 South, located at 155SB018 in area H. One bulk sample collected from stockpiles.

09:30 - 10:30 — Drill and sample Borehole 155SB023 to a completed depth of 3.8 m. A one-half hour site reconnaissance made by helicopter to determine access routes to the various drilling locations and photograph the drilling operation. The Cat kept busy ploughing out access trails to the various drilling locations.

10:30 - 11:30 — Drill and sample Borehole 155SB024 to a completed depth of 3.8 m. The Cat continues ploughing out

	access trails.
11:30 - 14:00	Drill and sample Borehole 155SB025 to a completed depth of 7.0 m.
14:00 - 19:00	Take CRREL ice core samples in Borehole 155SB023. Complete borehole at depth of 4.2 m.
19:00 - 20:30	Move rig to location 155SB026.
20:30 - 24:00	Drill and sample Borehole 155SB026 to a completed depth of 5.0 m.

March 18, 1989

00:00 - 03:00	Drill and sample Borehole 155SB027 to a completed depth of 4.0 m.
03:00 - 08:00	Drill and sample Borehole 155SB028 to a completed depth of 9.5 m.
08:00 - 13:00	Drill and sample Borehole 155SB029 to a completed depth of 10.0 m.
13:00 - 14:00	Move rig to location 155SB030.
14:00 - 16:00	Drill and sample Borehole 155SB030 to a completed depth of 4.0 m.
16:00 - 16:50	Move rig to location 155SB031.
16:50 - 19:00	Drill and sample Borehole 155SB031 to a completed depth of 5.0 m.
19:00 - 20:00	Move rig to location 155SB032.
20:00 - 23:00	Drill and sample Borehole 155SB032 to a completed depth of 3.0 m.
23:00 - 24:00	Commence drilling and sampling Borehole 155SB033.

March 19, 1989

00:00 - 02:00	Continue Borehole 155SB033 to a completed depth of 5.0 m.
02:00 - 04:00	Drill and sample Borehole 155SB034 to a completed depth of 2.6 m.
04:00 - 08:00	Rig down, prepare to move.
08:00 - 24:00	Move equipment to Willow River (467 Site). Cat begins ploughing out the access route at approximately 17:00 hours.

March 20, 1989

00:00 - 04:30	Continue move to Site 467.
04:30 - 06:00	The Cat pulls the rig up the hill slope and the rig is set-up.
06:00 - 11:30	Drill and sample Borehole 467B001 to a completed depth of 7.1 m.
11:30 - 12:30	Move rig to Borehole 467B002 site.
12:30 - 16:00	Drill and sample Borehole 467B002 to a completed depth of 7.3 m.
16:00 - 17:45	Drill and sample Borehole 467B003 to a completed depth of 2.5 m.
17:45 - 19:00	Move rig to Borehole 467B004 site.
19:00 - 19:30	Drill and sample Borehole 467B004 to a completed depth of 0.6 m.
19:30 - 21:00	Move rig to Borehole 467B005 site.

21:00 - 23:30	Drill and sample Borehole 467B005 to a completed depth of 4.5 m.
23:00 - 24:00	Move equipment back to Inuvik.

March 21, 1989

00:00 - 19:00	Continue move to Inuvik.

March 22 to 23, 1989

Ship out samples, deliver ice core samples to the Geological Survey of Canada, meet with INAC officials, and de-mobilize operations, including Midnight Sun Drilling Ltd.

ENG_GEO\CG10346T.D1

APPENDIX C

Laboratory Test Results

PROJECT: INAC Inuvialuit Granular Study
LOCATION: Kittigazuit Creek (155–S)

PROJECT NO.: CG10346

BOREHOLE #:	SAMPLE INTERVAL	%GRAVEL:	%SAND:	%FINES	D50	Cu	Cc	MOISTURE CONTENT %:	PETROGRAPHIC NUMBER (PN)	USC
155SB023	0.8 – 1.7	–	–	–				3.1		
155SB024	0.0 – 0.8	31	27	42	.35			12.1		GF
155SB025	0.8 – 2.3	60	34	6	7.5	52	2.3	1.8		GW–GF
155SB025	3.0 – 3.4	–	–	–				6.7		
155SB025	5.0 – 5.5	–	–	–				15.7		
155SB026	1.5 – 2.1	92	5	3	15	3.2	1.2	2.0		GP
155SB026	3.8 – 4.4	No test results available								
155SB027	1.2 – 1.8	44	48	8	3.3	44	0.56	6.5		SP–SF
155SB027	2.7 – 3.3	2	82	16	.27			17.7		SF
155SB028	1.5 – 2.1	48	38	14	4.0			18.9	165	GF
155SB028	4.4 – 5.0	2	83	15	.27			16.1		SF
155SB028	7.2 – 7.8	2	76	22	.17			16.8		SF
155SB029	0.3 – 0.8	48	42	10	4.0	100	0.28	5.0		GP–GF
155SB029	0.8 – 1.5	42	42	16	3.0			10.3		SF
155SB029	2.8 – 3.1	0	91	9	.16	2.4	1.0	16.5		SP–SF
155SB030	1.0 – 1.4	–	–	–				2.1		
155SB031	1.7 – 2.2	63	31	6	7.8	50	3.4	3.6	159	GP–GF
155SB032	0.3 – 0.9	69	28	3	10	62	6.6	4.4		GP
155SB032	1.2 – 1.8	4	75	21	.15			16.2		SF
155SB033	0.6 – 1.2	62	33	5	8.5	100	1.5	6.0		GW–GF
155SB033	2.5 – 3.0	–	–	–				12.1		
155SB034	1.0 – 1.5	65	28	7	7.5	36	5.3	4.4	176	GP–GF
East side of Stockpile	N/A	75	21	4	12	43	7.2	4.5		GP

PROJECT: INAC Inuvialuit Granular Study PROJECT NO.: CG10346
LOCATION: Kittigazuit Creek (155-S)

BOREHOLE #:	SAMPLE INTERVAL	%GRAVEL:	%SAND:	%FINES	D50	Cu	Cc	MOISTURE CONTENT %:	PETROGRAPHIC NUMBER (PN)
155SB023	0.8 - 1.7	-	-	-				3.1	
155SB024	0.0 - 0.8	31	27	42	.35			12.1	
155SB025	0.8 - 2.3	60	34	6	7.5	52	2.3	1.8	
155SB025	3.0 - 3.4	-	-	-				6.7	
155SB025	5.0 - 5.5	-	-	-				15.7	
155SB026	1.5 - 2.1	92	5	3	15	3.2	1.2	2.0	
155SB026	3.8 - 4.4	No test results available							
155SB027	1.2 - 1.8	44	48	8	3.3	44	0.56	6.5	
155SB027	2.7 - 3.3	2	82	16	.27			17.7	
155SB028	1.5 - 2.1	48	38	14	4.0			18.9	165
155SB028	4.4 - 5.0	2	83	15	.27			16.1	
155SB028	7.2 - 7.8	2	76	22	.17			16.8	
155SB029	0.3 - 0.8	48	42	10	4.0	100	0.28	5.0	
155SB029	0.8 - 1.5	42	42	16	3.0			10.3	
155SB029	2.8 - 3.1	0	91	9	.16	2.4	1.0	16.5	
155SB030	1.0 - 1.4	-	-	-				2.1	
155SB031	1.7 - 2.2	63	31	6	7.8	50	3.4	3.6	159
155SB032	0.3 - 0.9	69	28	3	10	62	6.6	4.4	
155SB032	1.2 - 1.8	4	75	21	.15			16.2	
155SB033	0.6 - 1.2	62	33	5	8.5	100	1.5	6.0	
155SB033	2.5 - 3.0	-	-	-				12.1	
155SB034	1.0 - 1.5	65	28	7	7.5	36	5.3	4.4	176
East side of Stockpile	N/A	75	21	4	12	43	7.2	4.5	

FILE: CG10346 PREPARED BY: BF SAMPLE: 155SB028
CLIENT: INAC DATE: May 8, 1989 1.5 – 2.1 M

LITHOLOGIC/MINEROLOGIC DESCRIPTION	Chemical Quality	Physical Quality	PN MULT.	WEIGHTED PERCENT IN EACH FRACTION							Total Weighed Composition %	PN # Contribution
				1 1/2"	1"	3/4"	5/8"	1/2"	3/8"	#4		
Crystalline	Good	Good	1		2.2		1.0	0.2	0.1	0.7	4.2	4.2
Metamorphic/Volcanic	Good	Good	1		2.2	4.4	1.5	2.7	3.3	6.1	20.2	20.2
Quartzite/Sandstone	Good	Good	1	9.2	4.4	9.8	1.5	6.0	6.2	15.1	52.2	52.2
Carbonate	Good	Good	1						0.2	0.7	0.9	0.9
Crystalline, weathered	Good	Fair	3							0.1	0.1	0.3
Metamorphic/Volcanic, weathered		Fair	3		2.2						2.2	6.6
Sandstone, weathered		Fair	3		2.2	4.4	1.0	0.7	0.8	1.2	10.3	30.9
Shale/ Mudstone		Fair	3						0.4	0.3	0.7	2.1
Carbonate, weathered		Fair	3						0.3	0.9	1.2	3.6
Chert	Fair		3			0.9	1.0	0.2	0.3	0.7	3.1	9.3
Sandstone, highly weathered		Poor	6		2.2					0.6	2.8	16.8
Shale/Mudstone, weathered		Poor	6						0.5	0.4	0.9	5.4
Ironstone	Deleterious		10					0.2		1.0	1.2	12.0
Totals				9.2	15.4	19.5	6.0	10.0	12.1	27.8	100.0	164.5

PETROGRAPHIC NUMBER: 165

SUMMARY OF PETROGRAPHIC EXAMINATION

FILE: CG10346 PREPARED BY: VP SAMPLE: 155SB031
CLIENT: INAC DATE: April 18, 1989 1.7 – 2.2 m

LITHOLOGIC/MINEROLOGIC DESCRIPTION	Chemical Quality	Physical Quality	PN MULT.	WEIGHTED PERCENT IN EACH FRACTION							Total Weighed Composition %	PN # Contribution
				1"	3/4"	5/8"	1/2"	3/8"	#4			
Sandstone/Quartzite	Good	Good	1	6.9	8.4	8.1	10.9	12.5	15.3		62.1	62.1
Metamorphic/Volcanic	Good		1		2.8	1.4	1.2	3.7	5.7		14.8	14.8
Crystalline	Good		1			1.4		0.8	1.0		3.2	3.2
Carbonate	Good		1						0.5		0.5	0.5
Mudstone		Fair	3					0.6	0.8		1.4	4.2
Sandstone/Quartzite, weathered		Fair	3		0.9		0.4	0.8	2.0		4.1	12.3
Chert	Fair		3		0.9	0.7	0.8	0.6	1.3		4.3	12.9
Carbonate, weathered		Fair	3			2.1	0.8	0.4	1.0		4.3	12.9
Volcanic, weathered		Fair	3			0.7					0.7	2.1
Mudstone/Sandstone, weathered		Poor	6			0.7	0.4	0.8	1.0		2.9	17.4
Volcanic, weathered	Deleterious		10		0.9						0.9	0.9
Ironstone/Limonite	Deleterious	Poor	10						0.8		0.8	8.0
Totals				6.9	13.9	15.1	14.5	20.2	29.4		100.0	159.4

	PETROGRAPHIC NUMBER: 159	SUMMARY OF PETROGRAPHIC EXAMINATION	

INAC159

FILE: CG10346 PREPARED BY: BF SAMPLE: 155SB034
CLIENT: INAC DATE: May 9, 1989 1.0 – 1.5 m

LITHOLOGIC/MINEROLOGIC DESCRIPTION	Chemical Quality	Physical Quality	PN MULT.	WEIGHTED PERCENT IN EACH FRACTION							Total Weighed Composition %	PN # Contribution
				1"	3/4"	5/8"	1/2"	3/8"	#4			
Crystalline	Good	Good	1	1.0		0.3	0.2	0.4	1.0		2.9	2.9
Quartzite/Sandstone	Good	Good	1	7.1	9.7	5.1	7.2	9.2	16.7		55.0	55.0
Metamorphic/Volcanic	Good	Good	1		1.6	1.5	2.2	4.3	7.6		17.2	17.2
Carbonate	Good	Good	1				0.2		0.4		0.6	0.6
Chert	Fair		3		0.5	0.3	0.6	0.8	1.4		3.6	10.8
Sandstone, weathered		Fair	3	1.0	0.5	0.6	1.1	1.3	2.0		6.5	19.5
Shale/Mudstone		Fair	3			0.3	0.2	0.6	1.4		2.5	7.5
Carbonate, weathered		Fair	3		1.1		0.5	0.4	1.6		3.6	10.8
Metamorphic/Volcanic, weathered		Fair	3				0.3				0.3	0.9
Sandstone, highly weathered		Poor	6			0.3	0.8	0.4	1.6		3.1	18.6
Shale/Mudstone, weathered		Poor	6		0.5	0.3	0.5	0.4	1.2		2.9	17.4
Carbonate, highly weathered		Poor	6					0.2	0.3		0.5	3.0
Chert, weathered	Poor	Poor	6				0.2				0.2	1.2
Ironstone	Deleterious		10				0.2		0.9		1.1	11.0
Totals				9.1	13.9	8.7	14.2	18.0	36.1		PN =	176.4

	PETROGRAPHIC NUMBER: 176	SUMMARY OF PETROGRAPHIC EXAMINATION

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES
CERTIFIED CONCRETE TESTING LABORATORY IN ACCORDANCE WITH STD. A283

LOS ANGELES ABRASION TEST REPORT

OFFICE: Calgary
PROJECT NO.: CG-10346
CLIENT:
COPIES TO:

TO: Department of Indian and Northern Development
1101 Place DuPortage, Phase III
11 Laurier Street
Hull, Quebec
K1A 0S5

PROJECT Inuvialuit Gravel Study

155-S — Combined Boreholes # B026, B027, B028, B029

SOURCE: SAMPLE I.D. Pit Run Aggregate SAMPLED BY: HBL - Geotechnical

DATE SAMPLED: - DATE RECEIVED: May 29, 1989 DATE TESTED: August 29, 1989

MATERIAL GRADING: "A"

ACTUAL SIEVE SIZES	AMOUNT
— 37.5 mm (1 1/2") + 25.0 mm (1")	1251.2 g
— 25.0 mm (1") + 19.0 mm (3/4")	1249.5 g
— 19.0 mm (3/4") + 12.5 mm (1/2")	1250.2 g
— 12.5 mm (1/2") + 9.5 mm (3/8")	1249.8 g
NO. OF REVOLUTIONS 500	TOTAL SAMPLE 5000.7 g
NO. OF SPHERES 12	+ #12 MATERIAL AFTER 3989.8 g
WT. OF SPHERES 4994.3	- #12 MATERIAL AFTER 1010.9 g
LOSS AT 100 REVOLUTIONS - %	LOSS AT 500 REVOLUTIONS 20.2 %
LOSS AT 200 REVOLUTIONS - %	LOSS AT 1000 REVOLUTIONS - %

TESTED IN ACCORDANCE WITH ☒ CSA A23.2 - 16A (ASTM C131) ☐ CSA A23.2 - 17A (ASTM C535)

COMMENTS: Additional Tests

1. Specific Gravity (SSD) = 2.62
2. Absorption (%) = 1.21 ASTM C127

Hardy BBT Limited
Per:

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of the test results is provided only on written request.

HBLT 45-87/08

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

SOUNDNESS OF AGGREGATE
SULPHATE TEST REPORT

TO: Department of Indian and Northern Development
Supply and Services
11C1 Place Du Portage, Phase III
11 Laurier Street
Hull, Quebec k1A 0S5

FILE: CG-10346
DATE: July 9, 1989
CLIENT P.O.:
C.C.:

PROJECT Inuvialuit Gravel Study

SOURCE 155-S- Combined Boreholes # B026, B027, B028, B029
DATE SAMPLED - TYPE OF SAMPLE Pit Run Material SAMPLED BY HBT - Geotechnical
DATE RECEIVED May 29, 1989 DATE TESTED July 3, 1989

SOLUTION Magnesium Sulphate NUMBER OF CYCLES 5

COARSE AGGREGATE				FINE AGGREGATE			
SIEVE SIZE		ORIGINAL GRADING PERCENT	Weighted AVERAGE PERCENT LOSS	SIEVE SIZE		ORIGINAL GRADING PERCENT	Weighted AVERAGE PERCENT LOSS
PASSING	RETAINED			PASSING	RETAINED		
3 IN.	2 In.			3/8 IN.	NO. 4		
2 In.	1-1/2 In.			NO. 4	NO. 8		
1-1/2 In.	1 IN.	11.9	0.11	NO. 8	NO. 16		
1 IN.	¾ IN.	18.6	0.74	NO. 16	NO. 30		
¾ IN.	½ IN.	24.0	0.68	NO. 30	NO. 50		
½ IN.	3/8 IN.	17.7	1.34	NO. 50	NO. 100		
3/8 IN.	NO. 4 IN	27.8	1.47	NO. 100			
TOTALS		100.0	3.60	TOTALS			

SIZE FRACTION	NO. PARTICLES	QUALITATIVE EXAMINATION OF PLUS ¾" MATERIAL
3/4" - 1"	ORIGINAL 30	
	FINAL 30	Some cracking occurred throughout the sample.
1" - 1½"	ORIGINAL 19	
	FINAL 19	Some cracking and disintegration occurred throughout the sample.
	ORIGINAL	
	FINAL	

COMMENTS:

REPORT CERTIFIED K.M. Dallimpaty, CET TECHNICIAN R.L.D.

TESTED IN ACCORDANCE WITH ASTM C88

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES
CERTIFIED CONCRETE TESTING LABORATORY IN ACCORDANCE WITH STD. A283

LOS ANGELES ABRASION TEST REPORT

OFFICE: Calgary
PROJECT NO.: CG-10346
CLIENT:
COPIES TO:

TO: Department of Indian and Northern Development
Supply and Services
11C1 Place Du Portage, Phase III
11 Laurier Street
HULL, Quebec
K1A 0S5

PROJECT Inuvialuit Gravel Study

SOURCE: 155-S - Stockpile SAMPLE I.D. Pit Run Aggregate SAMPLED BY: HBT - Geotechnical
DATE SAMPLED: - DATE RECEIVED: May 29/89 DATE TESTED: June 5/89

MATERIAL GRADING: "A"

ACTUAL SIEVE SIZES	AMOUNT
— 37.5 mm (1 1/2") + 25.0 mm (1")	1249.6 g
— 25.0 mm (1") + 19.0 mm (3/4")	1249.7 g
— 19.0 mm (3/4") + 12.5 mm (1/2")	1249.9 g
— 12.5 mm (1/2") + 9.5 mm (3/8")	1250.1 g

NO. OF REVOLUTIONS	500	TOTAL SAMPLE	4999.3 g
NO. OF SPHERES	12	+ #12 MATERIAL AFTER	4096.4 g
WT. OF SPHERES	4996.9	- #12 MATERIAL AFTER	902.9 g
LOSS AT 100 REVOLUTIONS	- %	LOSS AT 500 REVOLUTIONS	18.1 %
LOSS AT 200 REVOLUTIONS	- %	LOSS AT 1000 REVOLUTIONS	- %

TESTED IN ACCORDANCE WITH ☒ CSA A23.2 - 16A (ASTM C131) ☐ CSA A23.2 - 17A (ASTM C535)

COMMENTS: Additional Tests
(1) Specific Gravity (SSD) = 2.60, ASTM C127
(2) Absorption (%) = 1.43, ASTM C127

Hardy BBT Limited
Per: [signature]

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of the test results is provided only on written request.

HBLT 45-87/08

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

SOUNDNESS OF AGGREGATE
SULPHATE TEST REPORT

TO: Department of Indian and Northern Development
Supply and Services
11C1 Place Du Portage, Phase III
11 Laurier Street
HULL, Quebec
K1A 0S5

FILE: CG010346
DATE: June 12, 1989
CLIENT P.O.:
C.C.:

PROJECT Inuvialuit Gravel Study

SOURCE 155-S - Stockpile | TYPE OF SAMPLE Pit Run Aggregate | SAMPLED BY HBT - Geotechnical
DATE SAMPLED - | DATE RECEIVED May 29, 1989 | DATE TESTED June 6, 1989

SOLUTION Magnesium Sulphate NUMBER OF CYCLES 5

COARSE AGGREGATE				FINE AGGREGATE			
SIEVE SIZE		ORIGINAL GRADING PERCENT	WEIGHTED AVERAGE PERCENT LOSS	SIEVE SIZE		ORIGINAL GRADING PERCENT	WEIGHTED AVERAGE PERCENT LOSS
PASSING	RETAINED			PASSING	RETAINED		
3 IN.	2			3/8 IN.	NO. 4		
2 IN.	1-1/2 IN.	25.2	0.08 *	NO. 4	NO. 8		
1-1/2 IN.	1 IN.	3.4	0.01 *	NO. 8	NO. 16		
1 IN.	3/4 IN.	11.7	0.04	NO. 16	NO. 30		
3/4 IN.	1/2 IN.	28.9	0.32	NO. 30	NO. 50		
1/2 IN.	3/8 IN.	13.1	0.39	NO. 50	NO. 100		
3/8 IN.	NO. 4 IN	17.7	0.78	NO. 100			
TOTALS		100.0	1.62	TOTALS			

SIZE FRACTION	NO. PARTICLES	QUALITATIVE EXAMINATION OF PLUS 3/4" MATERIAL
3/4" - 1"	ORIGINAL 31	-
	FINAL 31	Some cracking, flaking and disintegration occurred through sample.
	ORIGINAL	
	FINAL	
	ORIGINAL	
	FINAL	

COMMENTS: *Weighted Average Percent Loss Adjustment as per Testing Requirement.

REPORT CERTIFIED R.W. Dillingham, C.E.T. TECHNICIAN R.L.D.

TESTED IN ACCORDANCE WITH ASTM C88

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

TECHNICAL REPORT

TO: Hardy BBT Limited

Calgary, Alberta

FILE EC-11279
DATE 3 August, 1989
CLIENT P.O. CG 10346
C.C.

Attention: Mr. K. Gillingwater

PROJECT: Potential Reactivity of Sand

SUBJECT: Results of Analysis

Sample		Concentration of SiO_2 (millimoles / Litre)	Reduction in Alkalinity (millimoles / Litre)
155-5-89B -4.75mm	1	264	200
Sand Fraction +#100 mat	2	338	200
	3	325	200
155-5-89B -4.75mm	1	403	168
Coarse Fraction	2	454	170
	3	456	170
I407 Borehole #16	1	167	75
-4.75mm Sand Fraction	2	203	68
I407 Borehole #16	1	641	165
+4.75mm Coarse Fraction	2	679	155
	3	688	155

Report Certified

Hardy BBT Limited

Per:

Silvan Zorzut
Laboratory Supervisor
Chemical Sciences Division

SFZ/tyl

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

TECHNICAL REPORT

TO: Hardy BBT Limited
Calgary, Alberta
ATTENTION: Mr. K. Gillingwater

FILE EC11193
DATE July 5, 1989
CLIENT P.O. CG10346
C.C.

PROJECT: Samples #155-S - Received June 19, 1989
SUBJECT: Results of Analysis - Potential Reactivity

	Concentration of SiO_2 (millimoles/litre)	Reduction in Alkalinity (millimoles/litre)
Fine/Sand fraction 1	43	118
2	48	108
3	45	113
Coarse/Crushed Agg 1	529	115
2	494	108
3	520	109

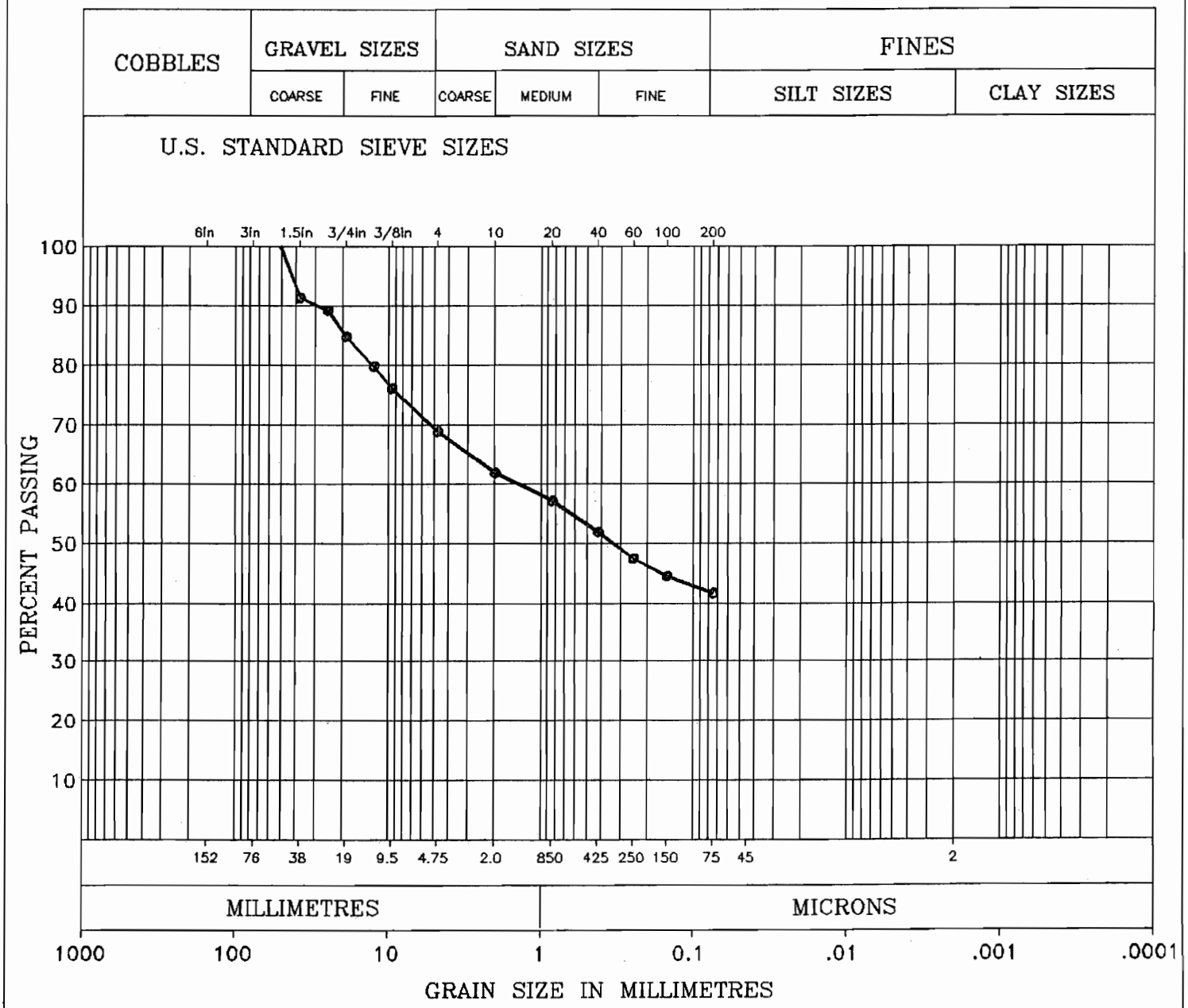
Report Certified

Hardy BBT Limited

Per:

Silvan Zorzut
Laboratory Supervisor
Chemical Sciences Division

SFZ/af



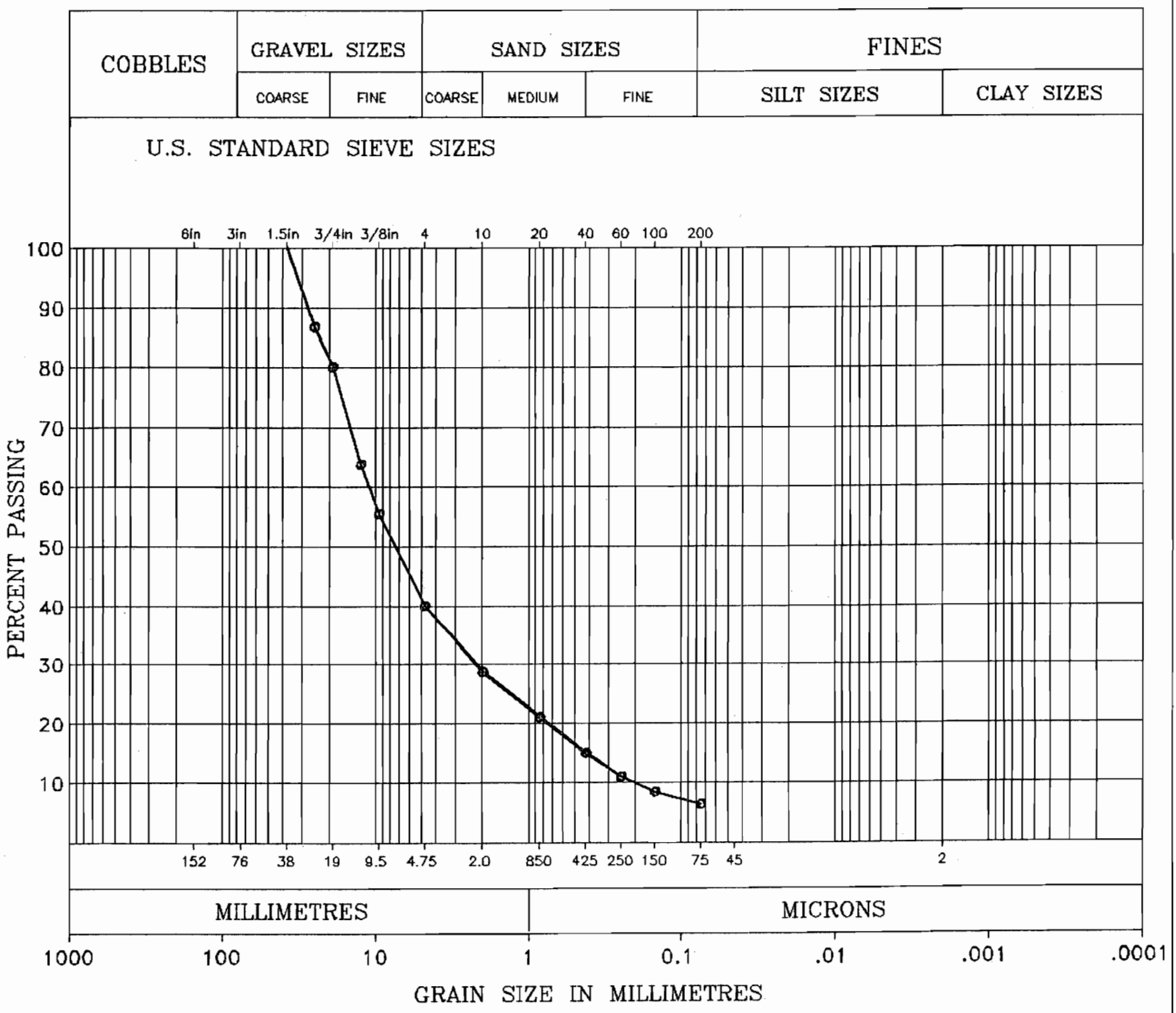
REMARKS: SANDY, GRAVEL

SUMMARY			
D_{10} =	mm	GRAVEL	31. %
D_{30} =	mm	SAND	27. %
D_{60} = 1.6	mm	FINES	42. %
C_U =			
C_C =			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B024 SAMPLE:
DEPTH: 0.0 - 0.8 m
TECHNICIAN: FP DATE: 89.04.07



REMARKS:

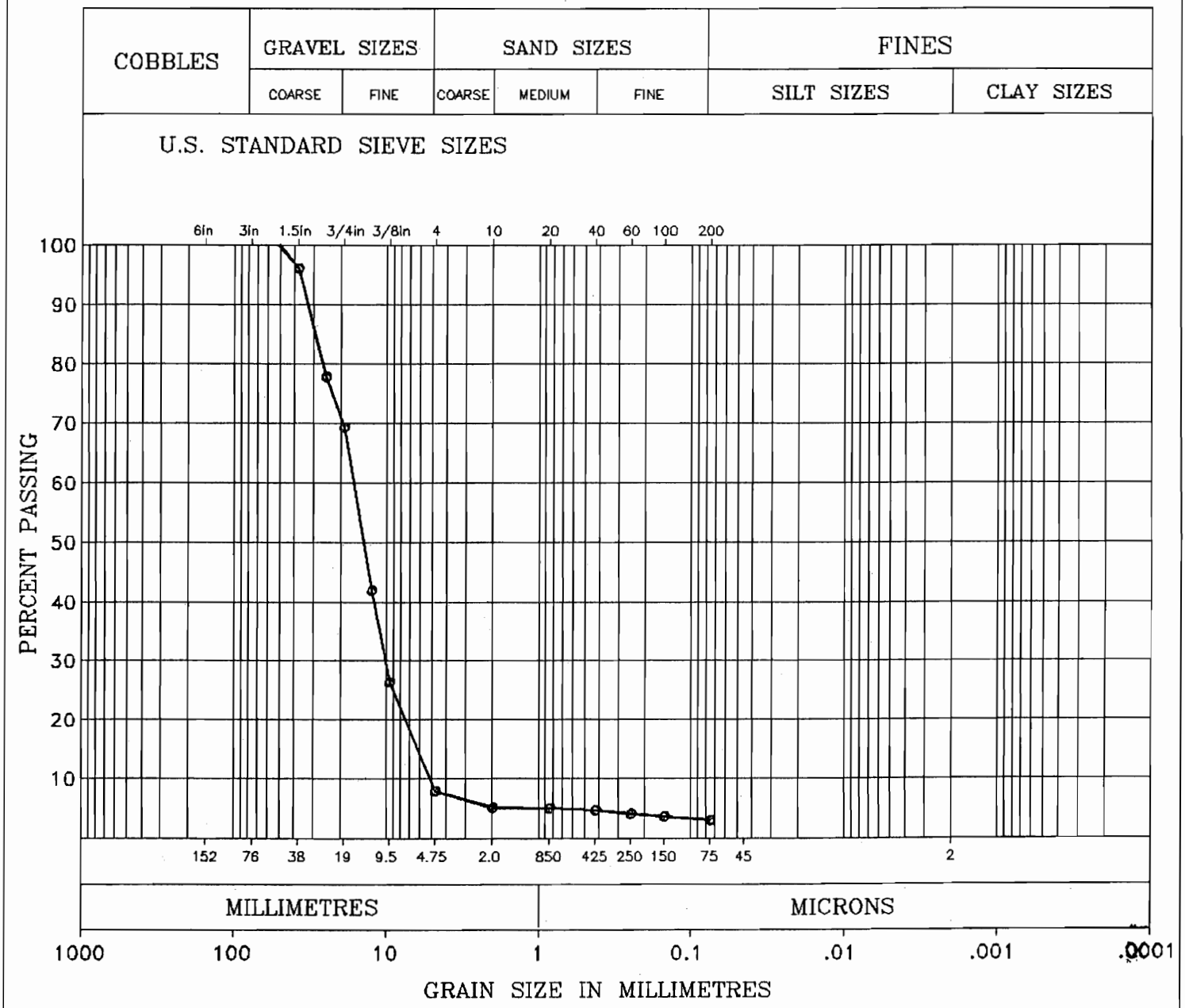
SUMMARY

D_{10} = 0.21	mm	GRAVEL	60. %
D_{30} = 2.3	mm	SAND	34. %
D_{60} = 11.	mm	FINES	6. %
C_U = 52.			
C_C = 2.3			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B025 SAMPLE:
DEPTH: 0.8 - 2.3 m
TECHNICIAN: JB DATE: 89.05.03



REMARKS:

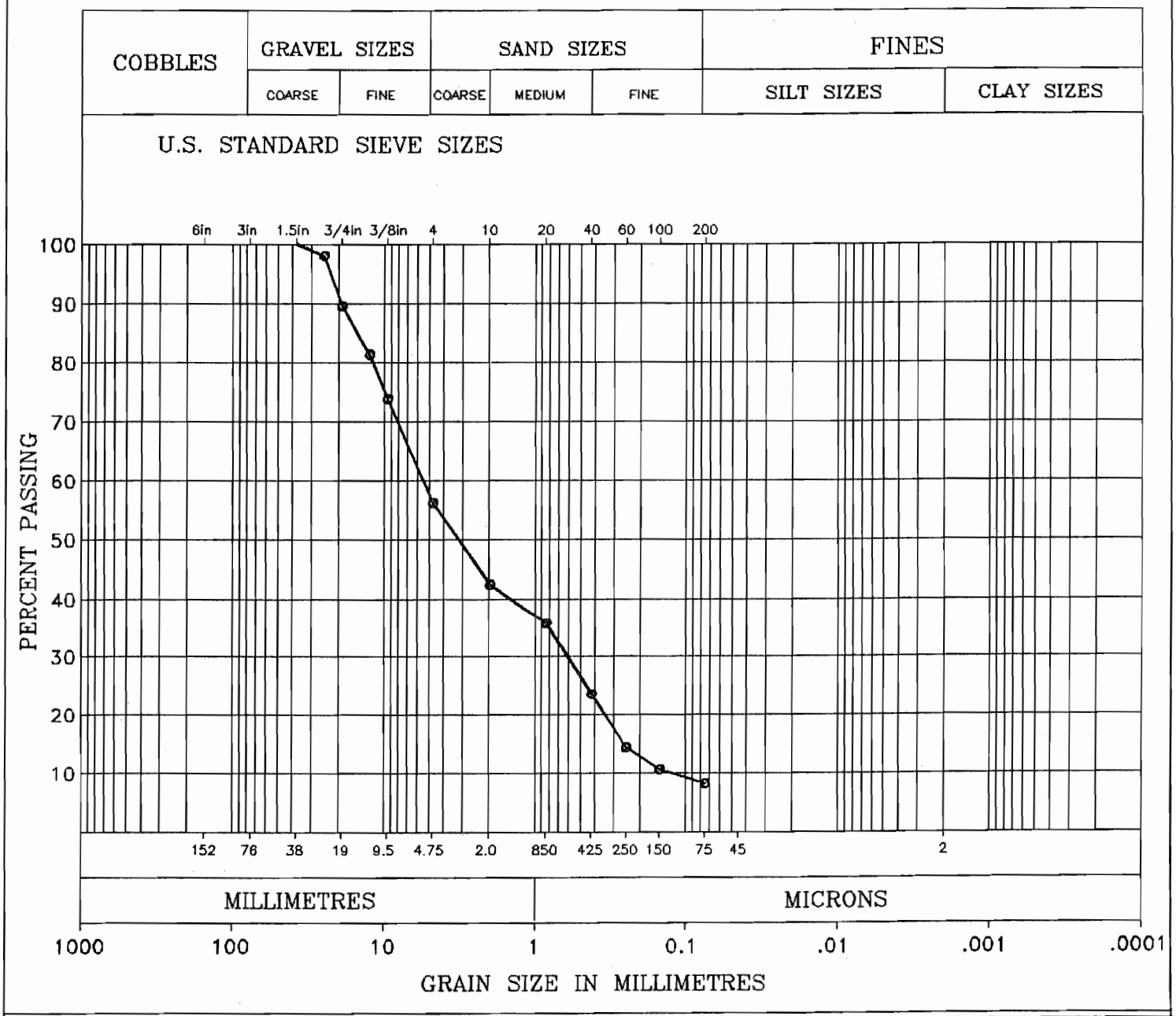
SUMMARY

D_{10} = 5.3	mm	GRAVEL	92. %
D_{30} = 10.	mm	SAND	5. %
D_{60} = 17.	mm	FINES	3. %
C_U = 3.2			
C_C = 1.2			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B026 SAMPLE:
DEPTH: 1.5 - 2.1 m
TECHNICIAN: FP DATE: 89.05.03



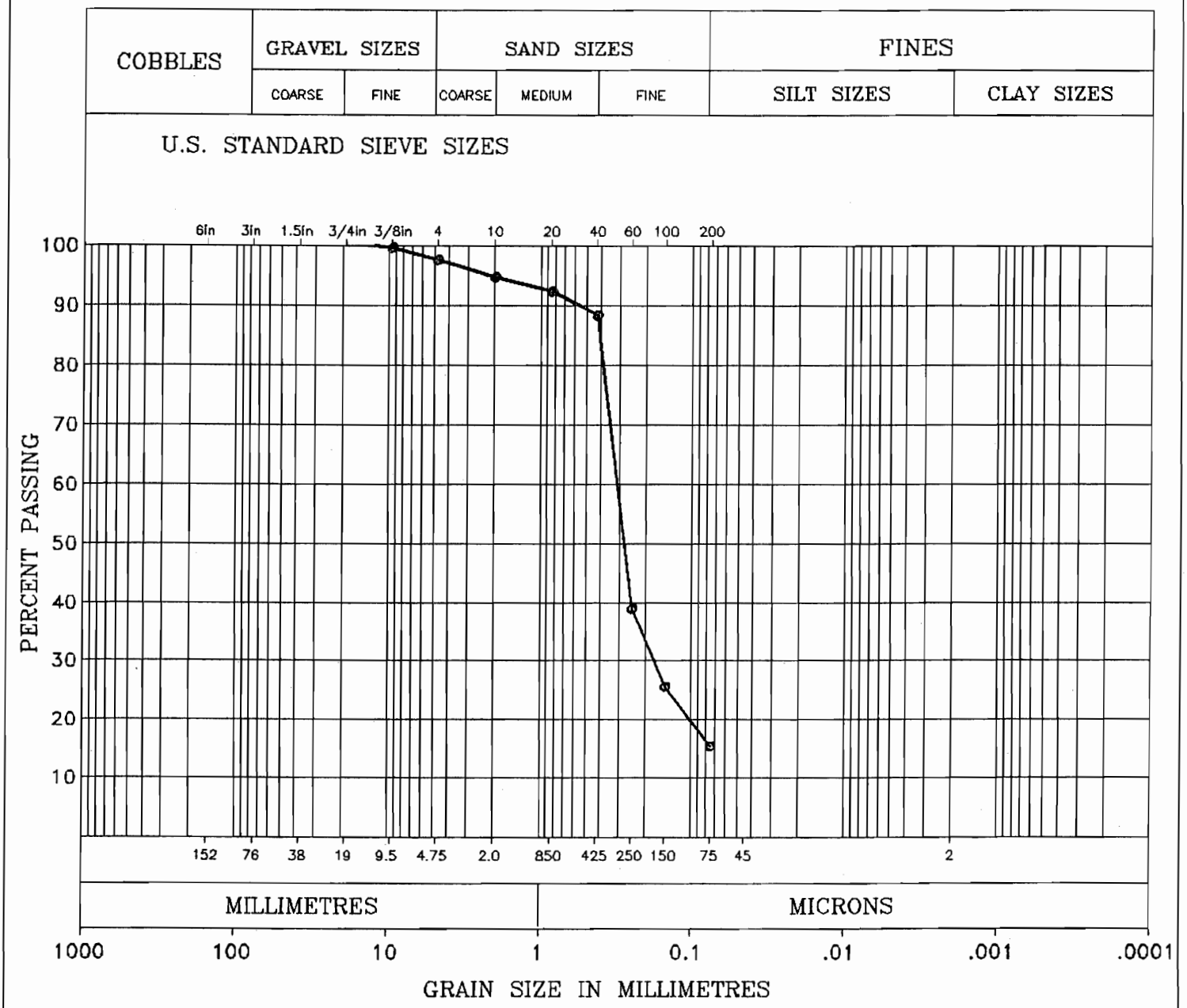
REMARKS: POORLY GRADED GRAVELLY SAND

SUMMARY			
D_{10} = 0.13	mm	GRAVEL	44. %
D_{30} = 0.65	mm	SAND	48. %
D_{60} = 5.8	mm	FINES	8. %
C_U = 44.			
C_C = 0.56			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B027 SAMPLE:
DEPTH: 1.2 - 1.8 m
TECHNICIAN: FP DATE: 89.05.03



REMARKS:

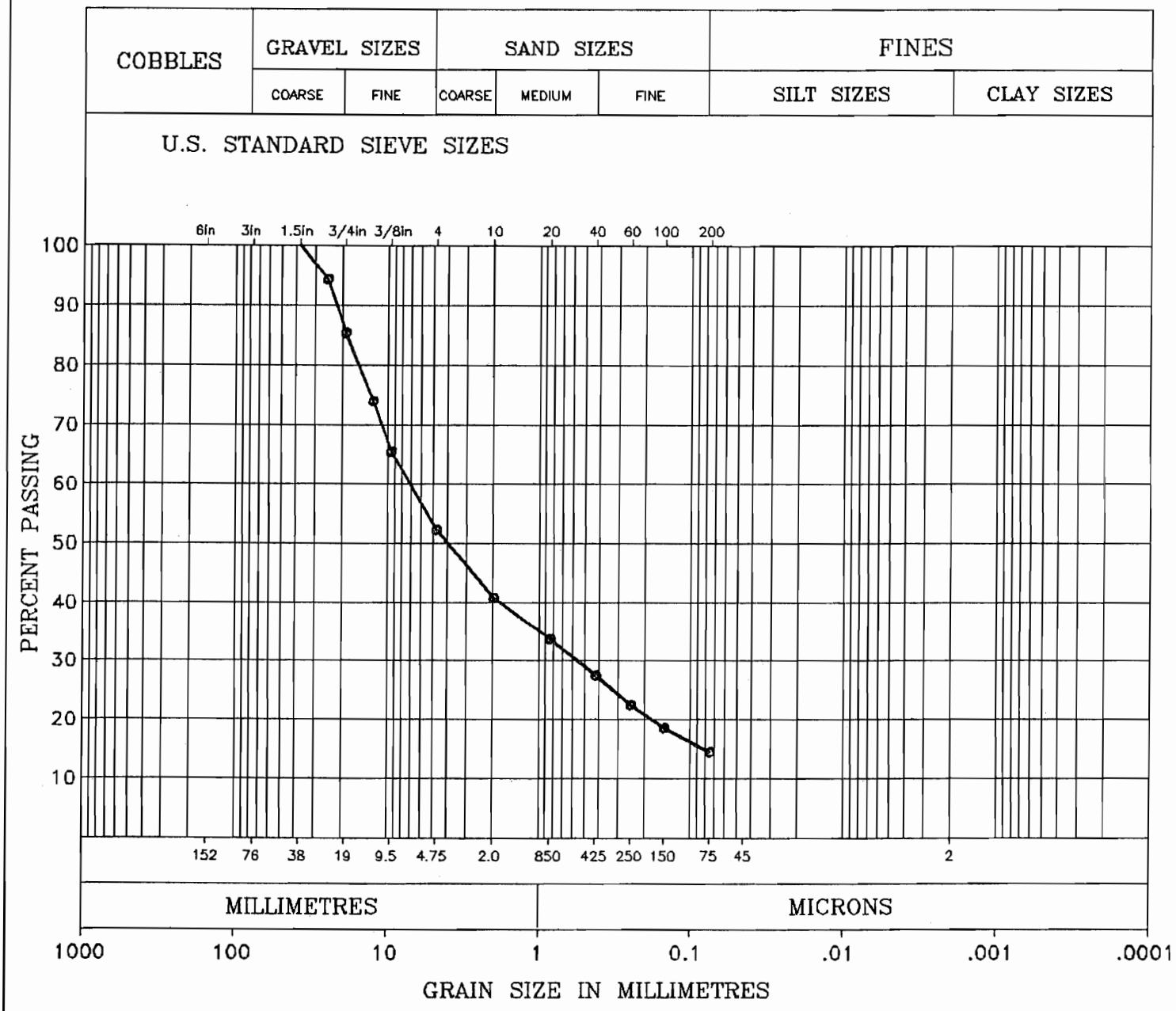
SUMMARY

D_{10} =	mm	GRAVEL	2. %
D_{30} = 0.18	mm	SAND	82. %
D_{60} = 0.32	mm	FINES	16. %
C_U =			
C_C =			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B027 SAMPLE:
DEPTH: 2.7 - 3.3 m
TECHNICIAN: JB DATE: 89.05.03



REMARKS:

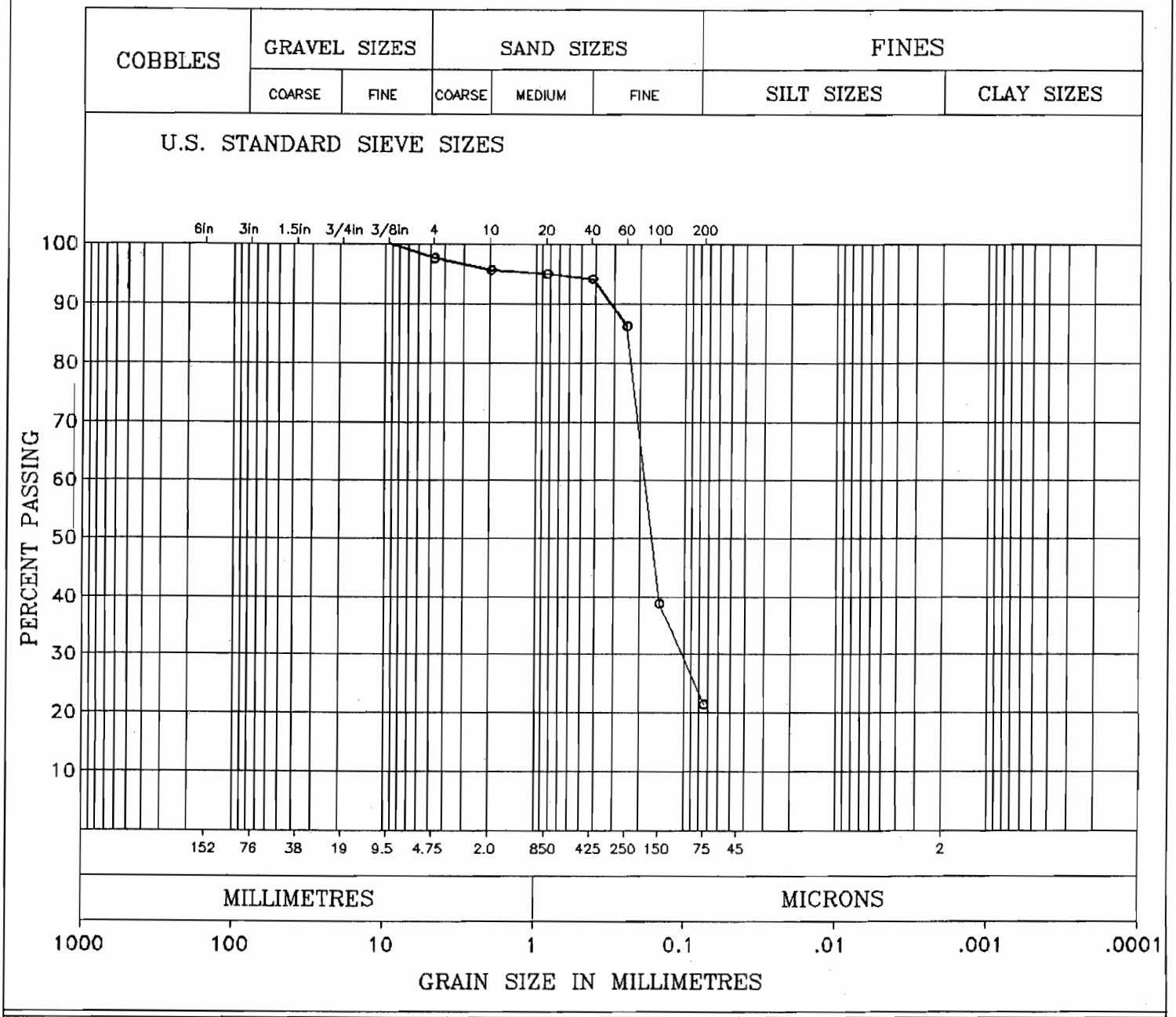
SUMMARY

D_{10} =	mm	GRAVEL	48. %
D_{30} = 0.60	mm	SAND	38. %
D_{60} = 7.5	mm	FINES	14. %
C_U =			
C_C =			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B028 SAMPLE:
DEPTH: 1.5 - 2.1 m
TECHNICIAN: JB DATE: 89.05.03



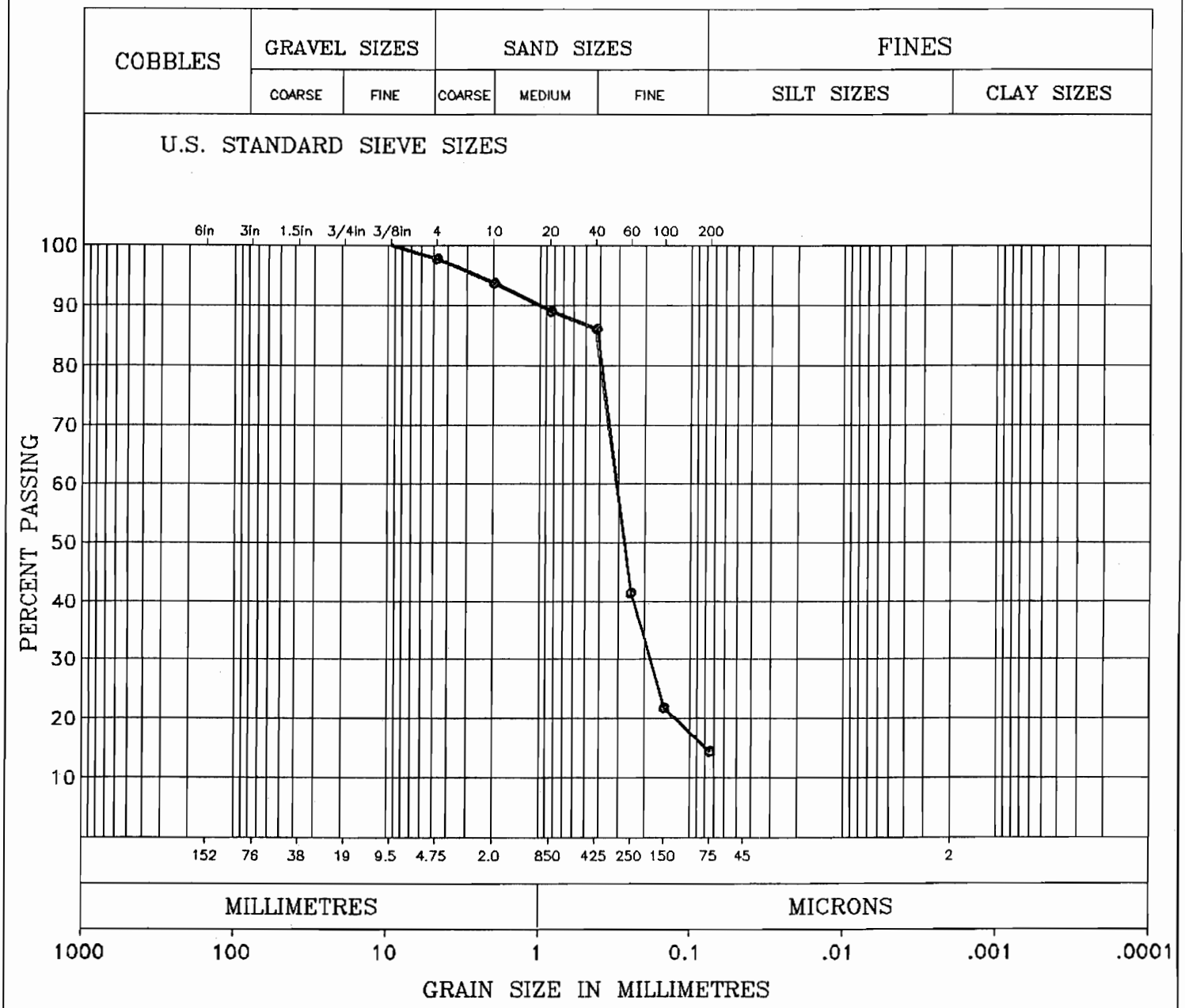
REMARKS: FINE GRAINED SILTY SAND

SUMMARY			
D_{10} =	mm	GRAVEL	2. %
D_{30} = 0.11	mm	SAND	76. %
D_{60} = 0.19	mm	FINES	22. %
C_U =			
C_C =			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B028 SAMPLE:
DEPTH: 7.2 - 7.8 m
TECHNICIAN: FP DATE: 89.05.03



REMARKS:

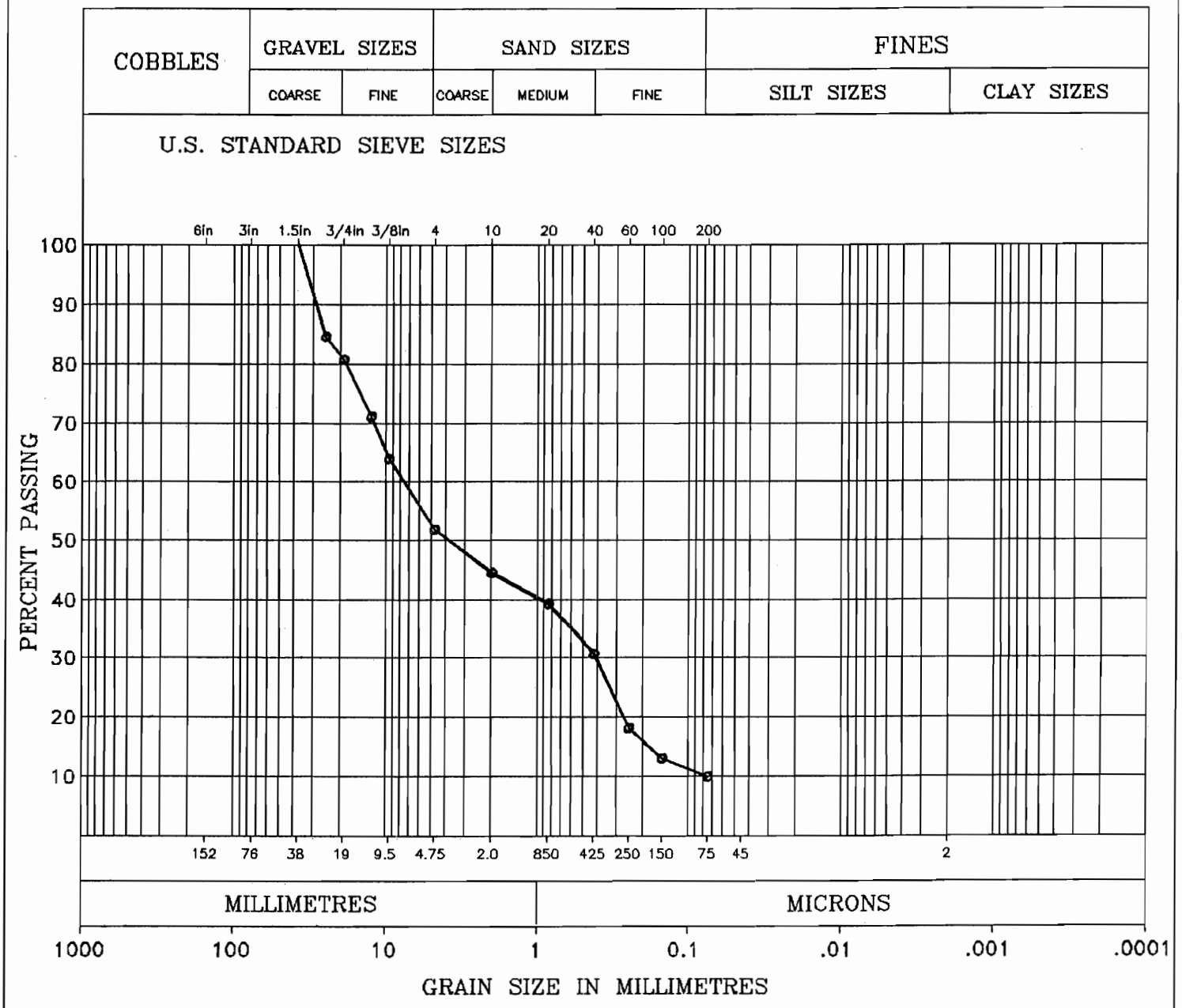
SUMMARY

D_{10} =	mm	GRAVEL	2. %
D_{30} = 0.19	mm	SAND	83. %
D_{60} = 0.32	mm	FINES	15. %
C_U =			
C_C =			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B028 SAMPLE:
DEPTH: 4.4 - 5.0 m
TECHNICIAN: JB DATE: 89.05.03



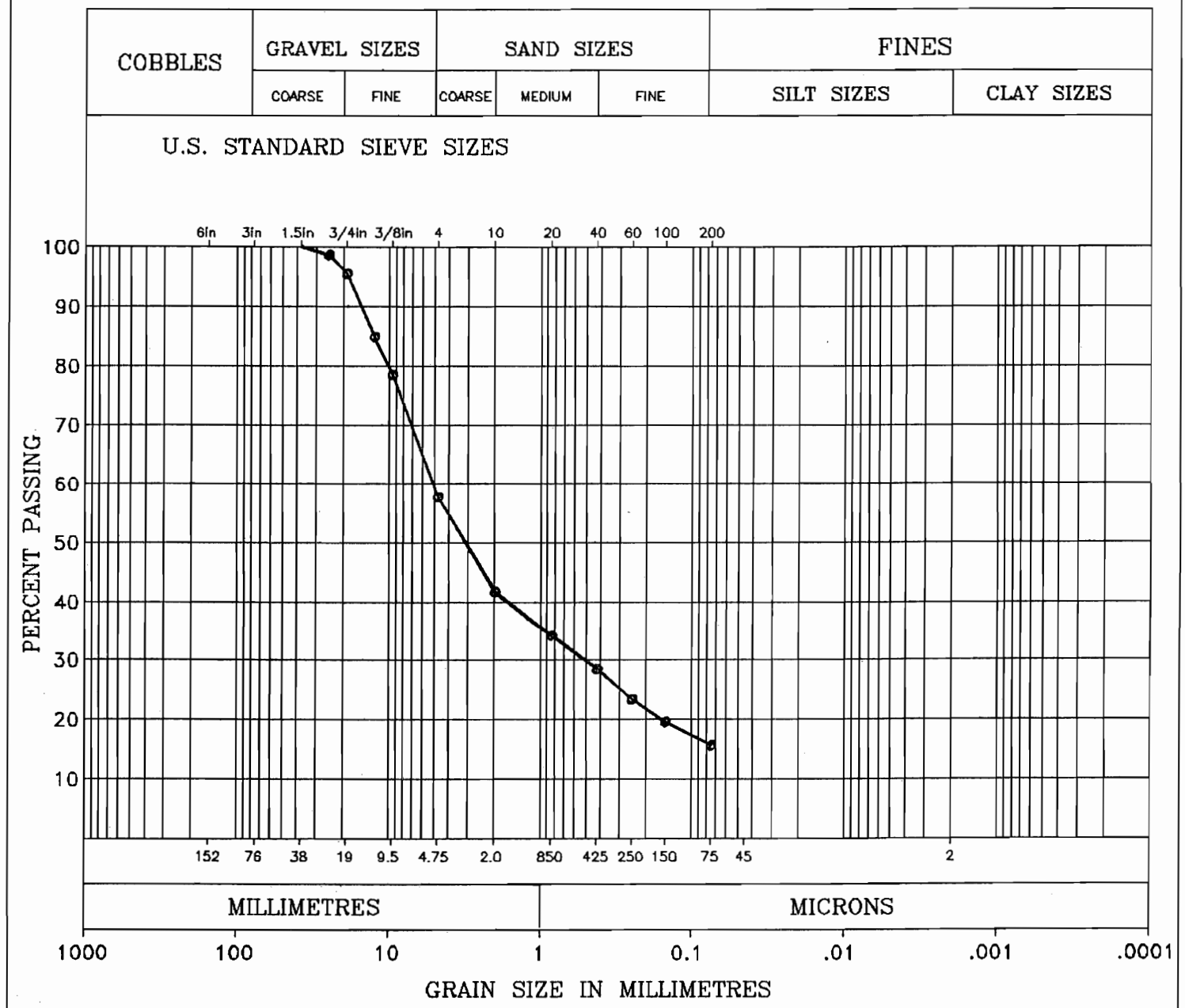
REMARKS:

SUMMARY			
D_{10} = 0.078	mm	GRAVEL	48. %
D_{30} = 0.42	mm	SAND	42. %
D_{60} = 8.0	mm	FINES	10. %
C_U = 100.			
C_C = 0.28			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B029 SAMPLE:
DEPTH: 0.3 - 0.8 m
TECHNICIAN: JB DATE: 89.05.03



REMARKS:

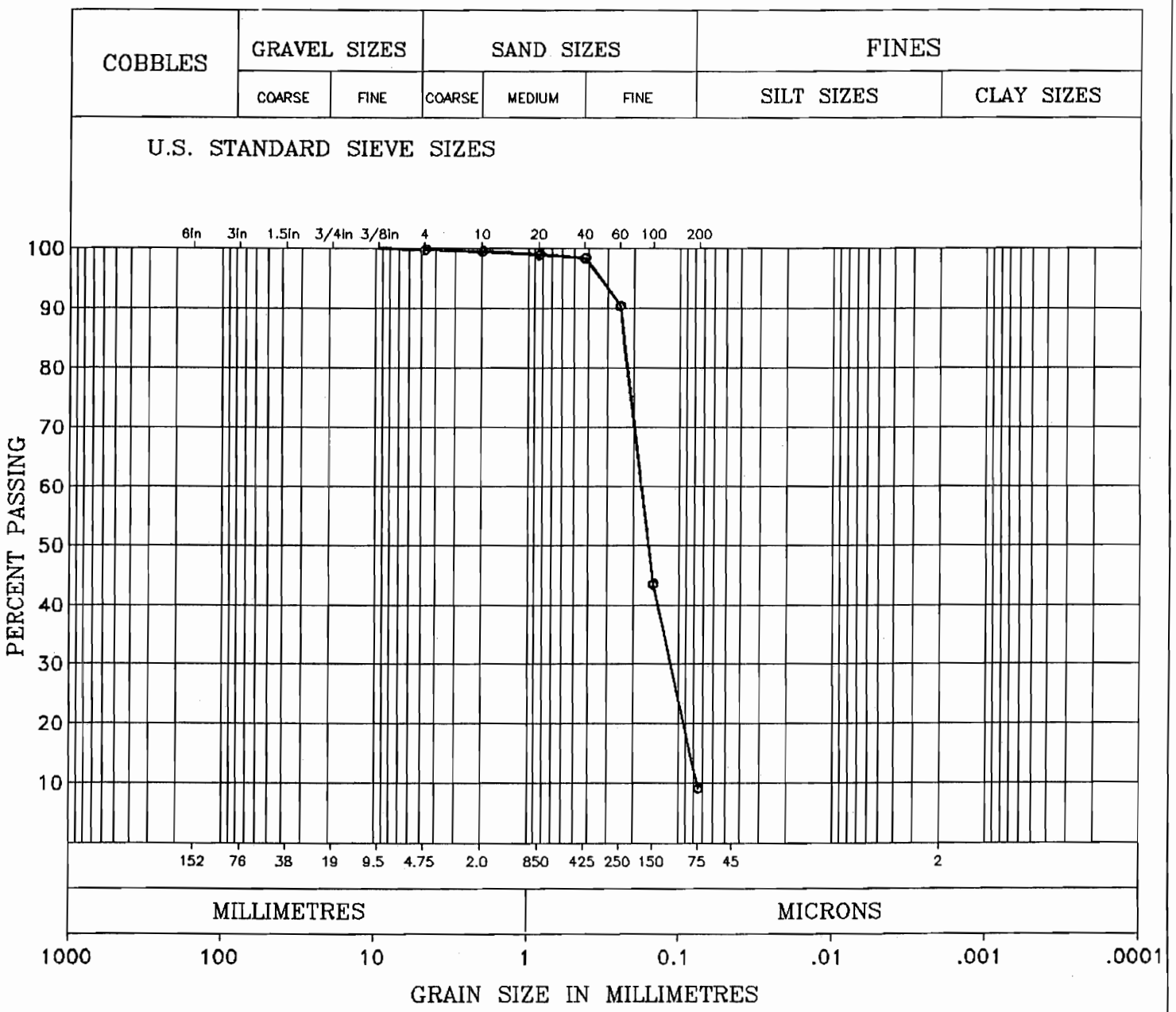
SUMMARY

D_{10} =	mm	GRAVEL	42. %
D_{30} = 0.55	mm	SAND	42. %
D_{60} = 5.3	mm	FINES	16. %
C_U =			
C_C =			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B029 SAMPLE:
DEPTH: 0.8 - 1.5 m
TECHNICIAN: JB DATE: 89.05.03



REMARKS: FINE GRAIN SAND

DUE TO SIZE OF SAMPLE ERROR IS 5.6%

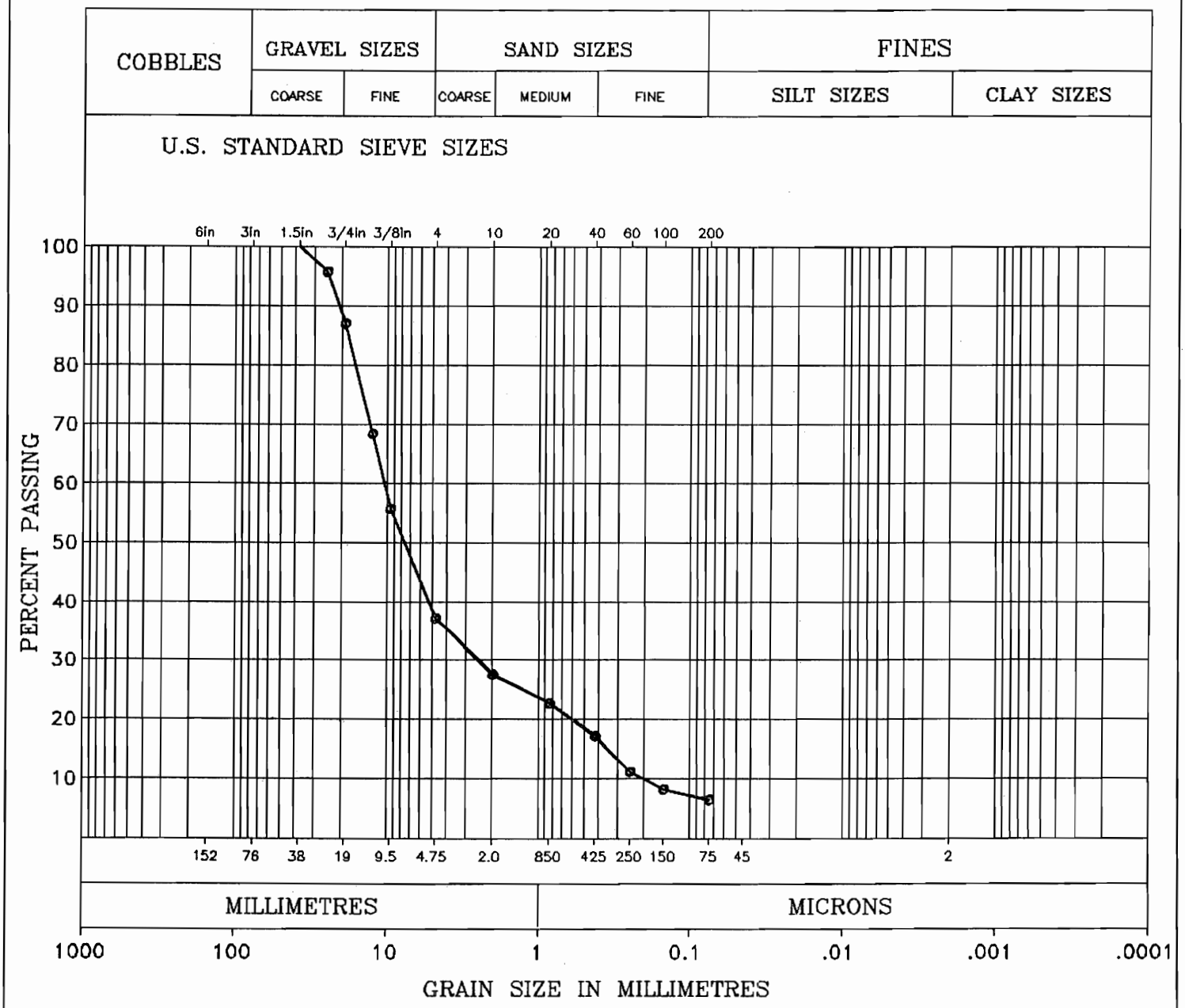
SUMMARY

D_{10} = 0.077	mm	GRAVEL	0. %
D_{30} = 0.12	mm	SAND	91. %
D_{60} = 0.19	mm	FINES	9. %
C_U = 2.4			
C_C = 1.0			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B029 SAMPLE:
DEPTH: 2.8 - 3.1 m
TECHNICIAN: FP DATE: 89.05.03



REMARKS:

SUMMARY

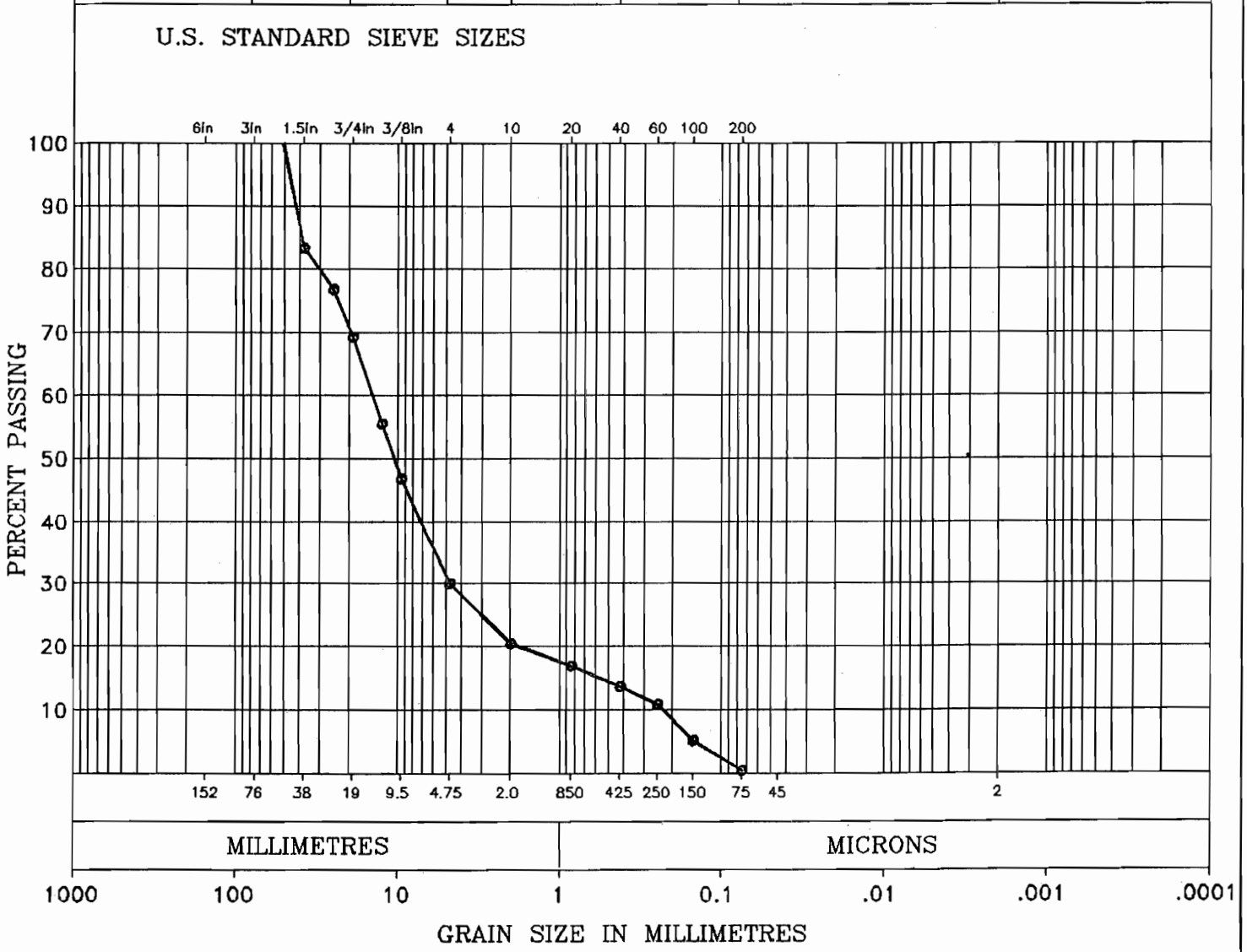
D_{10} = 0.21	mm	GRAVEL	63. %
D_{30} = 2.7	mm	SAND	31. %
D_{60} = 11.	mm	FINES	6. %
C_U = 50.			
C_C = 3.4			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B031 SAMPLE:
DEPTH: 1.7 - 2.2 m
TECHNICIAN: JB DATE: 89.05.03

COBBLES	GRAVEL SIZES		SAND SIZES			FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES



REMARKS: SANDY GRAVEL

NOTE: 3% ERROR IN SIEVE

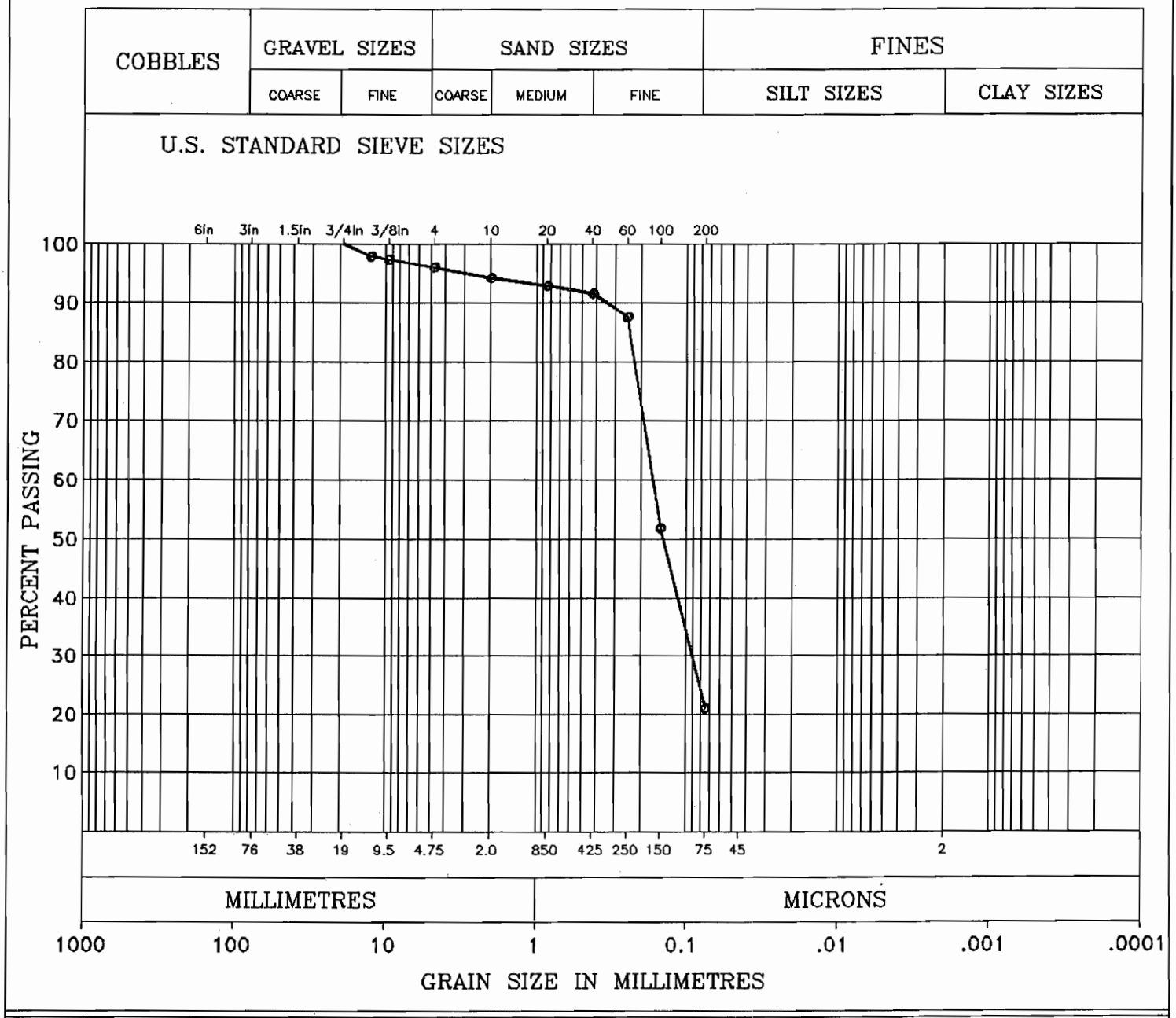
SUMMARY

D_{10} = 0.24	mm	GRAVEL	69 %
D_{30} = 4.8	mm	SAND	28 %
D_{60} = 15.	mm	FINES	3 %
C_U = 62.			
C_C = 6.6			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B032 SAMPLE:
DEPTH: 0.3 - 0.9 m
TECHNICIAN: FP DATE: 89.04.11



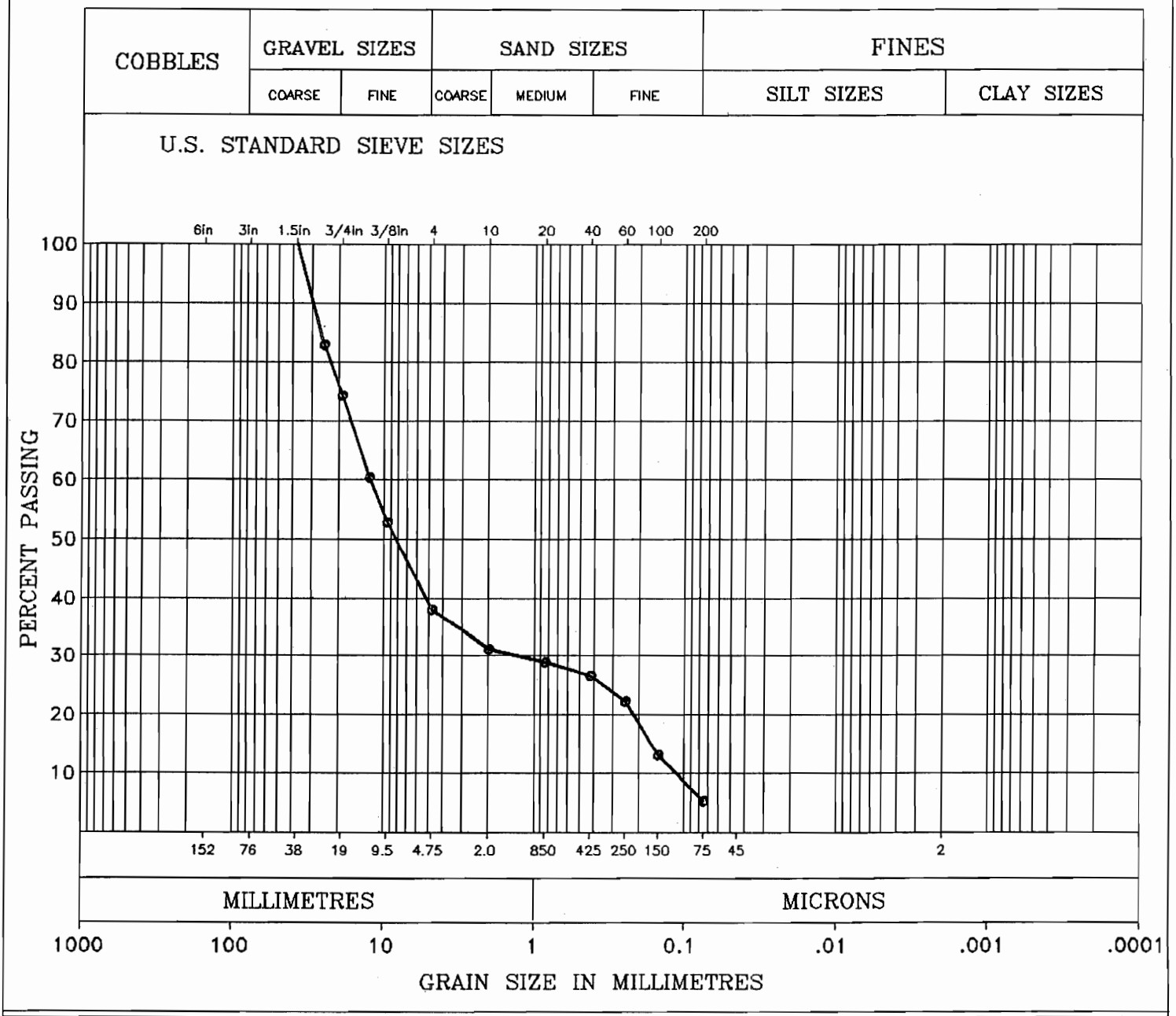
REMARKS: FINE GRAINED SILTY SAND, OCCASIONAL GRAVEL SIZES

SUMMARY			
D_{10} =	mm	GRAVEL	4. %
D_{30} = 0.097	mm	SAND	75. %
D_{60} = 0.17	mm	FINES	21. %
C_U =			
C_C =			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B032 SAMPLE:
DEPTH: 1.2 - 1.8 m
TECHNICIAN: FP DATE: 89.04.11



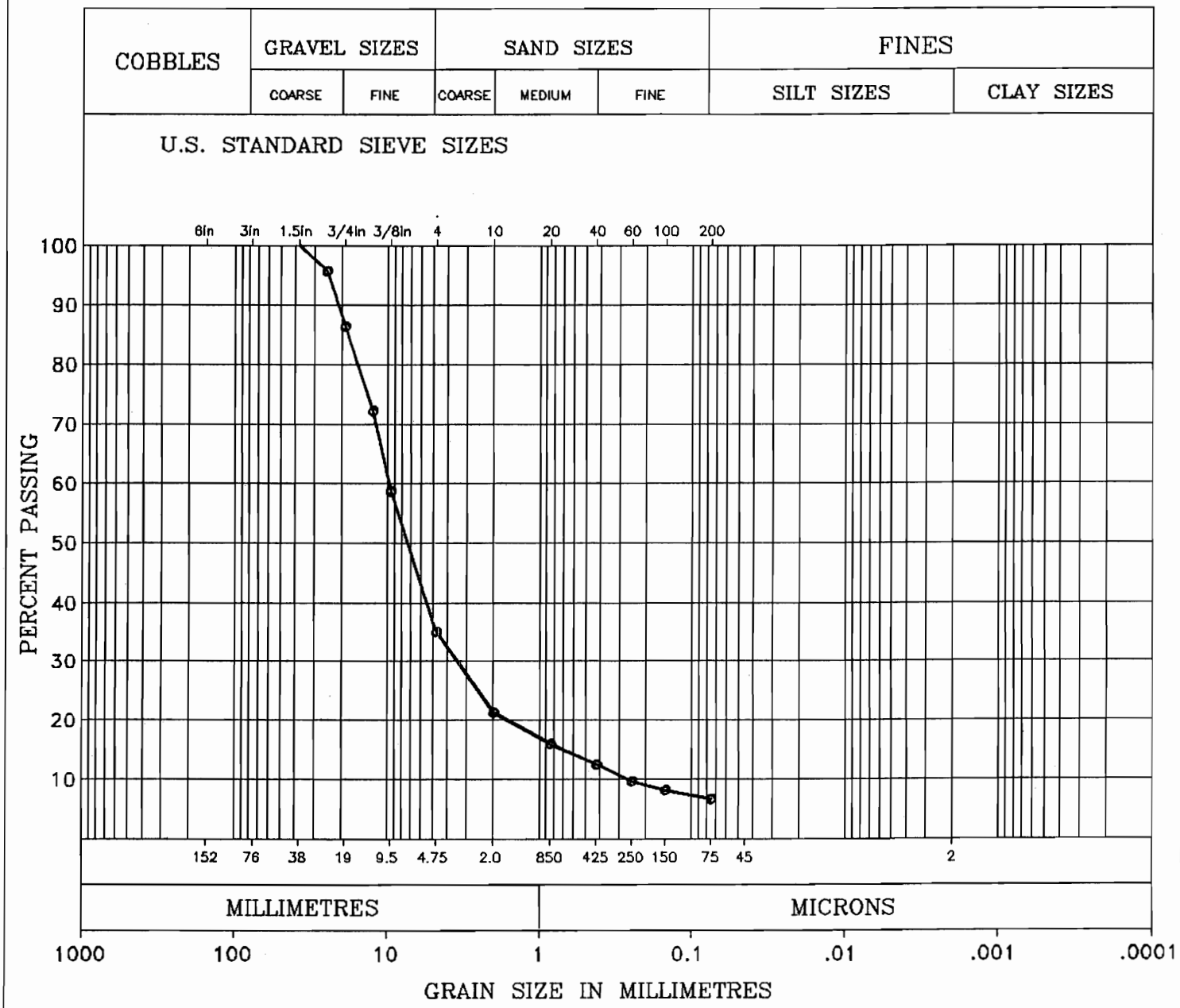
REMARKS: SANDY GRAVEL, POORLY GRADED

SUMMARY			
D_{10} = 0.12	mm	GRAVEL	62. %
D_{30} = 1.5	mm	SAND	33. %
D_{60} = 12.	mm	FINES	5. %
C_U = 100.			
C_C = 1.5			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B033 SAMPLE:
DEPTH: 0.6 - 1.2 m
TECHNICIAN: FP DATE: 89.05.03



REMARKS:

SUMMARY

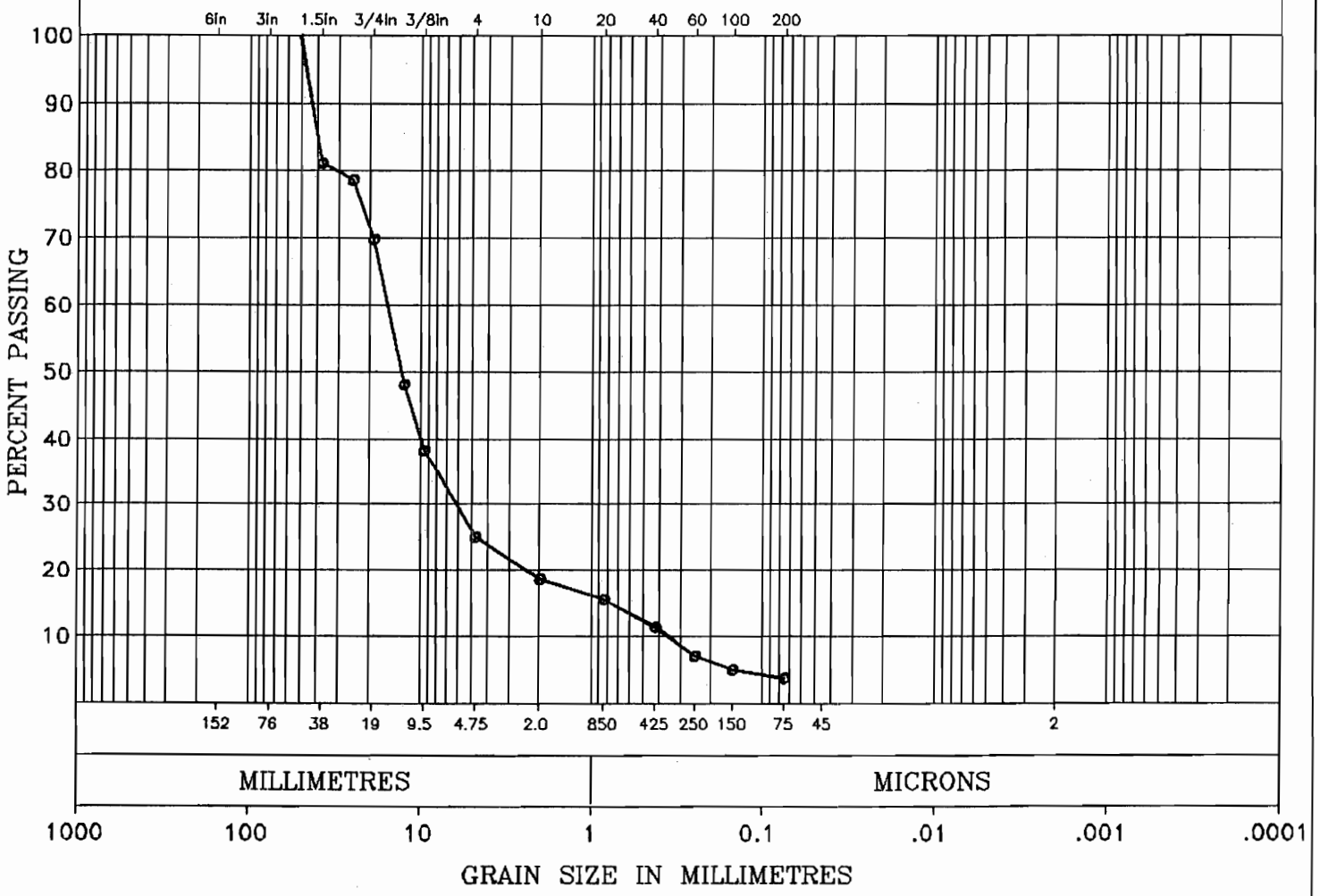
D_{10} = 0.27	mm	GRAVEL	65. %
D_{30} = 3.8	mm	SAND	28. %
D_{60} = 9.8	mm	FINES	7. %
C_U = 36.			
C_C = 5.3			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: B034 SAMPLE:
DEPTH: 1.0 - 1.5 m
TECHNICIAN: JB DATE: 89.05.03

COBBLES	GRAVEL SIZES		SAND SIZES			FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES



REMARKS:

SUMMARY

D_{10} = 0.37	mm	GRAVEL	75. %
D_{30} = 6.6	mm	SAND	21. %
D_{60} = 16.	mm	FINES	4. %
C_U = 43.			
C_C = 7.2			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 155-S
HOLE: SAMPLE: STOCKPILE
DEPTH: N/A m
TECHNICIAN: FP DATE: 89.05.03

APPENDIX D
Photographs

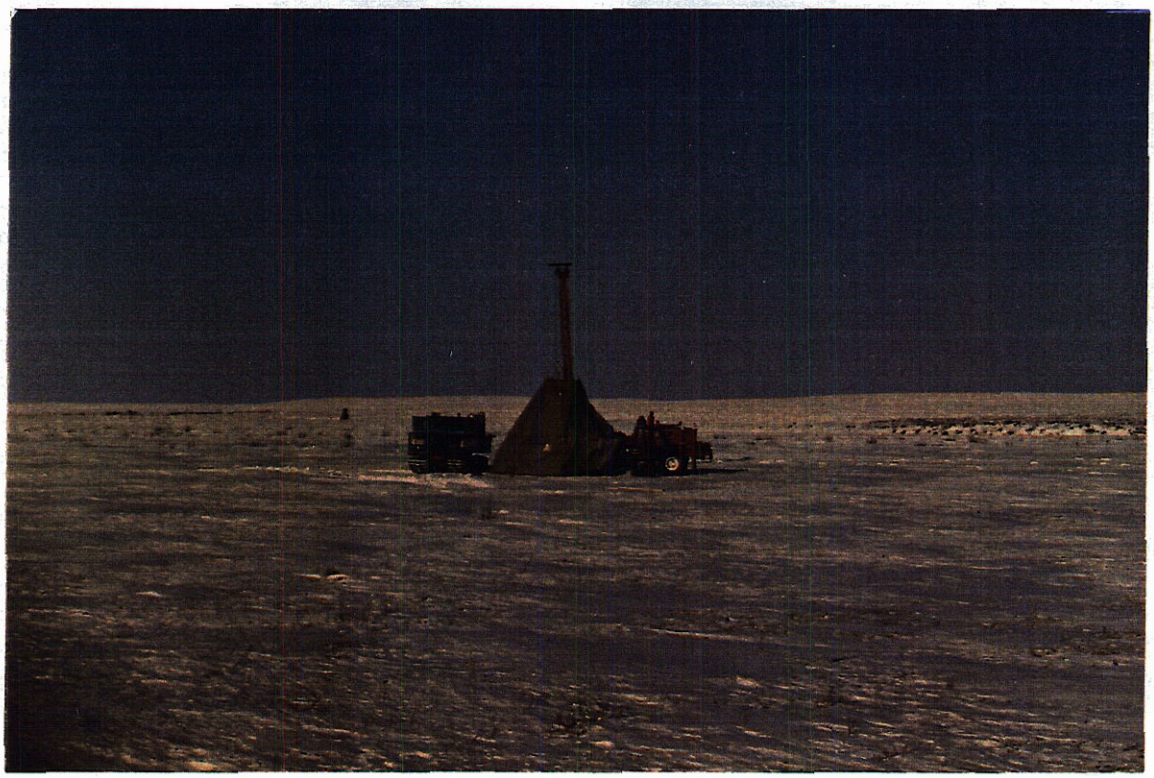


PHOTO 1:

Nodwell personnel transporter and CME 750 set up for cold weather work.

PHOTO 2:

CME 750 drill-rig in operation.

PHOTO 3:

CRREL core immediately after extrusion.

PHOTO 4:

CRREL core barrel.

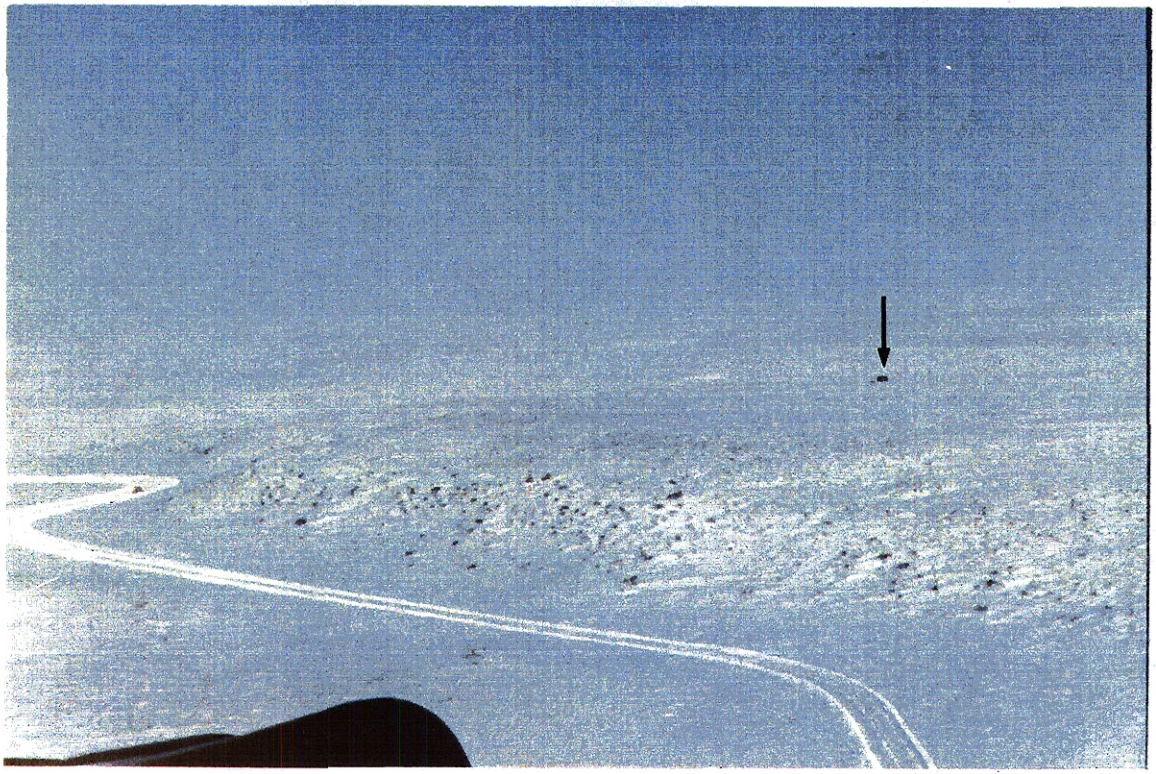


PHOTO 5:

Aerial view of the 155 South Area B. Access road adjacent to flat kame terrace with CME 750 drill in background.

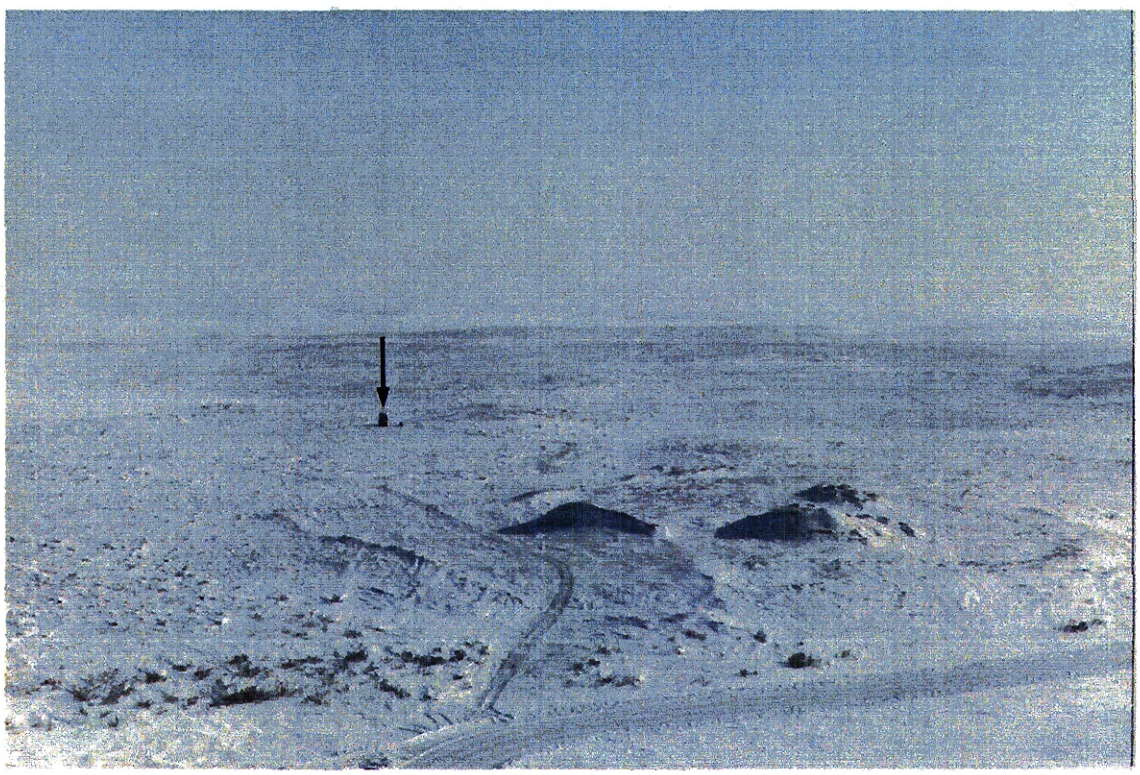
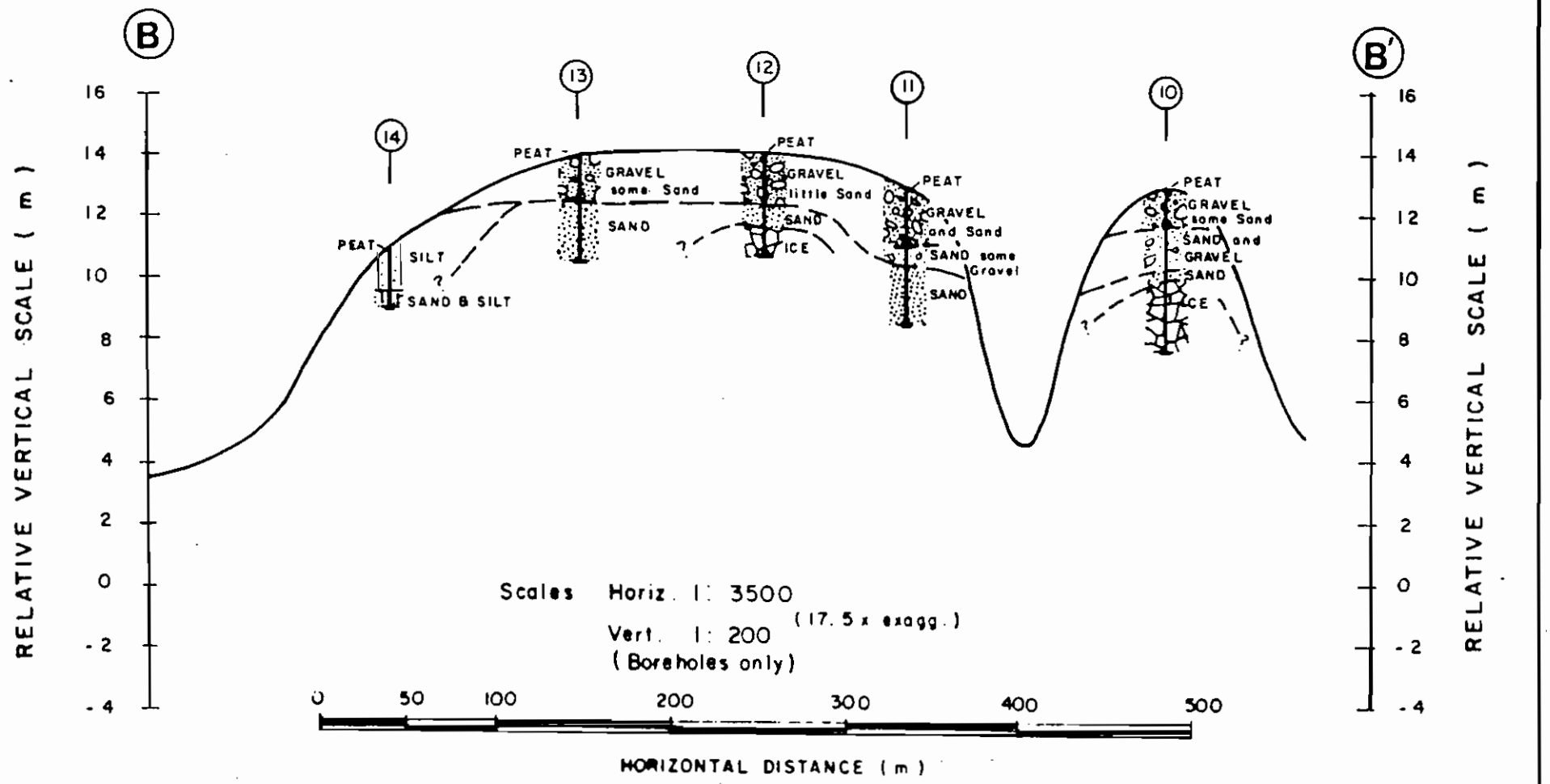


PHOTO 6:

Drilling on Area A with stockpile of granular material in foreground.

APPENDIX E

Cross-Sections from 1987b HBT Report



Note: Vertical profile is schematic only.
Topography and relative elevations
of boreholes are unknown

COMMUNITY GRANULAR MANAGEMENT PLAN
TUKTOYAKTUK , NWT

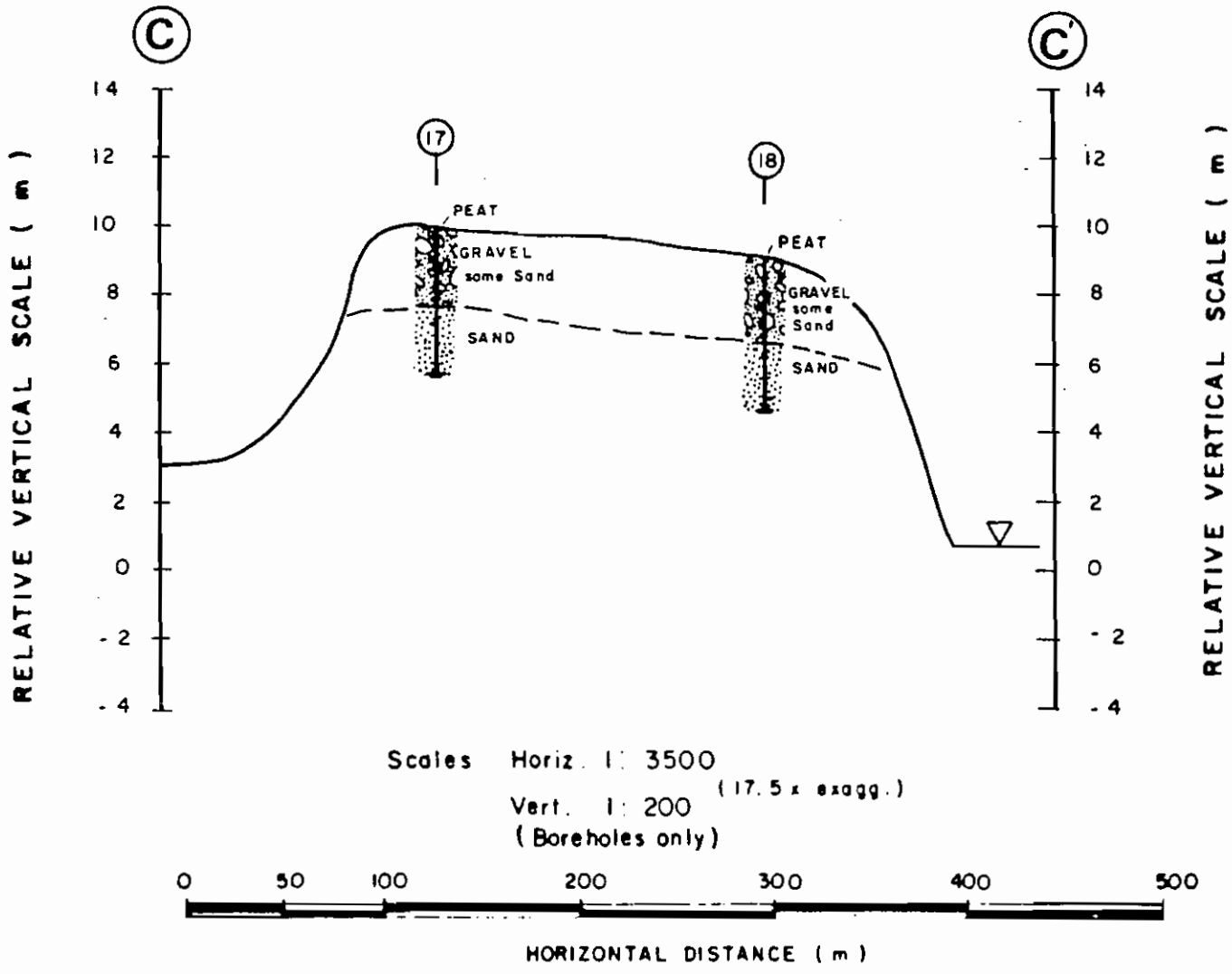
Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

DEPOSIT 155 SOUTH
SCHEMATIC GEOLOGIC SECTION B - B'

CG 14096

FIGURE 12

HT84-82/03



Note: Vertical profile is schematic only.
Topography and relative elevations of boreholes are unknown

COMMUNITY GRANULAR MANAGEMENT PLAN
TUKTOYAKTUK, NWT

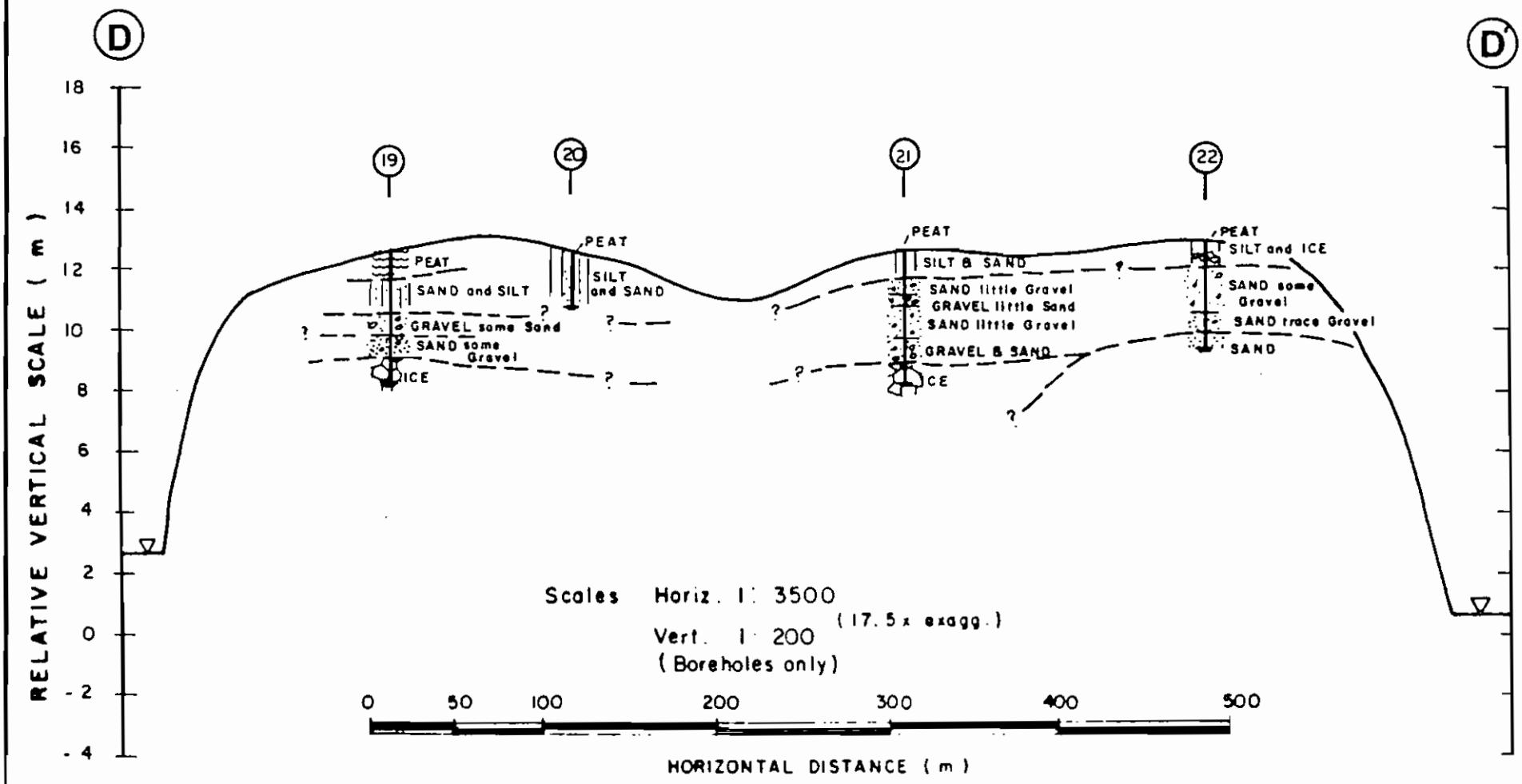
Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

DEPOSIT 155 SOUTH
SCHEMATIC GEOLOGIC SECTION C - C'

CG 14096

FIGURE 13

HTB4-82/03



Note: Vertical profile is schematic only.
Topography and relative elevations of boreholes are unknown

COMMUNITY GRANULAR MANAGEMENT PLAN
TUKTOYAKTUK , NWT

Hardy BBT Limited

DEPOSIT 155 SOUTH
SCHEMATIC GEOLOGIC SECTION D - D'

CG14096

FIGURE 14