GEOTECHNICAL INVESTIGATION OF POTENTIAL SAND AND GRAVEL RESERVES
INUVIALUIT SETTLEMENT REGION
I407 (CARIBOU HILLS) DEPOSIT
INUVIK, NORTHWEST TERRITORIES

Hardy BBT Limited

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Prepared for:

Indian and Northern Affairs Canada

Prepared by:

Hardy BBT Limited

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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 1989 geotechnical investigations at the I407 (Caribou Hills) Site, which had previously been identified as a potential source of granular material for the community of Inuvik.

A field drilling program was carried out at the I407 (Caribou Hills) Site to delineate areas containing potentially extractable granular materials. Laboratory and office studies followed the drilling program to establish the suitability of granular materials for various uses, to quantify potentially extractable volumes, and to discuss development considerations.

A proven volume of 655 500 m^3 of Classes 2 to 4 granular materials was delineated during this investigation, with corresponding estimates of 3 556 000 m^3 and 9 055 000 m^3 for probable and prospective reserves. The majority of the materials in each reserve subclass was Class 2 with proven reserves of 584 000 m^3 granular with lesser amounts of Classes 3 and 4 (55 000 m^3 and 16 000 m^3 proven reserves respectively) noted in Area A.

The volumes of proven reserves for Classes 2 and 4 are well in excess of the limited known requirements for these materials for the Inuvik region, up until at least the year 2006 (EBA, 1987). For Class 3, the proven reserves represent less than half of the projected demand. However, the probable reserves of 228 000 m^3 noted are well in excess of the 127 700 m^3 projected requirements for this category. In addition, proven volumes of low quality Class 2 materials could be used to augment the Class 3 reserves. Using Class 2 material as Class 3 should be discouraged. It is likely that once pit development is underway, further quantities of Class 3 material will be confirmed. Although no Class 1 material was identified in this deposit, it is suggested that by further processing of some Class 2 reserves, the limited demand (200 m^3) for Class 1 material will be met.

Development should proceed from Area B to A to C, consecutively. A winter extraction operation is considered to be the most appropriate. Commonly the uppermost 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 the I407 (Caribou Hills) deposit near Inuvik, 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. A-7134-8-0053/01ST, 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 to the communities of Inuvik, Aklavik, Tuktoyaktuk, Sachs Harbour, Paulatuk and Holman. In March, 1989, HBT submitted a proposed program. 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 is the report on the investigation of the I407 Site which is located approximately 61 km to the north of Inuvik, as shown on the Site Location Plan, Figure 2. A Glossary of Terms has been included at the end of the text immediately following the References.

1.2 PREVIOUS WORK

The initial identification of the I407 (Caribou Hills) deposit area 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 this source should be recommended for continued development on an increasing scale as the demand for granular material increases. A Hardy Associates (1978) Ltd. report, completed in 1986, provided a summary of granular resource potential in the Lower Mackenzie Valley, including the I407 deposit. The Hardy report designated I407 as borrow source number 2.13.

The present plan of investigations is based primarily upon the findings and recommendations presented in two recently completed studies for these six communities (EBA Engineering Consultants Ltd., 1987; Hardy BBT Limited, 1988). These studies determined the 20-year demand for granular materials and identified known granular sources available to each of the communities. The Hardy BBT study recommended a strategy for the reservation and development of supplies of sand and gravel on Inuvialuit lands for community use based upon the supply and demand data presented in the EBA report.

The geotechnical investigation plan prepared by HBT in March, 1989, noted that the I407 deposits, along with the Ya Ya Lakes site would likely continue to meet most local granular requirements for the Inuvik area for the next 20 years. In order to properly plan for the development of this site, it was recognized that further exploratory work would be required.

The reference section of this report lists previous studies relating to the I407 (Caribou Hills) Site.

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 I407 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 list 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 investigations 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 base of field operations in Inuvik were normally made by (206B) helicopter. A detailed summary of the field operations is included in Appendix B. Typical winter field operations are shown in photos 1 and 2, Appendix D.

Drilling or moving was maintained 24 hours per day in two 12-hour shifts. Sixteen boreholes were drilled using 150 or 200 mm diameter solid-stem flight augers. A 150 mm diameter CRREL core barrel was used to obtain undisturbed samples from four of the boreholes. Auger cuttings and core runs were visually logged on site (see photos 3 and 4, Appendix D).

Samples of representative materials were taken at regular intervals from the auger returns, 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 at Inuvik, Northwest Territories. These ice core samples were for use in a separate INAC cooperative research program with the Geological Survey of Canada.

Boreholes were located in three potential granular resource areas, designated A, B, and C of the I407 deposit. Areas A and B comprise the main portion of this source and were tested with 15 boreholes. Area C formed a smaller source area to the west of the site, and included just one borehole. Boreholes were extended to depths ranging between 3.3 and 9.8 m. Table 1 presents a summary of the field work undertaken including the distribution of boreholes depths and number of samples.

Borehole logs are presented in Appendix A, with locations shown on Figure 3.

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. ± 1m). 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 plant 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 samples in the HBT Yellowknife soils laboratory. This testing included: grain size analyses, moisture content determinations, and petrographic analyses.

One combined sample from Borehole I407B016 was forwarded to the HBT Calgary materials laboratory for concrete aggregate suitability testing. This work included a Los Angeles Abrasion test, a sulphate soundness determination, a specific gravity test, a water absorption test and an alkali-aggregate reactivity test. Laboratory test results are presented in Appendix C.

TABLE 1

SOURCE I407: SUMMARY OF FIELD WORK

AREA	BOREHOLE NUMBER	DEPTH OF HOLE (m)	NUMBER OF SAMPLE	
			GRAB	CORE
	*(12)	*(79.0)	*(24)	*(8)
A	I407B001	6.7	2	0
	I407B002	7.9	2	0
	I407B003	8.2	2	4
	I407B004	7.1	2	0
	I407B005	7.0	3	0
	I407B006	3.3	1	0
	I407B007	5.8	2	0
	I407B008	6.3	2	0
	I407B009	5.3	2	0
	I407B010	5.6	2	0
	I407B011	9.8	2	4
	I407B012	6.0	2	0
	*(3)	*(17.0)	*(6)	*(13)
B	I407B013	9.1	2	13
	I407B014	4.0	2	0
	I407B015	3.9	2	0
	*(1)	*(8.8)	*(0)	*(13)
C	I407B016	8.8	0	13

*( ) Totals

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Table 2 presents a summary of the 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.

On the borehole logs, a Modified Unified Soil Classification system symbol is used to identify each soil unit and any significant changes within each unit. The 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, whether silt or clay, has not been determined, this 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 I407 (Caribou Hills) Site, as shown on Figure 2, is situated about 61 km to the northwest of Inuvik at the northwestern end of the Caribou Hills, on the eastern edge of the MacKenzie Delta. The area investigated during 1989 was approximately 1.7 km in length and 0.8 km wide, and extends over a vertical range of more than 60 m.

The Caribou Hills form a rolling upland area consisting primarily of poorly indurated conglomerates, quartzitic sandstones and mudstones of Tertiary age. The I407 Site lies on a terrace remnant on the western flank of the Caribou Hills, where the fault controlled escarpment has been dissected by numerous small creeks. The terrace deposits at the site are believed to be derived largely from the adjacent Caribou Hills uplands. Photos 5 and 6 in Appendix D illustrate the topography of the site. Figure 3 shows the deposit outlines and borehole locations from a previous study by Ripley, Klohn, Leonoff (RKL, 1972). Drilling

TABLE 2

TEST SPECIFICATIONS AND PURPOSE

	Test Designation	Method	Number Done	Rationale For Test
Geotech-nical	Soil Moisture Content	ASTM D 2216	41	Basic material property; can indicate thaw pond potential and material workability
	Particle-Size Distribution	ASTM D 422 with sample preparation by ASTM D 421	30	Indicator of whether deposit meets gradation criteria for various uses (i.e. concrete); determines frost susceptibility
Lithology	Petrographic Analysis	ASTM C 295 - 85 CSA Can3 - A23.1 - M77, (Clause 5.5) CSA A23.2 - 15A (Appendix B)	4	Identifies particle types; specifically, determines any deleterious materials
Concrete Aggregate Suitability Analysis	Bulk Specific Gravity and Absorption	ASTM C 127 - C128	1	Minimum specific gravity required for some uses (eg. concrete, riprap); absorption results indicate susceptibility to freeze-thaw degradation
	Los Angeles Abrasion	CSA A 23.2-M77-16A and 17A	1	Determines resistance to physical wear
	Sulphate Soundness	CSA A23.2-M77-9A	1	Evaluates resistance to weathering
	Alkali-Aggregate Reactivity	ASTM C 289	5	Determines potential for adverse reactions between cement and aggregate

for the present 1989 program concentrated almost exclusively on the largest undrilled deposit identified by the RKL study. This deposit was located entirely on the upland plateau level and drilling revealed apparently substantially thinner granular reserves than occur in outcrop along the edge of the plateau. One explanation for this apparent thinning of granular deposits is the development of substantial ice-rich zones in the less well-drained portions of the deposit inland from the plateau edge. In effect, there may be greater thicknesses of granular material in the 1989 drilling area, but several metres of massive ice was taken as the base of exploration.

4.0 DESCRIPTION OF MATERIALS

4.1 GENERAL

The following section provides detailed descriptions for each of the principal material types identified at the I407 (Caribou Hills) Site, including the following:

- Surficial Peat
- Gravelly Sands
- Sandy Gravels
- Clays
- Massive Ice

Five schematic geological cross-sections; A-A' to E-E' illustrating the findings of the field investigation are presented in Figures 6 to 10. Cross-section locations are shown on Figure 3.

In summary, the stratigraphy of the I407 Site consists of a consistent but relatively thin peat layer. Underlying the peat, the predominant granular material throughout the deposit is gravelly sand, but locally, sandy gravels are present. Occasional relatively thin layers of low plastic clay are present, normally below the granular materials, and massive ice was encountered at depth in approximately one-half of the holes.

4.2 SURFICIAL PEAT

The field investigation encountered a thin, 0.2 to 0.4 m, layer of peat throughout Areas A and B. The single hole, I407B016 in Area C revealed granular material at ground surface.

Figure 4 presents the peat overburden thickness at each borehole location in Areas A and B.

4.3 GRAVELLY SANDS

The occurrences of gravelly sand in each borehole are summarized in Table 3, which includes the modified Unified Soil Classification (U.S.C.) designation for the material, along with the depth limits at which it was encountered.

Gravelly sands were encountered in all sixteen boreholes, and include a range of sand classification; well graded and poorly graded clean sands (SW, SP), as well as sands with a significant portion of unspecified fines type (SF). Locally there are a few layers of uniform medium - grained sand with only a trace of gravel. These layers are relatively scarce and poorly defined, and so have been included within this section. The thicknesses of these sediments ranged between 1.4 and

TABLE 3

SOURCE I407: SUMMARY OF GRAVELLY SAND DEPOSITS

AREA	BOREHOLE NUMBER	**MODIFIED UNIFIED SOIL CLASSIFICATION	DEPTHS OF SANDY GRAVEL DEPOSITS	
			From	To (m)
A	I407B001	SW-SF	2.5	6.0
	I407B002	SP-SF	0.3	7.5
	I407B003	SP-SF	0.4	5.5
	I407B004	SW	2.8	3.7
	I407B005	SP	0.4	4.3
	I407B005	SW-SF	4.3	6.9
	I407B006	SW	1.9	*3.3
	I407B007	SP-SF	0.2	5.7
	I407B008	SW-SF	0.3	6.2
	I407B009	SF	0.2	2.2
	I407B010	SW-SF	0.4	5.4
	I407B011	SW-SF	0.3	3.3
	I407B011	SF	3.3	5.4
	I407B012	SP-SF	0.2	5.4
B	I407B013	SP	0.2	3.8
	I407B014	SP	0.2	3.7
	I407B015	SP	0.2	3.6
C	I407B016	SP-SW-SF	0.0	2.6
	I407B016	SW-SF	3.3	4.1
	I407B016	SP-SF	4.8	*8.8

* Deposit only partially penetrated.

** These symbols include both laboratory-data-supported classifications and estimated classifications

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7.2 m with an approximate average value of 4.7 m. In two of the holes, the total thickness of the sand unit was not penetrated.

The individual grain size distribution curves are presented in Appendix C, and separate bands representing the gravelly sands and the four samples of the uniform medium sand facies are shown in the composite envelope in Figure 11. Excluding the two anomalous samples shown by the dashed lines on Figure 11, the 22 samples of the predominantly gravelly sand facies fall within a narrow band. Table 4 provides a summary of the percentages of gravel, sand and fines, as well as moisture contents for all samples tested.

Table 5 presents the results of concrete aggregate suitability tests on a combined sample of sand from Borehole I407B016, along with values of Petrographic Numbers, PN, for four samples.

All of the above data have been integrated with that from the previous study (RKL, 1972) to provide an evaluation of the quality classification for the gravelly sand as recorded on the borehole logs. Figure 5 is a plan of the deposit area delineating the interpreted extent and thickness of the different quality classes of granular materials.

As noted on the borehole logs, these gravelly sand materials fall within Classes 2 to 4 quality for granular materials.

4.4 SANDY GRAVELS

The occurrences of sandy gravels have not been tabulated separately as they were found in only four of the boreholes as follows:

TABLE 4

SOURCE I407: COMPONENT PERCENTAGES OF GRAVELLY SAND

AREA	BOREHOLE NUMBER	SAMPLE INTERVAL (m)	COMPONENT PERCENTAGES			MOISTURE CONTENT (%)
			%GRAVEL	%SAND	%FINES	
A	I407B002	1.7 – 2.2	25	69	6	8
	I407B002	4.2 – 4.7	23	69	8	10
	I407B003	0.9 – 1.7	15	77	8	6
	I407B003	4.7 – 5.2	5	89	9	24
	I407B005	1.5 – 2.1	35	62	3	9
	I407B005	4.5 – 5.0	45	49	6	5
	I407B007	1.5 – 2.1	33	59	8	7
	I407B007	4.5 – 5.0	26	67	7	8
	I407B009	1.5 – 2.1	30	45	25	20
	I407B009	4.0 – 4.5	29	65	6	30
	I407B011	1.5 – 2.1	10	81	9	15
	I407B011	4.5 – 5.0	3	78	19	27
	I407B012	1.5 – 2.1	19	69	12	11
	I407B012	4.3 – 4.8	28	66	6	8
B	I407B013	2.0 – 2.7	30	66	4	8
	I407B014	1.5 – 2.1	19	78	3	5
	I407B015	1.5 – 2.1	30	67	3	6
C	I407B016	0.3 – 1.0	19	78	3	3
	I407B016	1.0 – 1.5	30	56	14	5
	I407B016	1.5 – 2.1	33	64	3	9
	I407B016	2.1 – 2.6	33	60	7	5
	I407B016	3.3 – 4.1	42	49	9	14
	I407B016	4.8 – 5.6	36	58	6	15
	I407B016	5.6 – 6.3	27	61	12	7
	I407B016	6.3 – 7.1	39	51	10	8
	I407B016	7.1 – 7.8	23	67	10	14
	I407B016	7.8 – 8.1	40	56	4	8
	I407B016	8.1 – 8.7	3	89	8	25

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TABLE 5

SUMMARY OF CONCRETE AGGREGATE SUITABILITY DATA
SOURCE I407 (CARIBU HILLS)

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 I407B016	19.5	2.59	1.11	3.11	DELETERIOUS	DELETERIOUS	136
COMBINED SAMPLE FROM I407B002							132
I407B005 1.5 – 2.1 m							171
I407B005 4.7 –5.2 m							147

Borehole	Depth (m)
I407B001	0.3 - 2.5
I407B004	0.3 - 2.8 3.7 - 6.5
I407B006	0.2 - 1.9
I407B016	2.6 - 3.3 4.1 - 4.8

In three of the holes, gravel was found immediately below the surficial peat and overlying the gravelly sand and in the fourth, as two separate sub-layers within the gravelly sand unit.

The first four samples from Area A were all identified as well-graded clean gravels (GW). The other two samples from Borehole I407B016 in Area C, varied between well and poorly graded clean gravel (GW-GP) and gravel with fines (GF). No gravel deposits were found in Area B.

Gradings were obtained for only the two samples from I407B016. The component percentages of gravel, sand and fines respectively, for the upper layer are 49, 44, and 7, and for the lower 65, 31 and 4. The individual particle size-distribution curves are presented in Appendix C. These sandy gravels are all considered to be Class 2 granular materials.

4.5 CLAYS

Frozen silty, sandy, low to medium plastic clays, were encountered below the granular deposits in ten of the 15 boreholes in Areas A and B. No clay was encountered in Area C. In three instances, the clay layer was underlain by massive ice, and here clay thicknesses were 0.2, 0.5 and 0.2 m, respectively. Elsewhere, the clay was not penetrated.

4.6 MASSIVE ICE

Massive ice generally containing traces of silt and clay was encountered in eight of the 15 boreholes in Areas A and B. Massive ice was not detected to a depth of 8.8 m in the single borehole of Area C. In four of the holes encountering massive ice, the ice underlies a granular material, where as in the other four, the ice is associated with a clay layer. In I407B003, a 1.1 m thick massive ice layer is both underlain and overlain by silty clay. In the other seven boreholes, ice extended below the maximum depth of the hole. In two holes, I407B011 and I407B013, ice was cored for lengths of 4.2 and 4.5 m, respectively to obtain undisturbed samples for research purposes.

5.0 CLASSIFICATION OF GRANULAR MATERIALS

The quality of granular materials encountered during the field program has 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 6. In

TABLE 6

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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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 maximum 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 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 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 more 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 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 poorly graded granular soils with a substantial fines content of more than 20%. There are 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

The three separate areas within the I407 (Caribou Hills) Site investigated during the 1989 field program, have been evaluated in terms of quantities and quality of granular reserves. Table 7 presents quantities of material, by quality class, for each of the three areas within this deposit. Three confidence levels of reserves are presented and defined in Table 7 including proven, probable and prospective. These confidence levels represent increasing certainty moving from prospective to proven.

TABLE 7

SOURCE I407: GRANULAR MATERIAL RESERVES

AREA	GRANULAR MATERIAL CLASS	AVERAGE THICKNESS (m)	RESERVES (m^3)		
			PROVEN (1)	PROBABLE (2)	ROSPECTIVE (3
A	2	4.2	433 000	1 981 000	3 580 000
	3	2.6	55 000	228 000	411 000
	4	3.0	16 000	68 000	123 000
B	2	3.4	82 500	441 000	441 000
C	2	8.8	69 000	838 000	4 500 000
Totals	2		584 500(89%)	3 260 000(91.5%)	8 521 000 (94%)
	3		55 000(8.5%)	228 000(6.5%)	411 000(4.5%)
	4		16 000(2.5%)	68 000(2%)	123 000(1.5%)
	2+3+4		655 500	3 556 000	9 055 000

I407.T7

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.

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Proven quantities of granular borrow within the I407 deposit are calculated to be about 655 500 m^3 of which 584 500 m^3 was assessed as Class 2 material, 55 000 m^3 as Class 3, and 16 000 m^3 as Class 4. Probable and prospective material quantities are calculated to have roughly similar proportions for these three classes, with total probable volumes of about 3 556 000 m^3 and prospective volumes of about 9 055 000 m^3.

It should be noted that while some of the materials encountered may otherwise be upgraded to meet the INAC classification criteria for consideration as Class 1 material, chert exists in sufficiently high concentrations, that if reactive, it could render the aggregates unsuitable for use with high alkali cements. More detailed testing would be required if these materials were to be developed as a concrete aggregate source, particularly in view of the poor alkali-aggregate reactivity test results (see Table 5).

The anticipated total required volumes of granular materials for the Inuvik area, excluding speculative projects, up until the year 2006 are as follows (from EBA 1977):

Class 1	200 m^3
Class 2	5 800 m^3
Class 3	127 700 m^3
Class 4	2 000 m^3

The volumes of proven reserves delineated in the present report for Classes 2, 3 and 4 were 548 500 m^3, 55 000 m^3 and 16 000 m^3 respectively, indicating that the I407 site should be readily capable of meeting the projected demand for Classes 2 and 4 materials. In the case of Class 3 requirements, the proven reserves of the present study represent some 43% of projected demand. However, the probable and projected reserves of Class 3 material are 228 000 m^3 and 411 000 m^3 respectively, well in excess of projected demand for this category. In addition, proven volumes of Class 2 materials could be used to augment the Class 3 reserves. Using Class 2 material as Class 3 is to be discouraged. It is likely that once pit development is underway, further quantities of Class 3 material wil be confirmed. On this basis it is concluded that the I407 Site should be capable of meeting the projected demand for Class 3 material.

With regard to Class 1 requirements, no suitable deposits were identified in the present study. However, by further processing of some Class 2 reserves, the limited projected demand (200 m^3) of Class 1 requirements will be met.

7.0 DEVELOPMENT CONSIDERATIONS

7.1 GENERAL DEVELOPMENT STRATEGY

None of the areas investigated within the I407 Site have massive ice at depths shallower than 4 m. A favorable combination of material types and topography appears to have generally prevented the formation of thick ice units within about 2.5 to 3 m of the ground surface. Massive ice was usually found to be restricted to sand and clay layers below 6 m depth. Throughout the site, organic deposits overlying the granular materials are 0.4 m, or less, in thickness.

The majority of materials in all three areas of the I407 deposit are Class 2. There is, therefore, no preferred order of development based solely upon granular materials quality. Accordingly, since access from the Mackenzie River will be closest to the Area B and then Areas A and C, respectively, extraction operations should reasonably begin at Area B and proceed to Areas A and C, unless Classes 3 and 4 materials are specifically required, in which case Area A might be developed earlier.

7.2 DEVELOPMENT METHODOLOGY

It is assumed that the development methodology for the I407 Site will be by winter operation with access from the Inuvik-Tuktoyaktuk ice road. A winter operation would involve ripping any shallow overburden encountered, pushing it 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.

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 the granular materials should not present major ripping problems.

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

7.3 ABANDONMENT AND RECLAMATION

Since thaw of massive ice may follow extraction of granular materials, thaw ponds during the following summer may occur in some worked areas. Ponds and small lakes are quite 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 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 I407 (Caribou Hills) Site 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 655 500 m^3 of Classes 2 to 4 granular materials was delineated during this investigation. The majority of the materials were Class 2 granular with lesser amounts of Classes 3 and 4 in Area A.

It is considered that through additional processing of Class 2 material to Class 1 quality, the proven and probable resources identified in the study should be capable of meeting the projected demand of all classes up until the year 2006.

Development should proceed from Area B to A to C, consecutively. A winter extraction operation 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

PAUL K. GLEN
90-05-30

Paul Glen, P.Eng.
Senior Project Engineer

PERMIT TO PRACTICE
HARDY BBT LIMITED
Signature
Date May 30, 1990
PERMIT NUMBER: P 4546
The Association of Professional Engineers,
Geologists and Geophysicists of Alberta

Reviewed by:

VR Jobling

Vince Jobling, P.Eng.
Engineering Geologist

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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.

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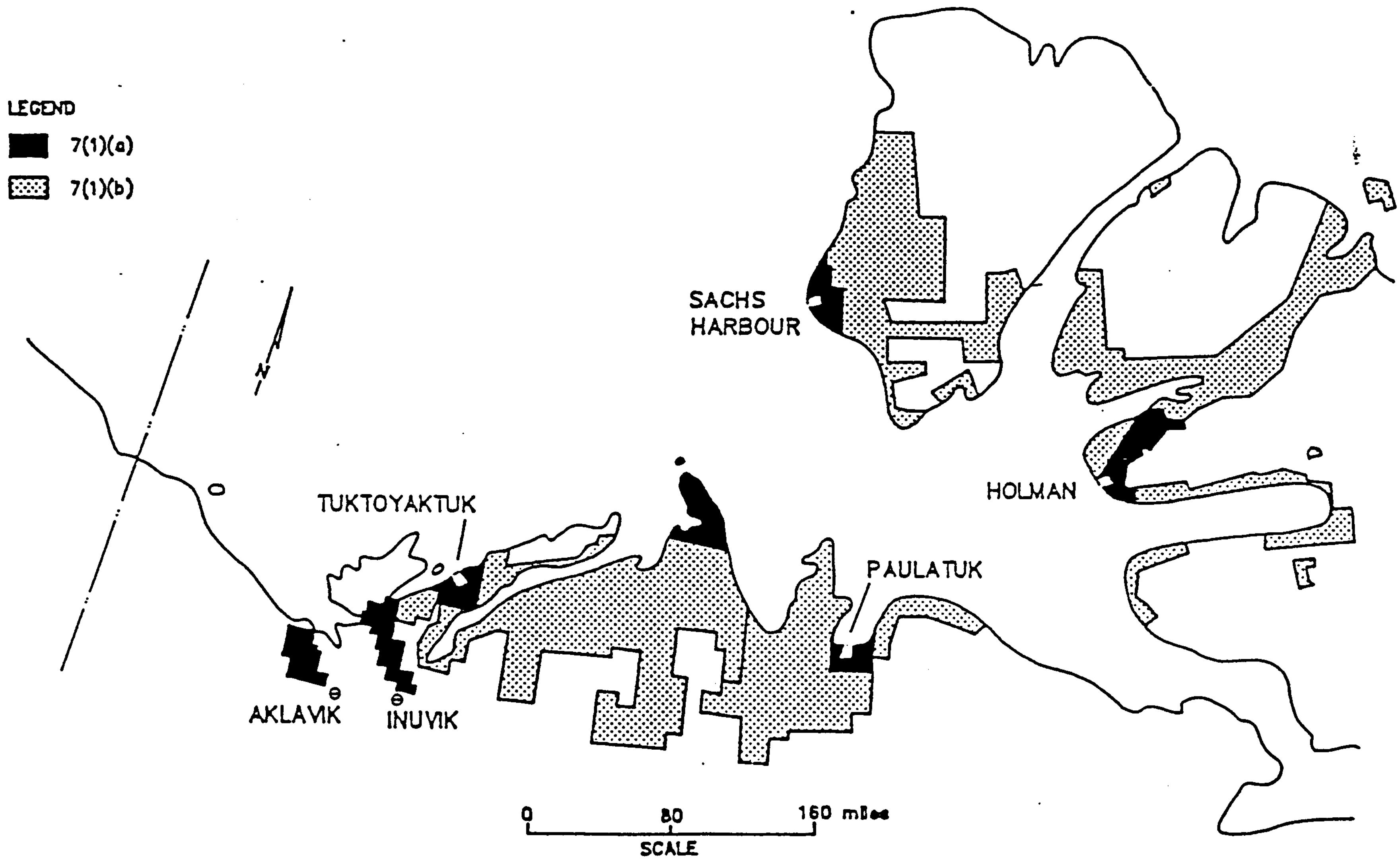

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FIGURE 1. INUVIALUIT LANDS LOCATION PLAN

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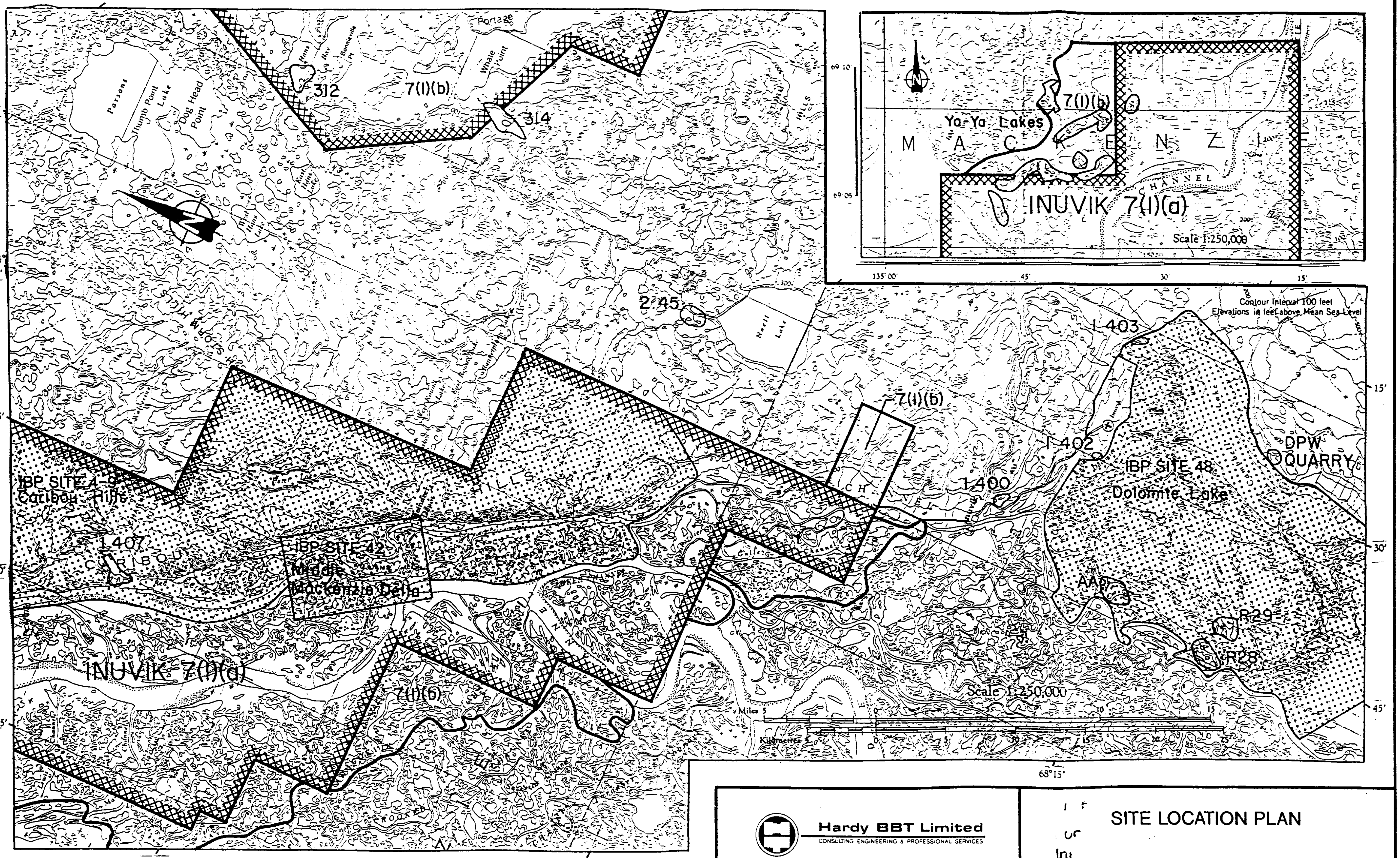

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SITE LOCATION PLAN

Figure 2

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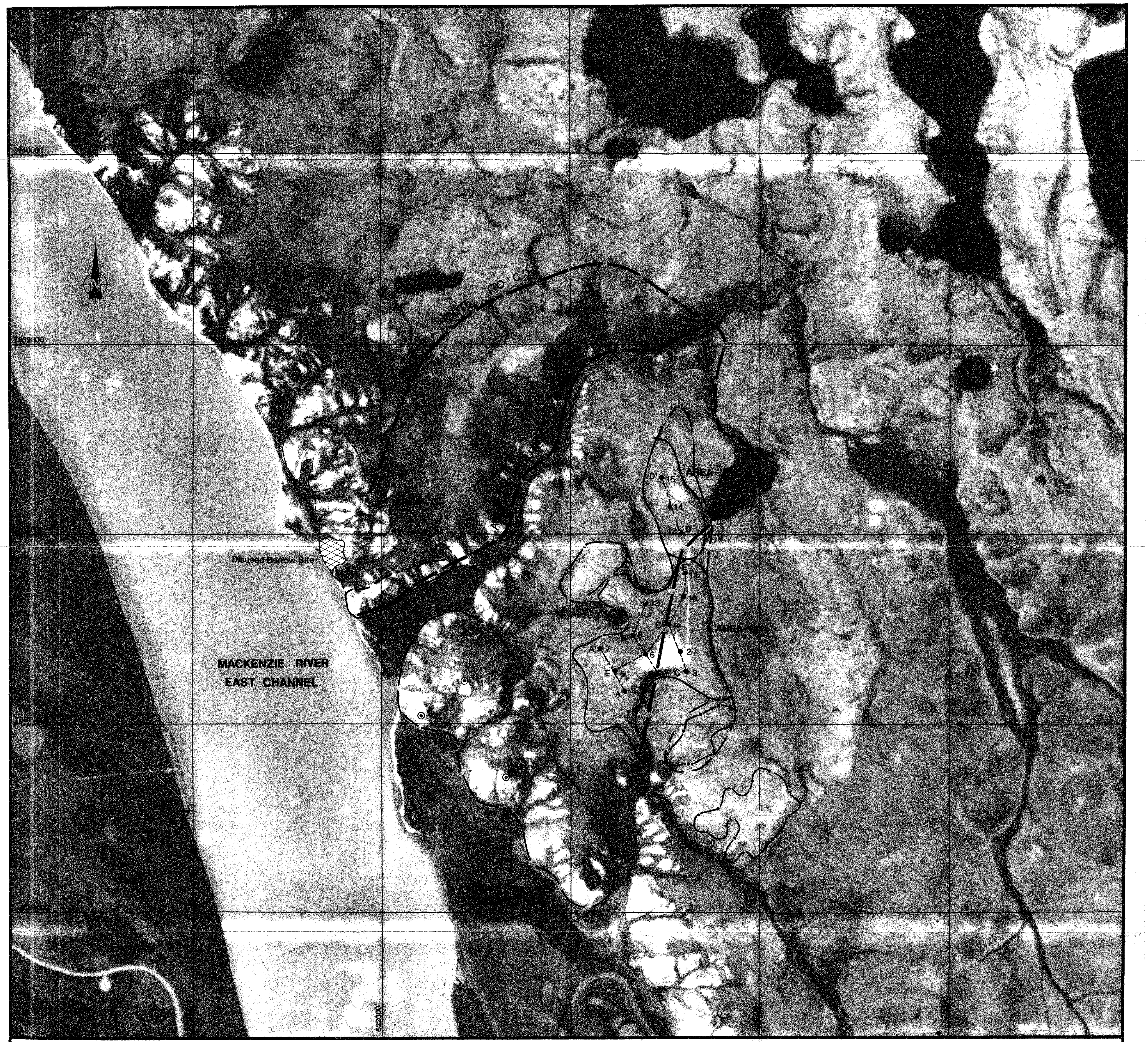

LEGEND

(—) Deposit Outlines From RKL, 1972

⊙ Boreholes RKL, 1972

● 1* Borehole location

⬭ Deposit drilled During 1989 program

⬭ Small deposit undrilled during 1989 program

A ●——●A' Cross Sections

NOTE: Geodetic control based on
107 B/14F Provisional Map
U T M Grid Zone 8

* Abbreviated borehole numbers eg 1=1407B001

0 100 200 300 400 500
SCALE (m)

REFERENCES

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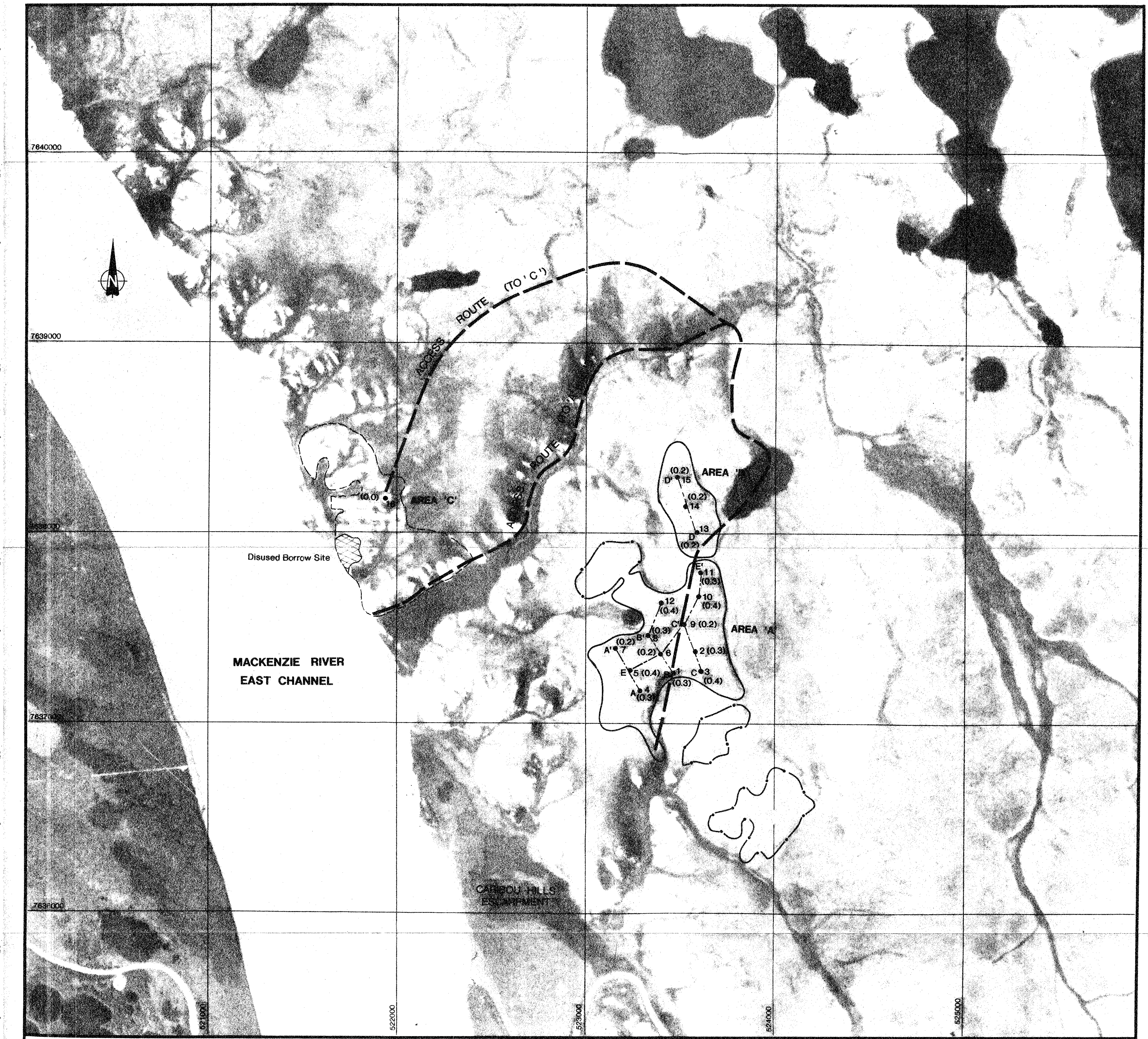
INUVIALUIT SETTLEMENT REGION
GRANULAR RESOURCES EVALUATION
DEPOSIT 1407
BOREHOLE LOCATIONS AND
GEOLOGICAL CROSS - SECTIONS

SCALE As Shown DATE MADE YK CHKD APPD PG
JOB No. CG10346 FIGURE 3 REV.



LEGEND

● 1*	Borehole location
⬭	Deposit drilled During 1989 program
⬭	Small deposit undrilled during 1989 program
A ●——● A'	Cross Sections
(0.4)	**Overburden Thickness at Borehole (in metres)**

NOTE: Geodetic control based on
107 B/14E Provisional Map
U.T.M. Grid Zone 8

* Abbreviated borehole numbers eg. 1=1407B001

0 100 200 300 400 500
SCALE (m)

REFERENCES

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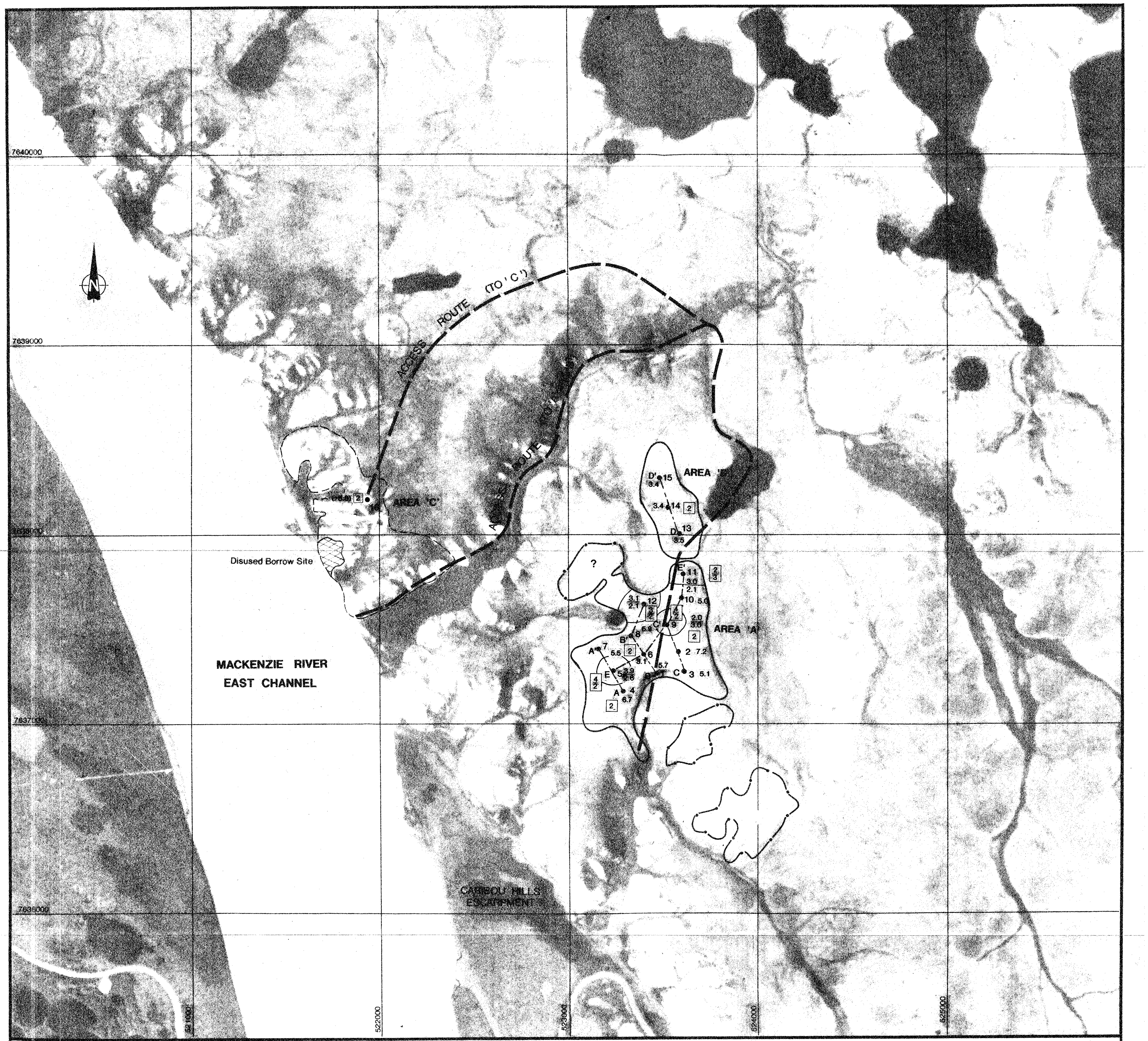
INUVIALUIT SETTLEMENT REGION
GRANULAR RESOURCES EVALUATION

DEPOSIT 1407

OVERBURDEN THICKNESS

SCALE As Shown DATE MADE YK CHKD APPD PG
JOB No CG10346 FIGURE 4 REV



Thickness at Borehole (in metres)

3.1 Thickness of Overlying Material
2.1 Thickness of Underlying Material

1 Quality of Overlying Material
2 Quality of Underlying Material

Source Quality Classes

1	Excellent
2	Good
3	Fair
4	Poor

NOTE: Geodetic control based on
107 B/ 14E Provisional Map
U.T.M. Grid Zone 8

* Abbreviated borehole numbers eg. 1=1407B001

LEGEND

● 1* Borehole location

Deposit drilled During 1989 program

Small deposit undrilled during 1989 program

A ●——● A' Cross Sections

0 100 200 300 400 500
SCALE (m)

REFERENCES

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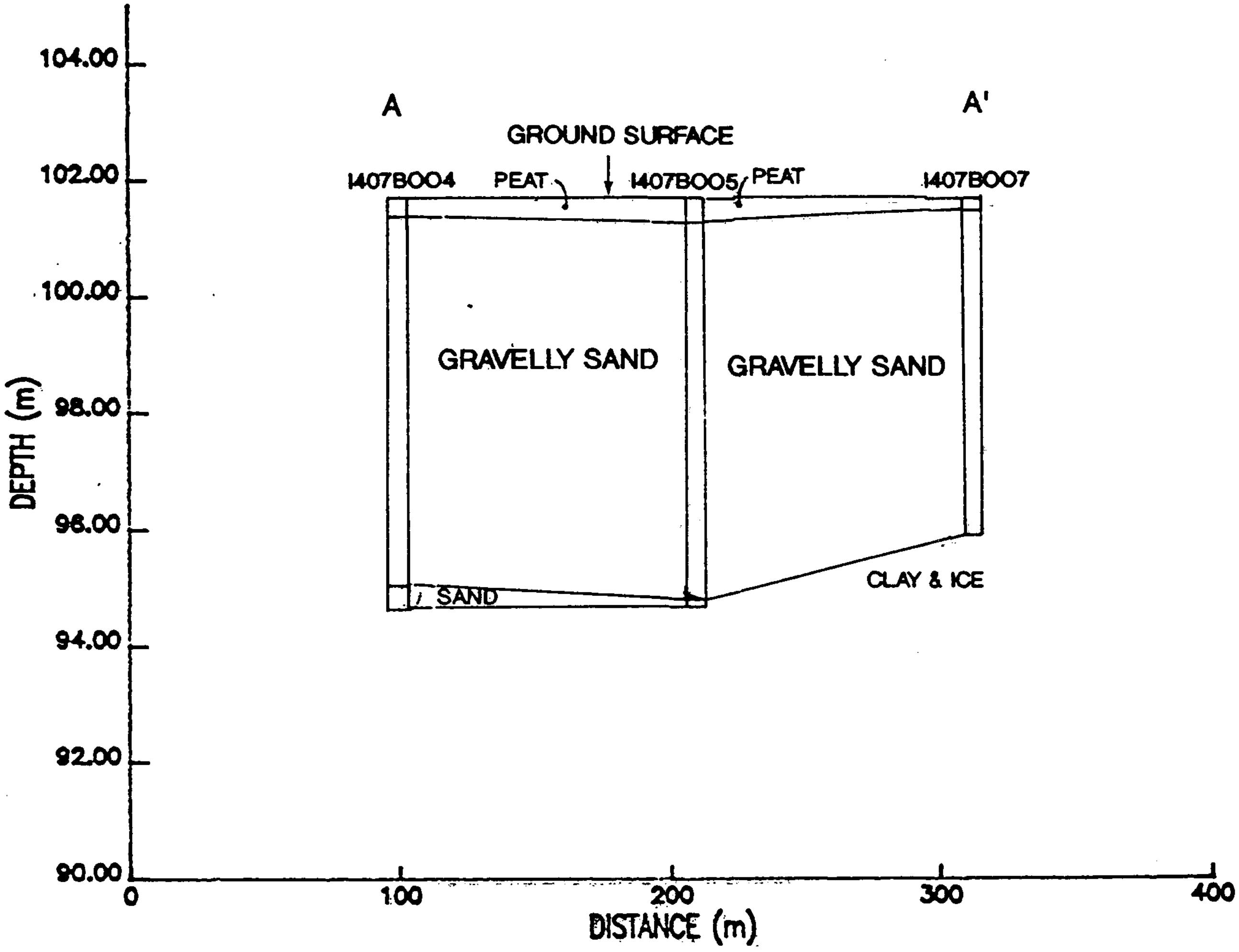
INUVIALUIT SETTLEMENT REGION
GRANULAR RESOURCES EVALUATION

DEPOSIT 1407
SOURCE QUALITY CLASS
GRANULAR MATERIAL THICKNESS

SCALE As Shown DATE MADE YK CHKD APPD PG
JOB No CG10346 FIGURE 5 REV



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CARIBOU HILLS (1407)
CROSS-SECTIONAL PLOT A – A'

Figure 6

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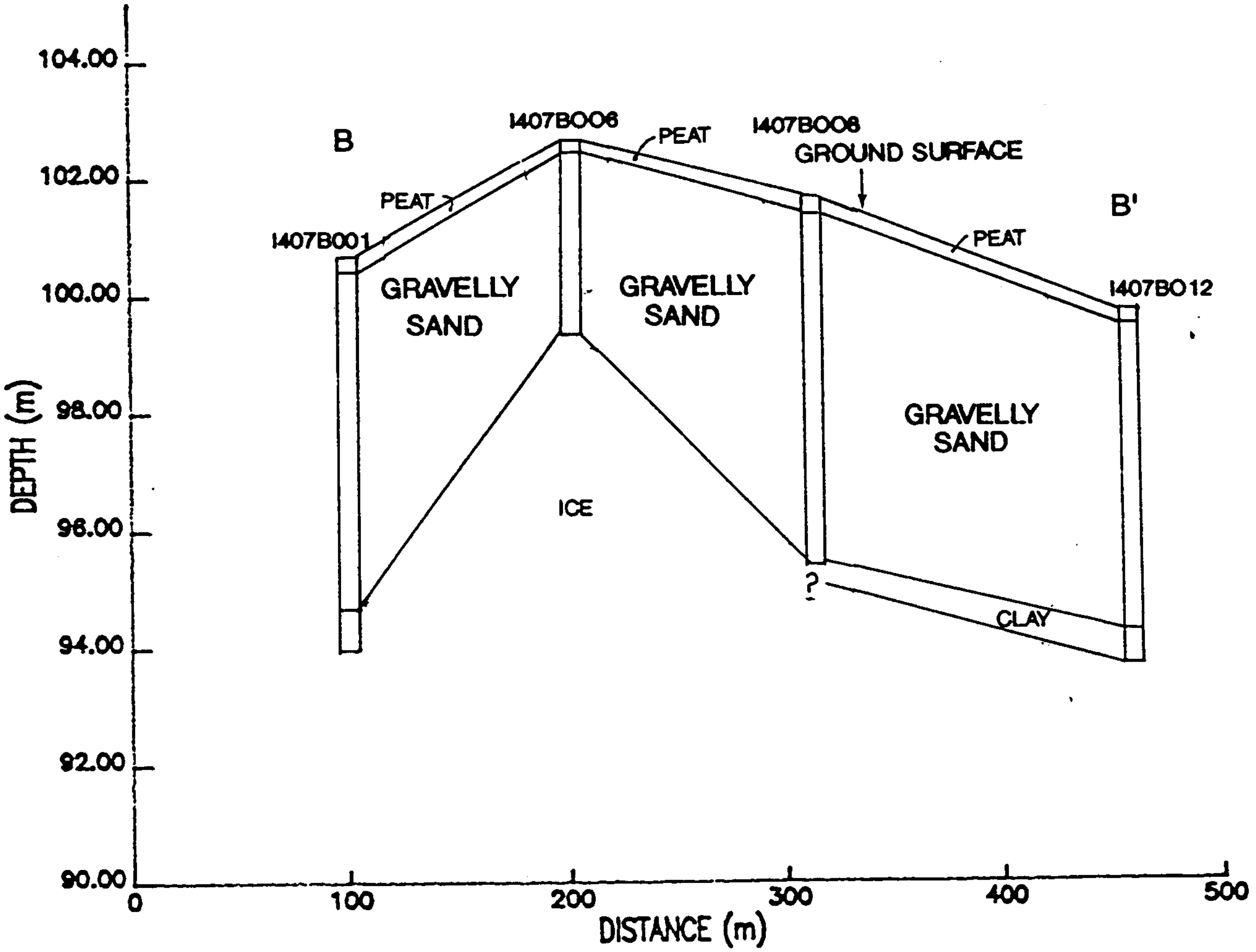

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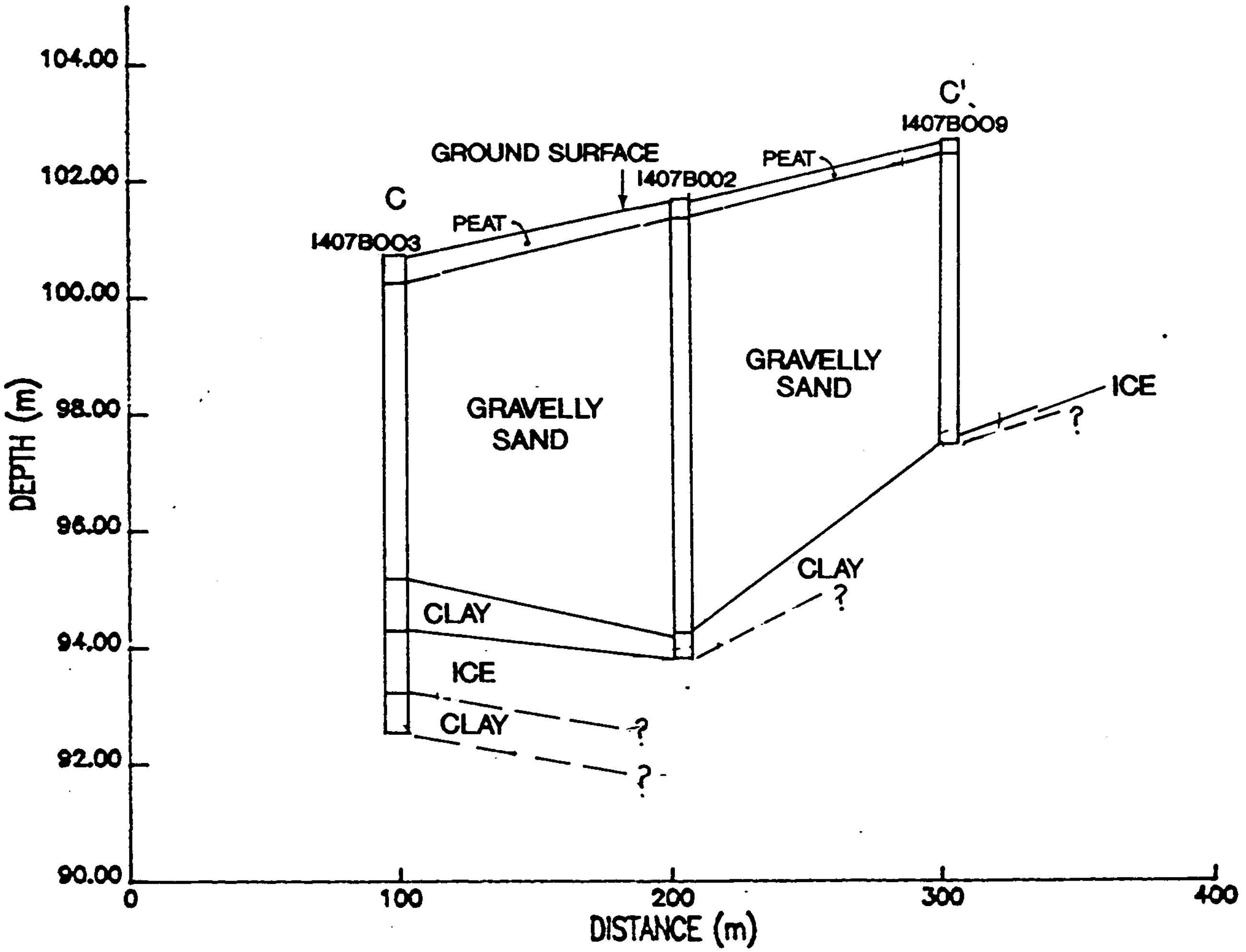
CARIBOU HILLS (1407)
CROSS-SECTIONAL PLOT B – B'

Figure 7



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CARIBOU HILLS (1407)
CROSS-SECTIONAL PLOT C – C'

Figure 8

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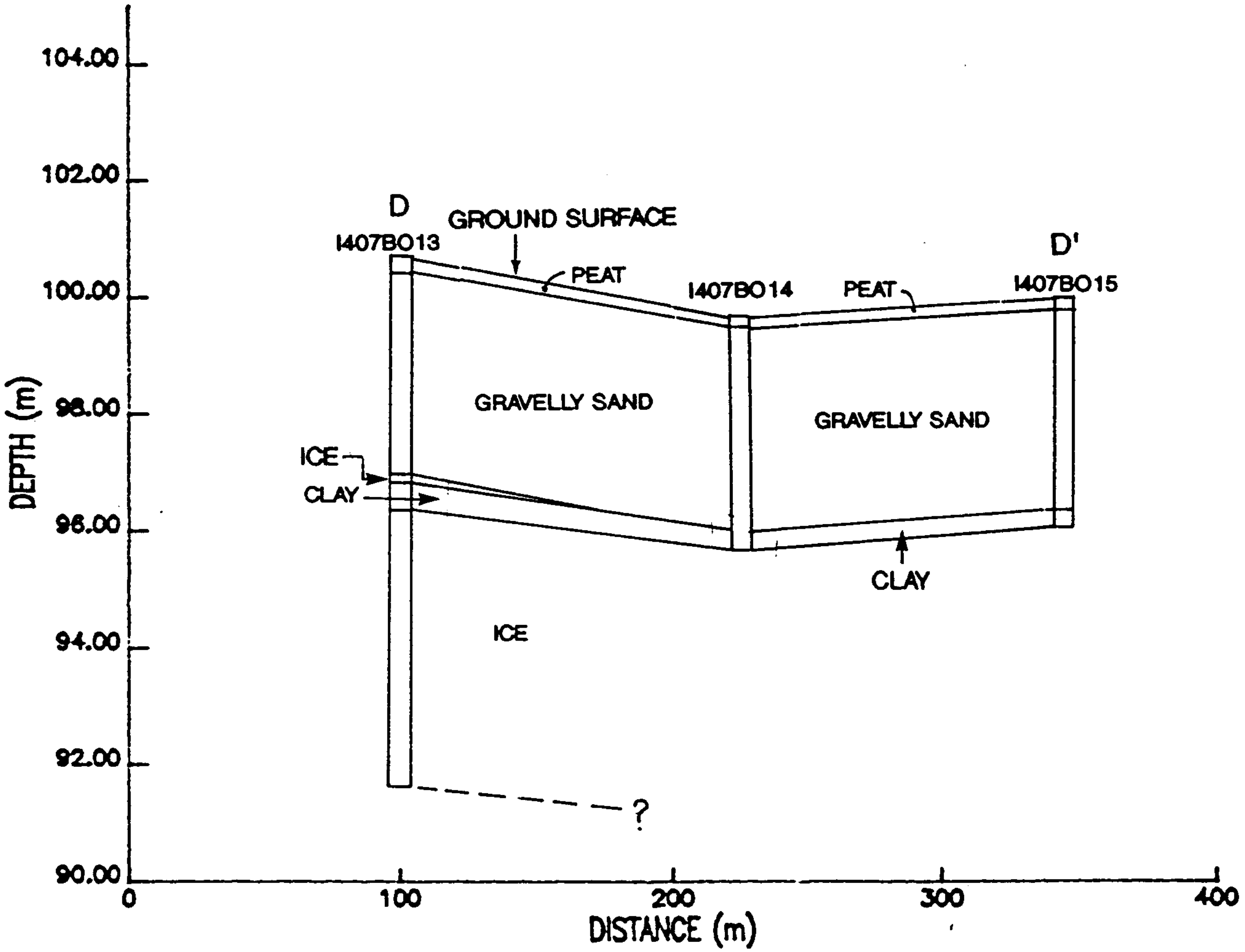

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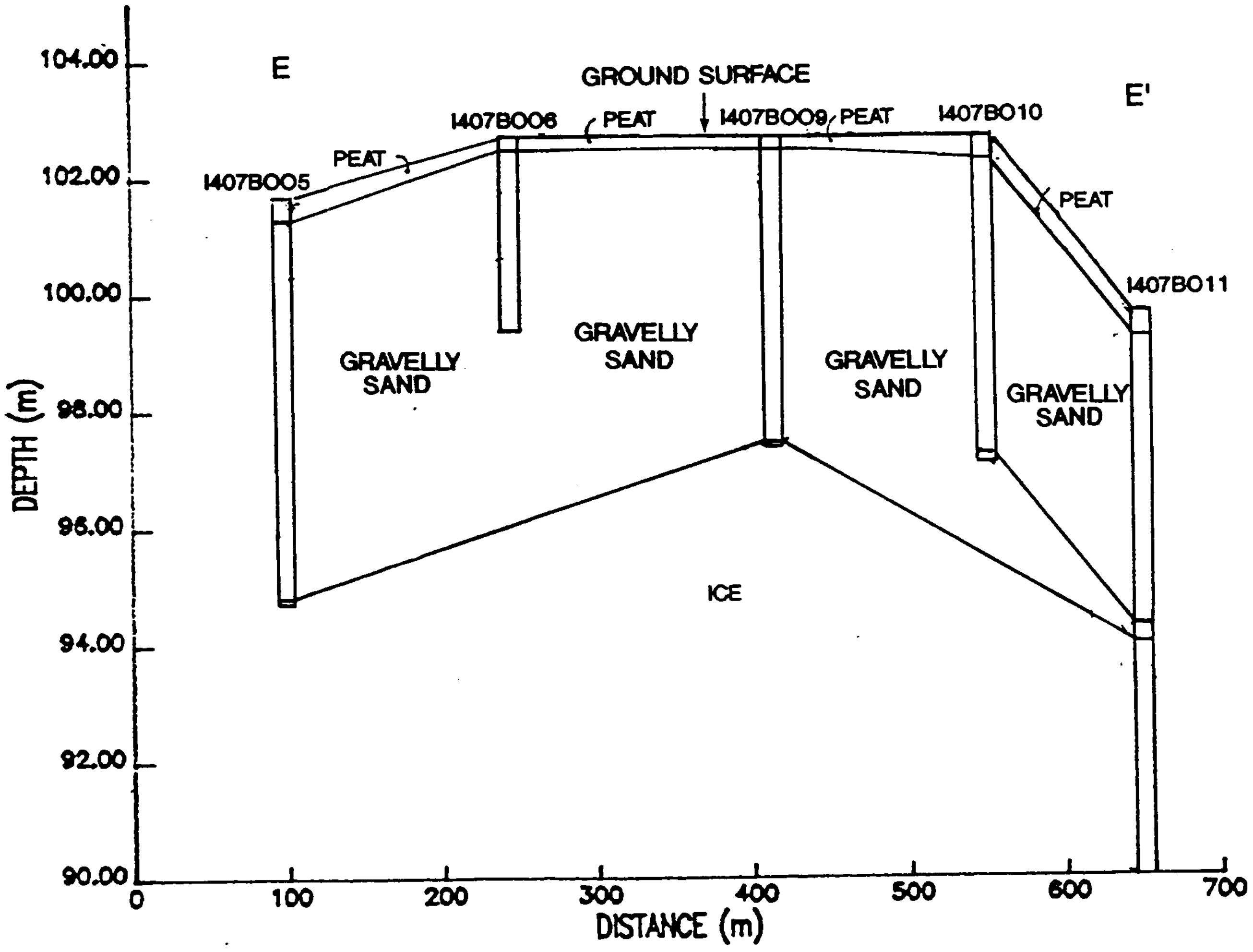
CARIBOU HILLS (1407)
CROSS-SECTIONAL PLOT D – D'

Figure 9

HBLT 15 · 87/05



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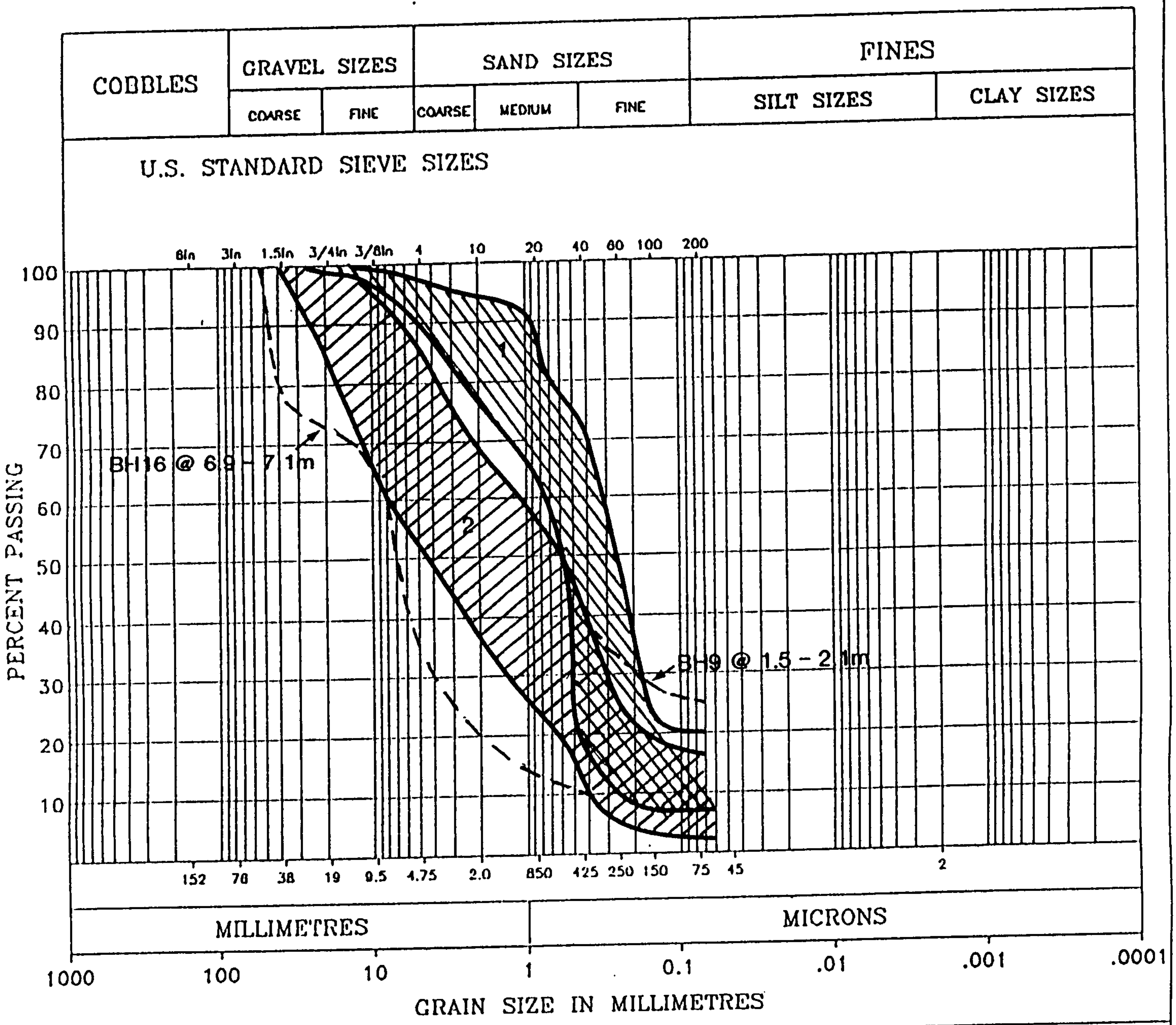
CARIBOU HILLS (1407)
CROSS-SECTIONAL PLOT E – E'

Figure 10



REMARKS: Sand-Gravelly Sand Units
(based on 28 samples)

(1) Upper/Finer Branch: 4 samples with < 10% gravel
- poorly graded medium sand

(2) Lower/Coarser Branch: 22 samples with
15% - 45% gravel
- well-graded gravelly sand

Anomalous samples shown with dashed lines

SUMMARY

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

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GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346

FIGURE 11

LOCATION: 1407

HOLE:

DEPTH:

TECHNICIAN:

Composite Grain Size Distribution Envelope For Gravelly Sands

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APPENDIX A

Borehole Logs and Explanatory Sheets

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
D_R	Relative density (formerly specific gravity)
Fines	Percentage by weight smaller than #200 sieve
k	Permeability coefficient
*MA	Mechanical grain size analysis and hydrometer test
N	Standard penetration test (CSA A119.1-60)
N_d	Dynamic cone penetration test
NP	Non plastic soil
pp	Pocket penetrometer strength
*q	Triaxial compression test
q_u	Unconfined compressive strength
*SB	Shearbox test
SO_4	Concentration of water-soluble sulphate
*ST	Swelling test
TV	Torvane shear strength
VS	Vane shear strength (undisturbed-remolded)
w	Natural moisture content (ASTM D 2216)
w_l	Liquid limit (ASTM D 423)
w_p	Plastic limit (ASTM D 424)
ε_f	Unit strain at failure
γ	Unit weight of soil or rock
γ_d	Dry unit weight of soil or rock
ρ	Density of soil or rock
ρ_d	Dry density of soil or rock
→	seepage
▼	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	$C_u = \frac{D_{60}}{D_{10}} > 4 \quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			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	$C_u = \frac{D_{60}}{D_{10}} > 6 \quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			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)

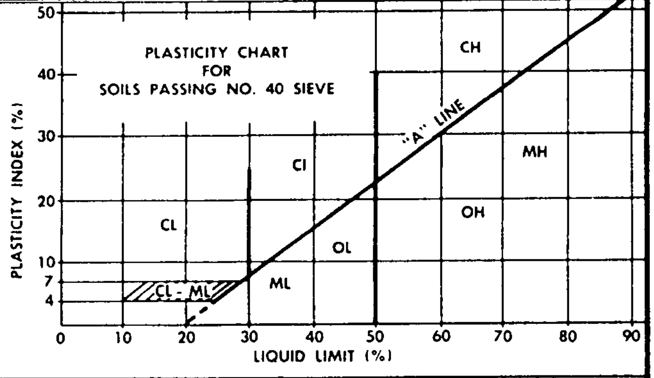
▩ VOLCANIC ASH

SOIL COMPONENTS

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

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%.

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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.

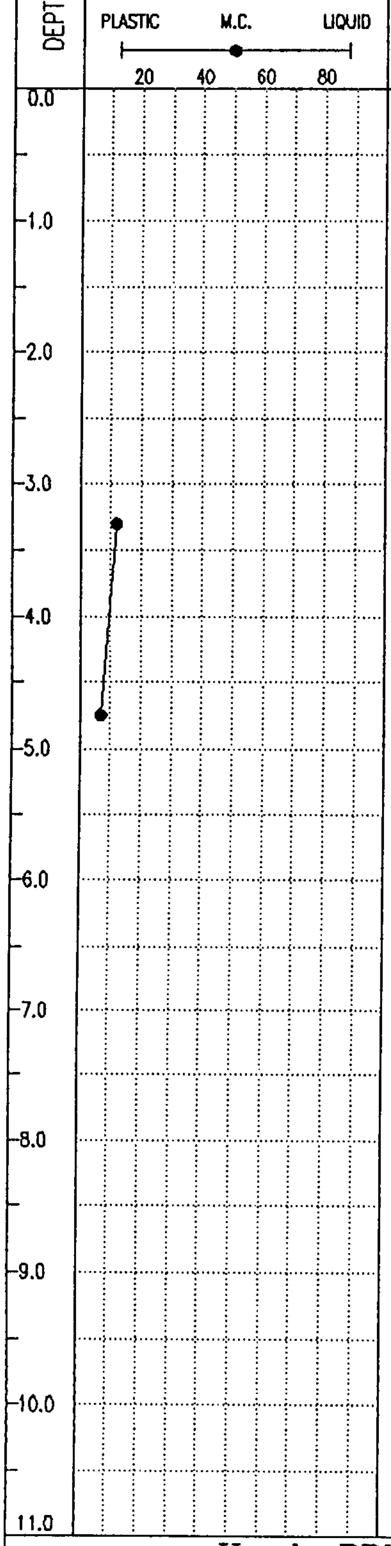
Class 5

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	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B001
UTM ZONE: 8 N7637450.00 E523630.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 100.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ◩ ☒ ▤ ◫ ◧ CRREL CORE

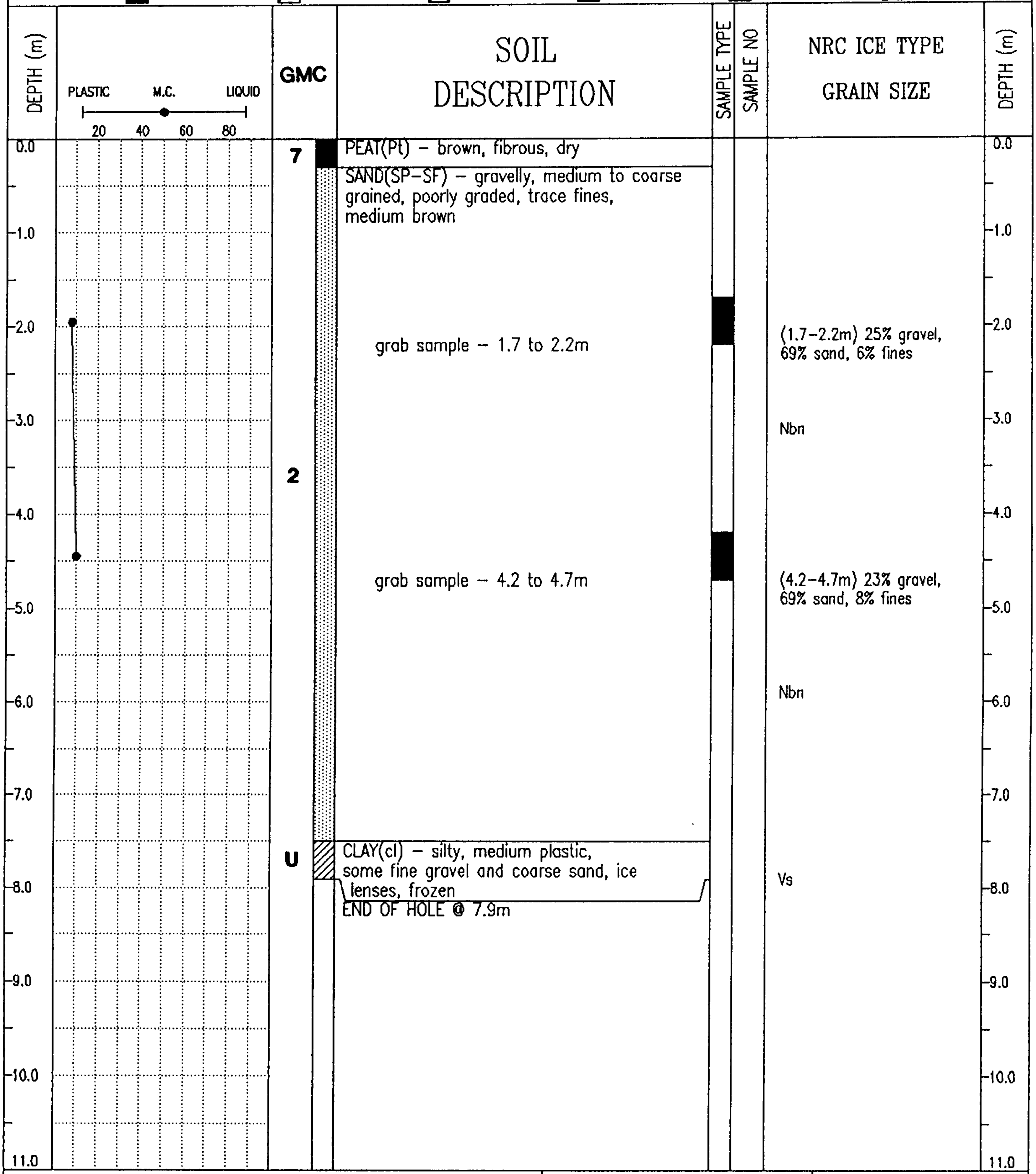


GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE
7	PEAT(Pt) – brown, fibrous, dry			
2	GRAVEL(gw) – sandy, fine grained, well graded, rounded to subrounded, medium brown, ice lenses			Nbn/Vx
2	SAND(sw-sf) – gravelly, medium to coarse grained, well graded, little fines, medium brown, ice lenses			
	grab sample – 3.0 to 3.6m	■		Vx/Vs
	grab sample – 4.5 to 5.0m	■		Vx/Vs
1	ICE – trace silt and clay, clear			97% ICE
	END OF HOLE @ 6.7m.			

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 6.7 m	COMPLETE 14/03/89
	LOGGED BY GB	DWG NO.

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B002
UTM ZONE: 8 N7637590.00 E523750.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 101.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ◪ ☒ ▤ ◫ ▮ CRREL CORE

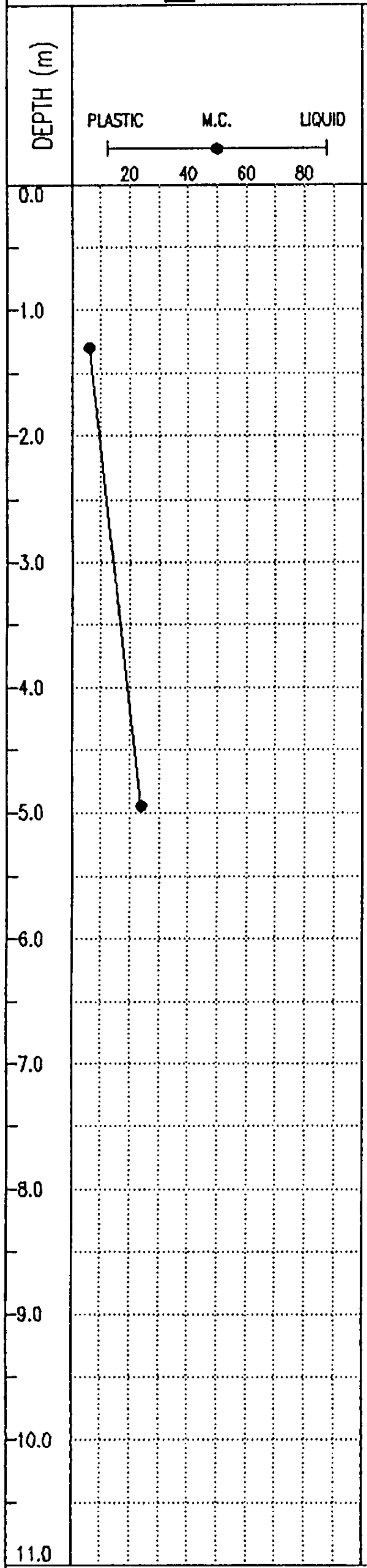


GMC	SOIL DESCRIPTION	NRC ICE TYPE GRAIN SIZE
7	PEAT(Pt) – brown, fibrous, dry	
	SAND(SP-SF) – gravelly, medium to coarse grained, poorly graded, trace fines, medium brown	
	grab sample – 1.7 to 2.2m	(1.7–2.2m) 25% gravel, 69% sand, 6% fines
		Nbn
2		
	grab sample – 4.2 to 4.7m	(4.2–4.7m) 23% gravel, 69% sand, 8% fines
		Nbn
U	CLAY(cl) – silty, medium plastic, some fine gravel and coarse sand, ice lenses, frozen	Vs
	END OF HOLE @ 7.9m	

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 7.9 m		COMPLETE 14/03/89
	LOGGED BY GB	DWG NO.	Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B003
UTM ZONE: 8 N7637480.00 E523780.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 100.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ⧄ ☒ ▤ ◫ ◧ CRREL CORE



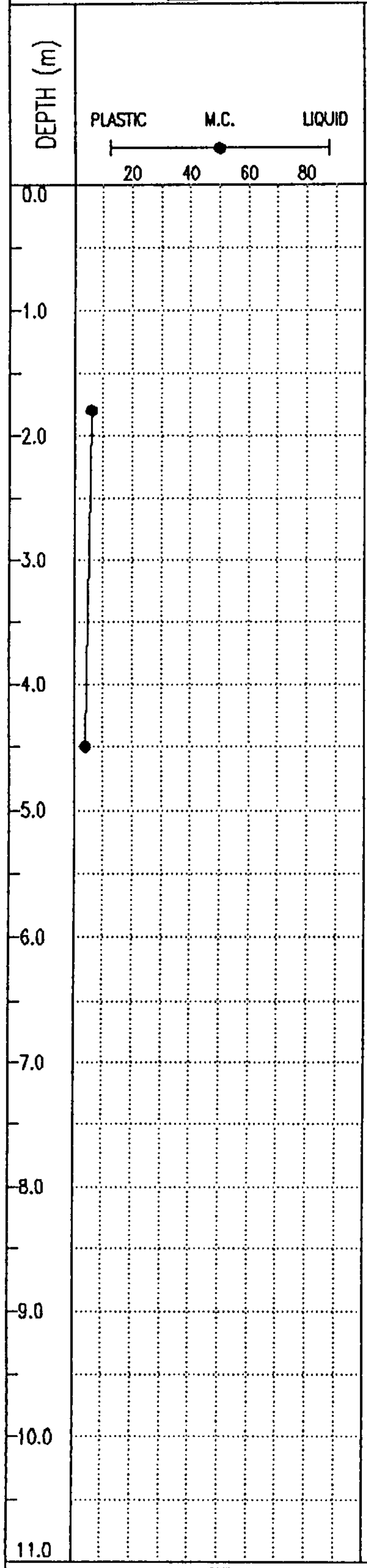
GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE
7	PEAT(Pt) – brown, fibrous, dry			
	SAND(SP-SF) – gravelly, medium to coarse grained, medium brown, trace fines CRREL SAMPLE – 0.4 to 2.4m	◧		
2	grab sample – 0.9 to 1.7m	■		Nbn (0.9–1.7m) 15% gravel, 77% sand, 8% fines 14% ICE
		◧		Nbn 17% ICE
	... interstitial and laminated ice CRREL SAMPLE – 2.4 to 5.0m	◧		24% ICE
	... decrease in gravel content	◧		Nbe/Vs
3		◧		
	grab sample – 4.7 to 5.2m CRREL SAMPLE – 5.0 to 5.5m	■		(4.7–5.2m) 5% gravel, 89% sand, 9% fines 29% ICE; Vx/Vr
U	CLAY(cl) – silty, low plastic, frozen, black/brown, ice lenses throughout CRREL SAMPLE – 5.5 to 6.4m	◧		Vx/Vs
I	ICE – massive, shale beds between 6.7 and 7.0m CRREL SAMPLE – 6.4 to 7.5m	◧		ICE + CLAY
U	CLAY(cl) – silty, sandy, low plastic, frozen, black/brown, ice laminations	◧		Vs
	End of hole @ 8.2m			

NOTE: 1407B003 is a compilation of field logs BH3 and BH3A.
BH3 and BH3A were spaced approximately 1 metre apart.

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 8.2 m	COMPLETE 14/03/89
	LOGGED BY GB	DWG NO.
		Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B004
UTM ZONE: 8 N7637380.00 E523420.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 101.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ◩ ☒ ▤ ◫ ◧ CRREL CORE

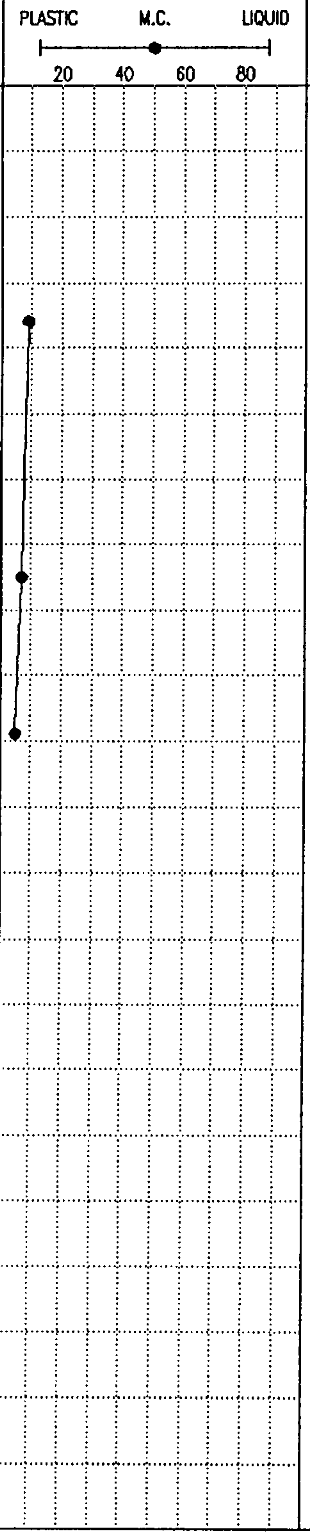


GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE
7	PEAT(Pt) – brown, fibrous,dry			
2	GRAVEL(gw) – sandy, fine grained, well graded, rounded to subrounded, medium brown grab sample – 1.5 to 2.1m	■		Nbn
2	SAND(sw) – gravelly, medium to coarse grained, medium brown, well graded			Nbn
2	GRAVEL(gw) – as above grab sample – 4.2 to 4.8m	■		Nbn
2	SAND(sw) – as above, clear ice crystals			
1	ICE – clear			Vx 100% ICE
	END OF HOLE @ 7.1m			

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 7.1 m	COMPLETE 14/03/89
	LOGGED BY GB	DWG NO. / Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B005
UTM ZONE: 8 N7637480.00 E523410.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 101.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ☒ ▤ ◫ ◫ CRREL CORE

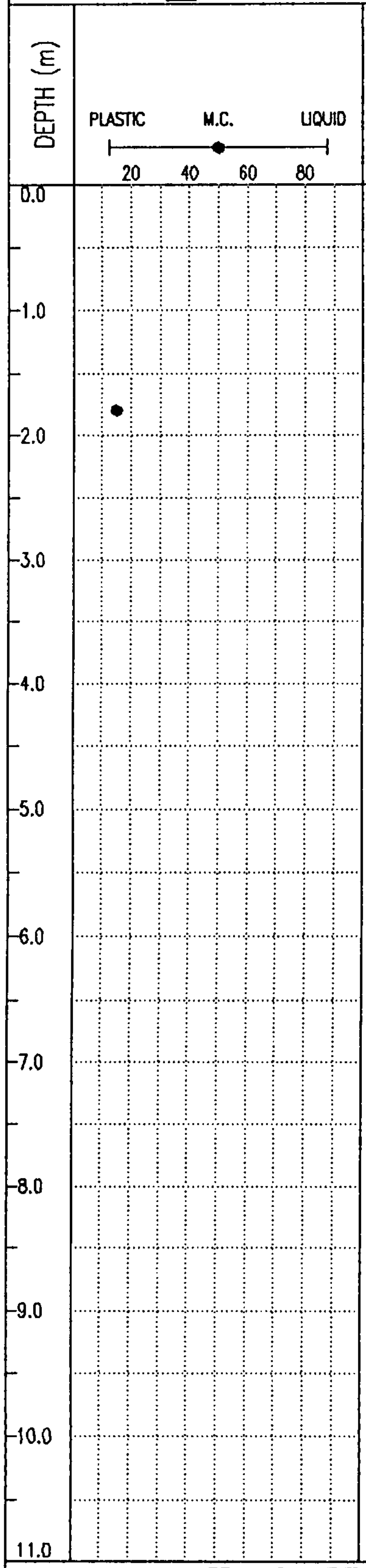


DEPTH (m)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE
0.0	7	PEAT(Pt) – brown, fibrous, dry SAND(SP) – gravelly, medium to coarse grained, trace fines, medium brown, ice crystals			
1.0					
2.0	2	grab sample – 1.5 to 2.1m	■		Nbn/Vx (1.5–2.1m) 35% gravel, 62% sand, 3% fines
3.0					Vx
4.0		grab sample – 3.5 to 4.0m SAND (SW–SF) – gravelly, well graded, medium brown, trace fines	■		
5.0	2	grab sample – 4.7 to 5.2m	■		(4.5–5.0m) 45% gravel, 49% sand, 6% fines Nbn
6.0					
7.0	1	ICE – clear, trace fines END OF HOLE @ 7.0m			100% ICE
8.0					
9.0					
10.0					
11.0					

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 7.0 m	COMPLETE 14/03/89
	LOGGED BY GB	DWG NO.
		Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B006
UTM ZONE: 8 N7637570.00 E523580.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 102.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ☒ ▤ ◫ ▮ CRREL CORE

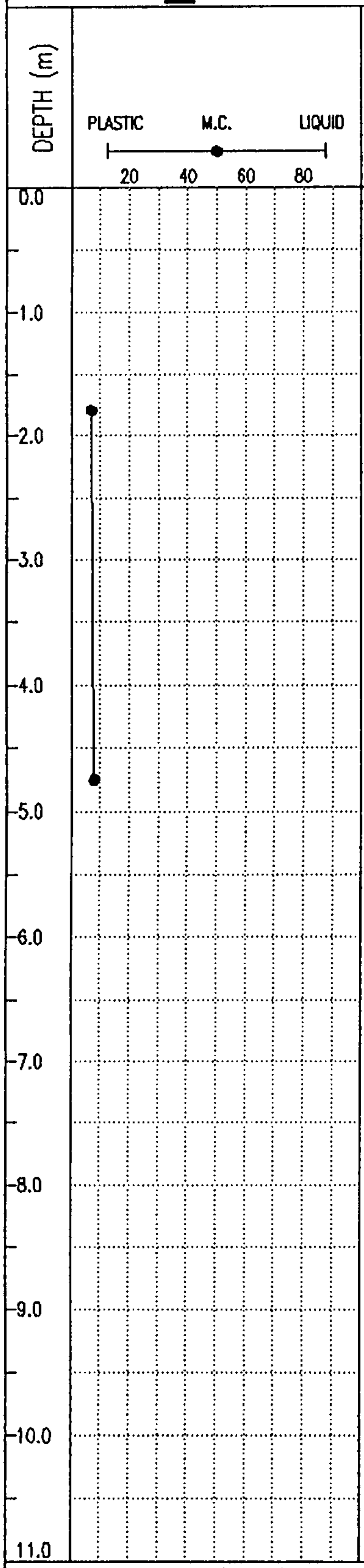


GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE
7	PEAT(Pt) – brown, fibrous, dry			
2	GRAVEL(gw) – sandy, fine grained, well graded, rounded to subrounded, medium brown, ice lenses grab sample – 1.5 to 2.1m	■		Nbn/Vx
2	SAND(sw) – gravelly, medium to coarse grained, medium brown, ice lenses			Vs/ICE
	END OF HOLE @ 3.3m			

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 3.3 m	COMPLETE 14/03/89
	LOGGED BY GB	DWG NO.

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B007
UTM ZONE: 8 N7637590.00 E523340.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 101.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ◸ ☒ ▤ ◫ ◫ CRREL CORE

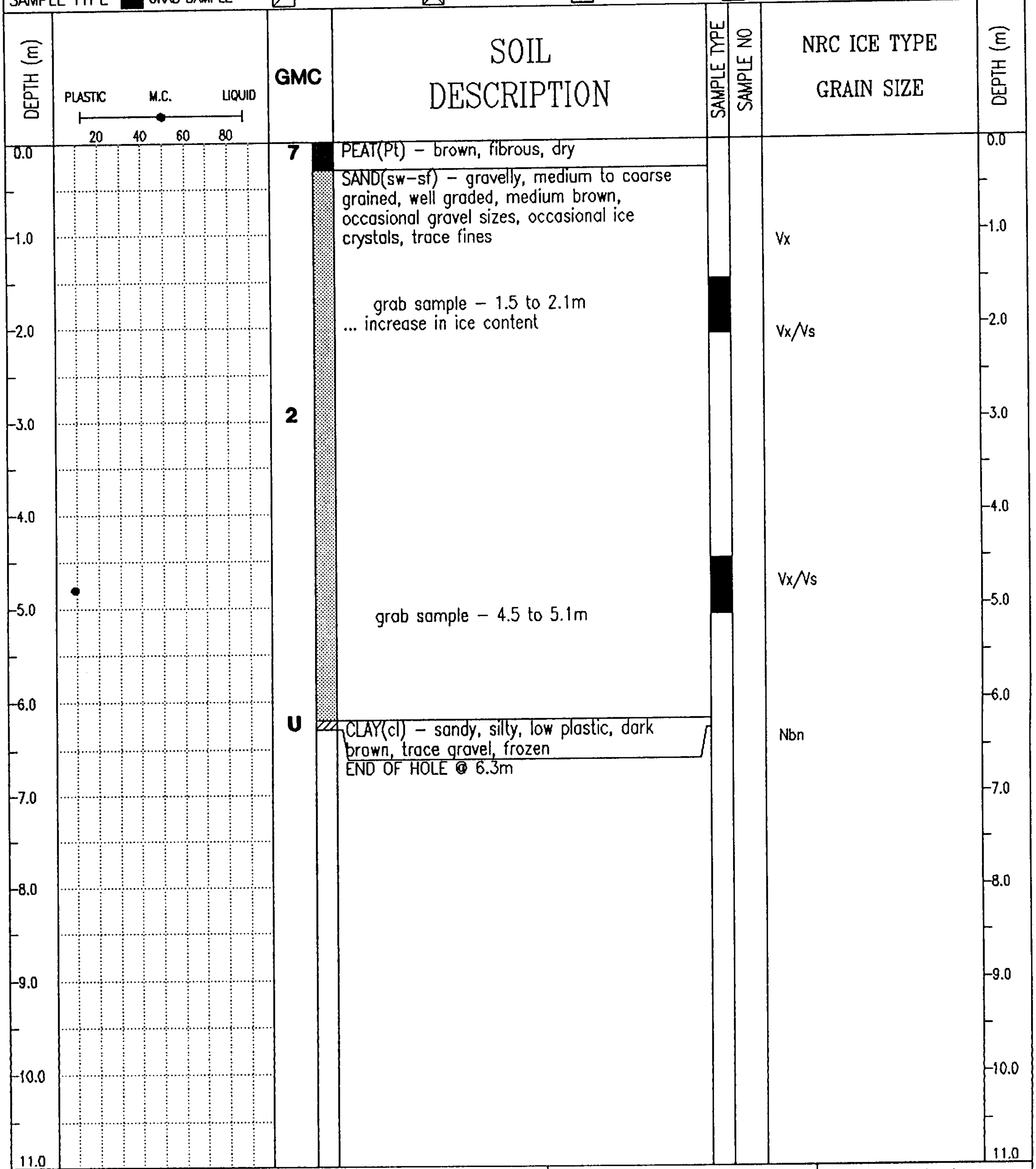


GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE
7	PEAT(Pt) – brown, fibrous, dry			
	SAND(SP-SF) – gravelly, medium to coarse grained, medium brown, occasional ice crystals, trace fines			
	grab sample – 1.5 to 2.1m	■		Vx (1.5–2.1m) 33% gravel, 59% sand, 8% fines
2				
	grab sample – 4.5 to 5.0m	■		Vx (4.0–4.5m) 26% gravel, 67% sand, 7% fines
U	CLAY(cl) – silty, low plastic, frozen			Nbe
	END OF HOLE @ 5.8m			

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 5.8 m	COMPLETE 14/03/89
	LOGGED BY GB	DWG NO.

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B008
UTM ZONE: 8 N7637670.00 E523510.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 101.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ☒ ▤ ▯▯ ▐▌ CRREL CORE



PEAT(Pt) – brown, fibrous, dry

SAND(sw–sf) – gravelly, medium to coarse grained, well graded, medium brown, occasional gravel sizes, occasional ice crystals, trace fines

grab sample – 1.5 to 2.1m
... increase in ice content

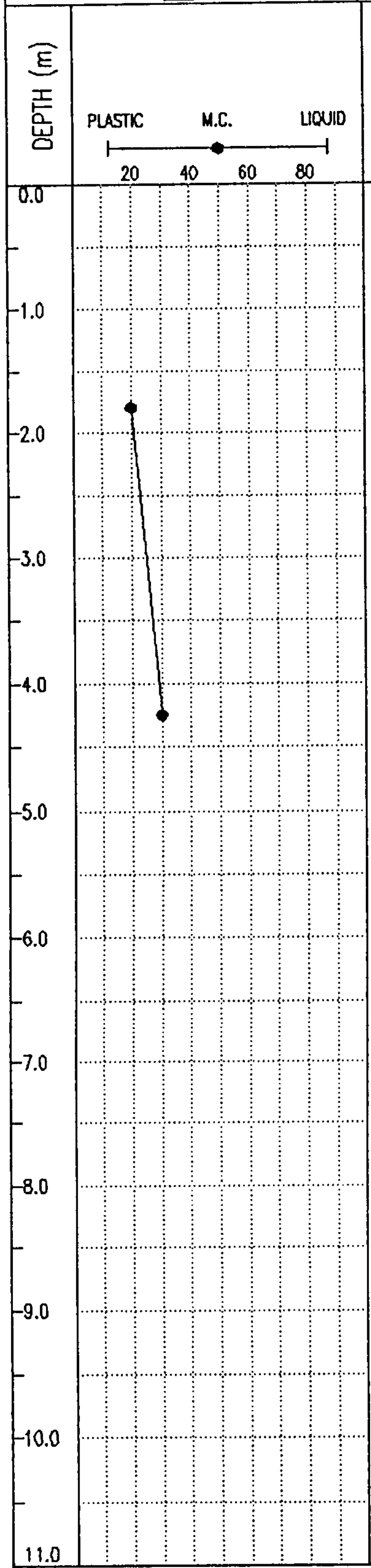
grab sample – 4.5 to 5.1m

CLAY(cl) – sandy, silty, low plastic, dark brown, trace gravel, frozen
END OF HOLE @ 6.3m

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 6.3 m	COMPLETE 14/03/89	
	LOGGED BY GB	DWG NO.	Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B009
UTM ZONE: 8 N7637720.00 E523700.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 102.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ⧄ ☒ ▤ ◫ ◧ CRREL CORE

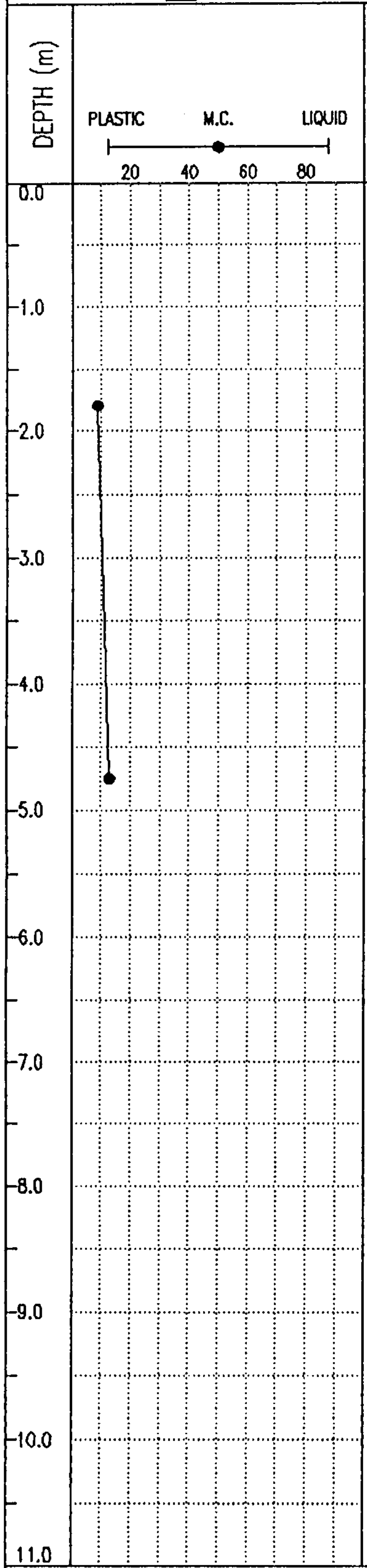


GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE
7	PEAT(Pt) – brown, fibrous, dry			
	SAND(SF) – gravelly, little fines, fine to medium grained, occasional ice lenses			
4				Vs
	grab sample – 1.5 to 2.1m	■		(1.5–2.1m) 30% gravel, 45% sand, 25% fines
	SAND(SP–SF) – gravelly, medium to coarse grained, poorly graded, medium brown, trace fines			
				Nbn
2				
	grab sample – 4.0 to 4.5m	■		(4.0–4.5m) 29% gravel, 65% sand, 6% fines
1	ICE – trace silt and clay			98% ICE
	END OF HOLE @ 5.3m			

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 5.3 m	COMPLETE 14/03/89
	LOGGED BY GB	DWG NO.

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B010
UTM ZONE: 8 N7637860.00 E523770.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 102.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ☒ ▤ ◫ ◫ CRREL CORE

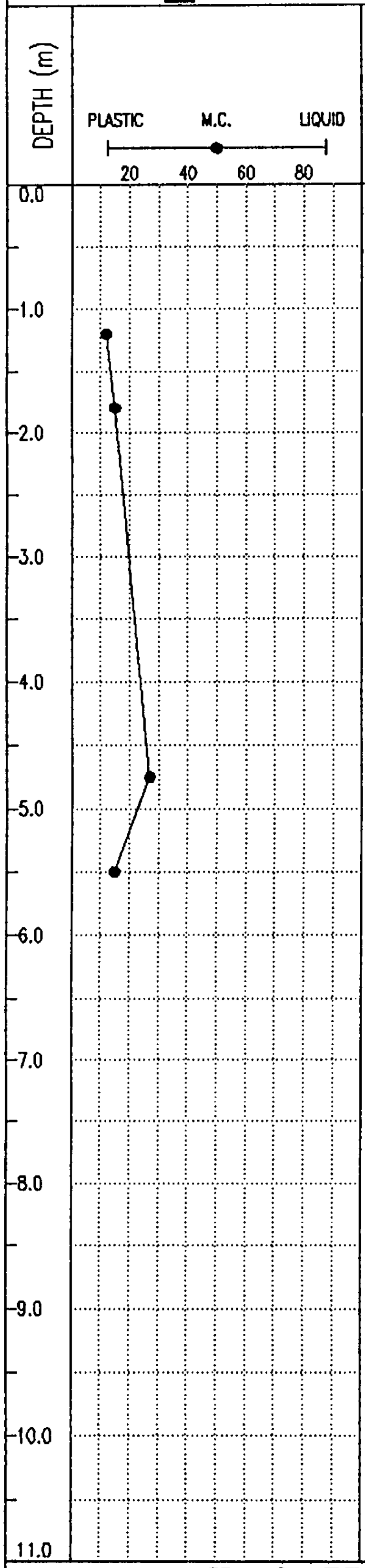


GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE
7	PEAT(Pt) – brown, fibrous, dry			
2	SAND(sw-sf) – gravelly, medium to coarse grained, well graded, little fines, medium brown, ice crystals throughout			Nbe/Vx
	grab sample – 1.5 to 2.1m	■		
	grab sample – 4.5 to 5.0m	■		
U	CLAY(cl) – sandy, trace gravel, low plastic, brown, frozen			Nbn
	END OF HOLE @ 5.6m			

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 5.6 m	COMPLETE 14/03/89
	LOGGED BY GB	DWG NO.
		Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B011
UTM ZONE: 8 N7637990.00 E523780.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 99.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ◪ ☒ ▤ ◫ ◫ CRREL CORE

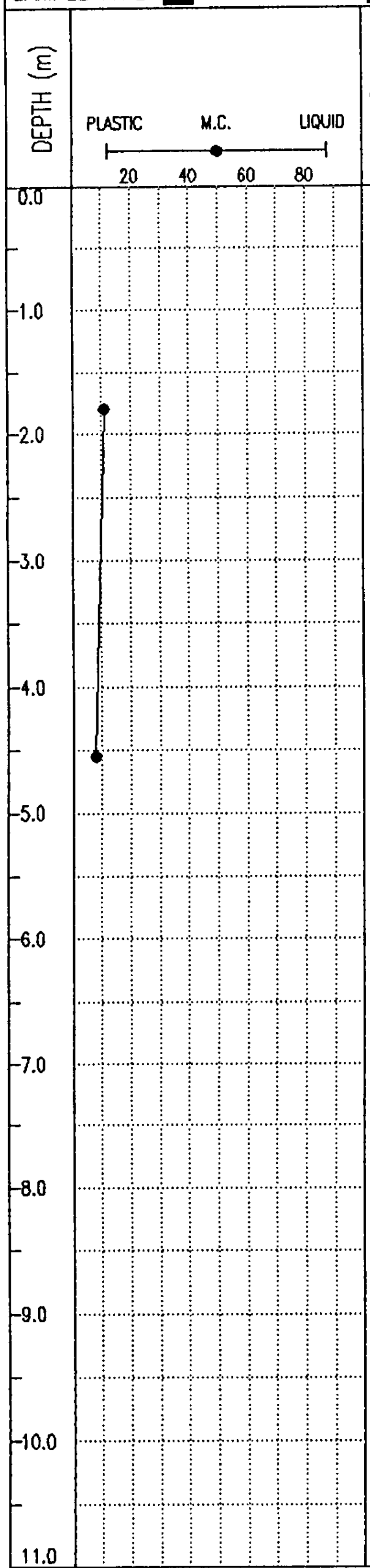


GMC	SOIL DESCRIPTION	NRC ICE TYPE GRAIN SIZE	DEPTH (m)
7	PEAT(Pt) – fibrous, brown, dry		0.0
2	SAND(SW–SF) – gravelly, medium to coarse grained, well graded, medium brown, trace fines, ice lenses throughout CRREL SAMPLE – 0.3 to 5.4m grab sample – 1.5 to 2.1m	Nbe/Vs (1.5–2.1m) 10% gravel, 81% sand, 9% fines Vx/Vs	-1.0 -2.0 -3.0
3	SAND(SF) – medium brown, little fines, trace gravel, medium grained, ice lenses grab sample – 4.5 to 5.0m	Vs (4.5–5.0m) 3% gravel, 78% sand, 19% fines	-4.0 -5.0
U	CLAY(cl) – low plastic, frozen, black–brown CRREL SAMPLE – 5.4 – 5.6m	Vx/Vs	
1	ICE – clear, crystalline, chattered by coring action, trace fines CRREL SAMPLE – 5.6 to 6.1m ... large ice crystals CRREL SAMPLE – 6.1 to 8.8m ... no sample retained from 8.8 to 9.8m ... increase in fines ... minor pebbles	99% ICE	-6.0 -7.0 -8.0 -9.0
	END OF HOLE AT 9.8m NOTE: 1407B011 is a compilation of field logs BH11 and BH11A. BH11 and BH11A were spaced approximately 1 metre apart.		-10.0 11.0

Hardy BBT Limited	COMPLETION DEPTH 9.8 m	COMPLETE 14/03/89
Calgary, Alberta	LOGGED BY GB	DWG NO. / Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	I407 (CARIBOU HILLS)	BOREHOLE No. I407B012
UTM ZONE: 8 N7637840.00 E523580.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 99.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ☒ ▤ ◫ ◨ CRREL CORE

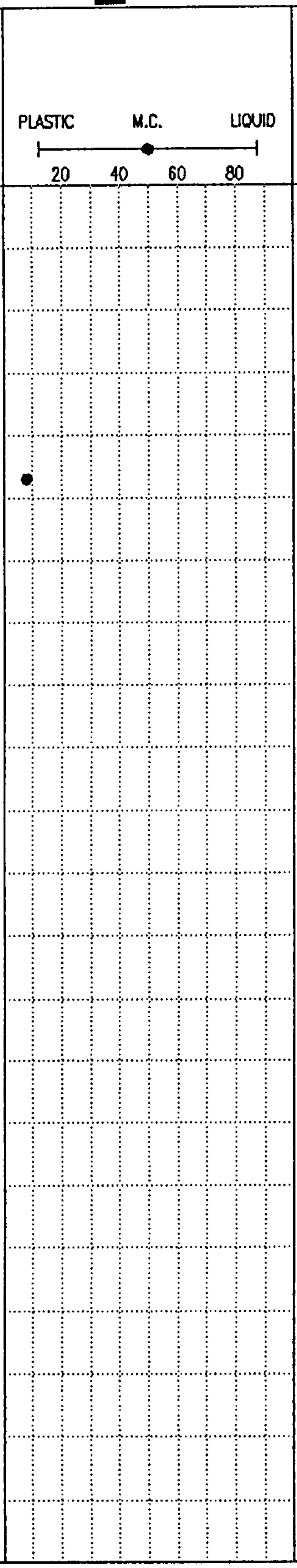


GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE	DEPTH (m)
7	PEAT(Pt) – brown, fibrous, dry				0.0
	SAND(SP-SF) – gravelly, medium to coarse grained, medium brown, little fines, poorly graded, frozen, ice crystals			Nbe/Vx	1.0
3	grab sample – 1.5 to 2.1m	■		(1.5–2.1m) 19% gravel, 69% sand, 12% fines	2.0
				Vx	3.0
2					4.0
	grab sample – 4.3 to 4.8m	■		(4.3–4.8m) 28% gravel, 66% sand, 6% fines	5.0
U	CLAY(ci) – medium plastic, some coarse sand and fine gravel, ice lenses			Vs	
	END OF HOLE @ 6.0m				6.0
					7.0
					8.0
					9.0
					10.0
					11.0

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 6.0 m	COMPLETE 14/03/89	
	LOGGED BY GB	DWG NO.	Page 1 of 1

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B013
UTM ZONE: 8 N7638180.00 E523770.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 100.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ☒ ▤ ◫ ▮ CRREL CORE

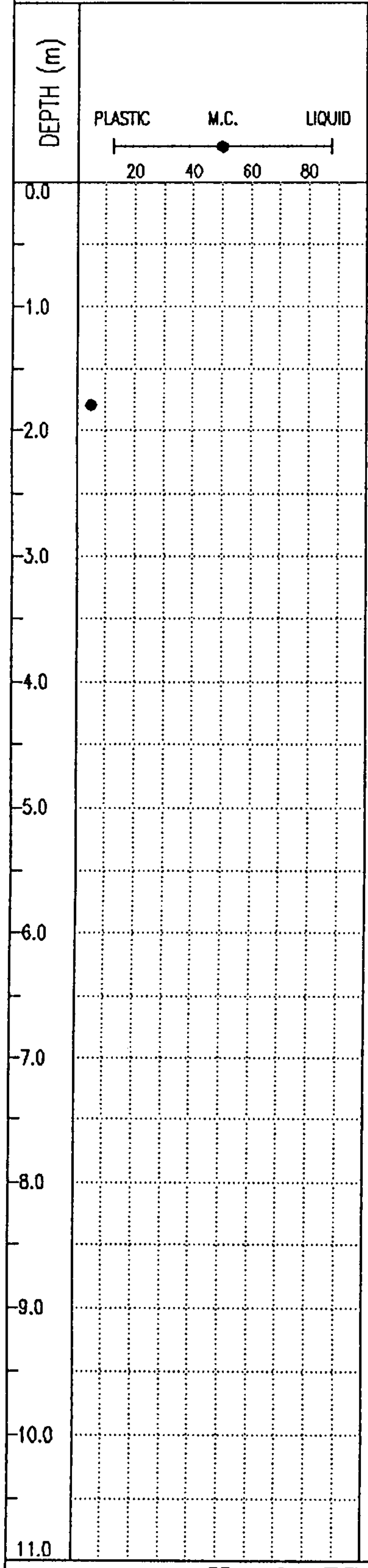


DEPTH (m)	GMC	SOIL DESCRIPTION	NRC ICE TYPE GRAIN SIZE
0.0	7	PEAT(Pt) – brown, fibrous, dry	
		SAND(SP) – gravelly, poorly graded, medium to coarse grained, medium brown, trace fines	
-1.0			Nbn
-2.0	2		Nbe/Vx
		grab sample – 2.0 to 2.7m	(2.0–2.7m) 30% gravel, 66% sand, 4% fines
-3.0		CRREL SAMPLE – 3.1 to 3.5m	
	I	CRREL SAMPLE – 3.5 to 4.1m	100% ICE
-4.0	U	ICE – clear	
		CLAY(ml) – till, low to medium plastic, medium brown, sand and gravel, ice lenses	Vs
		CRREL SAMPLE – 4.1 to 4.6m	
-5.0		ICE – silt and clay inclusions, occasional clear ice, occasional chattered ice	
		CRREL SAMPLE – 4.6 to 4.8m	
		CRREL SAMPLE – 4.8 to 5.2m	
-6.0		CRREL SAMPLE – 5.2 to 5.8m	
		CRREL SAMPLE – 5.8 to 6.1m	
	I	CRREL SAMPLE – 6.1 to 6.6m	95% ICE
-7.0		CRREL SAMPLE – 6.6 to 7.0m	
		CRREL SAMPLE – 7.0 to 7.4m	
-8.0		CRREL SAMPLE – 7.4 to 8.1m	
		CRREL SAMPLE – 8.1 to 8.6m	
-9.0		CRREL SAMPLE – 8.6 to 9.1m	
		End of hole @ 9.1m	
-10.0		NOTE: 1407B013 is a compilation of field logs BH13 and BH13A. BH13 and BH13A were spaced approximately 1 metre apart.	
11.0			

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 9.1 m	COMPLETE 14/03/89
	LOGGED BY GB	DWG NO.

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B014
UTM ZONE: 8 N7638320.00 E523720.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 99.70 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ☒ ▤ ◫ ◫ CRREL CORE

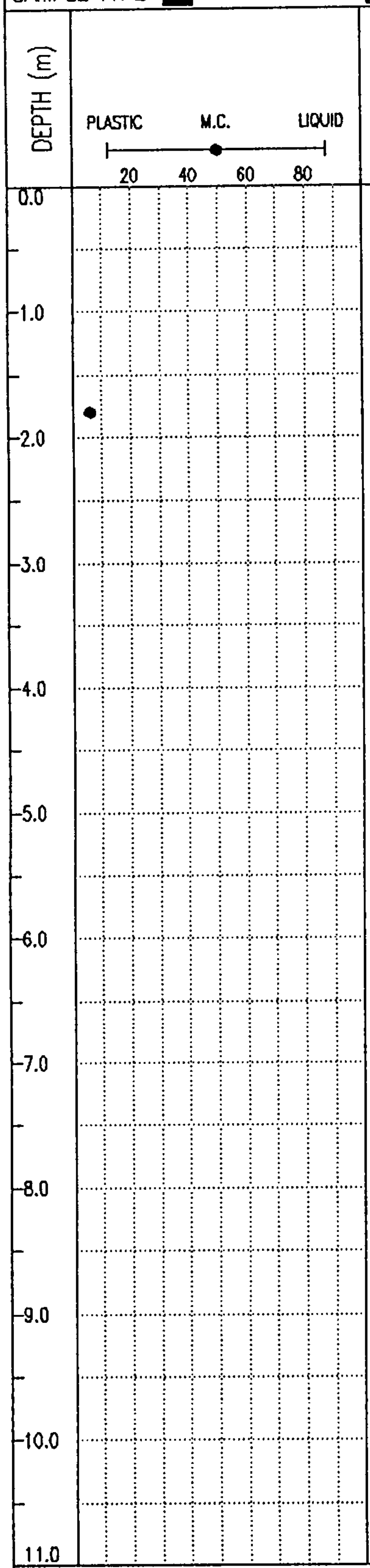


DEPTH (m)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE	DEPTH (m)
0.0	7	PEAT(Pt) – brown, fibrous, dry				0.0
		SAND(SP) – gravelly, medium to coarse grained, trace fines, medium brown,				
-2.0	2	grab sample – 1.5 to 2.1 m	■		1.5–2.1m) 19% gravel, 78% sand, 3% fines Nbn	-2.0
-4.0	U I	CLAY(ml) – silty, low to medium plastic, dark brown, some sand and fine gravel, frozen			Nbn 99% ICE	-4.0
		ICE – clear, trace silt and clay				
		END OF HOLE @ 4.0m				

Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 4.0 m	COMPLETE 14/03/89
	LOGGED BY GB	DWG NO.

ILA GRANULAR RESOURCES INVENTORY	1407 (CARIBOU HILLS)	BOREHOLE No. 1407B015
UTM ZONE: 8 N7638470.00 E523670.00	MIDNIGHT SUN DRILLING – SOLID STEM AUGER	Project No: CG10346
INAC – INUVIALUIT SETTLEMENT LANDS	NODWELL MOUNTED CME 750	ELEVATION 100.00 (m)

SAMPLE TYPE ■ GRAB SAMPLE ▨ ☒ ▤ ◫ ◧ CRREL CORE



DEPTH (m)	GMC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	NRC ICE TYPE GRAIN SIZE
0.0	7	PEAT(Pt) – brown, fibrous, dry			
		SAND(SP) – gravelly, medium to coarse grained, poorly graded, medium brown, ice crystals			
2.0	2	grab sample – 1.5 to 2.1m	■		(1.5-2.1m) 30% gravel, 67% sand, 3% fines Vx
4.0	U	CLAY(cl) – low to medium plastic, dark brown, trace sand and gravel, frozen			Nbn
		END OF HOLE @ 3.9m			

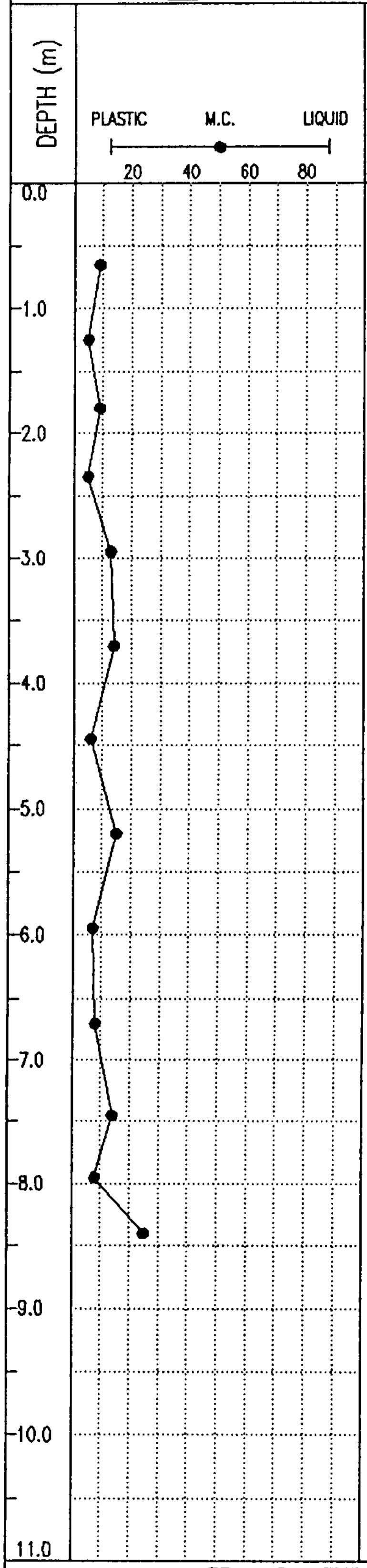
Hardy BBT Limited Calgary, Alberta	COMPLETION DEPTH 3.9 m	COMPLETE 14/03/89
	LOGGED BY GB	DWG NO.

ILA GRANULAR RESOURCES INVENTORY
UTM ZONE: 8 N 521990.00 E638130.00
INAC – INUVIALUIT SETTLEMENT LANDS

1407 (CARIBOU HILLS)
MIDNIGHT SUN DRILLING – SOLID STEM AUGER
NODWELL MOUNTED CME 750

BOREHOLE No. 1407B016
Project No: CG10346
ELEVATION 0.00 (m)

SAMPLE TYPE ■ GRAB SAMPLE ⧄ ☒ ▤ ◫ ◫ CRREL CORE



GMC

2

2

2

SOIL DESCRIPTION

SAND(SP) – gravelly, medium to coarse grained, trace silt, rounded pebbles, light brown
... poorly graded (SP)
... increase in gravel and fines (SF)
... poorly graded, trace fines (SP)
... well graded, trace fines (SW–SF)

GRAVEL(GW–GF) – sandy, well graded

SAND(SW–SF) – gravelly, well graded, trace fines

GRAVEL(GP) – sandy, fine to medium grained, poorly graded, trace fines, rounded pebbles, light brown

SAND(SP–SF) – gravelly, medium to coarse grained, trace silt, rounded pebbles, light brown
... grey to light grey

END OF HOLE @ 8.8m

SAMPLE TYPE

SAMPLE NO

NRC ICE TYPE GRAIN SIZE

Nf
(0.3–1.0m) 19% gravel, 78% sand, 3% fines
(1.0–1.5m) 30% gravel, 56% sand, 14% fines
(1.5–2.1m) 33% gravel, 64% sand, 3% fines
(2.1–2.6m) 33% gravel, 60% sand, 7% fines
(2.6–3.3) 49% gravel, 44% sand, 7% fines
Nf
(3.3–4.1m) 42% gravel, 49% sand, 9% fines
(4.1–4.8m) 65% gravel, 31% sand, 4% fines
(4.8–5.6m) 36% gravel, 58% sand, 6% fines
(5.6–6.3m) 27% gravel, 61% sand, 12% fines
(6.3–7.1m) 39% gravel, 51% sand, 10% fines
Nbn
(7.1–7.8m) 23% gravel, 67% sand, 10% fines
(7.8–8.1m) 40% gravel, 56% sand, 4% fines; Nbe/Vx
(8.1–8.7m) 3% gravel, 89% sand, 8% fines
Nbn

DEPTH (m)
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
-9.0
-10.0
11.0

Hardy BBT Limited
Calgary, Alberta

COMPLETION DEPTH 8.8 m
COMPLETE 14/03/89
LOGGED BY BW
DWG NO.

APPENDIX B

Operational Calender - INAC Inuvialuit Granular Resource Investigations, March 1989

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

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: DIAND INUVIALUIT GRANULAR STUDY
PROJECT NO.: CG10346
LOCATION: CARIBOU HILLS (I407)

BOREHOLE #:	SAMPLE INTERVAL	%GRAVEL:	%SAND:	%FINES	D50	Cu	Cc	MOISTURE CONTENT %:	PETROGRAPHIC NUMBER (PN)	USC
I407B001	3.0 – 3.6	–	–	–				12.1		
I407B001	4.5 – 5.0	–	–	–				7.2		
I407B002	1.7 – 2.2	25	69	6	1.4	15	0.70	7.8	132	SP-SF
I407B002	4.2 – 4.7	23	69	8	1.1	20	0.58	9.8		SP-SF
I407B003	0.9 – 1.7	15	77	8	0.73	12	0.95	5.9		SP-SF
I407B003	1.7 – 2.0	–	–	–				14.1		
I407B003	2.2 – 2.4	–	–	–				17.0		
I407B003	2.7 – 3.5	–	–	–				24.1		
I407B003	4.7 – 5.2	5	86	9	0.25	4.0	1.30	24.2		SP-SF
I407B003	5.2 – 5.8	–	–	–				28.6		
I407B004	1.5 – 2.1	–	–	–				5.6		
I407B004	4.2 – 4.8	–	–	–				4.3		
I407B005	1.5 – 2.0	35	62	3	1.7	17	0.33	8.5	171	SP
I407B005	3.5 – 4.0	–	–	–				6.6		
I407B005	4.7 – 5.2	45	49	6	3.8	23	1.40	4.6	147	SW-SF
I407B006	1.5 – 2.1	–	–	–				15.0		
I407B007	1.5 – 2.1	33	59	8	1.9	30	0.90	7.2		SP-SF
I407B007	4.5 – 5.0	26	67	7	1.6	20	0.99	8.3		SP-SF
I407B008	4.5 – 5.1	–	–	–				9.2		
I407B009	1.5 – 2.1	30	45	25	1.1			20.4		SF
I407B009	4.0 – 4.5	29	65	6	1.9	16	0.66	30.0		SP-SF
I407B010	1.5 – 2.1	–	–	–				8.8		
I407B010	4.5 – 5.0	–	–	–				12.9		
I407B011	0.3	–	–	–				12.0		
I407B011	1.5 – 2.1	10	82	8	0.60	7.3	1.90	15.3		SW-SF

PROJECT: DIAND INUVIALUIT GRANULAR STUDY PROJECT NO.: CG10346
LOCATION: CARIBOU HILLS (I407)

BOREHOLE #:	SAMPLE INTERVAL	%GRAVEL:	%SAND:	%FINES	D50	Cu	Cc	MOISTURE CONTENT %:	PETROGRAPHIC NUMBER (PN)	USC
I407B011	2.9	–	–	–				209.5		
I407B011	4.5 – 5.0	3	78	19	0.50			27.0		SF
I407B012	1.5 – 2.1	19	69	12	0.66			11.4		SP–SF
I407B012	4.3 – 4.8	28	66	6	1.8	17	0.66	8.0		SP–SF
I407B013	2.0 – 2.7	30	66	4	1.6	15	0.57	8.0		SP
I407B014	1.5 – 2.1	19	78	3	.78	6.7	0.93	5.1		SP
I407B015	1.5 – 2.1	30	67	3	1.3	14	0.45	6.1		SP
I407B016	0.3 – 1.0	19	78	3	0.85	3.7	0.61	9.3		SP
I407B016	1.0 – 1.5	30	56	14	1.6			4.5		SF
I407B016	1.5 – 2.1	33	64	3	1.7	17	0.44	9.3		SP
I407B016	2.1 – 2.6	33	60	7	2.7	26	1.1	5.3		SW–SF
I407B016	2.6 – 3.3	49	44	7	4.5	42	1.3	4.6		GW–GF
I407B016	3.3 – 4.1	42	49	9	3.5	48	2.5	8.1	136	SW–SF
I407B016	4.1 – 4.8	65	31	4	6.5	21	4.4	4.5		GP
I407B016	4.8 – 5.6	36	58	6	2.4	22	0.84	9.2		SP–SF
I407B016	5.6 – 6.3	27	61	12	1.9			6.9		SP–SF
I407B016	6.3 – 7.1	39	51	10	2.0	55	0.84	8.1		SP–SF
I407B016	7.1 – 7.8	23	67	10	0.78	23	0.51	10.0		SP–SF
I407B016	7.8 – 8.1	40	56	4	3.1	18	0.98	8.0		SP–SF
I407B016	8.1 – 8.7	3	89	8	58	2.5	1.4	24.5		SP–SF

FILE: CG10346
CLIENT: INAC

PREPARED BY: BF
DATE: June 16, 1989

SAMPLE: I407B002
1.7 – 2.2 m and 4.2 –4.7 m (combined)

LITHOLOGIC/MINEROLOGIC DESCRIPTION	Chemical Quality	Physical Quality	PN MULT.	WEIGHTED PERCENT IN EACH FRACTION							Total Weighed Composition %	PN # Contribution
						3/4"	5/8"	1/2"	3/8"	#4		
Quartzite/Sandstone	Good	Good	1			4.4	1.6	6.3	12.6	40.9	65.8	65.8
Metamorphic/Volcanic	Good	Good	1					1.9	3.7	9.4	15.0	15.0
Crystalline	Good	Good	1				0.8	0.4		0.7	1.9	1.9
Carbonate	Good	Good	1						0.3	0.9	1.2	1.2
Sandstone, moderately strong	Good	Moderately Good	1.5			1.5		0.4	0.8	0.9	3.6	5.4
Sandstone, weathered		Fair	3							1.0	1.0	3.0
Carbonate, weathered		Fair	3							0.2	0.2	0.6
Shale/Mudstone		Fair	3					0.8		0.3	1.1	3.3
Chert	Fair		3				1.6		1.4	5.6	8.6	25.8
Sandstone, highly weathered		Poor	6							0.3	0.3	1.8
Shale/Mudstone, weathered		Poor	6						0.6	0.5	1.1	6.6
Ironstone	Deleterious		10							0.2	0.2	2.0
Totals						5.9	4.0	9.8	19.4	60.9	100.0	132.4

PETROGRAPHIC NUMBER:
132

SUMMARY OF PETROGRAPHIC
EXAMINATION

FILE: CG10346
CLIENT: INAC

PREPARED BY: BF
DATE: June 2, 1989

SAMPLE: I407B005
1.5 – 2.1 m

LITHOLOGIC/MINEROLOGIC DESCRIPTION	Chemical Quality	Physical Quality	PN MULT.	WEIGHTED PERCENT IN EACH FRACTION							Total Weighed Composition %	PN # Contribution
							3/4" + 5/8"	1/2"	3/8"	#4		
Quartzite/Sandstone	Good	Good	1				6.5	12.4	10.6	23.7	53.2	53.2
Metamorphic/Volcanic	Good	Good	1				4.8	1.4	3.0	6.0	15.2	15.2
Crystalline	Good	Good	1						0.7		0.7	0.7
Carbonate	Good	Good	1						0.3	0.8	1.1	1.1
Sandstone, moderately strong	Good	Moderately Good	1.5							1.8	1.8	2.7
Sandstone, weathered		Fair	3						0.3	0.7	1.0	3.0
Chert	Fair		3				4.8	4.1	4.4	7.6	20.9	62.7
Shale/Mudstone		Fair	3					1.4	0.3	1.6	3.3	9.9
Carborate, weathered		Fair	3							0.2	0.2	0.6
Sandstone, highly weathered		Poor	6							0.3	0.3	1.8
Shale/Mudstone, weathered		Poor	6							0.7	0.7	4.2
Mudstone Concretions	Deleterious		10				1.6				1.6	16.0
Totals							17.7	19.3	19.6	43.4	100.0	171.1

PETROGRAPHIC NUMBER:
171

SUMMARY OF PETROGRAPHIC
EXAMINATION

FILE: CG10346
CLIENT: INAC

PREPARED BY: BF
DATE: June 17, 1989

SAMPLE: I407B005
4.7 – 5.2 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		
Quartzite/Sandstone	Good	Good	1			8.6	3.0	7.2	10.6	36.7	66.1	66.1
Metamorphic/Volcanic	Good	Good	1			2.2	0.8	2.5	2.0	8.9	16.4	16.4
Crystalline	Good	Good	1			2.2	0.8				3.0	3.0
Carbonate	Good	Good	1							0.4	0.4	0.4
Sandstone, moderately strong	Good	Moderately Good	1.5				0.8	0.4	0.2	0.6	2.0	3.0
Sandstone, weathered		Fair	3							1.1	1.1	3.3
Shale/Mudstone		Fair	3							1.5	1.5	4.5
Chert	Fair		3				0.8	1.1	1.3	2.1	5.3	15.9
Sandstone, highly weathered		Poor	6						0.2	0.4	0.6	3.6
Shale/Mudstone, weathered		Poor	6						1.0	0.4	1.4	8.4
Ironstone	Deleterious		10			2.2					2.2	22.0
Totals						15.2	6.2	11.2	15.3	52.1	100.0	146.6

PETROGRAPHIC NUMBER:
147

SUMMARY OF PETROGRAPHIC
EXAMINATION

FILE: CG10346
CLIENT: INAC

PREPARED BY: BF
DATE: June 16, 1989

SAMPLE: I407B016
2.6 – 4.8 m (combined)

LITHOLOGIC/MINEROLOGIC DESCRIPTION	Chemical Quality	Physical Quality	PN MULT.	WEIGHTED PERCENT IN EACH FRACTION							Total Weighed Composition %	PN # Contribution
						3/4"	5/8"	1/2"	3/8"	#4		
Quartzite/Sandstone	Good	Good	1			0.7	3.5	6.8	16.8	30.3	58.1	58.1
Metamorphic/Volcanic	Good	Good	1			2.1	1.0	2.2	3.9	14.0	23.2	23.2
Crystalline	Good	Good	1						0.3		0.3	0.3
Sandstone, moderately strong	Good	Moderately Good	1.5			0.7		0.2		0.6	1.5	2.3
Sandstone, weathered		Fair	3							1.5	1.5	4.5
Shale/Mudstone		Fair	3				0.7	0.4		0.4	1.5	4.5
Chert	Fair		3			0.6	1.4	1.1	3.6	6.9	13.6	40.8
Sandstone, highly weathered		Poor	6						0.3		0.3	1.8
Totals						4.1	6.6	10.7	24.9	53.7	100.0	135.5

PETROGRAPHIC NUMBER:
136

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
11C1 Place DuPortage, Phase III
11 Laurier Street
Hull, Quebec
K1A 0S5

PROJECT Inuvialuit Gravel Study

SOURCE: I407 - Combined
Bore Hole #16
SAMPLE I.D. Pit Run Material
SAMPLED BY: Client
DATE SAMPLED: -
DATE RECEIVED: May 29, 1989
DATE TESTED: Aug. 29, 1989

MATERIAL GRADING: "B"

ACTUAL SIEVE SIZES	AMOUNT
– +	g
– +	g
– 19.0 mm (3/4") + 12.5 mm (1/2")	2500.9 g
– 12.5 mm (1/2") + 9.5 mm (3/8")	2500.1 g

NO. OF REVOLUTIONS	500	TOTAL SAMPLE	5001.0 g
NO. OF SPHERES	11	+ #12 MATERIAL AFTER	4026.3 g
WT. OF SPHERES	4564.5	- #12 MATERIAL AFTER	974.7 g
LOSS AT 100 REVOLUTIONS	- %	LOSS AT 500 REVOLUTIONS	19.5 %
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) = 2.59
2. Absorption (%) = 1.11

ASTM C127

NOTE: Above sieve size weights modified to accommodate "B" Grading (ASTM C131)

Hardy BBT Limited
Per:

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 I407 - Combined Borehole #16
TYPE OF SAMPLE Pit Run Material
SAMPLED BY HBT - B.W.
DATE SAMPLED -
DATE RECEIVED May 29, 1989
DATE TESTED Aug. 30, 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.	4.9	0.01*	NO. 4	NO. 8		
1-1/2 In.	1 IN.	2.1	0.00*	NO. 8	NO. 16		
1 IN.	¾ IN.	6.4	0.01	NO. 16	NO. 30		
¾ IN.	½ IN.	16.1	0.22	NO. 30	NO. 50		
½ IN.	3/8 IN.	16.0	0.67	NO. 50	NO. 100		
3/8 IN.	NO. 4 IN	54.5	2.20	NO. 100			
TOTALS		100.0	3.11	TOTALS			

SIZE FRACTION	NO. PARTICLES		QUALITATIVE EXAMINATION OF PLUS ¾" MATERIAL
3/4" - 1"	ORIGINAL	30	Some cracking was observed throughout the sample
	FINAL	30	Some cracking was observed throughout the sample
1" - 1-½"	ORIGINAL		
	FINAL		
	ORIGINAL		
	FINAL		

COMMENTS: *Weighted Average Percent Loss Adjustment as per testing requirement.

REPORT CERTIFIED K.W. [illegible], 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

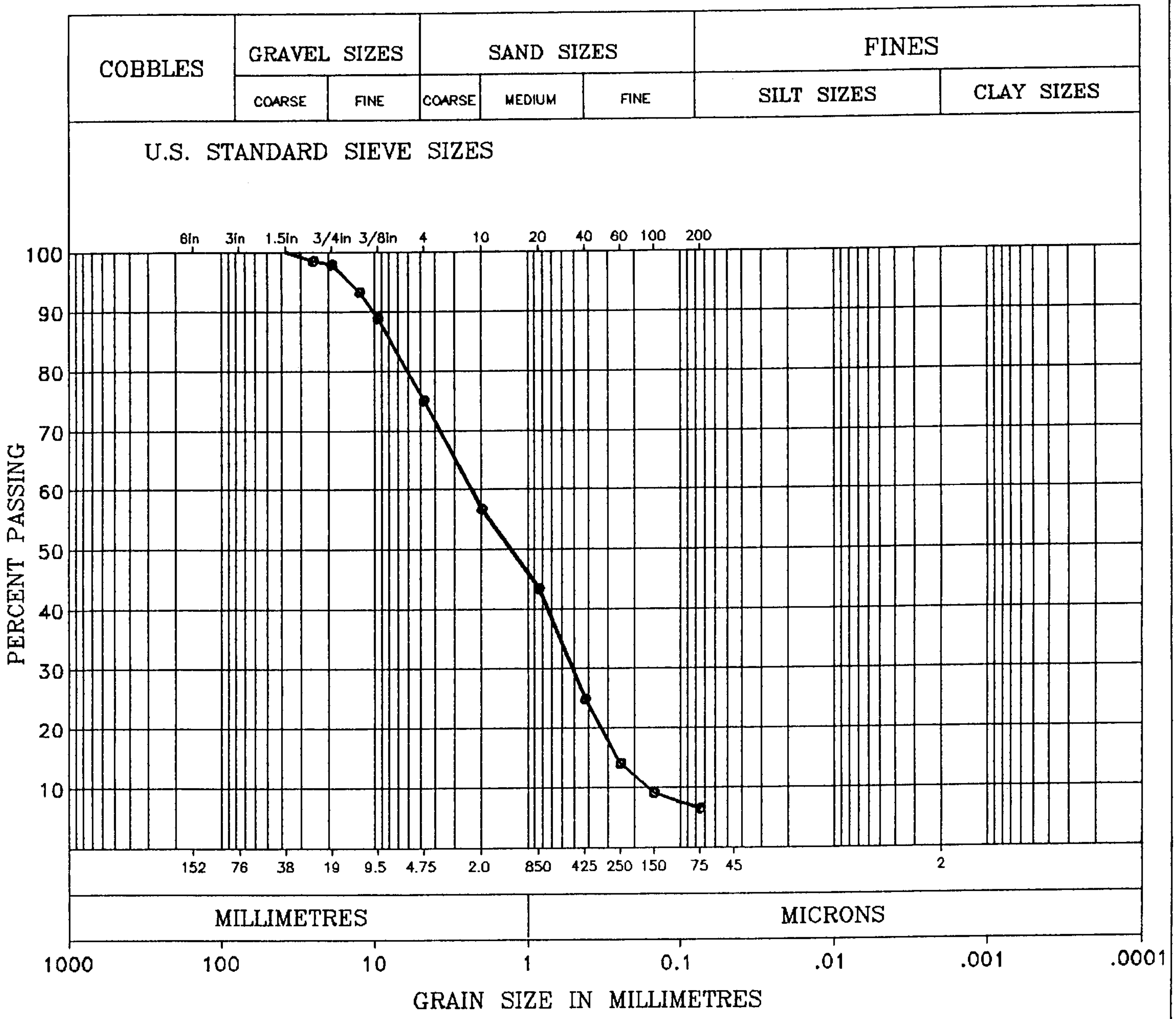
Report Certified

Hardy BBT Limited

Per:

Silvan Zorzut
Laboratory Supervisor
Chemical Sciences Division

SFZ/tyl



REMARKS:

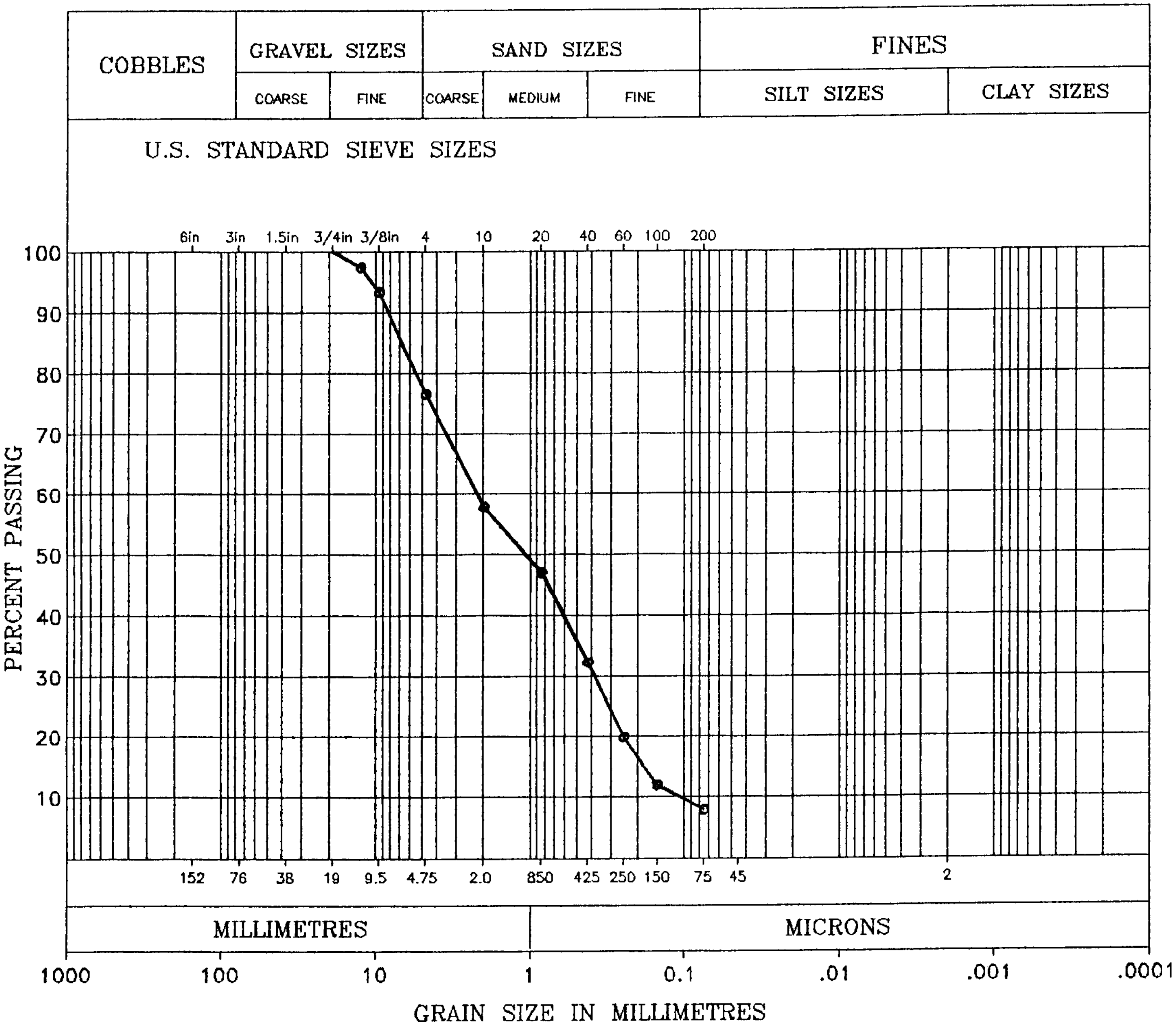
SUMMARY

D_{10} = 0.17 mm	GRAVEL	25. %
D_{30} = 0.54 mm	SAND	69. %
D_{60} = 2.5 mm	FINES	6. %
C_U = 15.		
C_C = 0.70		

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B002
SAMPLE:
DEPTH: 1.7 – 2.2 m
TECHNICIAN: JB
DATE: 89.04.18



REMARKS:

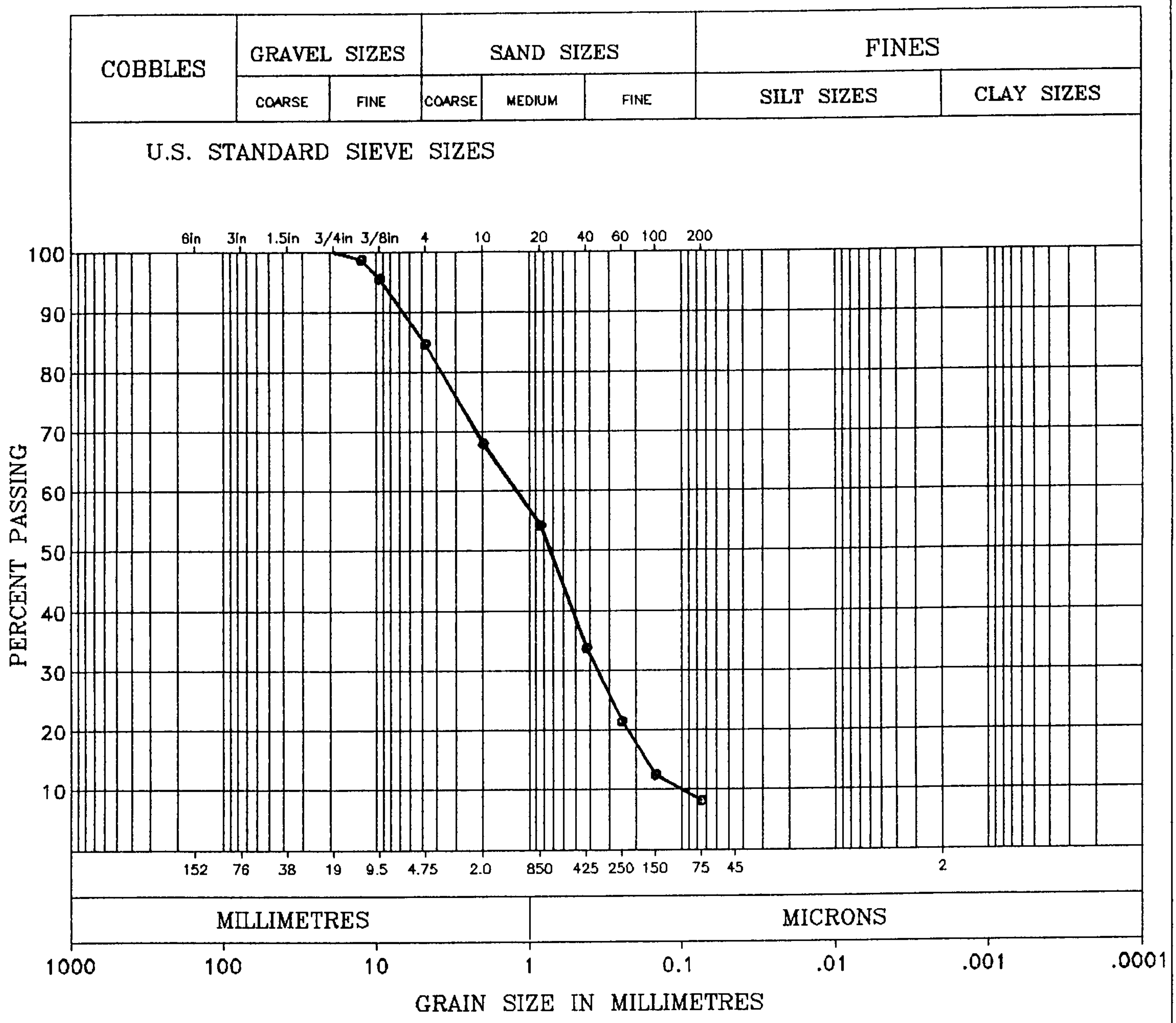
SUMMARY

D_{10} = 0.12 mm	GRAVEL	23. %
D_{30} = 0.39 mm	SAND	69. %
D_{60} = 2.3 mm	FINES	8. %
C_U = 20.		
C_C = 0.58		

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B002
SAMPLE:
DEPTH: 4.2–4.7 m
TECHNICIAN: JB
DATE: 89.04.18



REMARKS:

SUMMARY

D_{10} = 0.11 mm

D_{30} = 0.37 mm

D_{60} = 1.3 mm

C_U = 12.

C_C = 0.95

GRAVEL 15. %

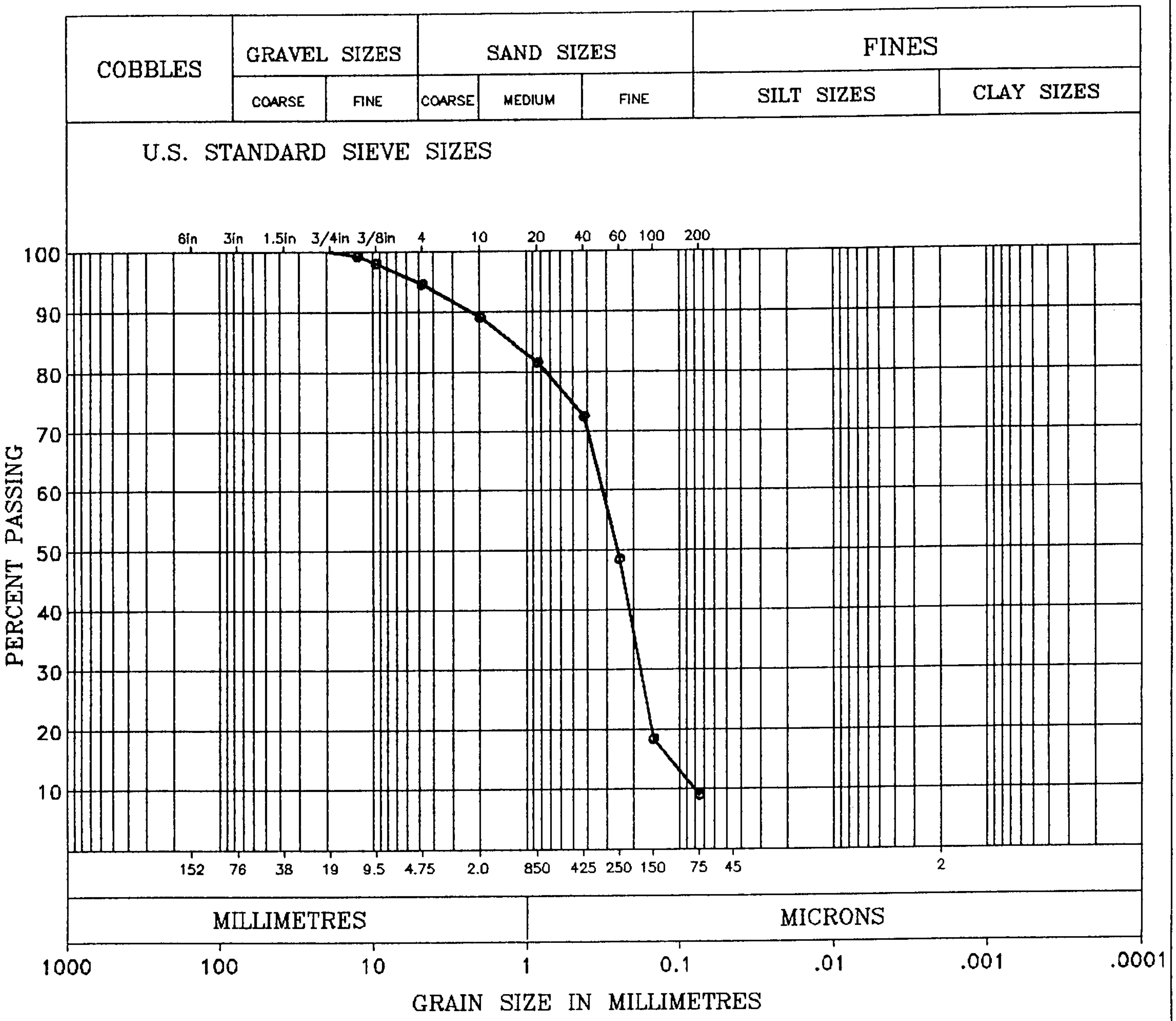
SAND 77. %

FINES 8. %

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B003 SAMPLE:
DEPTH: 0.9 - 1.7 m
TECHNICIAN: JB DATE: 89.05.05



REMARKS:

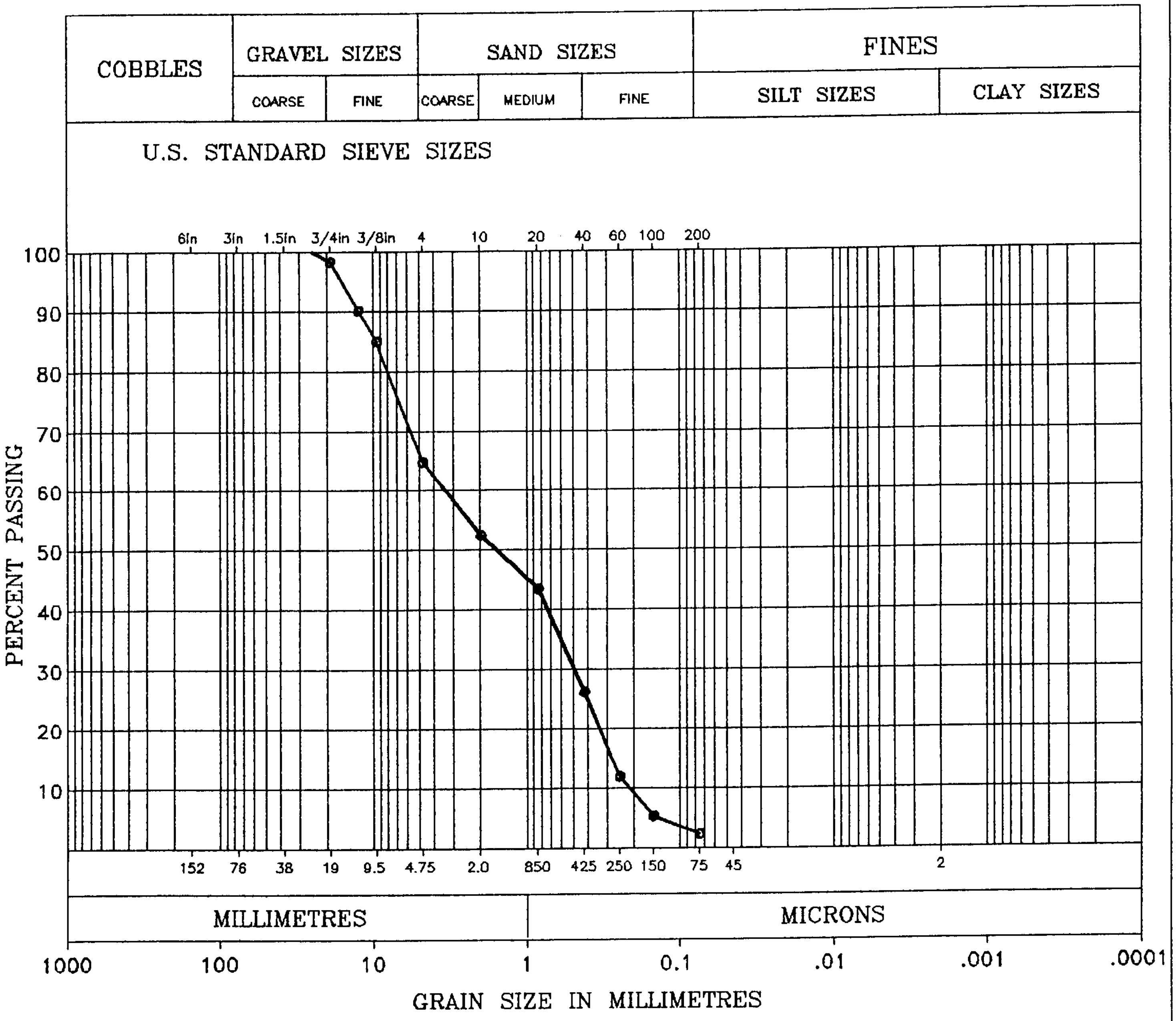
SUMMARY

D_{10} = 0.083 mm		GRAVEL	5. %
D_{30} = 0.19 mm		SAND	86. %
D_{60} = 0.33 mm		FINES	9. %
C_U = 4.0			
C_C = 1.3			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B003 SAMPLE:
DEPTH: 4.7 – 5.2 m
TECHNICIAN: JB DATE: 89.04.18



REMARKS:

SUMMARY

D_{10} = 0.22 mm

D_{30} = 0.52 mm

D_{60} = 3.7 mm

C_U = 17.

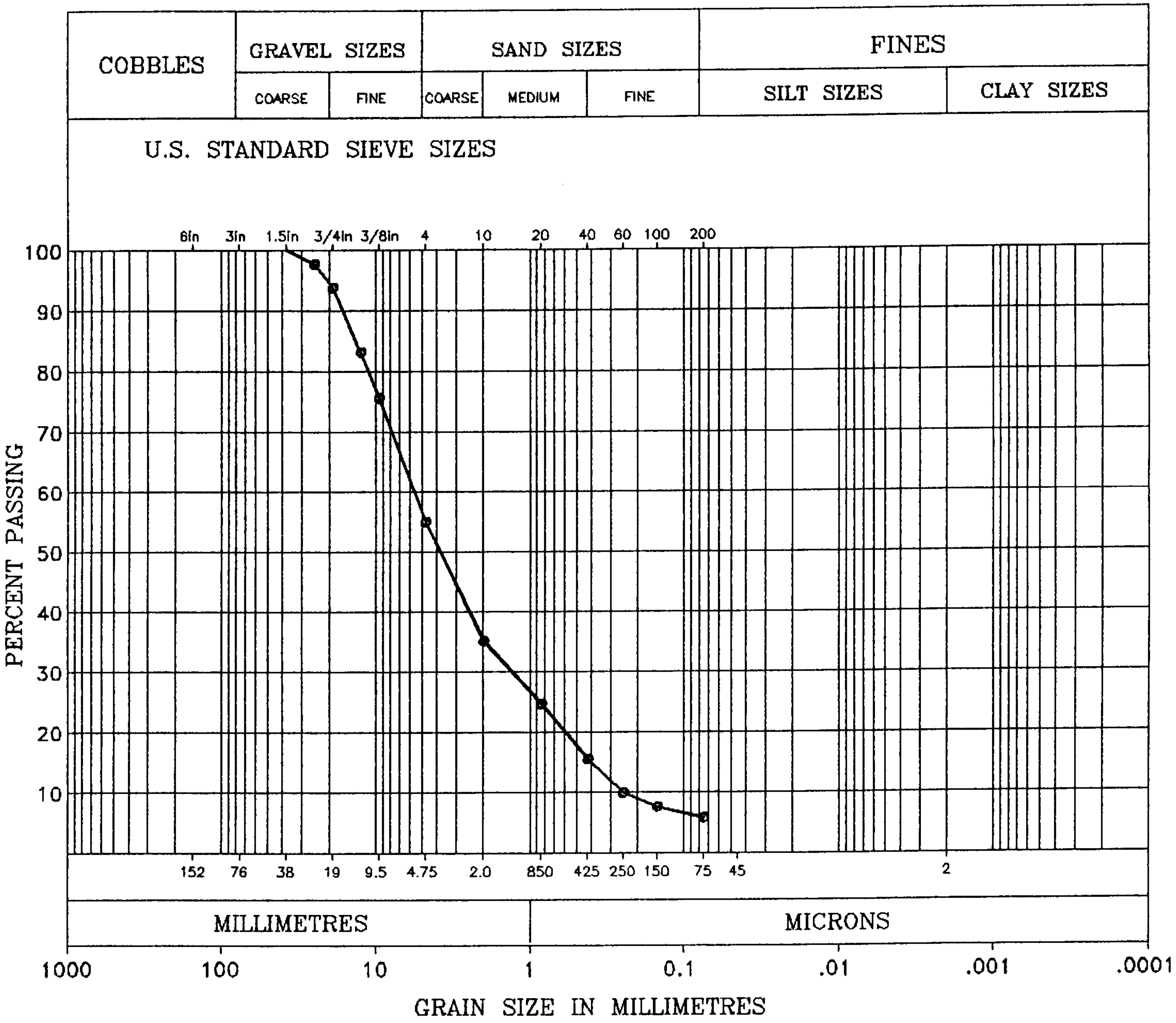
C_C = 0.33

GRAVEL	35. %
SAND	62. %
FINES	3. %

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: I407
HOLE: B005
SAMPLE:
DEPTH: 1.5 – 2.0 m
TECHNICIAN: JB
DATE: 89.04.18



REMARKS:

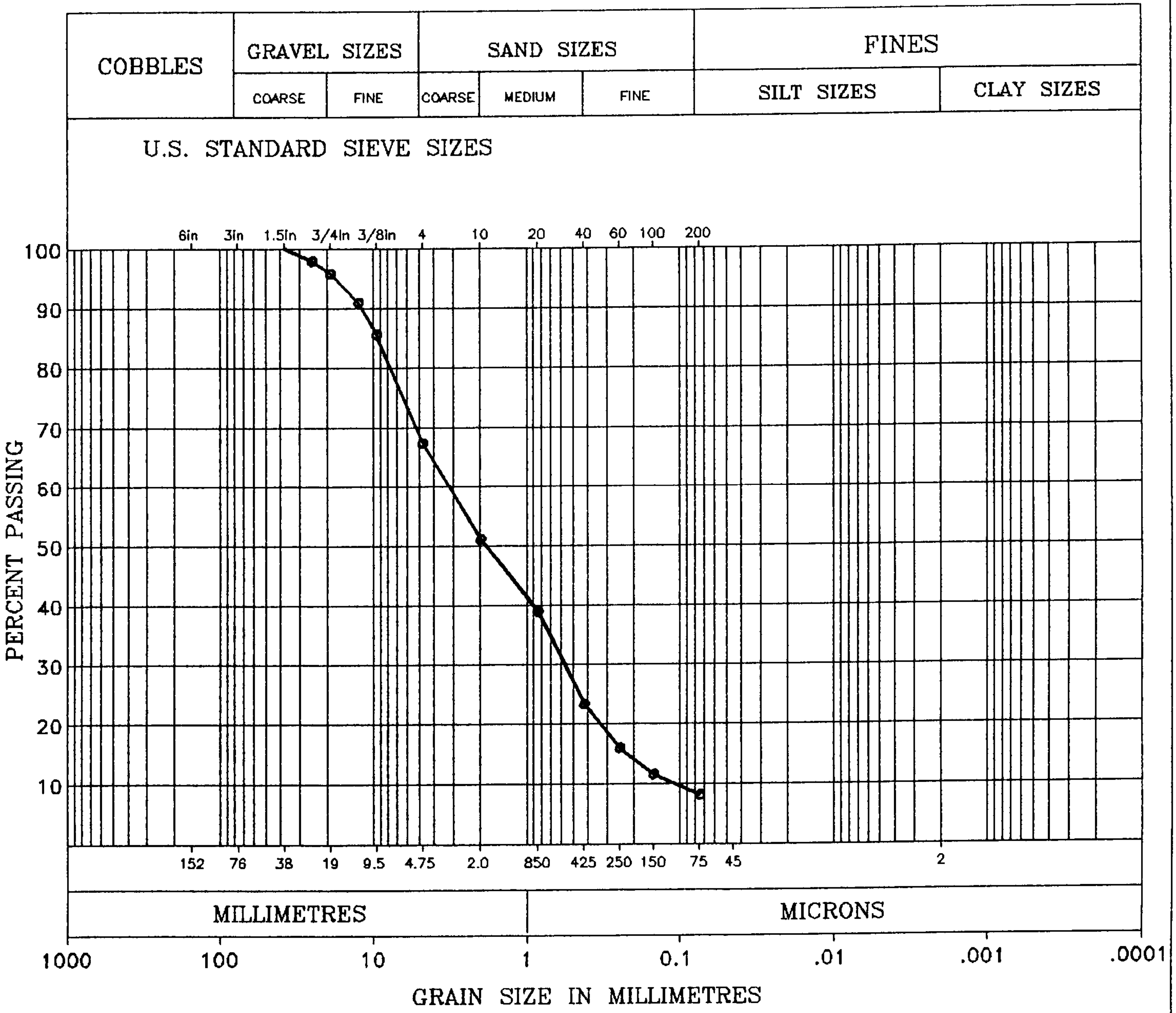
SUMMARY

D_{10} = 0.25	mm	GRAVEL	45. %
D_{30} = 1.4	mm	SAND	49. %
D_{60} = 5.9	mm	FINES	6. %
C_U = 23.			
C_C = 1.4			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B005 SAMPLE:
DEPTH: 4.7 – 5.2 m
TECHNICIAN: JB DATE: 89.04.18



REMARKS:

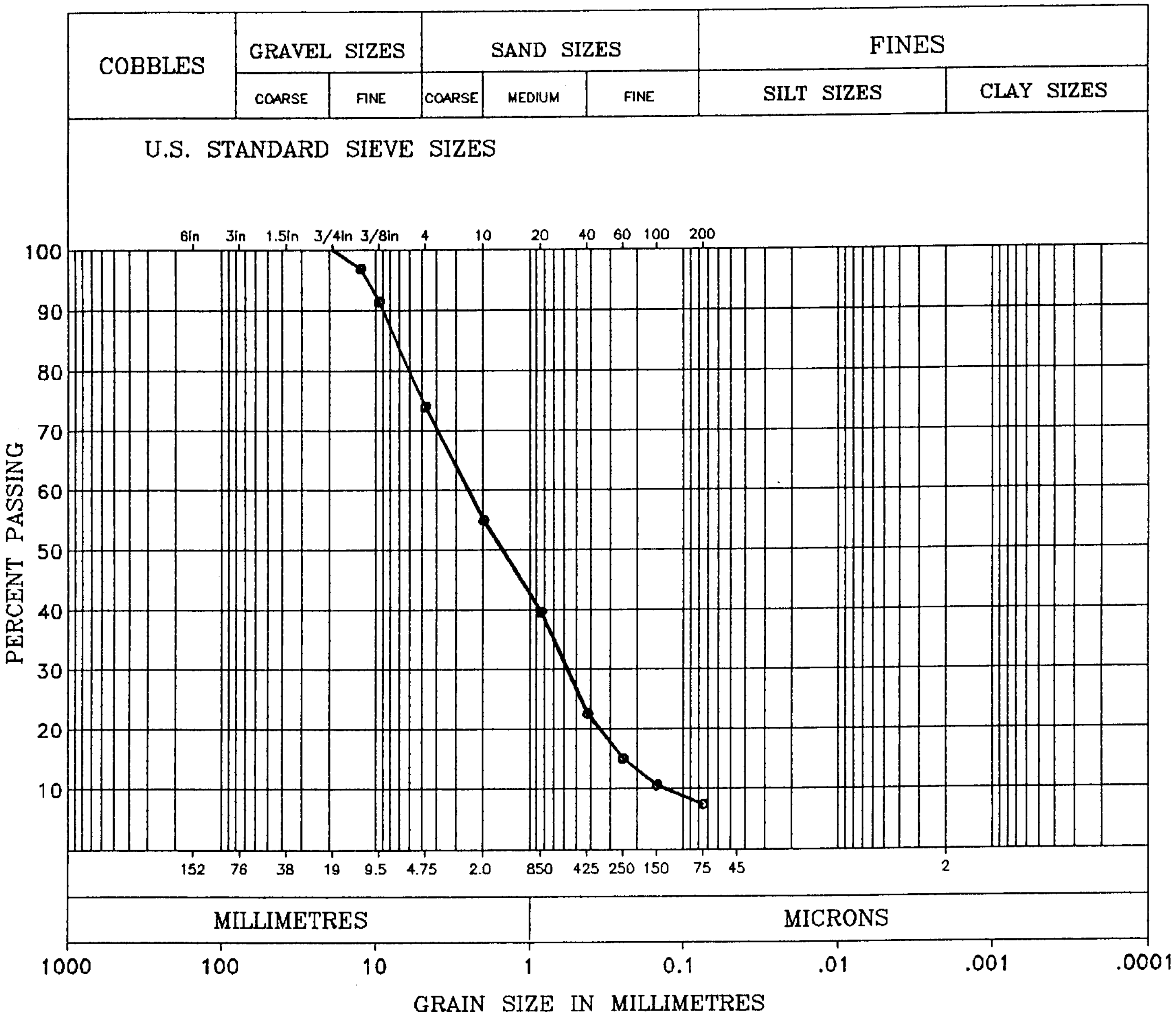
SUMMARY

D_{10} = 0.12	mm	GRAVEL	33.	%
D_{30} = 0.61	mm	SAND	59.	%
D_{60} = 3.5	mm	FINES	8.	%
C_U = 30.				
C_C = 0.90				

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B007 SAMPLE:
DEPTH: 1.5 – 2.1 m
TECHNICIAN: JB DATE: 89.04.18



REMARKS:

SUMMARY

D_{10} = 0.14 mm

D_{30} = 0.61 mm

D_{60} = 2.7 mm

C_U = 20.

C_C = 0.99

GRAVEL 26. %

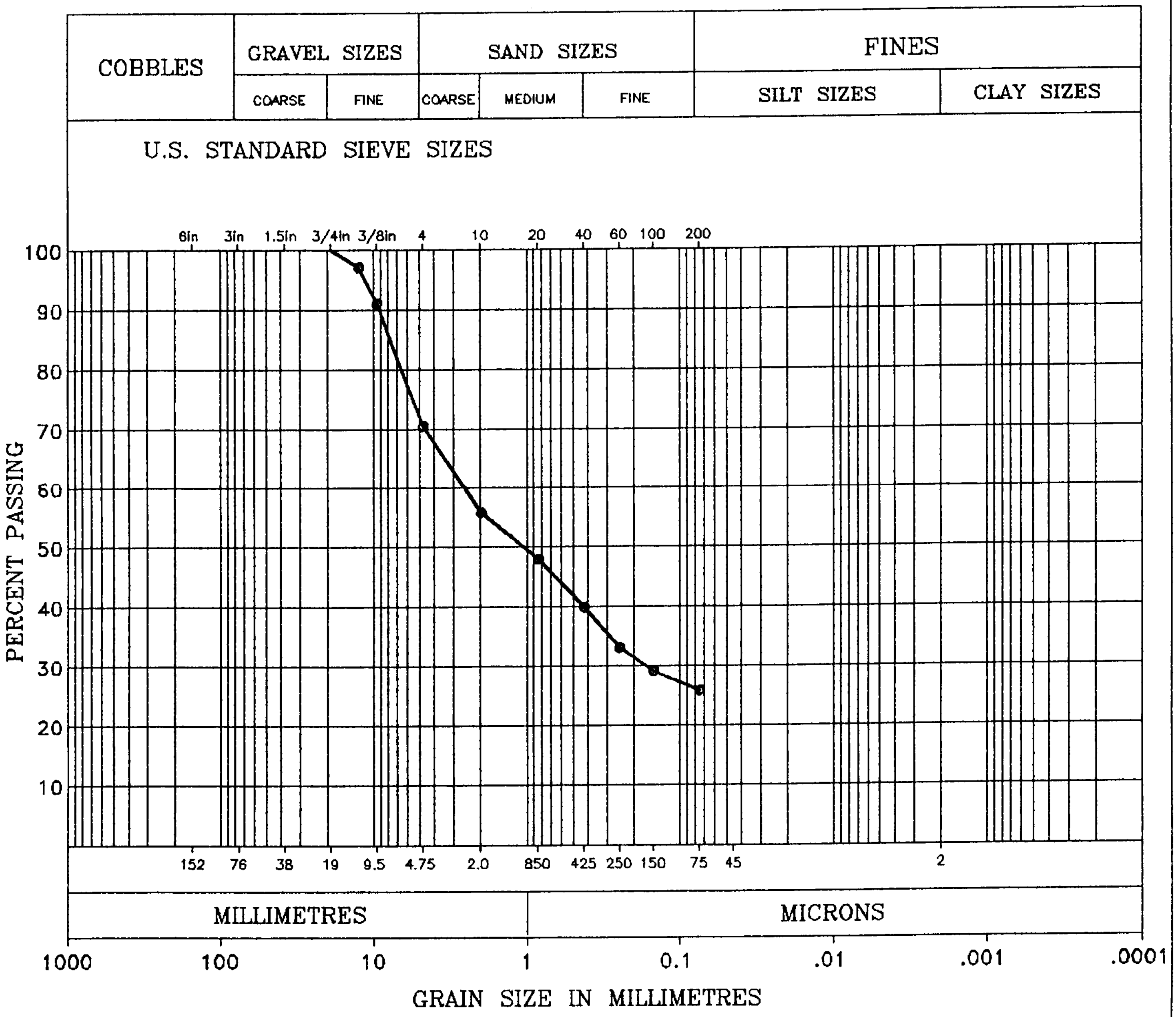
SAND 67. %

FINES 7. %

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B007 SAMPLE:
DEPTH: 4.5 – 5.0 m
TECHNICIAN: JB DATE: 89.04.18



REMARKS:

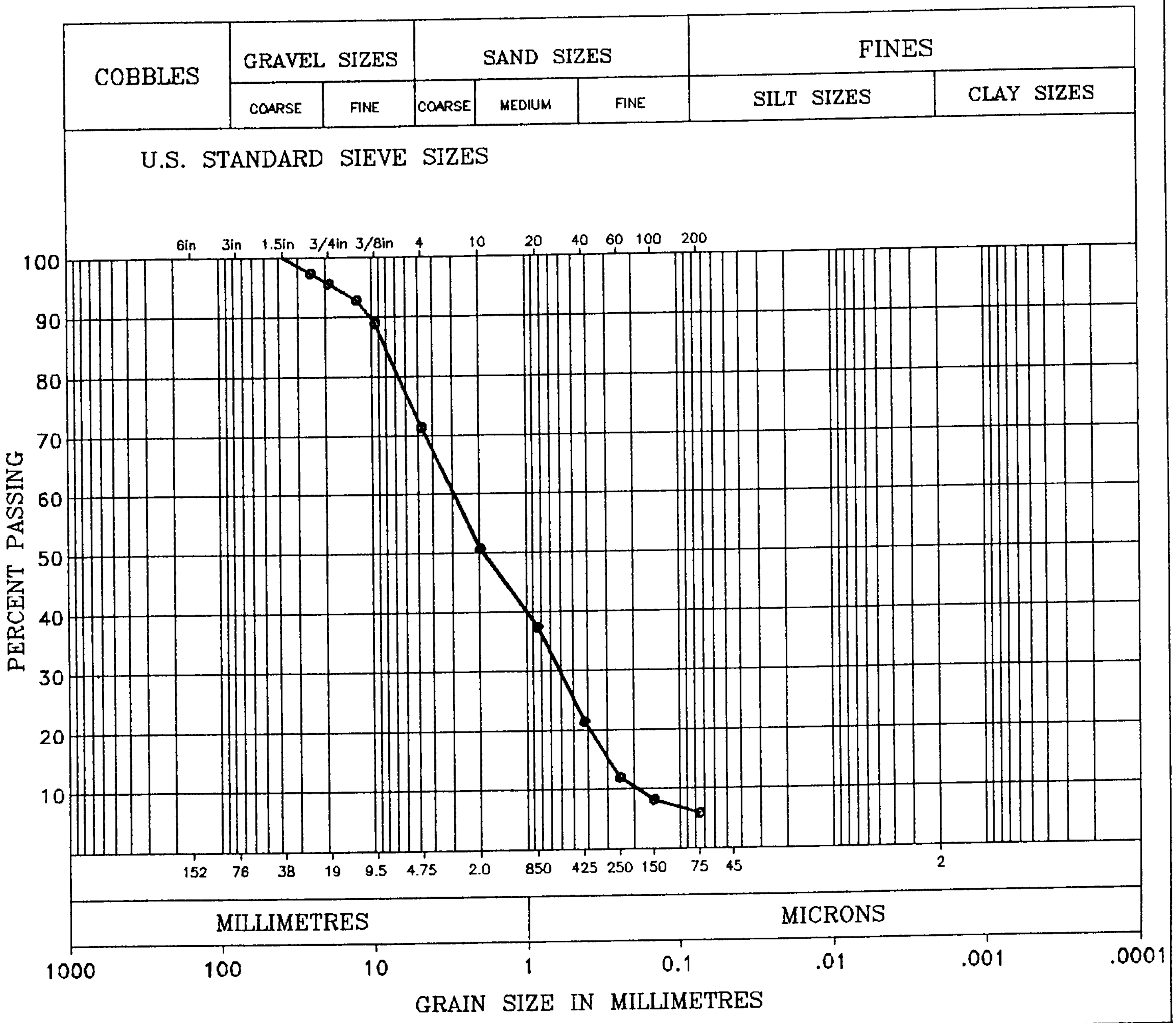
SUMMARY

D_{10} =	mm	GRAVEL	30. %
D_{30} = 0.17	mm	SAND	45. %
D_{60} = 2.8	mm	FINES	25. %
C_U =			
C_C =			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B009
SAMPLE:
DEPTH: 1.5 – 2.1 m
TECHNICIAN: JB
DATE: 89.04.18



REMARKS:

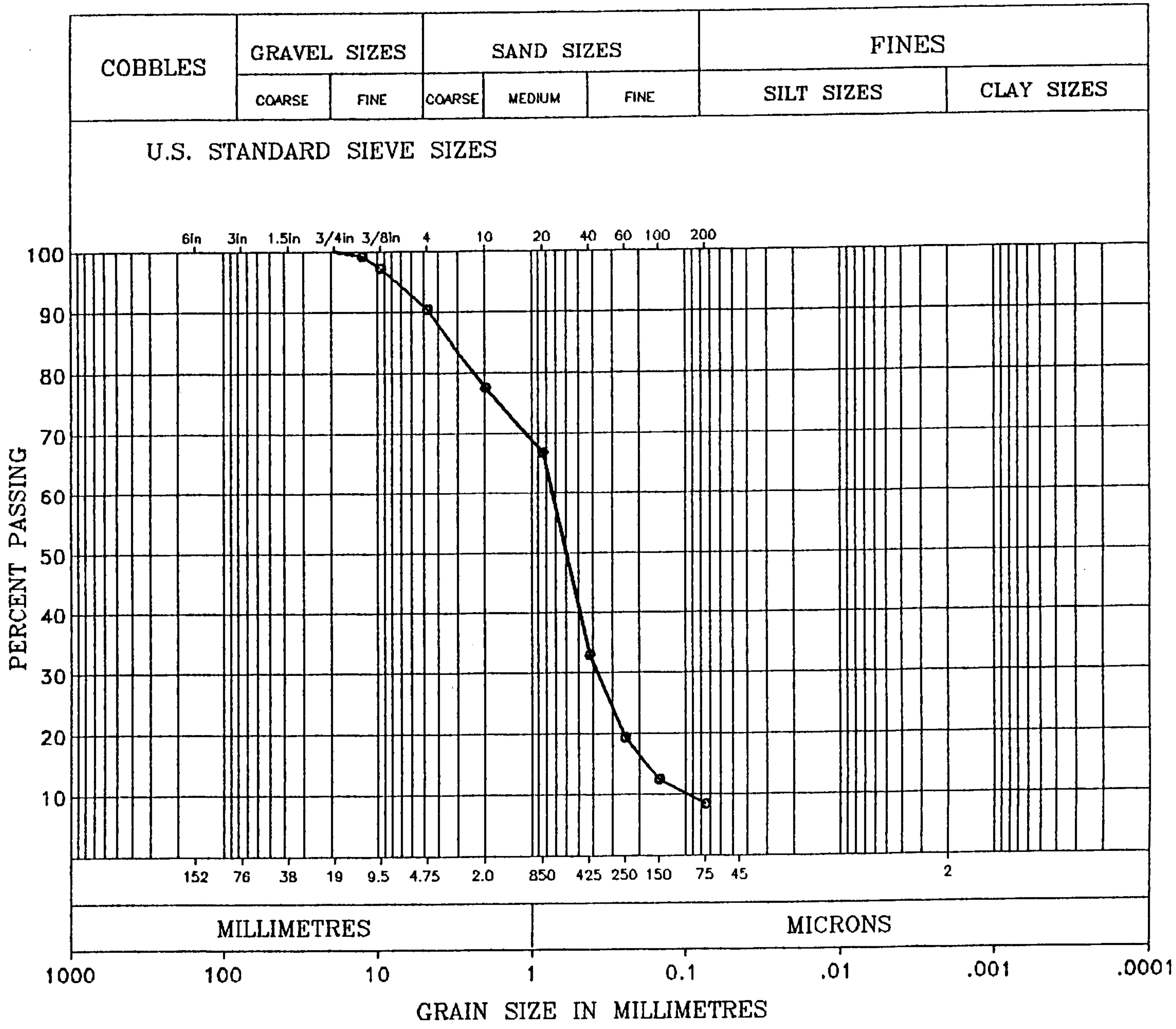
SUMMARY

D_{10} = 0.20 mm	GRAVEL	29. %
D_{30} = 0.65 mm	SAND	65. %
D_{60} = 3.2 mm	FINES	6. %
C_U = 16.		
C_C = 0.66		

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B009
SAMPLE:
DEPTH: 4.0 - 4.5 m
TECHNICIAN: JB
DATE: 89.04.18



REMARKS:

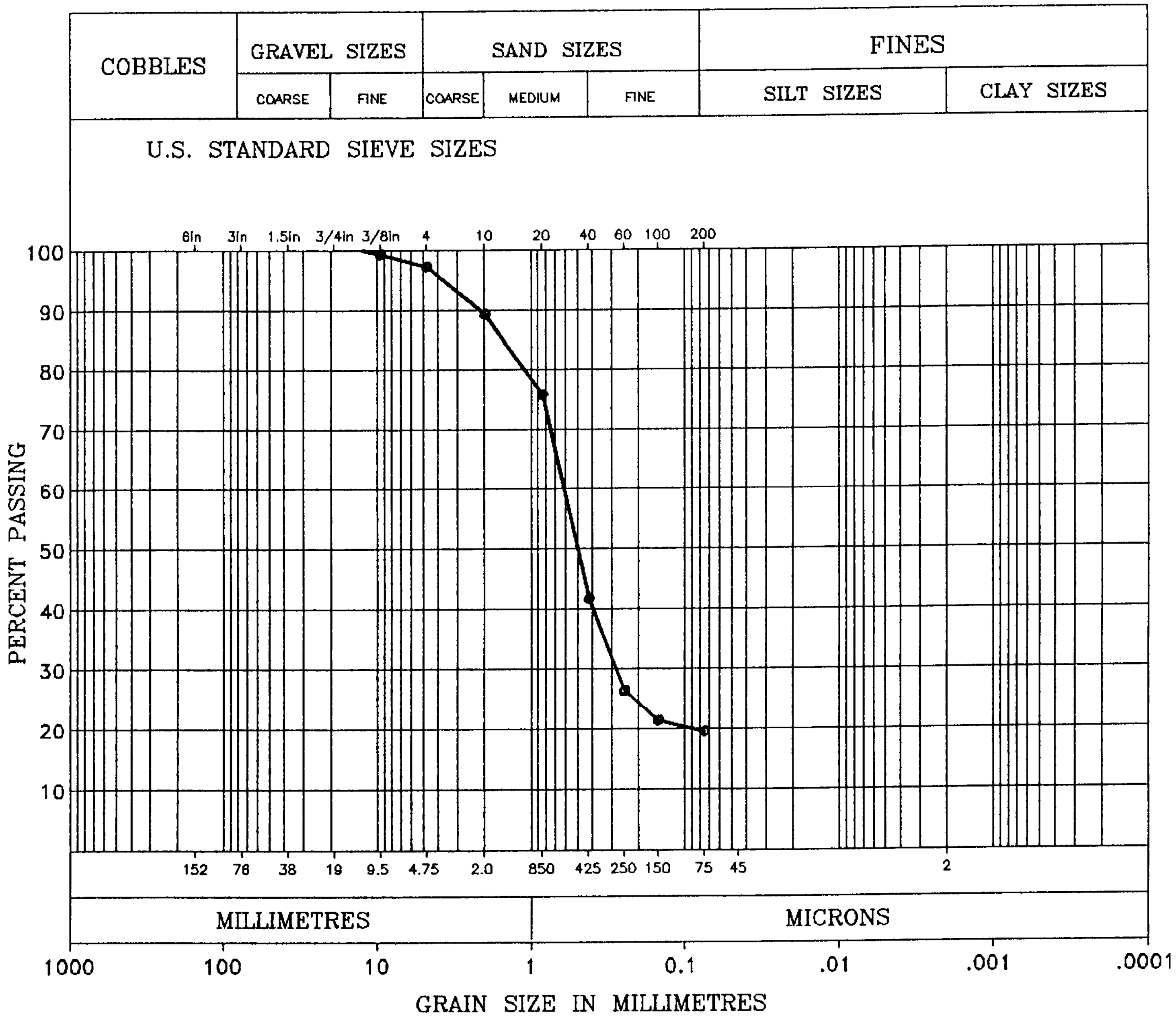
SUMMARY

D_{10} = 0.10	mm	GRAVEL	10. %
D_{30} = 0.39	mm	SAND	82. %
D_{60} = 0.77	mm	FINES	8. %
C_U = 7.3			
C_C = 1.9			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B011 SAMPLE:
DEPTH: 1.5–2.1 m
TECHNICIAN: JB DATE: 89.04.20



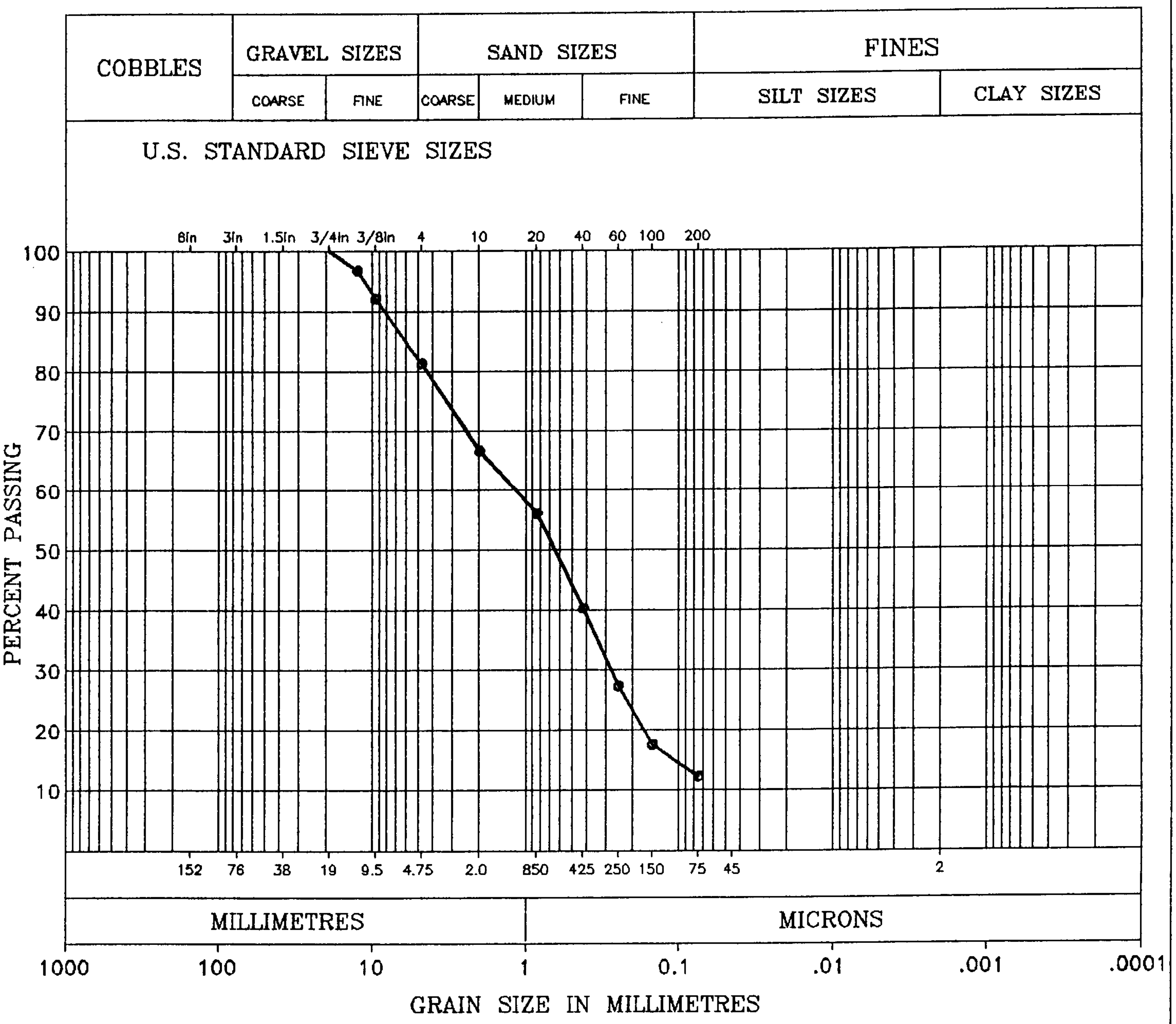
REMARKS:

SUMMARY			
D_{10} =	mm	GRAVEL	3. %
D_{30} = 0.29	mm	SAND	78. %
D_{60} = 0.65	mm	FINES	19. %
C_U =			
C_C =			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B011 SAMPLE:
DEPTH: 4.5 – 5.0 m
TECHNICIAN: JB DATE: 89.04.20



REMARKS:

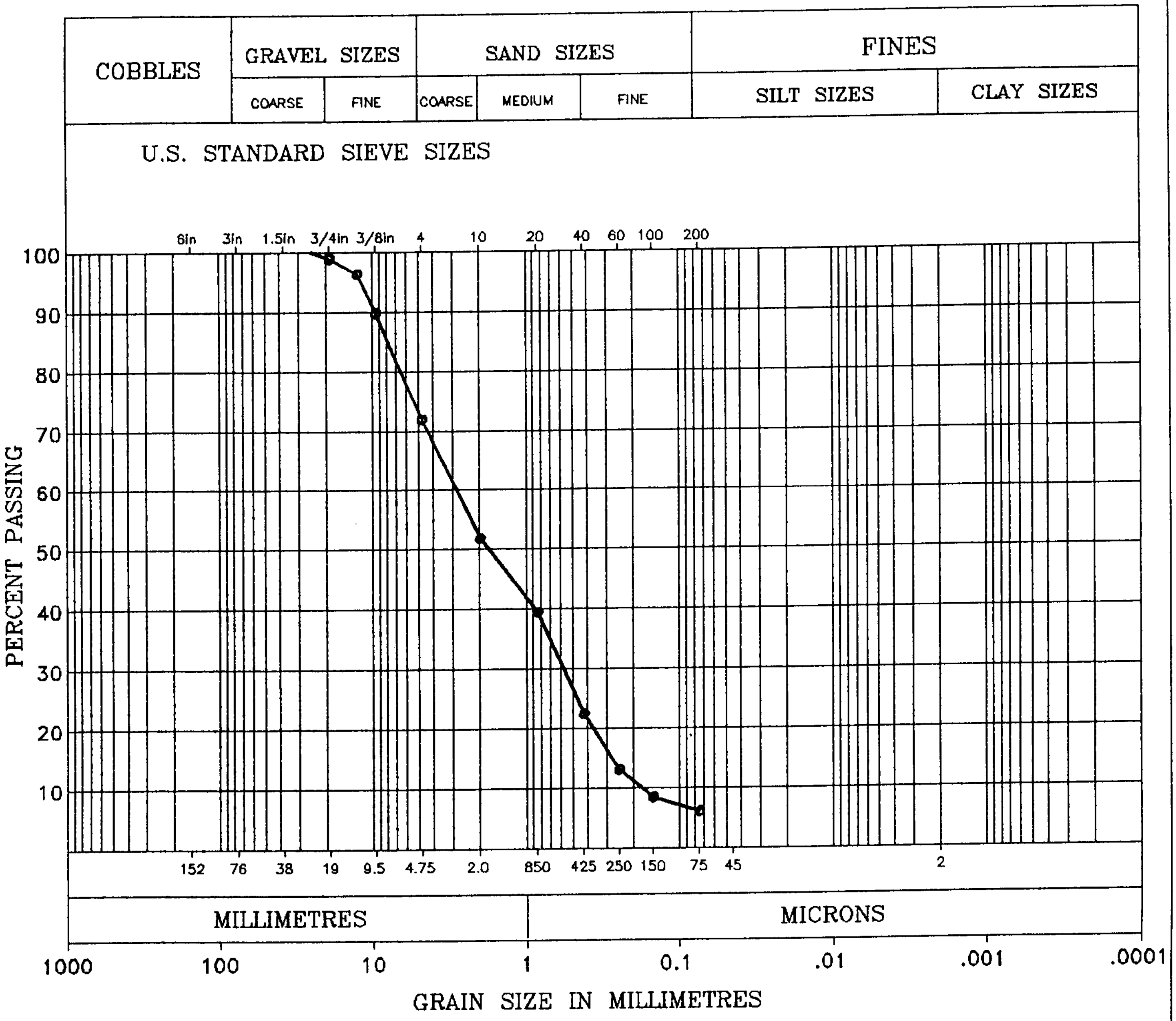
SUMMARY

D_{10} =	mm	GRAVEL	19. %
D_{30} = 0.29	mm	SAND	69. %
D_{60} = 1.3	mm	FINES	12. %
C_U =			
C_C =			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B012 SAMPLE:
DEPTH: 1.5 – 2.1 m
TECHNICIAN: JB DATE: 89.04.20



REMARKS:

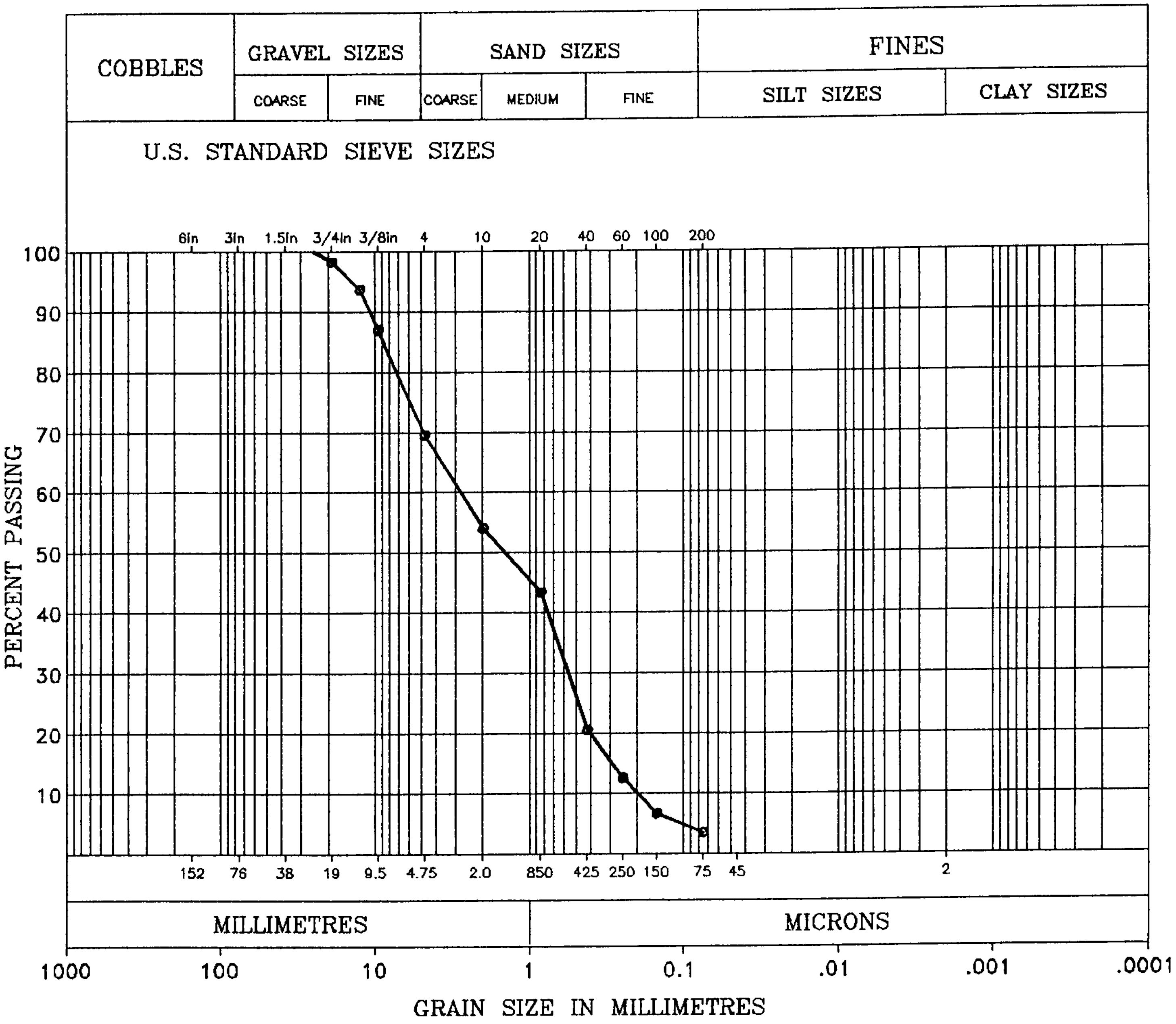
SUMMARY

D_{10} = 0.18 mm	GRAVEL 28. %
D_{30} = 0.61 mm	SAND 66. %
D_{60} = 3.1 mm	FINES 6. %
C_U = 17.	
C_C = 0.66	

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B012
SAMPLE:
DEPTH: 4.3 – 4.8 m
TECHNICIAN: JB
DATE: 89.04.20



REMARKS:

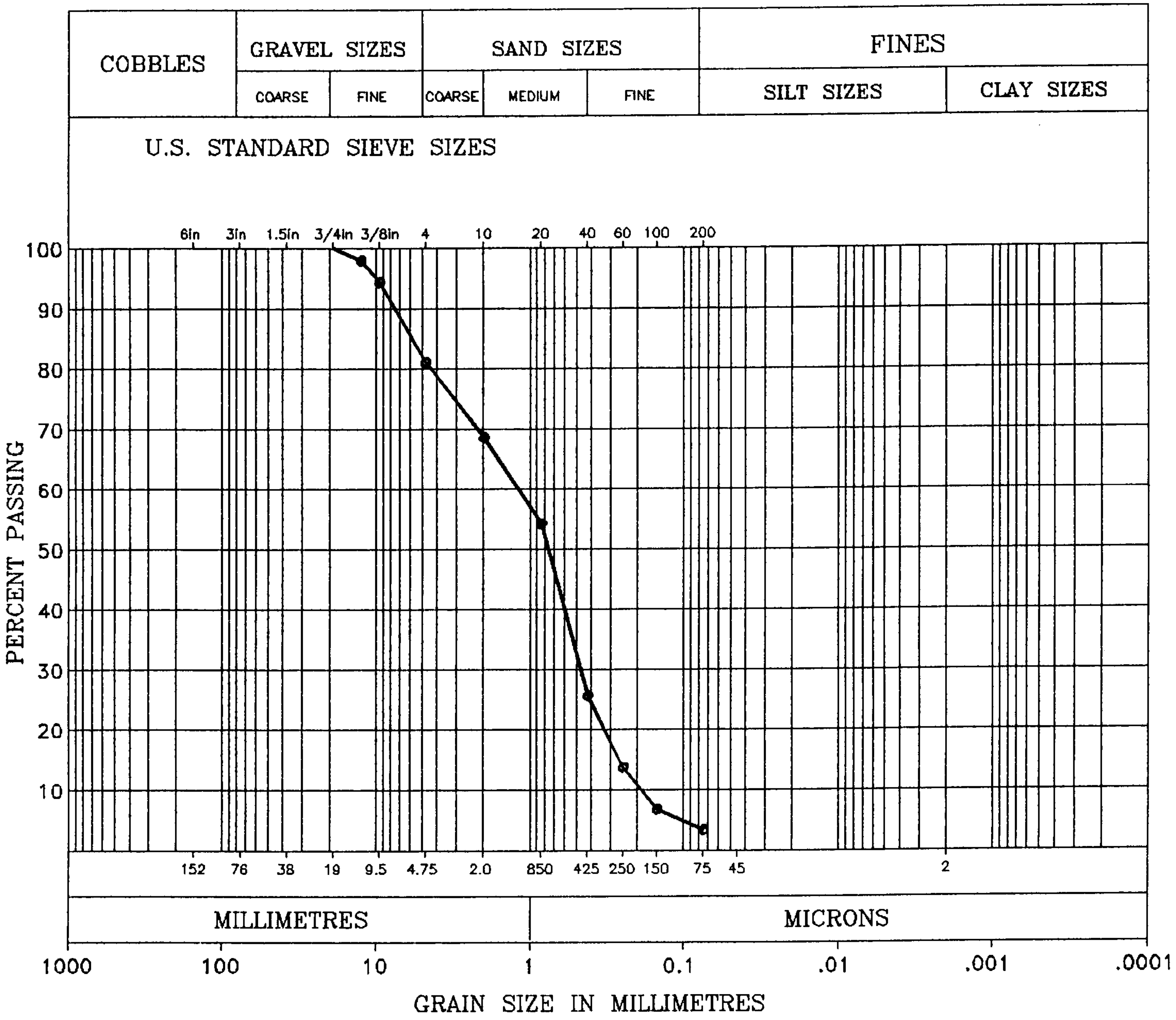
SUMMARY

D_{10} = 0.21 mm	GRAVEL	30. %
D_{30} = 0.60 mm	SAND	66. %
D_{60} = 3.1 mm	FINES	4. %
C_U = 15.		
C_C = 0.57		

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B013
SAMPLE:
DEPTH: 2.0 – 2.7 m
TECHNICIAN: JB
DATE: 89.04.20



REMARKS:

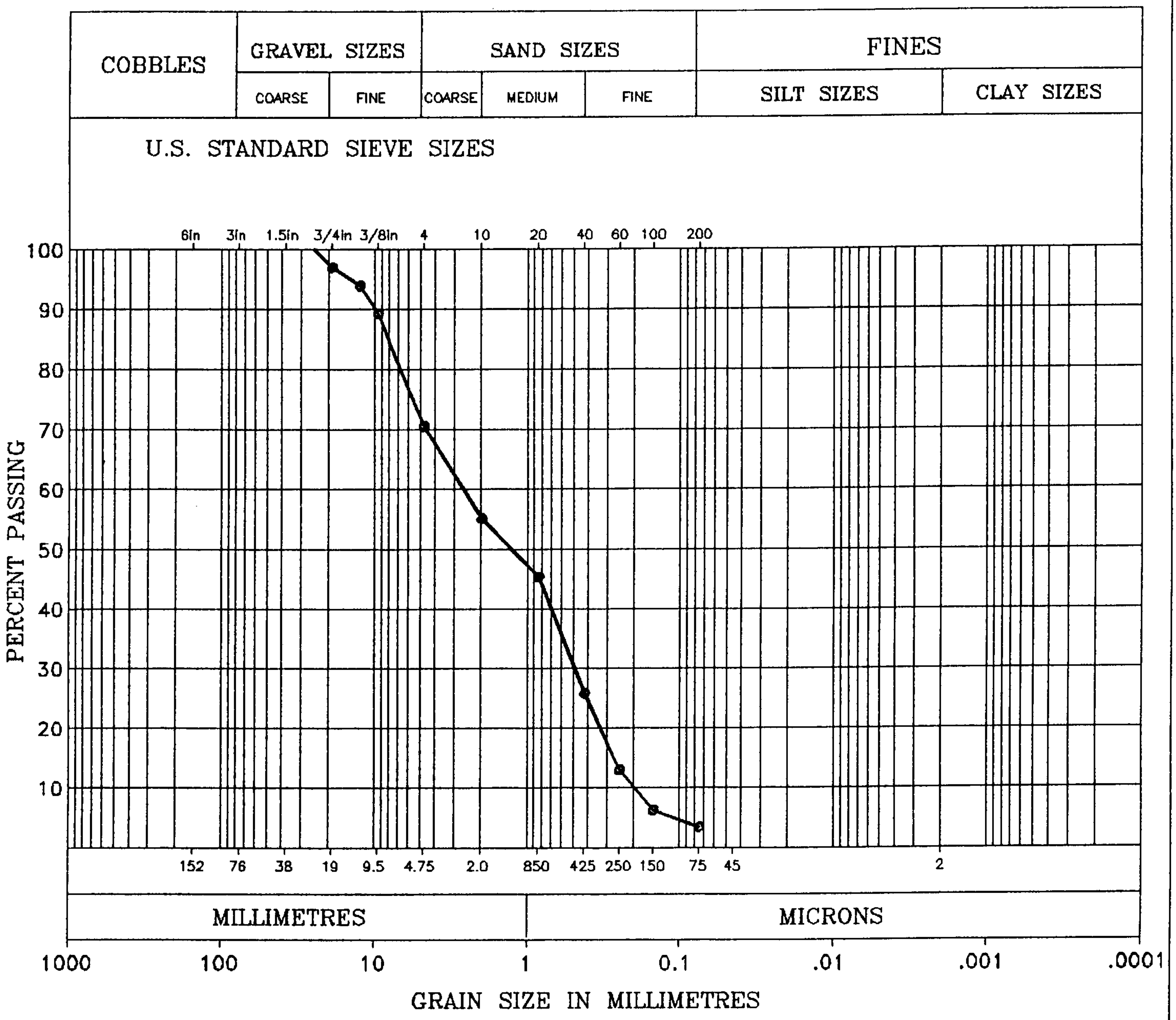
SUMMARY

D_{10} = 0.20	mm	GRAVEL	19. %
D_{30} = 0.49	mm	SAND	78. %
D_{60} = 1.3	mm	FINES	3. %
C_U = 6.7			
C_C = 0.93			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B014 SAMPLE:
DEPTH: 1.5 – 2.1 m
TECHNICIAN: JB DATE: 89.04.20



REMARKS:

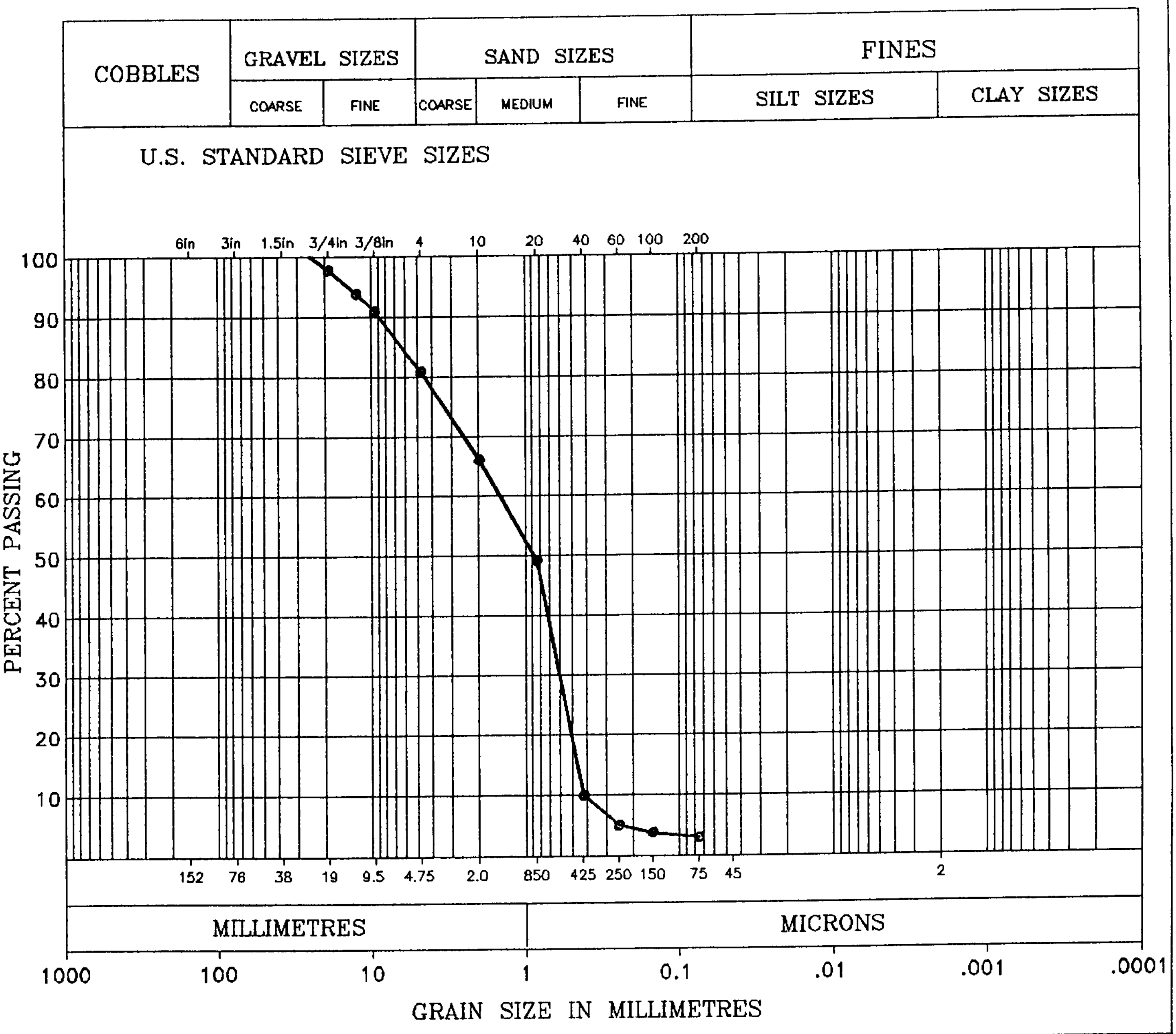
SUMMARY

D_{10} = 0.21	mm	GRAVEL	30. %
D_{30} = 0.52	mm	SAND	67. %
D_{60} = 2.9	mm	FINES	3. %
C_U = 14.			
C_C = 0.45			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B015 SAMPLE:
DEPTH: 1.5 – 2.1 m
TECHNICIAN: JB DATE: 89.04.20



REMARKS:

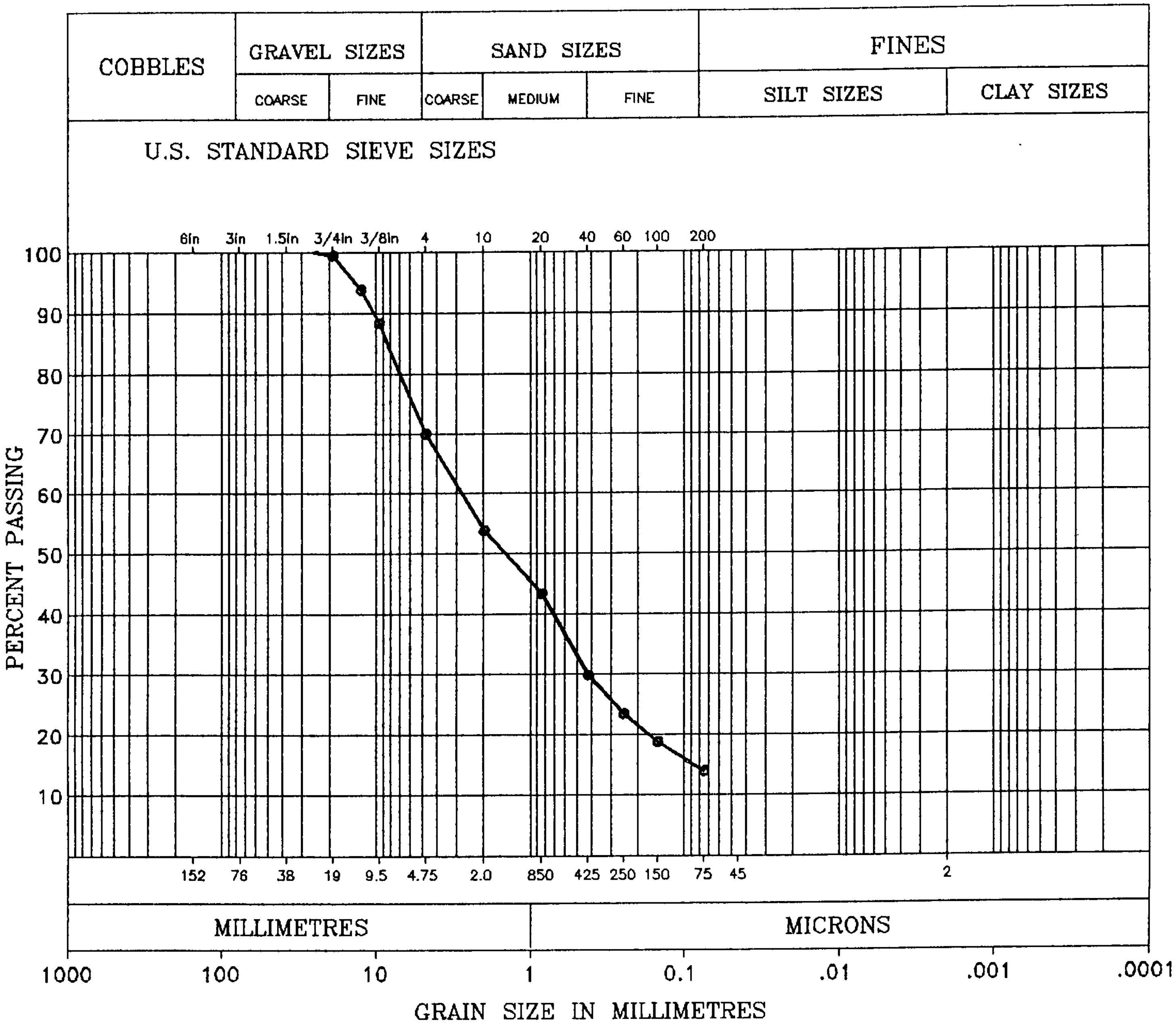
SUMMARY

D_{10} = 0.43	mm	GRAVEL	19. %
D_{30} = 0.64	mm	SAND	78. %
D_{60} = 1.6	mm	FINES	3. %
C_U = 3.7			
C_C = 0.61			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016
SAMPLE:
DEPTH: 0.3 – 1.0 m
TECHNICIAN: JB
DATE: 89.04.24



REMARKS:

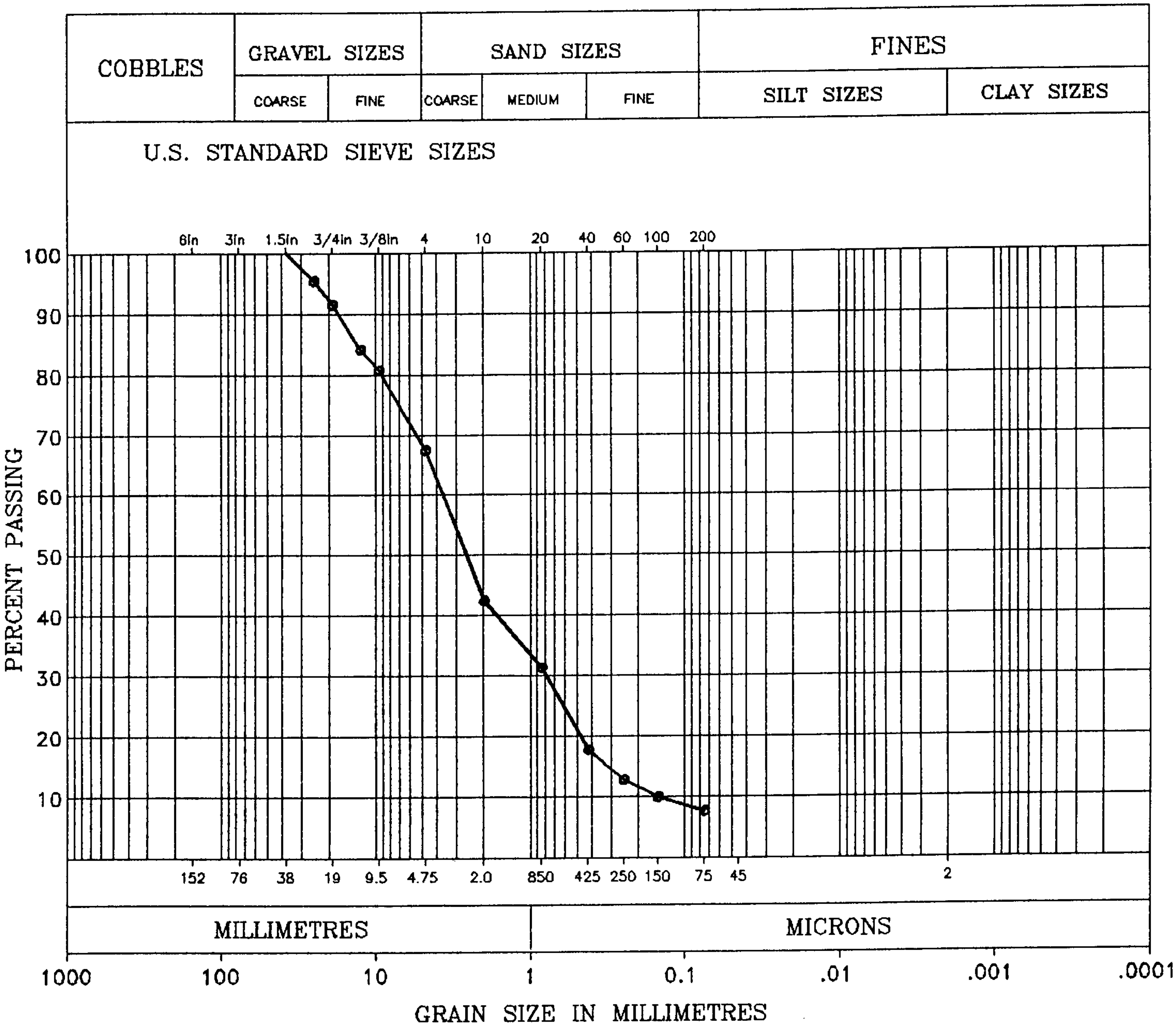
SUMMARY

D_{10} =	mm	GRAVEL	30. %
D_{30} = 0.43	mm	SAND	56. %
D_{60} = 3.1	mm	FINES	14. %
C_U =			
C_C =			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016
SAMPLE:
DEPTH: 1.0 – 1.5 m
TECHNICIAN: JB
DATE: 89.04.12



REMARKS:

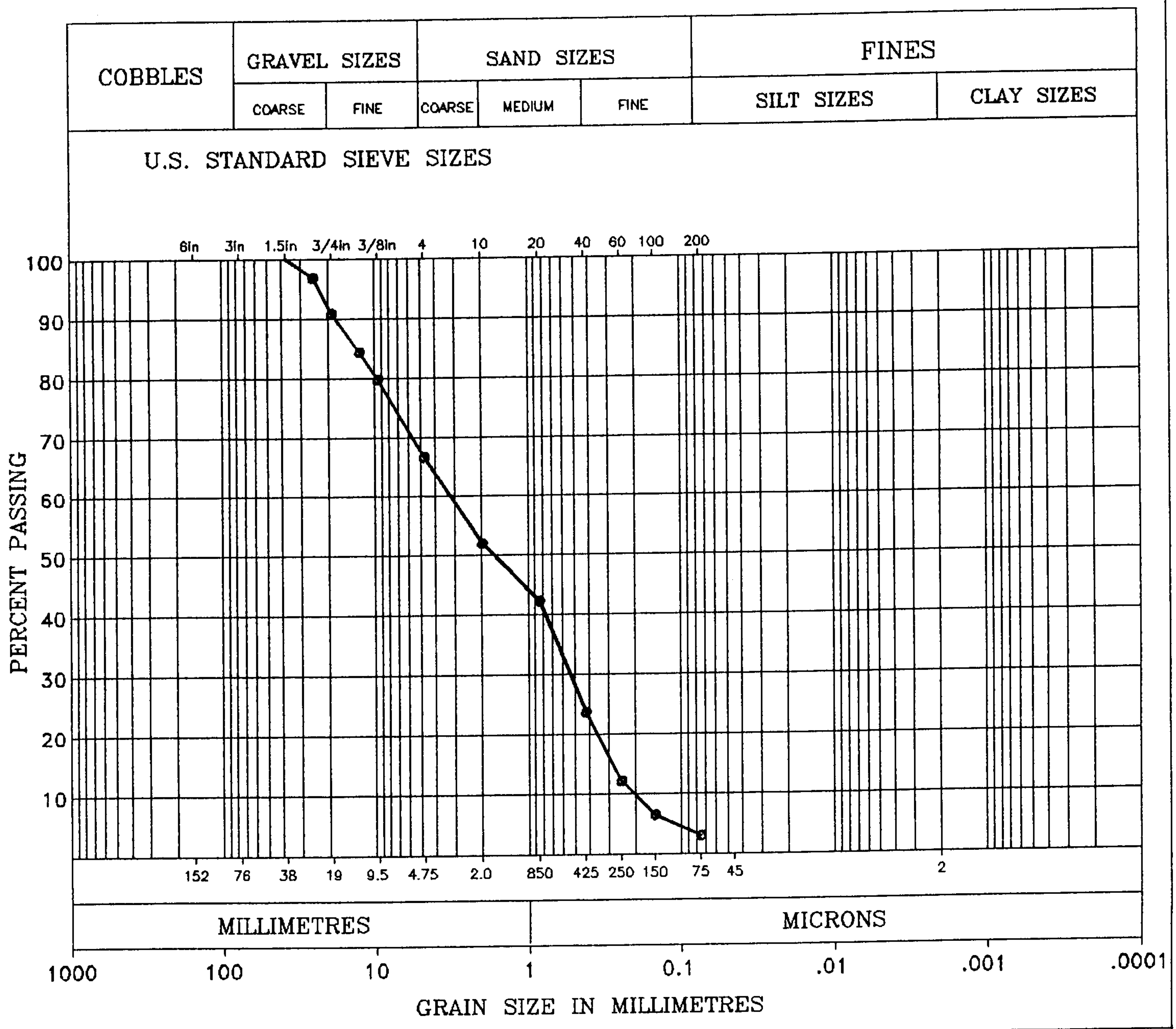
SUMMARY

D_{10} = 0.15	mm	GRAVEL	33. %
D_{30} = 0.81	mm	SAND	60. %
D_{60} = 3.9	mm	FINES	7. %
C_U = 26.			
C_C = 1.1			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016 SAMPLE:
DEPTH: 2.1 – 2.6 m
TECHNICIAN: JB DATE: 89.04.12



REMARKS:

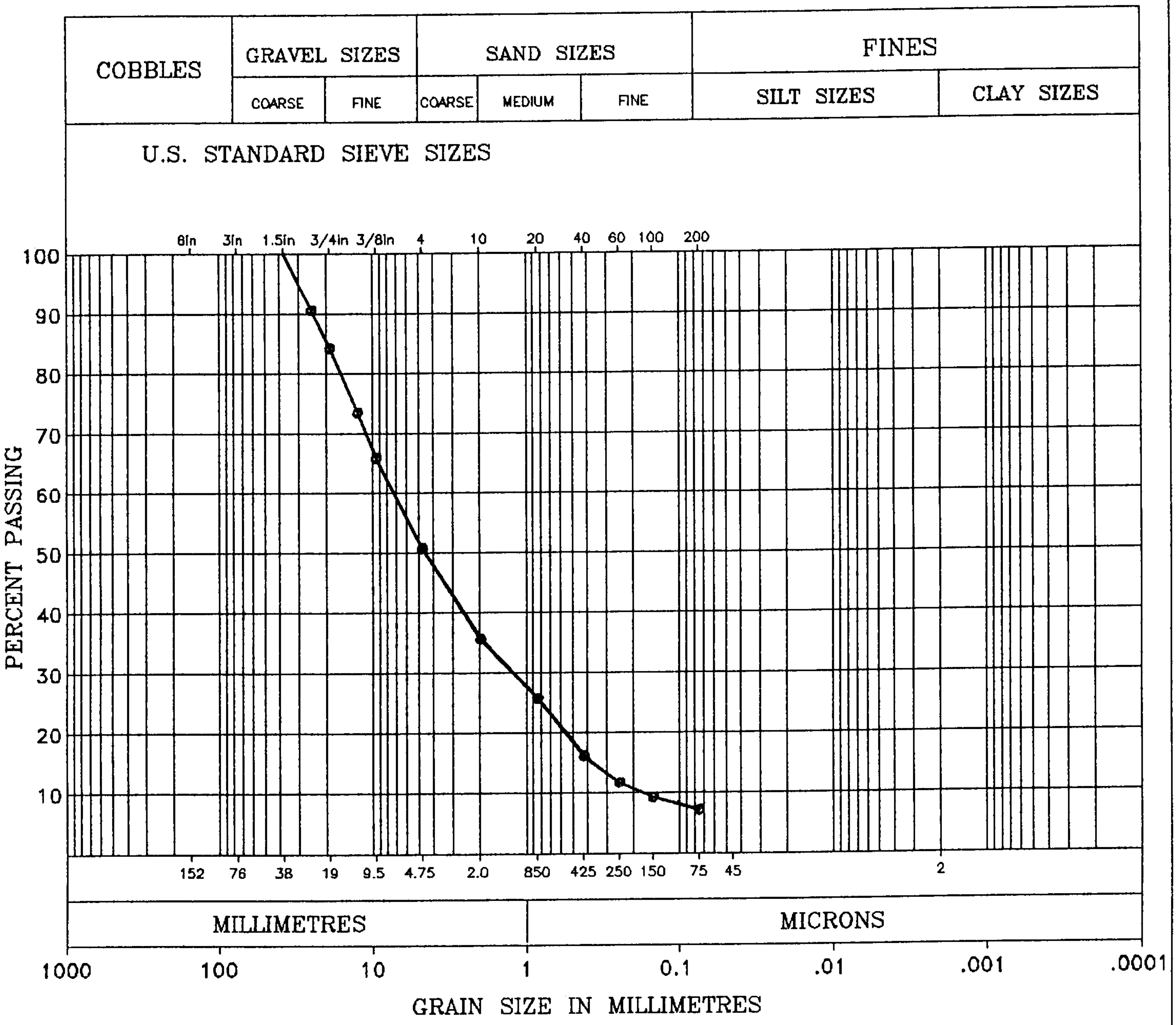
SUMMARY

D_{10} = 0.21 mm		GRAVEL	33. %
D_{30} = 0.57 mm		SAND	64. %
D_{60} = 3.5 mm		FINES	3. %
C_U = 17.			
C_C = 0.44			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016 SAMPLE:
DEPTH: 1.5 – 2.1 m
TECHNICIAN: JB DATE: 89.05.05



REMARKS:

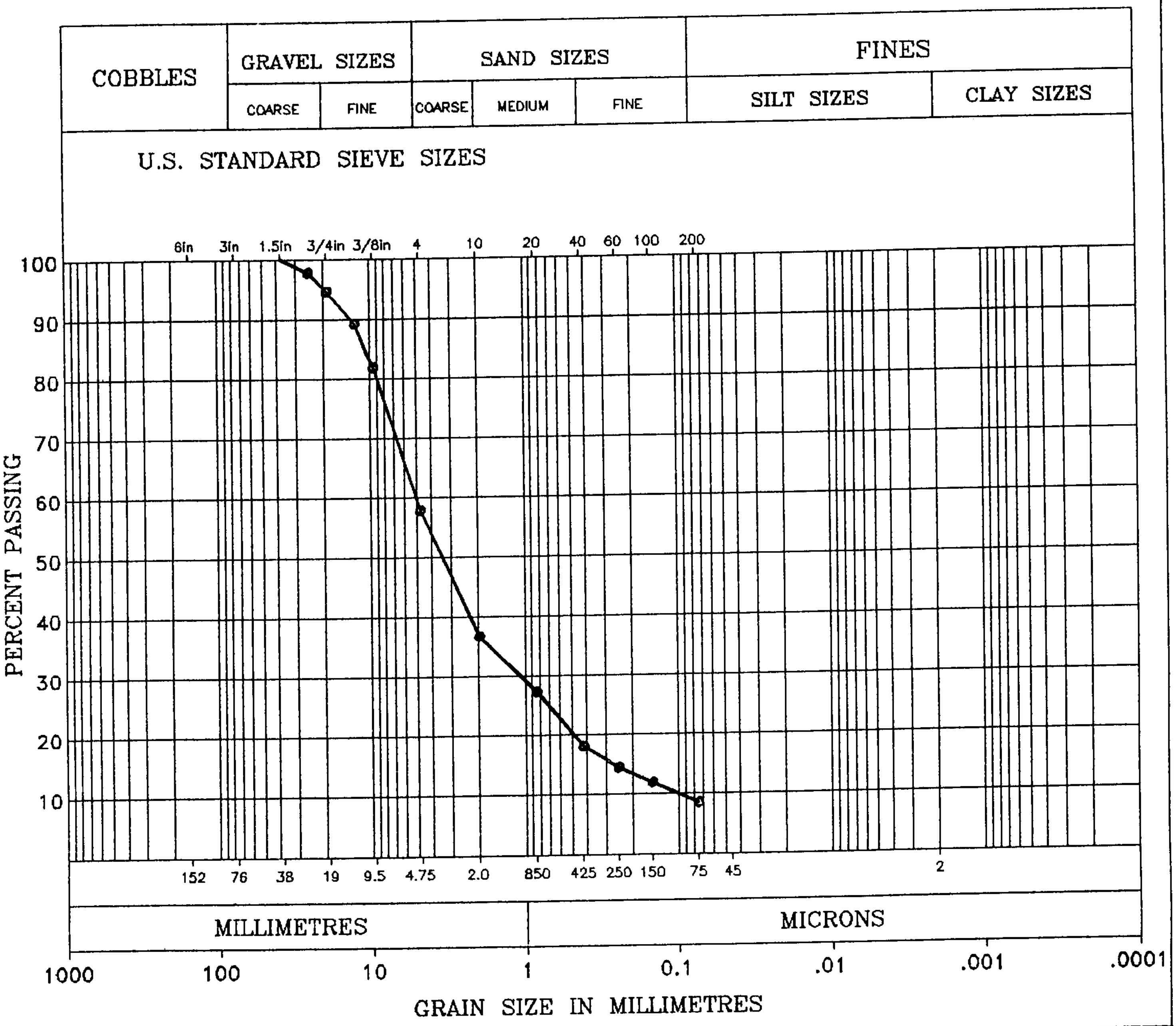
SUMMARY

D_{10} = 0.18	mm	GRAVEL	49. %
D_{30} = 1.4	mm	SAND	44. %
D_{60} = 7.7	mm	FINES	7. %
C_U = 42.			
C_C = 1.3			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016 SAMPLE:
DEPTH: 2.6 – 3.3 m
TECHNICIAN: JB DATE: 89.05.05



REMARKS:

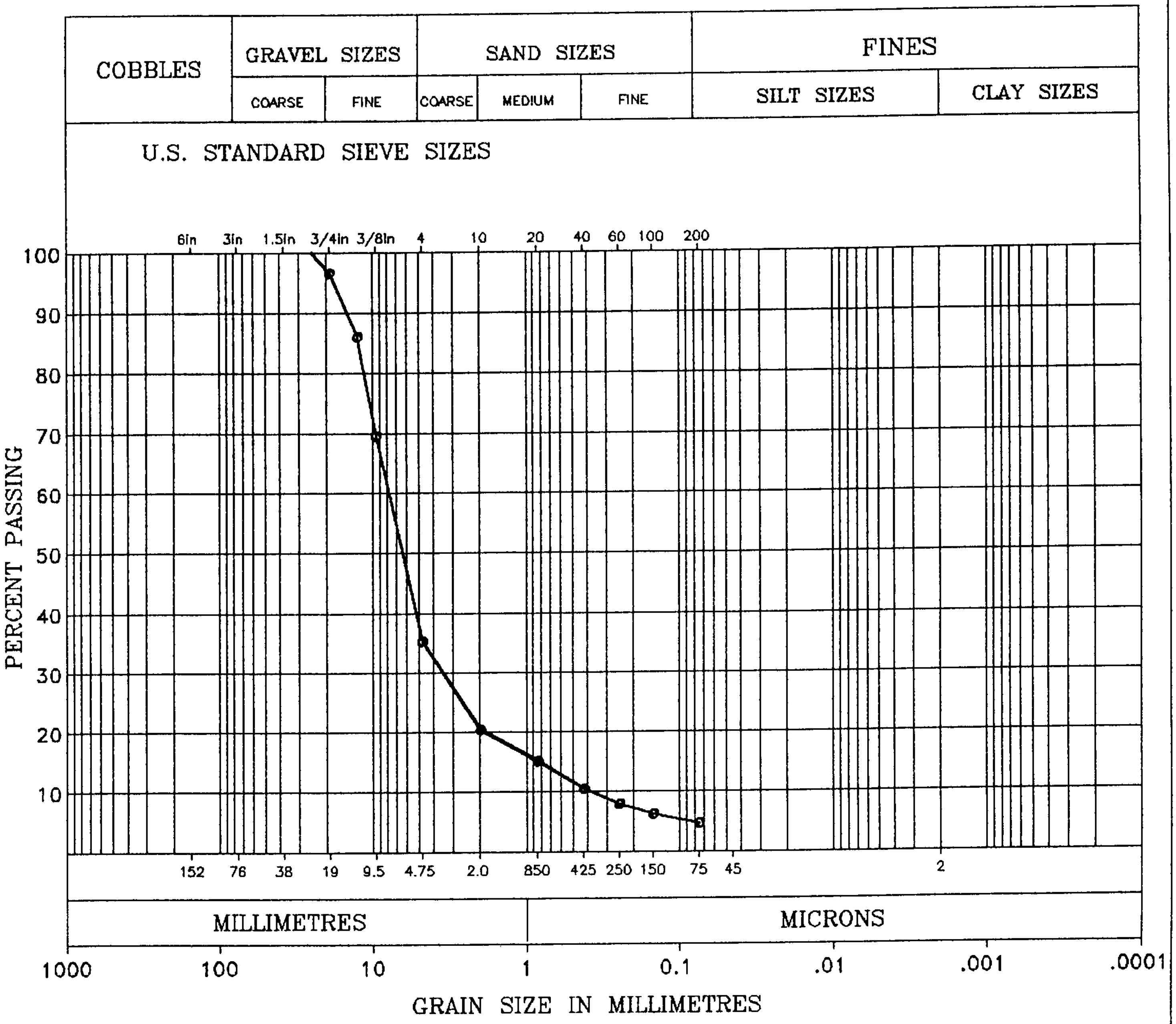
SUMMARY

D_{10} = 0.11	mm	GRAVEL	42. %
D_{30} = 1.2	mm	SAND	49. %
D_{60} = 5.2	mm	FINES	9. %
C_U = 48.			
C_C = 2.5			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016
SAMPLE:
DEPTH: 3.3 – 4.1 m
TECHNICIAN: JB
DATE: 89.05.05



REMARKS:

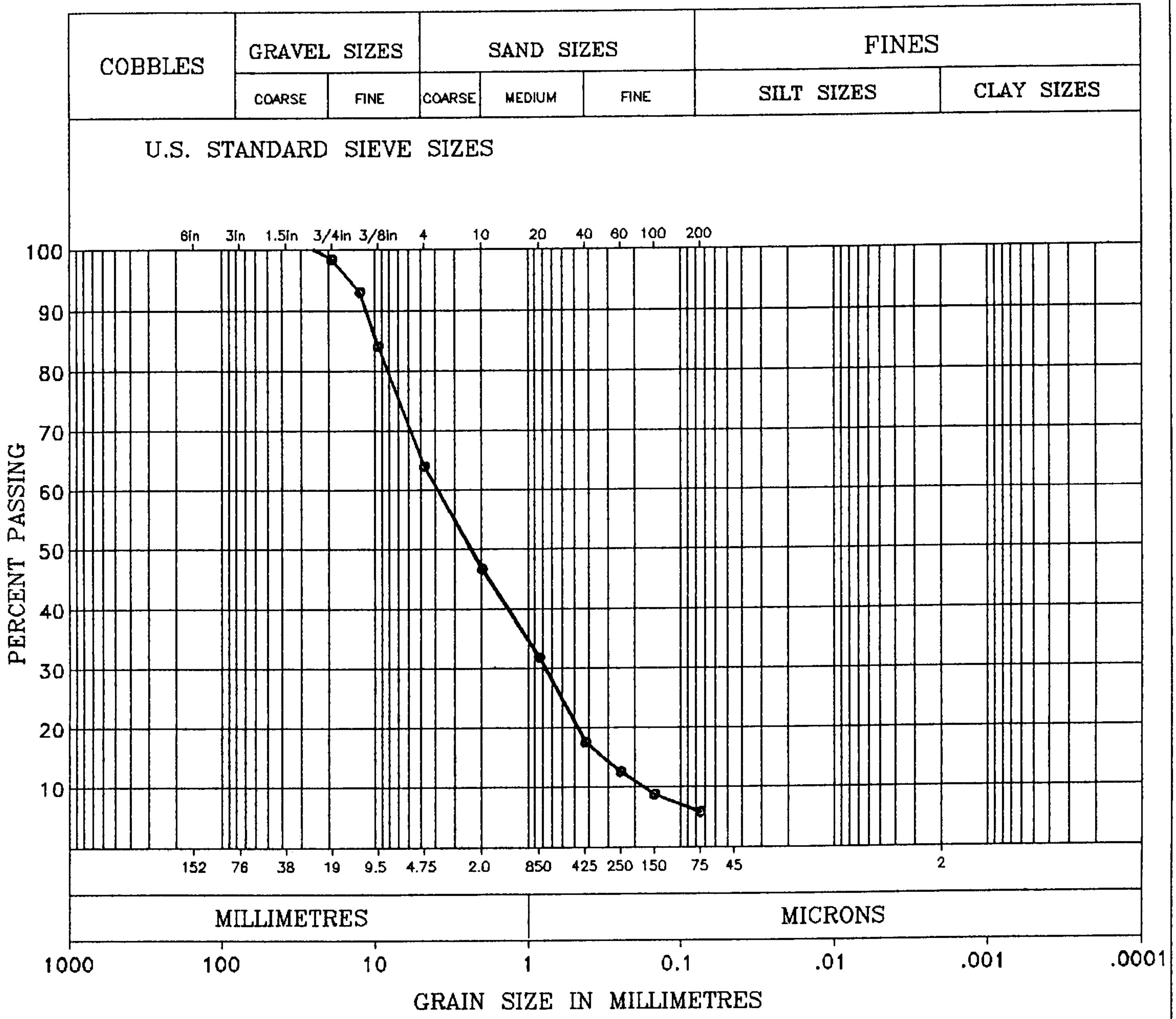
SUMMARY

D_{10} = 0.40 mm		GRAVEL	65. %
D_{30} = 3.8 mm		SAND	31. %
D_{60} = 8.2 mm		FINES	4. %
C_U = 21.			
C_C = 4.4			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016 SAMPLE:
DEPTH: 4.1 – 4.8 m
TECHNICIAN: JB DATE: 89.05.05



REMARKS:

SUMMARY

D_{10} = 0.18 mm

D_{30} = 0.80 mm

D_{60} = 4.1 mm

C_U = 22.

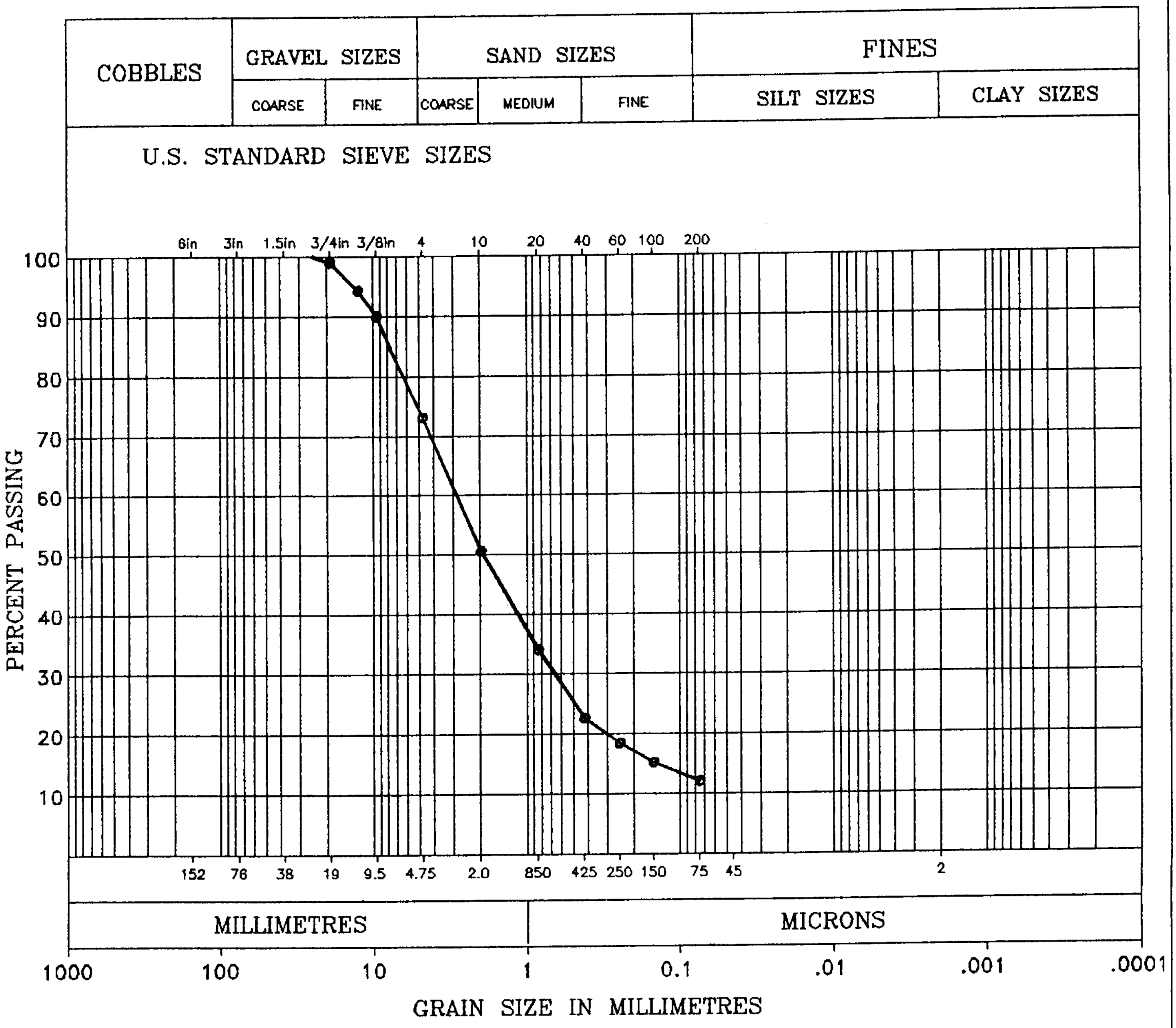
C_C = 0.84

GRAVEL	36. %
SAND	58. %
FINES	6. %

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016 SAMPLE:
DEPTH: 4.8 – 5.6 m
TECHNICIAN: JB DATE: 89.05.05



REMARKS:

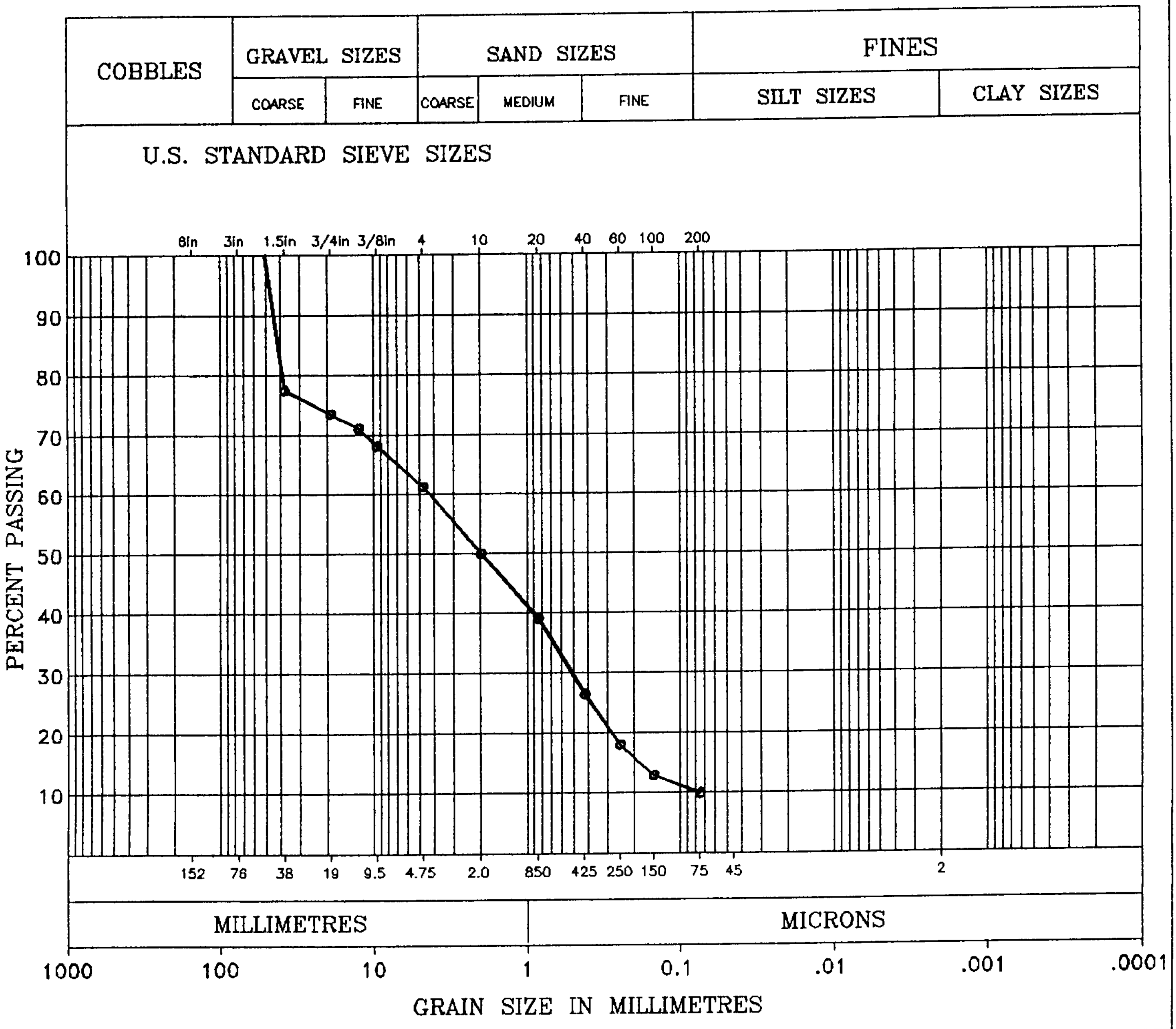
SUMMARY

D_{10} = mm	GRAVEL	27. %
D_{30} = 0.70 mm	SAND	61. %
D_{60} = 3.2 mm	FINES	12. %
C_U =		
C_C =		

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016 SAMPLE:
DEPTH: 5.6 – 6.3 m
TECHNICIAN: JB DATE: 89.05.05



REMARKS:

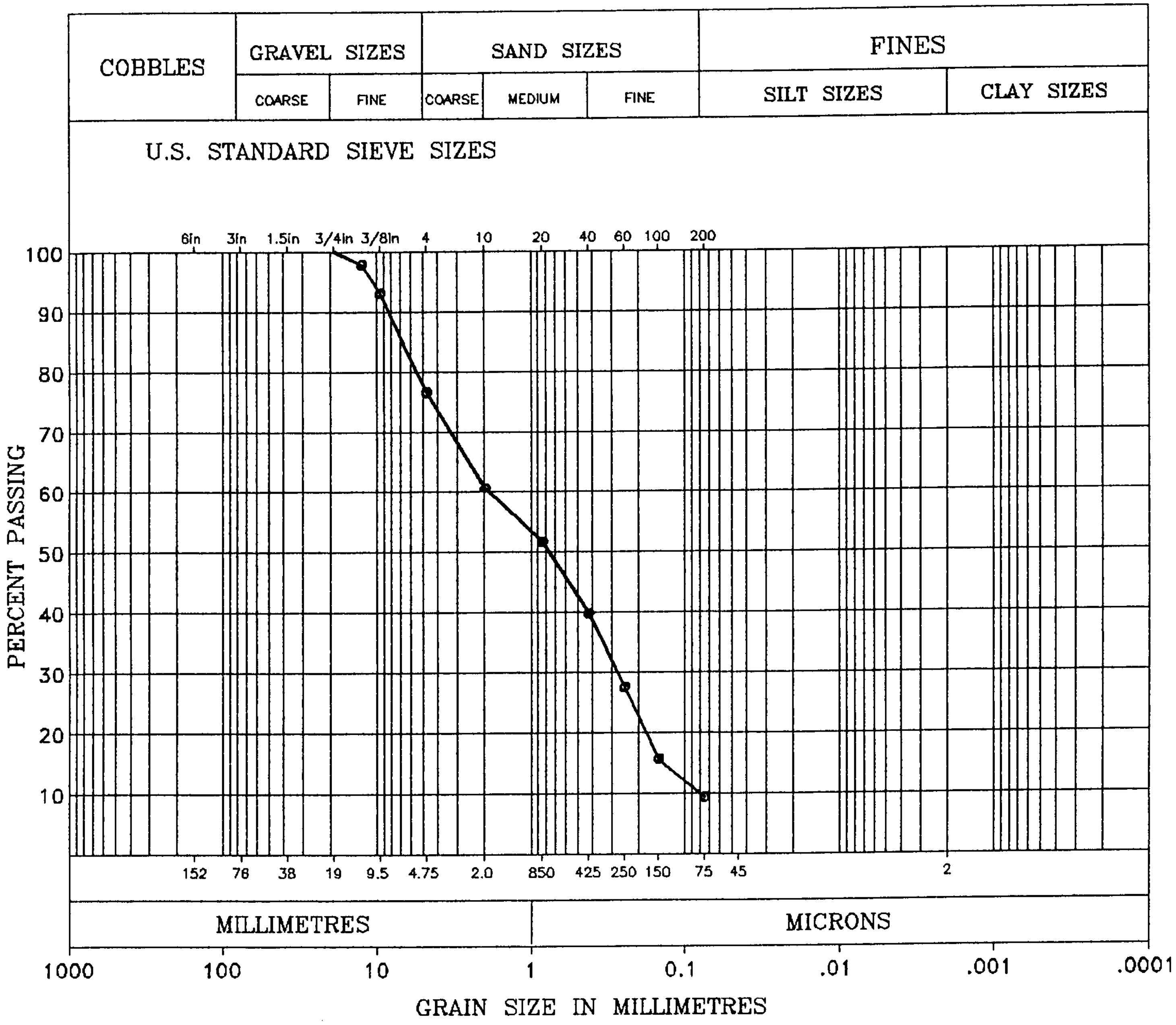
SUMMARY

D_{10} = 0.080 mm	GRAVEL	39. %
D_{30} = 0.55 mm	SAND	51. %
D_{60} = 4.5 mm	FINES	10. %
C_U = 55.		
C_C = 0.84		

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016
SAMPLE:
DEPTH: 6.3 – 7.1 m
TECHNICIAN: JB
DATE: 89.05.05



REMARKS:

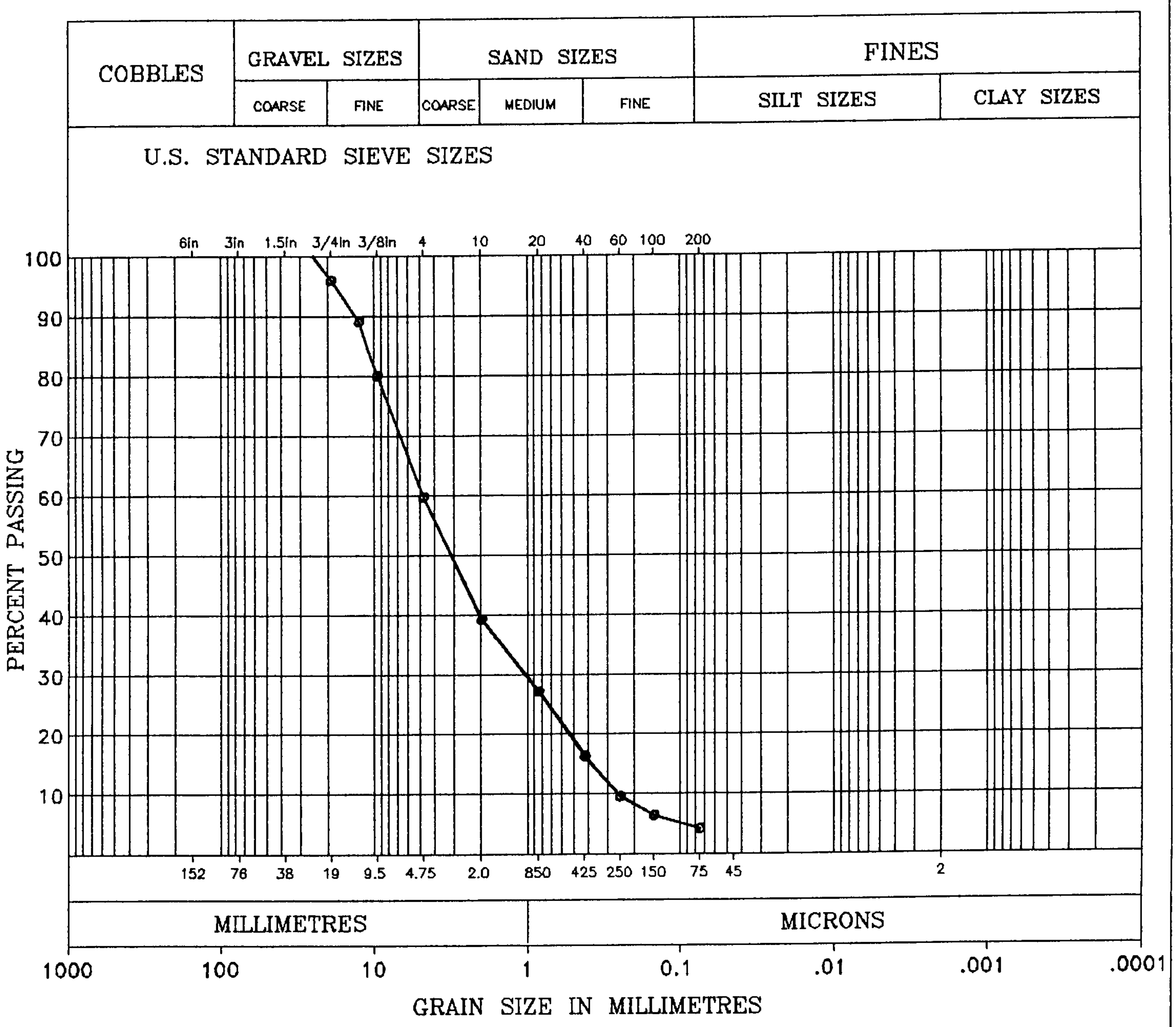
SUMMARY

D_{10} = 0.083 mm		GRAVEL	23. %
D_{30} = 0.29 mm		SAND	67. %
D_{60} = 1.9 mm		FINES	10. %
C_U = 23.			
C_C = 0.51			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016 SAMPLE:
DEPTH: 7.1 - 7.8 m
TECHNICIAN: JB DATE: 89.05.05



REMARKS:

2.4% ERROR

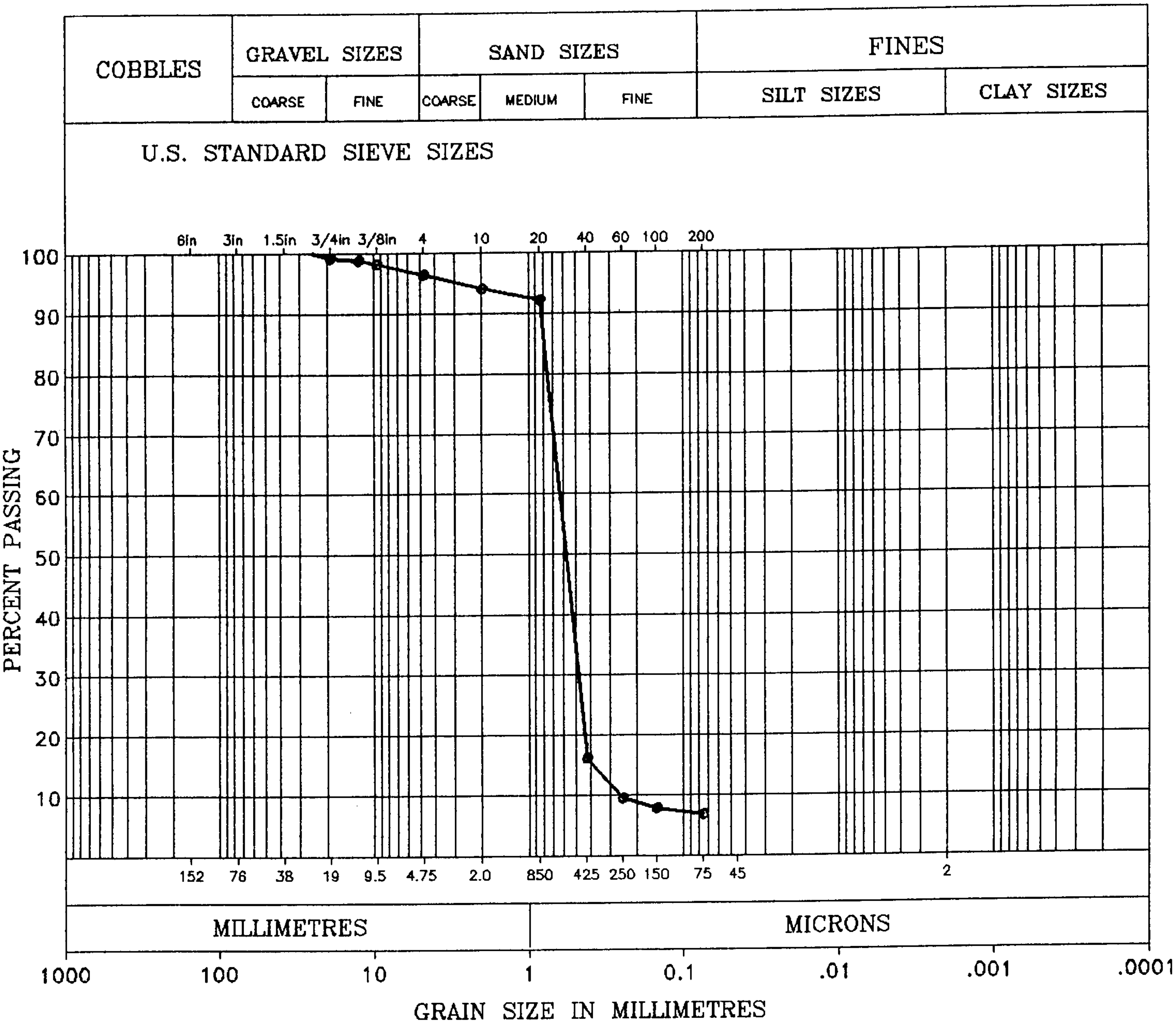
SUMMARY

D_{10} = 0.26	mm	GRAVEL	40. %
D_{30} = 1.1	mm	SAND	56. %
D_{60} = 4.8	mm	FINES	4. %
C_U = 18.			
C_C = 0.98			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016 SAMPLE:
DEPTH: 7.8 - 8.1 m
TECHNICIAN: JB DATE: 89.05.05



REMARKS: MEDIUM COARSE SAND

SUMMARY

D_{10} = 0.26	mm	GRAVEL	3 %
D_{30} = 0.50	mm	SAND	89 %
D_{60} = 0.67	mm	FINES	8 %
C_U = 2.5			
C_C = 1.4			

Hardy BBT Limited

GRAIN SIZE DISTRIBUTION

PROJECT No: CG10346
LOCATION: 1407
HOLE: B016 SAMPLE:
DEPTH: 8.1 – 8.7 m
TECHNICIAN: JB DATE: 89.05.05

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.

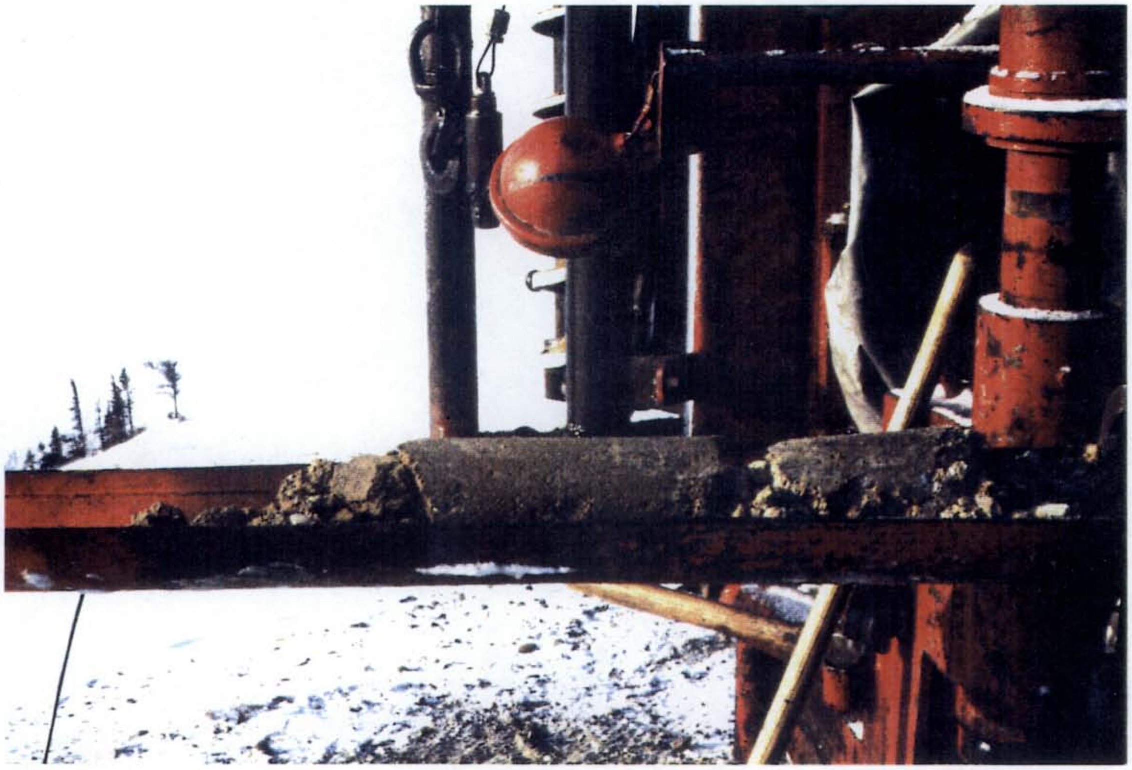


PHOTO 3:

CRREL core immediately after extrusion.

PHOTO 4:

CRREL core barrel.

PHOTO 5:

View of the disused Charlie Hills pit downslope of area 'C' (see Figure 3).

PHOTO 6:

View of the valley access route into I-407 (see Figure 3)