C. OTHER SUPPLEMENTAL SURVEY REPORTS FOR DESIGN

ENVIRONMENTAL CONSIDERATION

Environmental Consideration

1. Methodology

'Environmental Consideration' has been done in the project is composed of the following examinations:

- analysing environmental impacts of development activities on the project site and its surrounding areas during the stages of both construction and operation,
- proposing necessary mitigation measures to avoid and/or alleviate significant adverse impacts on natural and human environment.

However, because of the project nature which environmental impacts of the development activities are minor, the environmental consideration did not include environmental impact assessment based upon simulation works to forecast and evaluate environmental impacts using simulation models. As shown in below it mainly examined the impacts with qualitative expressions for evaluating.

(1) pre-assessment

- Reviews of the previous environmental studies

(2) analysis of existing constraints and potential impacts

- Collection of further data and maps
- On-site survey by JICA Study Team
- Discussion with experts of JICA Study Team and the authorities concerned

(3) mitigation measures

- On-site survey
- Literatural survey
- Discussion with experts of JICA Study Team and the authorities concerned

As the Jordanian Government does not have its own guidelines on environmental assessment, basically taking into consideration of the Environmental Consideration Guidelines of JICA and OECF, the important environmental items were carefully assessed through the above process.

The environmental examination was undertaken in each work component of the project from the viewpoints of both natural and social environment, mainly focussing on unclear or significant environmental issues pointed out in the previous environmental studies. Based upon such comprehensive environmental examination, the major negative and positive impacts at both construction and operational phases caused by the project implementation were identified. The possible impacts were classified according to the natures of the development activities such as site location and project scale. In addition, to reduce or avoid the negative impacts, some mitigation measures were proposed.

2. Previous assessment

2.1. Initial Environmental Examination (IEE) by JICA:

The IEE in JICA study reported that the following environmental issues were associated with

downtown area in Amman.

- traffic nuisance: air an noise pollution, traffic congestion and pedestrian severance:
- water: water supply irregularities and leakage, flooding and leakage of waste water
- amenities: deficiencies in provision of green space and insufficient attention to visual impact of building
- landslide: the steep slopes are subject to landslide.

The IEE concluded that an EIA was not necessary. This view was reached since the proposed project is intended to improve the existing environment. The potentials for negative environmental consequences were considered to be mainly associated with increased tourists and changes in the traffic situation.

2.2. Environmental consideration by SAPROF:

The SAPROF concurred with the view that this sub-project does not give rise to significant adverse environmental consequences which would required the formulation of an EIA.

The project was defined as a Category B given that:

- there are no environmental regulations or conventions affected
- there are no environmental standards applicable to the project
- there are no important and designated sites of nature conservation
- there are no resettlement measures
- the project will enhance local economic activities

3. Existing constraints to be solved

- Lack of green space
- Traffic nuisances such as traffic congestion and pedestrian disturbance
- Insufficient parking space for tourist coaches
- Difficult access between north-south and east-west area
- No integration between the location of the bus terminal and mosque

4. Examination on potential environmental impacts and proposed mitigation measures

4.1. Potential environmental impacts

The project site is located in the city centre where little natural environment can be seen. Therefore, adverse impact on the natural environmental will not expected by construction work. However, the site is very close commercial area, and nuisance and disturbance on socio-economic activities of restaurants and shops near the site might be expected. Environmental consideration based upon on-site survey has been undertaken, and the following environmental impacts caused by the project are identified.

The project can be expected different potential impacts depending upon the stages of construction and operation. Possible sources of negative impacts induced by the operation of the project are only those on the social environment.

The major negative impacts are air, noise and vibration pollution caused by construction works. Some of those impacts may cause serious health problem and specific mitigation measures for the reduction are necessary. Construction works also may cause indirect adverse impact upon economic activities such as restaurants and shops near the project site. Therefore working hours and schedule should be shortened to mitigate such impacts as much as possible

The major environmental impacts and proposed mitigation measures are shown in Table 1

Table 1 Potential Environmental Impacts

Factors	Actions	Impacts	Stage	Impact ranking	Type
Air Pollution	- construction work	- cause nuisance of the neighbouring residents by dust	construction	△	direct
Noise/Vibration Pollution	- construction work	- cause nuisance of the neighbouring residents	construction	△	direct
Water Pollution	- construction work	- wastewater cause water pollution	construction	△	direct
Waste Pollution	- construction work	- generate of huge amount of construction wastes	construction	○	direct
	- increase of tourists	- increase of litters	operational	○	cumulative
Traffic & Safety	- construction work	- increase pedestrian conflict	construction	○	direct
		- increase vehicles and visitors	operational	○	cumulative

○ major △ minor

Source: JICA Study Team

4.2. Proposed mitigation measures

The major negative impacts at the construction stage are air, noise and vibration pollution caused by renovation and construction works of the streets and the view terraces. Some of those impacts may cause health problems of neighbouring residents, and appropriate mitigation measures for the reduction are necessary.

In addition, construction work also may cause indirect negative impacts on economic activities such as restaurants and shops near the project site. Therefore, working hour and schedule should be considered in order to mitigate such impacts.

After construction increase of tourists may bring direct or indirect positive impacts on socio-economic activities of the town. Increase of traffic volume may cause traffic problems in particular shortage of parking space and traffic congestion but are not significant now. If they will become serious, an alternative policy such as alteration of traffic circulation will be required.

In addition, the sensitive issues such as traffic and pedestrian conflict and land use development should be monitored by the authorities concerned.

Table 2 Proposed Mitigation Measures

	Impacts	Mitigation measures
mitigation measures should be clarified in the tender document	Air Pollution	**[construction stage]** - use low emission equipment - provide sheets for dust control - watering for dust control
	Water Pollution	**[construction stage]** - wastewater treatment system and monitoring - avoid rainy season
	Noise & Vibration Pollution	**[construction stage]** - use low noise and vibration equipment - provide noise protection sheet - restrict working
	Waste Pollution	**[construction stage]** -secure transportation and disposal site
	Existing Infrastructure	**[construction stage]** - alleviate effects on existing infrastructures such as electricity and sewage systems by clarifying the existing conditions and scope of works
	Traffic & Safety	**[construction stage]** - conduct traffic control - avoid rash hours
others	Waste Pollution	**[operational stage]** - place litter box for increasing general wastes
	Traffic & Safety	**[operational stage]** - secure safety for visitors - raise awareness by environmental education

Source: JICA Study Team

Environmental Checklist of Ragadhan Bus Terminal

Construction Stage

		Major	Minor	None	Not Clear	Problems	Actions & Mitigation measures proposed	Remarks
Pollution	1. Air Pollution		−			• dust from construction work may cause nuisance of the neighbouring residents	• provide sheets for dust control • watering for dust control	
	2. Water Pollution			*				
	3. Soil contamination			*				
	4. Noise and vibration		−			• noise and vibration from construction work may cause nuisance of the neighbouring residents	• provide sheets for noise reduction	
	5. Subsidence			*				
	6. Waste generation	−				• construction wastes	• secure transport and disposal site • enhance recycling of construction wastes	
Natural	1. Effect on the ecology			*				
	2. Effect on landscape			*				
Human Environment	1. Historical and cultural heritage			*				
	2. Effect on existing infrastructure			*				
	3. Relocation			*				
	4. Traffic congestion and safety		−			• construction work may cause traffic conflict	• secure traffic circulation and traffic control • avoid rash hour	
	5. Socio-economic effects			*				
	6. Others			*				

Operational Stage

		Major	Minor	None	Not Clear	Problems	Actions & Mitigation measures proposed	Remarks
Pollution	1. Air Pollution			*				
	2. Water Pollution			*				
	3. Soil contamination			*				
	4. Noise and vibration			*				
	5. Subsidence			*				
	6. Waste generation		−			• increase of tourist litters	• improve the exsiting wastemanagement system	GAM is in charge of wastemanagement.
Natural	1. Effect on ecology			*				
	2. Effect on landscape		+			• increase of green space may improve existing landscape		
Human Environment	1. Historical and cultural heritage			*				
	2. Effect on existing infrastructure			*				
	3. Relocation			*				
	4. Traffic congestion and safety		−			• increase of tourists may cause conflic between vehicles and visitors	• secure safety for visitors • raise awareness by environmental education	
	5. Socio-economic effects		+			• increase of tourists may enhance commercial activities		
	6. Others			*				

+: positive impacts −: negative impacts

SOIL INVESTIGATION REPORT

TOUKAN AND SAKET Geo-Research

Foundation Engineering & Material Testing

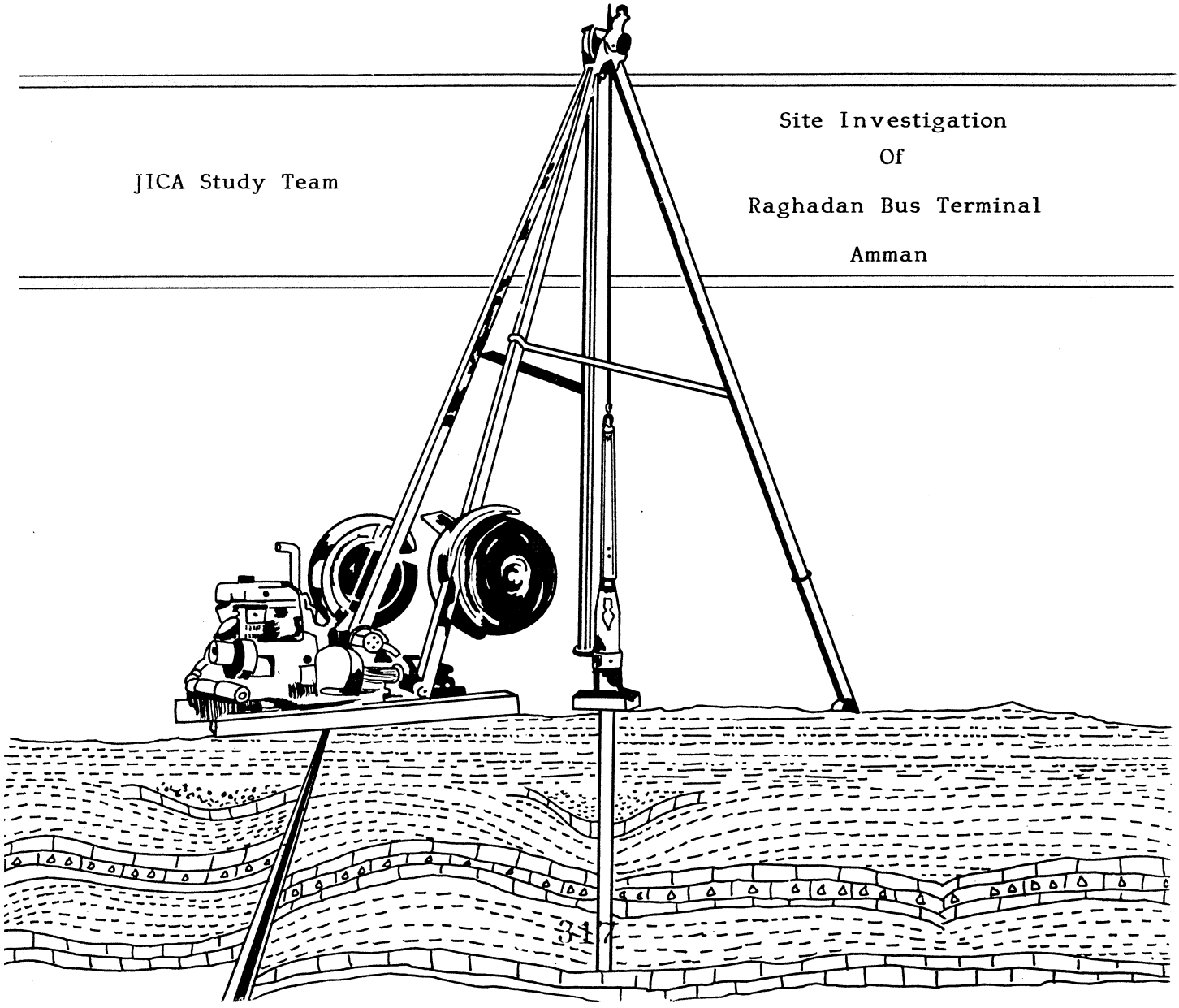
JICA Study Team

Site Investigation

Of

Raghadan Bus Terminal

Amman



TOUKAN & SAKET
Geo - Research & Foundation
Engineering Office
Drilling , Sampling , Testing
Engineering Geology , Foundations,
Geomechanics,
& Material Testing

مكتب طوقان والساكت
للدراسات الهندسية الجيولوجية والأساسات
تثقيب ، اخذ عينات ، تحليل ،
مسح هندسي جيولوجي ، دراسة
اساسات وميكانيكا الصخور والتربة
وفحص المـــواد

Ref : R99/20/1999

Date : 28/6/1999

Messrs : JICA Study Team

Site Investigation
Of
Raghadan Bus Terminal
Amman

Dear Sirs,

Upon your request, concerning the above mentioned project , we have the honour to submit for your consideration the attached report in which we summarized the results of the investigation undertaken by our firm.

We take the opportunity to express to you our highest consideration

Sincerely yours,
Toukan & Saket

Dr. S . Saket

ص.ب ٩٢٦٨٩٧ - تلفون ٦٦٢٤٠٥ - فاكس ٦٦٤٤٨٣ - تلكس : ٢١٥٤٢ طوقان جو عمان - الأردن
P.O.Box 926897 - Telephone 662405 - Fax. 664483 Telex : 21542 Toukan Jo - Amman - Jordan

Site Investigation
Of
Raghadan Bus Terminal
Amman

1.0 Introduction

Upon the request of Messrs. JICA Study Team , sub-soil investigation was carried out at the proposed site in accordance with the British Standards Specification, CP 2001 for site investigation and with the Jordanian Code .

The investigation was carried out by performing 5 boreholes, drilled at locations determined by the geotechnical Engineer to a depth ranging between 10 and 25 meters.

The proposed building is for the bus Terminal of Amman .

The site is mainly recent fill and made flat ground .

The investigated site has been used recently as a bus and taxi terminal . The site is paved and provided by ambrellas for passengers .

2.0 Scope of Work

The purpose of this study was to determine the ground conditions at the site , in order to provide full information about the ground conditions and geotechnical properties of foundation materials and all other information that would assists in the Engineer in the design of proper and safe foundation .

The works included the following

- Setting up locations of boreholes.
- Drilling 5 boreholes and carrying out the necessary field tests.
- Recovery of disturbed representative samples .
- Carrying out the required laboratory tests.

Analysis of the site investigation data, laboratory testing and geotechnical interpretation form the basis of this report.

3.0 General Geology

The natural material within the site is mainly Quaternary alluvial deposits covered by thick recent fill material . (see geologic map) .

The penetrated material within the site is heterogenous deposits (overburden) composed of brown blackish clay , silt , fine to coarse sand , fine to coarse gravel , cobbles and boulders, moist to saturated .

. No bed rock was encountered in any of the drilled boreholes .

4.0 Method of Investigation

All drilling, sampling and testing were performed in accordance with the British Standards, CP 2001.

The sub-surface was explored by using CME 75 type rig advance by rotary drilling allowing the performance of Standard and cone penetration tests and taking disturbed samples.

Dry drilling to refusal in boreholes was used to recover representative samples. The boreholes were monitored for any ingress of water during dry drilling.

Representative soil samples were obtained during the drilling operation and were placed in tight plastic bags and wooden boxes for description.

Standard and cone penetration tests were carried out in accordance with the BS Standards 1377(Test 19) and the results were recorded on the boreholes logs at depths to which they refer.

The penetration tests were executed with 2 and 3 inch standard sampling spoon with catchers and driven by dropping a 140 Ibs. Weight hammer with a 30 inches fall height. The 2 inches diameter spoon was lowered to the bottom of the boreholes and penetrated about 6 inches in the materials, whereupon the penetration test was started. The "N" value is the number of blows required to produce one foot of penetration.

In defining the density of the non-cohesive materials , the following could be classified :

Loose	**Less than 10 blows per foot .**
Medium dense	**10-30 blows per foot .**
Dense	**30-50 blows per foot .**
Very dense	**More than 50 blows per foot .**

In defining the relative density of the cohesive material , the following could be classified :

Soft	**Less than 4**	**blows per foot.**
Firm	**4-8**	**blows per foot.**
Stiff	**8-15**	**blows per foot**
Very stiff	**15-30**	**blows per foot**
Hard	**more than 30**	**blows per foot**

5.0 Field Works

5.1 Drilling

The locations of boreholes were chosen so as to represent the study area and provide as much information as possible.

A total of 5 boreholes were drilled . The locations of the drilled boreholes are shown on the attached plan .

The positioning and depth of the boreholes were determined by the geotechnical engineer .

5.2 Sampling

Continuous samples of the drilled materials were collected at regular depth intervals of 1.0m and at each lithological change of the material . The samples were labeled, described and logged. Representative samples were also obtained for laboratory testing and classification .

5.3 Insitu Testing

In order to obtain an estimate of the density insitu, Standard and cone Penetration tests were performed on the foundation material .
The penetration tests results indicate that the penetrated material is loose to very dense (soft to hard) with the SPT, "N" value, ranging between 3 and more than 50 blows per foot . (see borehole logs) . The low results are due to saturation of the clays .

- In order to find out the undrained shear strength , insitu vane shear tests were Performed . The tests show that the undrained shear strength is ranging between 0.38 kg/cm² and 0.62 kg/cm² (Table 3) .

5.4 Drilling Results

The drilled boreholes show that the penetrated materials are mainly heterogenous recent fill material , non-uniform in terms of lithology and density . The recent fill material is underlain by brownish blackish sandy silty clay with some gravels , moist to saturated . The underlying material is mainly Wadi deposits of gravels and cobbles with clay .

No cavities or water table were detected in any of the drilled boreholes . Saturated zones were encounted due to seepage of sewage water from the mountains .

6.0 Geomechanics

A laboratory testing program was devised and performed on representative samples obtained from the study area , to establish the engineering properties of the material involved. The only tests that could be performed on such material are :

- Grainsize analysis
- Atterberg limits
- Direct sheer test

The results of the grainsize analysis of the tested samples are summarized in (Table 1). The material is composed of gravels, between 9.0% and 44.5 % , sand, between 29.6% and 54.0%, and silt, between 15.0% and 38.1% and clay between 00 % and 27.0% .

The atterberg limits show that the liquid limit ranges between Np and 41.7 with a plasticity index between Np and 15.6 . Table (1).

The direct shear test performed on remoulded samples of brownish sandy, silty clayey material obtained from the drilled boreholes, show that the cohesion is ranging between 0.23 kg/cm² and 0.35 kg/cm² with a peak friction angles between 15 and 22 degrees . (Curves are attached) see table (2) .

7.0 Conclusions & Recommendation

As a result of this study and tests, the following conclusions could be summarized :

- The drilled boreholes show that the penetrated materials are :

- Overburden recent fill material composed of silt, sand and gravels with cobbles, and boulders .

- The underlying material is mainly moist to saturated brown blackish sandy silty clay With some gravels . The lower most part is Wadi deposits with some clay .

- The material is heterogenous and non-uniform in terms of lithology and density .

- No bedrock was encountered in any of the drilled boreholes .

- No cavities or water table were encountered in the drilled boreholes . Saturated zones were encountered due to seepage of sewage water from the mountains .

In order to have a safe and stable foundation, the following is recommended :

6.1 Foundation Type and Depth

In order to have safe structures , the foundation materials beneath the structures must have an adequate bearing capacity to support the design loads with an appropriate factor of safety and acceptable tolerable settlements.

Since the foundation will be laid on heterogenous, non-uniform material in terms of density and lithology , with different engineering properties , therefore excessive differential settlement will take place in the structure. Noting that the existing recent fill material is not capable to handle normal type of foundation .

To have safe foundation to support the structure, the following is suggested :

The safest type of foundation could handle sensitive and heavy structure is pre – bored cast insitu pile foundation .

The suggested diameter of piles is 80 cm . The estimated depth is between 15-18 m , dependent on the exerted loads of the structure .

Preliminary the pile load capacity could be calculated as follows :

Ultimate shaft friction = α . C (π d) D .
Ultimate base resistance = Pd x Nq x Ab .
(at Wadi deposits)

Ult. Shaft Friction = 0.40 x 4 x (3.14x0.8) 16
= 64 Tonnes

Allowable Shaft Friction = $\frac{64}{1.5}$ = 42.6 Tonnes

Ult. Base resistance = 25.6 x 20 x 0.5
= 256 Tonnes

Allowable base resistanc = $\frac{256}{2.5}$ = 102.4 Tonnes

α = Adhesion *
= 0.40
C = Undrained shear Strength
= 4 T/m²
d = Diameter of pile
Pd = effective overburder pressure
= d x γ
= 16 x 1.6
= 25.6
D = depth of pile
Nq = bearing capacity Factor = 20
Ab = base area
= 0.5 m²

The calculated allowable pile load capacity = 145 Tonnes .

Due to variation in water level in the study area , therefore we suggest the use of only 100 Tonnes pile load capacity .

Pilot load test should be performed prior to the construction of piles .

6.2 Excavation

Any pneumatic excavation equipment could be used for excavation, such as dozers and loaders .

The brown sandy clayey materials excavated during construction of the building is not suitable to be used as backfill material because it is unselected and of unengineered nature.

The materials to be used for backfilling purposes behind underground walls shall be a soil-rock mixture which is free from organic matter or other deleterious substances. It shall not contain rocks or lumps over 15cm in greatest dimension, and not more than 15 percent larger than 7cm. The plasticity index for the backfill material shall not be more than 15 percent . It shall be spread in layers not exceeding 25cm in uncompacted thickness, moisture conditioned to its optimum moisture content, and compacted to a dry density not less than 95 percent of the maximum dry density as obtained by standard proctor compaction test (ASTM D698).

- The study area is characterized by semi-arid climate, warm and dry in the summer with rainy winter . The rainfall is of medium to high intensity for a short period.
The average mean annual rainfall is about 500mm and this is limited to winter period.
The average maximum temperature is 40c and the lowest is 0c degree.

As far as the seismic activity in the area, Jordan has not witnessed any serious earth quakes in the last 60 years . It is a general practice to consider the study area within zone I of the unified Building code. Research in Jordan concluded that one earth quake with magnitude 6½ every 100 years and one earth quake with magnitude 7½ every 500 years might take place.

The intensity factor is 0.75 for zone A and it is 0.5 for zone B.of Mercalli scale.

A horizontal peak ground acceleration of at least 0.19g is suggested to be adopted in the design of the foundations .

The compaction should be under the supervision of our experienced geotechnical Engineers .

The recommendations given in this report are solely based on the results of the drilled boreholes at the time of investigation and our understanding, and concept of the project. Further check of the material at the foundation level by our geotechnical Engineer is very important . All of treatment and densification should be supervised by our geotechnical engineers .

Summary of Tests Results

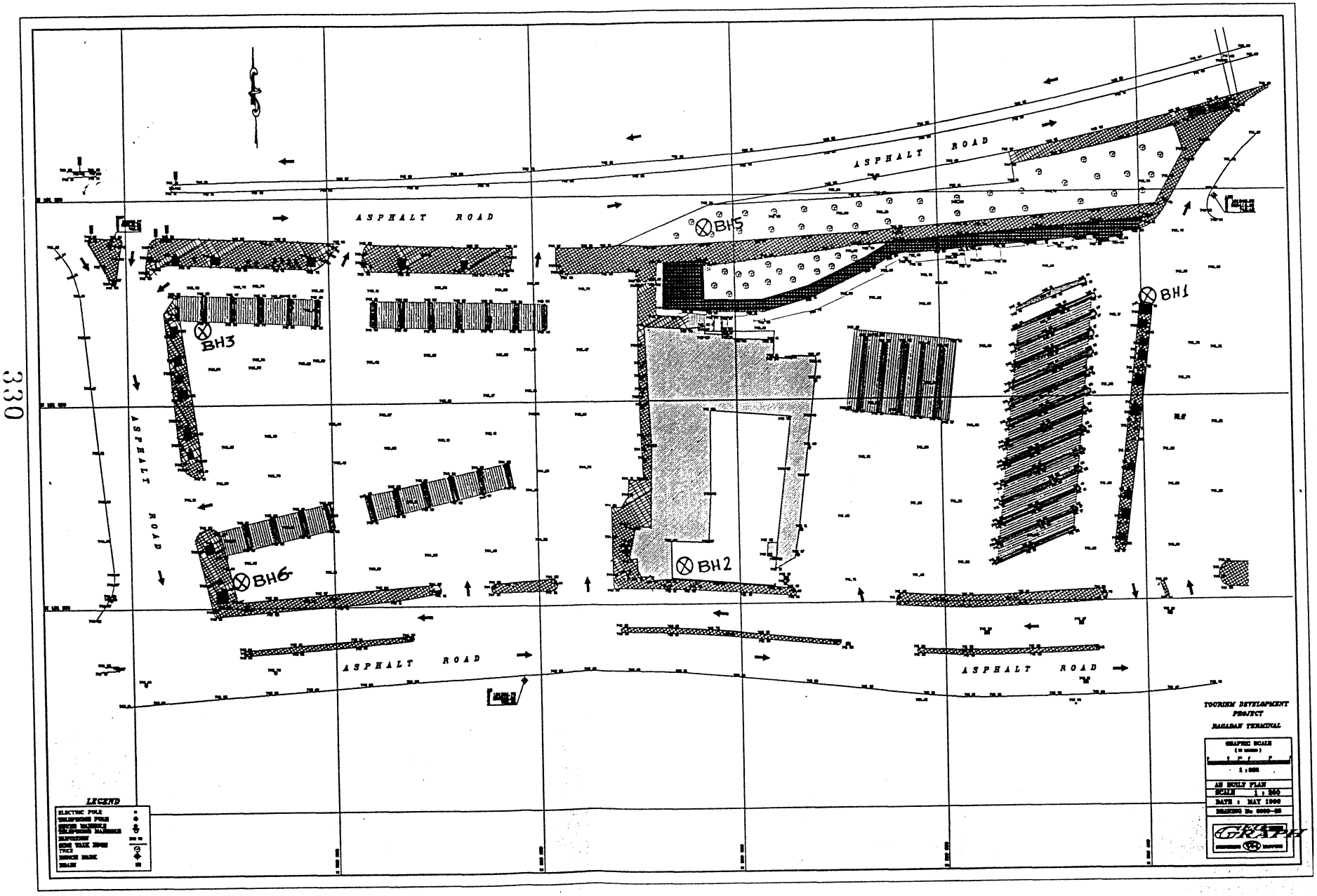
Borehole No.	Depth (m)	Grain Size Analysis				Atterberg Limits		
		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)
BH1	5.0	15.2	29.6	33.1	22.1	41.7	27.1	14.6
	7.5	17.8	32.2	31.7	18.3	38.1	28.3	9.8
	10.0	11.2	30.7	31.3	26.8	44.8	29.2	15.6
	12.5	9.0	31.0	33.0	27.0	46.2	30.4	15.6
	15.0	40.0	40.0	20	...	Np	Np	Np
	17.5	44.5	40.5	15.0	...	Np	Np	Np
BH2	5.0	14.5	37.5	28.0	20.0	40.8	30.3	10.5
	7.5	6.0	31.8	38.1	24.1	42.6	29.4	13.2
	10.0	10.5	34.0	34.3	21.2	37.9	27.5	10.4
	12.5	12.5	36.0	33.5	18.0	37.6	27.4	10.2
	15.0	37.0	45.0	18.0	...	Np	Np	Np
	17.5	41.9	46.1	12.0	...	Np	Np	Np
BH3	5.0	20.0	34.0	31.0	15.0	36.9	29.7	7.8
	10.0	16.5	21.5	39.2	22.8	41.2	31.6	9.6
	15.0	21.1	36.8	25.6	16.5	38.4	29.6	8.8
	20.0	38.1	48.9	13.0	...	Np	Np	Np
	25.0	27.0	54.0	19.0	...	Np	Np	Np
BH5	5.0	17.2	38.7	31.0	13.1	33.8	27.0	6.8
	7.5	17.0	28.1	33.1	21.8	38.0	28.9	9.1
	10.0	21.9	29.6	30.5	18.0	37.2	28.7	8.5
BH6	5.0	14.1	37.9	29.0	19.0	37.6	28.9	8.7
	7.5	12.0	31.2	34.3	22.5	38.2	30.0	8.2
	10.0	20.0	29.0	35.5	15.5	36.8	29.5	7.3
	12.5	13.1	40.7	31.2	15.0	36.4	29.3	7.1
	15.0	12.0	29.8	36.3	21.9	37.6	30.3	7.3

Table (1)

Insitu Vane Shear Tests Results

Borehole No. & Depth	Undrained Shear Strength (kg/cm²)
BH1 5.50m	0.38
BH1 8.50m	0.42
BH2 6.60m	0.40
BH3 5.5m	0.62
BH5 6.5m	0.56
BH6 4.5m	0.41

Table (3)


ASPHALT ROAD
ASPHALT ROAD
ASPHALT ROAD
ASPHALT ROAD
ASPHALT ROAD
BH1
BH2
BH3
BH5
BH6
LEGEND
ELECTRIC POLE
TELEPHONE POLE
GUARD RAILS
CATCH BASIN
MANHOLE
CONC WALK EDGE
TREE
BENCH MARK
DRAIN
TOURISM DEVELOPMENT PROJECT
BAGABAG TERRACES
GRAPHIC SCALE
1:500
AS BUILT PLAN
SCALE : 1 : 500
DATE : MAY 1990
GRAPH

Direct Shear Tests Results :-

Sample No. & (Depth) m	Cohesion (kg/cm²)		Friction Angle (Degree)	
	Cp	Cr	Qp	Qr
BH1 5.0m	0.23	0.00	18	15
BH2 6.5m	0.27	0.00	20	18
BH3 10.0m	0.33	0.00	22	20
BH6 5.0m	0.35	0.00	24	22

Table (2)

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BOREHOLE LOG DATA SHEET

PROJECT : Raghadan Bus Terminal			TYPE & SIZE OF DRILLING :							Rotary 4 ½"
BOREHOLE NO : BH.1			Date :						Started : 14/5/99 Finished : 15/6/99	
Depth (M)	L O G	DESCRIPTION ELEVATION: Flat	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	γ (gr/cm³)	Sample No.
1		Fill material composed of crushed cobbles and Gravels .								
2		Dark blackish brown sandy silty clay with fine gravels , plastic , semi saturated with sewage water .			3					
3					3					
4					5					
5					4					
6					4					
7					5					
8					6					
9					8					
10					7					
11					7					
12					8					
13					9					
14					10					

TOUKAN & SAKET
Geo. Research

BOREHOLE LOG DATA SHEET

PROJECT : Raghadan Bus Terminal			TYPE & SIZE OF DRILLING : Rotary 4 ½"							
BOREHOLE NO : BH.1			Date : Started : 14/5/99 Finished : 15/6/99							
Depth (M)	L O G	DESCRIPTION ELEVATION: Flat	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	γ (gr/cm³)	Sample No.
		.... as above								
15					28					
		Wadi deposits composed of cobbles , gravels , sand , silt and clay .								
16					33					
17					35					
18					38					
19					42					
20					47					
21		Final Depth (20.0m)								
22										
23										
24										
25										
26										
27										
28										

TOUKAN & SAKET
Geo. Research

BOREHOLE LOG DATA SHEET

PROJECT : Raghadan Bus Terminal	TYPE & SIZE OF DRILLING : Rotary 4 ½"
BOREHOLE NO : 2	Date : Started : 20/6/1999 Finished : 22/6/1999

Depth (M)	L O G	DESCRIPTION ELEVATION:	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	PLT (gr/cm²)	Sample No.
1		Fill material composed of sand , silt , Clay with gravel cobbles and boulders .			16					
2					21					
3					18					
4					12					
5		Dark brown balckish sandy silty clay with some fine,medium gravels , saturated .			7					
6					5					
7					4					
8					8					
9		Dark brown sandy silty clay semi – saturated , with gravels and cobbles .			11					
10					15					
11					13					
12					17					
13					20					
14					18					
15					25					
16		Wadi deposits composed of gravels cobbles and boulders with brown sandy silty clay semi – saturated .			31					
17					30					

TOUKAN & SAKET
Geo. Research

BOREHOLE LOG DATA SHEET

PROJECT : Raghadan Bus Terminal			TYPE & SIZE OF DRILLING :							Rotary 4 ½"
BOREHOLE NO : 2			Date :						Started :	20/6/1999
									Finished :	22/6/1999
Depth (M)	L O G	DESCRIPTION ELEVATION:	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	PLT (gr/cm²)	Sample No.
18		Wadi deposits composed of gravels cobbles and boulders with brown sandy silty clay semi – saturated .			29					
19					33					
20					29					
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
23										
33										
34										

TOUKAN & SAKET
Geo. Research

BOREHOLE LOG DATA SHEET

PROJECT : Raghadan Bus Terminal	TYPE & SIZE OF DRILLING : Rotary 4 ½"
BOREHOLE NO : BH3	Started : 16/6/1999 Date : Finished : 19/6/1999

Depth (M)	LOG	DESCRIPTION ELEVATION:	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	γ (gr/cm³)	Sample No.
1		Fill material composed of cobbles , gravels and brown soil .			4					
2					10					
3					9					
4					3					
5		Brown sandy silty clay with gravels , plastic, semi -saturated .			5					
6					9					
7		Gravels (angular , medium to coarse) increase downward .			6					
8					4					
9					7					
10					8					
11					12					
12					9					
13					10					
14					8					
15					10					
16					34					
17		Wadi deposits composed of cobbles , gravels , sand , silt and clay .			36					

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BOREHOLE LOG DATA SHEET

PROJECT : Raghadan Bus Terminal	TYPE & SIZE OF DRILLING : Rotary 4 ½"
BOREHOLE NO : BH3	Date : Started : 16/6/1999 Finished : 19/6/1999

Depth (M)	L O G	DESCRIPTION ELEVATION:	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	γ (gr/cm³)	Sample No.
		... as above								
18		Wadi deposits composed of cobbles , gravels , sand , silt and clay .			38					
19					43					
20					37					
21					35					
22					42					
23					48					
24					50					
25					53					
26		Final Depth (25.0m)								
27										
28										
29										
30										
31										
32										
33										
34										

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BOREHOLE LOG DATA SHEET

PROJECT : Raghadan Bus Terminal	TYPE & SIZE OF DRILLING :	Rotary 4 ½"
BOREHOLE NO : BH5	Date : Started :	23/6/1999
	Finished :	24/6/1999

Depth (M)	LOG	DESCRIPTION ELEVATION:	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	(gr/cm³)	Sample No.
1		Recent fill material (crushed gravels cobbles and sand) .			39					
2					15					
3		Dark brownish black sandy silty clay moist with gravels and some Cobbles .			18					
4					20					
5					21					
6					19					
7					30					
8					32					
9					38					
10										
11										
12										
13										
14										
15										
16										
17										
18										

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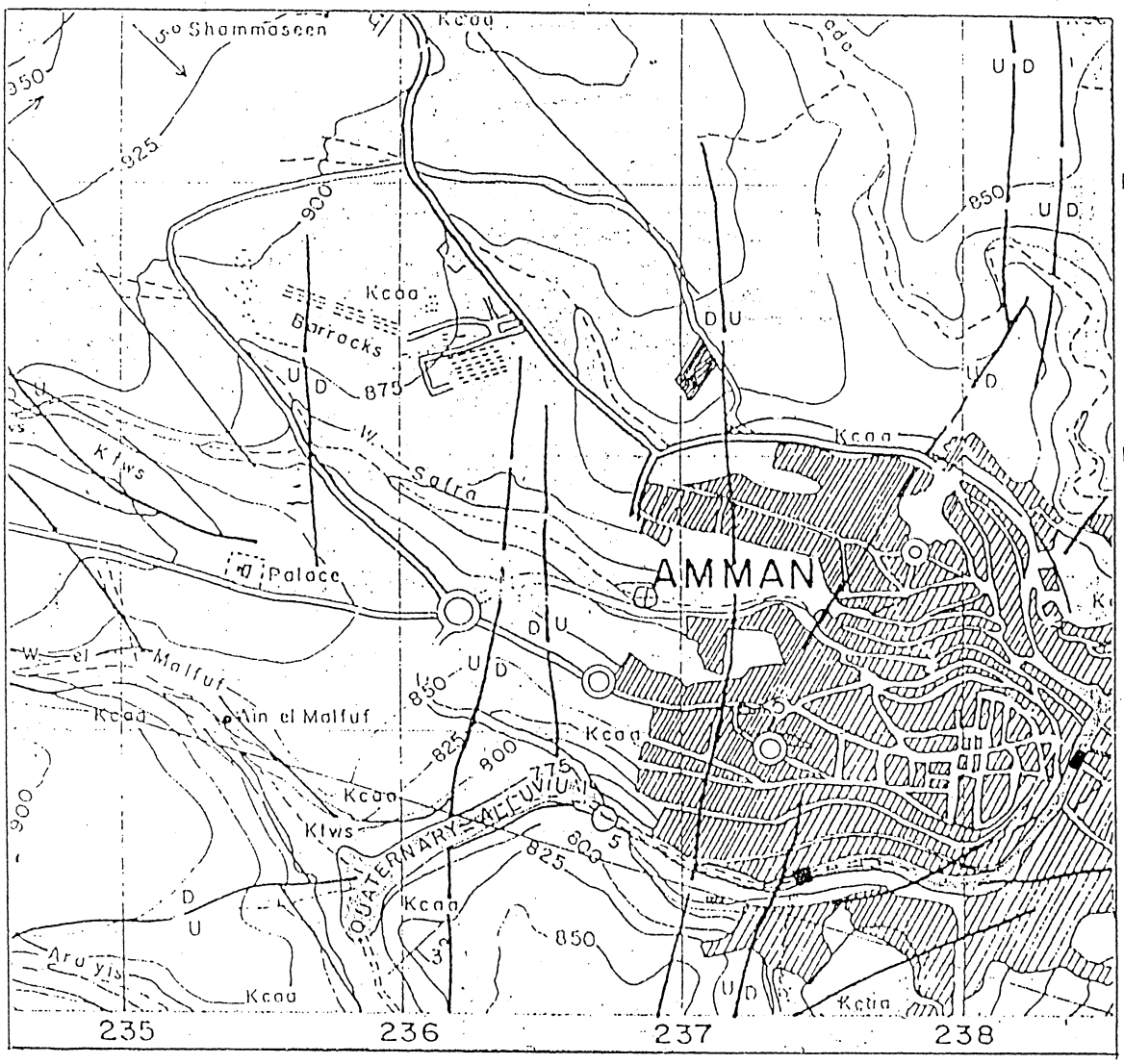
BOREHOLE LOG DATA SHEET

PROJECT : Raghadan Bus Terminal			TYPE & SIZE OF DRILLING : Rotary 4 ½"							
BOREHOLE NO : BH.6			Started : 15/6/99 Date : Finished : 16/6/99							
Depth (M)	L O G	DESCRIPTION ELEVATION: Flat	REC (%)	RQD. (%)	SPT. "N"	MC. (%)	LL	PI	γ (gr/cm³)	Sample No.
1		Fill material composed cobbles and gravels and silty clay .								
2					18					
3					5					
4		Dark blackish brown sandy silty clay with fine gravels , plastic , semi saturated with sewage water .			3					
5					3					
6					5					
7					6					
8					7					
9					7					
10					9					
11					8					
12					9					
13					10					
14					10					
15					9					
16		Final Depth (15.0m)								
17										

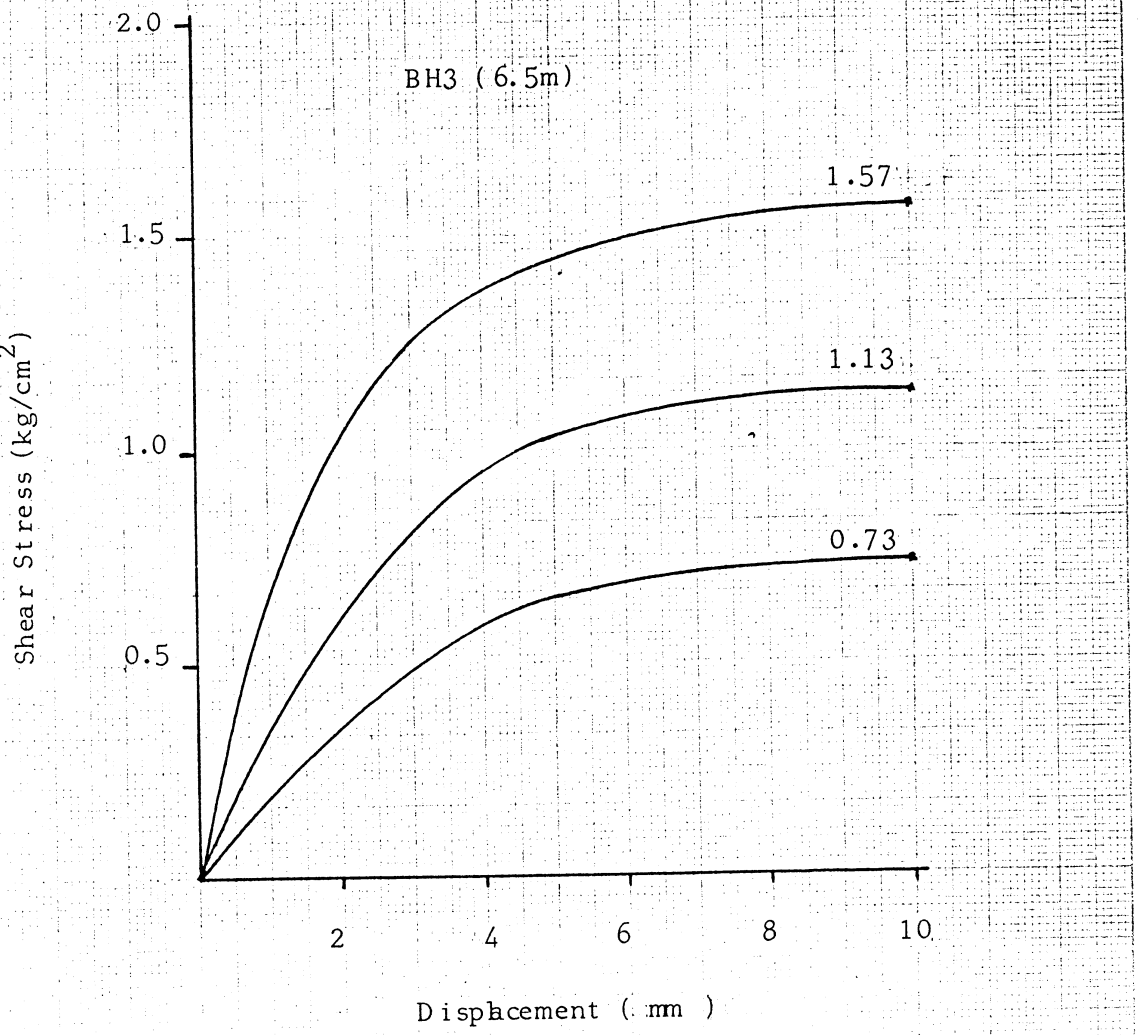
GEOLOGICAL MAP OF THE SITE

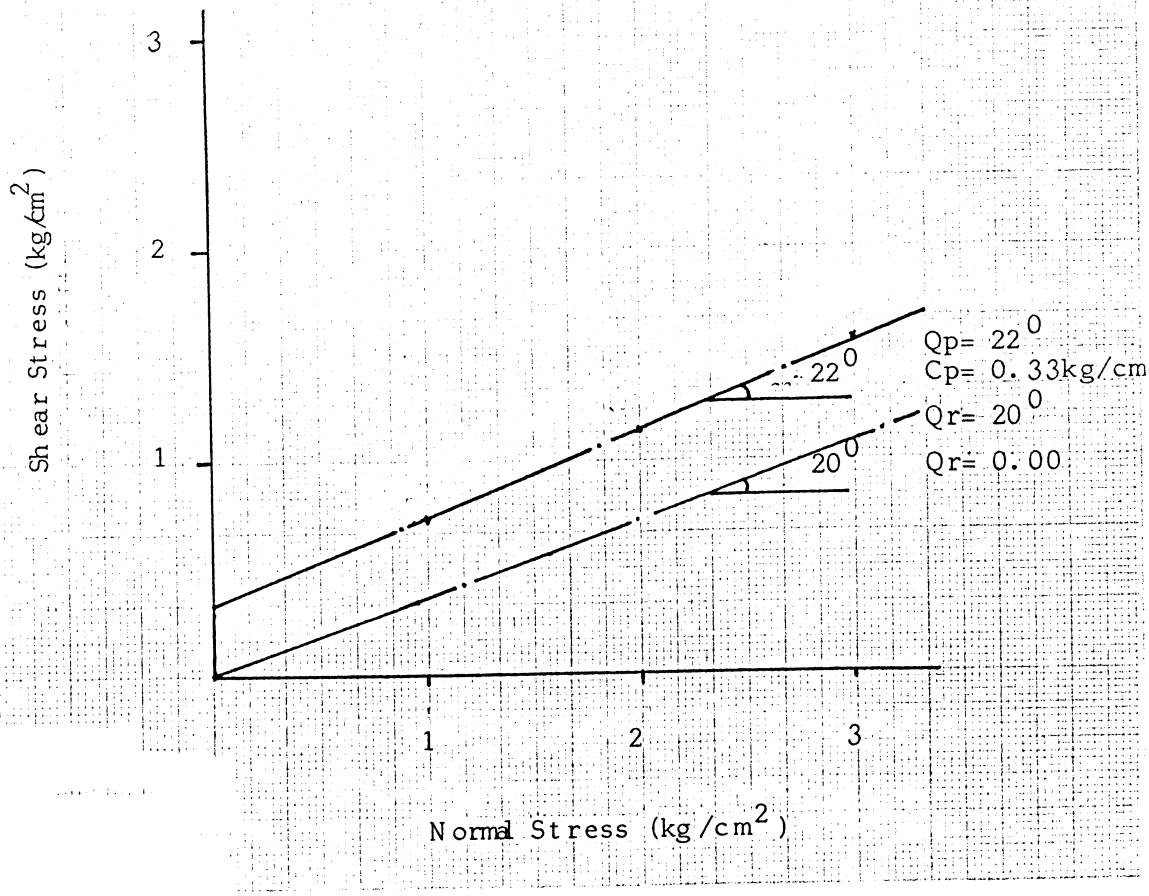


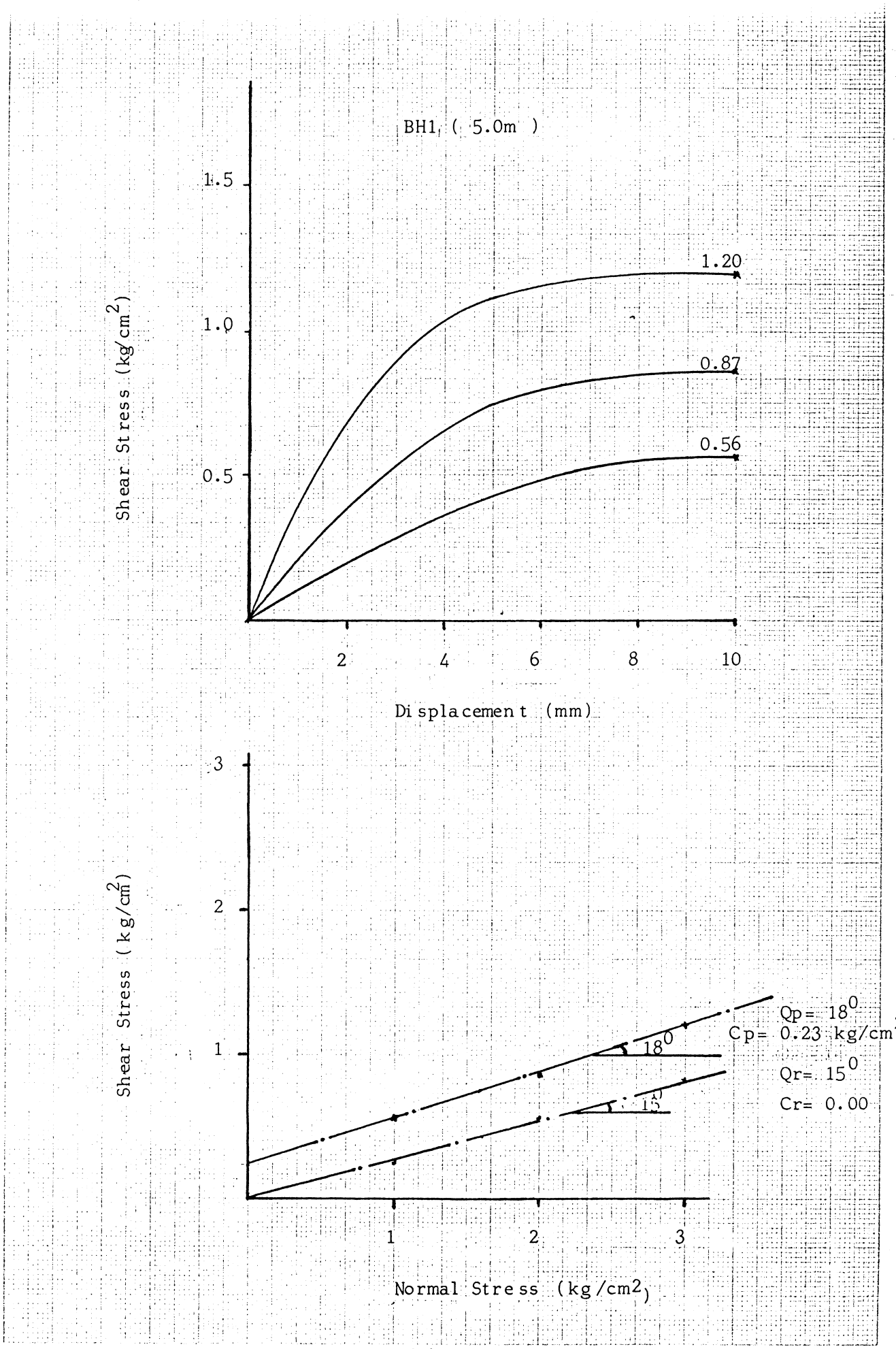
LEGEND

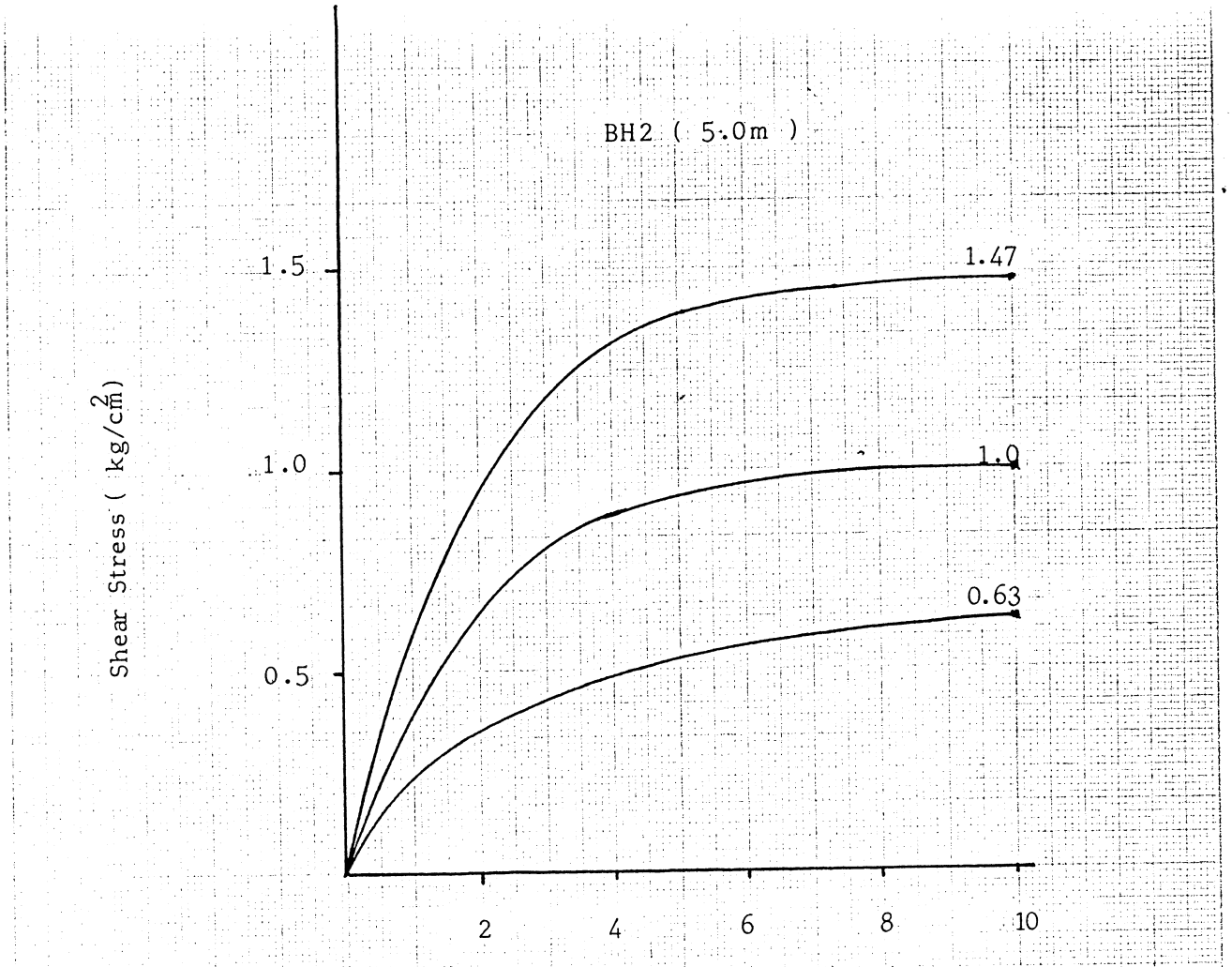
Kcaa B1/2	Amman-Um Ghudran
Ktws A7	W.Es Sir
	Quaternary alluvium
Formation boundary	
Anticlinal axis	
synclinal axis	
Fault with downthrow	D / U
Dip measured	12
Location site	
Town	
Road first class	
Wadi	
Contoure	125 / 100 / 75

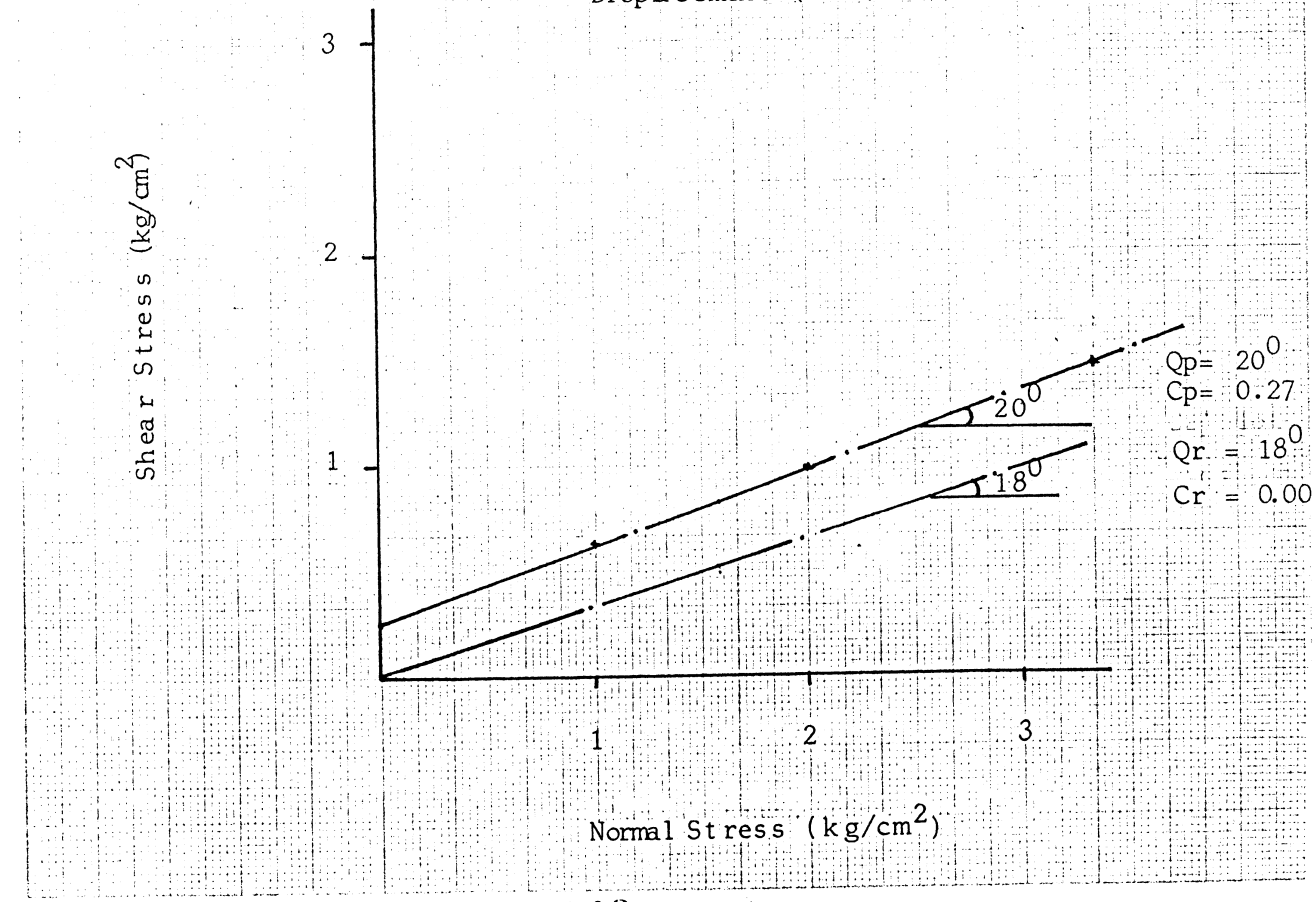
Scale 1:25000

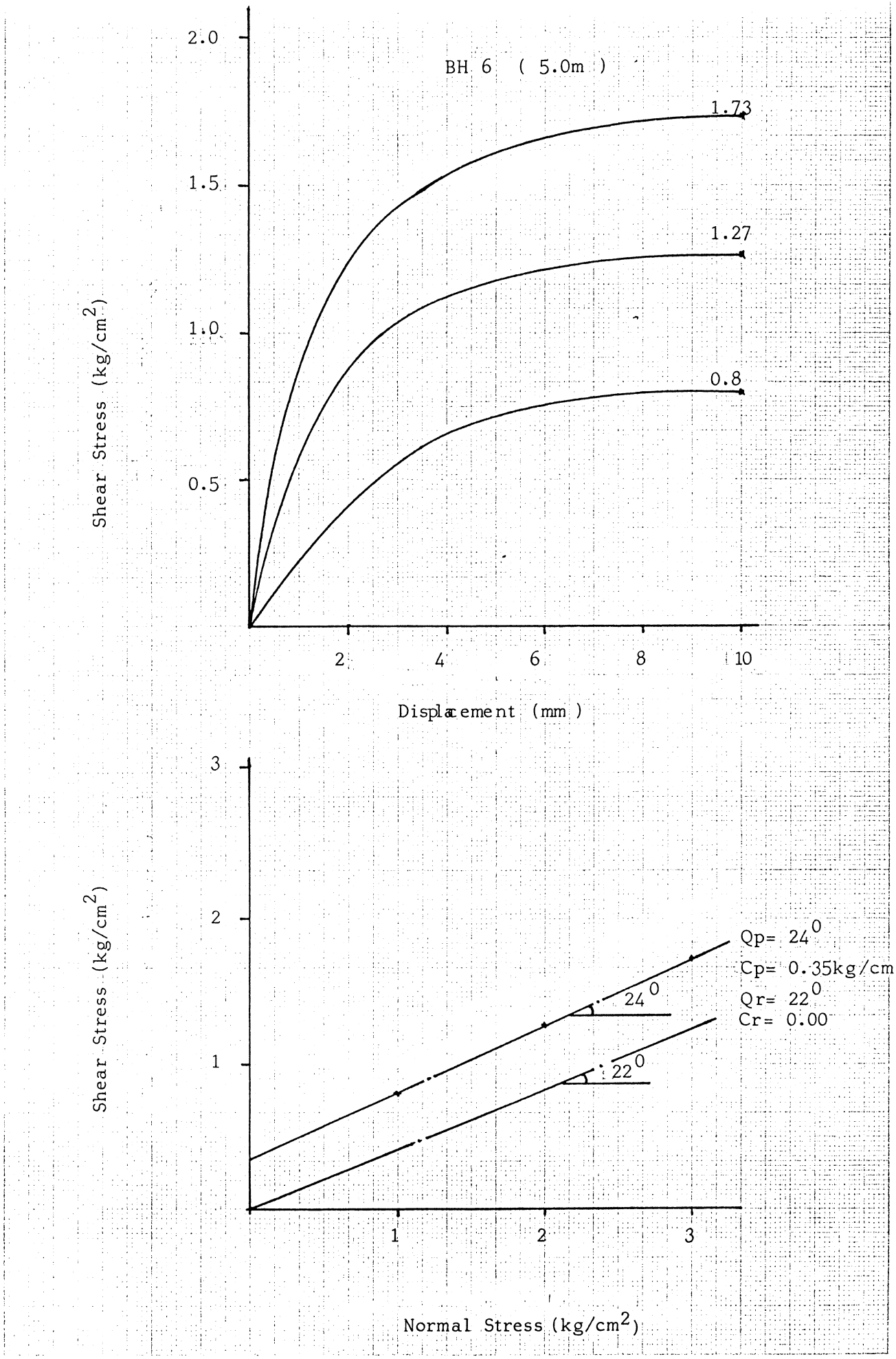

BH3 (6.5m)
Shear Stress (kg/cm2)
2.0
1.5
1.0
0.5
1.57
1.13
0.73
2
4
6
8
10
Displacement (mm)


Shear Stress (kg/cm2)
3
2
1
22°
20°
Qp= 22°
Cp= 0.33kg/cm
Qr= 20°
Qr= 0.00
1
2
3
Normal Stress (kg/cm2)


BH1 (5.0m)
Shear Stress (kg/cm2)
1.5
1.0
0.5
1.20
0.87
0.56
2
4
6
8
10
Displacement (mm)
Shear Stress (kg/cm2)
3
2
1
18°
15°
Qp= 18°
Cp= 0.23 kg/cm2
Qr= 15°
Cr= 0.00
1
2
3
Normal Stress (kg/cm2)


BH2 (5.0m)
Shear Stress (kg/cm2)
1.5
1.0
0.5
1.47
1.0
0.63
2
4
6
8
10
Displacement (mm)


Shear Stress (kg/cm2)
3
2
1
20°
18°
Qp= 20°
Cp= 0.27
Qr = 18°
Cr = 0.00
1
2
3
Normal Stress (kg/cm2)


BH 6 (5.0m)
1.73
1.27
0.8
2.0
1.5
1.0
0.5
Shear Stress (kg/cm2)
2
4
6
8
10
Displacement (mm)
3
2
1
Shear Stress (kg/cm2)
Qp= 24 0
Cp= 0.35kg/cm2
Qr= 22 0
Cr= 0.00
24 0
22 0
1
2
3
Normal Stress (kg/cm2)

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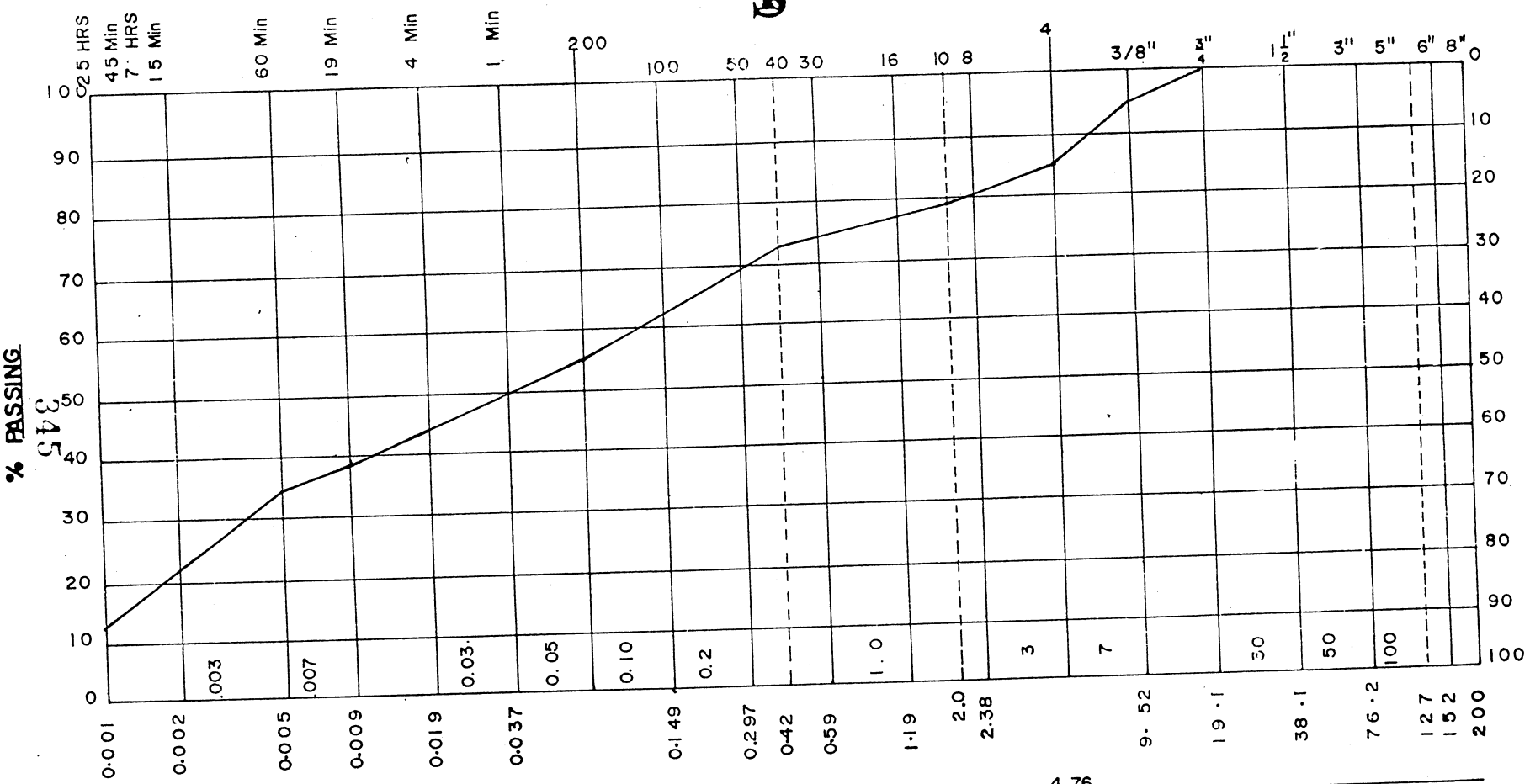
HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
0.074					4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH1				
5.0m	15.2	29.6	33.1	22.1

REMARKS _____

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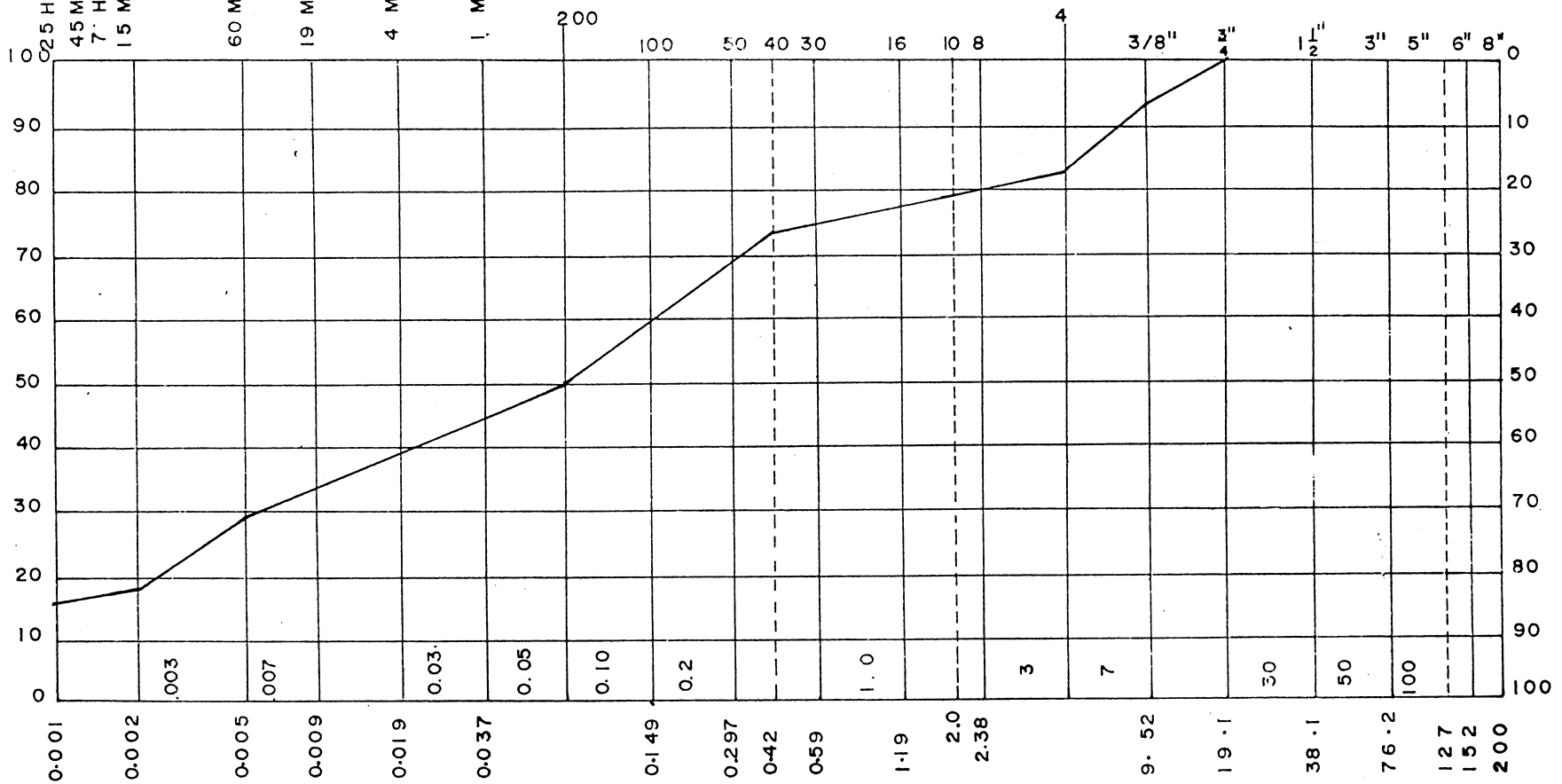
HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH				
7.5m	17.8	32.2	31.7	18.3

REMARKS _____

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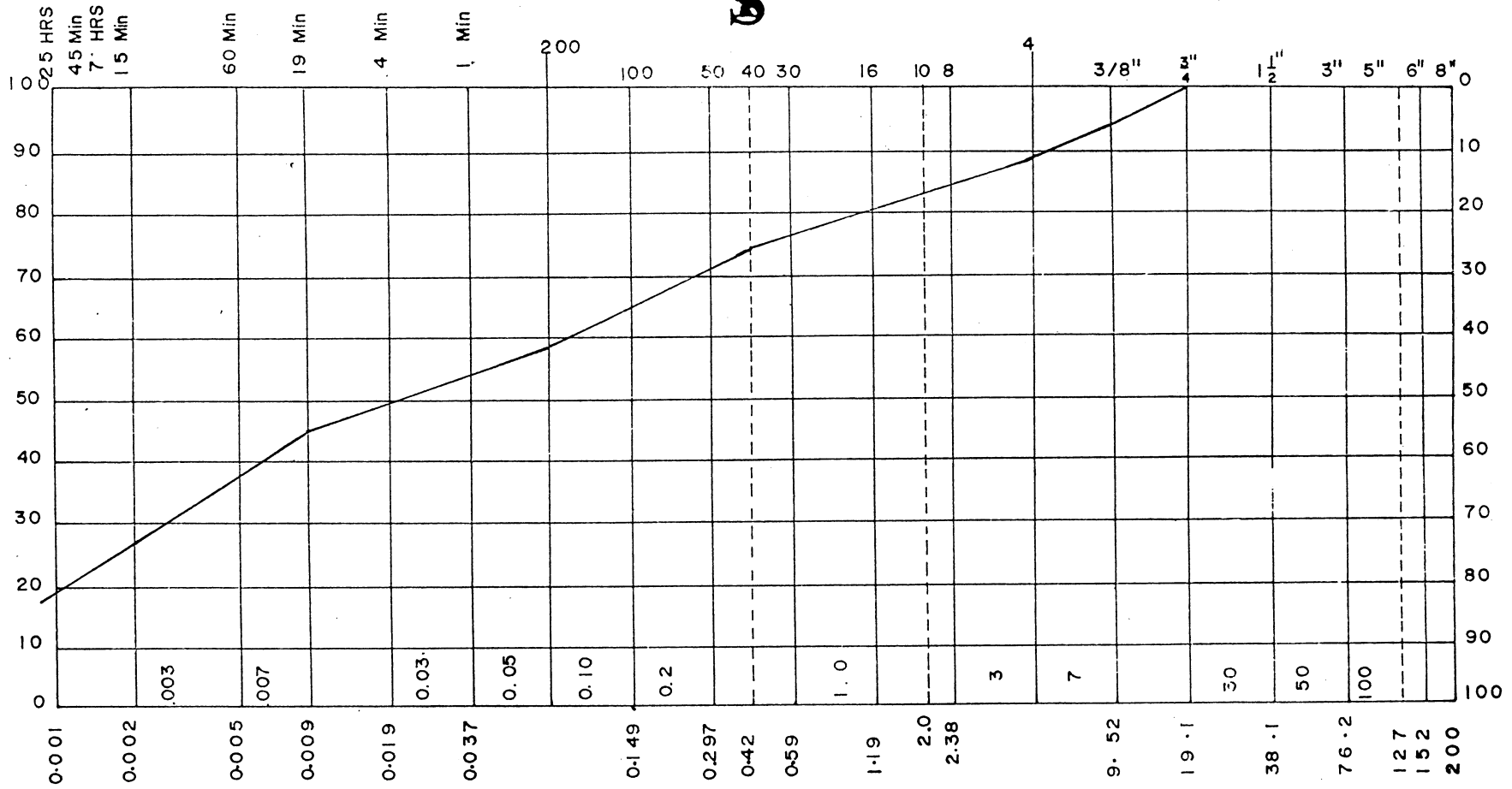
HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
0.074					4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH1				
10.0m	11.2	30.7	31.3	26.8

REMARKS _____

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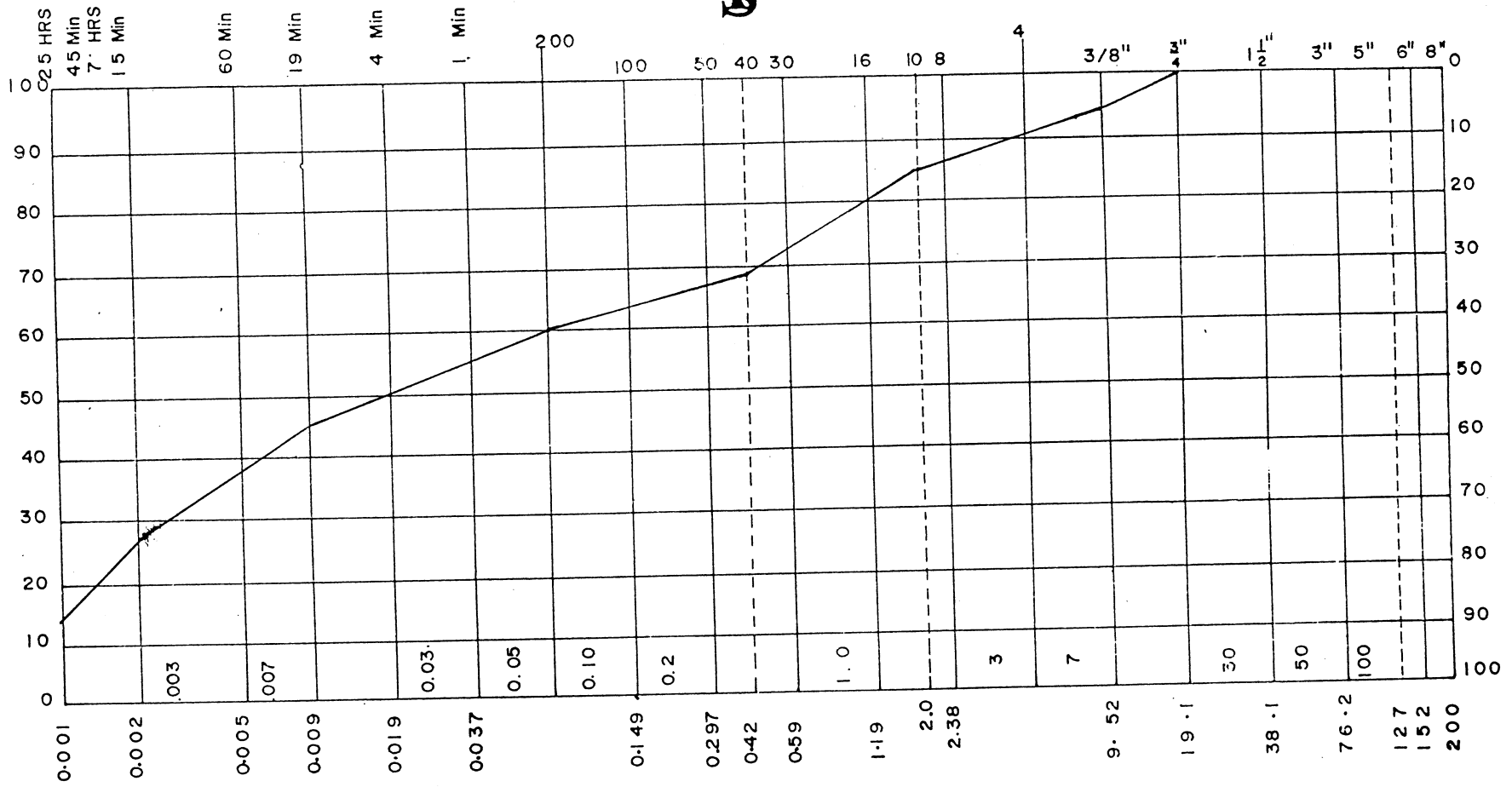
HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH1				
12.5m	9.0	31.0	33.0	27.0

REMARKS _____

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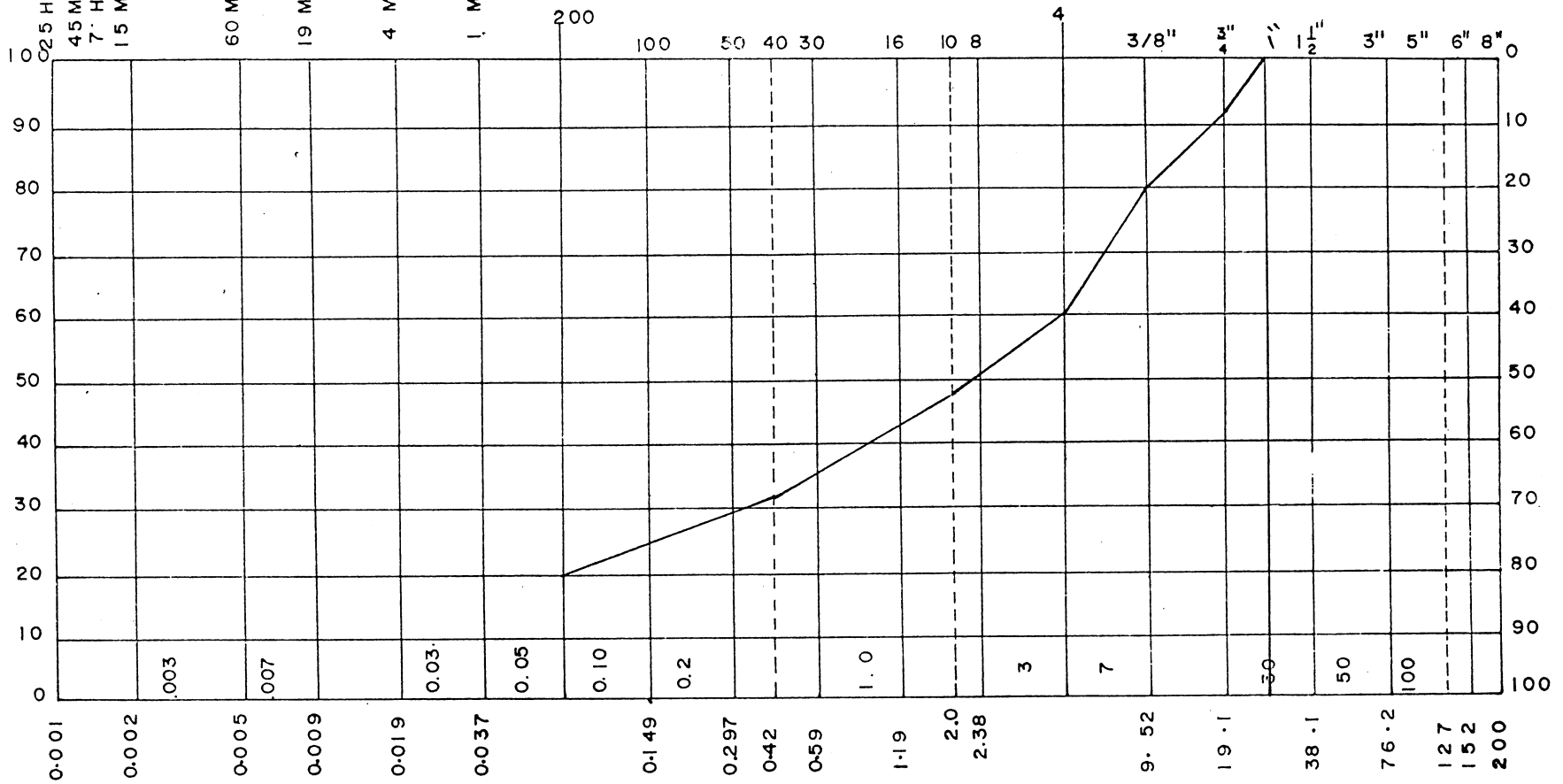
HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 1				
15.0 m	40.0	40.0	20.0	—

REMARKS _____

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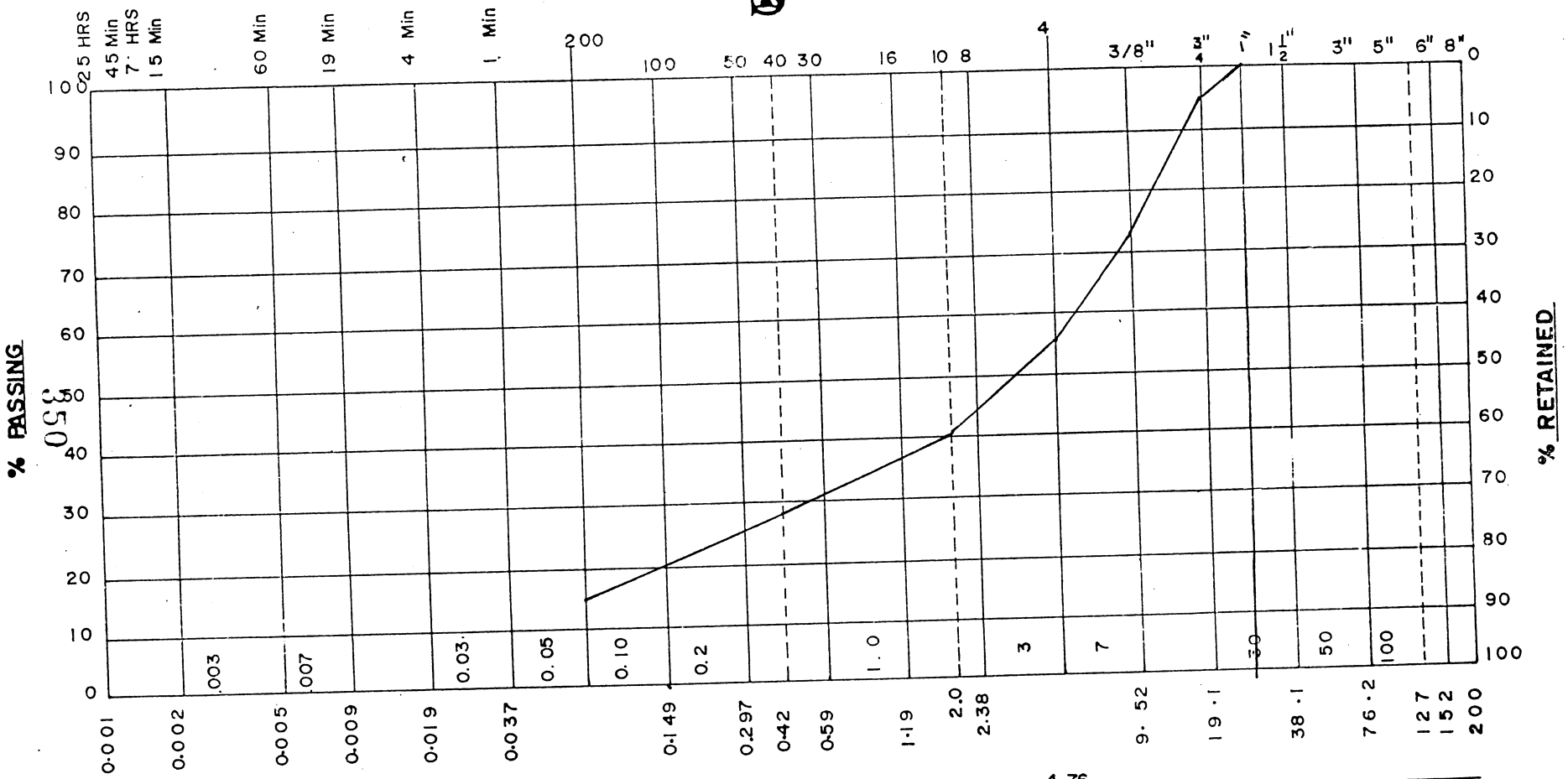
SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH1				
17.5m	44.5	40.5	15.0	-

REMARKS _____

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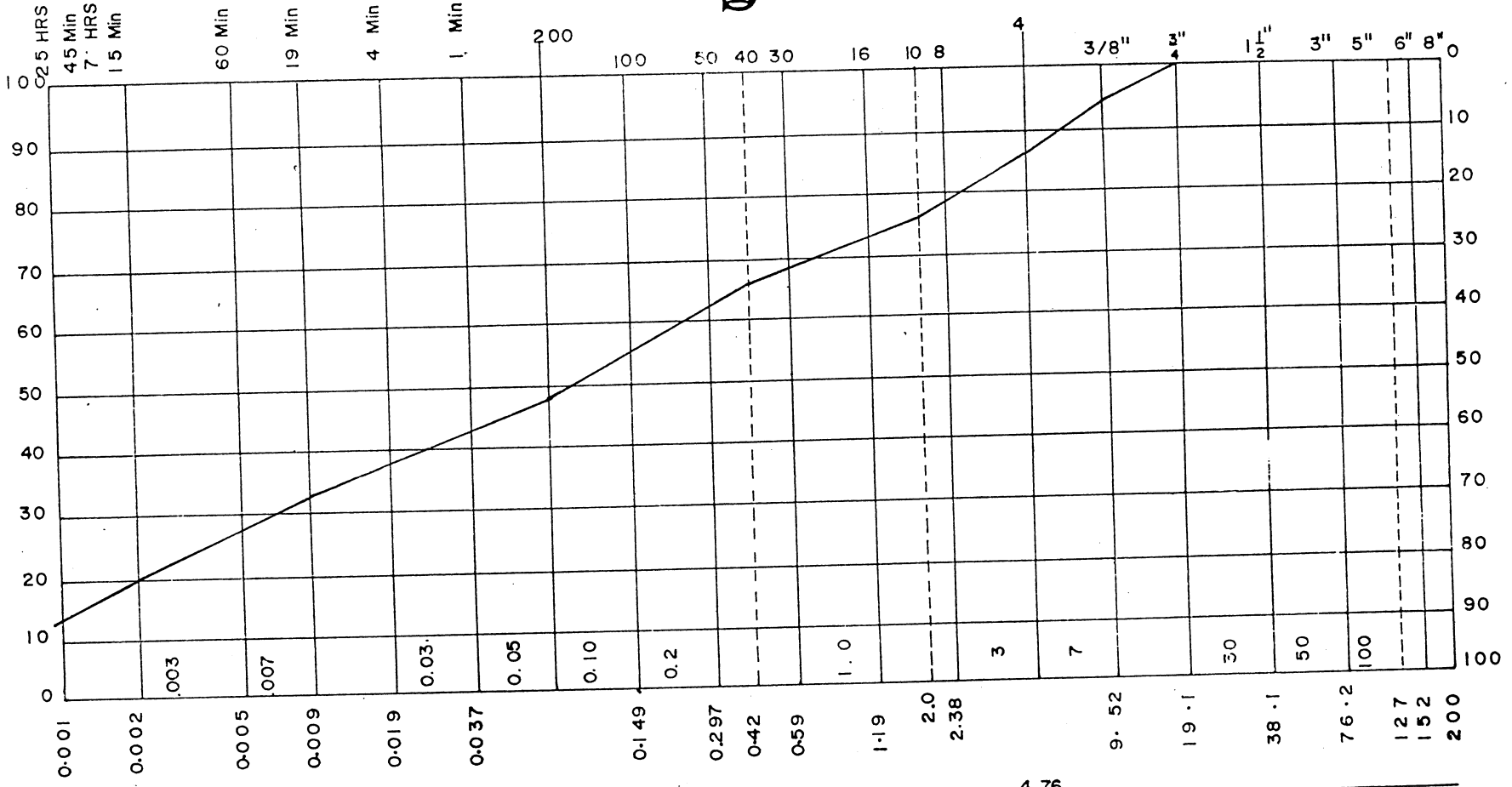
SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 2				
5.0m	14.5	37.5	28.0	20.0

REMARKS _____

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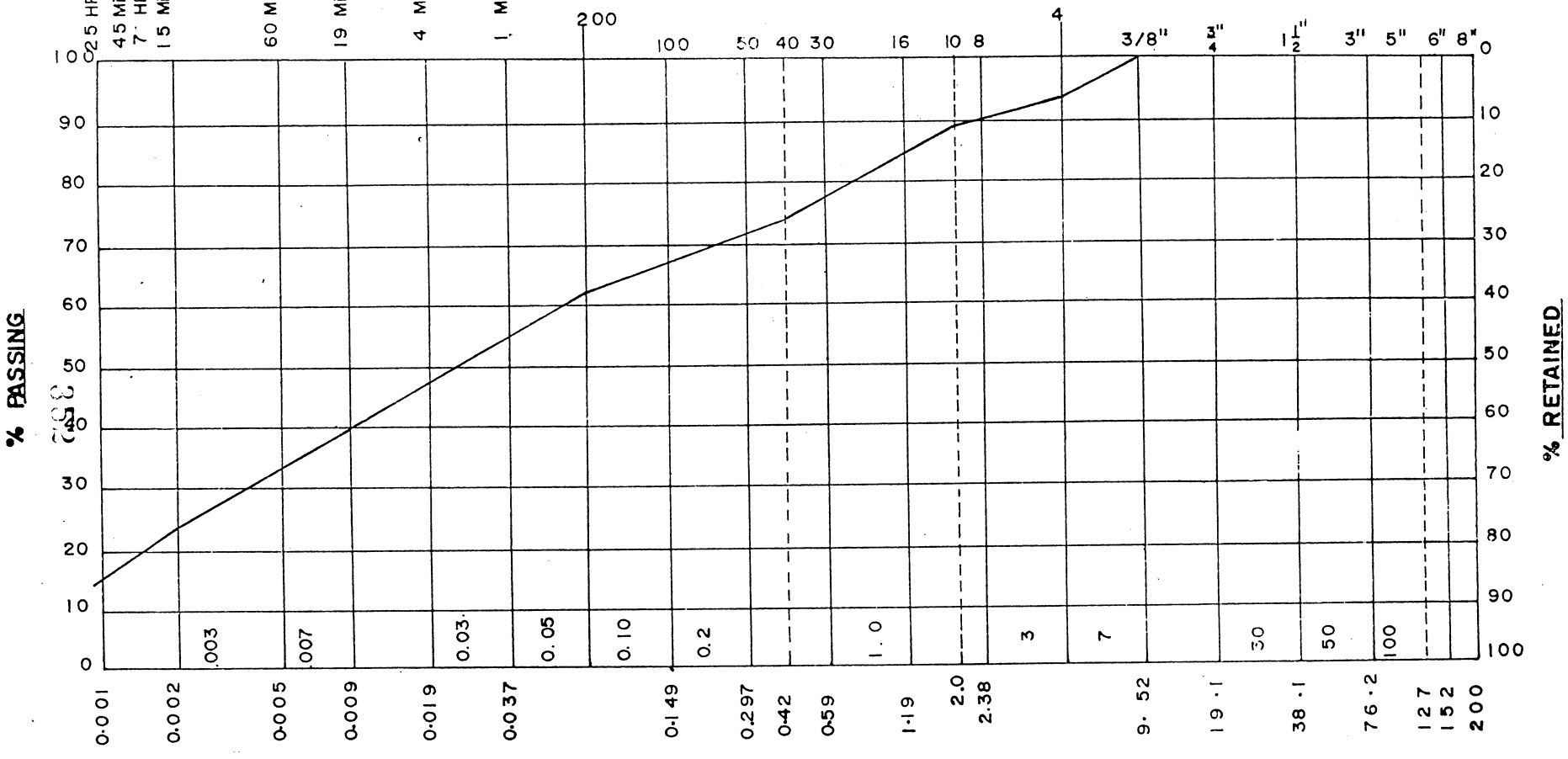
SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 2				
7.5 m	6.0	31.8	38.1	24.1

REMARKS _____

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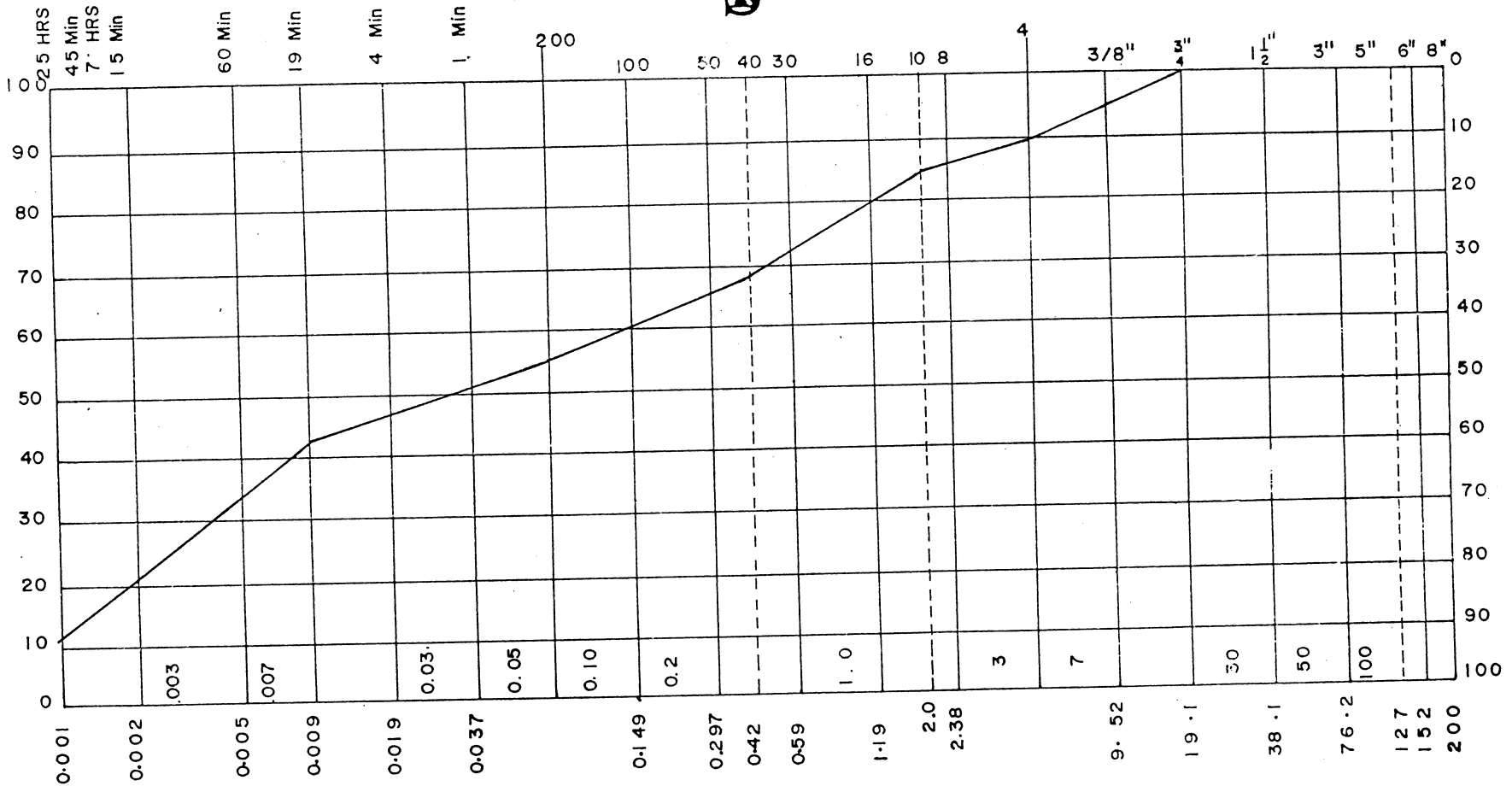
SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH2				
10.0 m	10.5	34.0	34.3	21.2

REMARKS _____

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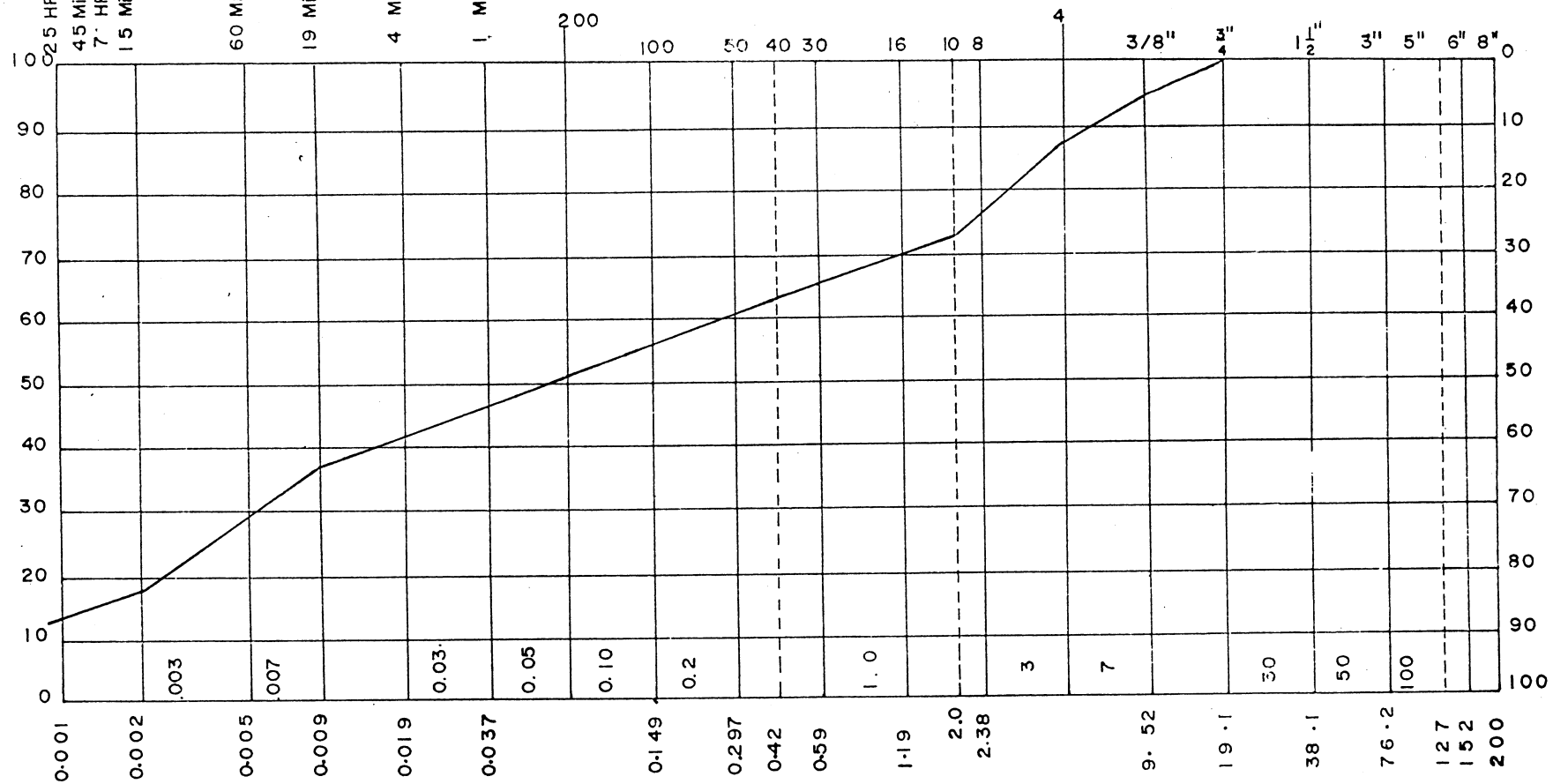
HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH2				
12.5 m	12.5	36.0	33.5	18.0

REMARKS _____

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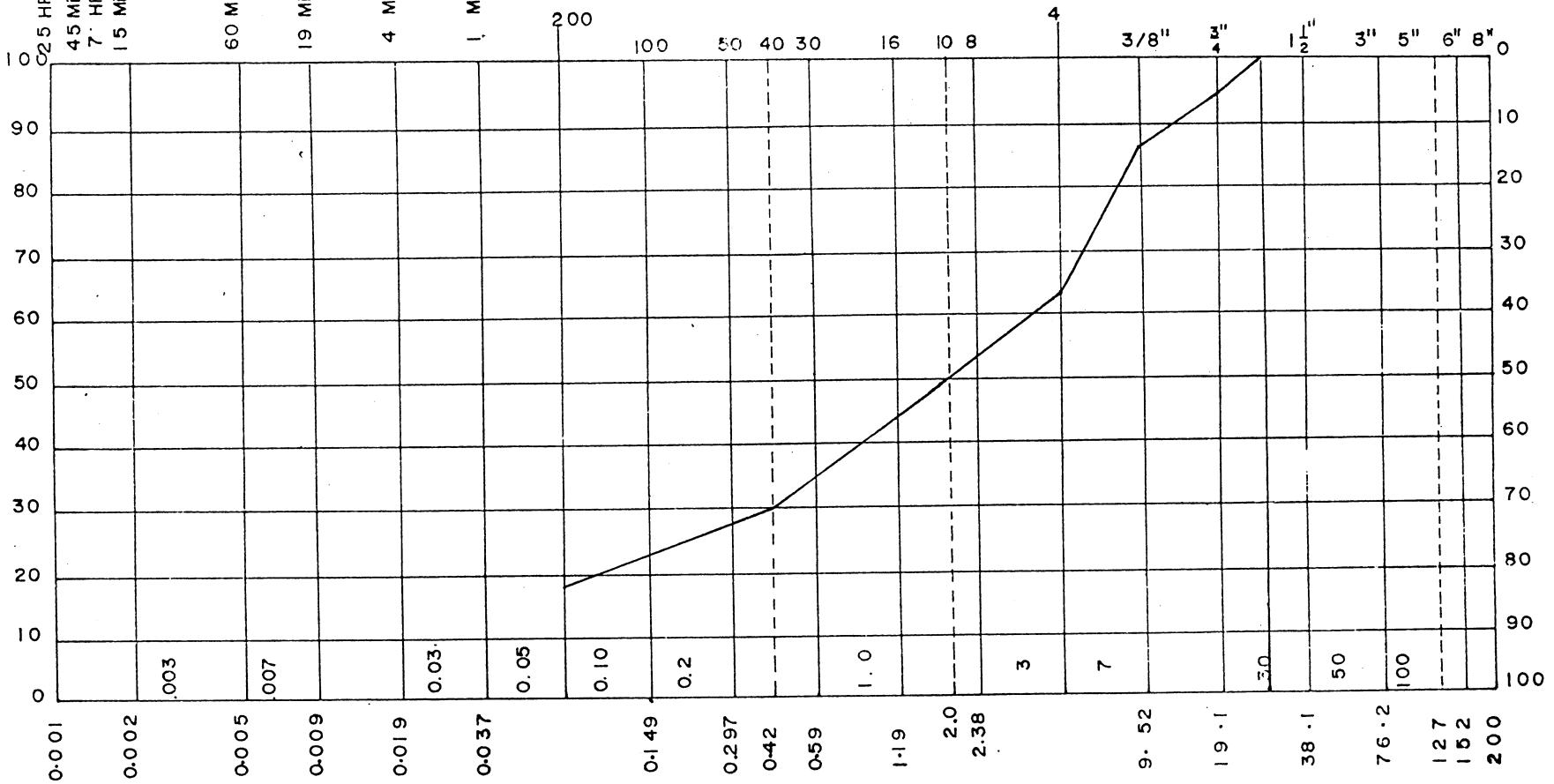
SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH2				
15.0	37.0	45.0	18.0	—

REMARKS _____

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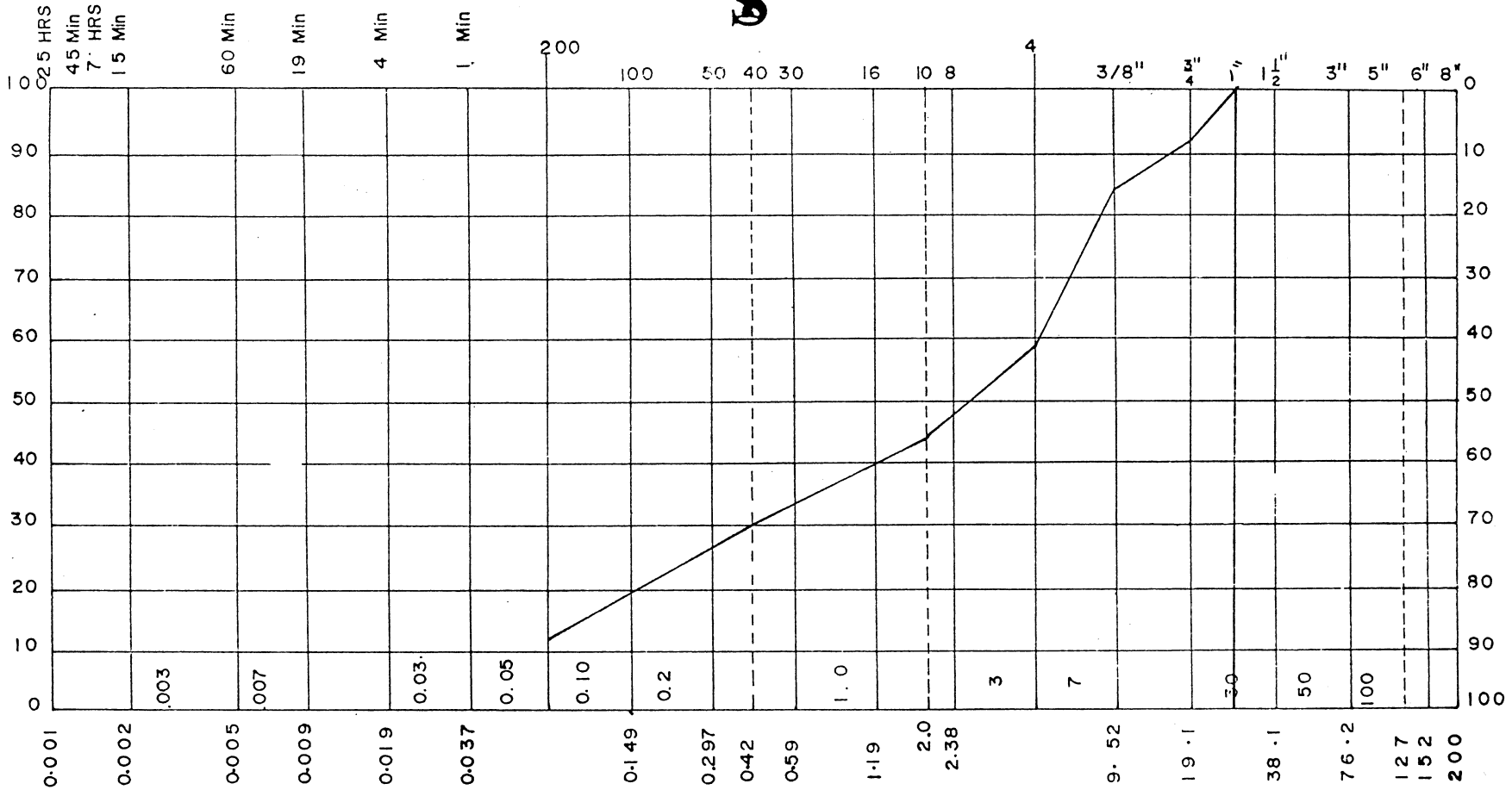
HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH2				
17.5m	41.9	46.1	12.0	—

REMARKS _____

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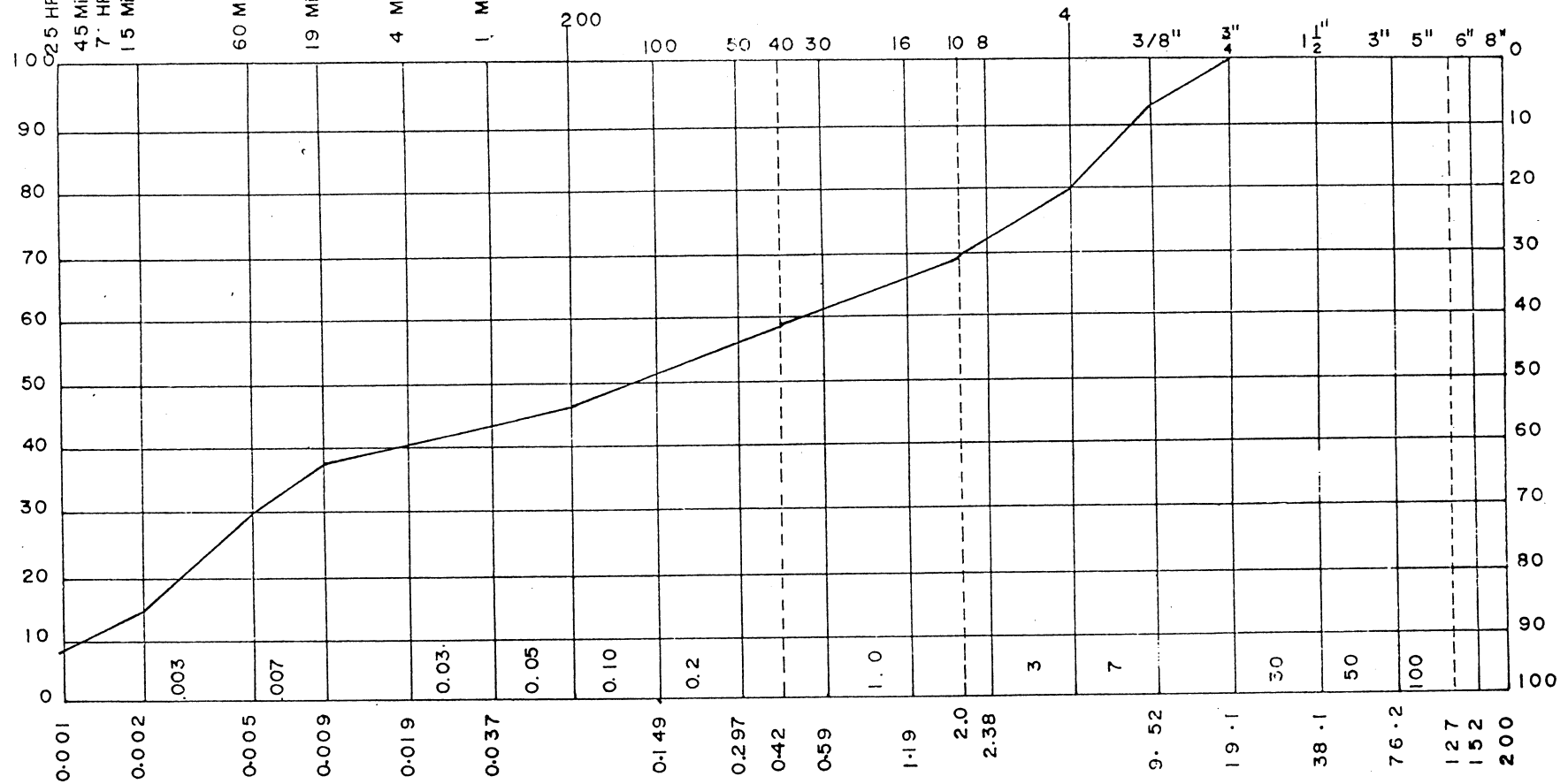
HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH3				
5.0m	20.0	34.0	31.0	15.0

REMARKS _____

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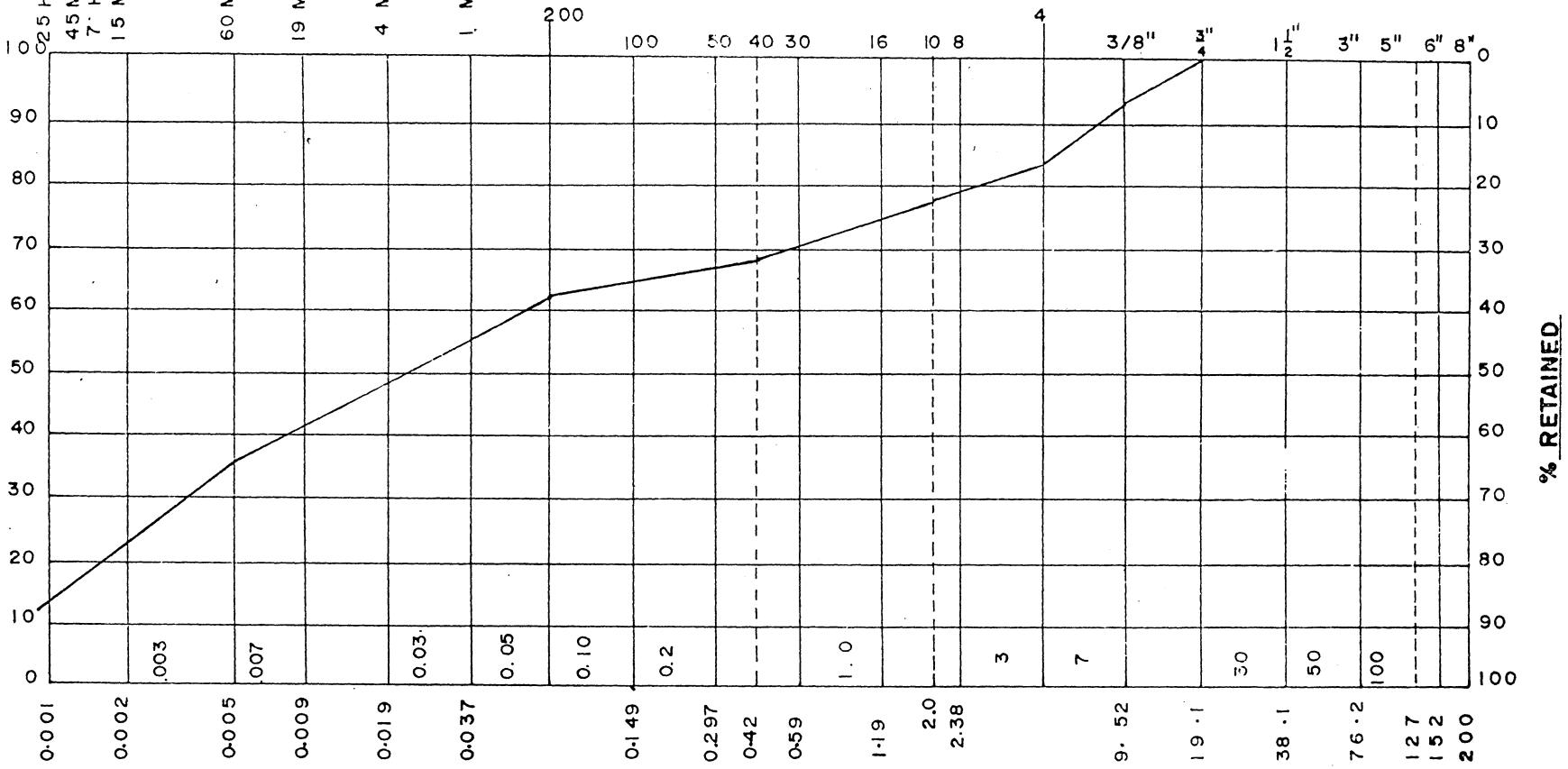
SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 3				
10.0m	16.5	21.5	39.2	22.8

REMARKS _____

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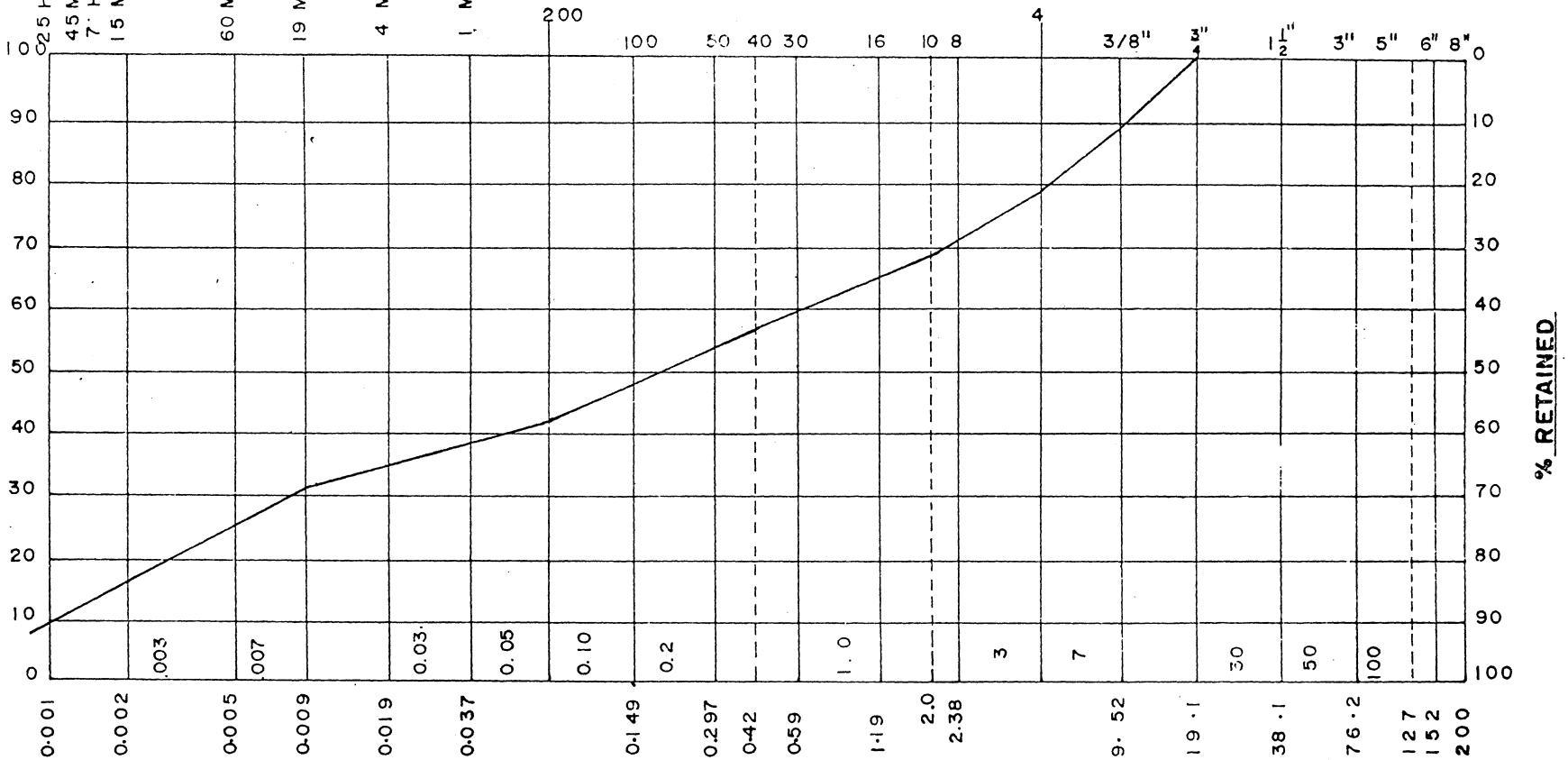
SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 3				
15.0	21.1	36.8	25.6	16.5

REMARKS _____

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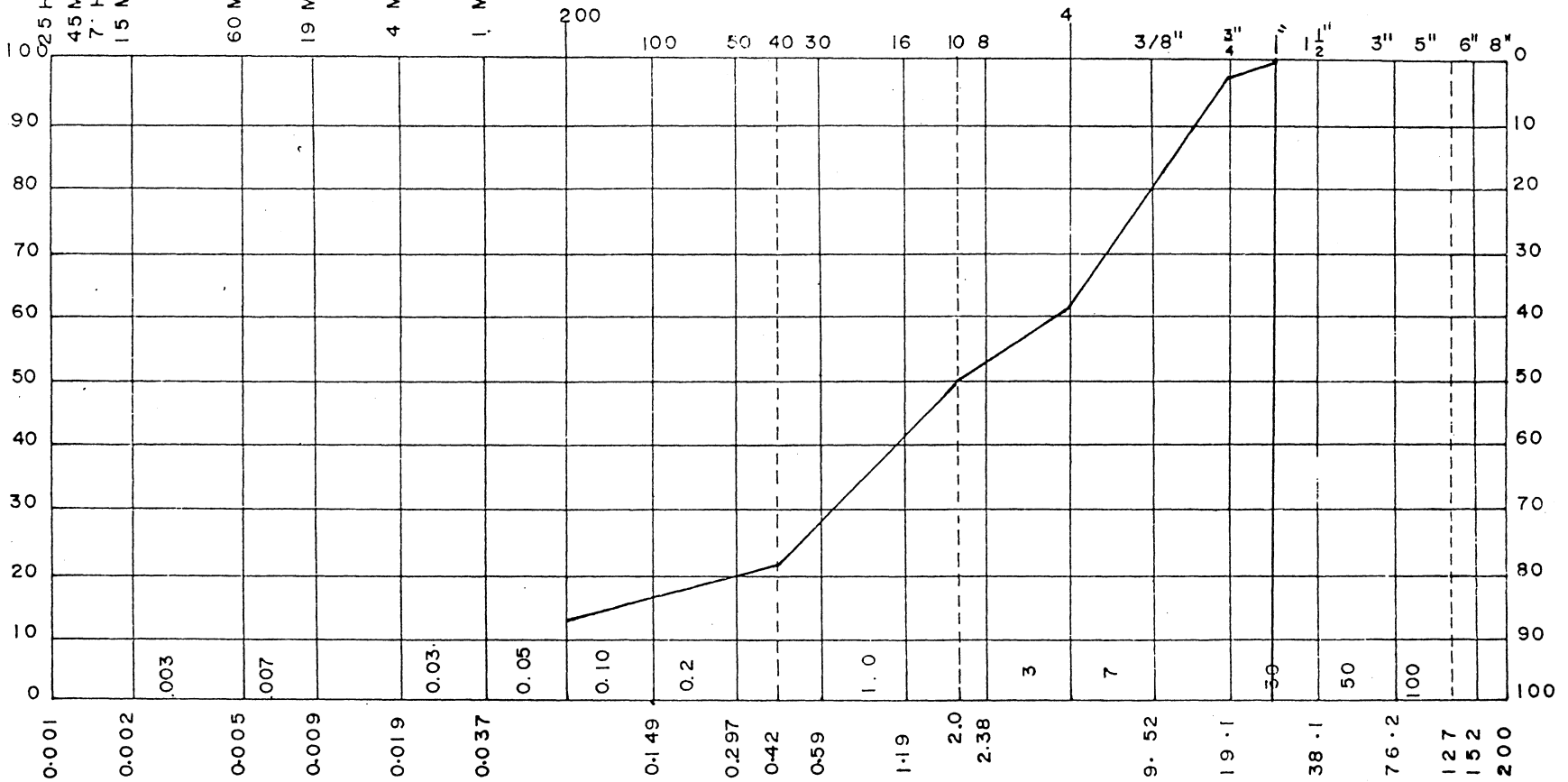
SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 3				
20.0m	38.1	48.9	13.0	-

REMARKS _____

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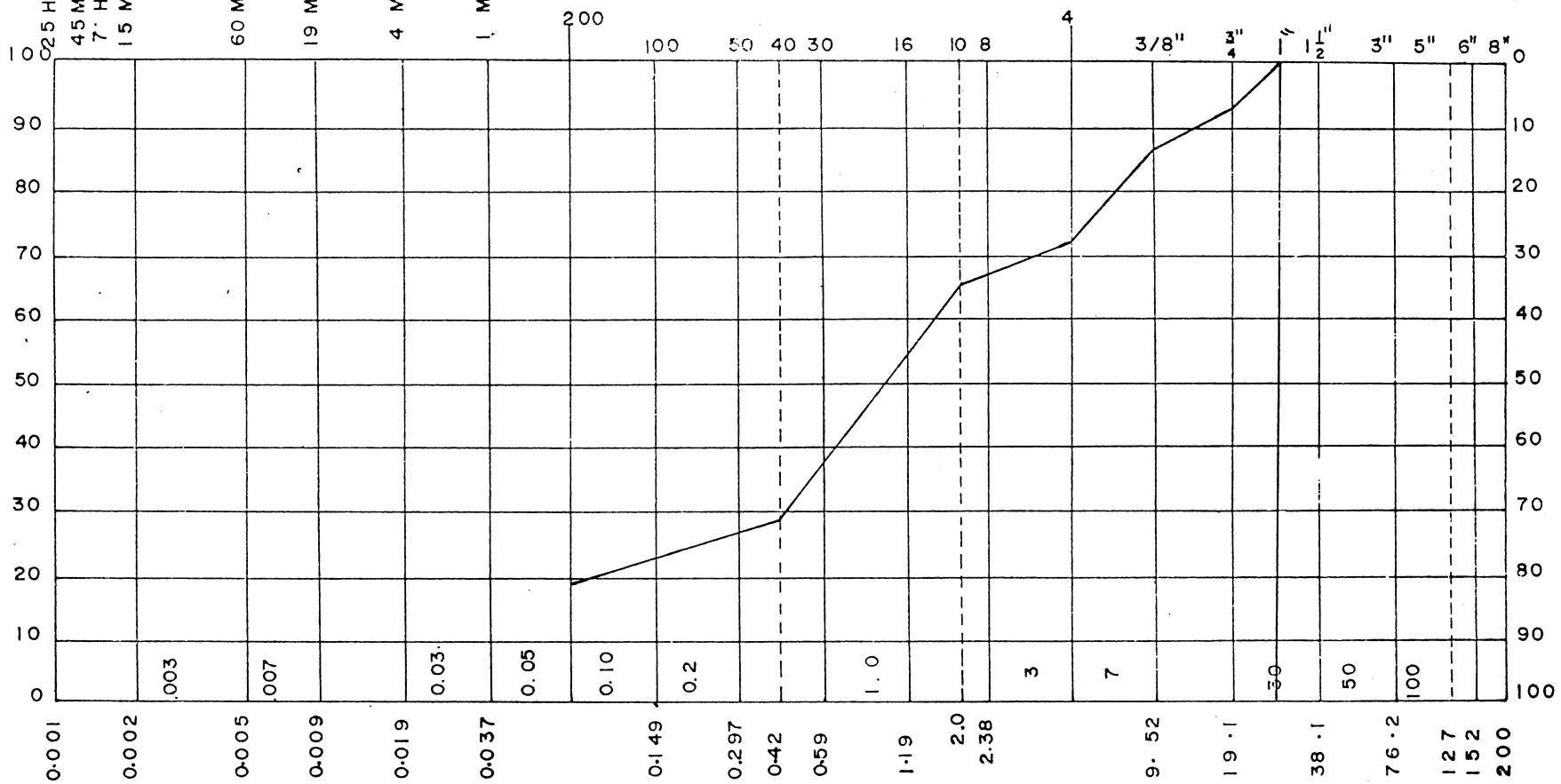
PROJECT _____

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH3				
25.0m	27.0	54.0	19.0	-

REMARKS _____

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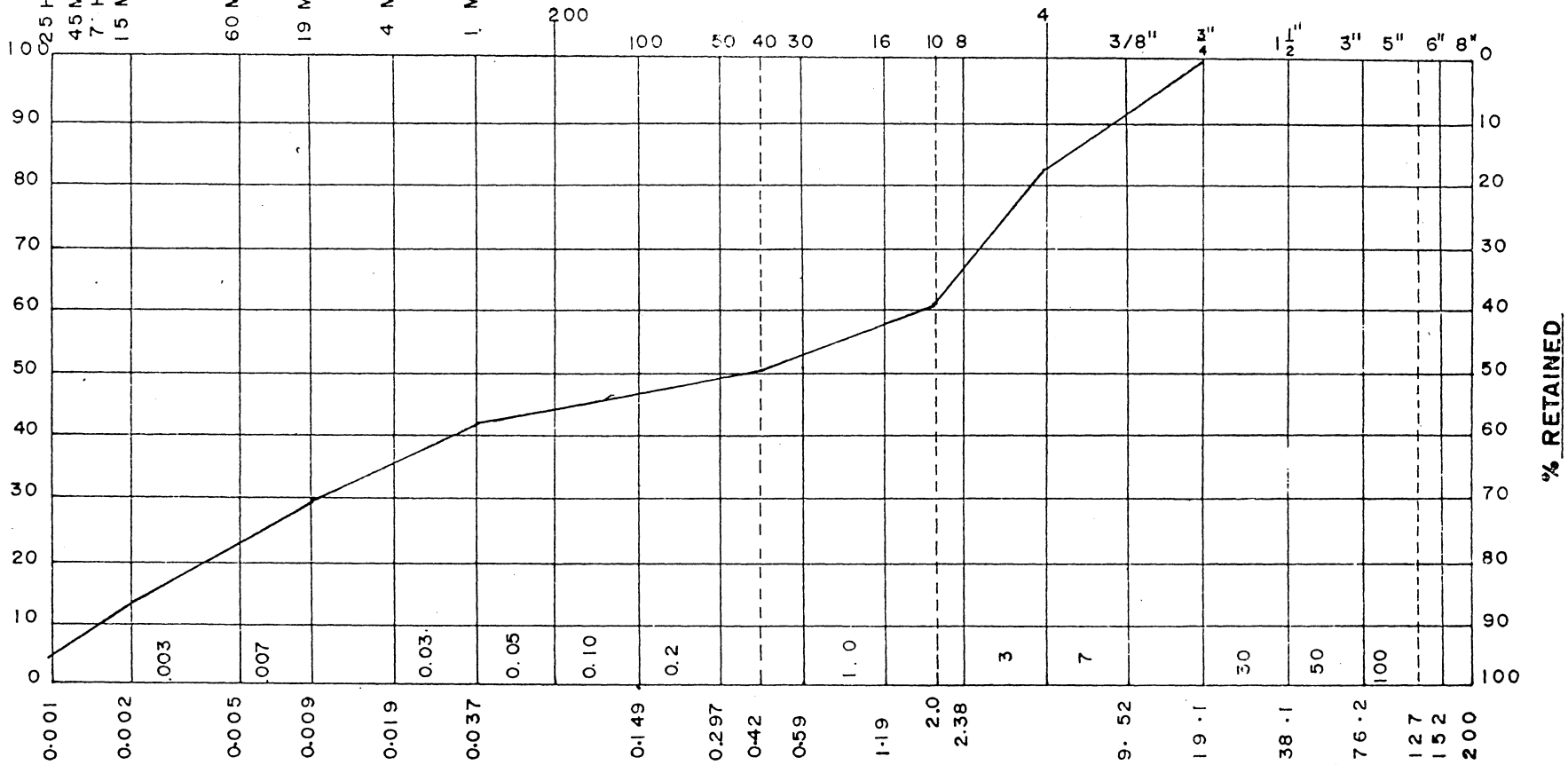
SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH5				
5.0m	17.2	38.7	31.0	13.1

REMARKS _____

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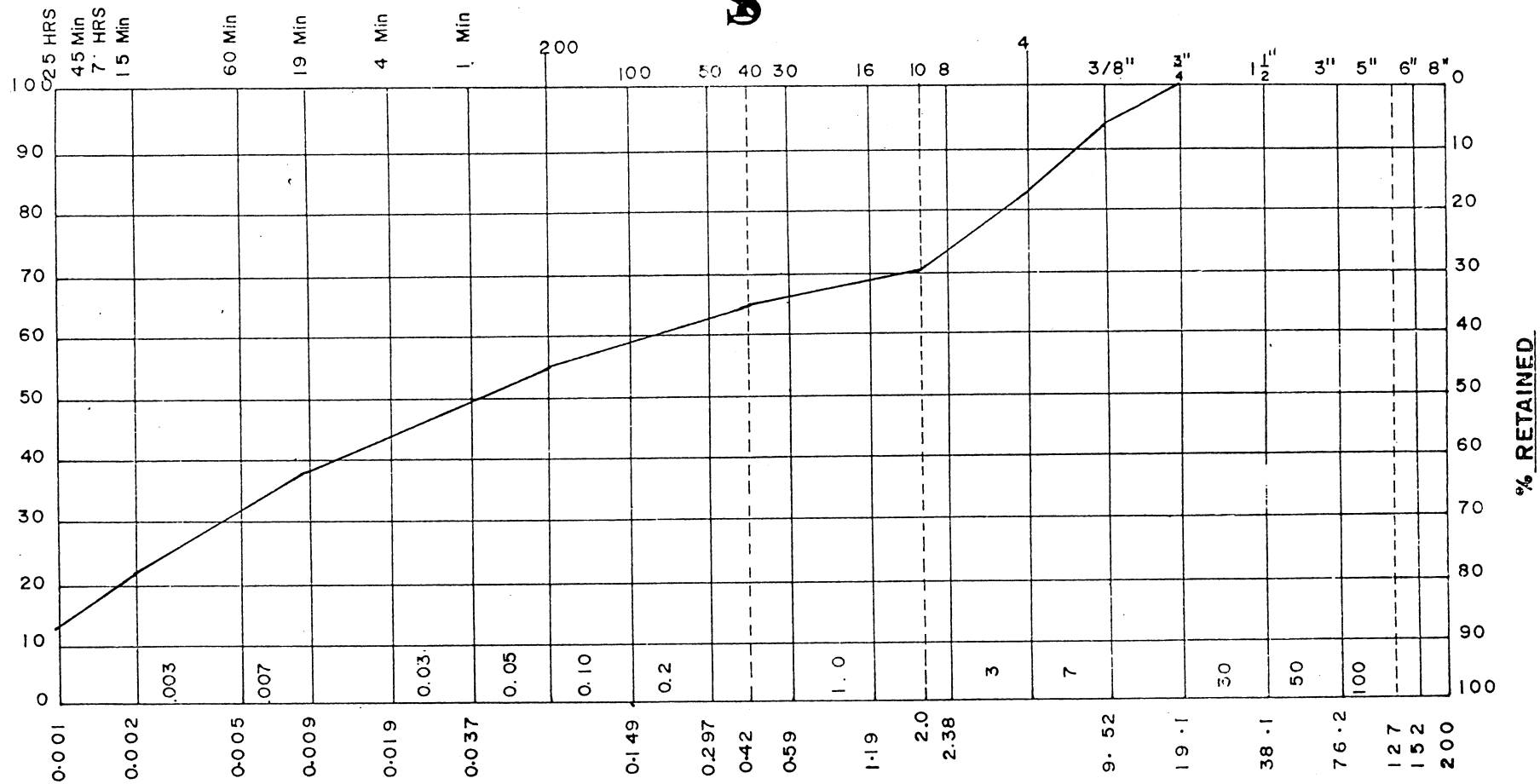
SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	0.074	SAND		4.76	GRAVEL		COBBLES
			FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH5				
7.5m	17.0	28.1	33.1	21.8

REMARKS _____

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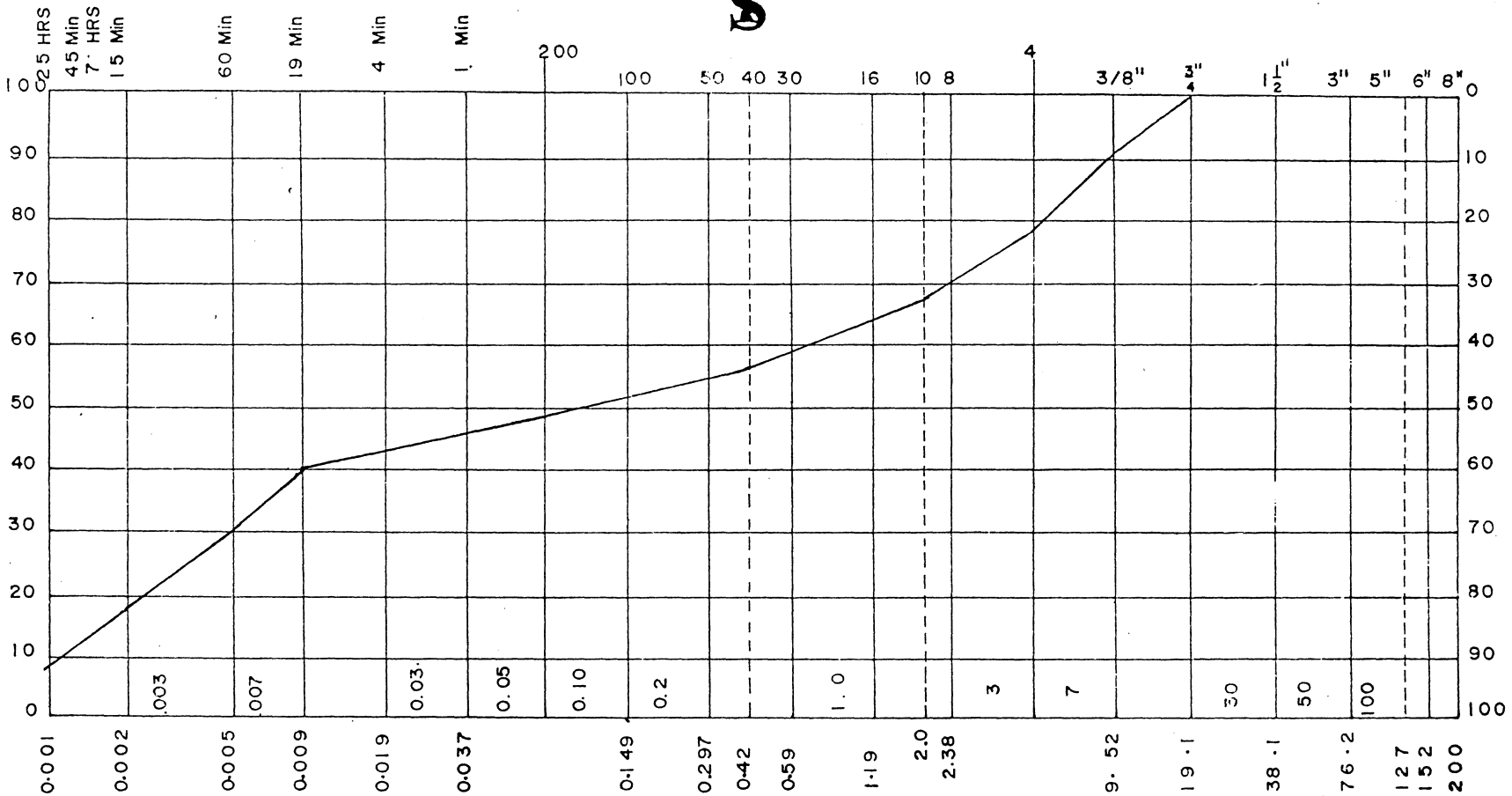
HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH5				
10.0 m	21.9	29.6	30.5	18.0

REMARKS _____

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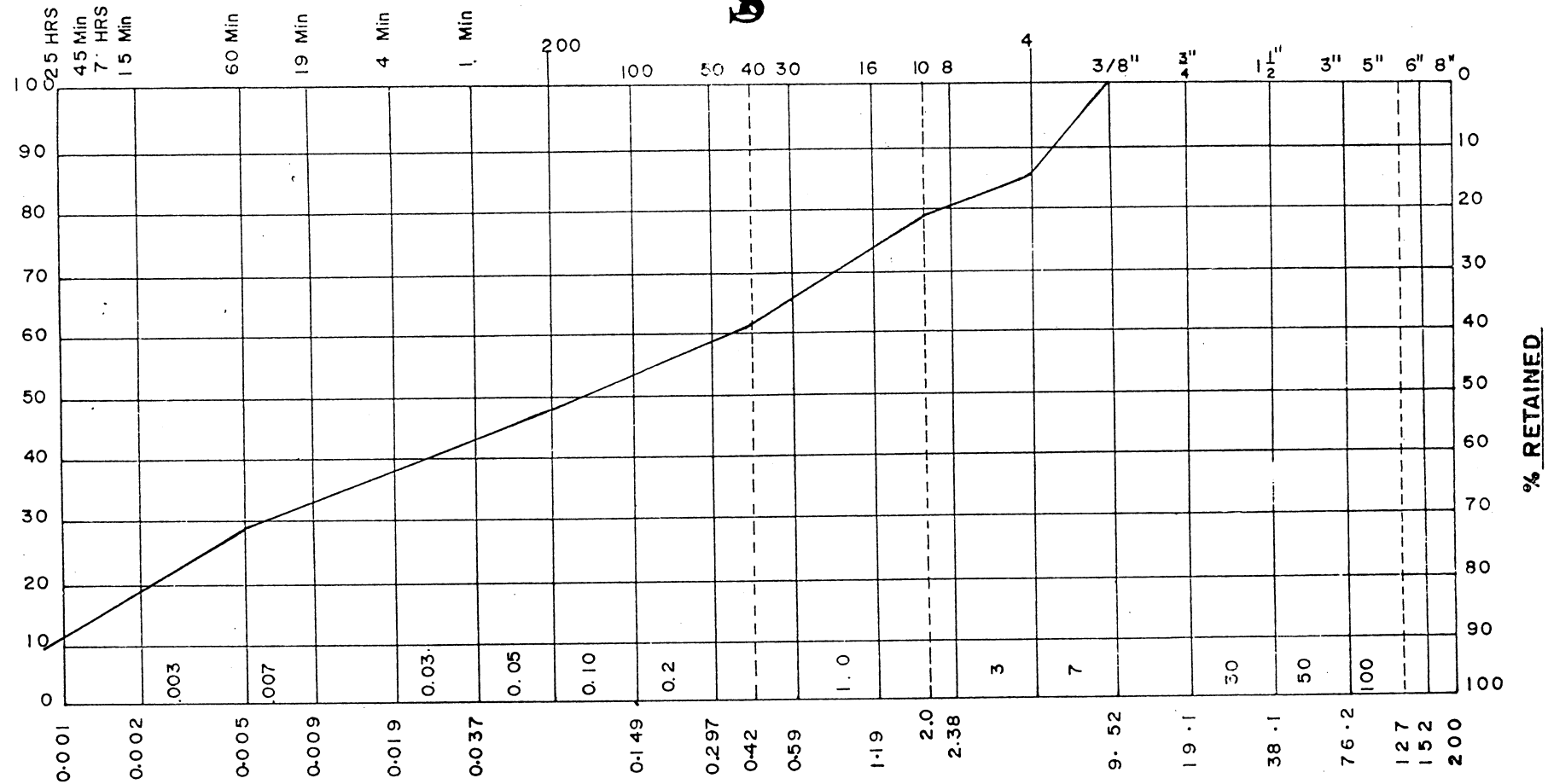

0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 6				
5.0m	14.1	37.9	29.0	19.0

REMARKS _____

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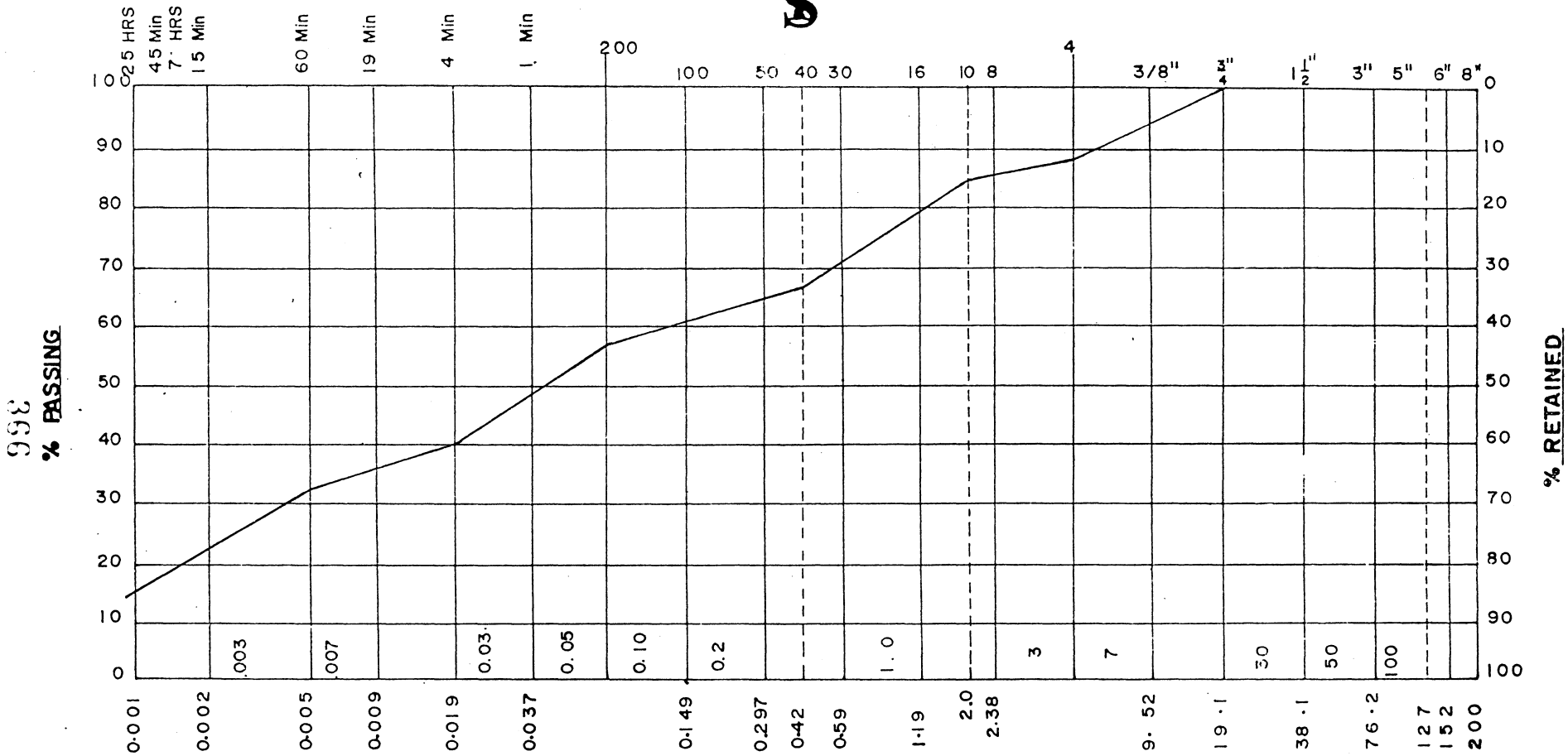

0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 6 7.5m	12.0	31.2	34.3	22.5

REMARKS _____

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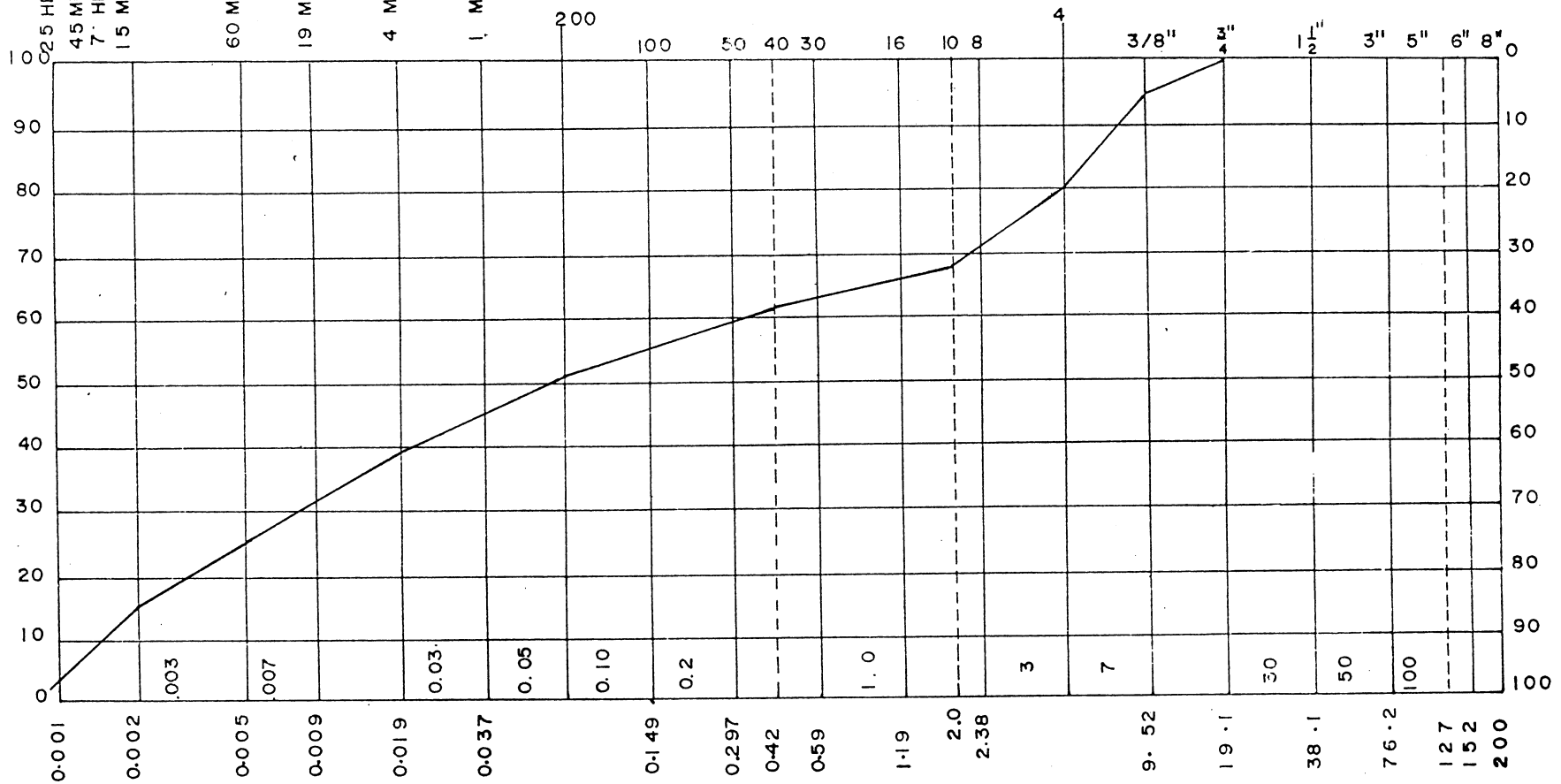
SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 6				
10.0m	20.0	29.0	35.5	15.5

REMARKS _____

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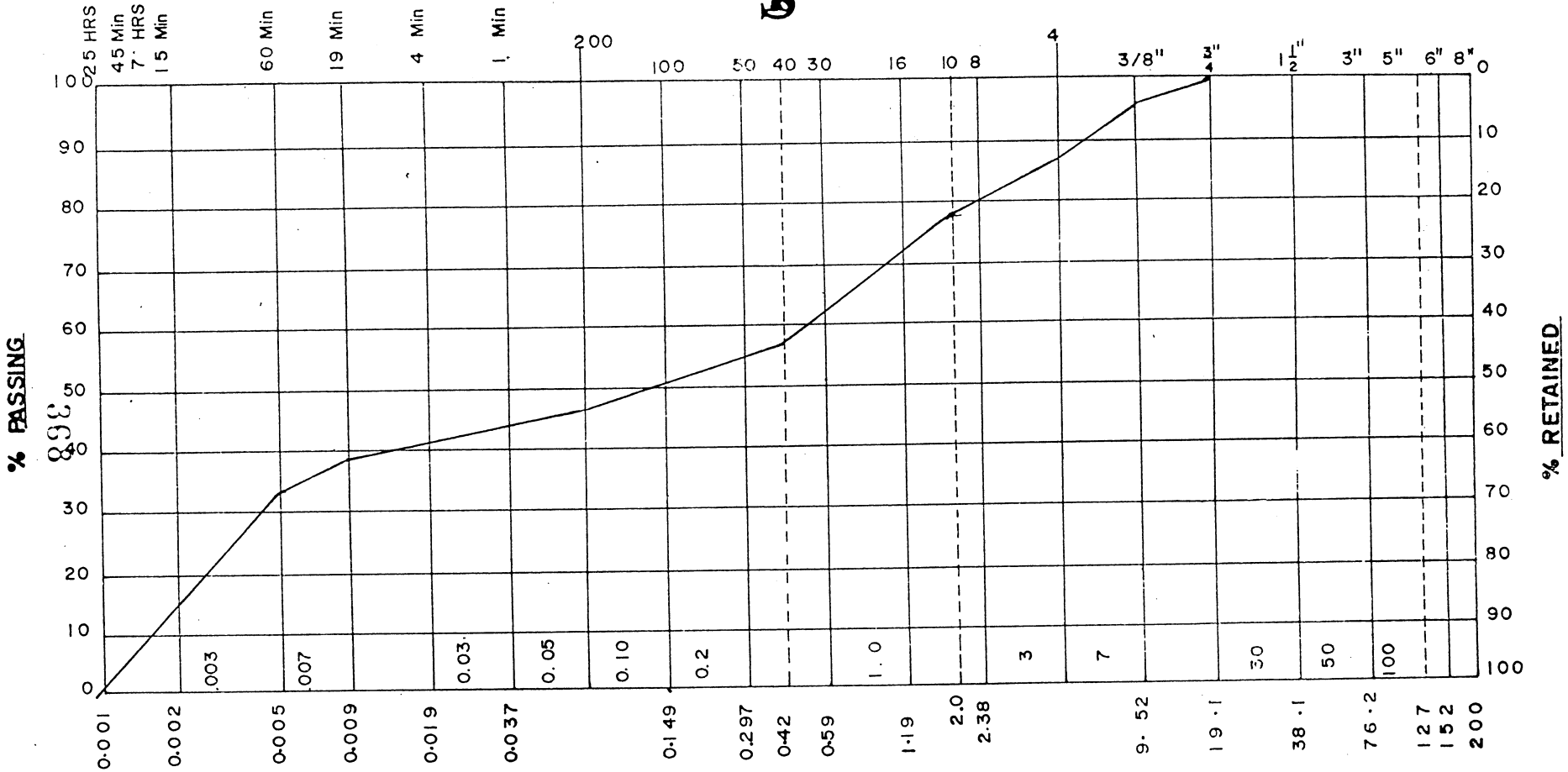
SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 6				
12.5 m	13.1	40.7	31.2	15.0

REMARKS _____

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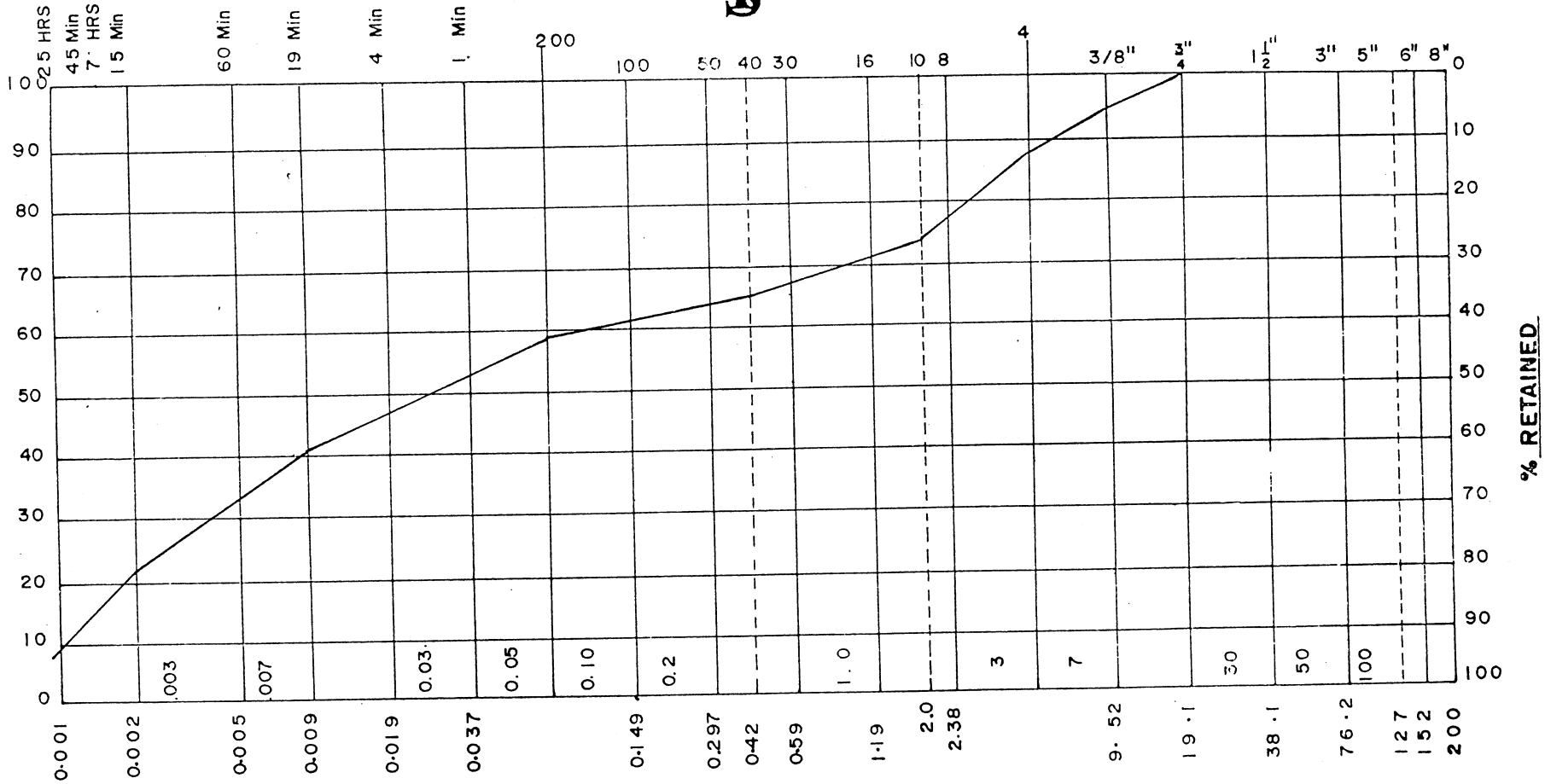
SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	0.074 SAND			4.76 GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH6				
15.0m	12.0	29.8	36.3	21.9

REMARKS _____