

**REPORT ON A SITE INVESTIGATION  
FOR A DEVELOPMENT  
AT SCHULL HARBOUR  
FOR  
HARBOUR DEVELOPMENT COMMITTEE**

**CRONIN MILLAR  
CONSULTING ENGINEERS**

**Report No. 14969**

**NOVEMBER 2010**

**I Introduction**

A major development is envisaged at Schull Harbour in County Cork. This development will involve construction of a new multi-berth marina, a new breakwater and associated infrastructure.

An investigation of the soils below sea bed in the development area has been ordered by the project Consulting Engineers, Cronin Millar, on behalf of The Schull Community Harbour Development Company.

The programme of this investigation included the construction of seven boreholes, from a floating pontoon platform, to establish geotechnical criteria on which to formulate a design programme. Work was carried out in accordance with BS 5930, Code of Practice for Site Investigations (1999). Following the borehole investigation two rotary drilled holes were completed to establish rock horizon and recover representative rock core.

A programme of laboratory testing to confirm geotechnical and environmental soil parameters followed site operations.

A marine geophysical survey has been carried out for the client independently and the results of this survey can be read in conjunction with this geotechnical report.

This report includes all factual data pertaining to the project and comments on the geotechnical findings relative to the proposed works.

## **II Fieldwork**

The site is located at Schull Harbour, County Cork. Boreholes and coreholes are located in positions as indicated on the attached site plan. Bed levels and co-ordinates for each borehole location have been established. Levels are related to Poolbeg datum.

Two particular sections of the development are addressed in this report.:.

1. Construction of 235 berth marina
2. Construction of 270 m long rubble breakwater.

### *a.Boreholes*

The exploratory holes were bored with conventional 200mm cable-tool methods using a Dando Exploratory Rig. The rig was mounted on a pontoon platform supplied and manned by Irish Diving Services of Wexford.

Boreholes A1 to A4 were located at the proposed marina while boreholes B1 to B3 were on the line of the proposed breakwater.

Detailed geotechnical records are contained in Appendix I to this report - the records give details of stratification, sampling, in-situ testing and groundwater. Note is also taken of any obstructions to normal boring requiring the use of the heavy chisel for advancement.

The records indicate the presence soft to very soft organic sandy silt (occasionally silty sand) with shells, extending from bed level to depths varying from about 1.50 metres closest to the shore to in excess of 14.50 metres below bed at the furthest location offshore . A thin layer of dense angular gravel underlies the soft soils (possibly weathered rock). Refusal of boring apparatus was recorded following a period of chiselling at the base of each of the boreholes, indicative of bedrock.

Disturbed and undisturbed soil samples were recovered for geotechnical and environmental analysis. Several attempts at undisturbed sampling were abortive, the very soft soils could not be retained in the sample tubes.

*b. Coreholes*

Following completion of the borehole investigation a rotary core drill was mobilised to confirm bedrock horizon and recover representative rock core. Drilling was carried out at two locations designated RC A2 and RC A4.

Drilling details are noted as follows, depths are measured below existing bed:

CH	Soft Alluvium	Gravel	Weathered Rock	Solid Rock
RC A2	0 - 2.50	2.50 – 3.80	3.80 - 4.70	4.70 – 6.70
RC A4	0 – 14.70	14.70 – 16.60	16.60 – 17.50	17.50 – 19.00

Detailed geotechnical core logs are presented in Appendix II and core photographs are also enclosed in this section.

The bedrock at RC A2 is strong grey blue Sandstone. At RC A4 this sandstone is overlain by approximately 1.00 metre of grey green Mudstone. In both locations an upper weathered zone of bedrock was noted from which core was not recovered.

### III Testing

*(a) In-Situ :*

Standard penetration tests were carried out at approximate 1.50 metre intervals in the geotechnical boreholes to measure relative in-situ soil strength. N values are noted in the right hand column of the boring records, representing the blow count required to drive the standard sampler 300mm into the soil, following initial seating blows. Where full test penetration was not achieved the blow count for a specific penetration is recorded, or refusal is indicated where appropriate.

The results of the tests are summarised as follows:

STRATUM	N VALUE RANGE	COMMENT
Organic sandy SILT	0 to 3	Very Soft to Soft
Sandy GRAVEL	24 to 43 to Refusal	Dense

Limited penetration SPT tests (refusal) were recorded at the base of several of the boreholes.

**(b) Laboratory :**

All samples from the boreholes have been returned to the IGSL laboratory for initial visual inspection, a schedule of testing was prepared to establish both geotechnical and environmental parameters and tests as appropriate carried out.

Geotechnical testing was carried out in the IGSL INab accredited laboratory in Naas. Environmental analysis was carried out by Alcontrol Geochem Ltd.

The geotechnical tests consisted of the following elements:

- a. Classification (Liquid and Plastic Limits)
- b. Grading Analysis (Wet sieve and Hydrometer)
- c. Triaxial Compression
- d. Consolidation

The liquid and plastic limits were established for samples of the soft sediment. The material is classified as varying from organic sandy silt to organic sandy clay typically with a high shell content, related moisture contents range from about 40 to 75%

The grading characteristics of the sub soil has been assessed by wet sieve analysis and by hydrometer. The resulting graphs show generally similar characteristics, defined as organic sandy silt or silty sand with a low percentage of fine gravel in some of the samples.

Undisturbed samples were recovered and Triaxial Compression tests carried out to establish soil strength. An average cohesion of 33 kN/sq.m. was determined. Hand vane tests on selected samples indicated lower cohesion values of 5 and 6 Kn/sq.m.

Consolidation testing was carried out on four undisturbed samples to establish extent and rate of possible settlement under various loads increments. The results indicate that the soils are of moderate to high compressibility.

All geotechnical data is presented in Appendix III A.

### **Environmental Testing**

Seven samples of the soft upper sand/silt were submitted to Alcontrol laboratories to provide information on any contamination present in the bed sediments. The laboratory data is contained in Appendix IIIB. The results will be relevant to disposal of dredged material either offshore or to a designated landfill area.

## **IV Discussion**

The proposed development of Schull Harbour is to include a new marina and new rock breakwater. This investigation provides detailed geotechnical information on which detailed design can be based. A geophysical survey has also been commissioned and the report on this work should be read in conjunction with this document.

Environmental analysis of soil samples from each location has also been scheduled and results will be relevant to disposal of excavated or dredged material.

The investigation has noted the presence of bedrock outcropping at or close to the shore, the rock deepens seawards and BH B3 attained a depth of 14.50 metres before refusal on presumed rock. The superficial soils consist of organic sandy silt / organic silty sand, typically containing shell fragments.

Field and laboratory data confirms that the overburden is soft to very soft in strength with N values ranging from N = <1 to N = 3. Laboratory analysis suggests cohesion varying from 5 to 30 kN/sq.m.

### **1. Proposed Marina:**

Boreholes A1 to A4 were located at the proposed marina. A1 and A2, closest to the shore indicate bedrock at 1.80 and 1.40 metres respectively. Boreholes A3 and A4, located seawards reached depths of 8.30 and 12.70 metres before refusal on presumed bedrock. Rotary core holes confirm rock horizon at -5.00 OD at RC A1 and – 20.00 OD at RC A2.

### ***Piled Support to Floating Units***

The marina will consist of floating units retained by tubular steel piles. Closest to the shore these piles must be socketed into the bedrock, while, as depth of overburden increases piles may penetrate the overburden to a sufficient depth to ensure fixity.

Specialist marine piling contractors should be consulted to provide detailed designs for both rock socketed piles and for piles founded in the overburden. This design should note particularly the very weak alluvium which will affect the lateral stability of the piles.

### ***Deepening of Proposed Marina by Dredging***

It is likely that a programme of dredging will be required in the marina area to ensure sufficient water depths for berthing at all times. This implies that rock excavation will probably be necessary close to the shore with removal of soft alluvium over the remainder of the development area.

Both geophysical data and examination of rock core indicate that hard bedrock is present below some upper weathered rock. Hydraulic breaking and/or a programme of drilling and blasting may be required.

The alluvial soils consist of soft or loose silt and sand with some organics and this material will be readily removed by bucket dredging or by suction dredging.

Specialist dredging contractors should be consulted to determine the most economically effective techniques in both overburden and bedrock for this particular project.

### **2. Proposed Breakwater**

A rock / rubble mound breakwater is proposed extending from the end of the existing pier eastwards for some 270 metres.

Boreholes B1, B2 and B3 were located along the line of the breakwater. Soft alluvial soils were noted in all locations with bed level between - 3.50 OD and – 4.00 OD. Borehole refusal (presumed bedrock) was noted at about - 7.00 OD closest to the pier deepening to about – 18.50 OD at the eastern extremity of the proposed breakwater.

Assuming top of breakwater at pier level ( 5.25 m OD) an approximately 9.00 metres high breakwater is envisaged.

A number of issues arise from the detailed field and laboratory study. We have assumed a breakwater structure 4.00 m wide at the top with side slopes of 2 : 1 (H to V).

The loads applied from such a structure will result in settlement of the underlying alluvium varying from about 100mm closest to the pier to about 500mm at the eastern end of the breakwater. Much of this settlement will take place over the construction period and an extended construction period will obviously assist in dissipating the projected settlement.

There is also a likelihood of shear failure of the underlying alluvium which exhibits very low shear strength in places. Again, staged construction over an extended period will reduce the possibility of shear failure.

We would suggest construction of the breakwater with heavy rock fill initially placed at bed level, allowing the rock fill to impregnate the very soft upper soils.

Once the initial rock fill is placed, more general rubble or rock fill material can be used. Heavy rock fill should of course be utilised as facing for the proposed breakwater to ensure stability and avoid scour or wash out.

Consideration could also be given to placement of a heavy duty combined geo-grid/geotextile as a separator between the breakwater and the alluvium to avoid loss of fill material. The cost of a suitable geo-grid and the placement requirements may be high. A specialist supplier (Tensar or similar) will provide design data on their products.

IGSL/JC  
November 2010

**SCHULL HARBOUR  
DEVELOPMENT**

**CRONIN MILLAR  
ENGINEERS**

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## **GEOTECHNICAL BORING RECORD**

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## GEOTECHNICAL BORING RECORD

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CONTRACT Schull Harbour		BOREHOLE NO. BHA2							
		SHEET Sheet 1 of 1							
CO-ORDINATES	92,944.00 E 31,406.00 N	RIG TYPE	Dando 3000						
GROUND LEVEL (m AOD)	-1.00	BOREHOLE DIAMETER (mm)	150						
		BOREHOLE DEPTH (m)	1.40						
CLIENT		SPT HAMMER REF. NO.	SPT6						
ENGINEER	Croinin Millar Consulting Engineers	ENERGY RATIO (%)	63						
Depth (m)	Description	Legend	Elevation	Depth (m)	Samples	Field Test Results	Standpipe Details		
0	Loose fine SAND with occasional gravel	[Dotted Pattern]	-1.80	0.80	AK1294 D 0.50 Recovery	N = 36 (1, 0, 1, 2, 14, 19)			
1	Dense fine to coarse gravelly SAND with angular cobbles	[Circles Pattern]	-2.40	1.40	AK1295 B 1.00	N = 50/100 mm (21, 4, 33, 17)			
2	End of Borehole at 1.40 m								
3									
4									
5									
6									
7									
8									
9									
HARD STRATA BORING/CHISELLING			WATER STRIKE DETAILS						
From (m)	To (m)	Time (h)	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
1.2	1.4	2							No water strike
GROUNDWATER DETAILS									
INSTALLATION DETAILS					Date	Hole Depth	Casing Depth	Depth to Water	Comments
Date	Tip Depth	RZ Top	RZ Base	Type					
REMARKS Deck to bed 4.5m, Deck to water 0.2m.					Sample Legend D - Small Disturbed (tub) B - Bulk Disturbed LB - Large Bulk Disturbed Env - Environmental Sample (Jar + Vial + Tub)				
					U - Undisturbed 100mm Diameter Sample P - Undisturbed Piston Sample W - Water Sample				



## **GEOTECHNICAL BORING RECORD**

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#### **HARD STRATA BORING/CHISELLING**

#### **WATER STRIKE DETAILS**

#### **INSTALLATION RECOMMENDATIONS**

**REMARKS** Deck to bed 6.1m, Deck to water 0.2m. Standing 02/10/10 bad weather and swell. Standing 04/10/10 gales.

### Sample Legend

## Sample Legend

B - Bulk Disturbed

L.B. - Large Bulk Disturbed  
Env. - Environmental Sample (jar + Vial + Tumbler)

#### U - Undisturbed 100mm Diameter Sample

#### P - Undisturbed Piston Sample

**W - Water Sample**



# GEOTECHNICAL BORING RECORD

REPORT NUMBER

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CONTRACT Schull Harbour

BOREHOLE NO. BHA4  
SHEET Sheet 1 of 2CO-ORDINATES 93,214.00 E  
31,441.00 N  
GROUND LEVEL (m AOD) -3.20RIG TYPE Dando 3000  
BOREHOLE DIAMETER (mm) 150  
BOREHOLE DEPTH (m) 12.70DATE COMMENCED 06/10/2010  
DATE COMPLETED 06/10/2010

CLIENT Croinin Millar Consulting Engineers

SPT HAMMER REF. NO. SPT6  
ENERGY RATIO (%) 63BORED BY P.Thomas, M.O.Keefe  
PROCESSED BY G.Doyle

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples				Field Test Results	Standpipe Details
					Ref. Number	Sample Type	Depth (m)	Recovery		
0	Grey sandy SILT with shells	x			AK1387	B	0.50-1.50			
1		x			AK1388	U	2.00		N = 0 (1, 0, 0, 0, 0)	
2		x			AK1389	B	4.00-6.00			
3		x			AK1390	B	6.00-8.00		N = 1 (1, 0, 0, 1, 0)	
4		x			AK1391	B	8.00-10.00			
5		x							N = 2 (1, 0, 0, 1, 0, 1)	
6		x								
7		x								
8		x								
9		x								

HARD STRATA BORING/CHISELLING				WATER STRIKE DETAILS					
From (m)	To (m)	Time (h)	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
12.5	12.7	1.5							No water strike

## GROUNDWATER DETAILS

INSTALLATION DETAILS					Date	Hole Depth	Casing Depth	Depth to Water	Comments
Date	Tip Depth	RZ Top	RZ Base	Type					

REMARKS Deck to bed 6.3m, Deck to water 0.2m. Works carried out at night due to bad weather conditions.

## Sample Legend

D - Small Disturbed (tub)  
B - Bulk Disturbed  
LB - Large Bulk Disturbed  
Env - Environmental Sample (Jar + Vial + Tub)

U - Undisturbed 100mm Diameter Sample  
P - Undisturbed Piston Sample  
W - Water Sample



## **GEOTECHNICAL BORING RECORD**

**REPORT NUMBER**

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#### **HARD STRATA BORING/CHISELLING**

#### **WATER STRIKE DETAILS**

WATER STRIKE DETAILS				
From (m)	To (m)	Time (h)	Comments	
12.5	12.7	1.5		No water strike

## **GROUNDWATER DETAILS**

#### **INSTALLATION DETAILS**

**REMARKS** Deck to bed 6.3m, Deck to water 0.2m. Works carried out at night due to bad weather conditions.

### Sample Legend

- Sample Legend**  
O - Small Disturbed (hub)  
B - Bulk Disturbed  
LB - Large Bulk Disturbed  
Env - Environmental Sample

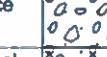
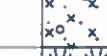
U - Undisturbed 100mm Diameter Sample  
P - Undisturbed Piston Sample  
W - Water Sample



## **GEOTECHNICAL BORING RECORD**

**REPORT NUMBER**

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CONTRACT Schull Harbour								BOREHOLE NO. BHB1					
SHEET Sheet 1 of 1													
CO-ORDINATES 92,984.00 E 31,286.00 N			RIG TYPE Dando 3000		BOREHOLE DIAMETER (mm) 150 BOREHOLE DEPTH (m) 3.50								
GROUND LEVEL (m AOD) -3.70			DATE COMMENCED 29/09/2010		DATE COMPLETED 29/09/2010								
CLIENT Croinin Millar Consulting Engineers			SPT HAMMER REF. NO. SPT6		BORED BY P.Thomas, M.O.Keefe		PROCESSED BY G.Doyle						
Depth (m)	Description	Legend	Elevation	Depth (m)	Samples			Field Test Results	Standpipe Details				
					Ref. Number	Sample Type	Depth (m)			Recovery			
0	Loose sandy GRAVEL with broken glass in abundance		-4.20	0.50	AK1284	D	0.50	N = 3 (1, 0, 1, 0, 1, 1)					
1	Soft grey slightly sandy SILT with shells and occasional fine gravel				AK1285	B	1.00	N = 2 (1, 0, 0, 1, 0, 1)					
2					AK1286	D	1.50 1.50	0% rec					
2					AK1287	B	2.00	N = 2 (1, 0, 0, 0, 1, 1)					
3	PEAT		-6.20	2.50	AK1288	C	2.50 2.50	0% rec					
3	Dense fine to coarse angular GRAVEL with cobbles		-6.40	2.70	AK1289	B	3.00	N = 40/100 mm (11, 14, 25, 15)					
3.50	End of Borehole at 3.50 m		-7.20	3.50	AK1290	B	3.50						
4													
5													
6													
7													
8													
9													
HARD STRATA BORING/CHISELLING					WATER STRIKE DETAILS								
From (m)	To (m)	Time (h)	Comments		Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments			
3	3.5	2								No water strike			
GROUNDWATER DETAILS													
INSTALLATION DETAILS					Date	Hole Depth	Casing Depth	Depth to Water	Comments				
Date	Tip Depth	RZ Top	RZ Base	Type									
REMARKS Deck to bed 6.0m, Deck to water 0.2m, 2x U100s attempted @1.5m and 2.5m - No Recovery					Sample Legend				U - Undisturbed 100mm Diameter Sample B - Bulk Disturbed LB - Large Bulk Disturbed Env - Environmental Sample (Jar + Vial + Tub)				
									P - Undisturbed Piston Sample W - Water Sample				



## **GEOTECHNICAL BORING RECORD**

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#### **HARD STRATA BORING/CHISELLING**

#### **WATER STRIKE DETAILS**

## GROUNDWATER DETAILS

**REMARKS** Deck to bed 6.1m. Deck to water 0.2m.

### Sample Legend

### **Sample Legend**

B Bulk Disturbed  
LB Low Bulk Disturbed

L8 - Large Bulk Disturbed  
Env - Environmental Sample

ENVIRONMENT & POLITICS

#### **U - Undisturbed 100mm Diameter Sample**

P - Undisturbed Piston Sample  
W - Water Sample

#### W - Water Sample

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## **GEOTECHNICAL BORING RECORD**

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## **GEOTECHNICAL BORING RECORD**

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CONTRACT	Schull Harbour			BOREHOLE NO.	BHB3
CO-ORDINATES	93,235.00 E 31,307.00 N	RIG TYPE	Dando 3000	SHEET	Sheet 2 of 2
GROUND LEVEL (m AOD)	-3.90	BOREHOLE DIAMETER (mm)	150	DATE COMMENCED	05/10/2010
CLIENT		SPT HAMMER REF. NO.	SPT6	BORED BY	P.Thomas, M.O.Keefe
ENGINEER	Croinin Millar Consulting Engineers	ENERGY RATIO (%)	63	PROCESSED BY	G.Doyle

#### **HARD STRATA BORING/CHISELLING**

**WATER STRIKE DETAILS**

## **GROUNDWATER DETAILS**

#### **INSTALLATION DETAILS**

**REMARKS** Deck to bed 5.8m, Deck to water 0.2m.

## Sample Legend

#### D - Small Disturbed (tub-

B - Bulk Disturbed

#### **L.B. Large Bulk Disturbed**

Env - Environmental Sample

#### **U - Undisturbed 100mm Diameter Sample**

#### P - Undisturbed Platon Sample

#### W - Water Sample

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## GEOTECHNICAL CORE LOG RECORD

REPORT NUMBER

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CONTRACT Schull Harbour

DRILLHOLE NO RCA2

CO-ORDINATES

SHEET Sheet 1 of 1

GROUND LEVEL (mOD)

DATE DRILLED 11/10/2010

RIG TYPE FLUSH

DATE LOGGED 11/10/2010

CLIENT

DRILLED BY IGSL

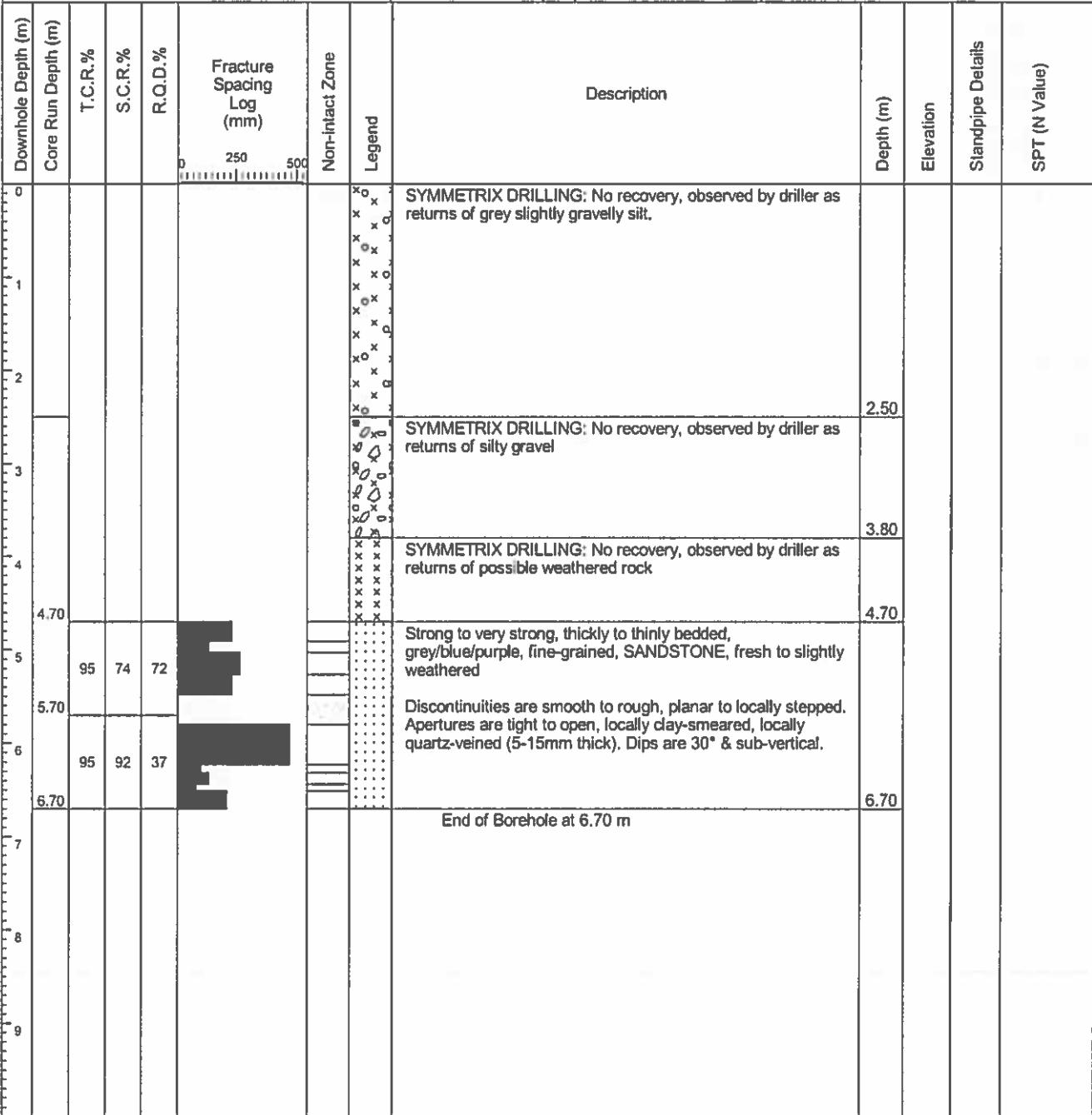
ENGINEER

Croinin Millar Consulting Engineers

LOGGED BY D.O'Shea

INCLINATION (deg) -90

CORE DIAMETER (mm) 84



## REMARKS

0.0m is bed level. Depth to bed 3.5m.

## WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike recorded

## GROUNDWATER DETAILS

## INSTALLATION DETAILS

Date Hole Depth Casing Depth Depth to Water Comments

Date	Tip Depth	RZ Top	RZ Base	Type	Date	Hole Depth	Casing Depth	Depth to Water	Comments



## GEOTECHNICAL CORE LOG RECORD

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CONTRACT Schull Harbour										DRILLHOLE NO	RCA4
CO-ORDINATES										SHEET	Sheet 1 of 2
GROUND LEVEL (mOD)										DATE DRILLED	11/10/2010
CLIENT Croinin Millar Consulting Engineers										DATE LOGGED	11/10/2010
ENGINEER										DRILLED BY	IGSL
										LOGGED BY	D.O'Shea
Downhole Depth (m)	Core Run Depth (m)	T.C.R.%	S.C.R.%	R.Q.D %	Fracture Spacing Log (mm)	Non-Intact Zone	Legend	Description			
0	0	0	0	0	250 500			SYMMETRIX DRILLING: No recovery, observed by driller as returns of grey sandy silt. Slightly gravelly from 12.0m.			
1											
2											
3											
4											
5											
6											
7											
8											
9											
REMARKS										WATER STRIKE DETAILS	
0.0m is bed level. Depth to bed 7.3m.										Water Strike	Casing Depth
										Sealed At	Rise To
										Time (min)	Comments
											No water strike recorded
INSTALLATION DETAILS										GROUNDWATER DETAILS	
Date	Tip Depth	RZ Top	RZ Base	Type			Date	Hole Depth	Casing Depth	Depth to Water	Comments



## GEOTECHNICAL CORE LOG RECORD

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CONTRACT Schull Harbour

DRILLHOLE NO RCA4

CO-ORDINATES

SHEET Sheet 2 of 2

GROUND LEVEL (mOD)

DATE DRILLED 11/10/2010

RIG TYPE FLUSH Air/Mist

DATE LOGGED 11/10/2010

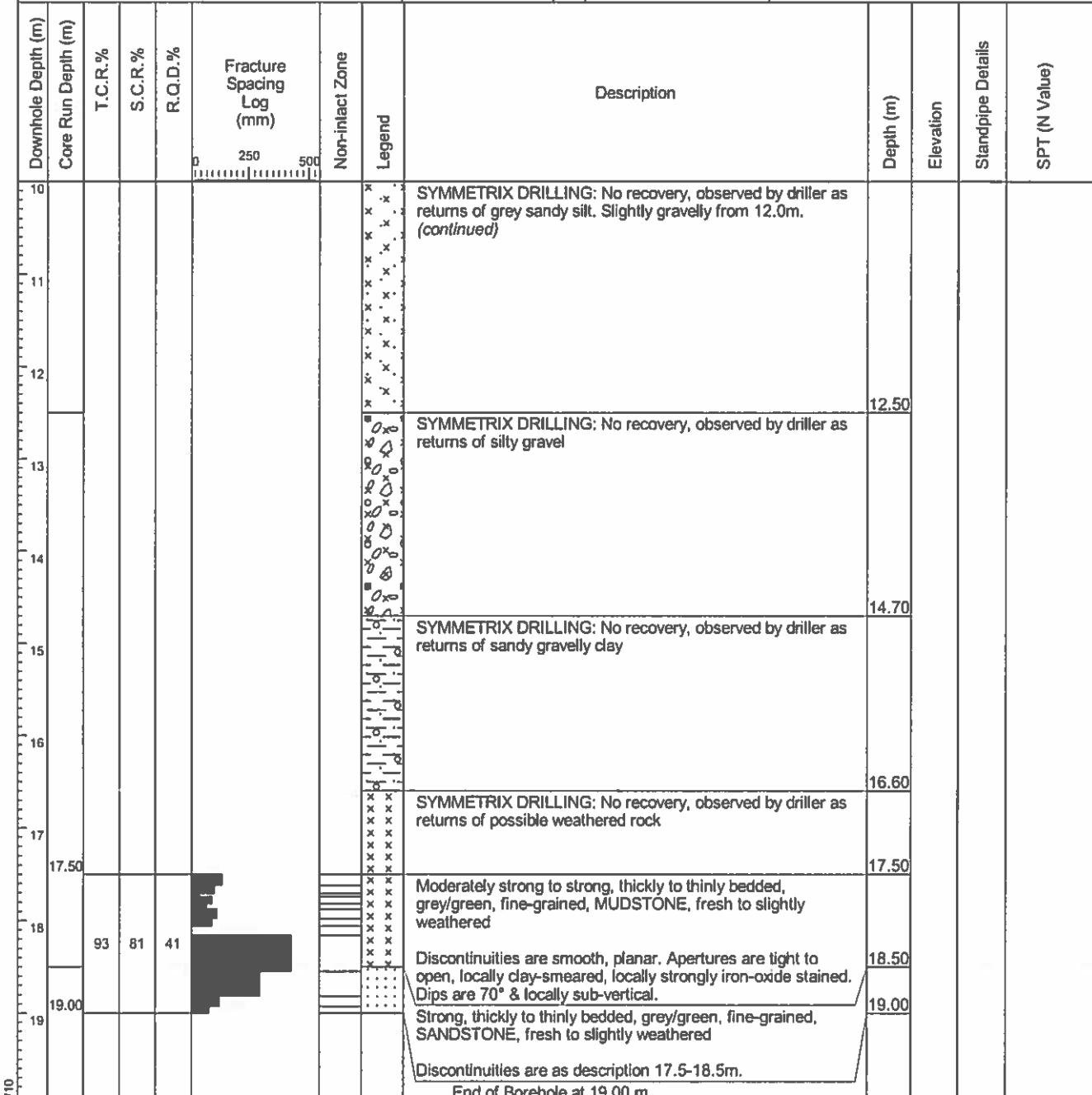
CLIENT ENGINEER Croinin Millar Consulting Engineers

DRILLED BY IGSL

INCLINATION (deg) -90

LOGGED BY D.O'Shea

CORE DIAMETER (mm) 84



IGSL RCFI 10M 14969.GPJ IGSL.GDT 22/10/10

## REMARKS

0.0m is bed level. Depth to bed 7.3m.

## WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike recorded

## GROUNDWATER DETAILS

## INSTALLATION DETAILS

Date Hole Depth Casing Depth Depth to Water Comments

Date Tip Depth RZ Top RZ Base Type



## **Summary of Classification Tests**

BS1377:Part 2:1990, clauses 3.2, 4.3, 5.3 & 5.4

BH/TP No.	Sample No.	Depth (m)	Sample Type	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index	<425µm %	Preparation	Classification	
										<425µm %	Description
BHA3	1297	1.00	U	44.7	45	NP		99	WS	Greenish grey organic SILT with shell fragments	
BHA3	1358	6.50	D	74.7	99	40	59	89	WS	Grey brown organic slightly sandy CLAY with shell fragments	
BHB1	1286	1.50	D	37.7	72	31	41	42	WS	Grey brown sandy gravelly organic CLAY with shell fragments & broken glass	
BHB2	1364	2.00	U	36.3	39	NP		95	WS	Grey organic slightly sandy SILT with shell fragments	
BHB2	1372	6.00	D	64.5	59	31	28	93	WS	Greenish grey organic SILT with shell fragments	
BHA4	1388	2.00	U	43	39	NP		98	WS	Greenish grey organic SILT with shell fragments	
BHA4	1391	8.00	D	75.5	70	30	40	97	WS	Greenish grey organic CLAY with shell fragments	
BHB3	1379	2.50	D	44.6	44	NP		94	WS	Greenish grey organic slightly sandy SILT with shell fragments	
BHB3	1380	4.00	U	61.3	56	30	26	99	WS	Greenish grey organic SILT with shell fragments	
BHB3	1386	12.00	D	16.8	33	NP		30	WS	Grey silty sandy GRAVEL	
										M I	
										C E	
										C V	
										M I	
										M H	
										M L	

Notes: NAT - tested as received WS - Wet sieved (425µm) NP - Non Plastic

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	Issued By	Date	Page	of
		10/11/2010		

Code	BH/TP	Sample	Depth (m)	MC%	LL%	PL%	%<42.5μm	Description	
▼	BHA3	1297	11.00	44.7	45	NP	99	Greenish grey organic SILT with shell fragments	
◆	BHA3	1358	6.50	74.7	99	40	59	Grey brown organic silty sandy CLAY with shell fragments	
●	BHB1	1286	11.50	37.7	72	31	41	Grey brown sandy gravelly organic CLAY with shell fragments	
■	BHB2	1364	2.00	36.3	39	NP	95	Grey organic silty sandy SILT with shell fragments	
×	BHB2	1372	6.00	64.5	59	31	28	Greenish grey organic CLAY with shell fragments	
◆	BHB3	1388	2.50	8.00	75.5	39	NP	98	Greenish grey organic CLAY with shell fragments
●	BHB3	1379	2.50	44.6	44	NP	97	Greenish grey organic CLAY with shell fragments	
□	BHB3	1380	4.00	61.3	56	30	26	Greenish grey organic SILT with shell fragments	
◊	BHB3	1386	12.00	16.8	33	NP	30	Grey very sandy GRAVEL	

NP denotes specimen is non-plastic

Liquid Limit %

Plastic Index

Contract: SCHUL CORK

Contract No. 14969

Plasticity Chart - Summary of Liquid & Plastic Limit Tests

Chart in accordance with BS5930 1999, fig. 18

## Determination of Particle Size Distribution

BS1377:Part2:1990 : clauses 9.2

particle size	% passing		Contract No:	14969
75	100	COBBLES	Contract:	SCHULL CORK
63	100		BH/TP No:	BHA1
50	100		SAMPLE No.:	1292
37.5	100		DEPTH (m):	1.00
28	100		TEST METHOD:	Wet sieve
20	100	GRAVEL	DESCRIPTION:	Grey organic silty, very gravelly, SAND with shell fragments
14	100			
10	100			
6.3	98			
5	96			
3.35	86			
2	70			
1.18	57			
0.6	48	SAND		
0.425	40			
0.3	30			
0.15	17			
0.063	9			
0.043	#N/A			
0.030	#N/A			
0.019	#N/A	SILT/CLAY		
0.011	#N/A			
0.008	#N/A			
0.005	#N/A			
0.002	#N/A			

Percentage passing (%)

Page no:

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## Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

**Determination of Particle Size Distribution**

BS1377:Part2:1990 , clauses 9.2

particle size	% passing	Contract No:	14969
75	100	Contract:	SCHULL CORK
63	87	BH/TP No:	BHA2
50	71	SAMPLE No.:	1295
37.5	51	DEPTH (m):	1.00
28	44	TEST METHOD:	Wet sieve
20	36	DESCRIPTION:	Grey slightly silty, sandy, GRAVEL with some cobbles
14	32		
10	29		
6.3	26		
5	25		
3.35	20		
2	15		
1.18	11		
0.6	8		
0.425	7		
0.3	6		
0.15	3		
0.063	2		
0.043	#N/A		
0.030	#N/A		
0.019	#N/A		
0.011	#N/A		
0.008	#N/A		
0.005	#N/A		
0.002	#N/A		

Percentage passing (%)

0.063    0.15    0.3    0.425    0.6    1.18    2    3.35    5    10    14    20    28    37    50    70    90    100

0.0001    0.001    0.01    0.1    1    10    100

CLAY    SILT    Sieve size (mm)    SAND    GRAVEL

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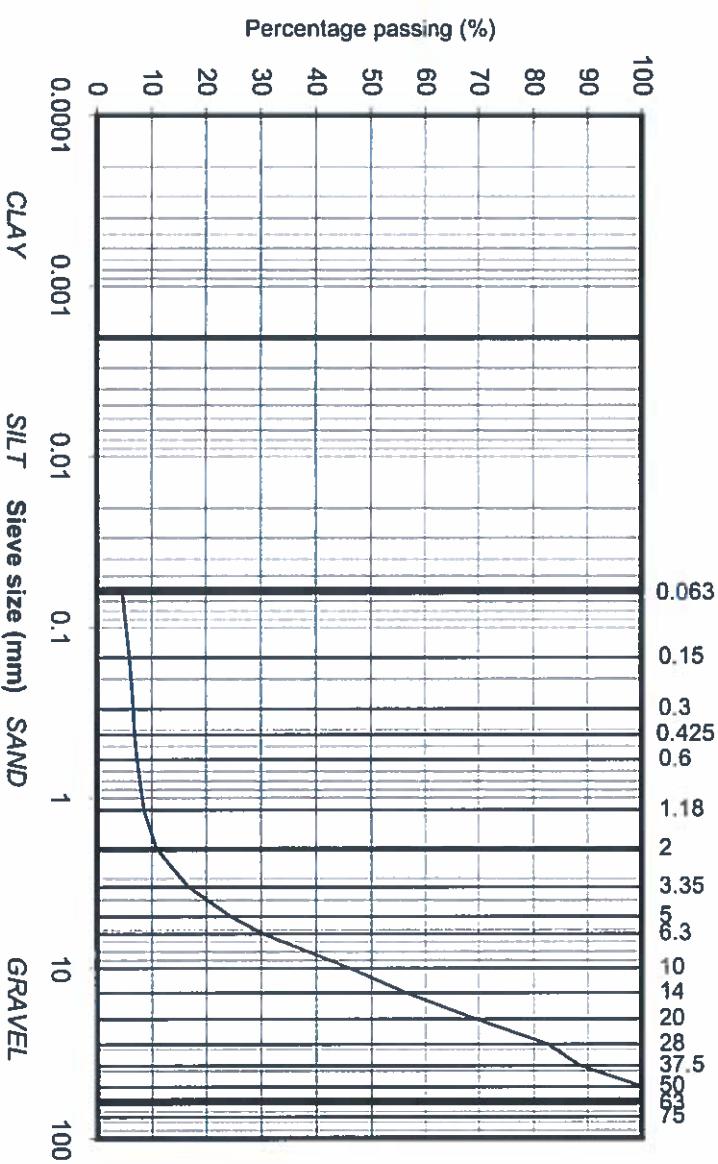
PSD V3.1 12/01



## Determination of Particle Size Distribution

BS1377:Part2:1990, clauses 9.2

particle size	% passing	Contract No.	14969
75	100	Contract:	SCHULL CORK
63	100	BH/TP No:	BHB1
50	100	SAMPLE No.:	1289
37.5	89	DEPTH (m):	3.00
28	83	TEST METHOD:	Wet sieve
20	69	DESCRIPTION:	Grey brown slightly silty, sandy, GRAVEL
14	56		
10	46		
6.3	30		
5	24		
3.35	17		
2	11		
1.18	9		
0.6	7		
0.425	7		
0.3	7		
0.15	6		
0.063	5		
0.043	#N/A		
0.030	#N/A		
0.019	#N/A		
0.011	#N/A		
0.008	#N/A		
0.005	#N/A		
0.002	#N/A		



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## Determination of Particle Size Distribution

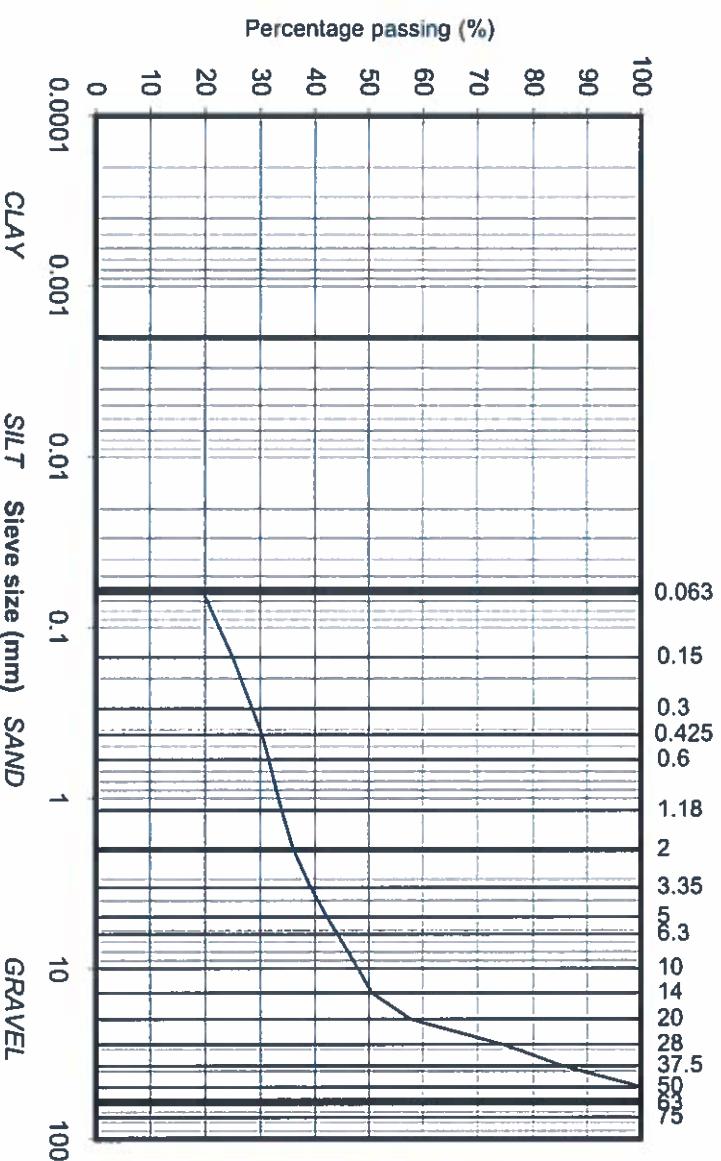
BS1377:Part2:1990 , clauses 9.2

		Contract No: 14969							
particle size	% passing	COBBLES	SCHULL CORK	BH/TP No:	BHE2				
75	100	COBBLES	Contract:	SAMPLE No.:	1377				
63	95		DEPTH (m):	TEST METHOD:	8.50				
50	95		DESCRIPTION:	Wet sieve	Grey slightly silty, slightly sandy, GRAVEL with occasional cobbles and with shell fragments.				
37.5	88								
28	76								
20	62	GRAVEL							
14	50								
10	35								
6.3	22								
5	17								
3.35	11								
2	6								
1.18	4								
0.6	3	SAND							
0.425	3								
0.3	3								
0.15	3								
0.063	3								
0.043	#N/A								
0.030	#N/A								
0.019	#N/A								
0.011	#N/A								
0.008	#N/A								
0.005	#N/A								
0.002	#N/A								
		SAMPLE TYPE: D							
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PSD V3.1 12.01									

## Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

particle size	% passing	Contract No:	14969
75	100	Contract:	SCHULL CORK
63	100	BH/TP No:	BHB3
50	100	SAMPLE No.:	1386
37.5	85	DEPTH (m):	12.00
28	74	TEST METHOD:	Wet sieve
20	58	DESCRIPTION:	Grey silty, sandy, GRAVEL
14	51		
10	48		
6.3	44		
5	42		
3.35	39		
2	36		
1.18	34		
0.6	32		
0.425	30		
0.3	29		
0.15	25		
0.063	20		
0.043	#N/A		
0.030	#N/A		
0.019	#N/A		
0.011	#N/A		
0.008	#N/A		
0.005	#N/A		
0.002	#N/A		



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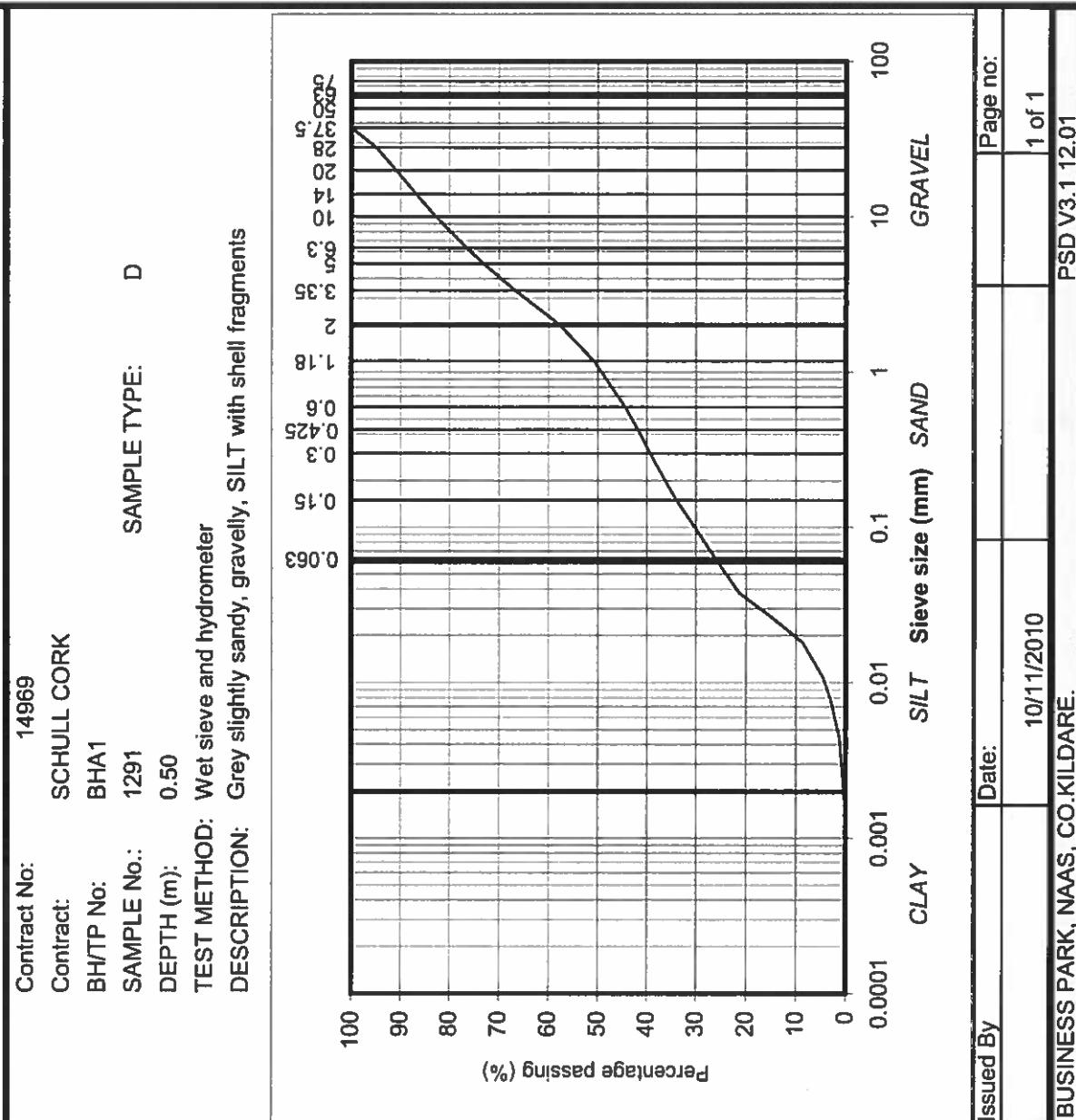
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## Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

particle size	% passing	COBBLES
75	100	
63	100	
50	100	
37.5	100	
28	95	
20	91	GRAVEL
14	87	
10	83	
6.3	76	
5	73	
3.35	67	
2	58	
1.18	51	
0.6	44	SAND
0.425	42	
0.3	39	
0.15	34	
0.063	26	
0.038	21	
0.028	16	
0.018	9	SILT/CLAY
0.011	4	
0.008	3	
0.004	1	
0.002	0	

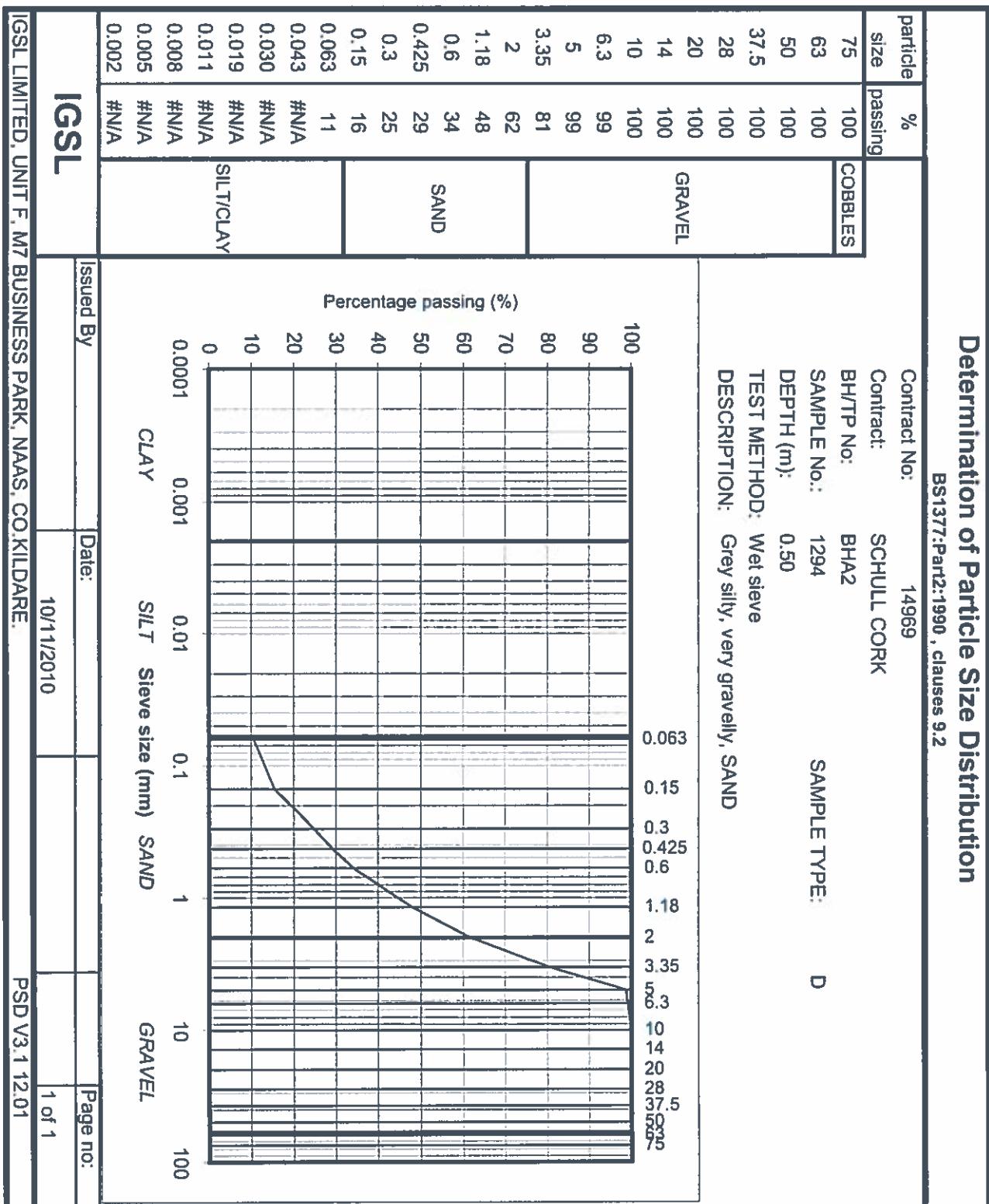


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## Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9,2



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## Determination of Particle Size Distribution

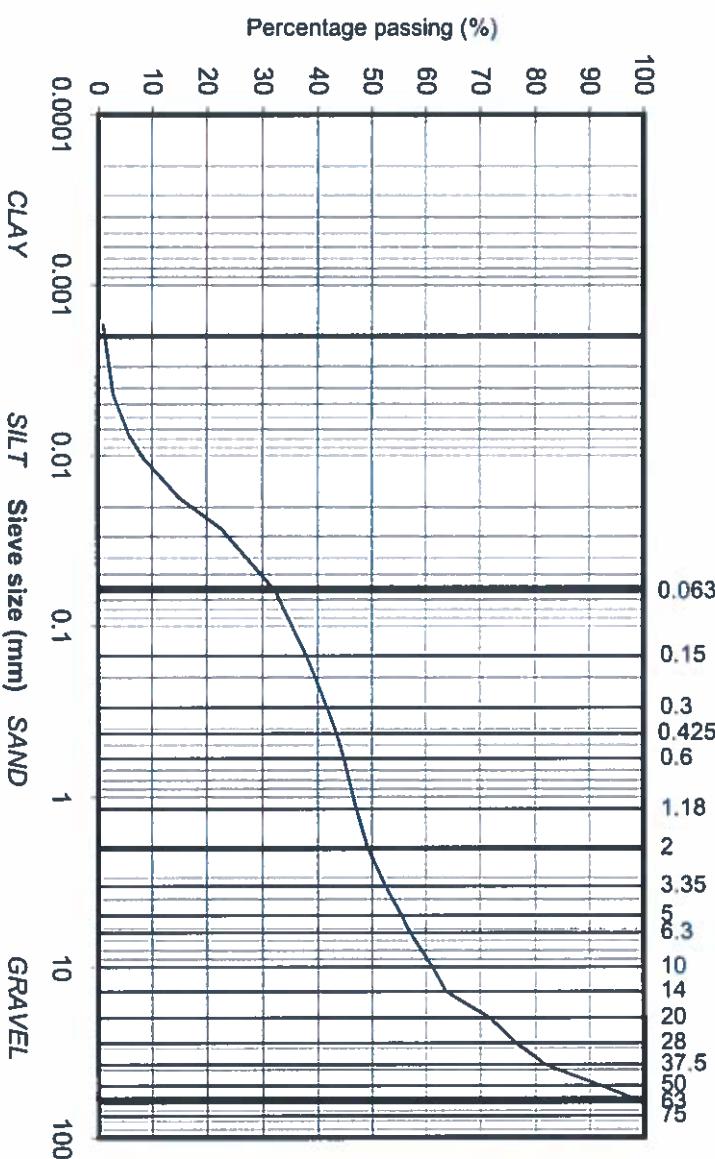
BS1377:Part2:1990 , clauses 9.2

		Contract No:		14969					
particle size	% passing	Contract:	SCHULL CORK	BHTP No:	BHA3				
75	100	COBBLES		SAMPLE No.:	1298				
63	100			DEPTH (m):	1.50				
50	100			TEST METHOD:	Wet sieve and hydrometer				
37.5	100			DESCRIPTION:	Greenish grey organic slightly sandy, slightly gravelly, SILT with shell fragments				
28	100								
20	100	GRAVEL							
14	100								
10	100								
6.3	100								
5	100								
3.35	99								
2	99								
1.18	99								
0.6	99	SAND							
0.425	99								
0.3	98								
0.15	98								
0.063	94								
0.038	77								
0.028	57								
0.018	31	SILT/CLAY							
0.011	16								
0.008	11								
0.004	5								
0.002	1								
		SAMPLE TYPE:		D					
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## Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

particle size	% passing		Contract No:	14969
		COBBLES	Contract:	SCHULL CORK
75	100		BH/TP No:	BHB1
63	100		SAMPLE No.:	1285
50	92		DEPTH (m):	1.00
37.5	82		TEST METHOD:	Wet sieve and hydrometer
28	77		DESCRIPTION:	Dark grey organic slightly sandy, gravelly, SILT with shell fragments
20	72			
14	64			
10	61			
6.3	57			
5	55			
3.35	53			
2	49			
1.18	47			
0.6	45			
0.425	44			
0.3	42			
0.15	38			
0.063	32			
0.038	27			
0.027	23			
0.018	15			
0.011	9			
0.008	6			
0.004	3			
0.002	1			



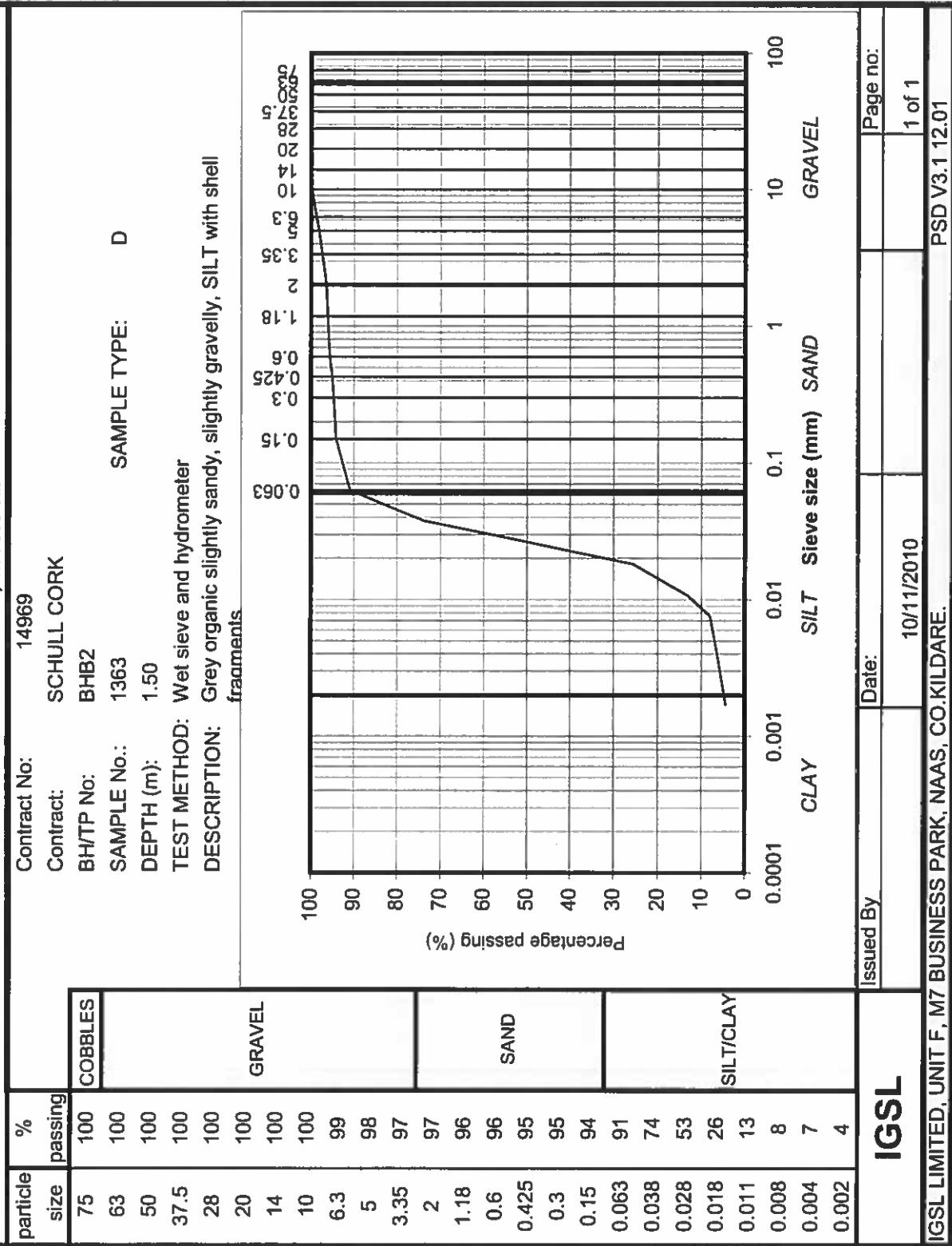
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## Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2



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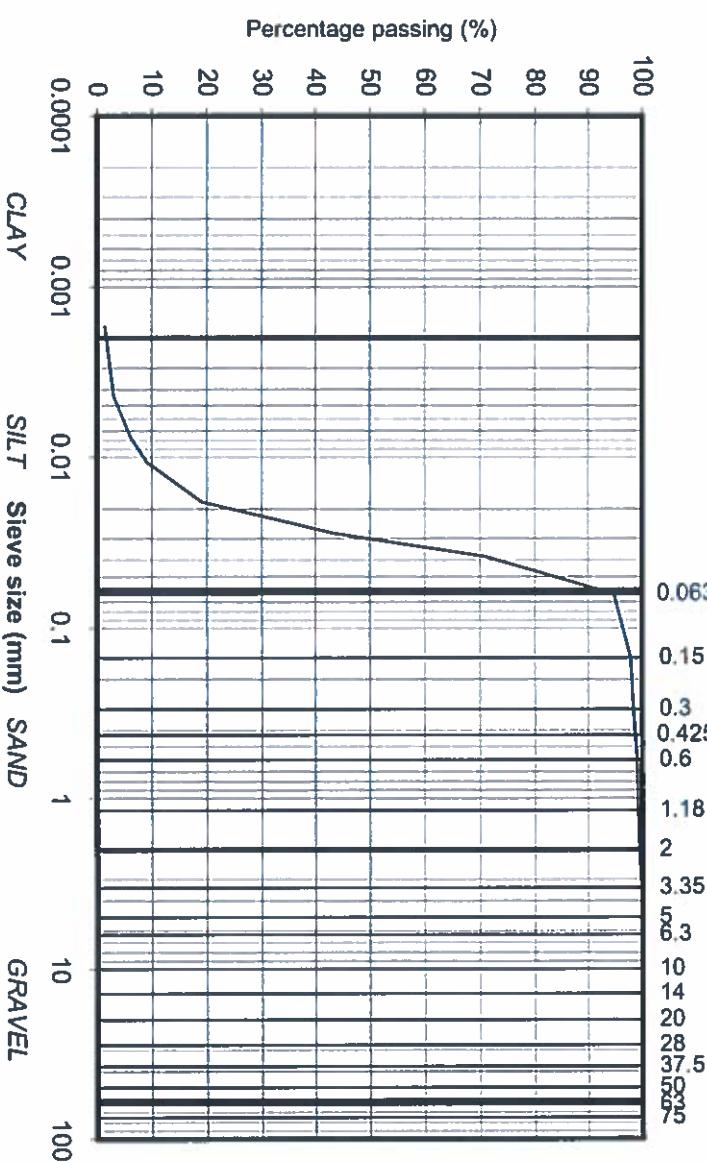
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## Determination of Particle Size Distribution

BS1377:Part2:1990, clauses 9.2

particle size	% passing		Contract No.	14969
75	100	COBBLES	Contract:	SCHULL CORK
63	100		BH/TP No.:	BHA4
50	100		SAMPLE No.:	1387
37.5	100		DEPTH (m):	1.00
28	100		TEST METHOD:	Wet sieve and hydrometer
20	100		DESCRIPTION:	Grey organic slightly sandy, slightly gravelly, SILT with shell fragments
14	100			
10	100			
6.3	100			
5	100			
3.35	100			
2	99			
1.18	99			
0.6	99			
0.425	99			
0.3	98			
0.15	98			
0.063	95			
0.038	71			
0.028	43			
0.018	19			
0.011	9			
0.008	6			
0.004	3			
0.002	2			



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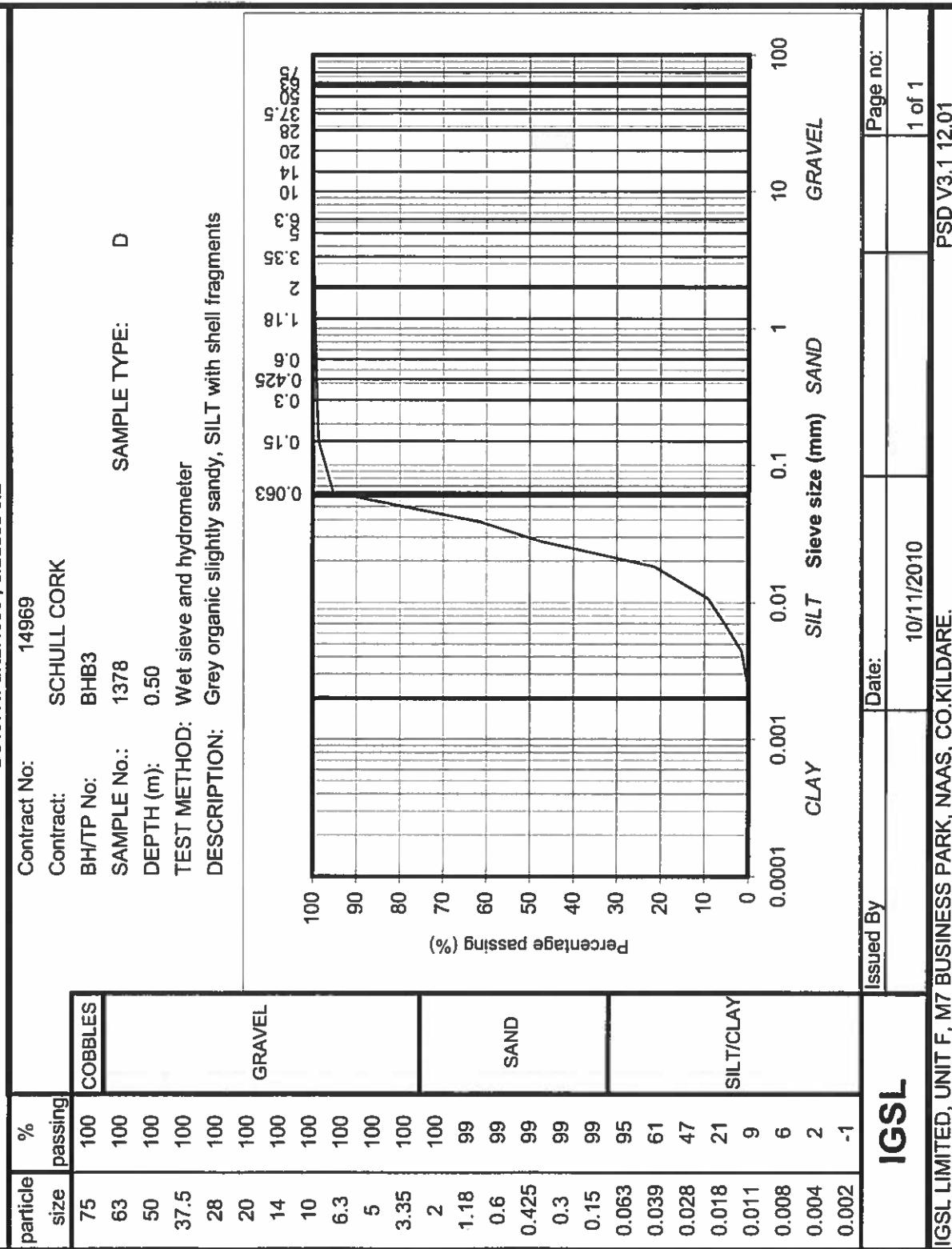
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## Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2



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TRIAXIAL COMPRESSION TEST										IGSL
SCHULL CORK										Report No
Bore- hole No	Sample No.	Depth metres	Description of Sample	Test Code	Lateral Pressure kN/m <sup>2</sup>	Compre- hension kN/m <sup>2</sup>	Co- hesion kN/m <sup>2</sup>	Ang. of Friction, deg.	Bulk Density Mg/m <sup>3</sup>	Remarks
BHA3	1297	1.20	Greenish grey organic SILT with shell fragments	U100	0				54.4	UNSUITABLE HAND VANE 6 KPA
BHB2	1364	2.00	Grey organic slightly sandy SILT with shell fragments	U100	50	67	33	0	1.80	33.8 Quick undrained triaxial
BHB3	1380	4.00	Greenish grey organic SILT with shell fragments	U100					61.0	UNSUITABLE HAND VANE 5 KPA
BHB3	1382	6.00	Grey organic SILT with shell fragments	U100	100	68	34	0	1.67	63.9 Quick undrained triaxial

IGSL CONSOLIDATION TEST CALCULATIONS

initial height	18.6
Wt. soil+ring	247.5
final wet wt.	231.6
final dry wt	191.3
wt. of ring	90.4
w/c initial	55.7%
w/c final	39.9%
S.G.	2.65
e final	1.0584242
change in e	0.1277097
Final Height	

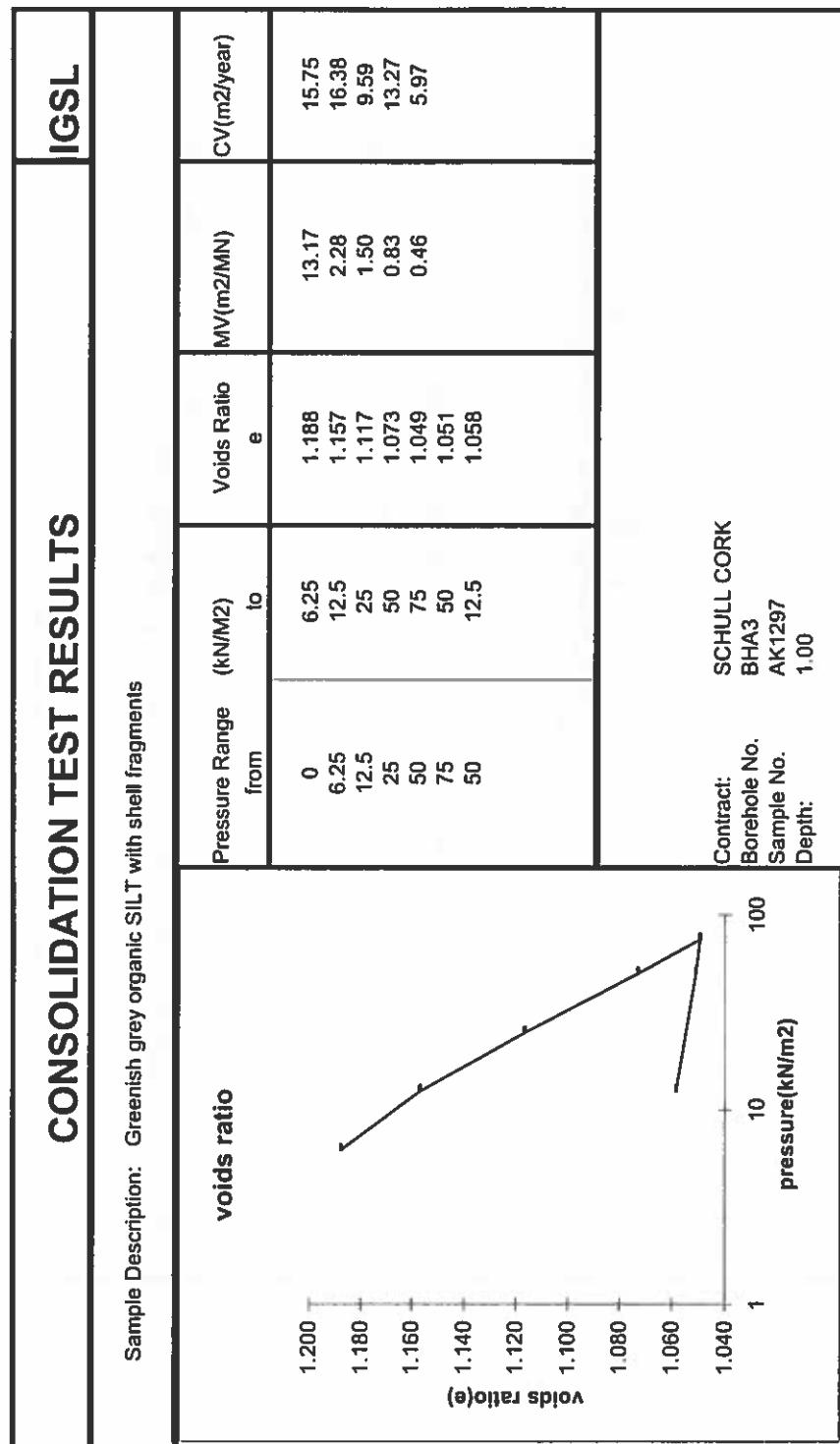
<b>Contract:</b>	SCHULL CORK
<b>Borehole No:</b>	BHA3
<b>Sample No:</b>	AK1297
<b>Sample Type:</b>	U
<b>Depth:</b>	1.00

I.G.S.L.

**CV calculations**

Pressure Range from to	150 mins	190 mins	av. Height	Cv=0.026H <sup>2</sup>	Cv=0.111H <sup>2</sup>
				150	190
0	6.25		2.25	17.865	15.75
6.25	12.5		1.96	17.009	16.38
12.5	25		3.24	16.731	9.59
25	50		2.25	16.403	13.27
50	75		4.84	16.14	5.97

Contact	SCHULL CORK
Borehole No.	BHA3
Sample No.	AK1297
Depth	1.0



CONSOLIDATION TEST CALCULATIONS  
IGSL

initial height	18.7
Wt. soil+ring	251.8
final wet wt.	240.9
final dry wt	201.8
wt. of ring	89.3
w/c initial	44.4%
w/c final	34.8%
S.G.	2.65 Assumed
e final	0.9210222
change in e	0.1182895 *change in Ht.
Final Height	16.24
<b>Contact:</b>	
Borehole No:	SCHULL CORK
Sample No:	BHA4
Sample Type	AK1388
Depth:	U 2.00

## CV calculations

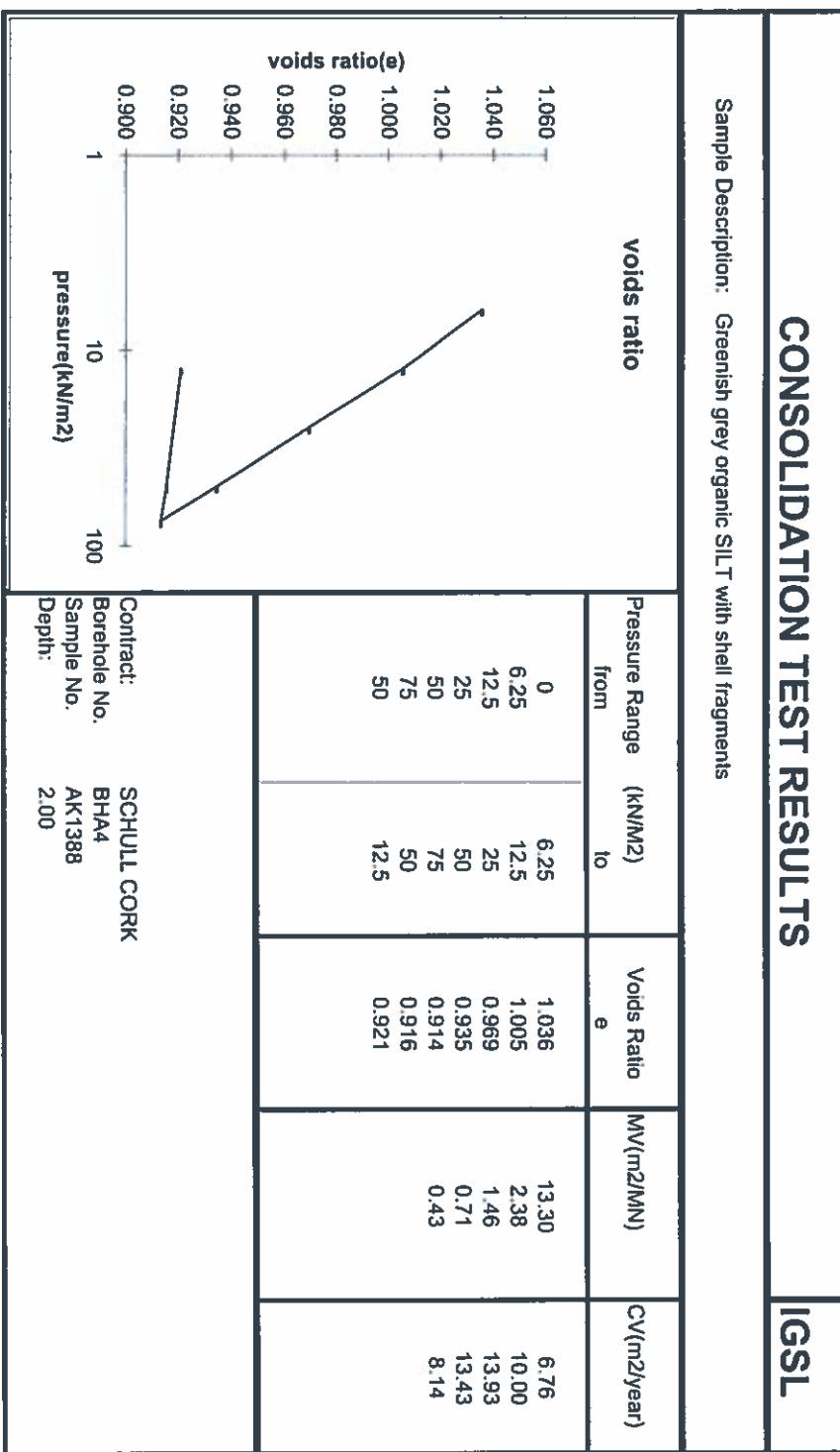
Pressure Range from to		t 50 mins	t 90 mins	av. Height	Cv = 0.026H2	Cv = 0.111H2
				150	190	
0	6.25		5.29	17.954		6.76
6.25	12.5		3.24	17.081		10.00
12.5	25		2.25	16.801		13.93
25	50		2.25	16.501		13.43
50	75		3.61	16.266		8.14

I.G.S.L.

# CONSOLIDATION TEST RESULTS

**IGSL**

**Sample Description:** Greenish grey organic SILT with shell fragments



IGSL CONSOLIDATION TEST CALCULATIONS

Initial height	18.7	
Wt. soil+ring	263	
final wet wt.	254.4	
final dry wt	214	
wt. of ring	89	
w/c initial	39.2%	
w/c final	32.3%	
S.G.	2.65	A
e final	0.85648	
change in e	0.108655	*c
Final Height		

<b>Contract:</b>	SCHULL CORK		
<b>Borehole No:</b>	BHB2		
<b>Sample No:</b>	AK1364		
<b>Sample Type</b>	U		
<b>Depth:</b>	2,00		

Pressure range from	Increment to	change in Ht.	change in e	e at end of stage	average e	MV (m <sup>2</sup> /MN.)	HEIGHT H	AV. HEIGHT
0	6.25	6.25	1.012	0.110	0.922	0.977	8.900	17.688
6.25	12.5	6.25	0.128	0.014	0.908	0.915	1.162	17.56
12.5	25	12.5	0.182	0.020	0.888	0.898	0.833	17.378
25	50	25	0.22	0.024	0.864	0.876	0.510	17.158
50	75	25	0.128	0.014	0.850	0.857	0.300	17.03
75	50	-25	-0.01	-0.001	0.851	0.851	0.023	17.04
50	12.5	-38	-0.046	-0.005	0.856	0.854	0.072	17.086
					0.856			
					0.856			
					0.856			

**CV calculations**

I.G.S.L.

Pressure Range from to	t 50 mins	t 90 mins	av. Height	Cv = 0.026H <sup>2</sup>	Cv = 0.111H <sup>2</sup>
0	6.25		4.41	18.194	8.33
6.25	12.5		1.96	17.624	17.59
12.5	25		1.96	17.469	17.28
25	50		1.69	17.268	19.58
50	75		2.25	17.094	14.42

Contract	SCHULL CORK
Borehole No.	BHB2
Sample No.	AK1364
Depth	2.0

