APPENDIX 4

GEOTECHNICAL SITE INVESTIGATION REPORT

Conducted by Geotech Specialists Ltd.

Engineer: Finbarr Gannon & Co. Ltd.

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GEOTECH SPECIALISTS LIMITED
Carewswood, Castlemartyr, Co. Cork, Ireland
Tel: (021) 4667164 Fax (021) 4667630
Email: geotech@indigo.ie

Youghal,
Co. Cork
REPORT ON GROUND INVESTIGATION

Interpretative Report No. KC4092

Engineer: Finbarr Gannon & Co. Ltd

Engineer:

Finbarr Gannon & Co. Ltd,

St Patrick's House,

Lower Glanmire Road,

Cork

Client:

SWS Group,

Shinagh House,

Bandon

CONTENTS

1 INTRODUCTION

During May 2004, Geotech Specialists Ltd (GSL) were commissioned by Finbarr Gannon & Co. Ltd (FG), on behalf of SWS Group, to carry out a ground investigation at Youghal, Co. Cork. The investigation was required to obtain geotechnical information for a proposed material recovery and sludge drying facility.

The scope of the investigation, which was specified by FG, comprised cable percussion boreholes, in situ testing and laboratory testing. The investigation was carried out in accordance with the contract specification and relevant standards (see References). The fieldwork was carried out between 25th June and 2nd July 2004.

This report presents the factual records of the fieldwork and laboratory testing together with an interpretation of the findings with respect to the proposed development.

2 THE SITE AND GEOLOGY

2.1 The Site

The site is situated about 2km north of Youghal in eastern Co. Cork adjacent to the landfill site and about 0.5km from the tidal estuary of the River Blackwater to the north and east. The site is at Irish National Grid reference NGR X 096 798, see Site Location Plan in Enclosure C.

At the time of the investigation, the site was a triangular shaped area of land of approximately 1Ha. The area was heavily overgrown and mostly level with the exception of some spoil heaps around the site. The entrance area was surfaced with hardcore and used as a storage area for skips. The area was bounded to the west by the landfill site access road and to the other sides by fields.

2.2 Published Geology

The published geological maps covering the site, GSI Sheet 25 (1995) solid, shows the site to be underlain by limestone of the Lower Carboniferous Waulsortian Formation.

3 FIELDWORK

3.1 General

The fieldwork was carried out in general accordance with BS 5930 (1999) and Part 9 of BS 1377 (1990).

The exploratory hole locations were selected by SWS as shown on the Site Plan in Enclosure B. The locations were set out from local features. The reduced levels were surveyed by GSL relative to Ordnance Datum (Malin), using information on a temporary benchmark supplied by SWS.

3.2 Exploratory Holes

The exploratory holes are listed in the following table.

SUMMARY OF EXPLORATORY HOLES

Type	Quantity	Maximum Depth (m)	Remarks
Cable Percussion Boring	4	12.0	BH1 to BH3, BH3R

The exploratory hole records are presented in Enclosure A and should be read in conjunction with the Key included therein. The records provide descriptions, in accordance with BS 5930 (1999), of the materials encountered and details of the samples taken, together with observations made during boring.

3.3 Instrumentation and Monitoring

The following instruments were installed:

SUMMARY OF INSTRUMENTATION

Type	Quantity	Remarks
Standpipes	3	Installed in BH1, BH2, BH3R

The instruments installed in the exploratory holes are shown on the logs and also detailed in Enclosure B. Records of groundwater monitoring carried out by GSL after the fieldwork period are also presented in Enclosure B.

3.4 In Situ Testing

In situ testing was carried in accordance with BS5930 (1999) and Part 9 of BS1377 (1990) unless otherwise stated. The testing is summarised below and the results are presented in Enclosure C.

SUMMARY OF IN SITU TESTING

Type	Quantity	Remarks
Standard Penetration Tests	26	

4 LABORATORY TESTING

On completion of the fieldwork all samples were transported to the Castlemartyr laboratory of GSL for temporary retention and testing. The laboratory testing was scheduled by GSL with the approval of FG.

The geotechnical testing was carried out in accordance with BS 1377 (1990). The testing is summarised below and the results are presented in Enclosure C.

SUMMARY OF GEOTECHNICAL LABORATORY TESTING

Type	No. of Tests
Moisture Content Determination	3
Atterberg Limit Determination	3
Organic Content	2
pH Level and Sulphate Content of Soils	3

5 GROUND CONDITIONS AND GROUNDWATER

5.1 Strata Encountered

Descriptions of the strata encountered are given on the exploratory hole records. The downward succession for the exploratory holes put down for this investigation is summarised below.

SUMMARY OF GROUND CONDITIONS

Stratum Encountered	Range of Thicknesses	Remarks
MADE GROUND: Sandy gravelly clay with builders and household rubbish	0.2-2.3m	All boreholes
GLACIAL TILL: Stiff sandy gravelly clay with occasional cobbles	up to 11.6m proven	All boreholes
FLUVIO-GLACIAL DEPOSITS: Loose clayey slightly gravelly sand	1.8m	BH2 only

Made Ground comprising clay fill with builders and household rubbish was encountered to a maximum observed depth of 2.3m. Due to its variability and the limited in-situ testing undertaken, it is not considered appropriate to assign geotechnical parameters to this material

A plot of Standard Penetration Test (SPT) 'N' values against depth for the Glacial Till is presented in Enclosure D. A suggested design line is shown on the drawing which by being apparently conservative attempts to reduce the influence of coarse particles, particularly cobbles and boulder on the SPT results where high blow counts can result from encountering such coarse material. Experience has shown that an over-estimation of the true in-situ density of the material can result otherwise. Using this line and correlations proposed by Stroud and Butler (1975), an undrained shear strength of the order 75kN/m^2 is calculated at 1 to 2m, increasing to about 100kN/m^2 at 4m. Using similar correlations by Stroud and Butler, a coefficient of volume compressibility of the order 0.13m^2/MN is calculated at 1-2m, decreasing to 0.1m^2/MN at 4m. Laboratory tests available to date show the material to be of low to intermediate plasticity (plastic index 15 to 25%) with a moisture content of 26 to 31%. A bulk density of the order 2Mg/m^3 is considered appropriate.

Due to the limited extent of the granular Fluvio-Glacial deposits and the possible disturbance by groundwater entry on the SPT results, it is not considered appropriate to assign geotechnical parameters to this strata.

5.2 Groundwater

Groundwater entries were noted only within BH1 and BH2 during drilling at depths of 6.0m and 4.1m, rising to 4.8m and 1.5m respectively over a 20 minute observation period. These observations do not necessarily indicate equilibrium conditions.

The results of monitoring of the standpipes after completion of the fieldwork gave standing groundwater levels of 1.89 to 7.77m below ground level. It is considered likely that the groundwater probably flows in a northerly direction given the groundwater levels. It will be appreciated that seasonal and possibly tidal fluctuations in groundwater level may occur. Other effects such as investigation and constructional excavation may also change groundwater levels.

6 GEOTECHNICAL ENGINEERING ASSESSMENT

6.1 Proposed Development

No details of the proposed development were provided, however light to moderate loads are anticipated.

6.2 Foundations

The boreholes encountered a variable thickness of Made Ground over the site overlying stiff Glacial Till occasionally interbedded with granular Fluvio-Glacial deposits. Groundwater levels of between 1m and 5m below ground level are anticipated.

Given the loads anticipated shallow foundations placed within the Glacial Till, that is below any Made Ground and upper soft layers, will probably be acceptable. Recommended bearing values are given in the following table:

Foundation Depth Below Present GL	Presumed bearing value (kN/m2) for foundations of various widths in stiff glacial clay assuming a maximum of 25mm long term settlement:		
	1m wide	2m wide	4m wide
1m	200	100	75
2m	220	135	80
3m	240	170	85

Should higher working loads be required, it may be necessary to resort to a piled foundation. It should be appreciated that the load bearing characteristics of piles are very dependent on the type of pile, method of installation and construction, and workmanship and as such it is recommended that detailed discussions be held with suitably experienced piling contractors prior to finalising design. In any event positive assurances should be sought from the piling contractor in respect of performance of their proprietary system. In choosing a piling method the presence of loose granular soils, a high water table and the likely obstructions found in both the Made Ground and natural soils would have to be considered.

6.3 Floor Slabs

Due to the thickness and compressible nature of the Made Ground, it is recommended that if practical, all fill material should be removed from site prior to construction where appropriate. Ground levels may then need to be raised by importing clean granular fill. Alternatively, if the fill material is left in place, it will be necessary to utilise a suspended floor slab depending on loadings.

It may be necessary to vent the floor to prevent the build-up of potentially harmful gas (especially methane and carbon dioxide) which may be generated from decomposing organic material within the underlying Made Ground. Standpipes within the fill should be monitored for gas to confirm or otherwise this requirement.

6.4 Excavations and Groundwater

Any excavations required within the strata observed should be easily accomplished using conventional back-acting hydraulic plant. However excavations may require support even at shallow depths. Any excavation requiring man entry should be fully supported or cut back to a safe slope in accordance with normal safe site practice.

As groundwater was encountered at relatively shallow depths, it is possible that groundwater may be encountered, especially if granular pockets are encountered within the Glacial Till. Groundwater levels may rise to depths of possibly 1-2m in places, and localised pockets of groundwater may occur within Made Ground. Generally, excavations within the Glacial Till should be easily controlled by pumping from internal filtered sumps. Any excavations into gravel are expected to encounter strong groundwater inflow which will require extensive dewatering.

6.5 Infrastructure

Any access roads, car parks or other areas of hardstanding may only be constructed on the Made Ground after first removing at least the top 500mm of Made Ground and replacing by granular fill underlain by a geotextile membrane or grid (Terram or similar) to prevent mixing of the granular material with the underlying soft material. Placing layers of geogrid within the granular material can reduce the total thickness of road construction required. For design, a CBR of not exceeding 1% should be used where founding on the Made Ground. Higher CBRs may be possible where any road, hardstanding etc is located on natural soils. In-situ CBR tests should be carried out to confirm the CBR values.

Any underground services should incorporate some flexibility in order to tolerate further settlement of the Made Ground which may occur.

6.6 Chemical Considerations for Buried Concrete

The results of three tests for sulphate concentration and pH levels on selected soil samples show sulphate concentrations of between 0.06 and 0.12 grams per litre (as SO_3) and pH values of between 7.7 and 8.0. These test results indicate a Design Sulphate Class 1 (DS-1) and Aggressive Chemical Environment for Concrete Class 1 (ACEC-1) (BRE Special Digest 1). No special precautions are therefore recommended with regards to concrete design. Due to the possibility of

saline groundwater, it is recommended that any reinforcement in concrete is protected from chloride corrosion by covering with at least 30mm of good quality concrete.

Prepared By	**A. Garne B.Sc., M.Sc., F.G.S.**
Reviewed By	**M.N. Harris B.Sc., M.Sc., DIC, FGS, MICE, C Eng.**
Approved for Issue By	

REFERENCES

British Standards and Codes of Practice

BS 1377 : 1990 : Methods of test for soils for civil engineering purposes. British Standards Institution.

BS 5930 : 1999 : Code of practice for site investigations. British Standards Institution.

Maps

GSI Sheet 25 : 1995 : "Geology of South Cork". 1:100000 geological map (solid). Geological Survey of Ireland.

Ordnance Survey Discovery Series. Sheet 81 : 2001 : Cork. 1:50000. Ordnance Survey of Ireland.

Publications and Reports

BS 8004 ; 1986. Code of Practice for Foundations.
British Standards Institution.

BRE Special Digest 1. 2001. Concrete in aggressive ground. Part 1: Assessing the aggressive chemical environment. Building Research Establishment.

Stroud M A and Butler F G (1975): The standard penetration test and the engineering properties of glacial materials. Proc of the engineering properties of glacial materials. Midlands Soc SMFE.

ENCLOSURE A
EXPLORATORY HOLE RECORDS

Key to Exploratory Hole Records	Key
Borehole Logs	BH1 to BH3, BH3R

Key to Exploratory Hole Records

GEOTECH

SAMPLES

Undisturbed

U	Driven tube sample
TW	Pushed thin wall tube sample } nominally 100 mm diameter and full recovery unless otherwise stated
P	Pushed piston sample
L	Liner sample (from Windowless or similar sampler), full recovery unless otherwise stated
CBR	CBR mould sample
BLK	Block sample
CS	Core sample (from rotary core) taken for laboratory testing

Disturbed

D	Small sample
B	Bulk sample

Other

W	Water sample
G	Gas sample
	Environmental chemistry samples (in more than one container where appropriate)
ES	Soil sample
EW	Water sample

TESTS

SPT S or SPT C	Standard Penetration Test, open shoe (S) or solid cone (C)

The Standard Penetration Test is defined in BS 1377 : Part 9 (1990). The incremental blow counts are given in the Field Records column; each increment is 75 mm unless stated otherwise and any penetration under self weight in mm (SW) is noted. Where the full 300 mm test drive is achieved the total number of blows for the test drive is presented as N = xx in the Test column. Where the test drive blows reach 50 (either in total or for a single increment) the total blow count beyond the seating drive is given (without the N = prefix).

IV	In situ vane test, peak (p) and remoulded (r)
HV	Hand vane test, peak (p) and remoulded (r)
PP	Pocket penetrometer test, strength value
KFH, KRH, KPI	Variable head permeability tests (KFH = falling head test, KRH = rising head test, KPI = packer test), permeability value
	Test results provided in Field Records column

DRILLING RECORDS

The mechanical indices (TCR/SCR/RQD & If) are defined in BS 5930 (1999)

TCR	Total Core Recovery, %
SCR	Solid Core Recovery, %
RQD	Rock Quality Designation, %
If	Fracture spacing, mm. Minimum, typical and maximum spacings are presented. The term non-intact (NI) is used where the core is fragmented.

Flush returns, estimated percentage with colour where relevant, are given in the Records column

CRF	Core recovered (length in m) in the following run
AZCL	Assessed zone of core loss
**	Drilling Foreman's Strata Description

GROUNDWATER

▼	Groundwater strike
▽	Groundwater level after standing period

INSTALLATION

Standpipe/ piezometer

Details of standpipe/piezometer installations are given on the Record. Legend column shows installed instrument depths including slotted pipe section or tip depth, response zone filter material type and layers of backfill.

The types of instrument installed is indicated by a code in the Legend column at the depth of the response zone:

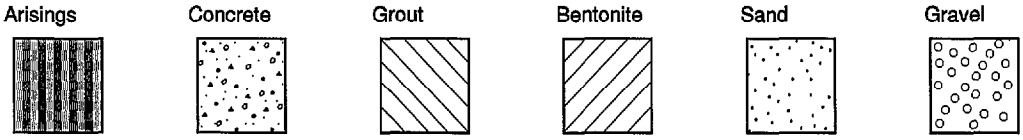
SP	Standpipe
SPIE	Standpipe piezometer
PPIE	Pneumatic piezometer
EPIE	Electronic piezometer

Notes:	Project: Youghal Project No.: KC4092 Carried out for: Finbarr Gannon & Company	Key Sheet 1

Key to Exploratory Hole Records

INSTALLATION LEGENDS

A legend describing the installation is shown in the rightmost column. Legends additional to BS5930 are used to describe the backfill materials as indicated below.



NOTES

1 Strata legends are in accordance with BS 5930 (1999).

2 Water level observations of discernible events during the advancing of the exploratory hole are given at the foot of the log and in the Legend column. The term "none observed" is used where no discrete entries are identified although this does not necessarily indicate that the hole has not been advanced below groundwater level. Under certain conditions groundwater cannot be observed, for instance, drilling with water flush or overwater, or boring at a rate much faster than water can make its way into the borehole (ref BS5930 : 1999, Clause 47.2.7). In addition, where appropriate, water levels in the hole at the time of recovering individual samples or carrying out in situ tests and at shift changes are given in the Records column.

3 Evidence of the occurrence of very coarse particles (cobbles and boulders) is presented on the logs, however, because of their size in relation to the exploratory hole these records may not be fully representative of their size and frequency in the ground mass.

4 The borehole logs present the results of Standard Penetration Tests recorded in the field without correction or interpretation. However, in certain ground conditions (eg high hydraulic head or where very coarse particles are present) some judgement may be necessary in considering whether the results are representative of in situ mass conditions.

5 The declination of bedding and joints is given with respect to the normal to the core axis. Thus in a vertical borehole this will be the dip.

6 The assessment of SCR, RQD and Fracture Spacing excludes artificial fractures

REFERENCES

BS 1377 : 1990 : British Standard Methods of test for soils for civil engineering purposes. British Standards Institution
BS 5930 : 1999 : Code of Practice for site investigations. British Standards Institution

Notes:	Project: Youghal Project No.: KC4092 Carried out for: Finbarr Gannon & Company	Key Sheet 2

Borehole Log

GEOTECH

Drilled	JC	Start	01/07/2004	Equipment, Methods and Remarks	Depth from	to	Diameter	Casing Depth	Ground Level	Datum?
Logged	AJ	End	01/07/2004	Cable Percussion 200mm diameter from 0.00m - 1.36m.	0.00m	1.36m	200mm		Coordinates	-
Checked	AG								National Grid	-

Samples and Tests

Depth	Type & No	Records	Date Casing	Time Water
0.50-1.00	B 1			
1.00-1.45	SPT C	N=58 (4,3/3,5,25,25)		
			01/07/2004	0.00

Strata

Description	Depth, Level (Thickness)	Legend	Backfill/ Instruments
MADE GROUND: CLAY fill with household and builders rubbish.	0.20		
Stiff orange brown mottled brown slightly sandy slightly gravelly CLAY (GLACIAL TILL).	(1.16)		
EXPLORATORY HOLE ENDS AT 1.36 m	1.36		

Depth	Type & No	Records	Date Casing	Time Water

Groundwater Entries

No.	Struck (m)	Post strike behaviour	Depth sealed (m)

None observed (see Key Sheet)

Depth Related Remarks *

From	to (m)	
1.30	-	Obstruction at 1.3m. Relocated 2m to BH3R.

Chiselling

Depths (m)	Time	Tools used
1.30 -1.36	60 mins	

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Scale 1:50 (c) MESG 298 v1.1517/06/2004 09:18:42 AGS

Project: Youghal
Project No.: KC4092
Carried out for: Finbarr Gannon & Co. Ltd.

Borehole
BH3
Sheet 1 of 1

Borehole Log

GEOTECH

Drilled	JC	Start	29/06/2004	Equipment, Methods and Remarks	Depth from	to	Diameter	Casing Depth	Ground Level	Datum?
Logged	AJ	End	30/06/2004	Cable Percussion 200mm diameter from 0.00m - 9.88m.	0.00m	9.88m	200mm	7.50m	Coordinates	-
Checked	AG								National Grid	-

Samples and Tests

Depth	Type & No	Records	Date Casing	Time Water
0.50-1.00	B 1			
1.00-1.45	SPT C	N=11 (3,2/2,3,3,3)		
1.50-2.00	B 2			
2.00-2.45	SPT C	N=11 (2,2/3,3,3,2)	1.50	
2.50-3.00	B 3			
3.00-3.45	SPT C	N=23 (3,3/4,6,7,6)	3.00	
4.00-4.45 4.00-4.50	SPT C B 4	N=8 (2,2/1,2,2,3)	4.00 29/06/2004 4.00	1.50
5.00-5.45 5.00-5.50	SPT C B 5	N=9 (1,2/2,3,2,2)	5.00	2.10
6.00-6.50	B 6			
6.50-6.95	SPT C	N=24 (5,5/6,5,7,6)	6.00	
7.50-8.00	B 7			
8.00-8.45	SPT C	N=29 (4,5/5,7,8,9)	7.50	
9.00-9.50	B 8			
9.50-9.95	SPT C	N=64 (5,6/6,8,25,25)	7.50 30/06/2004 7.50	

Strata

Description	Depth, Level (Thickness)	Legend	Backfill/ Instrument
MADE GROUND: Black sandy gravelly CLAY with cloth, wire, plastic, glass and paper debris.	(2.30)		
Firm to stiff orange brown very sandy CLAY (GLACIAL TILL).	2.30 (1.70)		
Loose orange brown clayey slightly gravelly SAND. Gravel is angular to rounded fine to coarse (FLUVIO-GLACIAL)	4.00 (1.80)		SP
Stiff to very stiff brown mottled grey brown slightly sandy to sandy slightly gravelly CLAY (GLACIAL TILL).	5.80 (4.08)		
EXPLORATORY HOLE ENDS AT 9.88 m	9.88		

Depth	Type & No	Records	Date Casing	Time Water

Groundwater Entries

No.	Struck (m)	Post strike behaviour	Depth sealed (m)
1	4.10	Rose to 1.50 m after 20 minutes.	-

Depth Related Remarks *

From to (m)

Chiselling

Depths (m)	Time	Tools used
0.80 -1.00	45 mins	
1.50 -1.68	45 mins	
9.80 -9.88	60 mins	

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Scale 1:50

Project	Youghal
Project No.	KC4092
Carried out for	Finbarr Gannon & Co. Ltd.

Borehole

BH2

Sheet 1 of 1

Borehole Log

GEOTECH

Drilled JC	Start 25/06/2004	Equipment, Methods and Remarks	Depth from	to	Diameter	Casing Depth	Ground Level	Datum?
Logged AJ	End 25/06/2004	Cable Percussion 200mm diameter from 0.00m - 12.00m.	0.00m	12.00m	200mm	10.50m	Coordinates	-
Checked AG							National Grid	-

Samples and Tests

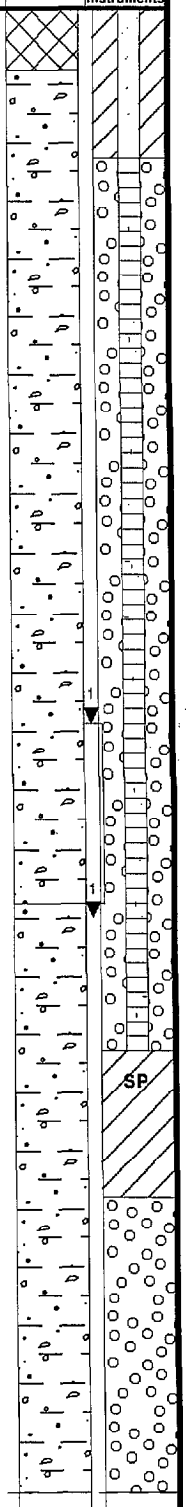
Depth	Type & No	Records	Date Casing	Time Water
0.50-1.00	B 1			
1.00-1.45	SPT S	N=20 (3,3/4,5,6,5)	1.00	
1.00-1.45	D 2			
1.50-2.00	B 3			
2.00-2.45	SPT S	N=27 (5,5/6,7,7,7)	1.50	
2.00-2.45	D 4			
2.50-3.00	B 5			
3.00-3.45	SPT S	N=26 (3,5/5,7,6,8)	3.00	
3.00-3.45	D 6			
3.50-3.95	U 7	65 blows No recovery		
3.50-4.00	B 8			
4.00-4.45	SPT S	N=26 (4,5/6,6,7,7)	3.80	
4.00-4.45	D 9			
4.50-5.00	B 10			
5.00-5.45	SPT S	N=29 (7,8/8,7,6,8)	4.50	
5.00-5.45	D 11			
6.00-6.50	B 12			
6.50-6.95	SPT S	N=31 (5,2/7,8,7,9)	6.00	
6.50-6.95	D 13			
7.50-8.00	B 14			
8.00-8.45	SPT S	N=34 (4,6/6,8,10,10)	7.50	
9.50-10.00	B 15			

Depth	Type & No	Records	Date Casing	Time Water

Strata

Description	Depth, Level (Thickness)
MADE GROUND: Firm CLAY with some fill material (household and builders rubbish).	(0.40)
	0.40
Stiff brown mottled orange brown slightly sandy slightly gravelly CLAY. Gravel is angular to rounded fine to medium (GLACIAL TILL).	(5.60)
Very stiff brown mottled grey brown slightly sandy slightly gravelly to gravelly CLAY. Gravel is angular to rounded fine to coarse (GLACIAL TILL).	6.00
	(6.00)

Legend / Backfill/Instruments



Groundwater Entries

No.	Struck (m)	Post strike behaviour	Depth sealed (m)
1	6.00	Rose to 4.80 m after 20 minutes.	-

Depth Related Remarks *

From to (m)

Chiselling

Depths (m) Time Tools used

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Scale 1:50 (c) MESG 298 v1.1517/08/2004 09:17:45 AGS

Project Youghal

Project No. KC4092

Carried out for Finbarr Gannon & Co. Ltd.

Borehole

BH1

Sheet 1 of 2

Borehole Log

GEOTECH

Drilled	JC
Logged	AJ
Checked	AG

Start	25/06/2004
End	25/06/2004

Equipment, Methods and Remarks
Cable Percussion 200mm diameter from 0.00m - 12.00m.

Depth from	to	Diameter	Casing Depth
0.00m	12.00m	200mm	10.50m

Ground Level	Datum?
Coordinates	-
National Grid	-

Samples and Tests

Depth	Type & No	Records	Date Casing	Time Water
10.00-10.45	SPT S	N=37 (5,5/7,8,10,12)	9.50	
10.00-10.45	D 16			
11.00-11.50	B 17			
11.50-11.95	SPT S	N=34 (7,7/6,8,10,10)	10.50	
			25/06/2004 10.50	dry

Strata

Description	Depth, *Level* (Thickness)	Legend	Backfill/ Instruments
Very stiff brown mottled grey brown slightly sandy slightly gravelly to gravelly CLAY. Gravel is angular to rounded fine to coarse (GLACIAL TILL).			
EXPLORATORY HOLE ENDS AT 12.00 m	12.00		

Depth	Type & No	Records	Date Casing	Time Water

Groundwater Entries

No.	Struck (m)	Post strike behaviour	Depth sealed (m)

Depth Related Remarks *

From	to (m)

Chiselling

Depths (m)	Time	Tools used

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Scale 1:50

Project	Youghal
Project No.	KC4092
Carried out for	Finbarr Gannon & Co. Ltd.

Borehole
BH1
Sheet 2 of 2

Borehole Log

GEOTECH

Drilled	JC	Start	01/07/2004	Equipment, Methods and Remarks	Depth from	to	Diameter	Casing Depth	Ground Level	Datum?
Logged	AJ	End	02/07/2004	Cable Percussion 200mm diameter from 0.00m - 11.16m.	0.00m	11.16m	200mm	8.00m	Coordinates	-
Checked	AG								National Grid	-

Samples and Tests

Depth	Type & No	Records	Date Casing	Time Water
0.50-1.00	B 1			
1.00-1.45	SPT S	N=17 (3,3/4,4,4,5)	1.00	
1.50-2.00	B 2			
2.00-2.45	SPT S	N=17 (3,4/4,5,4,4)	1.50	
2.00-2.45	D 3			
2.50-3.00	B 4			
3.00-3.45	SPT S	N=15 (3,3/4,3,4,4)	2.80	
3.00-3.45	D 5			
3.50-3.95	U 6	60 blows No recovery	3.00	
3.50-4.00	B 7			
4.00-4.45	SPT S	N=20 (3,3/4,5,6,5)	3.70	
4.50-5.00	B 8			
5.00-5.45	SPT S	N=29 (5,6/6,7,8,8)	4.50	
5.00-5.45	D 9			
			01/07/2004	
6.00-6.50	B 10		5.80	
6.50-6.95	SPT S	N=28 (5,6/6,7,8,7)	6.00	
6.50-6.95	D 11			
8.00-8.50	B 12			
8.50-8.95	SPT S	N=23 (4,4/5,5,7,6)	8.00	
9.50-10.00	B 13			

Strata

Description	Depth, *Level* (Thickness)	Legend	Backfill/ Instruments
MADE GROUND: CLAY fill.	0.20		
Stiff brown mottled reddish brown slightly sandy CLAY (GLACIAL TILL).	(3.30)		
Stiff grey brown mottled orange slightly sandy slightly gravelly CLAY (GLACIAL TILL).	3.50		
	(7.66)		

Groundwater Entries

No.	Struck (m)	Post strike behaviour	Depth sealed (m)
None observed (see Key Sheet)			

Depth Related Remarks *

From to (m)

Chiselling

Depths (m)	Time	Tools used
1.60 -1.72	30 mins	

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Scale 1:50

Project	Youghal
Project No.	KC4092
Carried out for	Finbarr Gannon & Co. Ltd.

Borehole

BH3R

Sheet 1 of 2

Borehole Log

GEOTECH

Drilled	JC
Logged	AJ
Checked	AG

Start	01/07/2004
End	02/07/2004

Equipment, Methods and Remarks
Cable Percussion 200mm diameter from 0.00m - 11.16m.

Depth from	to	Diameter	Casing Depth
0.00m	11.16m	200mm	8.00m

Ground Level	Datum?
Coordinates	-
National Grid	-

Samples and Tests

Depth	Type & No	Records	Date Casing	Time Water
10.00-10.45	SPT S	N=27 (3,5/6,7,6,8)	8.00	
			02/07/2004 8.00	0.00

Strata

Description	Depth, Level (Thickness)	Legend	Backfill/ Instruments
Stiff grey brown mottled orange slightly sandy slightly gravelly CLAY (GLACIAL TILL).			
EXPLORATORY HOLE ENDS AT 11.16 m	11.16		SP

Depth	Type & No	Records	Date Casing	Time Water

Groundwater Entries

No.	Struck (m)	Post strike behaviour	Depth sealed (m)

None observed (see Key Sheet)

Depth Related Remarks *

From	to (m)

Chiselling

Depths (m)	Time	Tools used
11.10 -11.16	60 mins	

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

Scale 1:50

Project	Youghal
Project No.	KC4092
Carried out for	Finbarr Gannon & Co. Ltd.

Borehole
BH3R
Sheet 2 of 2

ENCLOSURE B

INSTRUMENTATION MONITORING

Groundwater Installation Details

GEOTECH

Hole No	Installation Type	Date of Installation	Tip depth, (m)	Piezometer Diameter (mm)	Top of response zone, (m)	Base of response zone, (m)	Tubing Completion Details	Headworks	Remarks
BH2	SP	30 Jun 2004	5.00	50	1.00	5.00	Open	Lockable top cover	
BH1	SP	28 Jul 2004	7.00	50	1.00	7.00	Open	Lockable top cover	
BH3R	SP	02 Jul 2004	11.16	50	1.00	11.16	Open	Lockable top cover	

Notes: Type: SP - Standpipe, SPIE - Standpipe Piezometer, HPIE - Hydraulic Piezometer, PPIE - Pneumatic Piezometer, EPIE - Vibrating Wire Piezometer, PWEL - Pumping Well

Project

Project No. KC4092
Carried out for Finbarr Gannon & Co. Ltd.

Figure B1

Groundwater Monitoring

GEOTECH

Hole No.	Instrument Type	Tip Depth (mBGL)	Reading				
			Date	Time (hhmmss)	Water Level (mBGL)	Head (m above Tip)	Comments
BH1	SP	7.00	09 Jul 2004	61000	1.89	5.12	
BH2	SP	5.00	09 Jul 2004	161000	3.59	1.41	
BH3R	SP	11.16	09 Jul 2004	161000	7.77	3.40	

Notes: Type: SP - Standpipe, SPIE - Standpipe Piezometer, HPIE - Hydraulic Piezometer, PPIE - Pneumatic Piezometer, EPIE - Vibrating Wire Piezometer, PWEL - Pumping Well

Project: Youghal
Project No.: KC4092
Carried out for: Finbarr Gannon & Co. Ltd.

Sheet

ENCLOSURE C

GEOTECHNICAL LABORATORY TEST RESULTS

Key to Geotechnical Laboratory Results

GEOTECH

U	Undisturbed Sample
P	Piston Sample
TWS	Thin Wall Sample
B	Bulk Sample - Disturbed
D	Jar Sample - Disturbed
W	Water Sample
pH	Acidity/Alkalinity Index
SO_3	% - Total Sulphate Content (acid soluble)
SO_3	g/ltr - Water Soluble Sulphate (Water or 2:1 Aqueous Soil Extract)
+	Calcareous Reaction
Cl	Chloride Content
I_p	Plasticity Index
<425	% of material in sample passing 425 micron sieve
w_L	Liquid Limit
w_p	Plastic Limit
w	Water Content
NP	Non Plastic
γ_b	Bulk Density
γ_d	Dry Density
Ps	Particle Density
U/D	Undrained/Drained Triaxial
U/C	Unconsolidated/Consolidated Triaxial
T/M	Single Stage/Multistage Triaxial
100/38	Sample Diameter (mm)
REM	Remoulded Triaxial Test Specimen
TST	Triaxial Suction Test
V	Vane Test
DSB	Drained Shear Box
RSB	Residual Shear Box
RS	Ring Shear
σ_3	Cell Pressure
$\sigma_1-\sigma_3$	Deviator Stress
c	Cohesion
c'	Effective Cohesion Intercept
ϕ	Angle of Shearing Resistance - Degrees
ϕ'	Effective Angle of Shearing Resistance
εf	Strain at Failure
*	Failed under 1st Load
**	Failed under 2nd Load
#	Untestable
##	Excessive Strain
p'o	Effective Overburden Pressure
m_v	Coefficient of Volume Decrease
c_v	Coefficient of Consolidation
Opt	Optimum
Nat	Natural
Std	Standard Compaction - 2.5kg Rammer (¶ CBR)
Hvy	Heavy Compaction - 4.5kg Rammer (§ CBR)
Vib	Vibratory Compaction
CBR	California Bearing Ratio
Sat m.c.	Saturation Moisture Content
MCV	Moisture Condition Value

Notes:	Project: Youghal Project No.: KC4092 Carried out for: Finbarr Gannon & Company	Figure **Key Sheet**

Samples				Classification					Strength			Other Tests
Hole	Depth	Type	Description	<425 I_p	Prep w_L	w_p	Water %	$\gamma_{b\,3}$ Mg/m	Test	σ_3 kPa	c kPa	
BH1	1.00 - 1.45	D	Brown sl sandy sl gravelly CLAY				26					
BH1	1.50 - 2.00	B	Brown sl sandy sl gravelly CLAY	92 15	425µ 34	Sieve 19						pH = 8.0 SO3 (2:1) = 0.06g/l Passing 2mm = 94%
BH2	2.50 - 3.00	B	Orange brown very sandy CLAY	70 15	425µ 35	Sieve 20	31					Org = 1.7% Passing 2mm = 71% pH = 7.7 SO3 (2:1) = 0.08g/l Passing 2mm = 71%
BH3R	0.50 - 1.00	B	Brown slightly sandy CLAY	97 25	425µ 46	Sieve 21	26					Org = 1.0% Passing 2mm = 60% pH = 7.7 SO3 (2:1) = 0.12g/l Passing 2mm = 60%

Remarks

Form 10/2

Laboratory - Results Summary

Exploration Associates

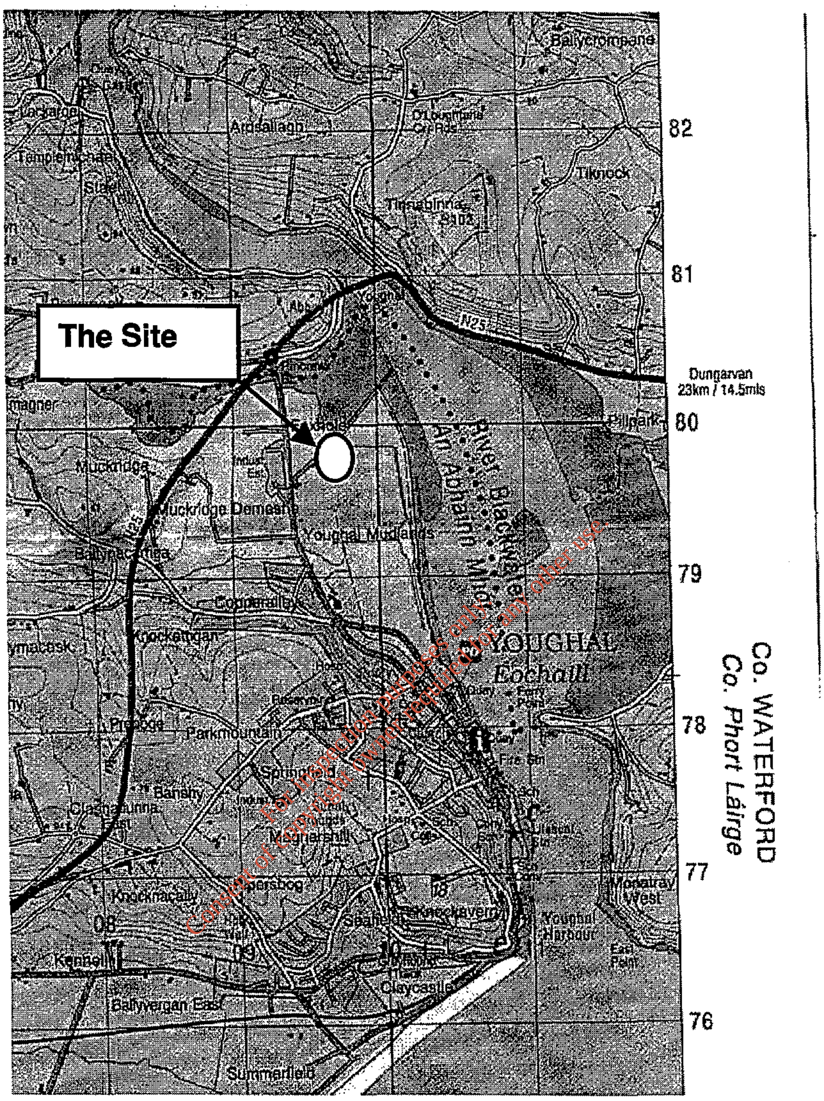
Project
Youghal
Finbarr Gannon & Co. Ltd.

Contract
KC4092

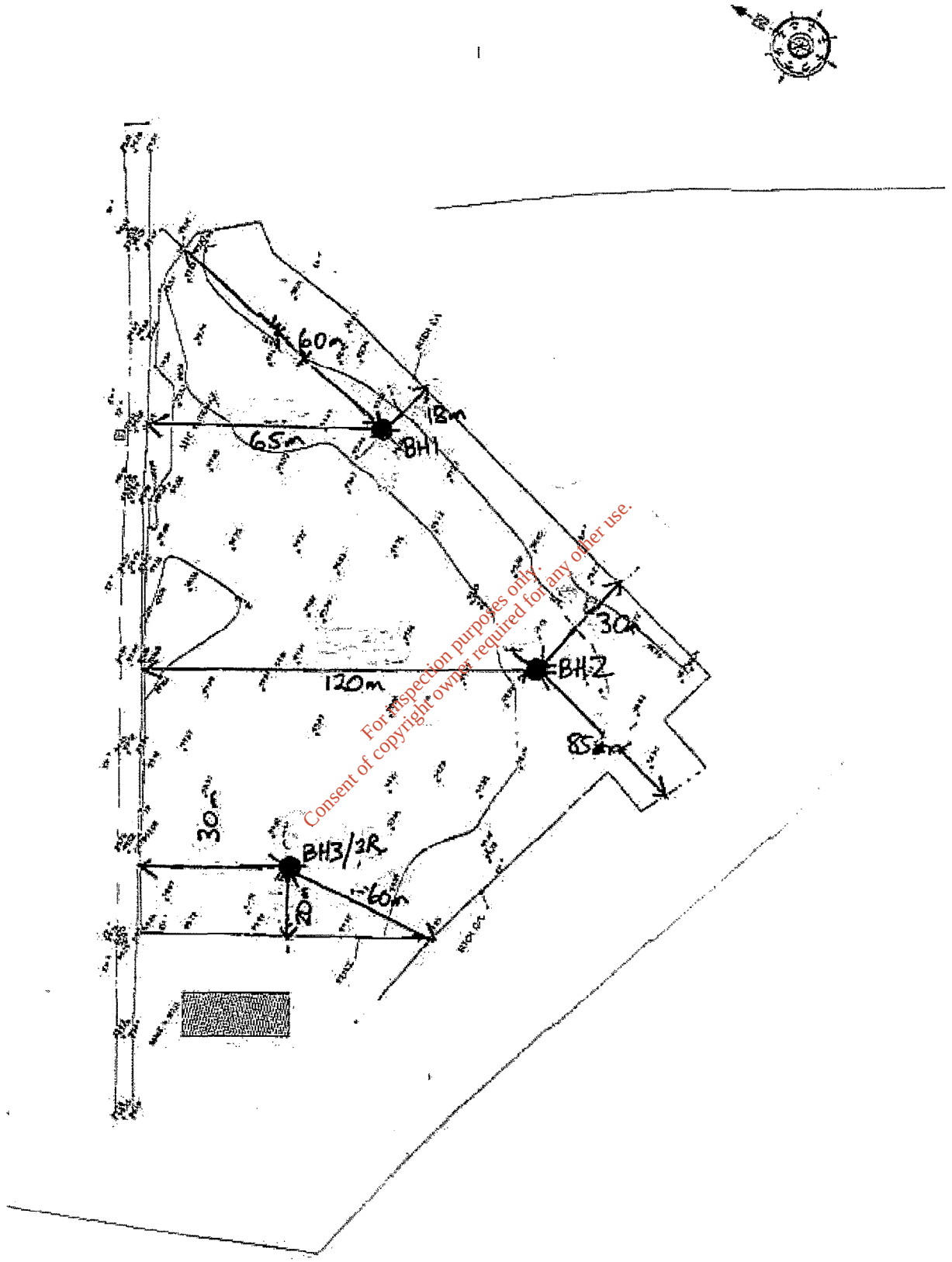
Sheet
C2

ENCLOSURE E

DRAWINGS

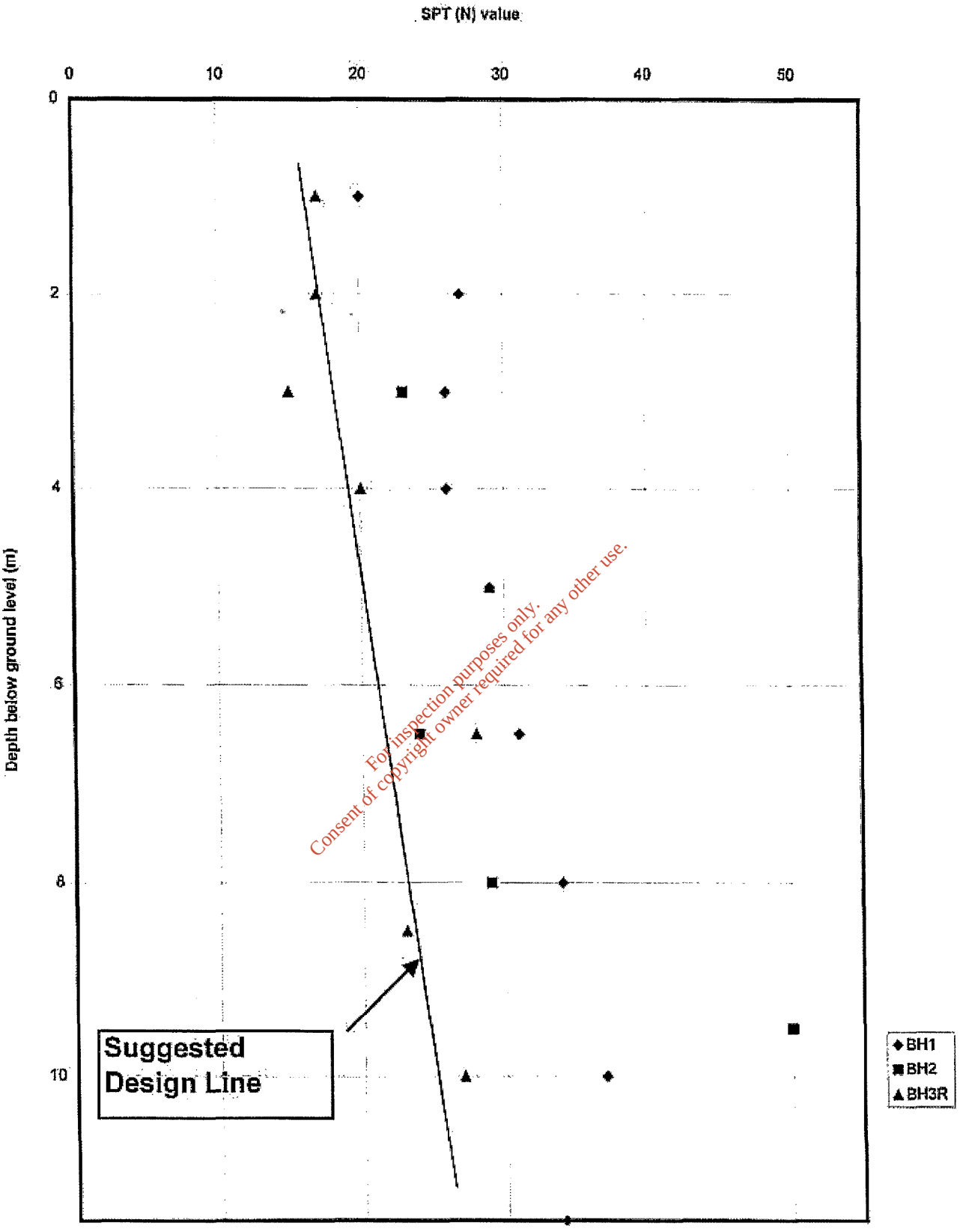


Site Location Plan	Project	Contract KC4092
GEOTECH	Youghal	Drawing 1



Site Plan	Project Youghal	Contract KC4092
GEOTECH		Drawing 2

PLOT OF SPT 'N' VALUE AGAINST DEPTH - Glacial Till



Notes:
In general 'N' values shown as 50 are maximum recorded values. 'N' values greater than 50 are also shown as 50

LOT OF SPT 'N' VALUE AGAINST DEPTH - Glacial Till	Project: Youghal	Contract: KC4092
GEOTECH		Drawing: 3