APPENDIX 8-2

Whiteford Geoservices Site Investigation Report

GROUND INVESTIGATION FOR PROPOSED WIND FARM SITE AT TAURBEG, ROCKCHAPEL, CO. CORK

Report No. 386/04

Prepared by

Whiteford *Geoservices Ltd*

on behalf of

RES Group Ltd

16th June 2004

Whiteford *Geoservices Ltd*
Unit 2 Curran Business Park
Portland Road,
LARNE, Co. Antrim
Northern Ireland UNITED KINGDOM
BT40 1DH

Web: www.whitefordgeoservices.com
Email: info@whitefordgeoservices.com

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1.0 Purpose and Scope of Works

Introduction

A geotechnical site investigation was requested by Mr Alan McMahon of RES Group Ltd to be carried out at the site of a proposed wind farm near to Rockchapel, Co. Cork, Republic of Ireland.

The purpose of this investigation was to assess the suitability of the ground for the construction of wind turbines on a site extending to approximately 2km^2 at Taurbeg.

Survey Date

The ground investigation took place between Monday 24th May and Friday 4th June 2004. The trial pit, CBR testing and Ground Resistance Tests were executed by the following staff members:-

Alistair Burns	CBR Tests / Ground Resistance Tests
Mark Heggen	CBR Tests / Ground Resistance Tests
John Whiteford	Trial Pit Analysis
John Rickert	Trial Pit Analysis

Generally fair to good weather conditions were experienced throughout the fieldwork period.

Survey Procedure

Renewable Energy Systems proposes to construct 11 wind turbines and 1 electrical sub-station on a site covering 2000m by 2000m.

The purpose of this investigation was as follows:-

- To determine ground conditions prevailing at the location of each proposed sub-station and turbine bases, as well as along proposed access roads, so that the engineer might adequately assess quantities of construction materials required.

This geotechnical investigation consisted of four parts. *These are as follows.*

- A ground investigation comprising of the excavation of 12 trial pits. Trial pits were sited at each planned turbine base and sub-station so that representative ground information could be obtained. Each trial pit was to continue until rock or a suitable bearing stratum had been encountered.
- In-situ CBR testing was to be used to assess soils along the route of proposed access roads. This would then be used to accurately calculate stone thickness for road base construction.
- Ground resistance tests were used to determine grounding parameters at the site of all turbines and the sub station.
- Additional ground investigation was carried out at the site of turbine bases where the trial pits carried out had not located rock.

2.0 Environmental Site Setting

Site Location

The site is located approximately 1 mile from Rockchapel, near Newmarket, Co. Cork and is approached by the minor road. Unmettled roads then provide access onto the proposed wind farm development.

(Refer to map below and location plan in appendix for site location details)

The proposed wind farm site is currently classified as peat bog, the lower reaches of which are grazed by sheep.

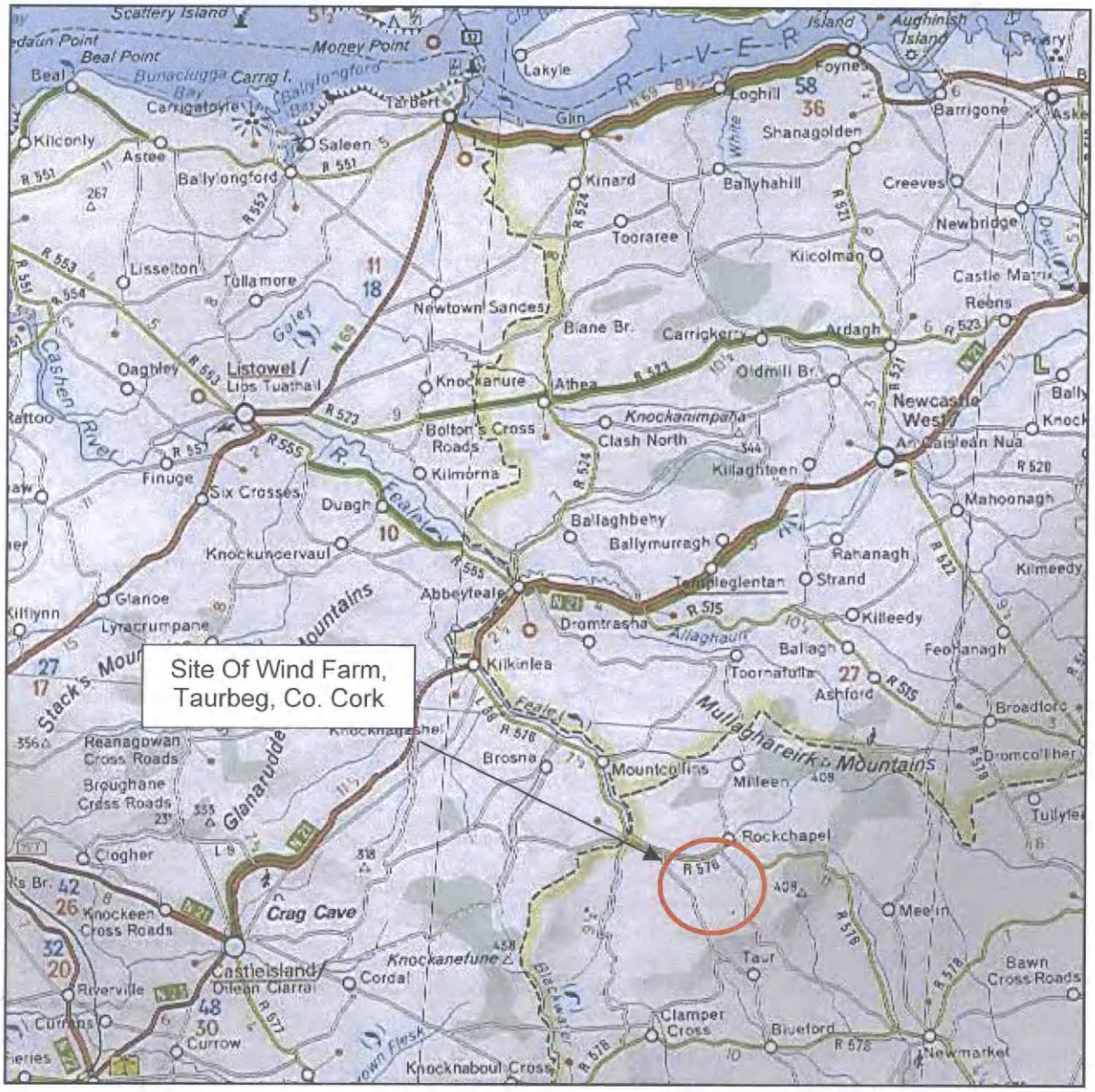

Figure 1 - Site Location Map

Reproduced from Ordnance Survey N.I. Discover 1:50 000 Series, Sheet 12

Geology

A study was made of available geological and hydro-geological information, including Geological Survey Memoirs. These were used to assess the potential for any contaminant migration from the site.

In general contaminants spilled or leaked at the ground surface will move downwards until they encounter an impermeable stratum or the groundwater table. They then start to spread laterally in a direction governed by the geological topography or groundwater gradient. It is therefore important that the geology and hydrogeology of the site are well known prior to commercial use.

Research into the geology of the area was made using the following sources:

1. Geological Survey Of Ireland, "Geological Map Of Ireland", 1:750 000, 3rd Edition, 1962.

This shows that the following general drift and solid geology can be expected at the site of Taurbeg Wind Farm:-

- Surface deposits consisting of peat, clayey sands and clayey gravels (the latter two being the weathering products of the underlying rock)
- Solid geology consisting of Coal Measures overlying the Millstone Grit and Flagstone Series overlying sandstone & shale of the Yordale and Pendleside Series.

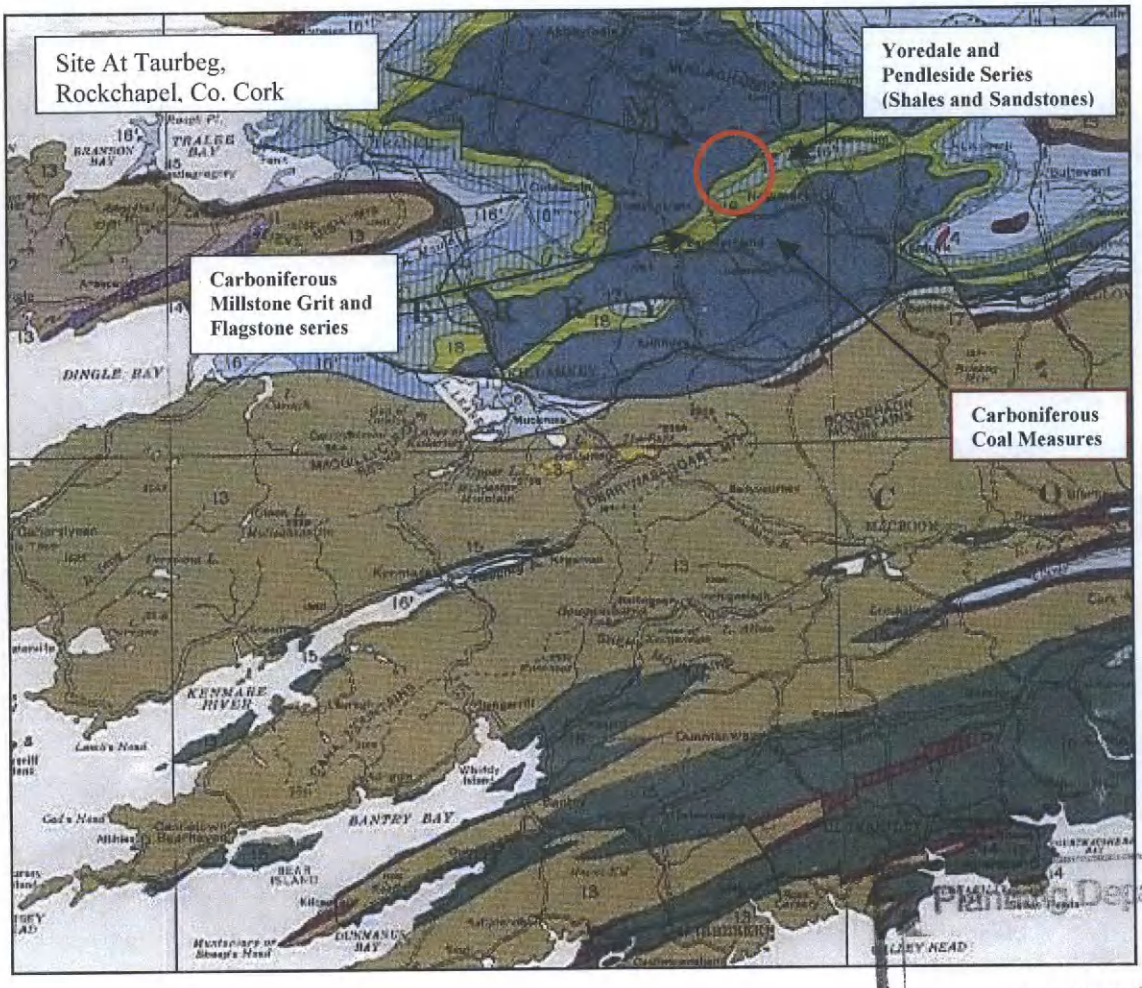

Figure 2 - Geology of the Site

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3.0 Environmental Assessment Procedure

Trial Pit Investigation

Please refer to appendix for location of trial pits and the logs obtained.

Trial pits were carried out using a 12T tracked excavator with a maximum reach of 5.5m. All due care and attention was given to ensuring that pits were excavated with a minimum of impact on the surrounding environment and the ground returned to a satisfactory state on completion.

Site investigation was carried out in line with the recommendations outlined in "Specification and Method of Measurement for Site Investigation", Dept. of Transport, 1987.

Penetrometer and vane tests were conducted within the granular and cohesive materials encountered to ascertain the compressive strength.

This information was later used to determine the calculated allowable bearing pressures of each soil horizon to provide recommendations for foundation design.

Borehole Investigation

Please refer to appendix for location of boreholes and the logs obtained.

Trial pits were carried out using a Dando Terrier site investigation boring rig. All due care and attention was given to ensuring that pits were excavated with a minimum of impact on the surrounding environment and the ground returned to a satisfactory state on completion.

Site investigation was carried out in line with the recommendations outlined in "Specification and Method of Measurement for Site Investigation", Dept. of Transport, 1987.

CBR – Insitu Testing.

In-situ CBR tests were carried out along the route of the proposed access roads at intervals of 100m. Additional, CBR tests were carried out along the main access road for a distance of approximately 1.5km at intervals of 200m.

At each position a series of 4 tests were carried out at 0m, 0.15m, 0.45m and 0.75m depth, where penetration was possible. These readings were repeated once to check consistency.

A Mexecone manufactured by L.Farnell & Co was used for this purpose.

Ground Resistivity Testing

Two orthogonal vertical electrical resistivity soundings were conducted at the location of each turbine and proposed sub-station.

This was carried out using the Schlumberger Palmer configuration.

A Megger Det 2/2 Ground Resistance Meter was used to collect the information in all cases.

Please refer to the appendix for details of the electrodes separations used.

Laboratory Testing

A single sample was removed from each proposed turbine and sub station location and tested for the following:-

1. Sulphate Content
2. pH

The results of all testing is given in section 4.0 and the appendix.

4.0 Results of Geotechnical Investigation

Turbine Bases

Soil Stratigaphy – Turbine Bases and Sub-Station

Analysis of the trial pit records shows that the following table approximates to the general site stratigraphy.

Layer	Soil Type	Thickness (m)	Description
Layer 1	Peat	0.2 – 1.7m	Dark brown compressible plastic PEAT.
Layer 2	Soft to Firm Sandy Clay	0.3 – 1.0m	Soft to firm yellow brown sandy CLAY or blue grey homogeneous CLAY
Layer 3	Medium Dense Coarse Gravel / Gravelly Clay	0.88m – 3.75m	Blue Grey highly discoloured crystalline SHALE. (Highly weathered)
Layer 4	Weak Rock	0.30 – 1.25m	Dark grey disintegrated thinly laminated MUDSTONE / SILTSTONE and yellowish green decomposed SANDSTONE
Layer 5	Strong Rock	N/A	Fresh to discoloured MUDSTONE / SILTSTONE and SANDSTONE

Table 1 – Approximate Soil Stratigraphy

Groundwater

Water was struck during the survey, in the following trial pits

TP1 No water struck
TP2 No water struck
TP3 Water seepage at 0.4m
TP4 No water struck
TP5 No water struck
TP6 No water struck
TP7 Water seepage at 0.4m
TP8 Water seepage at 0.6m and at 2.9m
TP9 No water struck
TP10 No water struck
TP11 Water seepage at 1.2m. Water struck at 1.9m – slight flow.
TP12 No water struck
BH1 No water struck
BH2 No water struck

Geotechnical Design Parameters – Turbine Bases

The following outline geotechnical profile has been determined on the basis of visual examination of soil samples, basic in-situ testing and by applying approximate average engineering parameters for the soil types observed.

Layer	Soil Type	Depth to top (m)	Approx. Density (kN/m^3)	Allowable Bearing Pressure (kN/m^2)
Layer 1	Peat	0	1600	Not suitable
Layer 2	Soft to Firm Sandy Clay	0 – 1.7	2000	10 - 50
Layer 3	Medium Dense Coarse Gravel / Gravelly Clay	0.7 – 2.2	2200	Generally 150 - 200
Layer 4	Weak Rock	0.86 – 2.5	2500	>1000
Layer 5	Strong Rock	1.3 – 5.9	2500	>5000

Table 2 - Geotechnical Parameters

Summary of Trial Pit and Borehole Data

Analysis of the trial pit records shows that the following table

Turbine No. / Substation	Trial pit No.	Location		Peat Thickness (m)	Depth to Refusal on Strong Rock (m)	Depth at which an allowable bearing pressure in excess of 150kN/m2 is available (m)
		Easting	Northing			
T1	TP7	122699	111332	0.42	N/A	1.5
T2	TP2	122453	111906	0.2	3.7	1.85
T3	TP4	122016	111912	0.4	3.7	1.95
T5	TP3	122290	112182	0.51	3.3	2.5
T6	TP12	122626	112212	N/A	2.85	1.3
T7	TP11	122889	112129	Between 0.6m and 1.15m	3.6	1.15
T8	TP5	122169	111647	1.7	4.3	2.1
T9	TP10	122902	111596	0.65	2.55	0.9
T10	TP8	122914	110925	0.75	3.55	2.0
T11	TP9	123006	111237	1.05	2.6	1.25
T12	TP6	122467	111590	1.2	N/A	1.4
T12	TP6A	122487	111584	1.2	N/A	2.2
Substation	TP1	122532	111994	0.52	2.85	0.86
T1	BH1	122674	111348	2.5	5.5	2.5
T12	BH2	122464	111545	1.1	4.0	2.0

Table 3 – Summary of Ground Conditions

Summary of Laboratory Test Data

The following table outlines the findings of the laboratory testing programme. Please refer to the appendix for full details of the test results.

Turbine location	Depth	Classification (rock / gravel / sand / silt / clay)	Sulphate Content (g/l)	pH
1	0.5	Clay	0.5	7.5
2	1.5	Clay	0.4	7.9
3	2.0	Gravel	0.6	8.0
5	1.5	Gravel	1.1	8.3
6	0.8	Sand	0.7	7.2
7	1.5	Gravel	0.3	7.5
8	4.3	Gravel	0.3	7.6
9	2.5	Clay	0.4	8.2
10	1.5	Gravel	0.3	7.0
11	2.0	Clay	0.5	7.8
12	1.8	Clay	0.6	7.4
Substation	1.2	Clay	0.4	7.4

Table 4 – Laboratory Test Results

CBR In-Situ Testing

Please refer to the appendix for details of the CBR values obtained.

Ground Resistance Testing

Please refer to the appendix for results of the testing carried out at turbine and substation locations.

5.0 RECOMMENDATIONS

Turbine Bases

It is recommended that bases for the wind turbines be located on the strong rock layer (MUDSTONE / SILTSTONE / SANDSTONE) layer found at a depth of 2.9 to 4.1m below ground level at each base and sub-station location.

The effective density of this material is in approx of 25kN/m^3.

Chemical tests find that soils are generally slightly alkaline with pH ranging from 7.0 – 8.3. Sulphate content was generally low and varied between 0.3g/l and 1.1g/l. Soil conditions are not expected to be aggressive to concrete. Class 1 concrete is recommended.

In-Situ tests carried out provide an allowable bearing capacity of greater than 5000kN/m^2 for this Strong Rock layer.

Sides of excavations are stable and unlikely to collapse. All excavations below 1.0m should however be adequately supported.

Water was only found to be present in measurable volumes within trial pit 11, at the site of turbine T7. This is unlikely to cause problems for the design as proposed as only a slight flow was observed. It is recommended that excavations are not left open / exposed to wet weather for longer than absolutely necessary, to prevent possible degradation of sensitive clays and gravelly clays..

Conditions would appear to be suitable for the emplacement of foundations (described previously) as follows:-

Turbine T1	Bases placed at 5.8m b.g.l.
Turbine T2	Bases placed at 3.7m b.g.l
Turbine T3	Bases placed at 3.7m b.g.l
Turbine T5	Bases placed at 3.3m b.g.l
Turbine T6	Bases placed at 2.85m b.g.l
Turbine T7	Bases placed at 3.6m b.g.l
Turbine T8	Bases placed at 4.3m b.g.l
Turbine T9	Bases placed at 2.55m b.g.l
Turbine T10	Bases placed at 3.55m b.g.l
Turbine T11	Bases placed at 2.6m b.g.l
Turbine T12	Bases placed at 4.0m b.g.l
Substation	Strip Foundations placed at 0.86m b.g.l on weathered sandstone

Access Roads

CBR In-Situ test results show that a value in excess of 3% is generally achieved at 0.95m depth beneath the peat layer. Minimal quantities of road base material, are likely to be required, for non-floating road construction.

The findings of this report are based entirely on field observations and analysis of trial pi, borehole and In-Situ test data.

6.0 SUMMARY

- The site is currently moorland, used for peat harvesting with the lower reaches employed for grazing sheep.
- Ground water was not found to be a major feature of the ground investigation. Generally the clays were found to be impervious to ground water, which tended to enter the hole through the surface peat layer. This peat layer was, at the time of the investigation, relatively firm underfoot.
- Soils tested exhibit a generally slightly alkaline pH and sulphate content was found to be low. Class 1 concrete is recommended.
- The underlying rock stratum is classified as sedimentary rock, generally Mudstone, Siltone and Sandstone, which show evidence of partial metamorphism. These rocks date from the Carboniferous period and are likely to be contain coal measures in places. These rocks were found to occur in a highly to slightly weathered condition.
- The strong rock identified was, capable of bearing loads in excess of 5000KN/m2 was found generally at depths of between 2m and 4m below ground level. There are two notable exceptions to this case at the current locations of turbine T1 and T12. At turbine T1 rock was located at 5.5m below ground level. The current location of T12 appears to be within a sediment filled gulley. It is recommended that this turbine location is adjusted 30 – 40m south of its current location, where rock is found closer to the surface (4.0m depth in borehole BH2.
- Should new access roads be considered CBR In-Situ testing shows that a value of >2% is generally available at 0.15m depth, below the peat layer . None of the CBR In-Situ tests did penetrated more than 0.45m below the peat. These results are in agreement with the results of the trial pit investigation.

The site is suitable for the proposed wind farm development

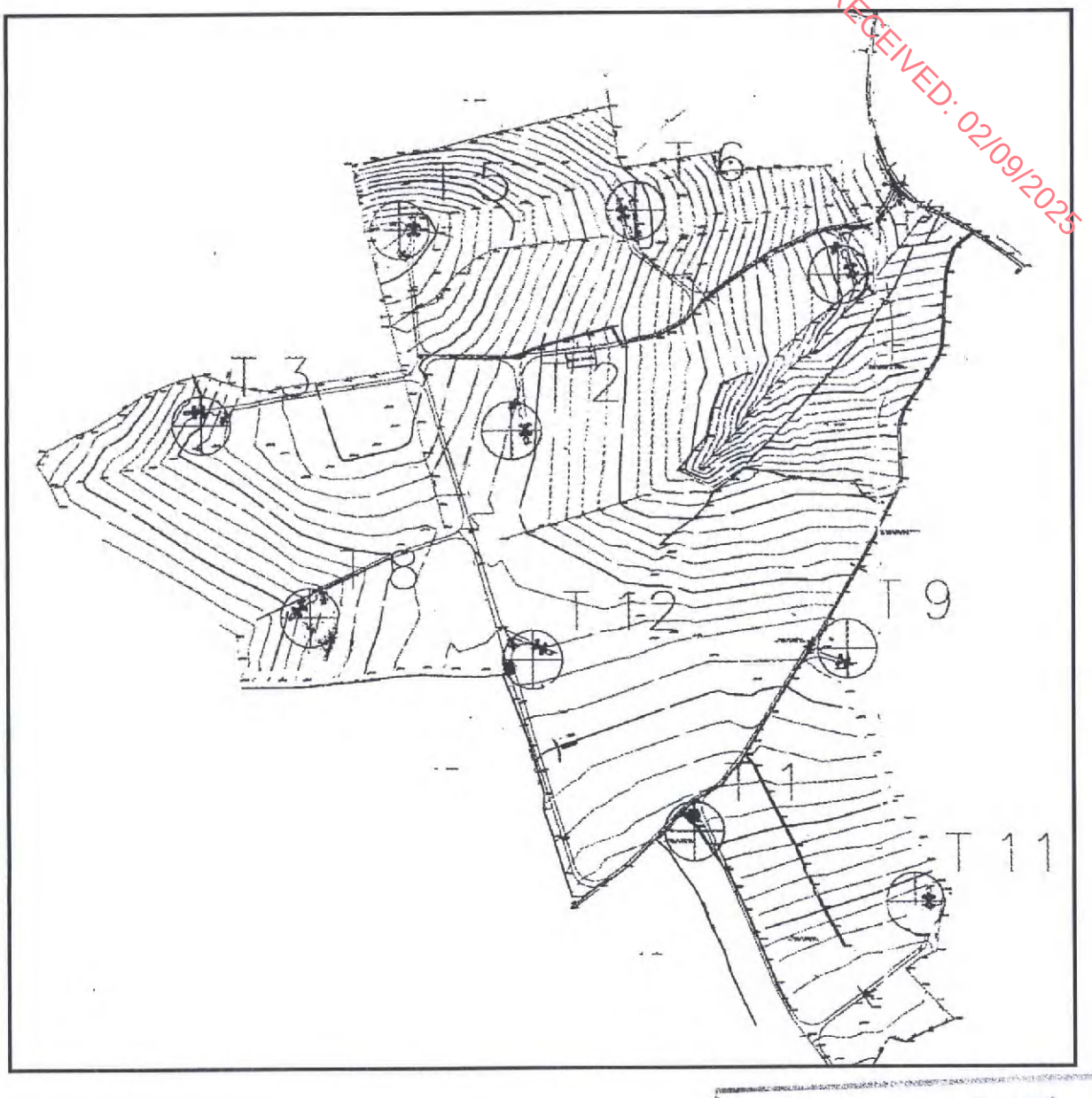
For Whiteford Geoservices Ltd

J Whiteford BSc FGS MEAGE MEEGS

Date: 16 June 2004

APPENDIX

Location Plans



Trial Pit Logs

Project No: 386/04

Project: Taurbeg Wind Farm

Client: RES Group Ltd

Location: Substation

Log of Trial Pit: TP1

Position Ref: E = 122532, N = 111994

SUBSURFACE PROFILE

Depth	Description	Elevation	REMARKS
	Ground Surface	0	
0	**PEAT** Dark brown, highly plastic PEAT	-0.42	No water struck
	Yellow - Brown Sandy CLAY Soft mottled yellow and brown sandy CLAY with numerous angular cobbles of fine grained sandstone.	-0.86	Photos 1 and 2 of pit at 1.2m No contamination observed No services encountered
1	**Weathered SANDSTONE** Disintegrated medium to fine grained, partially crystalline light grey SILTSTONE / SANDSTONE, tinged with dark yellow. Highly to moderately weathered (Grade III - IV).	-1.3	Schmidt Hammer At 1.0m = 22MPa At 1.3m = 36MPa Sides stable to 1.3m Sides tend to collapse after 1.3m
2	**SANDSTONE** Discoloured medium to fine grained slightly crystalline light grey siltstone / sandstone. Slightly weathered (Grade II - III). Becoming light grey and yellow grey, fresh to slightly discoloured tabular medium to fine grained sandstone.	-2.85	Sample taken at 1.3m Photo 3 - Spoil Photo 4 - Base of pit
3	Moderately strong to strong.		
	Very difficult to excavate below this level with 12 tonne machine. Evidence of bedding unclear.		
	End of Borehole		
4			
5			

Penetrometer kN/m2 (100 – 300): 105, 325

Vane Test kN/m2 (20 40 60 80 100): 37

Method: Trial Pit

Date: 24/5/04

Hole Size: 4m x 1m

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Portland Road
Larne BT40 1DH

Datum: Ground Level

Checked by: JW

Sheet: 1 of 1

Project No: 386/04

Project: Taurbeg Wind Farm

Client: RES Group Ltd

Location: Turbine 2

Log of Trial Pit: TP2

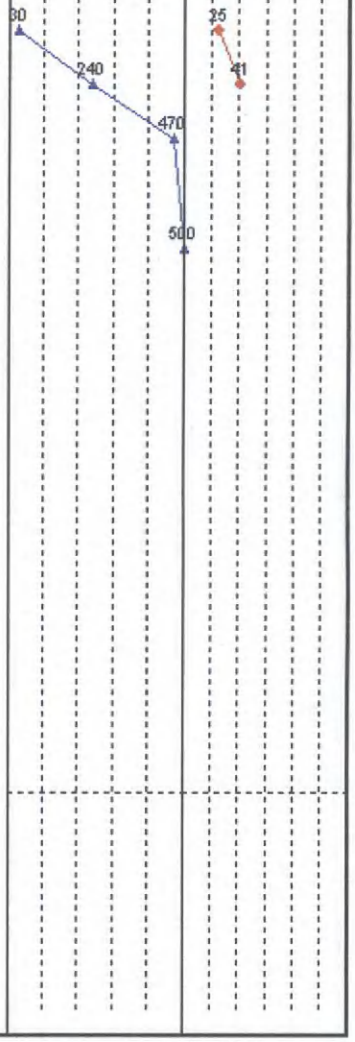
Position Ref: E = 122453, N = 111906

SUBSURFACE PROFILE

Depth	Description	Elevation	REMARKS
0	Ground Surface	0	
	PEAT Firm dark brown, fibrous PEAT	-0.2	No water struck
	Brown Sandy CLAY Softto firm, light brown sandy very gravelly CLAY	-0.5	No contamination observed
	Blue - Grey CLAY Soft to firm blue - grey organic CLAY with rootlets.	-0.75	No services encountered
1	**Medium Dense SAND** Medium dense mottled light green and blue gravelly fine SAND with numerous sub-angular boulders of sandstone.		No Schmidt Hammer test due to depth of pit
			Sides liable to collapse
			Sample taken at 1.5m
	(Completely weathered and decomposed sandstone. Weathering Grade - (IV - V)	-1.85	Photo 5 - Spoil (2.0m) Photo 6 - Base (2.0m)
2	**Dark Grey SANDSTONE** Dark grey thinly bedded (2cm) partially disintegrated fine grained SILTSTONE / SANDSTONE. Very weak - weak. Sub-vertically bedded dipping to the north at 70 degrees.		Photo 7 - Base of pit
			Photo 8 - Spoil
3	**Yellow Brown SANDSTONE** Yellow brown slightly to highly discoloured fine grained thinly bedded tabular / bocky SILTSTONE / SANDSTONE. Moderately weak, becoming moderately strong at base.	-3	
	End of Borehole	-3.7	
4			
5			

Penetrometer kN/m2 (100 – 300)

Vane Test kN/m2 (20 40 60 80 100)



Method: Trial Pit

Date: 24/5/04

Hole Size: 4m x 1.25m

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Sheet: 1 of 1

Project No: 386/04

Project: Taurbeg Wind Farm

Client: RES Group Ltd

Location: Turbine 5

Log of Trial Pit: TP3

Position Ref: E = 122290, N = 112182

SUBSURFACE PROFILE

Depth	Description	Elevation	REMARKS
0	Ground Surface	0	
	PEAT Firm dark brown, spongy PEAT	-0.51	No water struck
	Brown Sandy CLAY Soft light brown sandy organic CLAY	-0.75	No contamination observed
1	***Blue Coarse GRAVEL*** Medium dense fine sandy blue coarse GRAVEL (Totally decomposed SANDSTONE). Weathering Grade IV - V, very weak	-1.35	No services encountered No Schmidt Hammer test available due to depth of pit
2	***Dense Orange GRAVEL*** Dense orange mottled brown very coarse angular GRAVEL in a fine sandy matrix (Decomposed SANDSTONE with corestones). Weathering Grade III - IV. Very weak.	-2.5	Sides liable to collapse below 1.5m Sample taken at 1.5m Photo 9 - Pit Photo 10 -Spoil
3	***Yellow - Grey SANDSTONE*** Yellowish grey, discoloured fine grained, thickly bedded (5 - 10 cm) tabular to blocky partially crystalline SANDSTONE, moderately weak.	-3.1	
	Yellow - Grey SANDSTONE Yellowish grey, partially discoloured thinly bedded (2 -3cm), planar to tabular partially crystalline SANDSTONE, moderately strong to strong.	-3.3	
4	End of Borehole		
5			

Penetrometer kN/m2 (100, 300): 65, 310, 500

Vane Test kN/m2 (20, 40, 60, 80, 100): 40

Method: Trial Pit

Date: 24/5/04

Hole Size: 4m x 1m

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Datum: Ground Level

Checked by: JW

Sheet: 1 of 1

Project No: 386/04

Log of Trial Pit: TP4

Project: Taurbeg Wind Farm

Client: RES Group Ltd

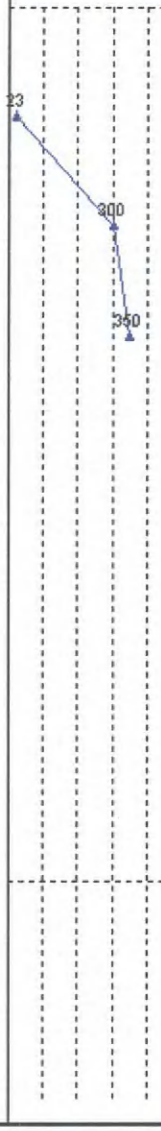
Location: Turbine 3

Position Ref: E = 122016, N = 111912

SUBSURFACE PROFILE

Depth	Description	Elevation	REMARKS
0	Ground Surface	0	
	PEAT Firm dark brown, spongy PEAT.	-0.4	Water seepage at 0.4m
	Gravelly Sandy CLAY Light brown very gravelly very sandy CLAY.	-0.75	No contamination observed
1	**Coarse GRAVEL** Medium dense coarse blue GRAVEL, very fine sandy matrix (Totally decomposed SANDSTONE) Weathering Grade IV - V.	-1.4	No services encountered No Schmidt Hammer test at 2.0m Rock Strength <1 MPa
	Dense GRAVEL Dense yellowish - brown coarse angular GRAVEL in a fine sandy matrix (Decomposed SANDSTONE with corestones). Weathering Grade IV - V.	-1.95	Sides liable to collapse below 2.0m Sample taken at 2.0m Photo 11 - Pit Photo 12 -Spoil
2	**Grey MUDSTONE** Dark grey disintegrated, thinly laminated MUDSTONE / SILTSTONE. Weak, sub vertically dipping beds - 70 degrees towards north.	-3.2	
3	**Grey MUDSTONE** Dark grey partially discoloured thinly laminated MUDSTONE / SILTSTONE. Moderately strong, subvertically dipping beds - 70 degrees towards north.	-3.7	No standing water on completion
4	End of Borehole		
5			

Penetrometer kN/m2 (100 – 300)



Vane Test kN/m2 (20 40 60 80 100)

Method: Trial Pit

Date: 24/5/04

Hole Size: 4m x 1.3m

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Datum: Ground Level

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Sheet: 1 of 1

Project No: 386/04

Project: Taurbeg Wind Farm

Client: RES Group Ltd

Location: Turbine 8

Log of Trial Pit: TP5

Position Ref: E = 122169, N = 111647

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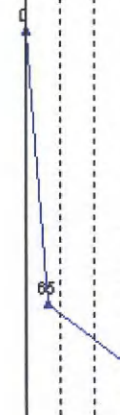
SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation	REMARKS
0		Ground Surface	0	
		PEAT Brown to dark brown, spongy PEAT.	-1.7	No contamination observed No services encountered Sides very unstable Sample taken at 4.3m Photo 13 - Pit Photo 14 -Spoil
2		***Gravelly Sandy CLAY*** Soft light brown very sandy very coarse gravelly CLAY	-2.1	
3		***Coarse GRAVEL*** Medium dense to dense, blue - grey coarse angular GRAVEL, very fine sandy matrix (Totally disintegrated MUDSTONE / SILTSTONE). Weathering Grade IV. Very weak.	-4.1	
4		***Grey MUDSTONE*** Dark grey, thinly laminated MUDSTONE / SILTSTONE. Moderately strong, subvertically dipping beds - 70 degrees towards north.	-4.3	
5		End of Borehole		

Penetrometer kN/m2 (100 – 300)

Vane Test kN/m2 (20 40 60 80 100)



Method: Trial Pit

Date: 24/5/04

Hole Size: 5m x 1.5m

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Unit 2 Curran Business Park
Portland Road
Larne BT40 1DH

Datum: Ground Level

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Sheet: 1 of 1

Project No: 386/04

Log of Trial Pit: TP6

Project: Taurbeg Wind Farm

Client: RES Group Ltd

Location: Turbine 12

Position Ref: E = 122467, N = 111590

SUBSURFACE PROFILE

Depth	Description	Elevation	REMARKS
0	Ground Surface	0	
	PEAT Brown to dark brown, spongy PEAT.	-1.2	No water struck No contamination observed No services encountered No rock encountered
	Light brown CLAY Soft to very soft light brown sandy CLAY.	-1.4	No obstructions encountered Sample taken at 1.8m Photo - Pit Photo - Spoil Sides stable
	Gravelly Sandy CLAY Firm to stiff mottled yellow and green very coarse gravelly fine grained sandy CLAY. Becoming very dense sandy clayey very coarse sub-angular GRAVEL towards base.		No standing water on completion
5		-5.25	End of hole at 5.25m - at limit of reach of excavator
	End of Borehole		

Penetrometer kN/m2 (100, 300) — 40, 367

Vane Test kN/m2 (20, 40, 60, 80, 100)

Method: Trial Pit

Date: 24/5/04

Hole Size: 4m x 1.5m

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Datum: Ground Level

Checked by: JW

Sheet: 1 of 1

Project No: 386/04

Log of Trial Pit: TP6A

Project: Taurbeg Wind Farm

Client: RES Group Ltd

Location: Turbine 12

Position Ref: E = 122487, N = 111584

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SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation	REMARKS	Penetrometer kN/m2 (100 – 300)	Vane Test kN/m2 (20 40 60 80 100)
0		Ground Surface	0			
1		***PEAT*** Very soft, brown to dark brown, plastic PEAT.	-1.2	No water struck No contamination observed No services encountered		
2		***Light brown CLAY*** Soft to very soft light brown - grey sandy CLAY.	-2.2	No obstructions encountered Sample taken at 1.8m No photo taken		
3		***Gravelly Sandy CLAY*** Firm light bluish - green sandy, very gravelly CLAY. Dense cobbles and boulders of sandstone at base.	-4.65	Sides stable No standing water on completion		
4		End of Borehole		End of hole at 4.65m No rock encountered		
5						

Method: Trial Pit

Date: 24/5/04

Hole Size: 5m x 1.5m

Whiteford Geoservices Ltd
Unit 2 Curran Business Park
Portland Road
Larne BT40 1DH

Datum: Ground Level

Checked by: JW

Sheet: 1 of 1

Project No: 386/04

Project: Taurbeg Wind Farm

Client: RES Group Ltd

Location: Turbine 1

Log of Trial Pit: TP7

Position Ref: E = 122699, N = 111332

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SUBSURFACE PROFILE

Depth	Description	Elevation	REMARKS
0	Ground Surface	0	
	PEAT Firm dark brown, spongy PEAT.	-0.42	Water seepage at 0.4m
	Slightly Sandy CLAY Soft light brown slightly sandy gravelly CLAY.	-0.71	No contamination observed No services encountered
1	***Gravelly CLAY*** Firm bluish - grey very sandy gravelly CLAY	-1.1	No Schmidt Hammer test
	Gravelly CLAY Firm yellow very gravelly CLAY. Gravel consists of disintegrated very weak mudstone fragments.	-2.45	Sides liable to collapse below 1.5m Photo 15 - Pit Photo 16 -Spoil
3	***Gravelly CLAY*** Stiff yellow, very gravelly CLAY (completely disintegrated MUDSTONE). Weathering grade (IV)	-4.6	No standing water on completion
4	End of Borehole		
5			

Penetrometer kN/m2 (100 – 300): 40, 125, 220

Vane Test kN/m2 (20 40 60 80 100)

Method: Trial Pit

Date: 25/5/04

Hole Size: 4m x 1m

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Larne BT40 1DH

Datum: Ground Level

Checked by: JW

Sheet: 1 of 1

Project No: 386/04

Project: Taurbeg Wind Farm

Client: RES Group Ltd

Location: Turbine 10

Log of Trial Pit: TP8

Position Ref: E = 122914, N = 110925

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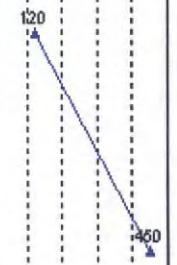
SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation	REMARKS
0		Ground Surface	0	
		PEAT Firm very dark brown PEAT.	-0.75	No services encountered No contamination observed Water seepage at 0.6m
		Brown Sandy CLAY	-0.92	
1		Firm, light brown homogeneous CLAY.	-1.08	No Schmidt Hammer test available due to depth of pit
		Blue - Grey CLAY Firm greenish blue - grey gravelly clay.		Sides liable to collapse below 1.0m
		Clayey GRAVEL Dense greenish - blue - grey sandy clayey angular coarse GRAVEL (Disintegrated MUDSTONE). Corestones present but no fabric. Weathering grade IV.		Sample taken at 1.5m Photo 17 - Pit Photo 18 - Spoil
2			-2.9	Water seepage at 2.90m
3		***Dark Grey SILTSTONE*** Dark grey partially discoloured to fresh fine grained SILTSTONE. Strong - very strong, weathering grade (I - II). No evidence of dipping strata. Rock fragments flaggy in nature (shaley in appearance).	-3.55	No standing water on completion.
4		End of Borehole		
5				

Penetrometer kN/m2 (100 – 300)

Vane Test kN/m2 (20 40 60 80 100)



Method: Trial Pit

Date: 25/5/04

Hole Size: 5m x 1m

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Datum: Ground Level

Checked by: JW

Sheet: 1 of 1

Project No: 386/04

Log of Trial Pit: TP9

Project: Taurbeg Wind Farm

Client: RES Group Ltd

Location: Turbine 11

Position Ref: E = 123006, N = 111237

SUBSURFACE PROFILE

Depth	Description	Elevation	REMARKS
0	Ground Surface	0	
	PEAT Dark brown firm spongy PEAT.	-1.05	No water struck No contamination observed No services encountered Becoming very difficult to excavate
1	***Light brown CLAY*** Light brown homogeneous CLAY.	-1.25	Sides collapsing below 1.2m depth
	Gravelly Sandy CLAY Greenish yellow dense fine sandy clayey angular GRAVEL (Completely decomposed SANDSTONE). Weathering grade IV.	-2.3	No obstructions enncountered Sample taken at 2.0m Photo 19 - Spoil Photo 20 - Pit
2	***Yellowish SANDSTONE*** Yellowish grey discoloured, thinly bedded (2 - 4 cm) fine to medium grained SANDSTONE, moderately weak.	-2.6	No standing water on completion Schmidt Hammer at 2.6m = 2 MPa
3	End of Borehole		
4			No rock encountered
5			

Penetrometer kN/m2 (100 – 300): 207

Vane Test kN/m2 (20 40 60 80 100)

Method: Trial Pit

Date: 25/5/04

Hole Size: 5m x 1.5m

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Datum: Ground Level

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Sheet: 1 of 1

Project No: 386/04

Project: Taurbeg Wind Farm

Client: RES Group Ltd

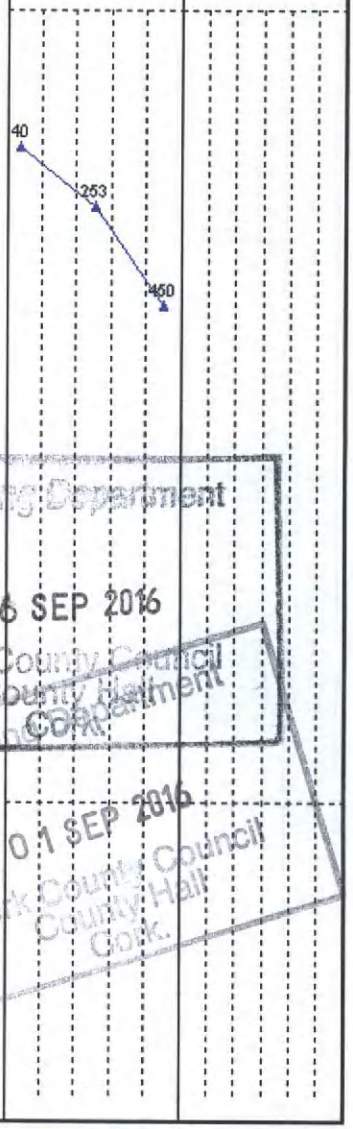
Location: Turbine 9

Log of Trial Pit: TP10

Position Ref: E = 122902, N = 111596

SUBSURFACE PROFILE

Depth	Description	Elevation	REMARKS
0	Ground Surface	0	
	PEAT Dark brown, spongy PEAT.	-0.65	No water struck
1	***Brown Sandy CLAY*** Soft to firm light brown homogeneous CLAY.	-0.9	No contamination observed No services encountered
	Sandy GRAVEL Medium dense greenish grey very clayey sandy GRAVEL (Decomposed SANDSTONE). Weathering grade IV-V.	-1.24	No Schmidt Hammer test available due to depth of pit Sides unstable Sample taken at 1.5m
2	***Yellow Brown GRAVEL*** Yellow brown medium dense to dense very sandy GRAVEL. (Disintegrated SANDSTONE). Corestones evident. Weathering grade IV.	-2.25	Photo 21 - Pit Photo 22 -Spoil
	Rose - Red SANDSTONE Rose - red highly discoloured, medium to fine grained flaggy SANDSTONE, moderately weak. Black staining.	-2.55	
3	End of Borehole		
4			
5			



Method: Trial Pit

Date: 25/5/04

Hole Size: 5m x 1m

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Larne BT40 1DH

Datum: Ground Level

Checked by: JW

Sheet: 1 of 1

Project No: 386/04

Project: Taurbeg Wind Farm

Client: RES Group Ltd

Location: Turbine 7

Log of Trial Pit: TP11

Position Ref: E = 122889, N = 112129

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SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation	REMARKS
0		Ground Surface	0	
		TOPSOIL Light brown, sandy TOPSOIL.	-0.6	No contamination observed
1		***PEAT*** Black firm PEAT.	-1.15	No services encountered No penetrometer results in gravel Water seepage at 1.20m
2		***Medium Dense GRAVEL*** Yellow mottled green, medium dense very sandy clayey coarse GRAVEL (Decomposed Sandstone). Weathering grade V.		Sides unstable Sample taken at 1.5m Water struck at 1.90m - small flow (c. 0.5 l/min) Photo 23 - Pit Photo 24 -Spoil
3			-3.2	No Schmidt Hammer test available due to depth of pit
		Grey SANDSTONE Greenish grey, highly discoloured flaggy, fine to medium grained thickly bedded SANDSTONE, moderately strong at base.	-3.6	No standing water on completion
4		End of Borehole		
5				

Penetrometer kN/m2 100 300

Vane Test kN/m2 20 40 60 80 100

60

Method: Trial Pit

Date: 25/5/04

Hole Size: 4m x 1m

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Datum: Ground Level

Checked by: JW

Sheet: 1 of 1

Project No: 386/04

Project: Taurbeg Wind Farm

Client: RES Group Ltd

Location: Turbine 6

Log of Trial Pit: TP12

Position Ref: E = 122626, N = 112212

SUBSURFACE PROFILE

Depth	Description	Elevation	REMARKS
0	Ground Surface	0	
	TOPSOIL Firm grey - brown sandy clay TOPSOIL	-0.42	No Water Struck
	Coarse SAND Mottled red - brown and greenish grey medium dense clayey very gravelly coarse SAND.	-0.86	No contamination observed No services encountered No Schmidt Hammer due to depth of pit.
1	**Coarse Grey GRAVEL** Medium dense to dense greenish grey sandy coarse GRAVEL with corestones of disintegrated sandstone. Weathering grade IV - V.	-1.3	
2	**Weathered SANDSTONE** Highly decomposed yellowish green flakey SANDSTONE, weak. Weathering grade III.	-2.04	Sides tend to collapse after 1.5m
	Thinly Bedded SANDSTONE Discouloured red and light yellow fine fine grained thinly bedded tabular SANDSTONE. Moderately strong. Occurring in red and light yellow thick beds dipping at c. 80 degrees to the north. Weathering grade II.	-2.85	Photo 25 - Base of pit Photo 26 - Spoil
3	End of Borehole		
4			
5			

Penetrometer kN/m2 (100, 300) — 100

Vane Test kN/m2 (20, 40, 60, 80, 100)

Method: Trial Pit

Date: 25/5/04

Hole Size: 4m x 1m

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Unit 2 Curran Business Park
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Datum: Ground Level

Checked by: JW

Sheet: 1 of 1

Borehole Logs

Project No: 386/04

Project: Taurbeg Wind Farm

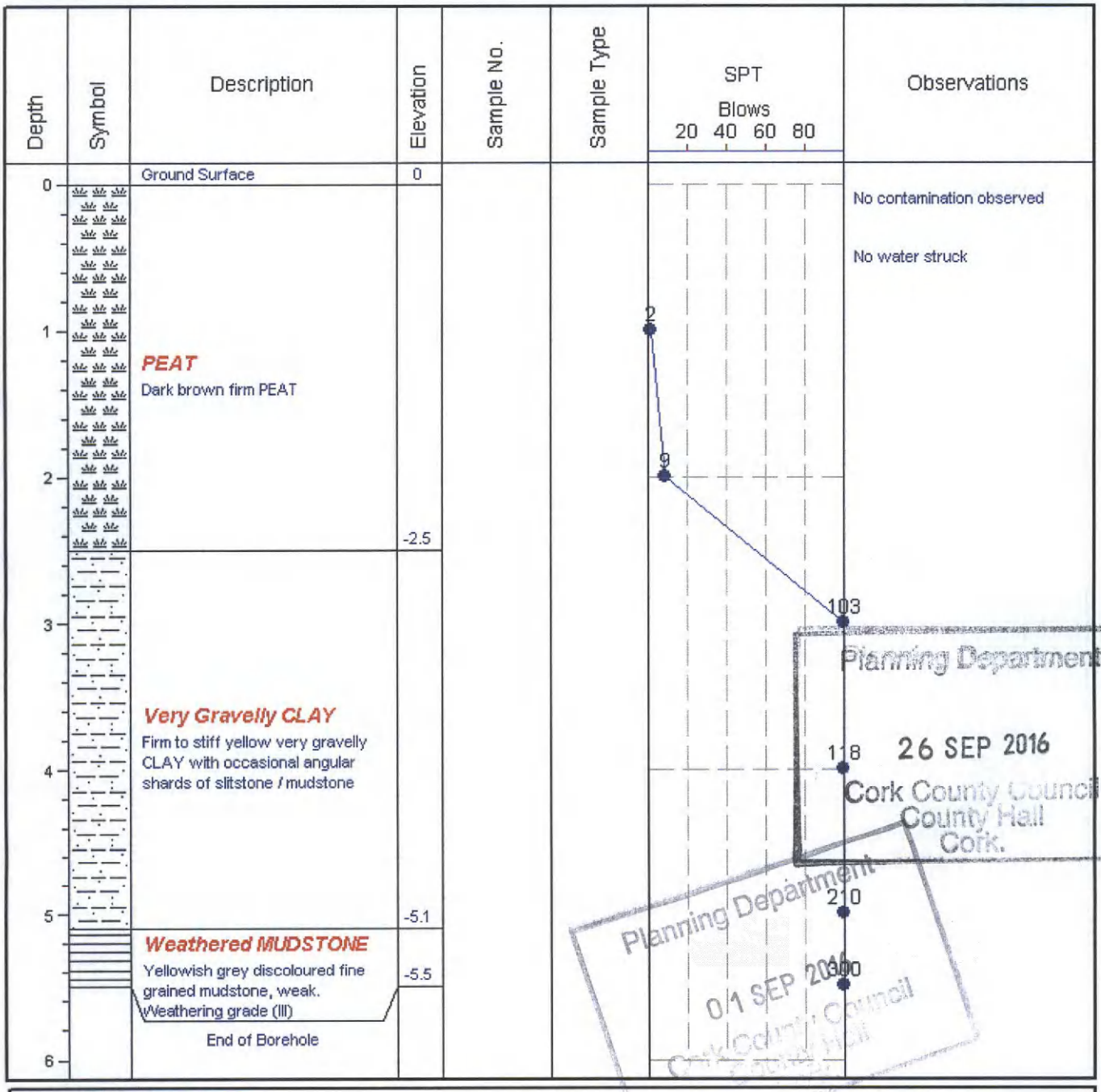
Client: RES Group Ltd

Location: Turbine T1

Borehole No: 1

Position: E = 122674, N = 111348

Engineer: RES Group Ltd



Bored By: ASAP Ltd

Bore Method: Dando Terrier

Bore Date: 12/06/04

Whiteford Geoservices
Unit 2 Curran Business Park
Larne
BT40 1DH

Hole Size: 110mm dia.

Datum: Below Ground Level

Sheet: 1 of 1

Project No: 386/04

Project: Taurbeg Wind Farm

Client: RES Group Ltd

Location: Turbine T12

Borehole No: 2

Position: E = 122464, N = 111545

Engineer: RES Group Ltd

Depth	Description	Elevation	Sample No.	Sample Type	SPT Blows (20 40 60 80)	Observations
0	Ground Surface	0				No contamination observed
	PEAT Dark brown firm PEAT	-1.1			5	No water struck
	Firm Gravelly CLAY Firm to stiff green sandy gravelly CLAY	-4			41, 156	
	Weathered SANDSTONE Yellow highly discoloured fine to medium grained sandstone, weak to moderately weak. Weathering grade (II - III)	-4.2			200, 300	
	End of Borehole					

Bored By: ASAP Ltd

Bore Method: Dando Terrier

Bore Date: 12/06/04

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Unit 2 Curran Business Park
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Hole Size: 110mm dia.

Datum: Below Ground Level

Sheet: 1 of 1

CBR In-Situ Test Results

CALIFORNIA BEARING RATIO LOG SHEET

PROJECT NAME: Taurbeg SI 386-04

OPERATOR: Al Burns

CBR TEST NUMBER	GPS Co-ordinates		IN-SITU CBR TEST RESULTS (%) Depth below peat layer			
	Easting	Northing	0	0.15	0.45	0.75
1	122988	112235	14/refusal			
2	122925	112106	14/refusal			
3	122815	112151	14/refusal			
4	122371	112097	1.5	14/refusal		
5	122632	112143	2	5	14/refusal	
6	122598	112225	14/refusal			
7	122653	112038	2	1.5	14/refusal	
8	122555	122018	2	7	14/refusal	
9	122310	112104	2.6	5	10/refusal	
10	122311	112204	2.5	14/refusal		
11	122226	111966	2.5	7	14/refusal	
12	122127	111950	14/refusal			
13	121989	111930	5	14/refusal		
14	122346	111908	5	12/refusal		
15	122466	111885	0.5	10/refusal		
16	122373	111812	4	12/refusal		
17	122292	111732	2	5	10/refusal	
18	122201	111692	2	14/refusal		
19	122134	111640	Peat too	deep to	take CBR	
20	122401	111716	3	10/refusal		
21	122499	111591	2	10/refusal		
22	122457	111524	2	4	10/refusal	
23	122486	111428	4	2	14/refusal	

CBR TEST NUMBER	GPS Co-ordinates		IN-SITU CBR TEST RESULTS (%) Depth below peat layer			
	Easting	Northing	0	0.15	0.45	0.75
24	122515	111332	3	2.5	10/refusal	
25	122574	111275	10/refusal			
26	122649	111340	2	10/refusal		
27	122739	111292	2	10/refusal		
28	122780	111200	1.5	10/refusal		
29	122819	111108	1	10/refusal		
30	122932	111116	3	10/refusal		
31	123012	111176	Peat too	deep to	take CBR	
32	123026	111263	Peat too	deep to	take CBR	
33	122875	111026	2	10	14/refusal	
34	122953	110910	1.5	10/refusal		
35	122726	111403	2	10/refusal		
36	122786	111483	2	10/refusal		
37	122837	11568	10/refusal			
38	122916	111575	2	10/refusal		
39	122931	111721	14/refusal			
40	122982	111811	14/refusal			
41	122987	111919	14/refusal			
42	123044	112013	14/refusal			
43	123052	112105	14/refusal			
44	123088	112152	14/refusal			
45	122697	111343	1.5	14/refusal		
46	122446	111904	1.5	14/refusal		
47	122013	111913	1.5	14/refusal		
48	122292	112185	2	8	14/refusal	
49	122621	112211	2.5	3	14/refusal	

CBR TEST NUMBER	GPS Co-ordinates		IN-SITU CBR TEST RESULTS (%) Depth below peat layer			
	Easting	Northing	0	0.15	0.45	0.75
50	122902	112120	2	14/refusal		