SOLAR 21 RENEWABLE ENERGY LIMITED

EFW PLANT,
STATHER ROAD, FLIXBOROUGH, SCUNTHORPE DN15 8SE

REPORT ON GROUND INVESTIGATION

Contract: 31554

Date: October 2018

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REPORT ON GROUND INVESTIGATION

Carried out at

EFW PLANT,

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Prepared for

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EXECUTIVE SUMMARY

It is understood that the investigation is to determine the suitability or otherwise of the proposed site for the construction of a power plant.

On the instructions of Solar 21 Renewable Energy Limited, an investigation was undertaken to determine ground conditions to enable foundation and earthworks design to be carried out, together with a contamination risk assessment and a review of gas emissions.

The site is situated on an industrial estate 1.2km to the west of Flixborough off Stather Road which is 4.5km to the northwest of Scunthorpe town centre and may be located by National Grid Reference 486925, 414906.

The geological map indicates the site to be underlain by superficial deposits of Alluvium, some of which is suggested to be of estuarine origin and was indicated to consist of clay, silt, sand and gravel.

The superficial deposits formed up to 2 million years ago in the Quaternary Period and are underlain by Mercia Mudstone Group consisting of a mudstone sedimentary bedrock formed approximately 201 to 252 million years ago in the Triassic Period.

The site work was carried out between 21st August and 3rd September 2018 and consisted of six boreholes, designated BH1 to BH6, sunk by light cable percussion methods. Boreholes BH2, 3, 4 and 6 were extended from rock-head levels to the terminal depth of 30.0mbgl by rotary coring methods using air/mist drilling techniques to obtain PW sized strata core.

The ground conditions encountered on the site was principally a thin covering of Made Ground overlying alluvial deposits of soft laminated clay, organic clay and peat onto a gravelly sand.

The alluvial deposits overlay the Mercia Mudstone which appeared to be initially weathered to a gravelly clay with bedrock found at 20.10 to 22.60mbgl.

Groundwater was encountered at 11.70/12.3mbgl rising to 6.3/ 6.7mbgl due to the nearby influence of the River Trent.

On the basis of observations made on site together with results of in-situ and laboratory tests, together with empirical correlations, consideration could be given to the adoption of deep foundations to support the proposed structures and a piled foundation is to be considered.

It is suggested that the alluvial soils would not provide adequate support for piling and due to the weak nature of these soils they could impart negative shaft adhesion and skin friction to the piles, which would increase the load on the piles.

It is suggested that all piling be taken into the Mercia Mudstone formation where rock sockets should be formed to provide adequate strength, predominantly in end bearing.

It should be noted that groundwater was present, which could affect the installation of

the piles.

A sample of organic clay indicated a water soluble sulphate content of 3450mg/l suggesting a DS4 classification and also indicate that pyrite is present and may be oxidised to sulphate where the ground is disturbed. The total potential sulphate gives a value greater than DS5 classification.

It is suggested that precautions should be taken when piles are sunk through organic clays and peat deposits and a lined pile should be considered an option, which would also reduce the risk of negative skin friction through the alluvial deposits.

The results of the soil analyses have initially been compared to Suitable 4 Use Levels (S4ULs), determined by LQM and CIEH, or CLEA SGVs published in Environment Agency Science Reports SC050021/SR3, and SC050021 and DEFRA C4SL (Category 4 Screening Levels) for lead, in accordance with current legislation and guidance.

Those contaminants with observed concentrations above the GAC are detailed below:

Location	Depth (m)	Contaminant	Concentration (mg/kg)	Guidance Level (mg/kg)
BH2	0.50	Nickel	1200	980

Where the concentration of any contaminant is above guidance values, the 'mean value test' is applied to the results giving the upper 95th percentile bound (UCL) of the sample. This upper bound indicates whether any high concentrations represent a significant possibility of harm to human health. The result is tabulated below:

Contaminant	Value of UCL (mg/kg)	Guidance Value (mg/kg)	Comments
Nickel	658	980	Risk within acceptable limits for proposed use

The results of the mean value tests determined that the elevated contaminant is unlikely to present a significant risk to human health in relation to the proposed site end use and requires no further consideration.

The site can be considered uncontaminated for the proposed industrial usage.

The presence of organic clays and peat beneath the site is the potential source of ground gas and it can be seen that the Gas Screening Values (GSV) are reducing over the time since the standpipe installations.

From monitoring of the standpipes, the GSV calculated for carbon dioxide ranged from 0.07 to 3.9 litres/hour. The GSV calculated for methane is between 2.58 and 53.7 litres/hour.

The recent monitoring would suggest a reduction from an initial readings giving Characteristic Situation 5 (Appendix 7, Table A7.2) to recent readings giving a Characteristic Situation 3.

For Situation A, being any development other than low rise residential with suspended floor slab and ventilated void, gas protective measures are given in Appendix 7. These protection requirements are outlined and these should be included in the building design.

These comments are based on three sets of readings over a period of three weeks at high atmospheric pressure (>1000mb), which does not follow the recommended guidelines, it is recommended that a continued programme of monitoring be carried out to comply more closely with these guidelines before final design is undertaken, the results of which will be issued as an addendum to this report. A further monitoring visits are scheduled.

CONTENTS

1.0 INTRODUCTION

1.1 It is understood that the investigation is to determine the suitability or otherwise of the proposed site for the construction of a power plant.

1.2 On the instructions of Solar 21 Renewable Energy Limited, an investigation was undertaken to determine ground conditions to enable foundation and earthworks design to be carried out, together with a contamination risk assessment and a review of gas emissions.

1.3 A Desk Study/ Preliminary Investigation, was not a requirement of this investigation.

1.4 It is recommended that a copy of this report be submitted to the relevant authorities to enable them to carry out their own site assessments and provide any comments.

1.5 This report has been prepared for the sole use of the Client for the purpose described and no extended duty of care to any third party is implied or offered. Third parties using any information contained within this report do so at their own risk.

1.6 The comments given in this report and the opinions expressed herein are based on the information received, the conditions encountered during site works, and on the results of tests made in the field and laboratory. However, there may be conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report.

1.7 The comments on groundwater conditions are based on observations made at the time the site work was carried out. It should be noted that groundwater levels vary owing to seasonal or other effects.

2.0 SITE SETTING

2.1 Site Location

2.1.1 The site is situated on an industrial estate 1.2km to the west of Flixborough off Stather Road which is 4.5km to the northwest of Scunthorpe town centre and may be located by National Grid Reference 486925, 414906.

2.1.2 The site is situated on the eastern banks of the River Trent and has wharfing and rail facilities.

2.1.3 A site location plan is included in Appendix 1, Figure A1.1.

2.2 Geological Setting

2.2.1 Details of the geology underlying the site have been obtained from the British Geological Survey map, Sheet No. 80, 'Kingston upon Hull', solid and drift editions, 1:50,000 scale, published 1983.

2.2.2 The geological map indicates the site to be underlain by superficial deposits of Alluvium, some of which is suggested to be of estuarine origin and was indicated to consist of clay, silt, sand and gravel.

2.2.3 Close to and on the inside of the bends in the river, Tidal Flat Deposits can be found consisting of clay and silt.

2.2.4 The superficial deposits formed up to two million years ago in the Quaternary Period and are underlain by Mercia Mudstone Group consisting of a mudstone sedimentary bedrock formed approximately 201 to 252 million years ago in the Triassic Period.

3.0 SITE WORK

3.1 The site work was carried out between 21st August and 3rd September 2018 with the borehole locations determined by the client and the site work carried out on the basis of the practices set out in BS 10175:2011+A2:2017, ref. 9.2, BS 5930: 2015, ref. 9.3, and ISO 1997:2007, ref. 9.4.

3.2 Six boreholes, designated BH1 to BH6, were sunk by light cable percussion methods, at the positions shown on the site plan, Appendix 1, Figure A1.2.

3.3 Borehole BH1 was terminated on an obstruction at 1.4mbgl in the Made Ground after three locations were attempted. All the other boreholes were extended to 30.0mbgl.

3.4 Boreholes BH2, 3, 4 and 6 were extended from rock-head levels of between 20.9 to 22.6mbgl to the terminal depth of 30.0mbgl by rotary coring methods using air/mist drilling techniques to obtain PW sized strata core.

3.5 The depths of boreholes, descriptions of strata encountered and comments on groundwater conditions are given in the borehole records, in Appendix 2.

3.6 Photographs of the rock core are also given in Appendix 2.

3.7 Representative disturbed and undisturbed samples were taken at the depths shown on the borehole records and were dispatched to the laboratory for examination and testing. Samples for environmental purposes were collected in amber glass jars.

3.8 Standard (split-barrel and cone) penetration tests, refs. 9.6 and 9.5, were carried out in the boreholes in the various strata to assess the relative density or consistency. The values of penetration resistance are given in the borehole records.

3.9 Monitoring installations protected by a stopcock cover were installed in boreholes BH3 and BH6, as detailed together with a visual representation of the standpipes in the relevant borehole records.

3.10 Groundwater and ground gas monitoring visits were undertaken on three occasions on the 28th September, 9th and 16th October 2018, records of which are presented in Appendix 2.

3.11 The ground levels at the borehole locations were not determined.

4.0 LABORATORY TESTS

4.1 Geotechnical Testing Soil

4.1.1 Geotechnical soil analysis was undertaken of samples obtained during the investigation as follows:

- 12 No. Water Content Tests
- 12 No. Plasticity Index Tests
- 3 No. Particle Size Distributions (by Wet Sieving)
- 6 No. Quick Undrained Single/Multi-stage Triaxial Tests

4.1.2 The laboratory test report is given in Appendix 3, Test Report 31554/1

4.2 Geotechnical Testing Rock

4.2.1 Geotechnical analysis was undertaken of samples of rock core obtained during the investigation as follows:

- 2 No. Water Content Tests
- 2 No. Bulk Density Tests
- 2 No. Uniaxial Compression Tests
- 9 No. Point Load Index Tests

4.2.2 The laboratory test report is given in Appendix 3, Test Report 31554R/1

4.3 Chemical Testing

4.3.1 The suite of chemical analyses has been based upon any on-site observations, to investigate the potential sources of contamination. The chemical analyses were carried out on ten soil samples, one groundwater sample. Leachate analysis was also conducted on four selected samples. The nature of the analyses is detailed below:

- **Metals** - arsenic, cadmium, chromium (hexavalent), chromium (total), copper, lead, mercury, nickel, selenium and zinc.
- **Inorganics** – pH, cyanide (total), soil organic matter
- **Organics -** petroleum hydrocarbons – EPH basic carbon banded analysis, polycyclic aromatic hydrocarbons (PAH) – USEPA 16 suite,
- **Others –** Asbestos fibres in soil, Sulphate Contents (Water and Acid Soluble) and Total Sulphur

4.3.2 The results of these tests are presented in Appendix 4, Certificate of Analysis 18/07080, 18/07187, 18/07299, and 18/07300.

5.0 GROUND CONDITIONS ENCOUNTERED

5.1 Sequence

5.1.1 The sequence of the strata encountered during the investigation generally confirms the anticipated geology as interpreted from the geological map.

5.1.2 Interpolation of strata depths between locations should be undertaken with caution, particularly for depths of Made Ground where structures are still present at the time of the investigation.

5.1.3 The sequence and indicative thicknesses of strata are provided below:

Strata Encountered	Depth Encountered (m bgl)		Strata Thickness (m)
	From	To	
Made Ground	0.00	0.60 to 2.10	0.60 to 2.10
Light brown sandy gravelly Clay	0.60 to 1.40	1.0 to 2.0	0.40 to 1.25
Laminated light brown sandy Clay	1.0 to 2.0	1.85 to 3.20	0.85 to 1.70
Laminated organic light grey brown sandy Clay	1.85 to 3.20	4.70 to 6.70	2.85 to 4.60
Laminated brown sandy Clay with peat	6.20 to 6.70	12.20 to 12.50	5.80 to 6.0
Peat	4.70 to 6.70	11.70 to 12.30	5.60 to 7.0
Gravelly Sand	11.70 to 12.50	17.10 to 19.40	4.90 to 7.10
Brown sandy gravelly clay	17.20	18.50	1.30
Red brown sandy gravelly Clay	17.10 to 19.40	20.10 to 22.60	1.80 to 4.20
Mercia Mudstone	20.10 to 22.60	30.0 to 30.10	7.40 to 9.90

5.2 Made Ground

5.2.1 Made Ground was encountered in all boreholes to a maximum thickness of 2.10m and consisted of a gravelly sand/ sandy gravel with brick, concrete, slag, sandstone and mudstone content.

5.2.2 In borehole BH4 a sandy gravelly clay with similar inclusions was encountered between 0.6 and 1.4mbgl.

5.3 Alluvial Deposits

5.3.1 The alluvial deposits consisted of soft laminated sandy clays often found to contain peat fibres and occasionally organic.

5.3.2 These upper laminated clays were underlain in boreholes BH3, 4 and 6 by a peat deposit at depths of between 4.70 to 6.70mbgl extending to depths of between 11.70 to 12.30mbgl.

5.3.3 The peat and organic clays were underlain by a gravelly sand deposit at 11.70 to 12.50mbgl and for a thickness of between 4.90 to 7.10m.

5.4 Weathered Mudstone

5.4.1 Weathered Mercia Mudstone was encountered at 17.10 to 19.40mbgl generally as a red brown sandy gravelly clay.

5.5 Mudstone

5.5.1 Mercia Mudstone bedrock was encountered in all boreholes (except BH1) at depths of between 20.10 to 22.60mbgl and was proven by rotary coring to circa 30.0mbgl.

5.6 Groundwater

5.6.1 Groundwater was encountered in the following boreholes and depths.

Groundwater Occurrence		
Borehole No	**Strike Depth metre**	**after 20minutes rest metre**
BH3	12.30	6.80
BH4	12.30	6.70
BH6	11.70	6.30

5.6.1 On return visits to monitor the standpipes groundwater rest levels were recorded between 1.65 and 2.08mbgl.

6.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO THE PROPOSED DEVELOPMENT

6.1 Structural Details

6.1.1 It is understood that the proposed development is to consist of an EFW plant, precise structural details were not available at the time of preparation of this report.

6.2 Assessment of Soil Condition

6.3 General

6.3.1 The ground conditions encountered on the site was principally a thin covering of Made Ground overlying alluvial deposits of soft laminated clay, organic clay and peat onto a gravelly sand.

6.3.2 The alluvial deposits overlay the Mercia Mudstone which appeared to be initially weathered to a gravelly clay with bedrock found at 20.10 to 22.60mbgl.

6.3.3 Ground water was encountered at 11.70/ 12.3mbgl rising to 6.3/ 6.7mbgl due to the nearby influence of the River Trent.

6.4 Alluvial Deposits

Cohesive

6.4.1 The plastic index test results are presented on the plasticity classification chart, Appendix 3, Figure A3.1.

- *Alluvial Clays*

6.4.2 The alluvial clays were found to be of an intermediate to high plasticity with plasticity index values of between 14 and 32% averaging 23%.

6.4.3 Consistency index determinations (w_L-w/PI) were between 0.58 and 1.21 averaging 0.83 suggesting the stratum to be generally firm consistency.

6.4.4 Unconsolidated un-drained triaxial compression tests, undertaken on 'undisturbed' (Class B) samples suggest c_u values of 29, 31 and 54kPa.

- *Organic Clays*

6.4.5 Laboratory testing indicated a high plasticity with a plasticity index value of 33%.

6.4.6 Consistency index determination was 0.53 suggesting the stratum to be generally soft/ firm consistency.

6.4.7 Unconsolidated un-drained triaxial compression tests, undertaken on 'undisturbed' (Class B) samples suggest c_u values of 35 and 59kPa.

- *Peat*

6.4.8 Samples of peat were found to be of a high and very high plasticity with classifications of MH and MV with plasticity index values of 30 and 44%.

6.4.9 Moisture contents were found to be above the liquid limit with values of 79.5 and 176%.

6.4.10 Unconsolidated un-drained triaxial compression tests, undertaken on 'undisturbed' (Class B) samples indicated a c_u value of 30kPa.

Granular

6.4.11 Participle size distributions undertaken on bulk samples taken from the boreholes indicated a slightly silty fine to medium grained sand with gravel content of 1 and 2%, sand content of between 94 and 95% and silt/clay content of 5 and 6%.

6.4.12 SPT's were undertaken and where full penetration was achieved, recorded relative densities of loose to medium dense.

6.5 Weathered Mudstone

6.5.1 The alluvial deposits were underlain by a weathered Mercia Mudstone presented as a firm red brown sandy gravelly clay.

6.5.2 This clays were found to be of an intermediate plasticity with plasticity index values of between 13 and 15% averaging 14%.

6.5.3 Consistency index determinations (w_L-w/PI) were between 0.77 and 1.23 averaging 1.07 suggesting the stratum to be generally firm and stiff consistency.

6.6 Mercia Mudstone Bedrock

6.6.1 Mercia Mudstone bedrock was encountered at depths of between 20.10 to 22.60mbgl and was proven by rotary coring to circa 30.0mbgl.

6.6.2 Uniaxial compression testing indicated compressive strengths of 0.4 and 0.7MPa.

6.6.3 Point load testing have suggested compressive strengths of between 0.48 and 5.76MPa with an average value of 1.84MPa, which might indicate predominately a very weak rock strength; BS5930 amendment 2, ref. 9.3.

6.7 Foundation Options

6.7.1 On the basis of observations made on site together with results of in-situ and laboratory tests, together with empirical correlations, consideration could be given to the adoption of deep foundations to support the proposed structures.

6.7.2 It may be considered that for foundations over a certain depth it may be more economical to adopt piles. Guidelines for the design of piles are given in Appendix 5.

6.7.3 It is suggested that the alluvial soils would not provide adequate support for piling and due to the weak nature of these soils they could impart negative shaft adhesion and skin friction to the piles, which would increase the load on the piles.

6.7.4 It is suggested that all piling be taken into the Mercia Mudstone formation where rock sockets should be formed to provide adequate strength, predominantly in end bearing.

6.7.5 The carrying capacity of piles depends not only on their size and the ground conditions but also on their method of installation. Pile design and installation are continuously evolving processes and state-of-the-art techniques are often employed before they reach the public domain, perhaps several years down the line. Therefore, it is recommended that specialist Piling Contractors be contacted as to the suitability and carrying capacity of their piles in the ground conditions pertaining to the site.

6.7.6 It should be noted that groundwater was present, which could affect the installation of the piles.

6.8 Excavations

6.8.1 On the basis of observations on site together with the results of in-situ and laboratory tests, it is considered that excavations to less than 1.20m would not stand unsupported in the short term.

6.8.2 Side support for safety purposes should of course be provided to all excavations which appear unstable, and those in excess of 1.20m deep, in accordance with Health and Safety Regulations, ref. 9.13.

6.8.3 Groundwater should not be expected in shallow excavations for services. However, it is possible that perched groundwater could be present in the Made Ground overlying the alluvial deposits. It is considered that this could be dealt with by the use of a small pump.

6.8.4 The close proximity of the River Trent will suggest that deep excavations could be affected by ground water inflow.

6.8.5 Groundwater could be expected in excavations taken to depths in excess of 6.0mbgl.

6.9 Road and Hard Standing Design

6.9.1 The structural design of a road or hard standing is based on the strength of the subgrade, which is assessed on the California Bearing Ratio, CBR, scale from which the subgrade surface modulus can be estimated.

6.9.2 In practice, the correlation given by the Highways Agency, ref. 9.14, is usually more appropriate than direct determination of the CBR.

6.9.3 The process of design given in the guidance notes requires an estimate of CBR and subgrade stiffness modulus to be made at the design stage and in-situ measurement prior to construction.

6.9.4 On the basis of laboratory classification tests it is recommended that for formation prepared in the alluvial clay, with a characteristic plastic index value of between 23 to 27%, a subgrade CBR value of 3% be adopted for design purposes.

6.9.5 The assessment assumes there to be a high water table, poor construction conditions and a thin pavement construction.

6.9.6 Any areas of soft or deleterious material in the Made Ground should be excavated and replaced with a properly compacted granular fill.

6.9.7 For routine cases, all material within 450mm of the road surface should be non frost-susceptible.

6.10 Chemical Attack on Buried Concrete

6.10.1 The site has been classified in accordance with BRE Special Digest 1, ref. 9.15, as natural ground without the presence of pyrite and laboratory testing undertaken accordingly. It is recommended that the guidelines given in BRE Special Digest 1, ref. 9.15, be adopted.

6.10.2 The non-pyritic soil samples tested included Made Ground, Alluvial Clays, Weathered Mercia Mudstone and ground water

6.10.3 The results of chemical tests in the non-pyritic soils indicate a sulphate concentration in the soil of between 41mg/l and 418mg/l as a 2:1 water/soil extract, with pH values in the range of 7.41 to 12.63.

6.10.4 It is recommended that for conventional shallow foundations the groundwater should be regarded as mobile.

6.10.5 A sample of organic clay from BH5 at 7.5mbgl indicated a water soluble sulphate content of 3450mg/l suggesting a DS4 classification. The values for Oxidisable Sulphate (OS) was 18% (greater than 0.30%) which would indicate that pyrite is present and may be oxidised to sulphate where the ground is disturbed. The total potential sulphate of 19.5 would give a value greater than DS5 classification.

6.10.6 It is suggested that precautions should be taken when piles are sunk through organic clays and peat deposits and a lined pile should be considered an option, which would also reduce the risk of negative skin friction through the alluvial deposits.

7.0 ENVIRONMENTAL RISK ASSESSMENT IN RELATION TO PROPOSED DEVELOPMENT

7.1 Contaminated Land

7.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref. 9.16, which was introduced by the Environment Act 1995, ref. 9.17, as;

7.1.2 'Land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

- significant harm is being caused or there is a significant possibility of such harm being caused; or
- significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused.'

7.2 Risk Assessment

7.2.1 The definition of contaminated land is based on the principles of risk assessment. Risk is defined as a combination of:

- The probability, or frequency of exposure to a substance with the potential to cause harm, and:
- The seriousness of the consequence.

7.3 Pollutant Linkage

7.3.1 The basis of an environmental risk assessment involves identifying a 'source' of contamination, a 'pathway' along which the contamination may migrate and a 'receptor' at risk from the contamination.

7.3.2 Current legislation defines the various elements of the pollution linkage as:

- A contaminant is a substance, which is in or under the ground and which has the potential to cause harm or to cause pollution of controlled waters.
- A pathway is one or more routes through which a receptor is being exposed to, or affected by, a contaminant, or could be so affected.
- A receptor is either a living organism, an ecological system, a piece of land or property, or controlled water.

7.3.3 A pollutant linkage indicates that all three elements have been identified. The site can only be defined as 'Contaminated Land' if a pollutant linkage exists and the contamination meets the criteria in Section 7.1 above.

7.3.4 The guidance proposes a four-stage approach for the assessment of contamination and the associated risks. The four stages are listed below:

- Hazard Identification
- Hazard Assessment
- Risk Assessment
- Risk Evaluation

7.3.5 The hazard identification and hazard assessment is based upon a Preliminary Investigation which was not a requirement of this investigation. The risk assessment and evaluation stages are presented in this phase 2 interpretive report, after an intrusive ground investigation has taken place.

7.4 Risk Assessment – Human Health

7.4.1 The proposed development consists of an EFW Plant. The risk assessment has therefore been based on guidelines for an

7.4.2 industrial end use. Should the proposed development be changed in the future then further risk assessment may be required, particularly should a more sensitive end-use be envisaged.

7.4.3 The results of the soil analyses have initially been compared to Suitable 4 Use Levels (S4ULs), determined by LQM and CIEH, ref. 9.20, or CLEA SGVs published in Environment Agency Science Reports SC050021/SR3, ref. 9.18, and SC050021, ref. 9.19, , and DEFRA C4SL (Category 4 Screening Levels) for lead, ref 9.22, in accordance with current legislation and guidance, as detailed in Appendix 6.

7.4.4 The Generic Assessment Criteria (GAC) used within this contamination assessment have been tabulated and are detailed within Appendix 6.

7.4.5 The results of chemical analyses have been processed in accordance with recommendations set out in the CIEH and CL:AIRE document 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref. 9.23. Where the concentrations determined on site are at or below the respective Generic Assessment Criteria, they are considered not to pose a risk and are removed from further consideration, unless otherwise stated.

7.4.6 Those contaminants with observed concentrations above the GAC are detailed below:

Location	Depth (m)	Contaminant	Concentration (mg/kg)	Guidance Level (mg/kg)
BH2	0.50	Nickel	1200	980

7.4.7 Where the concentration of any contaminant is above the GAC, further statistical analysis of the results has been conducted in accordance with the

CIEH and CL:AIRE guidance. The 'mean value test' was applied to the results of those contaminants which exceeded their relevant GAC. Applying the mean value test to the results gives the upper 95th percentile bound (UCL) of the samples. This upper bound indicates whether any high concentrations represent a significant possibility of harm to human health.

7.4.8 The result from the calculations from the mean value tests is tabulated below:

Contaminant	Value of UCL (mg/kg)	Guidance Value (mg/kg)	Comments
Nickel	658	980	Risk within acceptable limits for proposed use

7.4.9 The results of the mean value tests determined that the elevated contaminant is unlikely to present a significant risk to human health in relation to the proposed site end use and requires no further consideration.

7.4.10 The site can be considered uncontaminated for the proposed industrial usage.

7.5 Risk Assessment - Asbestos

7.5.1 Asbestos including Asbestos Containing Soils (ACS) only presents a risk to health if fibres are released into the air. It is generally assumed that only near surface ACS would contribute airborne fibres. However, in instances where gardens are proposed, then there is a risk that ACS could be exposed to the atmosphere through the action of digging.

7.5.2 Although no assessment criteria (AC) has been proposed in the new CIRIA C733, ref.: 9.27, Ian Farmer Associates have adopted the view that if asbestos is identified within soil then further sampling and testing will be required; specifically to quantify the amount and type of asbestos present. This information should then be used in Detailed Quantitative Risk Assessment (DQRA) as outline in CIRIA C733.

7.5.3 None of the samples at this site contained asbestos

7.6 Risk Assessment - Controlled Waters

7.6.1 The site is located adjacent to the River Trent

7.6.2 The leachate results have been screened against the Water Supply (Water Quality) Regulations 2000, ref. 9.28, and he *freshwater* Environmental Quality Standards (EQS), ref. 9.30.

7.6.3 The guidance levels used within the controlled waters assessment have been tabulated and are detailed within Appendix 6.

7.6.4 A sample of Made Ground from BH4 at 1.0mbgl indicated leachable values for arsenic, copper and lead above the water supply regulations but the content of these metals in the soil from this sample was low and below residential with gardens usage. In light of this the risk to the River Trent is considered to be a low risk.

7.6.5 It is recommended that the Environment Agency be consulted with regard to the significance of these results, within the Water Supply Regulations 2000.

7.6.6 Given the ground conditions encountered at the site and the results of this contamination assessment, it is considered unlikely that further assessment of the risks to controlled waters will be required.

7.7 Gas Generation

7.7.1 Gas monitoring visits were undertaken on three occasions on the 28th September, 9th and 16th October 2018. The results of the gas monitoring are included within Appendix 2.

7.7.2 The presence of organic clays and peat beneath the site is the potential source of ground gas and it can be seen that the Gas Screening Values are reducing over time since the standpipe installations.

7.7.3 In accordance with the methodology published in CIRIA Document C665, ref. 9.44, the maximum recorded values were taken to calculate a Gas Screening Value for the site.

7.7.4 Methane concentrations of between 89.1 and 92.9% by volume were recorded during the various monitoring phases together with carbon dioxide concentrations of between 17.4 and 19.1%v/v. Variable oxygen concentrations were recorded mostly depleted 1 and 14%.

7.7.5 Flow rates were recorded over a three minute period during the various return monitoring visits. The maximum of the three minute average flows was recorded at between 1.2 and 57.8 litres/hour.

7.7.6 The GSV calculated for carbon dioxide ranged from 0.07 to 3.9 litres/hour. The GSV calculated for methane is between 2.58 and 53.7 litres/hour.

7.7.7 The recent monitoring would suggest would suggest a reduction from an initial readings giving Characteristic Situation 5 (Appendix 7, Table A7.2) to recent readings giving a Characteristic Situation 3.

7.7.8 For Situation A, being any development other than low rise residential with suspended floor slab and ventilated void, gas protective measures are given in Appendix 7, sections A7.7 and A7.10.

7.7.9 The protection requirements are outlined and these should be included in the building design.

7.7.10 These comments are based on three sets of readings over a period of three weeks at high atmospheric pressure (>1000mb), which does not follow the recommended guidelines given in Appendix 7, Table A7.1.

7.7.11 However, these values were elevated and varied over the period of monitoring and therefore, it is recommended that a continued programme of monitoring be carried out to comply more closely with these guidelines before final design

is undertaken, the results of which will be issued as an addendum to this report.

7.7.12 It is recommended that the Local Authority are consulted regarding these gas protection measures for their approval prior to commencing construction.

7.8 Protection Of Services

7.8.1 Due to the increasing number of developments being undertaken on potentially contaminated land, the Water Supply Industry has identified the need to protect newly laid water supply pipes. They are likely to impose constraints on the nature of water supply pipes that are to be laid in contaminated land. Current guidance on the selection of materials for water pipes is provided by the UK Water Industry Research Limited, ref. 9.31, though some water supply companies may continue to refer to the previous guidance provided by Water Regulations Advisory Scheme, ref. 9.32, and should be consulted for confirmation.

8.0 MANAGEMENT OF CONTAMINATION

8.1 Remediation and Verification

8.1.1 The risk management framework set out in the Model Procedures for the Management of Land Contamination, CLR 11, ref. 9.33, is applicable to the redevelopment of sites that may be affected by contamination.

8.1.2 The risk management process set out in the Model Procedures has three main components:

- Risk assessment
- Options appraisal
- Implementation

8.1.3 This initial risk assessment has not identified the presence of elevated contaminant within the Made Ground and natural stratum across the site and therefore the site can be considered to be uncontaminated with respect to the proposed industrial usage.

8.2 Management of Unidentified Sources of Contamination

8.2.1 There is the possibility that sources of contamination may be present on the site, which were not detected during the investigation. Should such contamination be identified or suspected during the site clearance or ground works, these should be dealt with accordingly. A number of options are available for handling this material, which include:

- The removal from site and disposal to a suitably licensed tip of all material suspected of being contaminated. The material would need to be classified prior to disposal.
- Short-term storage of the suspected material while undertaking verification testing for potential contamination. The storage area should be a contained area to ensure that contamination does not migrate and affect other areas of the site. Depending upon the amounts of material under consideration, this could be either a skip or a lined area.
- Having a suitably experienced environmental engineer either on-call or with a watching brief for the visual and olfactory assessment of the material, and sampling for verification purposes.

8.3 Consultation

8.3.1 During the development of a site, consultation may be required for a number of reasons with a number of regulatory Authorities. The following provides an indication as to the most likely Authorities with which consultation may be required.

- **Local Authority.** There may be a planning condition regarding contamination and consultation will be required with a designated Contaminated Land Officer within the Environmental Health Department. The Local Authority is generally concerned with human health risks. Some Authorities now require 'Completion Certificates' to be signed off following remediation works.

- **Environment Agency.** Where a site is situated above an aquifer, within a groundwater protection zone or has been designated as a special site, the Environment Agency is likely to be involved to ensure that controlled waters are protected.

8.3.2 Based on the results of any consultation, there may be specific remediation requirements imposed by one or more of the Authorities.

8.4 Risk Management During Site Works

8.4.1 During ground works, some simple measures may have to be put in place to mitigate the risk of any known or previously unidentified contamination affecting the site workers and the environs. The majority of the proposed measures represent good practice for the construction industry and include:

- Informing the site workers of the contamination on site and the potential health effects from exposure.

- Where appropriate, the provision of suitable Personal Protective Equipment (PPE) for workers who may be potentially impacted by working in areas of the contamination.

- Ensuring good hygiene is enforced on site and washing facilities are maintained on the site. Workers are discouraged from smoking, eating or drinking without washing their hands first.

- Dust monitoring, and if necessary, suppression measures should be put into practice where contamination is becoming airborne.

- Site drainage should be prevented from entering any adjacent watercourse, ref. 9.34.

8.4.2 Where contaminated materials are being removed from the site they should be disposed of at a suitably licensed landfill, with a 'duty of care' system in place and maintained throughout the disposal operations.

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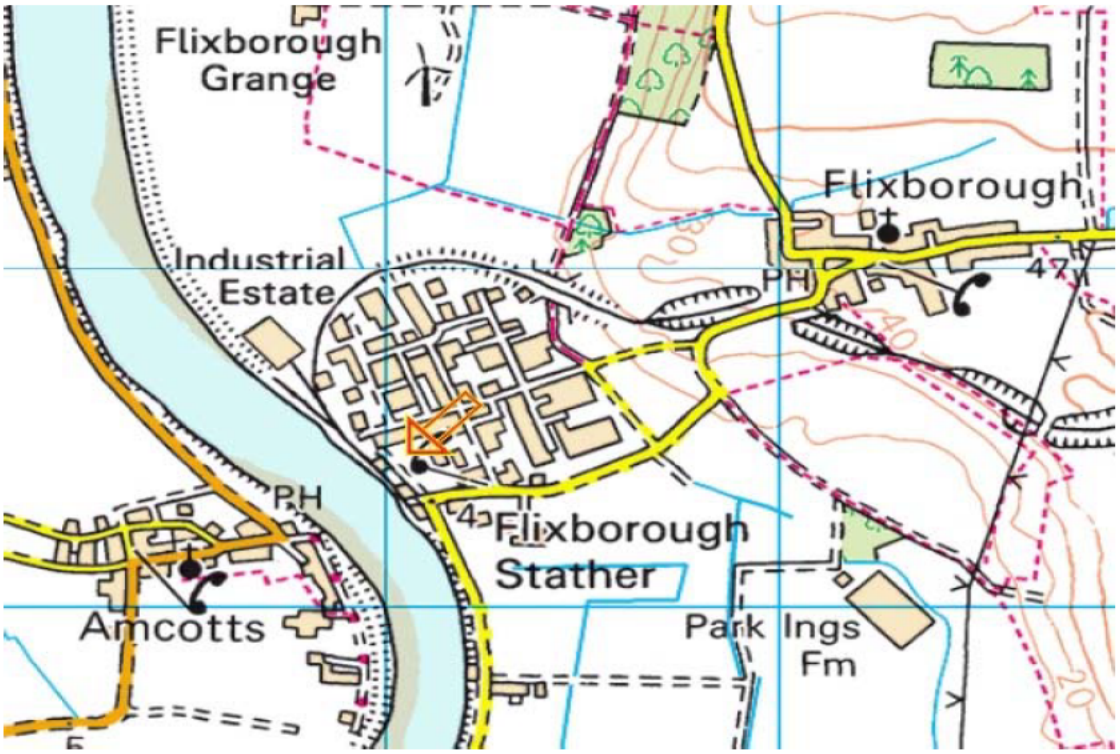
APPENDIX 1

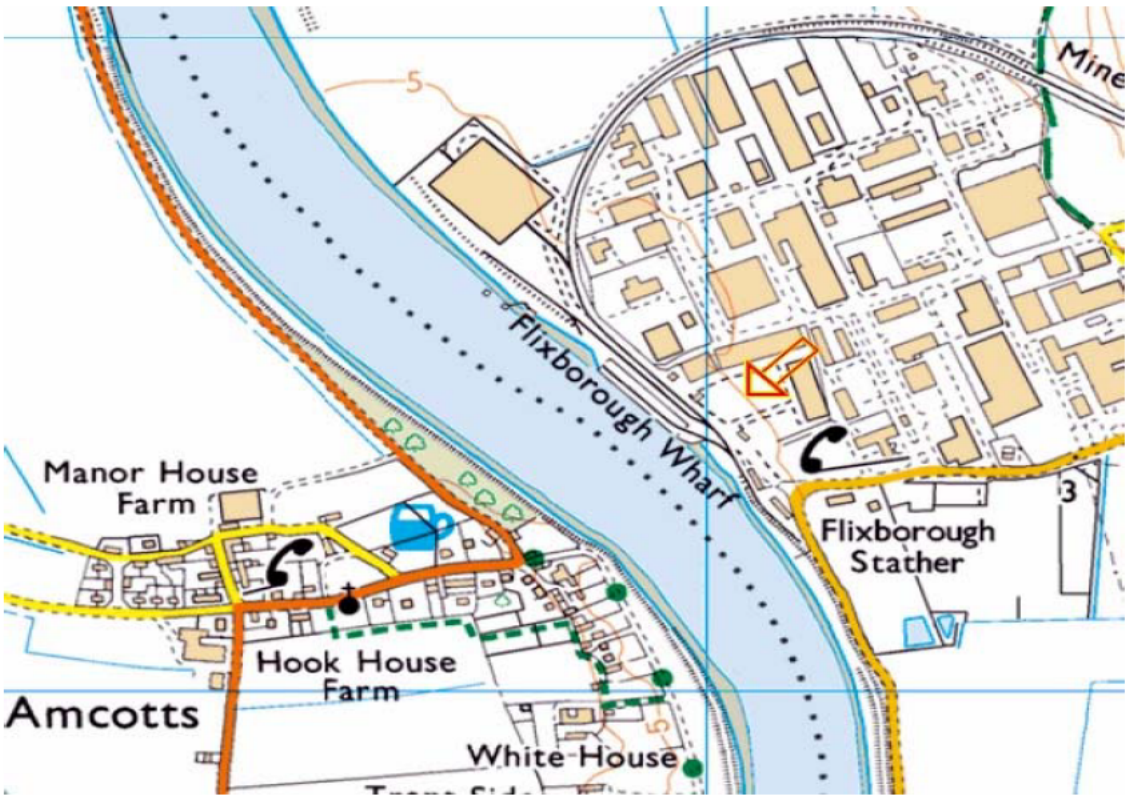
DRAWINGS & PHOTOGRAPHS

IAN FARMER ASSOCIATES

Contract: EFW Plant, Flixborough, Scunthorpe
Contract No: 31554
Site Location Plan
Figure No: A1.1

REPRODUCED FROM ORDNANCE SURVEY MAP WITH THE PERMISSION OF THE CONTROLLER OF HER MAJESTY'S STATIONARY OFFICE



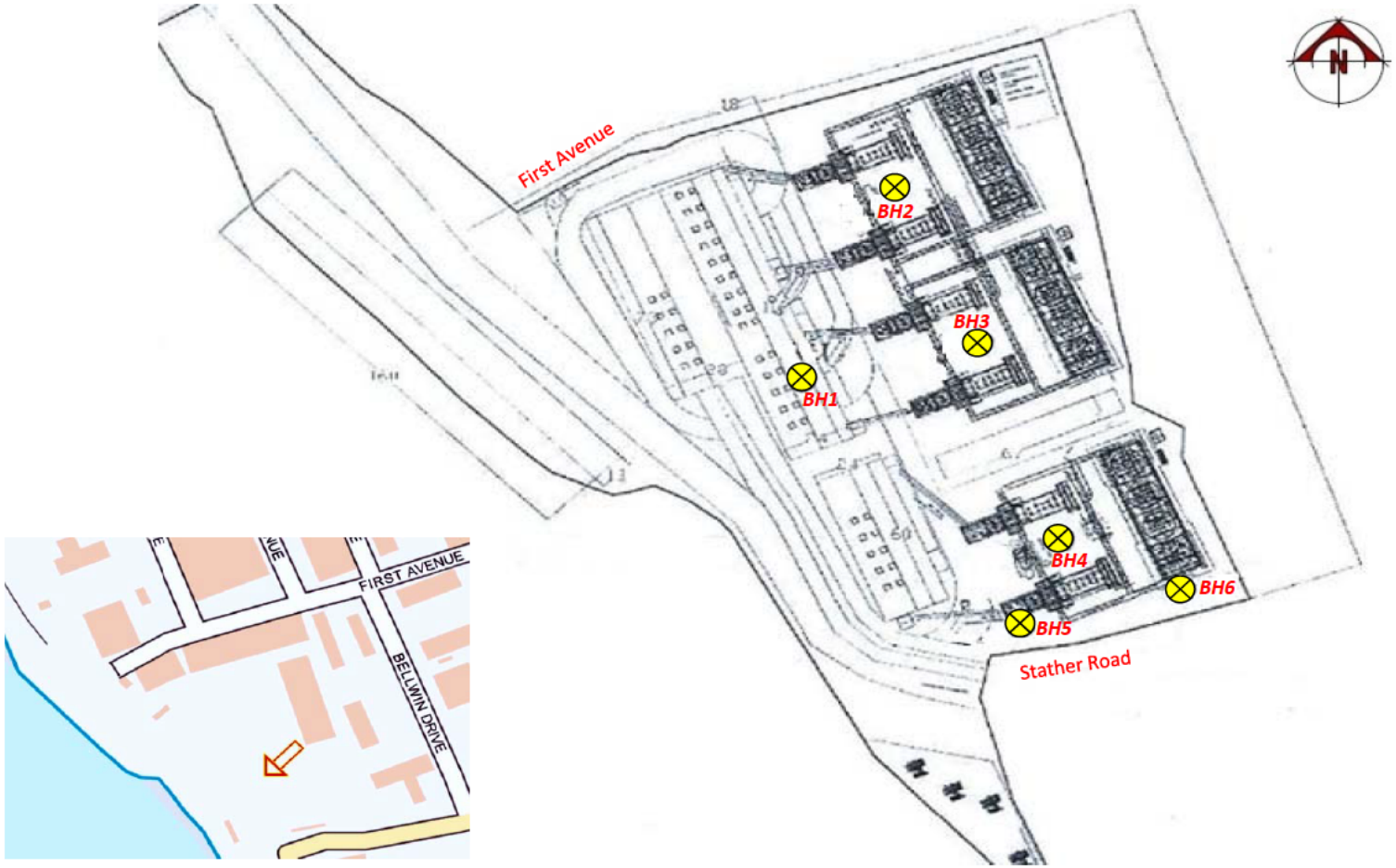


Licence No. LAN1001322

IAN FARMER ASSOCIATES

Contract: EFW Plant, Flixborough, Scunthorpe
Contract No: 31554
Figure No. A1.2

Exploratory Hole Location Plan



APPENDIX 2

SITE WORK

APPENDIX 2

GENERAL NOTES ON SITE WORKS

A2.1 SITE WORK

A2.1.1 General

Site work is carried out in general accordance with the guidelines given in ISO 1997, 9.4 and BS 5930, ref. 9.3.

A2.1.2 Light Cable Percussion Boring

For routine soil exploration to depths in excess of 3m, the light cable percussion rig is generally employed for boring through soils and weak rocks, refs 9.3, 9.4 and 9.5 It consists of a powered winch and tripod frame, with running wheels that are permanently attached so that the rig may be towed behind a suitable vehicle. The rig is towed into position and set up using its own winching system.

The locations of services are checked to make sure the borehole is not situated unacceptably near any services. Regardless of the proximity of services, a CAT scan is undertaken at the borehole location and a trial hole dug to 1.20m by hand.

Boreholes are advanced in soil by the percussive action of the cable tool. The force of the cylindrical tool as it is dropped a short distance cuts a plug of cohesive soil that is removed by the tool.

In non-cohesive soils, the borehole is advanced by a 'shell', otherwise known as a 'bailer' or 'sand pump', which incorporates a clack valve. Material is transferred into the shell and retained by the clack valve. The water level in a borehole is maintained above that in the surrounding granular soil to allow for temporary reductions in the head of water as the shell is withdrawn from the borehole. Water should flow from the borehole into the surrounding soil at all times to prevent 'piping' and loosening the soil at the base of the hole. The casing is always advanced with the borehole in granular soil so that material is drawn from the base rather than the borehole sides.

Obstructions to boring are overcome by fitting a serrated chiselling ring to the base of the percussion tool. For large obstructions, a heavy chisel with a hardened cutting edge may have to be used.

Disturbed samples are taken in polythene bags, jars or tubs that are sealed against air or water loss.

Undisturbed samples are generally taken in cohesive materials at changes in strata and at one metre intervals to 5 metres then at 1.5 metre intervals to the full depths of the borehole. The general purpose open-tube sampler is suitable for firm to stiff clays, but is often used to retrieve disturbed samples of weak rocks, soft or hard clay and also clayey sand or silts. This has been adopted for routine use, and usually consists of a 100mm internal diameter tube (U100), which is capable of taking soil samples up to 450mm in length. The undisturbed samples are sealed at each end using micro-crystalline wax to prevent drying.

Standard penetration tests are generally carried out in non-cohesive soils but also in stiff clays and soft rocks at frequencies similar to that of undisturbed sampling.

A2.1.3 Rotary Drilling

For exploration within rock rotary drilling methods are employed, where the drill bit is rotated on the bottom of the borehole. This method is occasionally used for drilling within soils. The drilling fluid is transferred from the surface though hollow drilling rods to the

bit cooling and lubricating. Drilling fluids commonly comprise clean water, air, foam, mud or polymers which aid the transportation of drill cuttings to the surface and maximise core recovery.

There are two basic types of rotary drilling:

- Open hole where the drill bit cuts all the material within the diameter of the borehole. This technique is sometimes used in soils and weak rocks as a rapid and economical means of making holes for taking soil samples, carrying out insitu soil tests, installing instruments and probing for voids such as mine workings or solution cavities. The only samples recovered are the poor quality drill cuttings.

- Core drilling where an annular bit fixed to the bottom of the core barrel cuts a core, which is recovered within the innermost tube of the core barrel. Coring is normally carried out by triple tube core barrels. At the end of the core run the core barrel assembly is brought to the surface. The core is prevented from dropping out of the barrel by a core catcher made of spring steel. The non-rotating inner barrel contains a removable sample tube or liner. At the end of each coring run the liner is extracted from the barrel and stored in a core box, where it can be photographed, described and tested.

A2.2 IN-SITU TESTS

A2.2.1 Standard Penetration Test

The Standard Penetration Test is carried out in accordance with the proposals recommended by ISO 1997, ref. 9.4, BS 1377, Part 9, 1990 ref. 9.6 and ISO 22476 ref. 9.5.

The standard penetration test, **SPT**, covers the determination of the resistance of soils to the penetration of a split barrel sampler. A 50mm diameter split barrel sampler is driven 450mm into the soil using a 63.5kg hammer with a 760mm drop. The penetration resistance is expressed as the number of blows required to obtain 300mm penetration below an initial seating drive of 150mm through any disturbed ground at the bottom of the borehole. The number of blows to achieve the standard penetration of 300mm is reported as the 'N' value.

The test is generally carried out in fine soils, however, it may also be carried out in coarse granular soils, weak rocks and glacial tills using the same procedure as for the SPT but with a 50mm diameter, 60° apex solid cone replacing the split spoon sampler, **CPT.**

When attempting the standard penetration test in very dense material or weathered rocks it may be necessary to terminate the test before completion to prevent damage to the equipment. In these circumstances it is important to distinguish how the blow count relates to the penetration of the sampler. This may be achieved in the following manner:

- Where the seating drive has been completed, the test drive is terminated if 50 blows are reached before the full penetration of 300mm is achieved. The penetration for 50 blows is recorded and an approximate N value obtained by linear extrapolation of the number of blows for the partial test drive.

- If the seating drive of 150mm is not achieved within the first 25 blows, the penetration after 25 blows is recorded and the test drive then commenced.

- For tests in soft rocks, the test drive should be terminated after 100 blows where the penetration of 300mm has not been achieved.

The N-value obtained from the Standard Penetration Test may be used to assess the relative density of sands and gravels as follows:

Term	SPT N-Value : Blows/300mm Penetration
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

A2.3 SAMPLES

A2.3.1 General

Samples have been recovered and stored in accordance with the guidelines given in ISO 22475-1:2006, ref. 9.35 and BS 5930, ref. 9.3.

The undisturbed samples recovered from the percussive sampler were of varying diameters depending upon the depth taken and the ground conditions encountered.

In accordance with EN ISO 22475, ref. 9.35, and BS 5930, ref. 9.3, the thick walled U100 sample is considered as a Class B sampling technique and will only produce Class 3 to 5 quality samples in accordance with EN 1997-2:2007, ref. 9.4. A similar assumption can be made from samples tested from the percussive window sample probing.

Laboratory strength and consolidation testing can only be carried out on Class 1 quality samples, which can be obtained from a Class A sampling technique, ref. 9.4. This is due to possible disturbance during sampling, giving a weaker strength in testing.

Therefore values for c_u and mv derived for use in this report can only be used as guidance and not used to determine the shear strength properties of the clay and is not used to give a descriptive strength in the borehole records.

UT represents undisturbed 100mm diameter samples taken in thin walled sample tubes, the number of blows to obtain the sample also recorded.

U represents undisturbed 100mm diameter sample, the number of blows to obtain the sample also recorded.

U fail indicates undisturbed sample not recovered

ES represents sample recovered in an amber jar, generally for environmental analysis

HV represents Hand Vane test with equivalent undrained shear strength in kPa.

PP represents Pocket Penetrometer test with equivalent undrained shear strength in kPa.

CBR represents California Bearing Ratio test

B represents large bulk disturbed samples

D represents small disturbed sample

W represents water sample

$\underline{\nabla}$ represents water strike

$\underline{\blacktriangledown}$ represents level to which water rose

A2.4 DESCRIPTION OF SOILS

A2.4.1 General

The procedures and principles given in ISO 14688 Parts 1 and 2, ref. 9.36, supplemented by section 6 of BS 5930, ref. 9.3 have been used in the soil descriptions contained within this report.

BOREHOLE RECORDS

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Flixborough EFW Plant, Scunthorpe		Solar 21			BH1
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
31554	24/08/2018	SP	PC	FINAL	
Cable Percussion Borehole Log	Easting:	Northing:	Ground Level:	Print Date: 18/10/2018	Scale: 1:50

SPT Hammer: ALMC1 Energy Ratio: 51%

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.10	D1			0.10		MADE GROUND: Tarmac/Concrete.		
0.30	ES2					MADE GROUND: Slag.		
0.50	ES3							
0.50 - 1.00	B4			(1.30)				
1.00	ES5							
1.20		SPT(S) 50 (25 for 21mm/50 for 13mm)		1.40				
1.20	D6					End of Borehole at 1.40m		

1 2 3 4 5 6 7 8 9 10

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
24-08-2018	00:00	1.40			1.40	200		

Remarks:

Inspection pit dug to 1.20m. Borehole terminated due to refusal at 1.40m. No groundwater observed.

Chiselling				Installation			
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)
1.20	1.40	01:30					

Water Strikes					
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Flixborough EFW Plant, Scunthorpe		Solar 21			BH1A
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
31554	28/08/2018	SP	PC	FINAL	
Cable Percussion Borehole Log	Easting:	Northing:	Ground Level:	Print Date: 18/10/2018	Scale: 1:50

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.20	D1			0.10		MADE GROUND: Tarmac and concrete.		
0.50	B3			(1.20)		MADE GROUND: Light grey sandy GRAVEL with high cobble content. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of concrete and slag. Cobbles are angular slag.		
0.50	ES2							
1.00	ES4			1.30		*Terminated on large cobble of slag.* End of Borehole at 1.30m		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
28-08-2018	00:00	1.30			1.30	200		

Chiselling			
From (m)	To (m)	Duration	Remarks
1.20	1.30	00:40	

Installation			
Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Inspection pit dug to 1.20m. Borehole terminated due to refusal at 1.30m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Flixborough EFW Plant, Scunthorpe		Solar 21			BH1B
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
31554	28/08/2018	SP	PC	FINAL	
Cable Percussion Borehole Log	Easting:	Northing:	Ground Level:	Print Date: 18/10/2018	Scale: 1:50

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
				0.10		MADE GROUND: Tarmac and concrete.		
0.50	B2			(0.80)		MADE GROUND: Light grey sandy GRAVEL with high cobble content. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse slag and concrete. Cobbles are angular slag.		
0.50	ES1							
0.90	ES3			0.90		*Terminated on large cobbles of slag.*		
						End of Borehole at 0.90m		

1 2 3 4 5 6 7 8 9 10

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
28-08-2018	00:00	0.90						

Chiselling				Installation			
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Inspection pit dug to 1.20m. Borehole terminated at 0.90m on cobbles of slag.

Water Strikes					
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Flixborough EFW Plant, Scunthorpe		Solar 21			BH2
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 4
31554	29/08/2018	SP/CL	PC	FINAL	
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:	Plant Used:	Print Date: 18/10/2018
					Scale: 1:50

SPT Hammer: ALMC1 Energy Ratio: 51%

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D1 0.10		0.10		MADE GROUND: Tarmacadam.		
					ES2 0.30				MADE GROUND: Light brown gravelly fine to coarse SAND with low cobble content. Gravel is angular to subrounded fine to coarse of flint, brick, concrete, slag, mudstone and sandstone. Cobbles are angular slag.		
					ES3 0.50		(0.65)				
					B4 0.75		0.75		Soft light brown slightly gravelly sandy CLAY. Gravel is subangular to rounded fine to medium of mudstone, flint and coal. occasionally laminated at 1.00mbgl.		
					ES5 1.00						
1.20					B7 1.20 D6 1.20 N=5 (1,1/1,1,1,2) (S)		(1.25)				
					D8 1.85						
					D9 2.00 U10 2.00		2.00		Firm light brown mottled grey sandy CLAY occasionally laminated.		
					D11 2.45		(1.20)				
					D12 2.75						
3.00					B15 3.00 D13 3.00 N=6 (1,1/1,1,2,2) (S)		3.20		Very soft to soft light grey brown slightly silty slightly sandy to sandy laminated CLAY.		
					D14 3.20						
					D16 3.75						
					U17 4.00						
					D18 4.45						
					D19 4.75						
5.00					B21 5.00 D20 5.00 N=5 (1,1/1,1,1,2) (S)		(3.50)		At 5.00m plant matter noted		
					D22 5.75						
					U23 6.50						
					D25 6.70		6.70		Soft to firm brown slightly sandy slightly silty laminated CLAY with large pockets of dark brown fibrous peat.		
					D24 6.95						
					D26 7.25						
8.00					B28 8.00 D27 8.00 N=8 (1,1/1,2,2,3) (S)		(5.80)				
					D29 8.75						
					U30 9.50						
					D31 9.95						
									Continued next sheet		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
29-08-2018	00:00	18.00	18.00	16.90	12.90	200	12.90	200
30-08-2018	00:00	21.90	21.58	9.60	21.90	150	21.80	150
06-09-2018	00:00	30.10		28.10				

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Inspection pit dug to 1.20m. Groundwater encountered at 12.50m. Borehole backfilled with bentonite grout on completion.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Flixborough EFW Plant, Scunthorpe			Client: Solar 21		Borehole ID: BH2
	Contract Number: 31554	Date Started: 29/08/2018	Logged By: SP/CL	Checked By: PC	Status: FINAL	Sheet 2 of 4
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:		Print Date: 18/10/2018	Scale: 1:50
					SPT Hammer: ALMC1 Energy Ratio: 51%	

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D32 10.25						
11.00					B34 11.00 D33 11.00 N=9 (1,1/2,2,2,3) (S) D35 11.75				At 11.00mbgl peat content increasing		
12.50					B39 12.50 D36 12.50 D37 12.50 EW38 12.50 N=5 (1,0/0,1,2,2) (S) D40 13.25		12.50		Loose becoming medium dense light grey slightly gravelly fine to medium SAND. Gravel is angular to subrounded fine to coarse of quartzite, flint, mudstone and coal.		
14.00					B42 14.00 D41 14.00 N=8 (0,0/0,2,3,3) (S) D43 14.75		(3.70)				
15.50					B45 15.50 D44 15.50 N=14 (1,1/2,3,4,5) (S) D46 16.25				Medium dense at 15.50m.		
							16.20		Medium dense light brown to brown gravelly fine to coarse SAND. Gravel is angular to rounded fine to coarse of mudstone, flint, quartzite and occasional coal.		
17.00					B48 17.00 D47 17.00 N=16 (1,2/2,3,5,6) (S) D49 17.60 D50 17.75		(1.40)				
							17.60		Firm red brown mottled grey slightly gravelly slightly sandy CLAY. Gravel is angular to rounded fine to coarse of flint, mudstone and quartzite		
					B51 18.50						
19.00					B53 19.00 D52 19.00 N=18 (2,3/3,5,5,5) (S) D54 19.75		(4.20)		Becoming stiff at 19.00m.		
									Continued next sheet		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
29-08-2018	00:00	18.00	18.00	16.90	12.90	200	12.90	200
30-08-2018	00:00	21.90	21.58	9.60	21.90	150	21.80	150
06-09-2018	00:00	30.10		28.10				

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Inspection pit dug to 1.20m. Groundwater encountered at 12.50m. Borehole backfilled with bentonite grout on completion.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Flixborough EFW Plant, Scunthorpe			Client: Solar 21		Borehole ID: BH2
	Contract Number: 31554	Date Started: 29/08/2018	Logged By: SP/CL	Checked By: PC	Status: FINAL	Sheet 3 of 4
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:		Print Date: 18/10/2018	Scale: 1:50
					SPT Hammer: ALMC1 Energy Ratio: 51%	

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
20.50					B56 20.50 D55 20.50 N=16 (2,2/3,3,4,8) (S) D57 21.25						
21.80					D58 21.80		21.80				
21.90					D59 21.80 50 (25 for 37mm/50 for 97mm) (S) D60 21.90 50 (25 for 29mm/50 for 28mm) (S)		21.90		Light blue / green grey weathered MUDSTONE with quartz veins.		
22.00 - 23.10	100	90	34	11			(2.00)		Very weak to weak red brown and green grey MUDSTONE with very closely and closely spaced laminations, very thin and occasional thin beds of gypsum. Discontinuities: Horizontal and subhorizontal, very closely and closely spaced, planar smooth.		
23.10 - 24.00	66	27	0	NI NI NR 24 NI NI NR			24.00		From 23.50m to 23.57m: Gypsum.		
24.00 - 24.60	92	92	52	C1 24.18 11			(2.80)		Weak red brown, locally green grey, MUDSTONE with very closely to medium spaced laminations and very thin beds of gypsum. Discontinuities: Horizontal and subhorizontal, very closely to medium spaced, planar and undulating, smooth.		
24.60 - 26.10	87	87	63	NR 9			26.80				
26.10 - 27.60	100	100	67	C2 26.34 11 3 27			(2.60)		Weak grey, locally red brown, MUDSTONE with very closely to medium spaced laminations and very thin beds of gypsum. Discontinuities: Horizontal and subhorizontal, very closely to medium spaced, planar and undulating, smooth.		
27.60 - 29.10	97	92	69	C3 27.60 4 30 NI NI 5			29.40				
29.10 - 30.10	100	100	80	C4 29.14 13			(0.60)		Weak red brown MUDSTONE with closely spaced spaced laminations and thin beds of gypsum. Discontinuities: Horizontal and subhorizontal, planar smooth.		
							30.00		Continued next sheet		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
29-08-2018	00:00	18.00	18.00	16.90	12.90	200	12.90	200
30-08-2018	00:00	21.90	21.58	9.60	21.90	150	21.80	150
06-09-2018	00:00	30.10		28.10				

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Inspection pit dug to 1.20m. Groundwater encountered at 12.50m. Borehole backfilled with bentonite grout on completion.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Flixborough EFW Plant, Scunthorpe		Solar 21			BH2
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 4 of 4
31554	29/08/2018	SP/CL	PC	FINAL	
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:	Print Date: 18/10/2018	Scale: 1:50
				SPT Hammer: ALMC1 Energy Ratio: 51%	

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
									End of Borehole at 30.100m		

31 32 33 34 35 36 37 38 39 40

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
29-08-2018	00:00	18.00	18.00	16.90
30-08-2018	00:00	21.90	21.58	9.60
06-09-2018	00:00	30.10		28.10

Borehole Diameter

Depth (m)	Dia (mm)
12.90	200
21.90	150

Casing Diameter

Depth (m)	Dia (mm)
12.90	200
21.80	150

Flush Information

Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation

Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Inspection pit dug to 1.20m. Groundwater encountered at 12.50m.
Borehole backfilled with bentonite grout on completion.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Flixborough EFW Plant, Scunthorpe		Solar 21			BH3
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 4
31554	30/08/2018	SP/CL	PC	FINAL	
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:	Print Date: 18/10/2018	Scale: 1:50
				SPT Hammer: ALMC1 Energy Ratio: 51%	

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D1 0.20 ES2 0.30 B4 0.50 ES3 0.50 ES5 1.00		0.15 (1.95)		MADE GROUND: Tarmac/concrete. MADE GROUND: Light grey brown sandy GRAVEL with high cobble content of slag. Sand is fine to coarse. Gravel is angular to subangular fine to coarse slag, concrete, flint and mudstone. Cobbles are angular slag.		
3.00					B8 2.10 D6 2.10 U7 2.10 D9 2.75 B10 3.00 N=3 (1,1/0,1,1 ,1) (S) D11 3.75 U12 4.00		2.10 (2.00) 4.10		Soft grey brown slightly sandy slightly gravelly, locally laminated, CLAY. Gravel is angular to subrounded fine to coarse flint and mudstone.		
5.00					D13 4.45 D14 4.75 B16 5.00 D15 5.00 N=5 (1,1/1,1,2 ,1) (S) D17 5.75 U18 6.50		(2.60)		Soft light grey brown slightly sandy silty laminated slightly organic CLAY with inclusions of peat.		
8.00					D20 6.70 D19 6.95 D21 7.25 B23 8.00 D22 8.00 N=8 (1,1/2,2,2 ,2) (S) D24 8.75 U25 9.50 D26 9.95		6.70 (5.60)		Brown fibrous PEAT with pockets of brown slightly sandy silty organic clay.		
									Continued next sheet		

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
30-08-2018	00:00	3.45	2.90	
31-08-2018	00:00	18.00	16.90	8.10
03-09-2018	00:00	21.25	21.00	2.30
05-09-2018	00:00	30.00		2.90

Borehole Diameter

Depth (m)	Dia (mm)
13.00	200
18.00	150

Casing Diameter

Depth (m)	Dia (mm)
13.00	200
21.00	150

Flush Information

Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation

Top (m)	Base (m)	Type	Dia (mm)
0.00	2.00	PLAIN	
2.00	12.00	SLOTTED	

Remarks:

Inspection pit dug to 1.20m. Water encountered at 0.35m in inspection pit. Groundwater strike at 12.30m. water level on completion of borehole, 3.90m. Standpipe installed to 12.00m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
0.35			0		
12.30			20	6.80	

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Flixborough EFW Plant, Scunthorpe		Client: Solar 21		Borehole ID: BH3
	Contract Number: 31554	Date Started: 30/08/2018	Logged By: SP/CL	Checked By: PC	Status: FINAL	Sheet 2 of 4
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:		Print Date: 18/10/2018	Scale: 1:50
					SPT Hammer: ALMC1 Energy Ratio: 51%	

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D27 10.25						
11.00					B29 11.00 D28 11.00 N=9 (1,1/2,2,2,3) (S) D30 11.75						
					D31 12.30 EW36 12.30 B33 12.50 D32 12.50 N=6 (1,0/0,1,2,3) (S) D34 13.25		12.30		Loose becoming medium dense light grey slightly silty slightly gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse sandstone and mudstone.		
12.50											
14.00					B37 14.00 D35 14.00 N=11 (0,0/0,3,3,5) (S) D38 14.75		(3.90)		*Medium dense below 14.00m.*		
15.50					B40 15.50 D39 15.50 N=13 (1,2/2,3,3,5) () D41 16.25		16.20		Medium dense red brown slightly silty very gravelly fine to coarse SAND.. Gravel is angular to subrounded fine to coarse sandstone and mudstone.		
17.00					B43 17.00 D42 17.00 N=17 (2,3/3,3,5,6) (S) D44 17.50 D45 17.75		(2.90)				
18.50					B47 18.50 D46 18.50 N=20 (2,2/3,5,5,7) (S) D48 19.10		19.10		Firm light red brown mottled grey sandy CLAY.		
					B49 20.00		(1.80)				
									Continued next sheet		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
30-08-2018	00:00	3.45	2.90		13.00	200	13.00	200
31-08-2018	00:00	18.00	16.90	8.10	18.00	150	21.00	150
03-09-2018	00:00	21.25	21.00	2.30				
05-09-2018	00:00	30.00		2.90				

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)
					0.00	2.00	PLAIN	
					2.00	12.00	SLOTTED	

Remarks:

Inspection pit dug to 1.20m. Water encountered at 0.35m in inspection pit. Groundwater strike at 12.30m. water level on completion of borehole, 3.90m. Standpipe installed to 12.00m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
0.35			0		
12.30			20	6.80	

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Flixborough EFW Plant, Scunthorpe		Client: Solar 21		Borehole ID: BH3
	Contract Number: 31554	Date Started: 30/08/2018	Logged By: SP/CL	Checked By: PC	Status: FINAL	Sheet 3 of 4
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:		Print Date: 18/10/2018	Scale: 1:50
					SPT Hammer: ALMC1 Energy Ratio: 51%	

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
20.50					D50 20.50 N=15 (2,2/3,3,4,5) (S) D51 20.75 D52 20.90 D53 21.20 D54 21.20 50 (25 for 58mm/50 for 55mm) (S) D55 21.25 50 (25 for 32mm/50 for 47mm) (S) C1 21.98 C2 22.59		20.90		Light grey weathered MUDSTONE with inclusions of gypsum..		
21.20							(0.90)				
21.25							21.80		Weak red brown, locally green grey, MUDSTONE with very closely and closely spaced laminations and very thin beds of gypsum. Discontinuities: Horizontal to subhorizontal very closely to closely spaced, occasionally medium spaced, planar smooth.		
21.80 - 23.00	100	77	59	NI 33 6 NI 10 NI							
23.00 - 24.50	100	83	75	17 NI 20 NI	C3 23.80		(3.38)				
24.50 - 26.00	100	100	95	6	C4 24.70		25.18		Weak green grey MUDSTONE, locally grading to siltstone, with very closely and closely spaced laminations and very thin beds of gypsum. Discontinuities: Horizontal and subhorizontal, closely and medium spaced, planar smooth.		
26.00 - 27.50	100	97	97	NI 6	C5 26.00		(2.32)				
27.50 - 29.00	100	100	78	14 8	C6 27.71		27.50		Weak red brown, locally green grey, MUDSTONE with very closely and closely spaced laminations and very thin beds of gypsum. Discontinuities: Horizontal to subhorizontal very closely to closely spaced, planar smooth. *From 27.50m to 27.57m: Weak red brown fine grained sandstone.*		
29.00 - 29.60	100	42	33	NI 10 NI 10 NI			(2.50)		*Below 29.00m: Predominantly recovered none intact. Driller notes fractured mart.*		
29.60 - 30.00	88	0	0	NR NI			30.00				
30.00									Continued next sheet		

Start & End of Shift Observations				
Date	Time	Depth (m)	Casing (m)	Water (m)
30-08-2018	00:00	3.45	2.90	
31-08-2018	00:00	18.00	16.90	8.10
03-09-2018	00:00	21.25	21.00	2.30
05-09-2018	00:00	30.00		2.90

Borehole Diameter		Casing Diameter	
Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
13.00	200	13.00	200
18.00	150	21.00	150

Flush Information				
Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation			
Top (m)	Base (m)	Type	Dia (mm)
0.00	2.00	PLAIN	
2.00	12.00	SLOTTED	

Remarks:

Inspection pit dug to 1.20m. Water encountered at 0.35m in inspection pit. Groundwater strike at 12.30m. water level on completion of borehole, 3.90m. Standpipe installed to 12.00m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
0.35			0		
12.30			20	6.80	

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Flixborough EFW Plant, Scunthorpe		Solar 21			BH3
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 4 of 4
31554	30/08/2018	SP/CL	PC	FINAL	
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:	Print Date: 18/10/2018	Scale: 1:50
				SPT Hammer: ALMC1 Energy Ratio: 51%	

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					50 (17,8/50 for 75mm) (C)				End of Borehole at 30.000m		

31 32 33 34 35 36 37 38 39 40

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
30-08-2018	00:00	3.45	2.90	
31-08-2018	00:00	18.00	16.90	8.10
03-09-2018	00:00	21.25	21.00	2.30
05-09-2018	00:00	30.00		2.90

Borehole Diameter

Depth (m)	Dia (mm)
13.00	200
18.00	150

Casing Diameter

Depth (m)	Dia (mm)
13.00	200
21.00	150

Flush Information

Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation

Top (m)	Base (m)	Type	Dia (mm)
0.00	2.00	PLAIN	
2.00	12.00	SLOTTED	

Remarks:

Inspection pit dug to 1.20m. Water encountered at 0.35m in inspection pit. Groundwater strike at 12.30m. water level on completion of borehole, 3.90m. Standpipe installed to 12.00m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
0.35			0		
12.30			20	6.80	

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Flixborough EFW Plant, Scunthorpe		Solar 21			BH4
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 3
31554	22/08/2018	SP/CL	PC	FINAL	
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:	Print Date: 18/10/2018	Scale: 1:50

SPT Hammer: ALMC1 Energy Ratio: 51%

Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D1 0.10		0.05		MADE GROUND: Tarmacadam.		
					ES2 0.30		(0.55)		MADE GROUND: Light grey slightly sandy GRAVEL. Gravel is angular to rounded fine to coarse of dolerite, hardcore, slag and concrete. Sand is fine to coarse.		
					ES3 0.50 B4 0.60		0.60		MADE GROUND: Soft brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to coarse of coal, mudstone and brick.		
					ES5 1.00		(0.80)				
1.20					B8 1.20 D6 1.20 N=8 (1,1/1,2,2,3) (S)		1.40		Very soft to soft light brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to coarse of coal, mudstone and possible brick..		
					D7 1.40		(0.45)				
					D9 1.85		1.85		Soft light brown slightly silty slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to coarse of sandstone and mudstone.		
					D11 2.00 U10 2.00		2.00		Soft light brown mottled grey slightly silty slightly sandy laminated CLAY.		
					D12 2.75		(1.20)				
3.00					B15 3.00 D13 3.00 N=5 (1,1/1,1,1,2) (S)		3.20		Soft light grey slightly sandy CLAY.		
					D14 3.20						
					D16 3.75						
					U17 4.00						
					D18 4.45						
					D19 4.75		(2.90)				
5.00					B21 5.00 D20 5.00 N=6 (1,1/1,1,2,2) (S)						
					D22 5.75						
					D23 6.10		6.10		Soft dark brown slightly silty slightly sandy clayey fibrous PEAT with large wood fragments and plant matter.		
					U24 6.50						
					D25 6.95						
					D26 7.25						
8.00					B28 8.00 D27 8.00 N=9 (1,1/2,2,2,3) (S)		(6.20)				
					D29 8.75						
					U30 9.50						
					D31 9.95						

Continued next sheet

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
22-08-2018	00:00	8.45	7.80	
23-08-2018	00:00	22.70	22.50	7.45

Borehole Diameter

Depth (m)	Dia (mm)
12.50	200
22.70	150

Casing Diameter

Depth (m)	Dia (mm)
12.50	200
22.50	150

Flush Information

Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation

Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Inspection pit dug to 1.20m. Groundwater encountered at 12.30m.
Borehole backfilled with bentonite grout.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
12.30	12.20		20	6.70	

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Flixborough EFW Plant, Scunthorpe		Solar 21			BH4
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 2 of 3
31554	22/08/2018	SP/CL	PC	FINAL	
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:	Print Date: 18/10/2018	Scale: 1:50
				SPT Hammer: ALMC1 Energy Ratio: 51%	

Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D32 10.25						
11.00					B34 11.00 D33 11.00 N=7 (1,1/1,1,2,3) (S) D35 11.75						
					D36 12.30		12.30				
12.50					B38 12.50 D37 12.50 N=2 (2,1/0,0,1,1) (S) D39 13.25		(1.80)		Very loose Light grey slightly gravelly fine and medium SAND. Gravel is angular to subrounded fine to coarse of mudstone, flint and coal.		
14.00					B42 14.00 D40 14.00 EW41 14.00 N=9 (1,1/2,2,4) (S) D43 14.75		14.10		Loose to medium dense light grey brown slightly gravelly to gravelly SAND. Gravel is angular to subrounded fine to coarse of sandstone, mudstone , flint and some coal.		
15.50					B45 15.50 D44 15.50 N=15 (1,1/2,4,4,5) (S) D46 16.25		(3.30)		*Medium dense at 15.50m.*		
17.00					B48 17.00 D47 17.00 N=18 (1,2/3,5,5,5) (S) D49 17.40 D50 17.75		17.40		Medium dense light brown gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse of sandstone, flint, mudstone and coal.		
							(1.10)				
18.50					B51 18.50 N=17 (2,2/3,3,4,7) (S) D52 19.25 D53 19.40		18.50		Medium dense light brown SAND and GRAVEL. Gravel is angular to subrounded fine to coarse of sandstone, mudstone, flint and coal. Sand is fine to coarse.		
							(0.90)				
20.00					B55 20.00		19.40		Firm to stiff light brown mottled grey slightly gravelly slightly silty CLAY. Gravel is angular to subrounded fine to coarse of mudstone, coal and flint.		

Continued next sheet

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
22-08-2018	00:00	8.45	7.80	
23-08-2018	00:00	22.70	22.50	7.45

Borehole Diameter

Depth (m)	Dia (mm)
12.50	200
22.70	150

Casing Diameter

Depth (m)	Dia (mm)
12.50	200
22.50	150

Flush Information

Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation

Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Inspection pit dug to 1.20m. Groundwater encountered at 12.30m.
Borehole backfilled with bentonite grout.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
12.30	12.20		20	6.70	

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Flixborough EFW Plant, Scunthorpe			Client: Solar 21		Borehole ID: BH4
	Contract Number: 31554	Date Started: 22/08/2018	Logged By: SP/CL	Checked By: PC	Status: FINAL	Sheet 3 of 3
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:		Print Date: 18/10/2018	Scale: 1:50
					SPT Hammer: ALMC1 Energy Ratio: 51%	

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D54 20.00 N=23 (2,2/4,5,6 ,8) (S)						
					D56 20.75						
					B57 21.50		(3.20)				
					D58 22.25						
22.60 22.70				NI	D59 22.60		22.60 22.70		Light grey weathered MUSTONE.		
22.60 - 23.50	100	90	68	9	D60 22.60 50 (10,14/50 for 78mm) (S)				Very weak to weak grey MUDSTONE with very closely and closely spaced very thin beds and thin laminations of white gypsum. Discontinuities: Subhorizontal and horizontal very closely and closely spaced, some poosible drilling induced.Weathering: None discernible. *From 22.70m to 22.74m: Gypsum.* *From 22.77m to 22.80m: Gypsum.* *23.06m to 23.11m: Gypsum.*		
23.50 - 24.70	84	84	28	NR 9 NI 11	50 (22 for 57mm/50 for 24mm) (S) C1 22.76 C2 22.88 C3 23.10 4 23.60		(2.14)		*From 23.06m to 24.06m: Gypsum.* *From 24.04m to 24.12m: Gypsum.* *From 24.25m to 24.31m: Gypsum.* *From 24.57m to 24.58m: Gypsum.*		
24.70 - 26.20	100	84	35	14 NI 13 NI 33 7 11			(2.80)		Very weak to weak red brown MUDSTONE with very closely and closely spaced very thin beds and laminations of gypsum. Discontinuities: Subhorizontal and horizontal, very closely and closely spaced, undulating and planar, smooth. Weathering: None discernible. *From 23.06m to 24.06m: Gypsum.* *From 24.04m to 24.12m: Gypsum.* *From 24.25m to 24.31m: Gypsum.* *From 24.57m to 24.58m: Gypsum.* *From 25.00m to 25.03m: Gypsum.* *From 25.34m to 25.37m: Gypsum.* *From 25.60m to 25.64m: GYpsum.* *Weak red brown fine grained sandstone.*		
26.20 - 27.70	60	49	7	NR 10 NI 16 NI 17			26.20 (0.60) 26.80		Red and grey MARL with gypsum bands (DRiller's description, no core recovery). *From 26.37m to 26.375m: Gypsum.* Weak red brown and locally green grey MUDSTONE and locally green grey I with very closely and closely spaced very thin beds and laminations of gypsum. Discontinuities: Subhorizontal and horizontal, very closely and closely spaced, undulating and planar, smooth. *From 27.08m to 27.12m: Gypsum.*		
27.70 27.70 - 28.00	100	0	0	NI 29	50 (25 for 140mm/50 for 75mm) (C)						
28.00 - 29.00	100	83	52	NI 7			(3.20)				
29.00 - 30.00	100	85	51	19 NI 22 NI 9 NI 9			30.00		End of Borehole at 30.000m		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
22-08-2018	00:00	8.45	7.80		12.50	200	12.50	200
23-08-2018	00:00	22.70	22.50	7.45	22.70	150	22.50	150

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Inspection pit dug to 1.20m. Groundwater encountered at 12.30m. Borehole backfilled with bentonite grout.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
12.30	12.20		20	6.70	

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Flixborough EFW Plant, Scunthorpe		Solar 21			BH5
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 3
31554	03/09/2018	SP/CL	PC	FINAL	
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:	Print Date: 18/10/2018	Scale: 1:50

SPT Hammer: ALMC1 Energy Ratio: 51%

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D1 0.20 ES2 0.30		0.15		MADE GROUND: Tarmac/concrete.		
					B4 0.50 ES3 0.50		(0.35) 0.50		MADE GROUND: Light grey and dark brown sandy GRAVEL. Gravel is angular to subrounded fine to coarse slag, brick and concrete.		
					B4a 0.85		(0.50)		MADE GROUND: Red brown slightly silty sandy GRAVEL Gravel is angular to subrounded fine to coarse brick with slag and mudstone. Cobbles of brick also noted.		
					ES5 1.00		1.00		Soft/very soft light brown, locally mottled grey sandy CLAY.		
1.20					B7 1.20 D6 1.20 N=5 (1,0/1,1,1 ,2) (S)						
					D8 1.85 B10 2.00 U9 2.00		(1.70)				
					D11 2.70		2.70		Soft/very soft grey brown slightly sandy silty laminated CLAY.		
3.00					B13 3.00 D12 3.00 N=4 (1,1/1,1,1 ,1) (S)						
					D14 3.75						
					U15 4.00						
					D16 4.45		(3.50)				
					D17 4.75						
5.00					B19 5.00 D18 5.00 N=6 (1,1/1,1,2 ,2) (S)						
					D20 5.75						
					D21 6.20		6.20		Soft, occasionally firm, dark brown slightly sandy organic CLAY with inclusions of fibrous peat.		
					U22 6.50						
					D23 6.95						
					D24 7.25						
8.00					B26 8.00 D25 8.00 N=8 (1,1/1,2,2 ,3) (S)		(6.00)				
					D27 8.75						
					B29 9.50 U28 9.50						
									Continued next sheet		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
03-09-2018	00:00	8.45	7.90		13.00	200	13.00	200
04-09-2018	00:00	21.05	20.60	6.30	21.05	150	21.05	150

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Inspection pit 1.20m. Water seepage at 0.60m in inspection pit. Water strike at 12.20m. Borehole backfilled with bentonite grout.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Flixborough EFW Plant, Scunthorpe		Client: Solar 21		Borehole ID: BH5
	Contract Number: 31554	Date Started: 03/09/2018	Logged By: SP/CL	Checked By: PC	Status: FINAL	Sheet 2 of 3
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:		Print Date: 18/10/2018	Scale: 1:50
					SPT Hammer: ALMC1 Energy Ratio: 51%	

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D30 10.25						
11.00					B32 11.00 D31 11.00 N=6 (1,1/1,2,1,2) (S) D33 11.75						
					D34 12.20 EW45 12.20 D35 12.50 D36 12.50 N=11 (0,0/1,3,3,4) (S) D37 13.25		12.20		Medium dense and loose light grey brown silty fine to coarse SAND.		
12.50											
14.00					B39 14.00 D38 14.00 N=9 (1,0/0,2,2,5) (S) D40 14.75		(4.10)				
15.50					B42 15.50 D41 15.50 N=14 (1,2/2,2,5,5) (S) D43 16.30		16.30		Grey brown slightly silty gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse mudstone and quartzite.		
							(0.80)				
17.00					B47 17.00 D44 17.00 N=14 (1,2/2,3,4,5) (S) D46 17.10 D48 17.75		17.10		Firm becoming stiff red and grey sandy slightly gravelly CLAY. Gravel is subangular mudstone.		
18.50					B50 18.50 D49 18.50 N=19 (2,3/3,5,5,6) (S) D51 19.25		(3.00)				
20.00					B54 20.00				Continued next sheet		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
03-09-2018	00:00	8.45	7.90		13.00	200	13.00	200
04-09-2018	00:00	21.05	20.60	6.30	21.05	150	21.05	150

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Inspection pit 1.20m. Water seepage at 0.60m in inspection pit. Water strike at 12.20m. Borehole backfilled with bentonite grout.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Flixborough EFW Plant, Scunthorpe		Solar 21			BH5
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 3 of 3
31554	03/09/2018	SP/CL	PC	FINAL	
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:	Print Date: 18/10/2018	Scale: 1:50

SPT Hammer: ALMC1 Energy Ratio: 51%

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D52 20.00 N=46 (5,8/9,11, 13,13) (S) D53 20.10 D55 20.80 D57 20.95		20.10		Grey brown weathered MUDSTONE with inclusions of gypsum.		
							(0.95)				
				NR			21.05				
				NI			21.20		Red and grey MARL with gypsum bands (Driller's description, no core recovery).		
21.00 - 22.00	80	61	0	15					From 21.19m to 21.26m: Gypsum. Weak grey MUDSTONE with closely spaced very thin beds and thin laminations of gypsum. Discontinuities: Horizontal, occasionally sub horizontal, very closely to closely spaced, undulating, smooth.		
							(1.30)		From 21.30m to 21.34m: Gypsum. From 21.97m to 21.99m: Gypsum From 22.00m to 22.02m: Gypsum		
				6	C1 22.07						
22.00 - 23.50	100	100	74	10			22.50		Weak red brown, occasionally green grey, MUDSTONE with very closely and closely spaced very thin beds and thin laminations of white gypsum. Discontinuities: Horizontal to subhorizontal, closely spaced, planar and undulating, smooth.		
				26					From 22.72m to 22.735m: Gypsum. From 22.86m to 22.875m: Gypsum. From 23.12m to 23.125m: Gypsum.		
23.50 - 24.70	79	100	100		C2 23.90				From 24.50m to 24.63m: Gypsum.		
24.70 - 26.30	100	93	73	6			(7.50)				
					C3 26.58						
26.30 - 27.80	86	94	86	10					From 27.60m to 27.68m: Gypsum.		
				6					From 27.80m to 27.87m: Gypsum.		
				NI							
				14							
				7							
27.80 - 29.30	100	51	29	NI					FRom 28.80m to 28.80m: Gypsum.		
				7							
				NI							
29.30 - 30.00	100	100	87	9			30.00		End of Borehole at 30.000m		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
03-09-2018	00:00	8.45	7.90		13.00	200	13.00	200
04-09-2018	00:00	21.05	20.60	6.30	21.05	150	21.05	150

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Inspection pit 1.20m. Water seepage at 0.60m in inspection pit. Water strike at 12.20m. Borehole backfilled with bentonite grout.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Flixborough EFW Plant, Scunthorpe			Client: Solar 21		Borehole ID: BH6
	Contract Number: 31554	Date Started: 21/08/2018	Logged By: SP/CL	Checked By: PC	Status: FINAL	Sheet 1 of 4
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:		Print Date: 18/10/2018	Scale: 1:50
					SPT Hammer: ALMC1 Energy Ratio: 51%	

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D1 0.00		(0.30)		MADE GROUND: Black tarmacadam with dolomite hardcore.		
					ES2 0.30		0.30				
					B4 0.50 ES3 0.50		(0.30)		MADE GROUND: Light grey sandy GRAVEL. Gravel is angular to subrounded fine to coarse of slag, concrete and tarmacadam,		
							0.60				
							(0.40)		Firm light brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of sandstone and possible brick.		
					ES5 1.00		1.00				
1.20					B8 1.20 D6 1.20 N=4 (1,1/1,1,1 ,1) (S)		(0.85)		Soft to firm light brown mottled grey slightly sandy slightly silty CLAY.		
					D7 1.30						
					D9 1.85		1.85		Soft lightly grey slightly sandy silty CLAY.		
					U10 2.00						
					D11 2.45						
					D12 2.75						
3.00					B14 3.00 D13 3.00 N=7 (1,1/1,1,2 ,3) (S)		(2.85)				
					D15 3.75						
					U16 4.00						
					D17 4.45						
					D18 4.70		4.70		Very soft occasionally soft brown slightly sandy clayey fibrous PEAT with large wood matter and plant matter. Clay is locally laminated.		
5.00					B20 5.00 D19 5.00 N=5 (1,1/1,1,1 ,2) (S)						
					D21 5.75						
					U22 6.50						
					D23 6.95		(4.80)				
					D24 7.25						
8.00					B26 8.00 D25 8.00 N=6 (1,1/1,1,2 ,2) (S)						
					D27 8.75						
					B29 9.50 U28 9.50		9.50		Soft black slightly sandy slightly silty clayey amorphous PEAT.		
									Continued next sheet		

Start & End of Shift Observations				
Date	Time	Depth (m)	Casing (m)	Water (m)
21-08-2018	00:00	17.45	16.90	10.50
22-08-2018	00:00	21.20	21.00	13.10
31-08-2018	00:00	23.10	22.00	
03-09-2018	00:00	30.00	22.00	22.30

Borehole Diameter		Casing Diameter	
Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
12.00	200	12.00	200
21.20	150	21.00	150

Flush Information				
Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation			
Top (m)	Base (m)	Type	Dia (mm)
0.00	1.00	PLAIN	
1.00	12.00	SLOTTED	

Remarks:

Inspection pit dug to 1.20m. Groundwater encountered at 11.70m. Standpipe installed to 12.00m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
11.70	11.50		20	6.30	

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Flixborough EFW Plant, Scunthorpe		Client: Solar 21		Borehole ID: BH6
	Contract Number: 31554	Date Started: 21/08/2018	Logged By: SP/CL	Checked By: PC	Status: FINAL	Sheet 2 of 4
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:		Print Date: 18/10/2018	Scale: 1:50
					SPT Hammer: ALMC1 Energy Ratio: 51%	

Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D30 10.25		(2.20)				
11.00					B32 11.00 D31 11.00 N=7 (1,1/1,2,2,2) (S) D33 11.70		11.70		Loose brown grey slightly silty fine to medium SAND.		
12.50					B35 12.50 D34 12.50 N=5 (3,0/0,0,1,4) (S) D36 13.25		(1.55)				
							13.25		Loose grey brown slightly silty slightly gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse of sandstone, mudstone, flint, with small inclusions of wood.		
14.00					B38 14.00 D37 14.00 5 (2,1/1,2,2) (S) D39 14.75 W41 15.00		(2.85)				
15.50					D40 15.50 D42 15.50 N=9 (1,1/1,2,3,3) (S) D43 16.25		16.10		Medium dense light grey red slightly clayey gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse of sandstone, flint, mudstone and occasional coal.		
							(1.10)				
17.00					B45 17.00 D44 17.00 N=17 (2,3/3,4,5,5) (S) D46 17.75		17.20		Firm slightly silty slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to coarse of flint, mudstone, quartzite and occasional coal.		
							(1.30)				
18.50					D47 18.50 N=15 (1,2/2,3,5,5) (S) D48 19.25		18.50		Medium dense light grey red slightly gravelly clayey fine to coarse SAND. Gravel is angular to subrounded fine to coarse of mudstone, flint and quartzite.		
							(0.75)				
							19.25		Light grey red sandy CLAY.		
							(1.15)				
20.00					D50 20.00				Continued next sheet		

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
21-08-2018	00:00	17.45	16.90	10.50
22-08-2018	00:00	21.20	21.00	13.10
31-08-2018	00:00	23.10	22.00	
03-09-2018	00:00	30.00	22.00	22.30

Borehole Diameter

Depth (m)	Dia (mm)
12.00	200
21.20	150

Casing Diameter

Depth (m)	Dia (mm)
12.00	200
21.00	150

Flush Information

Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation

Top (m)	Base (m)	Type	Dia (mm)
0.00	1.00	PLAIN	
1.00	12.00	SLOTTED	

Remarks:

Inspection pit dug to 1.20m. Groundwater encountered at 11.70m. Standpipe installed to 12.00m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
11.70	11.50		20	6.30	

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Flixborough EFW Plant, Scunthorpe		Client: Solar 21		Borehole ID: BH6
	Contract Number: 31554	Date Started: 21/08/2018	Logged By: SP/CL	Checked By: PC	Status: FINAL	Sheet 3 of 4
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:		Print Date: 18/10/2018	Scale: 1:50
					SPT Hammer: ALMC1 Energy Ratio: 51%	

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					D51 20.00 N=16 (2,2/3,4,4,5) (S) D52 20.40 D53 20.75 D54 20.80 D55 21.00 50 (25 for 97mm/50 for 68mm) (S) D56 21.10 D57 21.20 50 (25 for 42mm/50 for 70mm) (S)		20.40 (0.40)		Light brown clayey gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse of mudstone and flint.		
21.00 21.20							20.80 (0.30) 21.10 (0.90)		Firm light grey red slightly gravelly sandy CLAY with low cobble content of angular mudstone. Gravel is angular to subrounded fine to coarse of mudstone, flint and quartzite. Light grey slightly weathered MUDSTONE.		
22.00 - 22.50	92	92	50	NR 9	C1 22.17		22.00 (1.10)		Weak green grey MUDSTONE with very closely and closely spaced laminations and very thin beds of gypsum. Discontinuities: Horizontal and subhorizontal very closely and closely spaced. planar and undulating, smooth.		
22.50 - 23.10	88	88	32	NR 11	C2 22.91		23.10 (0.53)		Red and grey marl with gypsum bands (Driller's description, no core recovery).		
23.10 - 24.60	65	45	17	31 NI 22 NI	C3 24.26		23.63 23.90		Weak green grey MUDSTONE with occasional very thin beds of gypsum. Discontinuities: Horizontal, very closely spaced. planar smooth. Weak red brown, locally grey, MUDSTONE with very and closely spaced laminations and very thin beds of gypsum. Discontinuities: Horizontal and subhorizontal, predominantly closely spaced, occasionally very closely spaced, planar and undulating, smooth.		
24.60 - 26.10	100	81	60	8 NI 13 NI	C4 25.60		(4.00)				
26.10 - 27.60	100	100	89	7							
27.60 - 27.90	100	77	50	NI			27.90		Very weak to weak green grey and locally red brown MUDSTONE with closely spaced laminations of gypsum. Predominantly recovered none intact.		
27.90 - 28.80	100	58	29	NI 12 NI NI 8 NI			(0.90)				
28.80 - 30.00	67	9	9	NR NI 9 NI	50 (20,5/50 for 75mm) (C)		28.80 (1.20)		Very weak red brown MUDSTONE with occasional thin bed of gypsum. Predominantly recovered none intact (Probable disturbance caused by CPT testing).		
30.00							30.00		Continued next sheet		

Start & End of Shift Observations				
Date	Time	Depth (m)	Casing (m)	Water (m)
21-08-2018	00:00	17.45	16.90	10.50
22-08-2018	00:00	21.20	21.00	13.10
31-08-2018	00:00	23.10	22.00	
03-09-2018	00:00	30.00	22.00	22.30

Borehole Diameter		Casing Diameter	
Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
12.00	200	12.00	200
21.20	150	21.00	150

Flush Information				
Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation			
Top (m)	Base (m)	Type	Dia (mm)
0.00	1.00	PLAIN	
1.00	12.00	SLOTTED	

Remarks:

Inspection pit dug to 1.20m. Groundwater encountered at 11.70m. Standpipe installed to 12.00m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
11.70	11.50		20	6.30	

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Flixborough EFW Plant, Scunthorpe		Solar 21			BH6
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 4 of 4
31554	21/08/2018	SP/CL	PC	FINAL	
CP & Rotary Core Drilling Log	Easting:	Northing:	Ground Level:	Print Date: 18/10/2018	Scale: 1:50
				SPT Hammer: ALMC1 Energy Ratio: 51%	

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					50 (18,7/50 for 75mm) (C)				End of Borehole at 30.000m		

31 32 33 34 35 36 37 38 39 40

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
21-08-2018	00:00	17.45	16.90	10.50	12.00	200	12.00	200
22-08-2018	00:00	21.20	21.00	13.10	21.20	150	21.00	150
31-08-2018	00:00	23.10	22.00					
03-09-2018	00:00	30.00	22.00	22.30				

Flush Information				
Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation			
Top (m)	Base (m)	Type	Dia (mm)
0.00	1.00	PLAIN	
1.00	12.00	SLOTTED	

Remarks:

Inspection pit dug to 1.20m. Groundwater encountered at 11.70m. Standpipe installed to 12.00m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
11.70	11.50		20	6.30	

Fracture Index reported as number per metre. TCR, SCR and RQD reported in %

PHOTOGRAPHS OF ROCK CORE

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Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH2

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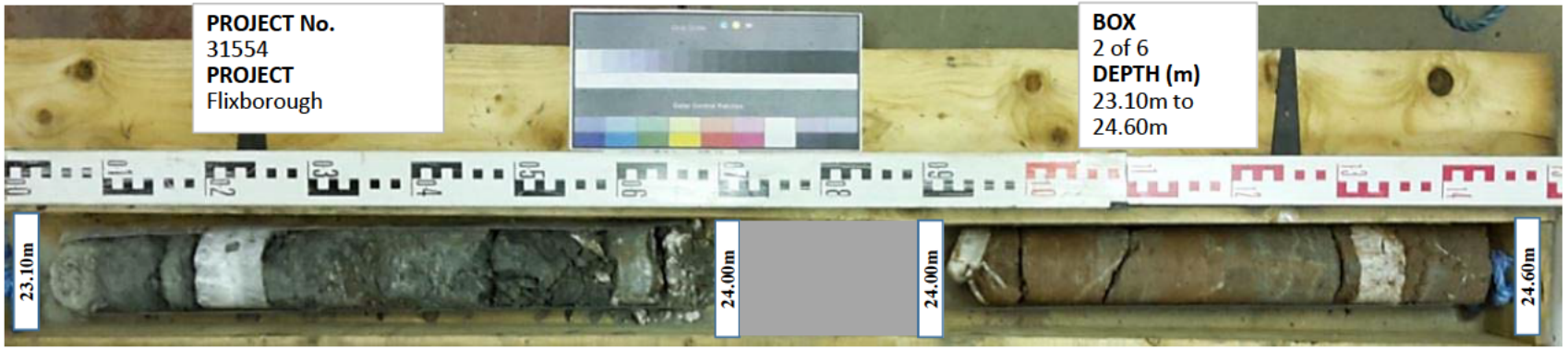
Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH2



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Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH2

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Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH2

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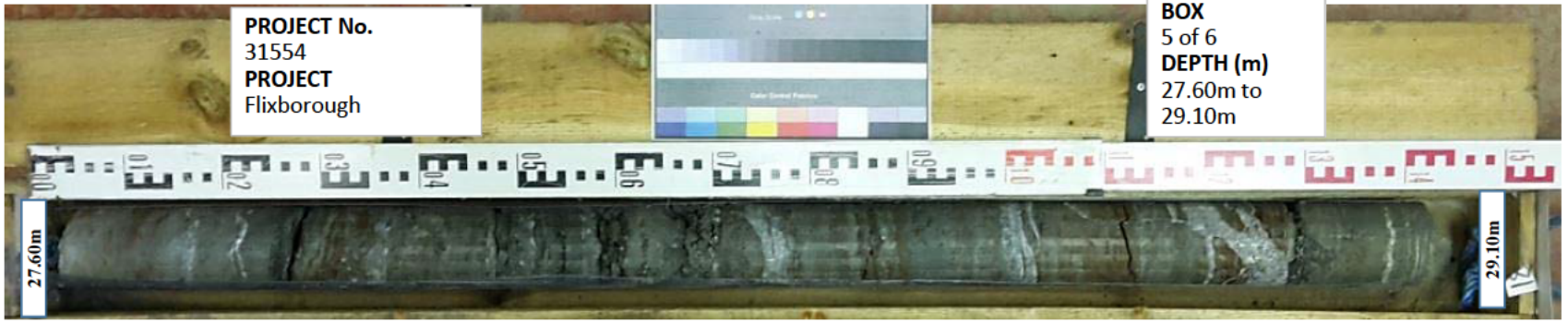
Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH2



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Contract No. 31554
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BH2

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Contract Name: Flixborough
Contract No. 31554
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BH3

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Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH3

IAN FARMER ASSOCIATES

Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH3

IAN FARMER ASSOCIATES

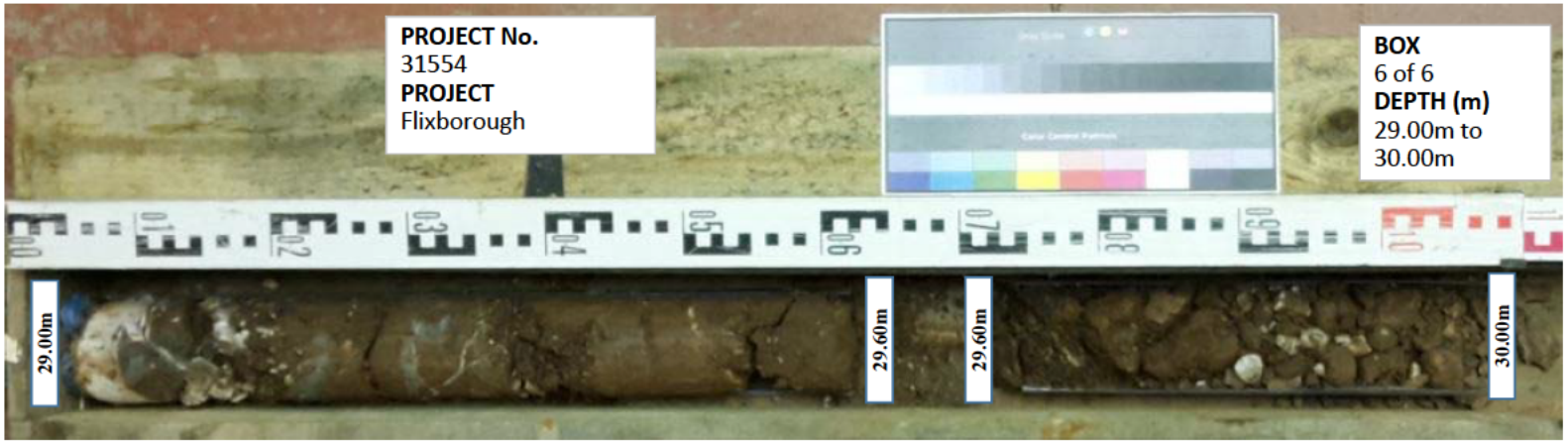
Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH3

IAN FARMER ASSOCIATES

Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH3

IAN FARMER ASSOCIATES

Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH3



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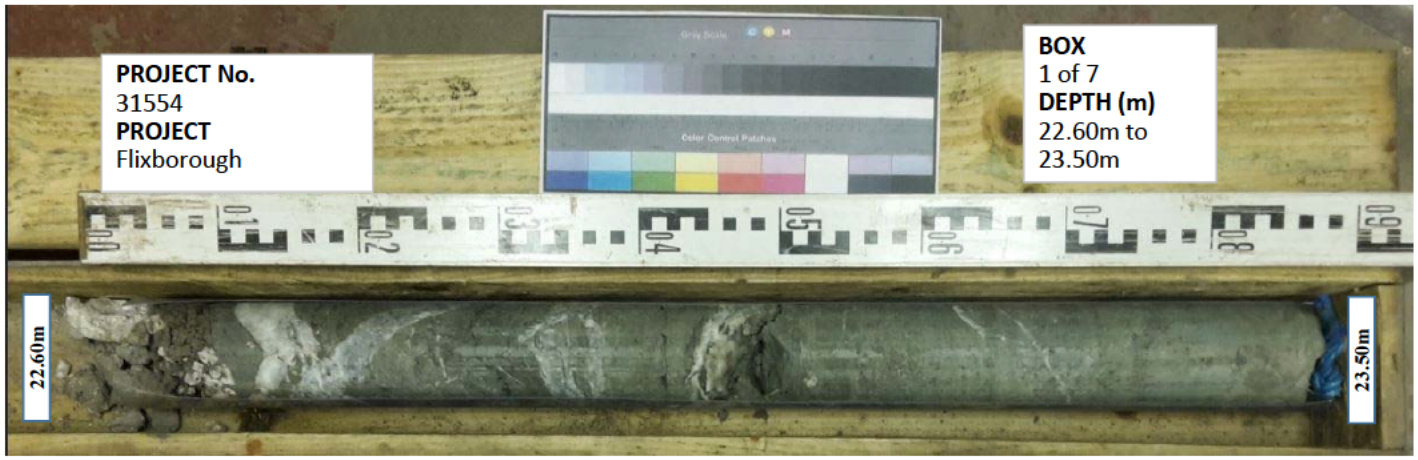
Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH4



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Core Photographs
BH4

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Contract Name: Flixborough
Contract No. 31554
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BH4

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Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH4

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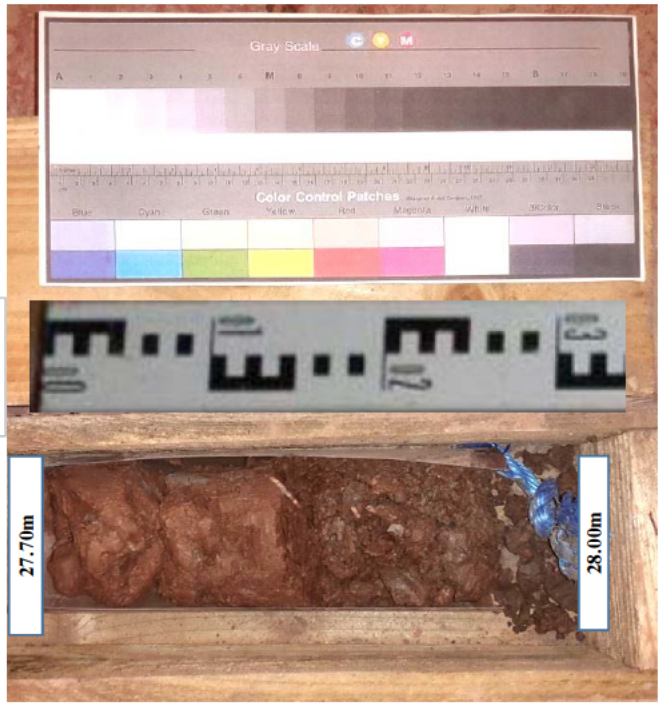
Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH4

PROJECT No.
31554
PROJECT
Flixborough



BOX
5 of 7
DEPTH (m)
27.70m to

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Contract No. 31554
Core Photographs
BH4

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Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH5

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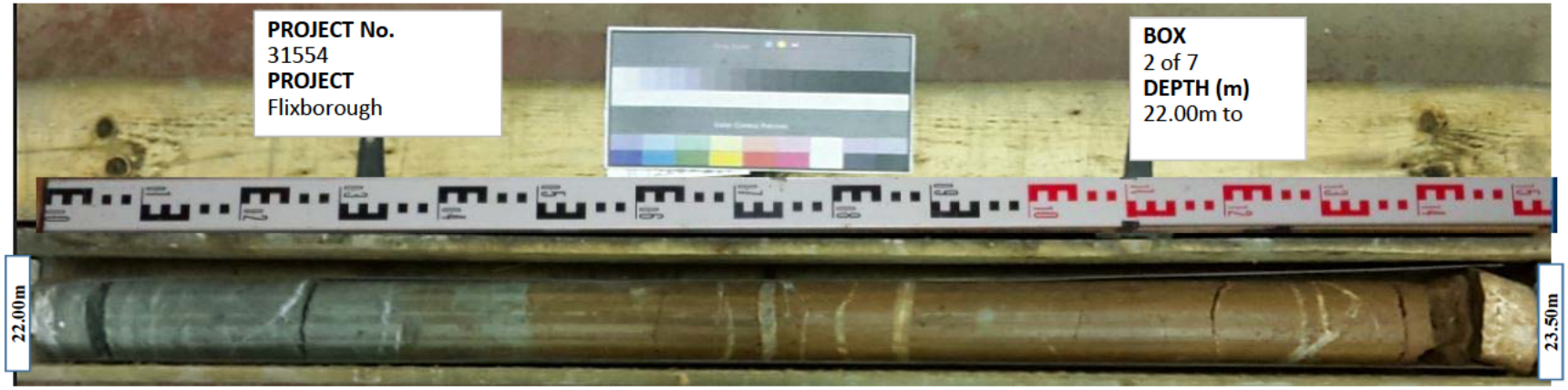
Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH5



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BH5

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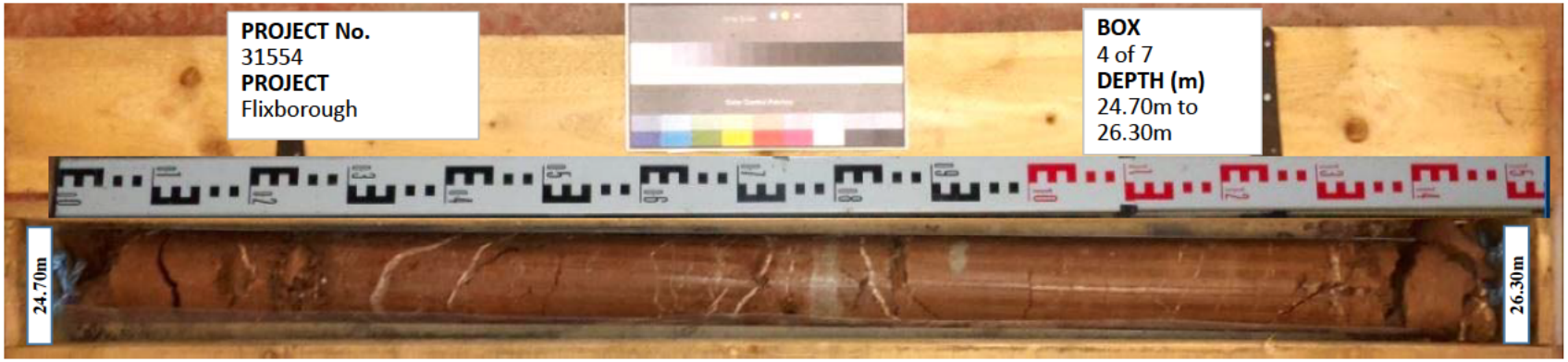
Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH5



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Contract Name: Flixborough
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BH5

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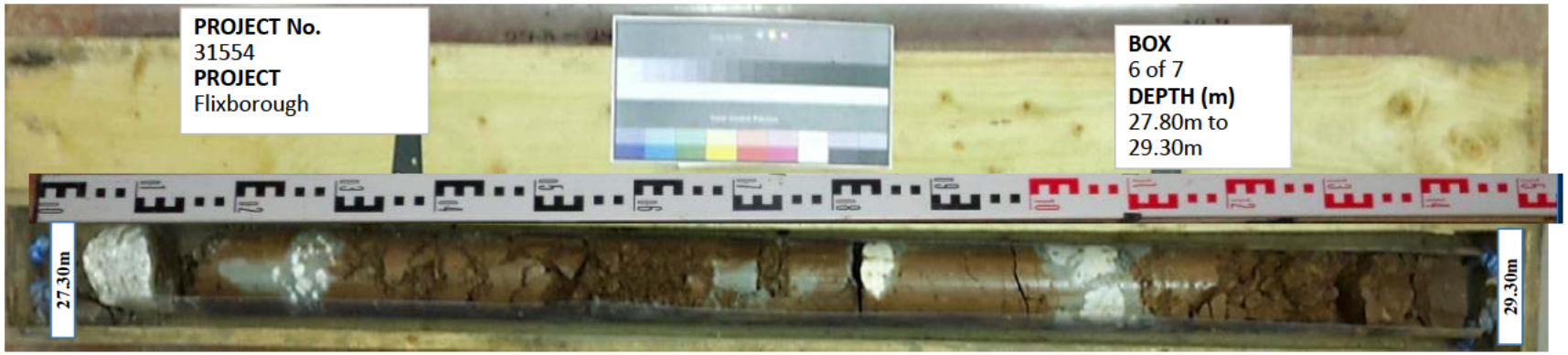
Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH5



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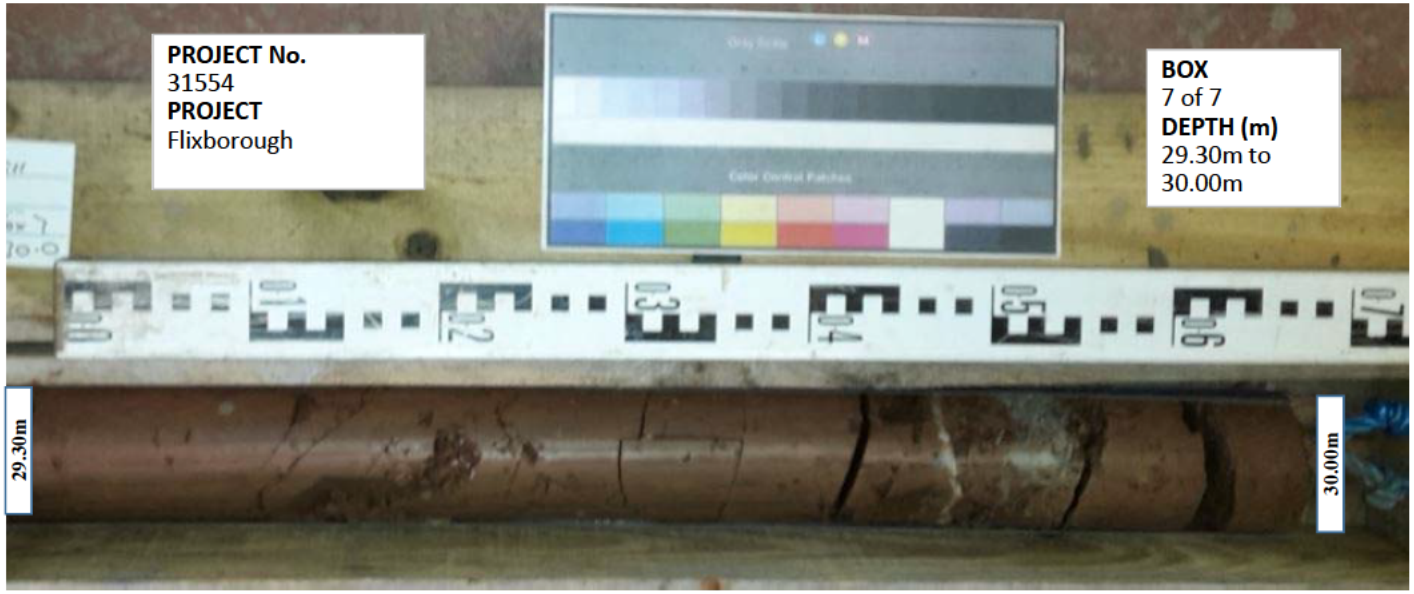
Contract No. 31554
Core Photographs
BH5



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Core Photographs
BH6

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Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH6

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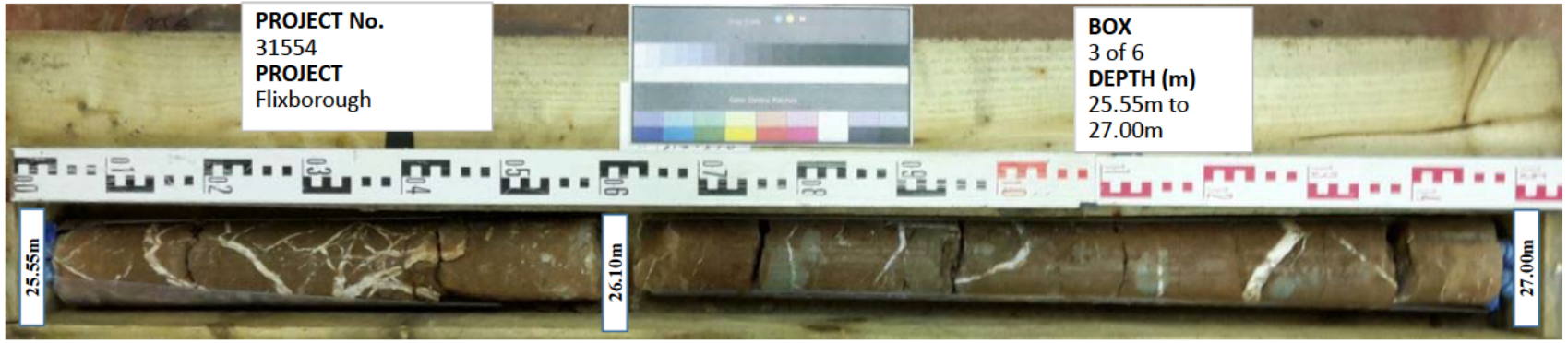
Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH6



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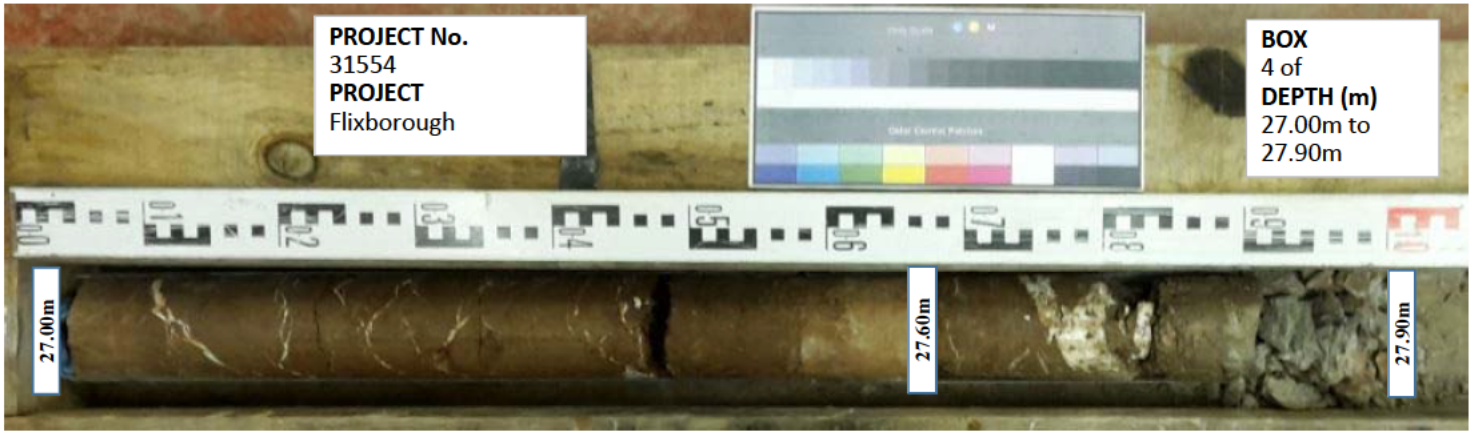
Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH6



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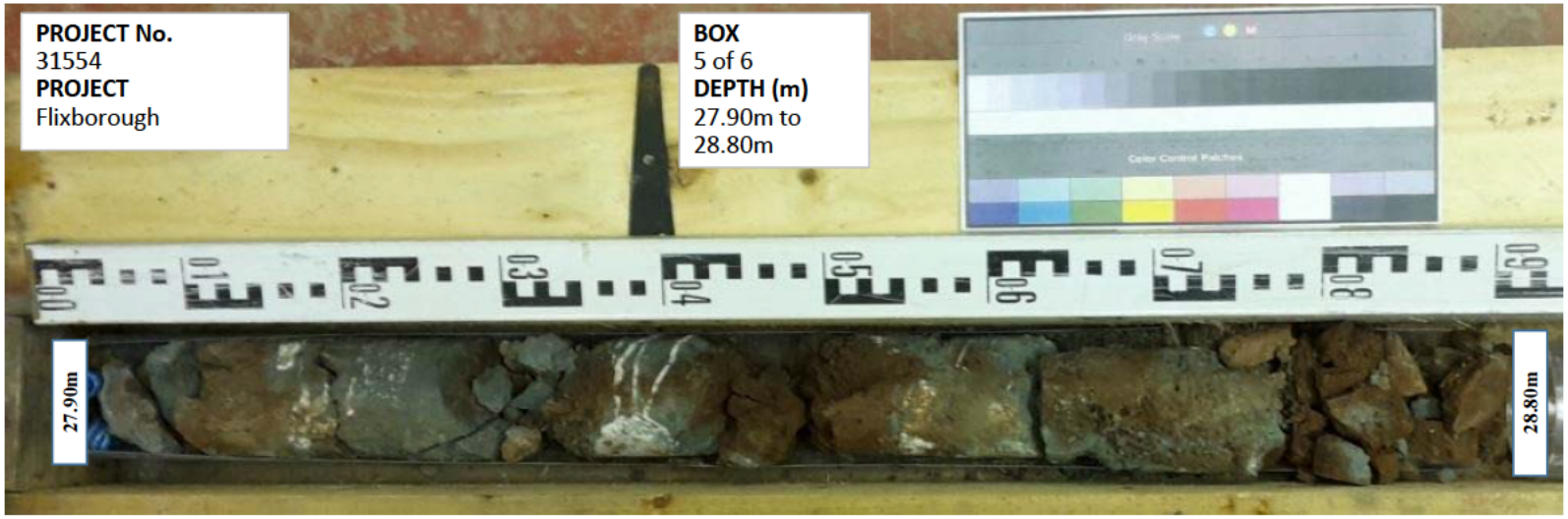
Contract No. 31554
Core Photographs
BH6



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Contract Name: Flixborough
Contract No. 31554
Core Photographs
BH6

GROUND GAS & GROUNDWATER MONITORING RECORDS

IAN FARMER ASSOCIATES

Gas and Groundwater Monitoring Results

Contract No:	31554
Contract Name:	Flixborough
Date:	14/09/2018

Background Readings:						
	O_2 % v/v	20.6	**CO_2 % v/v**	ND	**CH_4 % v/v**	N/D
	Weather Conditions					
	Ground Conditions (dry/wet etc.)					
	Atmospheric Pressure (Start):					
	Atmospheric Pressure (Finish):					

Hole No:	Time (hh:mm)	O_2 % v/v		CO_2 % v/v		CH_4 % v/v		CO ppm		H_2S ppm		VOCs ppm		Gas Flow Rate (l/hr)	SWL	Base of Pipe	Comments
		Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Steady	mBGL	mBGL	
BH3																12.00	
BH6																12.00	

Remarks:

ND = Below detection limit of instrument. NR = Not Recorded.

Readings Taken By:	**PS**	
Checked By:		

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Gas and Groundwater Monitoring Results

Contract No:	31554
Contract Name:	Flixborough
Date:	28/09/2018

Background Readings:

O_2 % v/v	20.8	**CO_2 % v/v**	ND	**CH_4 % v/v**	N/D

Weather Conditions	Sunny, Dry
Ground Conditions (dry/wet etc.)	Dry
Atmospheric Pressure (Start):	1033mb
Atmospheric Pressure (Finish):	1033mb

Hole No:	Time (hh:mm)	O_2 % v/v		CO_2 % v/v		CH_4 % v/v		CO ppm		H_2S ppm		VOCs ppm		Gas Flow Rate (l/hr)	SWL	Base of Pipe	Comments
		Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Steady	mBGL	mBGL	
BH3	14:20	0.8	0.0	N/D	N/D	92.9	92.9	ND	ND	ND	ND	ND	ND	57.8	2.08	12.00	
BH6	14:35	1.0	0.0	19.8	19.1	76.0	75.9	ND	ND	ND	ND	ND	ND	20.4	1.65	12.00	

Remarks:

ND = Below detection limit of instrument. NR = Not Recorded.

Readings Taken By:	**SP**	
Checked By:	**CL**	

IAN FARMER ASSOCIATES

Gas and Groundwater Monitoring Results

Contract No:	31554
Contract Name:	Flixborough
Date:	09/10/2018

Background Readings:

O_2 % v/v	20.8	**CO_2 % v/v**	ND	**CH_4 % v/v**	N/D

Weather Conditions	Sunny, Dry
Ground Conditions (dry/wet etc.)	Dry
Atmospheric Pressure (Start):	1015mb
Atmospheric Pressure (Finish):	1015mb

Hole No:	Time (hh:mm)	O_2 % v/v		CO_2 % v/v		CH_4 % v/v		CO ppm		H_2S ppm		VOCs ppm		Gas Flow Rate (l/hr)	SWL	Base of Pipe	Comments
		Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Steady	mBGL	mBGL	
BH3	10:48	1.2	0.0	N/D	N/D	91.4	91.4	ND	ND	ND	ND	ND	ND	3.8	2.14	12.00	
BH6	10:25	14.0	0.0	18.4	18.4	75.0	74.8	ND	ND	ND	ND	ND	ND	1.8	1.75	12.00	

Remarks:

ND = Below detection limit of instrument. NR = Not Recorded.

Readings Taken By:	**SP**	
Checked By:	**CL**	

IAN FARMER ASSOCIATES

Gas and Groundwater Monitoring Results

Contract No:	31554
Contract Name:	Flixborough
Date:	16/10/2018

Background Readings:

O_2 % v/v	20.6	**CO_2 % v/v**	ND	**CH_4 % v/v**	N/D

Weather Conditions	Clooudy, Dry
Ground Conditions (dry/wet etc.)	Slightly wet
Atmospheric Pressure (Start):	1019mb
Atmospheric Pressure (Finish):	1018mb

Hole No:	Time (hh:mm)	O_2 % v/v		CO_2 % v/v		CH_4 % v/v		CO ppm		H_2S ppm		VOCs ppm		Gas Flow Rate (l/hr)	SWL	Base of Pipe	Comments
		Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Steady	mBGL	mBGL	
BH3	10:17	1.0	0.0	2.3	N/D	89.9	89.1	ND	ND	ND	ND	ND	ND	2.9	2.08	12.00	
BH6	10:34	9.1	0.0	17.4	17.4	81.0	81.0	ND	ND	ND	ND	ND	ND	1.2	1.69	12.00	

Remarks:

ND = Below detection limit of instrument. NR = Not Recorded.

Readings Taken By:	**SP**	
Checked By:	**CL**	

APPENDIX 3

LABORATORY TESTS

APPENDIX 3

GENERAL NOTES ON LABORATORY TESTS ON SOILS

A3.1 GENERAL

A3.1.1 Where applicable all tests are carried out in accordance with the relevant British Standard. The laboratory test procedures are given in the laboratory test reports.

A3.1.2 Any discussion in this report is based on the values and results obtained from the appropriate tests. Due allowance should be made, when considering any result in isolation, of the possible inaccuracy of any such individual result. Details of the accuracy of results are included in this section, where applicable.

A3.2 SOIL CLASSIFICATION

A3.2.1 Classification of soils is usually undertaken by means of the Plasticity Classification Chart, sometimes called the A-Line Chart. This is graphical plot of PI against LL with the A-Line defined as PI = 0.73(LL - 20).

A3.2.2 This line is defined from experimental evidence and does not represent a well-defined boundary between soil types, but forms a useful reference datum. When the values of LL and PI for inorganic clays are plotted on the chart they generally lie just above the A-Line in a narrow band parallel to it, while silts and organic clays plot below this line.

A3.2.3 Clays and silts are divided into five zones of plasticity:

Low Plasticity (L)	LL less than 35
Intermediate Plasticity (I)	LL between 35 and 50
High Plasticity (H)	LL between 50 and 70
Very High Plasticity (V)	LL between 70 and 90
Extremely High Plasticity (E)	LL greater than 90

A3.2.4 In general, clays of high plasticity are likely to have a lower permeability, are more compressible and consolidate over a longer period of time under load than clays of low plasticity. Clays of high plasticity are more difficult to compact as fill material.

REPORT 31554/1

IAN FARMER ASSOCIATES

Unit 4, Faraday Close, Pattinson North Industrial Estate, Washington, NE38 8QJ. Tel: 0191 482 8500 Fax: 0191 482 8520
washington@ianfarmer.co.uk www.ianfarmer.co.uk

F.A.O.

Test Report - 31554 / 1

Site:	Flixborough EFW Plant, Scunthorpe
Job Number:	31554
Originating Client:	Solar 21
Originating Reference:	31554
Date Sampled:	Not Given
Date Scheduled:	07/09/2018
Date Testing Started:	19/09/2018
Date Testing Finished:	26/09/2018
Remarks:	

Authorised By: [redacted]

Tim Robinson
Quality Technician

Date: 26/09/2018

Constructionline
Part of Capita plc

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Newcastle upon Tyne (0191) 482 8500. Motherwell (01698) 230231. Warrington (01925) 855440. Washington (0191) 482 8500.

AGS

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Laboratory Test Report | 31554 / 1

Site: Flixborough EFW Plant, Scunthorpe **Job Number:** 31554

Client: Solar 21 **Page:** 2

Determination of Water Content, Liquid Limit and Plastic Limit and Derivation of Plasticity and Liquidity Index

Borehole / Trial Pit	Depth (m)	Sample	Natural / Sieved	Natural Water Content %	Sample Passing 425 µm Sieve		Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Class	Description / Remarks
					Percentage %	Water Content %						
BH2	2.00	U10	Natural	28.9	99	29.0	52	25	27	0.15	CH	Brown sandy CLAY
BH2	19.00	D52	Natural	23.1	68	32.0	40	26	14	0.41	MI	Brown slightly gravelly sandyCLAY
BH3	2.10	U7	Natural	30	88	33.0	38	24	14	0.67	CI	Brown sandy gravelly CLAY
BH3	4.00	U12	Natural	44.4	100	45.0	62	29	33	0.47	CH	Brown sandy organic CLAY
BH4	4.00	U17	Natural	44.5	99	45.0	63	31	32	0.43	CH	Brown sandy CLAY
BH4	20.00	D54	Sieved	37.4	77	47.0	49	34	15	0.88	MI	Red/Brown slightly gravelly SILT
BH5	1.85	D8	Natural	32	99	32.0	46	23	23	0.40	CI	Brown sandy CLAY
BH5	4.45	D16	Natural	35.3	98	36.0	51	33	18	0.17	MH	Brown laminated SILT
BH5	6.50	U22	Sieved	176	95	185.0	88	44	44	3.20	MV	Black organic SILT (PEAT)
BH5	18.50	D49	Natural	28	65	41.0	44	31	13	0.74	MI	Red/Brown gravelly CLAY
BH6	1.20	D6	Natural	28	91	30.0	46	25	21	0.25	CI	Brown sandy CLAY
BH6	6.50	U22	Sieved	79.5	98	81.0	64	34	30	1.58	MH	Brown SILT (PEAT)

Method of Preparation: BS EN ISO 17892 : Part 1 : 2014 : Clause 5.1 Water content test preparation
BS 1377 : Part 1 : 2016 : Clause 8.4.3 Preparation of samples for plasticity tests
BS 1377 : Part 2 : 1990 : Clause 4.2 Preparation of samples for plastic limit tests

Method of Test: BS EN ISO 17892 : Part 1 : 2014 : Clause 5.2 Water content test execution
BS 1377 : Part 2 : 1990 : Clause 4.3 or 4.4 Determination of the liquid limit
BS 1377 : Part 2 : 1990 : Clause 5.3 Determination of the plastic limit and plasticity index

UKAS TESTING 1464

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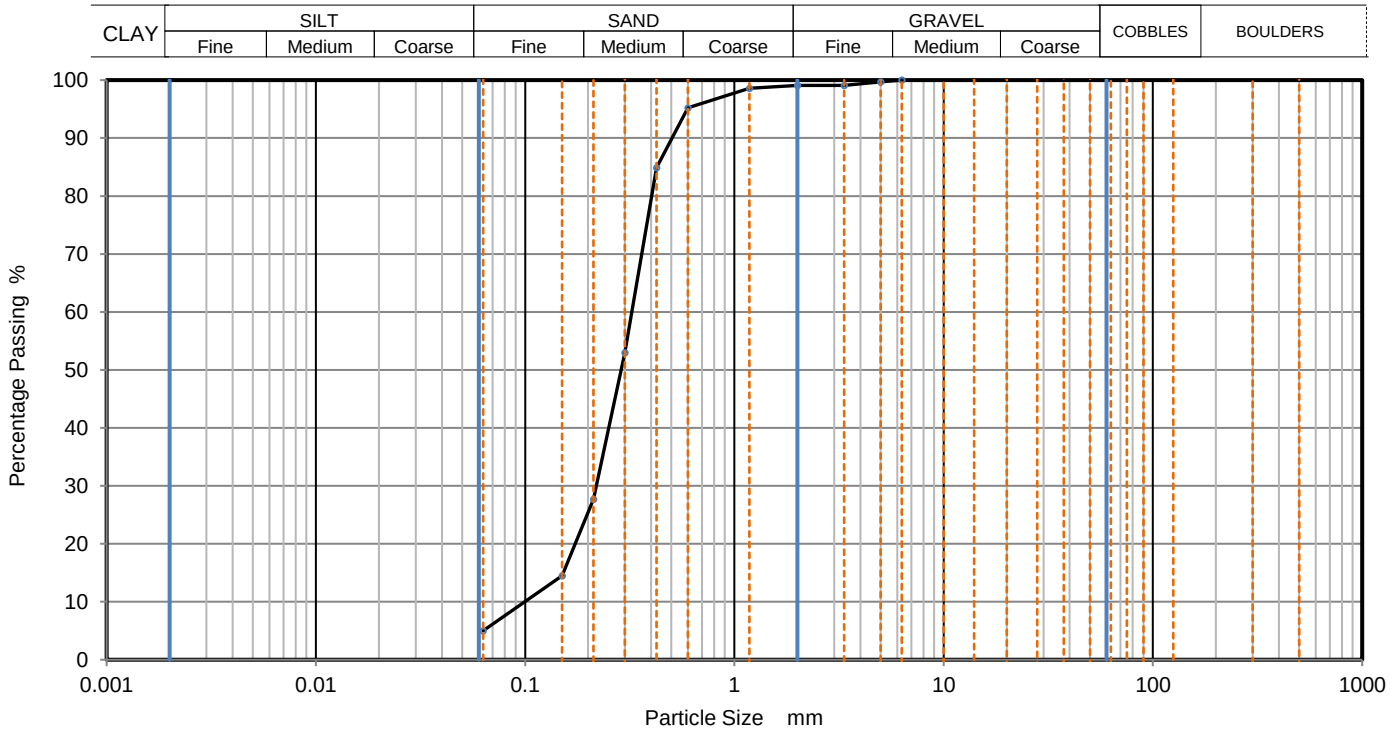
Laboratory Test Report | 31554 / 1

Site: Flixborough EFW Plant, Scunthorpe | **Job Number:** 31554

Client: Solar 21 | **Page:** 3

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
BH2	14.00	B42	Wet Sieve	Brown slightly silty slightly gravelly SAND



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
6.3	100		
5	100		
3.35	99		
2	99		
1.18	99		
0.6	95		
0.425	85		
0.3	53		
0.212	28		
0.15	15		
0.063	5		

Dry Mass of sample, g: 1659

Sample Proportions	% dry mass
Very coarse	0
Gravel	1
Sand	94
Fines <0.063mm	5

Grading Analysis		
D100	mm	6.3
D60	mm	0.324
D30	mm	0.219
D10	mm	0.0997
Uniformity Coefficient		3.2
Curvature Coefficient		1.5

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Method of Preparation: BS 1377:Part 1:1990, clause 7 3 Initial preparation
BS 1377:Part 1:1990, clause 7.4.5 Preparation of particle size tests

Method of Test: BS1377:Part 2:1990, clause 9.2 Determination of particle size distribution by wet sieving method

UKAS TESTING 1464

IAN FARMER ASSOCIATES

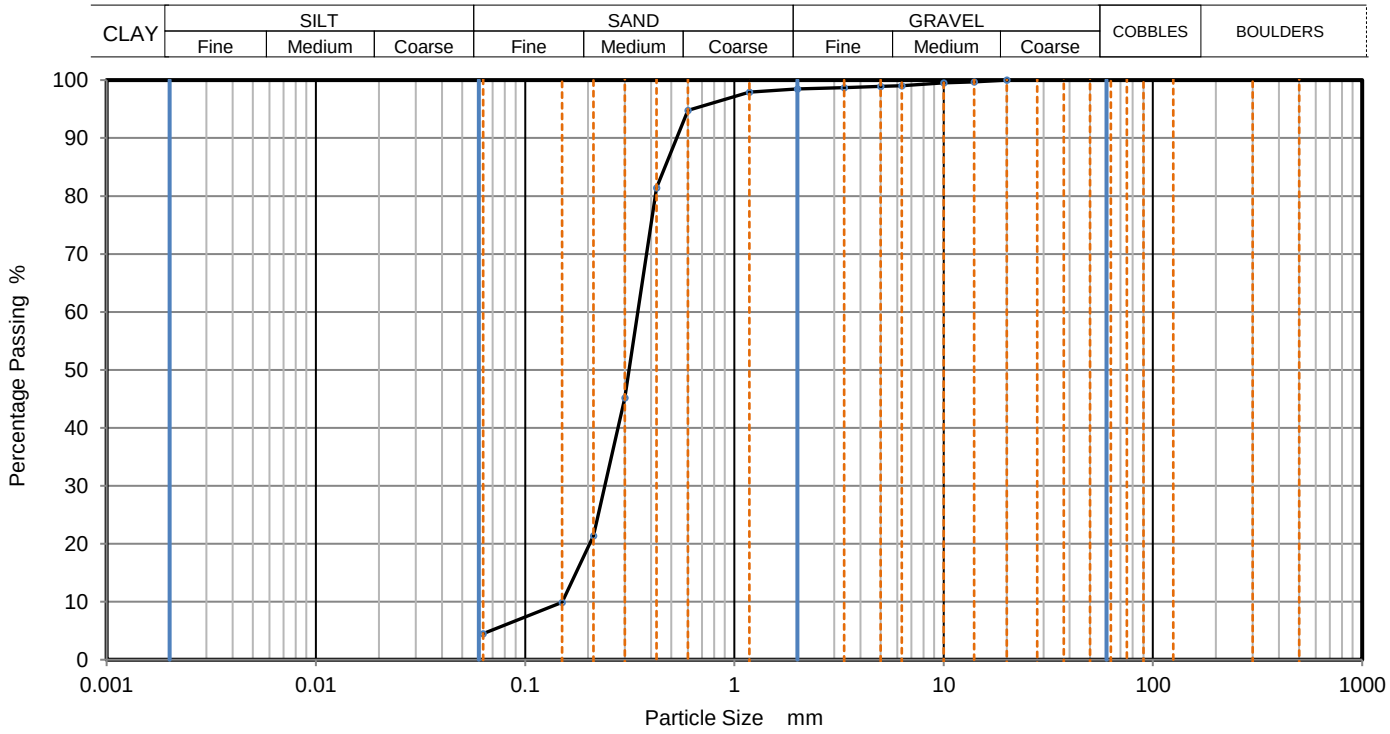
Laboratory Test Report | 31554 / 1

Site: Flixborough EFW Plant, Scunthorpe | **Job Number:** 31554

Client: Solar 21 | **Page:** 4

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
BH4	12.50	B38	Wet Sieve	Brown slightly silty slightly gravelly SAND



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
20	100		
14	100		
10	100		
6.3	99		
5	99		
3.35	99		
2	99		
1.18	98		
0.6	95		
0.425	81		
0.3	45		
0.212	21		
0.15	10		
0.063	5		

Dry Mass of sample, g	1612

Sample Proportions	% dry mass
Very coarse	0
Gravel	2
Sand	94
Fines <0.063mm	5

Grading Analysis		
D100	mm	20
D60	mm	0.346
D30	mm	0.24
D10	mm	0.15
Uniformity Coefficient		2.3
Curvature Coefficient		1.1

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Method of Preparation: BS 1377:Part 1:1990, clause 7 3 Initial preparation
BS 1377:Part 1:1990, clause 7.4.5 Preparation of particle size tests

Method of Test: BS1377:Part 2:1990, clause 9.2 Determination of particle size distribution by wet sieving method

UKAS TESTING 1464

IAN FARMER ASSOCIATES

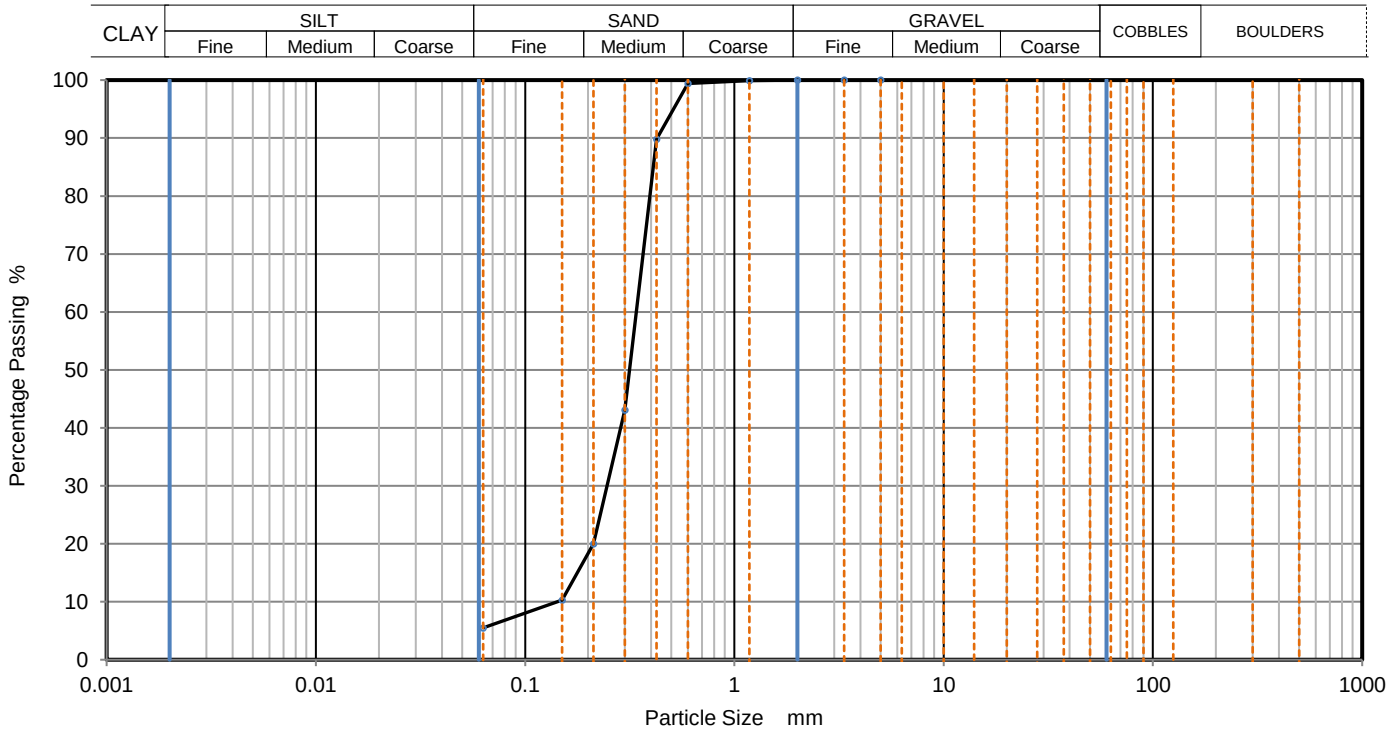
Laboratory Test Report | 31554 / 1

Site: Flixborough EFW Plant, Scunthorpe | **Job Number:** 31554

Client: Solar 21 | **Page:** 5

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
BH6	12.50	B35	Wet Sieve	Brown slightly silty SAND



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
5	100		
3.35	100		
2	100		
1.18	100		
0.6	99		
0.425	90		
0.3	43		
0.212	20		
0.15	10		
0.063	6		

Dry Mass of sample, g: 1063

Sample Proportions	% dry mass
Very coarse	0
Gravel	0
Sand	95
Fines <0.063mm	6

Grading Analysis		
D100	mm	2
D60	mm	0.34
D30	mm	0.246
D10	mm	0.142
Uniformity Coefficient		2.4
Curvature Coefficient		1.3

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Method of Preparation: BS 1377:Part 1:1990, clause 7 3 Initial preparation
BS 1377:Part 1:1990, clause 7.4.5 Preparation of particle size tests

Method of Test: BS1377:Part 2:1990, clause 9.2 Determination of particle size distribution by wet sieving method

UKAS TESTING 1464

Site: Flixborough EFW Plant, Scunthorpe **Job Number:** 31554

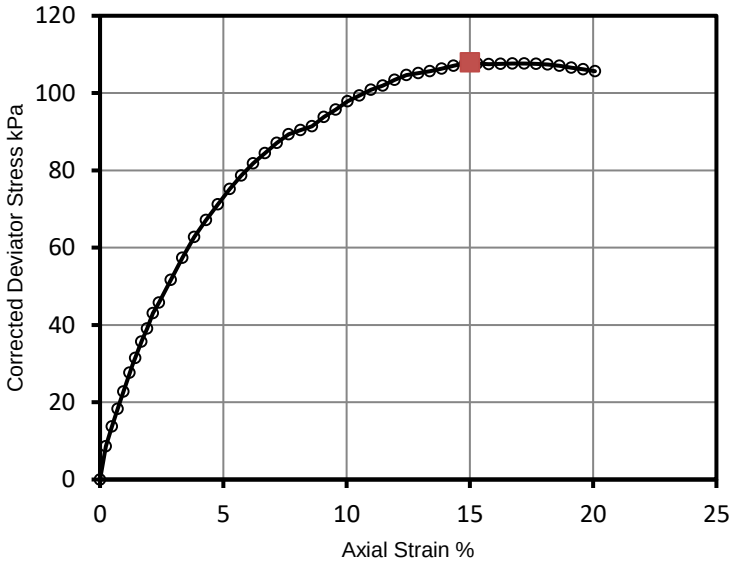
Client: Solar 21 **Page:** 6

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen (Definitive Method)

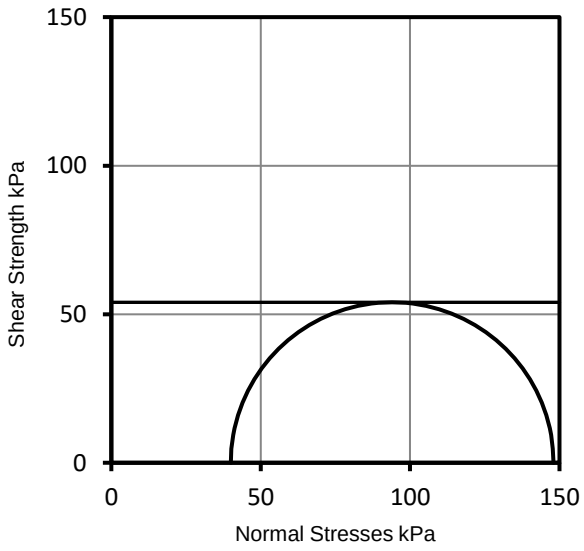
Borehole / Trial Pit	Depth (m)	Sample	Description
BH2	2.00	U10	**Brown slightly gravelly sandy CLAY**

Initial Sample	Test Number	1
	Original Length (mm)	450.00
	Depth from Top (mm)	27.11
	Condition	Undisturbed
	Orientation	Vertical
Length (mm)		209.24
Diameter (mm)		102.11
Moisture Content (%)		28.10
Bulk Density (Mg/m3)		2.05
Dry Density (Mg/m3)		1.60
Membrane Thickness (mm)		0.3
Membrane Type		Latex
Rate of Strain (%/min)		1.9
Test Results	Cell Pressure (kPa)	40
	Axial Strain (%)	15
	Membrane Corr. (kPa)	0.88
	Deviator Stress, (σ1 - σ3)f (kPa)	108
	Undrained Shear Strength, cu = ½(σ1 - σ3)f (kPa)	54
	Mode of Failure	Compound

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

UKAS TESTING 1464

IAN FARMER ASSOCIATES	Laboratory Test Report	31554 / 1

Site: Flixborough EFW Plant, Scunthorpe **Job Number:** 31554

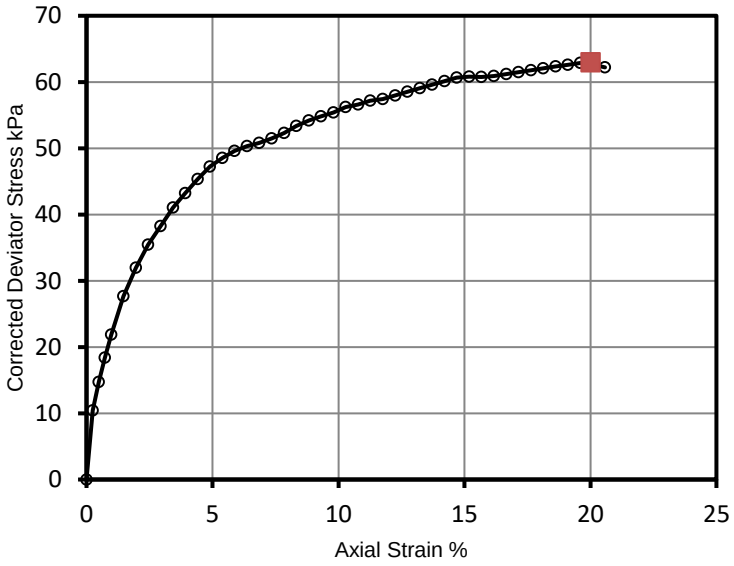
Client: Solar 21 **Page:** 7

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen (Definitive Method)

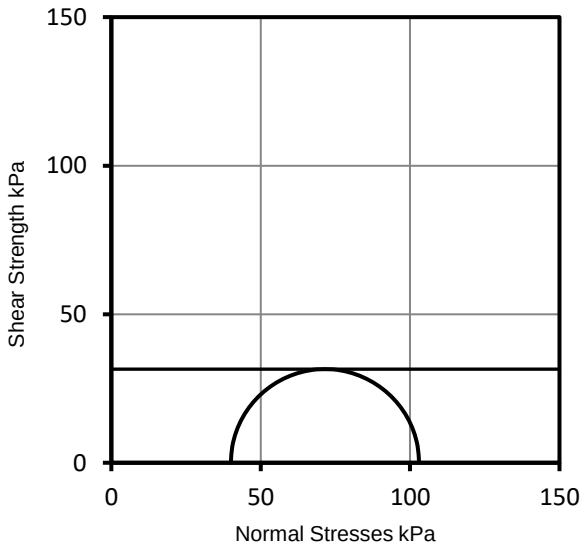
Borehole / Trial Pit	Depth (m)	Sample	Description
BH3	2.10	U7	**Brown gravelly CLAY**

Initial Sample	Test Number	1
	Original Length (mm)	400.00
	Depth from Top (mm)	40.00
	Condition	Undisturbed
	Orientation	Vertical
Length (mm)		204.10
Diameter (mm)		102.19
Moisture Content (%)		30.00
Bulk Density (Mg/m3)		2.11
Dry Density (Mg/m3)		1.62
Membrane Thickness (mm)		0.36
Membrane Type		Latex
Rate of Strain (%/min)		2.0
Test Results	Cell Pressure (kPa)	40
	Axial Strain (%)	20
	Membrane Corr. (kPa)	1.33
	Deviator Stress, (σ1 - σ3)f (kPa)	63
	Undrained Shear Strength, cu = ½(σ1 - σ3)f (kPa)	31
	Mode of Failure	Compound

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

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Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
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Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

UKAS TESTING 1464

IAN FARMER ASSOCIATES	Laboratory Test Report	31554 / 1

Site: Flixborough EFW Plant, Scunthorpe **Job Number:** 31554

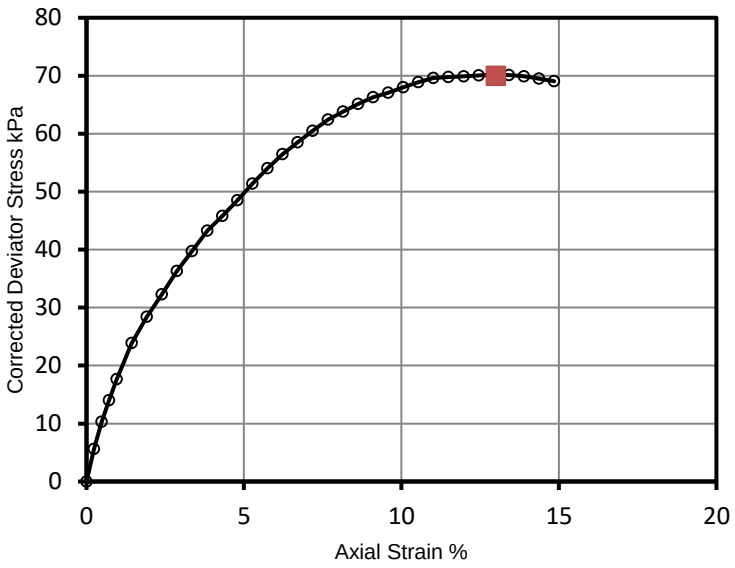
Client: Solar 21 **Page:** 8

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen (Definitive Method)

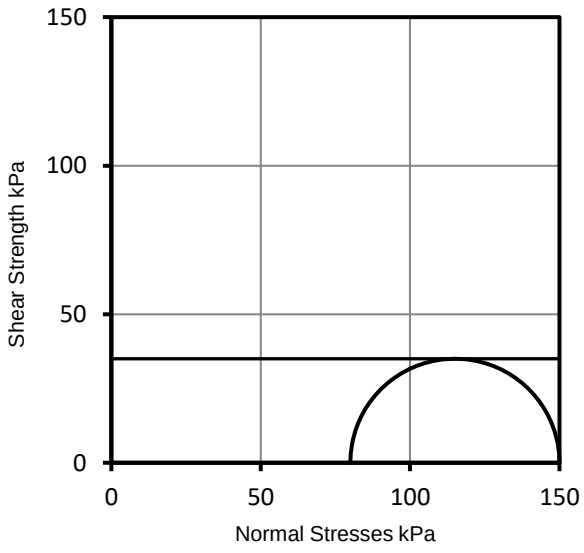
Borehole / Trial Pit	Depth (m)	Sample	Description
BH3	4.00	U12	**Brown slightly gravelly organic CLAY**

Initial Sample	Test Number	1
	Original Length (mm)	450.00
	Depth from Top (mm)	30.17
	Condition	Undisturbed
	Orientation	Vertical
Length (mm)		208.78
Diameter (mm)		102.44
Moisture Content (%)		44.60
Bulk Density (Mg/m3)		1.81
Dry Density (Mg/m3)		1.25
Membrane Thickness (mm)		0.31
Membrane Type		Latex
Rate of Strain (%/min)		1.9
Test Results	Cell Pressure (kPa)	80
	Axial Strain (%)	13
	Membrane Corr. (kPa)	0.82
	Deviator Stress, (σ1 - σ3)f (kPa)	70
	Undrained Shear Strength, cu = ½(σ1 - σ3)f (kPa)	35
	Mode of Failure	Plastic

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

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BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

UKAS TESTING 1464

Site: Flixborough EFW Plant, Scunthorpe **Job Number:** 31554

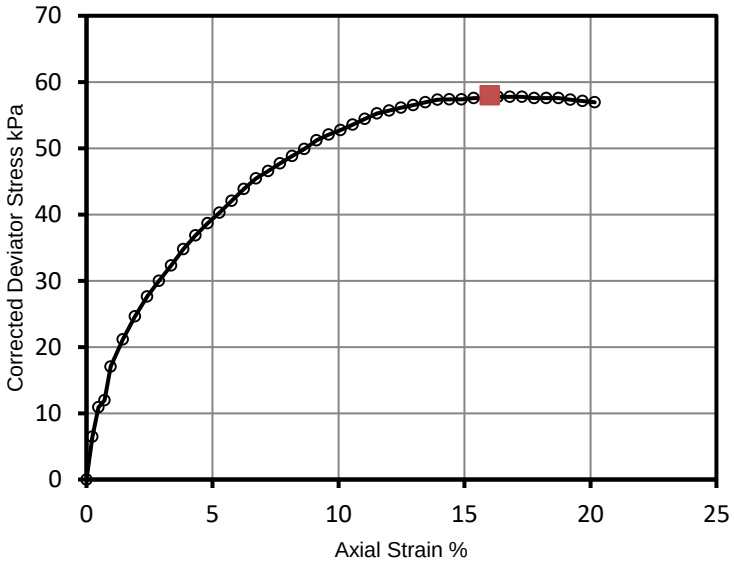
Client: Solar 21 **Page:** 9

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen (Definitive Method)

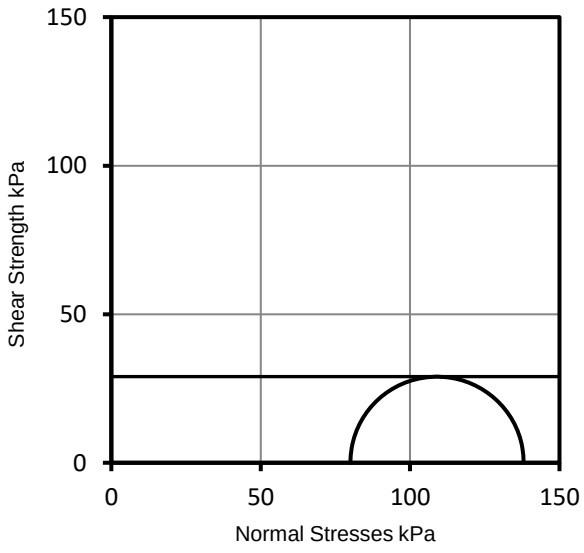
Borehole / Trial Pit	Depth (m)	Sample	Description
BH4	4.00	U17	**Brown slightly sandy CLAY**

Initial Sample	Test Number	1
	Original Length (mm)	450.00
	Depth from Top (mm)	42.62
	Condition	Undisturbed
	Orientation	Vertical
Length (mm)		208.22
Diameter (mm)		100.56
Moisture Content (%)		30.60
Bulk Density (Mg/m3)		1.82
Dry Density (Mg/m3)		1.39
Membrane Thickness (mm)		0.29
Membrane Type		Latex
Rate of Strain (%/min)		1.9
Test Results	Cell Pressure (kPa)	80
	Axial Strain (%)	16
	Membrane Corr. (kPa)	0.94
	Deviator Stress, (σ1 - σ3)f (kPa)	58
	Undrained Shear Strength, cu = ½(σ1 - σ3)f (kPa)	29
	Mode of Failure	Plastic

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
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Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

UKAS TESTING 1464

Site: Flixborough EFW Plant, Scunthorpe **Job Number:** 31554

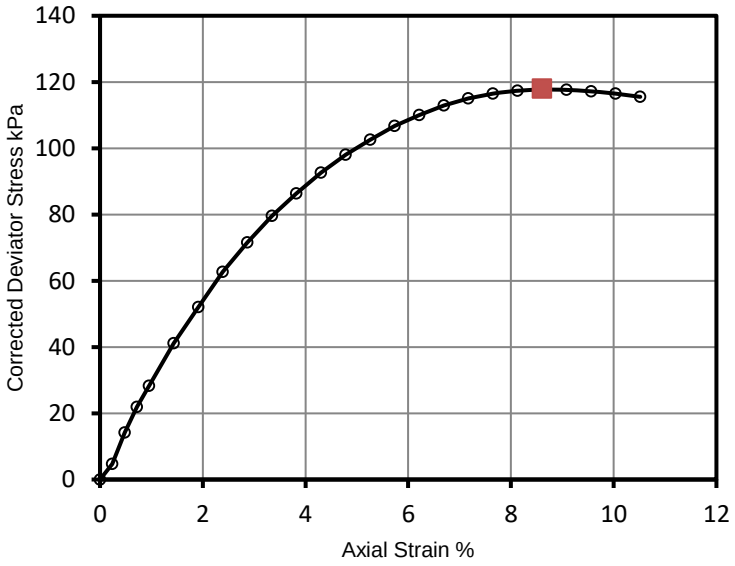
Client: Solar 21 **Page:** 10

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen (Definitive Method)

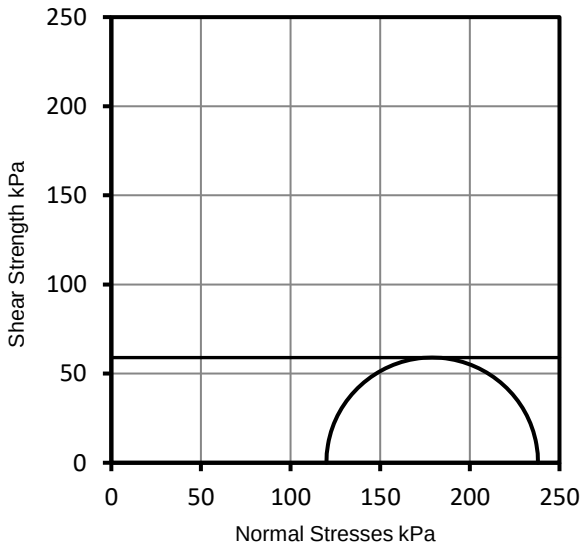
Borehole / Trial Pit	Depth (m)	Sample	Description
BH5	6.50	U22	**Black organic CLAY with inclusions of peat.**

Initial Sample	Test Number	1
	Original Length (mm)	450.00
	Depth from Top (mm)	42.18
	Condition	Undisturbed
	Orientation	Vertical
Length (mm)		209.18
Diameter (mm)		102.67
Moisture Content (%)		133.00
Bulk Density (Mg/m3)		1.23
Dry Density (Mg/m3)		0.53
Membrane Thickness (mm)		0.31
Membrane Type		Latex
Rate of Strain (%/min)		1.9
Test Results	Cell Pressure (kPa)	120
	Axial Strain (%)	8.6
	Membrane Corr. (kPa)	0.6
	Deviator Stress, (σ1 - σ3)f (kPa)	118
	Undrained Shear Strength, cu = ½(σ1 - σ3)f (kPa)	59
	Mode of Failure	Plastic

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

UKAS TESTING 1464

IAN FARMER ASSOCIATES	Laboratory Test Report	31554 / 1

Site: Flixborough EFW Plant, Scunthorpe **Job Number:** 31554

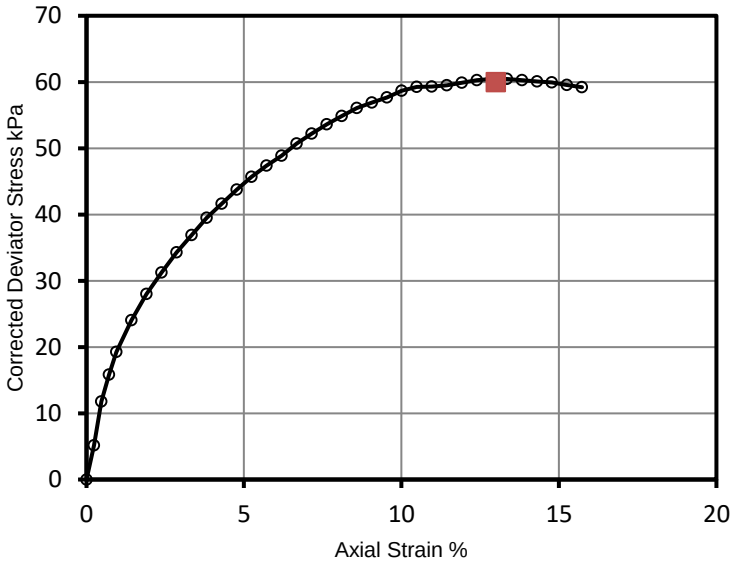
Client: Solar 21 **Page:** 11

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen (Definitive Method)

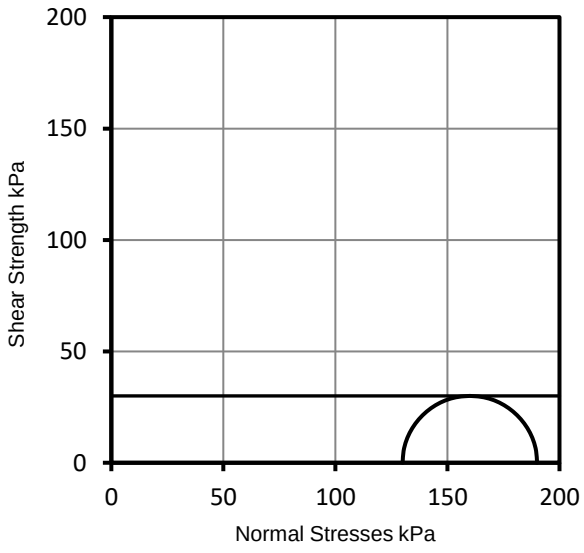
Borehole / Trial Pit	Depth (m)	Sample	Description
BH6	6.50	U22	**Brown organic SILT**

Initial Sample	Test Number	1
	Original Length (mm)	450.00
	Depth from Top (mm)	41.17
	Condition	Undisturbed
	Orientation	Vertical
Length (mm)		209.76
Diameter (mm)		102.50
Moisture Content (%)		97.80
Bulk Density (Mg/m3)		1.42
Dry Density (Mg/m3)		0.72
Membrane Thickness (mm)		0.28
Membrane Type		Latex
Rate of Strain (%/min)		1.9
Test Results	Cell Pressure (kPa)	130
	Axial Strain (%)	13
	Membrane Corr. (kPa)	0.76
	Deviator Stress, (σ1 - σ3)f (kPa)	60
	Undrained Shear Strength, cu = ½(σ1 - σ3)f (kPa)	30
	Mode of Failure	Plastic

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
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Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

UKAS TESTING 1464

Test Report - 31554 / 1

Site:	Flixborough EFW Plant, Scunthorpe
Job Number:	31554
Originating Client:	Solar 21

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Date: 26/09/2018

REPORT 31544R/1

IAN FARMER ASSOCIATES

Unit 4, Faraday Close, Pattinson North Industrial Estate, Washington, NE38 8QJ. Tel: 0191 482 8500 Fax: 0191 482 8520
washington@ianfarmer.co.uk www.ianfarmer.co.uk

F.A.O.

Test Report - 31554R / 1

Site:	Flixborough EFW Plant, Scunthorpe
Job Number:	31554R
Originating Client:	Solar 21
Originating Reference:	31554
Date Sampled:	Not Given
Date Scheduled:	25/09/2018
Date Testing Started:	28/09/2018
Date Testing Finished:	01/10/2018

Remarks:

Authorised By: [redacted]

Tim Robinson
Quality Technician

Date: 01/10/2018

Constructionline
Part of Capita plc

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Laboratory Test Report 31554R / 1

Site: Flixborough EFW Plant, Scunthorpe **Job Number:** 31554R

Client: Solar 21 **Page:** 2

UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions2			Bulk Density2	Water Content 1	Uniaxial Compression3				Remarks
				Dia. mm	Length mm	H/D	Mg/m3	%	Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
BH3	23.80	C3	Grey MUDSTONE	83.8	101.2	*1.2	2.09	21.2	as received	0.4171	F	0.4	
BH3	26.00	C5	Grey MUDSTONE	85.8	79.5	*0.9	2.17	20.0	as received	0.3981	MS	0.7	

Notes
1 ISRM p87 test 1, water content at 105 ± 3 oC, specimen as tested for UCS
2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density
3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials
above notes apply unless annotated otherwise in the remarks

*Denotes length diameter ratio outside ISRM specification

Mode of failure :
S - Single shear MS - multiple shear
AC - Axial cleavage F - Fragmented

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

IAN FARMER ASSOCIATES

Laboratory Test Report	31554R / 1

Site: Flixborough EFW Plant, Scunthorpe **Job Number:** 31554R

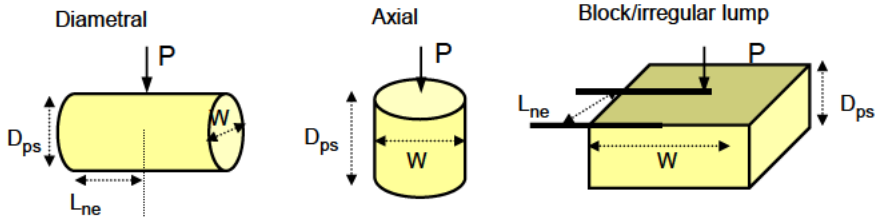
Client: Solar 21 **Page:** 3

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm	kN	mm	Is . MPa	Is (50) MPa	
BH2	24.18	C1	Red/Brown MUDSTONE As received	A	PD	YES		82.5	85.1	74.1	0.3	94.6	0.03	0.05	
BH2	27.6	C3	Grey MUDSTON E	A	PD	YES		85.8	90.5	68.5	0.9	99.5	0.09	0.13	
BH2	29.14	C4	Grey MUDSTONE	A	PD	YES		81.5	118.6	101.6	0.4	111.0	0.04	0.05	
BH3	24.7	C4	Red MUDSTON E	A	PD	YES		85.1	106.6	91.6	0.4	107.5	0.03	0.05	
BH4	22.76	C1	Red MUDSTONE	A	PD	YES		86.2	105.9	63.9	2.0	107.8	0.17	0.24	
BH4	22.88	C2	Grey MUDSTON E	A	PD	YES		86.3	116.7	50.7	0.5	113.2	0.04	0.05	
BH5	26.58	C3	Grey MUDSTON E	A	PD	YES		86.3	91.0	71.0	0.3	100.0	0.03	0.04	
BH6	22.17	C1	Grey MUDSTONE	A	PD	YES		86.2	125.0	101.0	0.6	117.1	0.04	0.06	
BH6	22.91	C2	Grey MUDSTONE	A	PD	YES		83.0	123.9	96.9	0.2	114.4	0.02	0.02	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Test Report - 31554R / 1

Site:	Flixborough EFW Plant, Scunthorpe
Job Number:	31554R
Originating Client:	Solar 21

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Date: 01/10/2018

PLASTICITY CLASSIFICATION CHART

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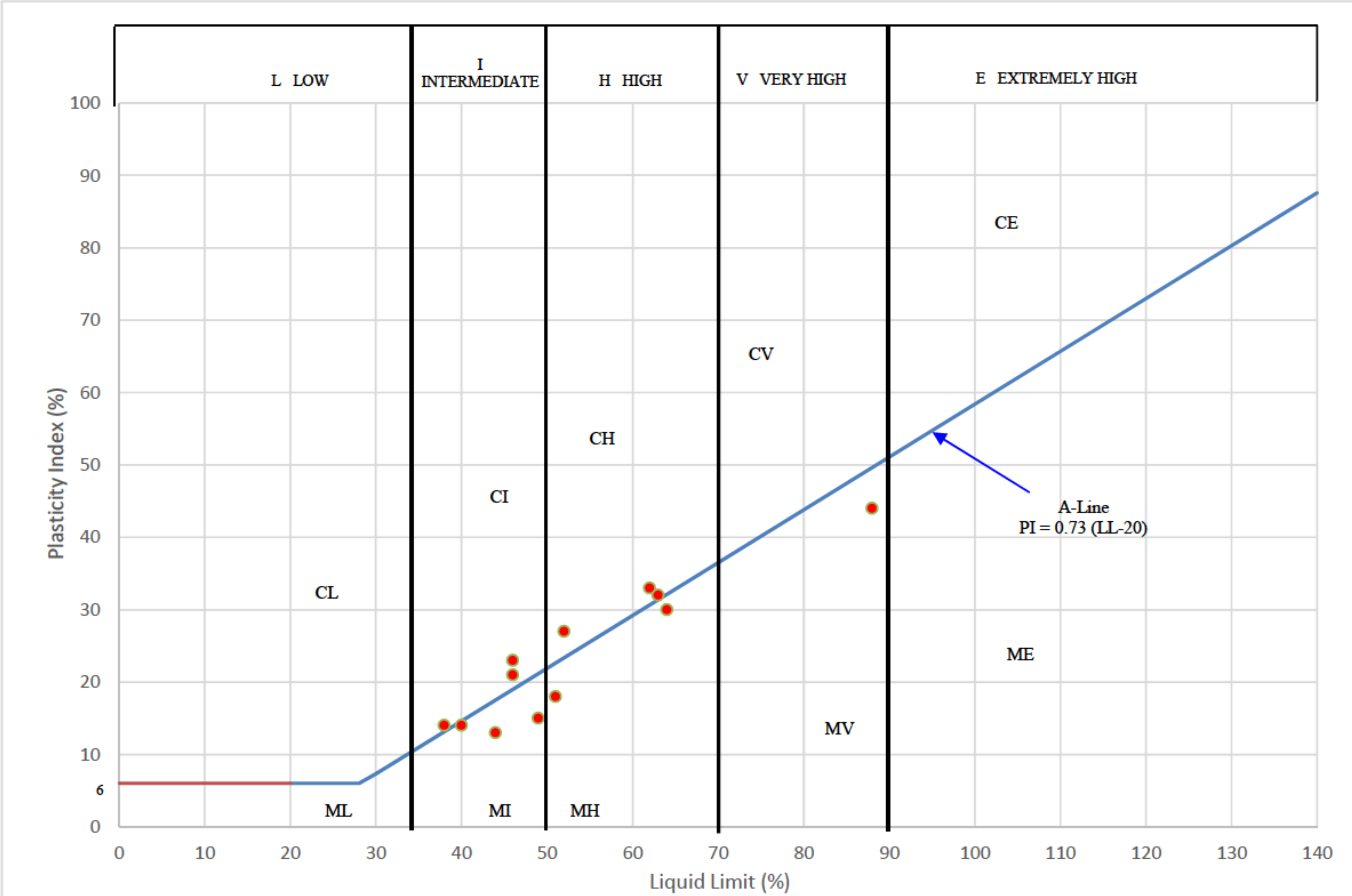
PLASTICITY CLASSIFICATION CHART

Site: EFW Plant Flixborough near Scarborough

Contract No. 31554

Figure No. A3.1



SILTS generally plot below A Line
CLAYS generally plot above A Line

APPENDIX 4

CHEMICAL TESTS

Certificate No. 18/07080

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/07080
Issue Number: 1 **Date:** 13 September, 2018

Client:
Ian Farmer Associates (Newcastle)
Unit 4, Faraday Close
Pattinson North Industrial Estate
Washington
Tyne and Wear
NE38 8QJ

Project Manager: Chris Lewis
Project Name: Flixborough EFW Plant
Project Ref: 31554
Order No: 93507
Date Samples Received: 05/09/18
Date Instructions Received: 05/09/18
Date Analysis Completed: 13/09/18

Prepared by:

[redacted]

Holly Neary-King
Sales Executive

Approved by:

[redacted]

Georgia King
Admin & Client Services Supervisor

Envirolab Job Number: 18/07080

Client Project Name: Flixborough EFW Plant

Client Project Ref: 31554

Lab Sample ID	18/07080/1	18/07080/2	18/07080/3	18/07080/4	18/07080/5				Units	Method ref
Client Sample No	3	3	5	5	3					
Client Sample ID	BH2	BH4	BH4	BH6	BH1					
Depth to Top	0.50	0.50	1.00	1.00	0.50					
Depth To Bottom										
Date Sampled	29-Aug-18	22-Aug-18	22-Aug-18	21-Aug-18	24-Aug-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4A	4A	6AB	6	4A					
% Stones >10mm$_A$	25.4	33.8	6.4	<0.1	26.5				% w/w	A-T-044
Cyanide (total)$_A^{M\#}$	<1	<1	<1	4	-				mg/kg	A-T-042sTCN
Organic matter$_D^{M\#}$	-	-	6.2	2.2	-				% w/w	A-T-032 OM
Arsenic$_D^{M\#}$	<1	<1	10	<1	-				mg/kg	A-T-024s
Cadmium$_D^{M\#}$	1.1	0.7	0.9	0.8	-				mg/kg	A-T-024s
Copper$_D^{M\#}$	<1	2	34	16	-				mg/kg	A-T-024s
Chromium$_D^{M\#}$	84	111	33	26	-				mg/kg	A-T-024s
Chromium (hexavalent)$_D$	-	<1	<1	-	-				mg/kg	A-T-040s
Lead$_D^{M\#}$	5	13	80	41	-				mg/kg	A-T-024s
Mercury$_D$	<0.17	<0.17	<0.17	<0.17	-				mg/kg	A-T-024s
Nickel$_D^{M\#}$	1200	381	41	47	-				mg/kg	A-T-024s
Selenium$_D^{\#}$	1	3	<1	<1	-				mg/kg	A-T-024s
Zinc$_D^{M\#}$	24	34	127	98	-				mg/kg	A-T-024s
Leachate Prep BS EN 12457-2 (10:1)$_A$	-	-	*	-	*					A-T-001
Cyanide (total) (leachable)$_A$	-	-	<0.005	-	<0.005				mg/l	A-T-042wTCN
Arsenic (leachable)$_A^{\#}$	-	-	19	-	<1				µg/l	A-T-025w
Cadmium (leachable)$_A^{\#}$	-	-	<1	-	<1				µg/l	A-T-025w
Copper (leachable)$_A^{\#}$	-	-	7	-	1				µg/l	A-T-025w
Chromium (leachable)$_A^{\#}$	-	-	<1	-	1				µg/l	A-T-025w
Lead (leachable)$_A^{\#}$	-	-	16	-	<1				µg/l	A-T-025w
Mercury (leachable)$_A^{\#}$	-	-	<0.1	-	<0.1				µg/l	A-T-025w
Nickel (leachable)$_A^{\#}$	-	-	2	-	<1				µg/l	A-T-025w
Selenium (leachable)$_A^{\#}$	-	-	1	-	4				µg/l	A-T-025w
Zinc (leachable)$_A^{\#}$	-	-	23	-	4				µg/l	A-T-025w

Envirolab Job Number: 18/07080

Client Project Name: Flixborough EFW Plant

Client Project Ref: 31554

Lab Sample ID	18/07080/1	18/07080/2	18/07080/3	18/07080/4	18/07080/5				Units	Method ref
Client Sample No	3	3	5	5	3					
Client Sample ID	BH2	BH4	BH4	BH6	BH1					
Depth to Top	0.50	0.50	1.00	1.00	0.50					
Depth To Bottom										
Date Sampled	29-Aug-18	22-Aug-18	22-Aug-18	21-Aug-18	24-Aug-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4A	4A	6AB	6	4A					
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_A^{\#}$	NAD	-	NAD	-	-					A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	-	N/A	-	-					

Envirolab Job Number: 18/07080

Client Project Name: Flixborough EFW Plant

Client Project Ref: 31554

Lab Sample ID	18/07080/1	18/07080/2	18/07080/3	18/07080/4	18/07080/5				Units	Method ref
Client Sample No	3	3	5	5	3					
Client Sample ID	BH2	BH4	BH4	BH6	BH1					
Depth to Top	0.50	0.50	1.00	1.00	0.50					
Depth To Bottom										
Date Sampled	29-Aug-18	22-Aug-18	22-Aug-18	21-Aug-18	24-Aug-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4A	4A	6AB	6	4A					
PAH-16MS										
Acenaphthene$_A^{M\#}$	<0.01	0.03	2.66	<0.01	-				mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	0.01	0.04	<0.01	-				mg/kg	A-T-019s
Anthracene$_A^{M\#}$	<0.02	0.09	5.83	<0.02	-				mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	0.14	0.47	9.65	<0.04	-				mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	0.14	0.47	8.06	<0.04	-				mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	0.17	0.58	7.69	<0.05	-				mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	0.07	0.22	1.95	<0.05	-				mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	0.07	0.22	3.07	<0.07	-				mg/kg	A-T-019s
Chrysene$_A^{M\#}$	0.17	0.54	8.42	<0.06	-				mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	0.07	0.69	<0.04	-				mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	0.15	0.75	19.4	<0.08	-				mg/kg	A-T-019s
Fluorene$_A^{M\#}$	<0.01	0.03	2.52	<0.01	-				mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	0.09	0.27	2.96	<0.03	-				mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	<0.03	<0.03	4.94	<0.03	-				mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	0.06	0.33	16.7	<0.03	-				mg/kg	A-T-019s
Pyrene$_A^{M\#}$	0.21	0.70	16.3	<0.07	-				mg/kg	A-T-019s
Total PAH-16MS$_A^{M\#}$	1.27	4.78	111	<0.08	-				mg/kg	A-T-019s

Envirolab Job Number: 18/07080

Client Project Name: Flixborough EFW Plant

Client Project Ref: 31554

Lab Sample ID	18/07080/1	18/07080/2	18/07080/3	18/07080/4	18/07080/5				Units	Method ref
Client Sample No	3	3	5	5	3					
Client Sample ID	BH2	BH4	BH4	BH6	BH1					
Depth to Top	0.50	0.50	1.00	1.00	0.50					
Depth To Bottom										
Date Sampled	29-Aug-18	22-Aug-18	22-Aug-18	21-Aug-18	24-Aug-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	4A	4A	6AB	6	4A					
PAH 16MS (leachable)										
Acenaphthene (leachable)$_A$	-	-	0.20	-	0.03				µg/l	A-T-019w
Acenaphthylene (leachable)$_A$	-	-	<0.02	-	<0.02				µg/l	A-T-019w
Anthracene (leachable)$_A$	-	-	0.05	-	<0.02				µg/l	A-T-019w
Benzo(a)anthracene (leachable)$_A$	-	-	0.07	-	<0.02				µg/l	A-T-019w
Benzo(a)pyrene (leachable)$_A$	-	-	0.08	-	<0.02				µg/l	A-T-019w
Benzo(b)fluoranthene (leachable)$_A$	-	-	0.07	-	<0.02				µg/l	A-T-019w
Benzo(ghi)perylene (leachable)$_A$	-	-	0.05	-	<0.02				µg/l	A-T-019w
Benzo(k)fluoranthene (leachable)$_A$	-	-	0.04	-	<0.02				µg/l	A-T-019w
Chrysene (leachable)$_A$	-	-	0.09	-	<0.02				µg/l	A-T-019w
Dibenzo(ah)anthracene (leachable)$_A$	-	-	<0.02	-	<0.02				µg/l	A-T-019w
Fluoranthene (leachable)$_A$	-	-	0.23	-	0.06				µg/l	A-T-019w
Fluorene (leachable)$_A$	-	-	0.06	-	<0.02				µg/l	A-T-019w
Indeno(123-cd)pyrene (leachable)$_A$	-	-	0.05	-	<0.02				µg/l	A-T-019w
Naphthalene (leachable)$_A$	-	-	<0.02	-	<0.02				µg/l	A-T-019w
Phenanthrene (leachable)$_A$	-	-	0.02	-	<0.02				µg/l	A-T-019w
Pyrene (leachable)$_A$	-	-	0.22	-	0.06				µg/l	A-T-019w
Total PAH 16MS (leachable)$_A$	-	-	1.23	-	0.15				µg/l	A-T-019w
TPH Banded 13										
>C6-C8$_A^{M\#}$	<5	-	-	<5	-				mg/kg	A-T-007s
>C8-C10$_A^{M\#}$	<1	-	-	<1	-				mg/kg	A-T-007s
>C10-C12$_A^{M\#}$	<1	-	-	<1	-				mg/kg	A-T-007s
>C12-C16$_A^{M\#}$	2	-	-	<2	-				mg/kg	A-T-007s
>C16-C21$_A^{M\#}$	13	-	-	<2	-				mg/kg	A-T-007s
>C21-C35$_A^{M\#}$	34	-	-	5	-				mg/kg	A-T-007s
>C35-C44$_A$	17	-	-	3	-				mg/kg	A-T-007s
Total TPH Banded 13$_A$	66	-	-	8	-				mg/kg	A-T-007s

REPORT NOTES

General:
This report shall not be reproduced, except in full, without written approval from Envirolab.
All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.
Analytical results reflect the quality of the sample at the time of analysis only.
Opinions and interpretations expressed are outside the scope of our accreditation.
If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any “A” subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:
Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.
Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

Key:
IS indicates Insufficient Sample for analysis.
US indicates Unsuitable Sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Superscript "M" indicates method accredited to MCERTS.
Subscript "A" indicates analysis performed on the sample as received.
Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Certificate No. 18/07187

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/07187
Issue Number: 1 **Date:** 17 September, 2018

Client:
Ian Farmer Associates (Newcastle)
Unit 4, Faraday Close
Pattinson North Industrial Estate
Washington
Tyne and Wear
NE38 8QJ

Project Manager: Chris Lewis
Project Name: Fixborough EFW Plant
Project Ref: 31554
Order No: 93514
Date Samples Received: 07/09/18
Date Instructions Received: 07/09/18
Date Analysis Completed: 15/09/18

Prepared by:

[redacted]

Melanie Marshall
Laboratory Coordinator

Approved by:

[redacted]

Danielle Brierley
Client Manager

Envirolab Job Number: 18/07187

Client Project Name: Fixborough EFW Plant

Client Project Ref: 31554

Lab Sample ID	18/07187/1								Units	Method ref
Client Sample No	2									
Client Sample ID	BH3									
Depth to Top	0.50									
Depth To Bottom										
Date Sampled	30-Aug-18									
Sample Type	Soil - ES									
Sample Matrix Code	5A									
% Stones >10mm$_A$	4.9								% w/w	A-T-044
Cyanide (total)$_A^{M\#}$	<1								mg/kg	A-T-042sTCN
Organic matter$_D^{M\#}$	1.0								% w/w	A-T-032 OM
Arsenic$_D^{M\#}$	2								mg/kg	A-T-024s
Cadmium$_D^{M\#}$	1.0								mg/kg	A-T-024s
Copper$_D^{M\#}$	7								mg/kg	A-T-024s
Chromium$_D^{M\#}$	15								mg/kg	A-T-024s
Lead$_D^{M\#}$	15								mg/kg	A-T-024s
Mercury$_D$	0.20								mg/kg	A-T-024s
Nickel$_D^{M\#}$	12								mg/kg	A-T-024s
Selenium$_D^{\#}$	<1								mg/kg	A-T-024s
Zinc$_D^{M\#}$	43								mg/kg	A-T-024s

Envirolab Job Number: 18/07187

Client Project Name: Fixborough EFW Plant

Client Project Ref: 31554

Lab Sample ID	**18/07187/1**								**Units**	**Method ref**
Client Sample No	**2**									
Client Sample ID	**BH3**									
Depth to Top	**0.50**									
Depth To Bottom										
Date Sampled	**30-Aug-18**									
Sample Type	**Soil - ES**									
Sample Matrix Code	**5A**									
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_{A}^{\#}$	**NAD**									**A-T-045**
Asbestos ACM - Suitable for Water Absorption Test?	**N/A**									

Envirolab Job Number: 18/07187

Client Project Name: Fixborough EFW Plant

Client Project Ref: 31554

Lab Sample ID	18/07187/1								Units	Method ref
Client Sample No	2									
Client Sample ID	BH3									
Depth to Top	0.50									
Depth To Bottom										
Date Sampled	30-Aug-18									
Sample Type	Soil - ES									
Sample Matrix Code	5A									
PAH-16MS										
Acenaphthene$_A^{M\#}$	0.01								mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01								mg/kg	A-T-019s
Anthracene$_A^{M\#}$	0.06								mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	0.21								mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	0.16								mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	0.20								mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	0.06								mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	0.08								mg/kg	A-T-019s
Chrysene$_A^{M\#}$	0.19								mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04								mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	0.44								mg/kg	A-T-019s
Fluorene$_A^{M\#}$	0.02								mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	0.08								mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	<0.03								mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	0.24								mg/kg	A-T-019s
Pyrene$_A^{M\#}$	0.42								mg/kg	A-T-019s
Total PAH-16MS$_A^{M\#}$	2.17								mg/kg	A-T-019s

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Soil chemical analysis:
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any “A” subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:
Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.
Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

Key:
IS indicates Insufficient Sample for analysis.
US indicates Unsuitable Sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Superscript "M" indicates method accredited to MCERTS.
Subscript "A" indicates analysis performed on the sample as received.
Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Certificate No. 18/07299

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/07299
Issue Number: 1 **Date:** 20 September, 2018

Client:
Ian Farmer Associates (Newcastle)
Unit 4, Faraday Close
Pattinson North Industrial Estate
Washington
Tyne and Wear
NE38 8QJ

Project Manager: Chris Lewis
Project Name: Flixborough EFW Plant
Project Ref: 31554
Order No: 93515
Date Samples Received: 11/09/18
Date Instructions Received: 12/09/18
Date Analysis Completed: 20/09/18

Prepared by:

[redacted]

Melanie Marshall
Laboratory Coordinator

Approved by:

[redacted]

Georgia King
Admin & Client Services Supervisor

Envirolab Job Number: 18/07299 **Client Project Name: Flixborough EFW Plant**

Client Project Ref: 31554

Lab Sample ID	18/07299/1	18/07299/2	18/07299/3	18/07299/4	18/07299/5	18/07299/6	18/07299/7	18/07299/8	Units	Method ref
Client Sample No	24	9	29	8	24	7	4	15		
Client Sample ID	BH2	BH3	BH4	BH5	BH6	BH2	BH3	BH4		
Depth to Top	6.95	2.75	8.75	1.85	7.25	1.20	0.50	3.00		
Depth To Bottom	7.00					1.70	1.00	3.50		
Date Sampled	29-Aug-18	30-Aug-18	23-Aug-18	03-Sep-18	21-Aug-18	29-Aug-18	30-Aug-18	22-Aug-18		
Sample Type	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Solid	Soil - D		
Sample Matrix Code	6	6	6AE	3	6	6	7	6		
% Stones >10mm$_A$	<0.1	<0.1	8.5	<0.1	<0.1	<0.1	<0.1	<0.1	% w/w	A-T-044
pH BRE$_D^{M\#}$	-	-	-	-	-	8.13	12.63	8.48	pH	A-T-031s
Sulphate BRE (water sol 2:1)$_D^{M\#}$	-	-	-	-	-	44	41	398	mg/l	A-T-026s
Sulphate BRE (acid sol)$_D^{M\#}$	-	-	-	-	-	-	0.76	-	% w/w	A-T-028s
Sulphur BRE (total)$_D$	-	-	-	-	-	-	0.28	-	% w/w	A-T-024s
Organic matter$_D^{M\#}$	18.7	4.0	24.6	2.3	8.0	-	-	-	% w/w	A-T-032 OM

Envirolab Job Number: 18/07299 **Client Project Name: Flixborough EFW Plant**

Client Project Ref: 31554

Lab Sample ID	18/07299/9	18/07299/10							Units	Method ref
Client Sample No	24	55								
Client Sample ID	BH5	BH2								
Depth to Top	7.50	20.50								
Depth To Bottom		21.00								
Date Sampled	03-Sep-18	30-Aug-18								
Sample Type	Soil - D	Soil - D								
Sample Matrix Code	6E	5A								
% Stones >10mm$_A$	<0.1	<0.1							% w/w	A-T-044
pH BRE$_D^{M\#}$	6.86	7.82							pH	A-T-031s
Sulphate BRE (water sol 2:1)$_D^{M\#}$	3450	418							mg/l	A-T-026s
Sulphate BRE (acid sol)$_D^{M\#}$	1.48	-							% w/w	A-T-028s
Sulphur BRE (total)$_D$	6.52	-							% w/w	A-T-024s

REPORT NOTES

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A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any “A” subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:
Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.
Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

Key:
IS indicates Insufficient Sample for analysis.
US indicates Unsuitable Sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Superscript "M" indicates method accredited to MCERTS.
Subscript "A" indicates analysis performed on the sample as received.
Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Certificate No. 18/07300

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/07300
Issue Number: 1 **Date:** 19 September, 2018

Client:
Ian Farmer Associates (Newcastle)
Unit 4, Faraday Close
Pattinson North Industrial Estate
Washington
Tyne and Wear
NE38 8QJ

Project Manager: Chris Lewis
Project Name: Flixborough EFW Plant
Project Ref: 31554
Order No: 93515
Date Samples Received: 11/09/18
Date Instructions Received: 12/09/18
Date Analysis Completed: 18/09/18

Prepared by:

[redacted]

Richard Wong
Client Manager

Approved by:

[redacted]

Gill Walker
Director/Laboratory Manager

UKAS TESTING
1247

Envirolab Job Number: 18/07300

Client Project Name: Flixborough EFW Plant

Client Project Ref: 31554

Lab Sample ID	18/07300/1								Units	Method ref
Client Sample No	41									
Client Sample ID	BH6									
Depth to Top	15.00									
Depth To Bottom										
Date Sampled	21-Aug-18									
Sample Type	Water - EW									
Sample Matrix Code	N/A									
pH BRE (w)$_A^\#$	7.41								pH	A-T-031w
Sulphate BRE (w)$_A^\#$	90								mg/l	A-T-026w

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APPENDIX 5

DESIGN CONSIDERATIONS

APPENDIX 5

GUIDELINES FOR THE DESIGN OF PILES

FIRST APPROXIMATION OF WORKING LOAD

A5.1 GENERAL

The ultimate carrying capacity, Qu, of a particular pile is taken as the sum of the ultimate shaft friction resistance, Qs, and the ultimate end bearing resistance, Qb. This may be expressed as follows:-

$$Qu = Qs + Qb$$

$$= f.As + q.Ab$$

where f = unit shaft resistance

As = embedded surface area of pile

q = unit end bearing resistance

Ab = effective cross-sectional area of pile base

A5.2 COHESIVE SOILS

A5.2.1 Shaft Resistance

The ultimate shaft resistance, f, for piles in both compression or tension in cohesive soils is determined by applying a factor to the undrained shear strength, Cs, which exists in the soils along the embedded length of the pile, and is given by:-

$$f = \alpha.Cs$$

Where α is an adhesion factor, which for straight-shafted bored piles may be taken as 0.45 to 0.60.

Ultimate unit shaft friction should not exceed 100kPa.

A5.2.2 End Bearing

For piles terminating in cohesive soils, the ultimate unit end bearing resistance q, is given by:-

$$q = Nc.Cb$$

where Cb is the undrained shear strength at the base of the pile

and Nc is a bearing capacity factor

The value of Nc for a cohesive material is variable, depending on the depth of the penetration of the pile into the bearing stratum. Generally, Nc could be taken to have a value of 9, except in the case of large diameter short piles where a lesser value should be used.

A5.3 COHESIONLESS SOILS

A5.3.1 Shaft Resistance

For piles driven in cohesionless soils the ultimate unit shaft resistance, f, may be calculated using the following method, which gives:-

$$f = 0.5\gamma' (D+d) K_s \tan \delta$$

where γ' = average effective unit weight of soil surrounding the pile

D = depth to the pile toe or to the base of the granular stratum whichever is the lesser

d = depth to the top of the granular stratum

δ = angle of friction between pile and soil (see below)

K_s = a coefficient (see below)

VALUES OF Ks AND δ

Pile Type	δ	Ks		
		Relative Density		Tension Piles
		Low	High	
Steel	20°	0.5	1.5	0.5
Concrete	0.75ϕ	1.0	2.0	0.5

The value of ϕ may be interpreted from standard penetration tests.

For bored and cast-in-place piles, $\delta = 22°$ and $K_s = 1$ should be used to allow for loosening of the soil during boring.

It has been found that the ultimate unit shaft resistance does not exceed 100kPa and therefore this value should not be exceeded in design.

A5.3.2 End Bearing

The unit ultimate end bearing resistance (q) of piles in cohesionless soils may be calculated as follows:-

$$q = \gamma'.D.Nq$$

where γ' = average effective unit weight of soil surrounding the pile

D = depth to pile toe

Nq = bearing capacity factor

In addition, the ultimate unit base resistance should not exceed a value of 11,000kPa. For bored and cast-in-place piles the value of Nq used should correspond to loose soil conditions.

A5.4 FACTORS OF SAFETY

A5.4.1 Cohesive and Non-cohesive Soils

For cohesive and non-cohesive soils a factor of safety of 3 may be used to obtain the allowable or safe carrying capacity of piles from the ultimate carrying capacity.

APPENDIX 6

CONTAMINATION ASSESSMENT

APPENDIX 6

GENERAL NOTES ON CONTAMINATION ASSESSMENT

A6.1 STATUTORY FRAMEWORK AND DEFINITIONS

A6.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref. 9.16, which was introduced by the Environment Act 1995, ref. 9.17;

'Land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) pollution of controlled waters is being, or is likely to be, caused.'

A6.1.2 The UK guidance on the assessment of contaminated has developed as a direct result of the introduction of these two Acts. The technical guidance supporting the new legislation has been summarised in a number of key documents collectively known as the Contaminated Land Reports (CLRs), a proposed series of twelve documents. Seven were originally published in March 1994, four more were published in April 2002, while the last remaining guidance document, CLR 11, ref. 9.33 was published in 2004. In 2008 CLR reports 7 to 10 were withdrawn by DEFRA and the Environment Agency and updated version of CLR 9 and 10 were produced in the form of Science Reports SR2, ref. 9.24 and SR3, ref. 9.18.

A6.1.3 In establishing whether a site fulfils the statutory definition of 'contaminated land' it is necessary to identify, whether a pollutant linkage exists in respect of the land in question and whether the pollutant linkage:

- is resulting in significant harm being caused to the receptor in the pollutant linkage,
- presents a significant possibility of significant harm being caused to that receptor,
- is resulting in the pollution of the controlled waters which constitute the receptor, or
- is likely to result in such pollution.

A6.1.4 A *'pollutant linkage'* may be defined as the link between a contaminant *'source'* and a *'receptor'* by means of a *'pathway'*.

A6.2 ASSESSMENT METHODOLOGY

A6.2.1 The guidance proposes a four-stage assessment process for identifying potential pollutant linkages on a site. These stages are set out in the table below:

No.	Process	Description
1	Hazard Identification	Establishing contaminant sources, pathways and receptors (the conceptual model).
2	Hazard Assessment	Analysing the potential for unacceptable risks (what linkages could be present, what could be the effects).
3	Risk Estimation	Trying to establish the magnitude and probability of the possible consequences (what degree of harm might result and to what receptors, and how likely is it).
4	Risk Evaluation	Deciding whether the risk is unacceptable.

A6.2.2 Stages 1 and 2 develop a *'conceptual model'* based upon information collated from desk based studies, and frequently a walkover of the site. The walkover survey should be conducted in general accordance with CLR 2, ref. 9.38. The formation of a conceptual model is an iterative process and as such, it should be updated and refined throughout each stage of the project to reflect any additional information obtained.

A6.2.3 The extent of the desk studies and enquiries to be conducted should be in general accordance with CLR 3, ref. 9.39. The information from these enquiries is presented in a desk study report with recommendations, if necessary, for further work based upon the conceptual model. CLR 8, ref. 9.40, together with specific DoE 'Industry Profiles' provides guidance on the nature of contaminants relating to specific industrial processes. Although CLR 8 has been withdrawn, no replacement guidance has been published that lists the contaminants likely to be present on contaminated sites and as such the guidance relating to this issue of CLR 8 is considered to still be relevant.

A6.2.4 If potential pollutant linkages are identified within the conceptual model, a Phase 2 site investigation and report will be recommended. The investigation should be planned in general accordance with CLR 4, ref. 9.1. The number of exploratory holes and samples collected for analysis should be consistent with the size of the site and the level of risk envisaged. This will enable a contamination risk assessment to be conducted, at which point the conceptual model can be updated and relevant pollutant linkages can be identified.

A6.2.5 A two-stage investigation may be more appropriate where time constraints are less of an issue. The first stage investigation being conducted as an initial assessment for the presence of potential sources, a second being a more refined investigation to delineate wherever possible the extent of the identified contamination.

A6.2.6 All site works should be in general accordance with the British Standards, BS 5930:1999, ref. 9.3, ISO 1997, ref. 9.4 and BS 10175:2001, ref. 9.2.

A6.2.7 The generic contamination risk assessment screens the results of the chemical analysis against generic guidance values which are dependent on the proposed end-use of the development.

A6.2.8 The end-use may be defined as one of the following ref. 9.22;

- Residential with homegrown produce – domestic low rise and low density housing with gardens where vegetable may be grown for home consumption
- Residential without homegrown produce – domestic low density and low density housing where no gardens are present.
- Allotments – specific areas where vegetables are grown for home consumption.
- Public open space in close proximity to residential housing – includes the predominantly grassed area adjacent to high density housing and the central green area around which houses are developed. This land-use includes the smaller areas commonly incorporated in newer developments as informal grassed areas or more formal landscaped areas with a mixture of open space and covered soil with planting.
- Public open space in use as general parkland – provided for recreational use and may be used for family visits and picnics, children's play area, sports grounds and dig walking.
- Commercial – industrial premises where there is limited exposure to soil.

A6.2.9 Exposure pathways for each type of end-use are given below:

Standard Land Use	Oral Routes			Dermal Routes		Inhalation Routes			
	Direct soil & dust ingestion	Consumption of homegrown produce	Soil attached to homegrown produce	Indoor	Outdoor	Indoor dust	Outdoor dust	Indoor vapour	Outdoor vapour
Residential with homegrown produce	✓	✓	✓	✓	✓	✓	✓	✓	✓
Residential without homegrown produce	✓	X	X	✓	✓	✓	✓	✓	✓
Allotments	✓	✓	✓	X	✓	X	✓	✓	✓
Public open space – adjacent to dwellings	✓	X	X	✓	✓	✓	✓	X	✓
Public open space – parkland	✓	X	X	X	✓	X	✓	X	✓
Commercial	✓	X	X	✓	X	✓	X	✓	X

A6.2.10 Soils will be compared to Suitable 4 Use Levels (S4ULs) published by LQM ref. 9.20 Assessment Criteria. Where no S4UL is available, the assessment criteria (AC) are generated using the Contaminated Land Exposure Assessment (CLEA) Software Version 1.06, ref. 9.20. Toxicological and physico-chemical/fate and transport data used to generate the AC has been derived from a hierarchy of data sources as follows:

1. Environment Agency or Department of Environment Food and Rural Affairs

   (DEFRA) documents;

2. Other documents produced by UK Government or state organisations;

3. European institution documents;

4. International organisation documents;

5. Foreign government institutions.

A6.2.11 In the case of the majority of contaminants considered, the toxicological data has been drawn from the relevant CLR 9 TOX report, or updated toxicological data published by the Environment Agency (2009), ref. 9.19, where available. Where no TOX report is available reference has been made to the health criteria values, derived for use in Land Quality Press (2006), ref. 9.25, as this is considered to represent a peer reviewed data source. Similarly, fate and transport data has been derived in the first instance from Environment Agency (2003), ref. 9.41 and for contaminants not considered in this document the fate and transport data used in previous versions of the CLEA model has been used.

A6.2.12 Chemical laboratory test results are processed as follows. A statistical analysis of the results is conducted, as detailed in CIEH and CL:AIRE 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref. 9.20. Individual concentrations are compared to the selected guideline values to identify concentrations of contaminants that are above the selected screening criteria.

A6.2.13 Initially the distribution of the data set is to determine if the data set is, or is not, normally distributed. Where the distribution of the data is shown to be normal, the mean value test is applied to determine whether the mean characteristics of the selected soil unit present a significant possibility of significant harm to human health. Where the data is not normally distributed a method based on the Chebychev Theorem can be applied to test the same hypothesis. The significance of the data is further tested using the maximum value test. This determines whether the highest recorded contaminant concentrations are from the same statistical distribution or whether they may represent a 'hot spot'.

A6.2.14 Where the risk estimation identifies significant concentrations of one or more contaminants, a further risk evaluation needs to be undertaken.

A6.2.15 The risk evaluation will address the potential pollutant linkages between an identified source of contamination and the likely receptors both on and off site.

A6.2.16 The potential receptors include:

1) Humans – current site occupants, construction workers, future site users and neighbouring site users.

2) Controlled Waters – surface water and groundwater resources

3) Plants – current and future site vegetation

4) Building materials

A6.2.17 The potential hazards to be considered in relation to contamination are:

a) Ingestion and inhalation.

b) Uptake of contaminants via cultivated vegetables.

c) Dermal contact

d) Phytotoxicity (the prevention or inhibition of plant growth)

e) Contamination of water resources

f) Chemical attack on building materials and services

g) Fire and explosion

A6.2.18 Dependent on the outcome of the initial, generic contamination risk assessment, further detailed assessment of the identified risks may be required.

A6.3 Generic Guidance Values Used Within Contamination Risk Assessment

Commercial End Use

Commercial	Determinant	Guidance Value (mg/kg) 1% SOM	Guidance Value (mg/kg) 2.5% SOM	Guidance Value (mg/kg) 6% SOM	Primary Data Source
PAH	Acenaphthene	29000	30000	30000	LQM/CIEH S4UL
	Acenaphthylene	29000	30000	30000	LQM/CIEH S4UL
	Anthracene	150000	150000	150000	LQM/CIEH S4UL
	Benzo(a)anthracene	49	56	62	LQM/CIEH S4UL
	Benzo(a)pyrene	11	12	13	LQM/CIEH S4UL
	Benzo(b)fluoranthene	13	15	16	LQM/CIEH S4UL

Commercial	Determinant	Guidance Value (mg/kg) 1% SOM	Guidance Value (mg/kg) 2.5% SOM	Guidance Value (mg/kg) 6% SOM	Primary Data Source
	Benzo(ghi)perylene	1400	1500	1600	LQM/CIEH S4UL
	Benzo(k)fluoranthene	370	410	440	LQM/CIEH S4UL
	Chrysene	93	110	120	LQM/CIEH S4UL
	Dibenzo(ah)anthracene	1.1	1.3	1.4	LQM/CIEH S4UL
	Fluoranthene	6300	6300	6300	LQM/CIEH S4UL
	Fluorene	20000	20000	20000	LQM/CIEH S4UL
	Indeno(123-cd)pyrene	150	170	180	LQM/CIEH S4UL
	Naphthalene	1200	1900	3000	LQM/CIEH S4UL
	Phenanthrene	6200	6200	6200	LQM/CIEH S4UL
	Pyrene	15000	15000	15000	LQM/CIEH S4UL
Other Organics	Phenol	760	1500	3200	LQM/CIEH S4UL
Metals	Arsenic	640	640	640	LQM/CIEH S4UL
	Beryllium	12	12	12	LQM/CIEH S4UL
	Boron	240000	240000	240000	LQM/CIEH S4UL
	Cadmium	190	190	190	LQM/CIEH S4UL
	Chromium (III)	8600	8600	8600	LQM/CIEH S4UL
	Chromium (VI)	49	49	49	LQM/CIEH S4UL
	Copper	68000	68000	68000	LQM/CIEH S4UL
	Lead	2330	2330	2330	DEFRA C4SL
	Mercury	58	58	58	LQM/CIEH S4UL
	Nickel	980	980	980	LQM/CIEH S4UL
	Selenium	12000	12000	12000	LQM/CIEH S4UL
	Vanadium	9000	9000	9000	LQM/CIEH S4UL
	Zinc	730000	730000	730000	LQM/CIEH S4UL

Commercial	Guidance Value (mg/kg) 1% SOM	Guidance Value (mg/kg) 2.5% SOM	Guidance Value (mg/kg) 6% SOM	Primary Data Source
Aliphatic				
EC 5-6	3200 (304)	5900 (558)	12000 (1150)	LQM/CIEH S4UL
EC >6-8	7800 (144)	17000 (322)	40000 (736)	LQM/CIEH S4UL
EC >8-10	2000 (78)	4800 (190)	11000 (451)	LQM/CIEH S4UL
EC >10-12	9700 (48)	23000 (118)	47000 (283)	LQM/CIEH S4UL
EC >12-16	59000 (24)	82000 (59)	90000 (142)	LQM/CIEH S4UL
EC >16-35	1600000	1700000	1800000	LQM/CIEH S4UL
EC >35-44	1600000	1700000	1800000	LQM/CIEH S4UL
Aromatic				
EC 5-7 (benzene)	26000 (1220)	46000 (2260)	86000 (4710)	LQM/CIEH S4UL
EC >7-8 (toluene)	56000 (869)	110000 (1920)	180000 (4360)	LQM/CIEH S4UL
EC >8-10	3500 (613)	8100 (1500)	17000 (3580)	LQM/CIEH S4UL
EC >10-12	16000 (364)	28000 (899)	34000 (2150)	LQM/CIEH S4UL
EC >12-16	36000 (169)	37000	38000	LQM/CIEH S4UL
EC >16-21	28000	28000	28000	LQM/CIEH S4UL
EC >21-35	28000	8000	28000	LQM/CIEH S4UL
EC >35-44	28000	28000	28000	LQM/CIEH S4UL
Aliphatic and Aromatic				
EC >44-70	28000	28000	28000	LQM/CIEH S4UL

BTEX				
Benzene	27	47	90	LQM/CIEH S4UL
Toluene	56000	110000	180000	LQM/CIEH S4UL
Ethylbenzene	5700	13000	27000	LQM/CIEH S4UL
m/p Xylenes	5900	14000	30000	LQM/CIEH S4UL
o Xylene	17000	24000	33000	LQM/CIEH S4UL

SOM = Soil Organic Matter
Values in brackets indicate the vapour saturation limit where this is exceeded by the GAC or SGV

A6.4 Guidance Values Used For Assessment of Risk To Controlled Waters

Contaminant	Units	EQS Freshwater[1]	EQS Saltwater[1]	Water Supply[5]
Alachlor	ug/l	0.7	0.7	
Abamectin	ug/l	0.03	0.01	
Acrylamide	ug/l			0.1
Aluminium	ug/l	10[3]	25	200
Ammonia (unionised)	ug/l	15	21[2]	
Ammonium (as NH4)	mg/l			0.5
Anthracene	ug/l	0.4	0.4	
Antimony	ug/l			5
Arsenic	ug/l	50[2]	25[2]	10
Atrazine	ug/l	2	2	
Azamethiphos	ug/l	0.05	0.05	
Barium	ug/l			1000
Benzene	ug/l	50	50	1
Benzyl-butyl-phthalate	ug/l	7.5[2]	0.75[2]	
Boron	mg/l	2	7	1
Brominated Diphenylether	ug/l	0.0005[2]	0.0005[2]	
Bromine	ug/l	5	10	
Bromoxynil	ug/l	1000	1000	
Cadmium	ug/l	0.45[3]	0.2[2]	5
Calcium	*mg/l*			*250*
Carbon Tetrachloride	ug/l	12[2]	12[2]	
Carbendazin	ug/l	0.15[2]	-	
C10-C13 Chloroalkanes	ug/l	1.4	1.4	
Chlorenvinphos	ug/l	0.3	0.3	
Chlorpyrifos (Chlorpyrifos-ether)	ug/l	0.1	0.1	
Chlorothalonil	ug/l	0.035[2]	-	
Cyclodiene Pesticides (aldrin, Dieldrin, Endrin, Isodrin)	ug/l	Σ=0.01[2]	Σ=0.005[2]	
Chloride	mg/l	250	-	400
Chlorpropham	ug/l	40	40	
Chlortoluron	ug/l	20	-	
Chromium III	ug/l	4.7[2]	-	50
Chromium VI	ug/l	3.4[2]	0.6[2]	
Cobalt	ug/l	100	100	
Copper	ug/l	1[2]	3.76[2]	2
Coumaphos	ug/l	0.1	0.1	
Cyanide (hydrogen cyanide)	ug/l	1[2]	1[2]	50
Cypermethrin	ug/l	0.1[2]	0.1[2]	
Cyfluthrin	ug/l	0.001	0.001	
1,2-Dichloroethane	ug/l			3
2,4-Dichlorophenoxyacetic acid (2,4-D)	ug/l	0.3[2]	0.3[2]	
2,4-Dichlorophenol	ug/l	4.2[2]	0.042[2]	
3,4-Dichloroaniline	ug/l	0.2[2]	0.2[2]	
DDT (total)	ug/l	0.025[2]	0.025[2]	
Diazinon	ug/l	0.01[2]	0.01[2]	
Dibutylphthalate (DBP)	ug/l	40	40	
Dichlorobenzenes (all isomers)	ug/l	200	200	
para, para-DDT	ug/l	0.01[2]	0.01[2]	
Diethylphthalate (DEP)	ug/l	1000	1000	
Dimethylphthalate (DMP)	ug/l	4000	4000	
Dioctylphthalate (DOP)	ug/l	40	40	
Dimethoate	ug/l	0.48[2]	0.48[2]	
Diflubenzuron	ug/l	0.015	0.1	
Doromectin	ug/l	0.01	0.01	
Diuron	ug/l	1.8	1.8	
Endosulfan	ug/l	0.01	0.004	
Epichlorohydrin	ug/l			0.1
EDTA	ug/l	4000	4000	
Ethylbenzene	ug/l	200	200	
Fenchlorphos	ug/l	0.1	0.1	
Flucofuron	ug/l	1	1	
Fluoride	mg/l	3[4]	15	1.5
Fluoranthene	ug/l	1	1	
Formaldehyde	ug/l	50	-	

Contaminant	Units	EQS Freshwater[1]	EQS Saltwater[1]	Water Supply[5]
Glyphosate	ug/l	196[2]	196[2]	
Hexachlorobenzene	ug/l	0.05	0.05	
Hexachlorobutadiene	ug/l	0.6	0.6	
Hexachlorocyclohexane (lindane)	ug/l	0.04	0.02	
Hydrogen Sulphide	ug/l	1	10	
Ioxynil	ug/l	100	100	
Iron	ug/l	1000[2]	1000[2]	200
Isoproturon	ug/l	1	1	
Ivermectin	ug/l	0.001	0.001	
Kjeldahl Nitrogen (as N)	mg/l			1
Lead	ug/l	7.2[2]	7.2[2]	10
Linuron	ug/l	0.5[2]	0.5[2]	
Malachite Green	ug/l	100	100	
Magnesium	*mg/l*			*50*
Manganese	ug/l	123[2]	-	50
Mecoprop	ug/l	18[2]	18[2]	
Methiocarb	ug/l	0.01[2]	-	
Mancozeb	ug/l	20	20	
Maneb	ug/l	30	30	
MCPA	ug/l	120[3]	800	
Methylphenols	ug/l	300	300	
Mevinphos	ug/l	0.02	-	
Monochlorophenols	ug/l	250	250	
Mercury	ug/l	0.07	0.07	1
Naphthalene	ug/l	2.4[2]	1.2[2]	
Nickel	ug/l	20[2]	20[2]	20
NTA	ug/l	10000	30000	
Nitrate (as N)	mg/l			50
Nitrite (as NO2)	mg/l			0.5
Nonylphenol (4-nonylphenol)	ug/l	2	2	
Oils/hydrocarbons	ug/l			10
Pendimethylin	ug/l	0.3[2]	-	
Permethrin	ug/l	0.001[2]	0.0002[2]	
Polycyclic Aromatic Hydrocarbons (PAH)	ug/l			0.1
- Benzo(a)pyrene	ug/l	0.1	0.1	0.01
- Benzo(b)fluoranthene	ug/l	Σ=0.03[2]	Σ=0.03[2]	
- Benzo(k)fluoranthene	ug/l			
- Benzo(ghi)perylene	ug/l	Σ=0.002[2]	Σ=0.002	
- Indeno(123-cd)perylene	ug/l			
Pentachlorobenzene	ug/l	0.007[2]	0.0007[2]	
Pentachlorophenol	ug/l	1	1	
Pesticides (individual)	ug/l			0.1
- Aldrin	ug/l			0.03
- Dieldrin	ug/l			0.03
- Heptachlor	ug/l			0.03
- Heptachlor epoxide	ug/l			0.03
Pesticides (total)	ug/l			0.5
Phenol	ug/l	7.7[2]	7.7[2]	0.5
PCSDs	ug/l	0.05	0.05	
Pirimicarb	ug/l	5	5	
Pendimethalin	ug/l	6	6	
Primaphos-methyl	ug/l	0.05	0.05	
Prochloraz	ug/l	40	40	
Propetamphos	ug/l	0.1	0.1	
Propyzamide	ug/l	1000	1000	
Phosphorous	ug/l			2200
Potassium	mg/l			12
Selenium	ug/l			10
Silver	ug/l	0.1	1	10
Simizine	ug/l	4	4	
Styrene	ug/l	500	500	
Sulcofuron	ug/l	25	25	
Sulphate	mg/l	400	-	250
Surfactants (as lauryl sulphate)	ug/l			200
Tecnazene	ug/l	10	10	
Tetrachloromethane (PCM)	ug/l	2.5[2]	2.5[2]	3

Contaminant	Units	EQS Freshwater[1]	EQS Saltwater[1]	Water Supply[5]
Tetrachloroethylene (PCE)	ug/l	10[2]	10[2]	10
Tetrachloroethane	ug/l	140[2]	-	
Trichloroethylene (TCE)	ug/l	10[2]	10[2]	10
Thiabendazole	ug/l	50	50	
Tin (inorganic)	ug/l	25[2]	10[2]	
Trihalomethanes	ug/l			100
Trichlorobenzenes	ug/l	0.4[2]	0.4[2]	
Toluene	ug/l	74[2]	74[2]	
Tributyl phosphate	ug/l	500	500	
Tributyltin	ug/l	0.0015	0.0015	
Trifluralin	ug/l	0.03[2]	0.03[2]	
Vanadium	ug/l	20[4]	100	
Vinyl chloride	ug/l			0.5
Zinc	ug/l	11.9[2]	7.9[2]	5000

[1] MAC – Maximum Allowed Concentration
[2] AA – Average Annualised
[3] Dependant on pH
[4] Dependant on water hardness
[5] For sample taken at consumers' taps

APPENDIX 7

GAS GENERATION

APPENDIX 7

GENERAL NOTES ON GAS GENERATION

A7.1 GENERAL

A7.1.1 In the past, a series of guidance documents were published by CIRIA, ref. 9.42, providing advice on hazards associated with methane. This earlier guidance was consolidated in CIRIA Document C659 to provide a risk based approach to gas contaminated land. This was subsequently re-issued as CIRIA Document C665, ref. 9.44. In 2007, British Standard, BS8485, ref. 9.45, dealing with ground gas was published. It is recommended that guidance in C665 and BS8485 is adopted to provide a consistent approach in dealing with ground gas contamination, the principal details being as follows.

A7.1.2 This guidance is based on a similar approach to that for dealing with contaminated soil. The presence of hazardous gases could be deemed to be the 'source' in a 'pollutant linkage' that could lead to the conclusion that significant harm is or could be caused to people, buildings or the environment. In such circumstances the land could be deemed 'contaminated', ref. 9.16.

A7.1.3 Should a potential source of gas be identified in the conceptual model, a gas risk assessment should be carried out, sufficient to demonstrate to the local authority that the proposals mitigate any hazards associated with ground gas. The authority enforces compliance with Approved Document Part C of the Building Regulations, ref. 9.46.

A7.2 APPROACH

A7.2.1 A flow chart detailing the approach to assessing a site is given in CIRIA document C665, Figure 1.1. This may be summarised as follows.

- Carry out Phase 1 desk study, including initial conceptual model
- Assess site, potential presence of gas / potential unacceptable risk / identify further action, if necessary
- Monitor gas concentrations
- Assessment of Risk
- Recommendations / remediation
- Validation

A7.3 POLLUTANT LINKAGE ASSESSMENT

A7.3.1 A pollutant linkage assessment is presented in Appendix 3 of the Phase 1 Desk Study Report.

A7.3.2 Using the risk model in the desk study, the pollutant linkage can be identified and a preliminary estimate of risk undertaken. If there is no relevant pollutant linkage identified there is no risk. If there is a very low risk, it is likely that no further assessment is required. If further assessment is necessary, then gas monitoring is required.

A7.4 SITE MONITORING

A7.4.1 For sites with low generation potential, giving consistently low concentrations of soil gas under the worst-case conditions, a limited programme of monitoring would be appropriate. Where high or variable concentrations are anticipated or recorded, an extended programme of monitoring would be appropriate. The following guideline has been proposed, ref. 9.48.

Table A7.1

		Generation potential of source				
Sensitivity of development		Very low	Low	Moderate	High	Very high
	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with gardens)	6/3*	9/6	12/6	24/12	24/24

Notes

1. First number is minimum number of readings and second number is minimum period in months, for example 4/1 – Four sets of readings over 1 month.
2. At least two sets of readings must be at low and falling atmospheric pressure (but not restricted to periods below <1000mb) known as worst case conditions (see Boyle and Witherington, 2006).
3. The frequency and period stated are considered to represent typical minimum requirements. Depending on specific circumstances fewer or additional readings may be required (e.g. any such variation subject to site specific justification). * The NHBC guidance is also recommending these periods/frequency of monitoring (Boyle and Witherington, 2006)
4. Historical data can be used as part of the data set.
5. Not all sites will require gas monitoring however, this would need to be confirmed with demonstrable evidence.
6. Placing high sensitivity end use on a high hazard site is not normally acceptable unless the source is removed or treated to reduce its gassing potential. Under such circumstances long-term monitoring may not be appropriate or required.

A7.4.2 Before taking any readings, zero the instrument, record atmospheric pressure and temperature.

A7.4.3 Gas flow should be recorded, giving the range of pressures, ensuring positive or negative flow is recorded.

A7.4.4 Record gas levels, recording peak and steady. Where steady state not obtained within 3 minutes, record change in concentration, where concentrations are decreasing, always record peak value. For very high concentrations, record for longer period of up to 10 minutes.

A7.5 ASSESSMENT OF RISK AND RECOMMENDATIONS

A7.5.1 The main method of characterising a site is the method described by Wilson and Card, ref. 9.49 and is termed Situation A. This can be used for all types of development except conventional low-rise housing with suspended ground floor and ventilated underfloor void.

A7.5.2 Low rise housing, Situation B, was developed by Boyle and Witherington, ref. 9.50 and was developed for the NHBC for classifying gassing sites for houses with suspended ground floor slab with ventilated void.

A7.5.3 Although the Code of Practice, ref. 9.45, assesses the characteristic gas situation as CIRIA recommend for Situation A, see Table A7.2 below, their solution for gas protection systems is different, see section **Error! Reference source not found.**.

A7.6 SITUATION A - ASSESSMENT

A7.6.1 This system proposed by Wilson and Card, ref. 9.49 was originally developed in CIRIA Report 149, ref. 9.42.

A7.6.2 The method uses both gas concentrations and borehole flow rate for methane and carbon dioxide to define a Characteristic Situation for a site.

A7.6.3 Gas Screening Value (litre/hr) = borehole flow rate (litre/hr) x (gas concentration (%))/100. The GSV is determined for methane and carbon dioxide and the worst case adopted. The Characteristic Situation can then be determined from the table below. The GSV can be exceeded if the conceptual model indicates it is safe to do so, and other factors may lead to a change in the Characteristic Situation.

Table A7.2

Characteristic Situation	Risk Classification	Gas screening value (CH_4 or CO_2(1/hr)[1]	Additional factors	Typical source of generation
1	Very low risk	<0.07	Typically methane ≤1% and/or carbon dioxide ≤5%. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" Made Ground
2	Low risk	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to Characteristic Situation 3	Natural soil, high peat/organic content. "Typical" Made Ground
3	Moderate risk	<3.5		Old landfill, inert waste, mineworking flooded
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures	Mineworking – susceptible to flooding, completed landfill (WMP 26B criteria)
5	High risk	<70		Mineworking unflooded inactive with shallow workings near surface
6	Very high risk	>70		Recent landfill site

1. Site characterisation should be based on gas monitoring of concentrations and borehole flow rates for the minimum periods defined in Table A7.1
2. Source of gas and generation potential/performance must be identified.
3. If there is no detectable flow use the limit of detection of the instrument.

A7.7 SITUATION A – SOLUTION

A7.7.1 The Characteristic Situation can be used to define the scope of gas protective measures required.

A7.7.2 The CIRIA approach uses the characteristic situation to define the level of gas protection as follows:

Table A7.3

Characteristic situation	Residential building (Not low-rise traditional housing)		Office/commercial/industrial development	
	Number of levels of protection	Typical scope of protective measures	Number of levels of protection	Typical scope of protective measures
1	None	No special precautions	None	No special precautions
2	2	a) Reinforced concrete cast in situ floor slab (suspended non-suspended or raft) with at least 1200g DPM and underfloor venting b) Beam and block or pre-cast concrete and 2000g DPM / reinforced gas membrane and underfloor venting All joints and penetrations sealed	1 to 2	a) Reinforced concrete cast in-situ floor slab (suspended non-suspended or raft) with at least 1200g DPM b) Beam and block or pre cast concrete slab and minimum 2000g DPM/reinforced gas membrane c) Possibly underfloor venting or pressurisation in combination with a) and b) depending on use All joints and penetrations sealed
3	2	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space	1 to 2	All types of floor slab as above. All joints and penetrations sealed. Minimum 2000g/reinforced gas proof membrane and passively ventilated underfloor sub-space or positively pressurised underfloor sub-space
4	3	All types of floor slab as above.	2 to 3	All types of floor slab as above.

Characteristic situation	Residential building (Not low-rise traditional housing)		Office/commercial/industrial development	
		All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated underfloor subspace or positively pressurised underfloor sub-space, oversite capping or blinding and in ground venting layer		All joints and penetration sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility
5	4	Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and ventilated or positively pressurised underfloor sub-space, oversite capping and in ground venting wells or barriers	3 to 4	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility. In ground venting wells or barriers
6	5	Not suitable unless gas regime is reduced first and quantitative risk assessment carried out to assess design of protection measures in conjunction with foundation design	4 to 5	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and actively ventilated or positively pressurised underfloor sub-space with monitoring facility, with monitoring. In ground venting wells and reduction of gas regime.

1. Typical scope of protective measures may be rationalised for specific developments on the basis of quantitative risk assessments.

2. Note the type of protection is given for illustration purposes only. Information on the detailing and construction of passive protection measures is given in BR414, ref. 9.47.

3. In all cases there should be minimum penetration of ground slabs by services and minimum number of confined spaces such as cupboards above the ground slab. Any confined spaces should be ventilated.

4. Foundation design must minimise differential settlement particularly between structural elements and ground-bearing slabs.

5. Commercial buildings with basement car parks, provided with ventilation in accordance with the Building Regulations, may not require gas protection for characteristic situations 3 and 4.

6. Floor slabs should provide an acceptable formation on which to lay the gas membrane. If a block and beam floor is used it should be well detailed so it has no voids in it that membranes have to span, and all holes for service penetrations should be filled. The minimum density of the blocks should be 600kg/m^3 and the top surface should have a 4:1 sand cement grout brushed into all joints before placing any membrane (this is also good practice to stabilise the floor and should be carried out regardless of the need for gas membrane).

7. The gas-resistant membrane can also act as the damp-proof membrane.