# **SOLAR 21 RENEWABLE ENERGY LIMITED**

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

# **REPORT ON GROUND INVESTIGATION**

## Contract: 31554

## Date: October 2018

Ian Farmer Associates (1998) Limited Unit 4 Faraday Close, Washington, Tyne and Wear, NE38 8QJ Tel: 0191 482 8500 Fax: 0191 482 8520



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Carried out at

# EFW PLANT,

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Prepared for

#### SOLAR 21 RENEWABLE ENERGY LIMITED Rathcoole Premier Office Centre Main Street Rathcoole Co. Dublin D24 K519

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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 21<sup>st</sup> August and 3<sup>rd</sup> 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 11.70/12.3 mbgl rising to 6.3/6.7 mbgl 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 95<sup>th</sup> 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.



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## **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 21<sup>st</sup> August and 3<sup>rd</sup> 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 28<sup>th</sup> September, 9<sup>th</sup> and 16<sup>th</sup> 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.

Stucto Encountered	Depth Encountered (m bgl)		Strata Thickness	
Strata Encountered	From	То	(m)	
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	

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

#### 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 Strike Depth after 20minutes rest				
No	metre	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.
  - <u>Alluvial Clays</u>
- 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<sub>L</sub>-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<sub>u</sub> 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 cu values of 35 and 59kPa.
  - <u>Peat</u>
- 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 cu value of 30kPa.

#### <u>Granular</u>

- 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 95<sup>th</sup> 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 28<sup>th</sup> September, 9<sup>th</sup> and 16<sup>th</sup> 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





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
- ▼ 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**

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Ca	Die P Boreh	ercus مابر ا	sion oa	Easting	y.	ľ	NOIT	ng.		Gro	unu Le'	vel.					18/10/2	2018	Scale:	1:50	
		5.0 L	- 3	I		-+				1									I		
	Sa	imples &	& In Situ	Testing								Str	rata Deta	ls						Groun	dwater
Depth	Sa	mple ID		Test Resu	lt	Lev (mAC	rel I DD) (	Depth (m) Thickness)	Legen	d				Strata De	escriptio	on				Water Strike	Backfill/ Installation
0.20		D1						0.10				GROU GROU	JND: Tar JND: Lig	mac and ht grev sa	concre indv G	ete. RAVF	I with hi	ah cobble			
0.20		D0								ġ	content.	Sand	d is fine t	to coarse.	Grave	el is an	igular to	911 000010	-		
0.50		ES2						(1.20)		a	angular	slag.		arse or co	ncrete	e and s	siag. Coi	DDIes are	-		
-								(0)											÷ .		
- 1.00		ES4																	- 1		
-								1.30	~~~~~	∞	Termin	ated on	<i>i large cobi</i> En	<i>ble of slag.</i> d of Boreh	ole at ?	1.30m					
E																			-		
-																			-		
-																			- 2		
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-																			-		
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[																			E		
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<u> </u>																			- 10		
Date	Star 1	t & End Time	of Shift Ol Depth (m	bservations ı) Casing (m	) Water (m	) De	Borehol pth (m)	e Diamete Dia (m	er im) De	Casin pth (n	ng Diame n) Dia	ter (mm)	Remark	S:		20m P	oreholo	terminata			at
28-08-20	018 0	0:00	1.30			1	1.30	200	)				1.30m.		ι <b>υ</b> 1.2	D		Grinnale		o reiusal	a
																	Water St	rikes			
From (m)	To (~~)	(	Chiselling	Barr	Jarke		n (m)	Base (m	nstallatio	n Fyrc		(mm)	Strike (m	i) Casing (	m) Sea	aled (m)	Time (min	s) Rose to	(m)	Remar	ks
1.20	1.30 (m)	0	0:40	Rem	IdIKS	10	יף (m) ש	Dase (m		уре	Dia	(mm)									
													IFA CP	l Femplate	Issue I	Numbe	r:5d ls:	sue Date: :	28/06/17		
	1	1						1	1					•							

				Contrac	t Name:							Clien	nt:								Boreho	le ID:	
:0	IAN	FARM	ER	Flixbor			Plant	, Scunt	horpe		00000	1 By:		Chor		Solar 2	21	ue:				BH1E	3
	ASSO	CIAT	ES	3	31554	51.	2 Date	8/08/20	)18		oggeu	SP		Chec	PC		Sta	FIN	AL		Cheat		_
Ca	ble Per	cussion		Easting	:		– North	ing:		G	round	d Level:					Prin	t Date:			Sneet	I OF 1	
E	Borehole	e Log																18/10/	/201	8		1:50	
Depth	Samp	les & In Si le ID	tu Test Te	ing st Result		Lev	/el	Depth (m)	Leger	nd		St	trata D	etails	Strata De	escriptio						Groun Water	dwater Backfill/
						(mA		0.10	20g0.	~	MAE	DE GROL	UND:	Tarm	ac and	concre	ete.				7	Strike	Installation
-											MAE cont	DE GROU ent. Sano	UND: d is fi	Light ne to	grey sa coarse.	andy G Grave	BRAVE el is ar	L with h ngular to	nigh d C	cobble	-		
- 0.50 0.50	B2 ES	2						(0.80)			subr angi	ounded f ular slag.	fine to	o coai	rse slag	and c	oncret	e. Cobl	oles a	are	-		
0.90	ES	3						0.90		***	Te	erminated or	n large	cobble	s of slag.		0.00				-		
-														Ena	of Boren	iole at	0.90m				- 1		
-																					-		
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			-						<u> </u>				1-								- 10		
Date	Start & Time	End of Shift	(m) C	vations Casing (m)	Water (n	1) De	oreho pth (m	ie Diamete ) Dia (m	er nm) D	Ca lepth	ising Di i (m)	iameter Dia (mm)	Rem Insp	narks: ectior	n pit duc	y to 1.2	20m. E	orehole	e terr	ninate	d at 0.9	0m on co	obbles of
28-08-20	0:00	0 0.9											slag			_							
													L						_				
		Chicollin				_			Installati	on			Strik	e (m)	Casing (	m) Sea	aled (m)	Water S Time (m	Strikes ins) R	Rose to (	m)	Remar	ks
From (m)	To (m)	Duration		Rema	ırks	Тс	op (m)	Base (n	n sæilati 1)	Тур	e	Dia (mm)											
																leoure	Numb -	r: 54	001/2	Data: 0	8/06/17		
1								1					ILLEA (		mpiate	ISSUE	INUIIDE	a.gu l	้อรมต	Date: 2	0/00/17		

					Contrac	ct Name:						Clie	ent:					Boreho	le ID:	
P		NF	ARM	IER	Flixbor	rough EF	- • • •	Plant,	Scunt	norpe					Solar 2	l Otaturu			BH2	
	AL		- m		Contrac		r.	Date S	Marted:	112		gged By:			y.	Status:			2112	
	00	0 D-			Eacting	51554		Z9	/00/20	10	G	SP/CL		PL Plant Lised		FINAL Drint Date:	-	Sheet 1	l of 4	
	Dril	& R0 lina l	tary (	core	Lasung			NOTUII	ıy.		G	ound Level.		Fiant Useu.		18/10/20	18	Stale.	1.20	
	Dill	ing c	Jog				_				_			l	SPT Ham	mer: Al MC1 F	nerav F	Ratio: 51	1%	
		Sample	s&In \$	Situ Tes	ting							5	Strata (	Details		Incr. ALMOTE	incry, r	<b>u</b> uo. o	Groun	dwater
Dept	h	TCR	SCR	RQD	FI	Samples / Tests	Lev (mA)	vel D OD) (T	epth (m) hickness)	Lege	nd			Strata D	escription	1			Water Strike	Backfill/ Installation
t						D1 0.10			0.10		*	MADE GRO		Tarmacada	m.	fine to coarse		1		
1						ES2 0.30			0.65)			with low col	ble co	ontent. Grave	el is angu	lar to subround	ded fine	1		
-						ES3 0.50		`	0.00)			to coarse of sandstone.	flint, l Cobbl	brick, concre es are angul	te, slag, lar slag.	mudstone and		F		
ł						B4 0.75			0.75	<u>~~~~</u>	~~	Soft light bro	own s	lightly gravel	ly sandy	CLAY. Gravel i	S	-		
-						ES5 1.00						coal. occasi	to rou onally	nded fine to laminated a	medium it 1.00mb	of mudstone, fi gl.	int and	- 1		
1.20	וי					B7 1.20 D6 1.20 N=5			1 25)				-			-		Ē		
F.						(1,1/1,1,1		`										E		
-						(3) D8 1.85												-		
F						D9 2.00 U10 2.00			2.00			Firm light br	own n	nottled grey	sandy Cl	AY occasional	ly	<u>+</u> 2		
											_	laminated.		5,				ŧ		
-						D11 2.45			(1.20)									-		
[						D12 2.75		<b>`</b>	1.20)									E		
- 3.00	ו נ					B15 3.00					_							- 3		
ŀ						N=6 (1,1/1,1,2			3.20			Very soft to	soft li	aht grey brow	wn slightl	v siltv slightly s	andy to	-{		
ŀ						.2) (S) D14 3.20						sandy lamin	ated	ČLAY.	5	, , , ,	,	Ł		
ŀ						D16 3.75												-		
Ē						U17 4.00												E		
																		-		
ŀ						D18 4.45												Ē		
-						D10.4.75												È I		
5.00						P21 5 00			3.50)						_					
5.00	,					D20 5.00 N=5						At 5.00m plant r	natter note	ed	-			- 2		
-						(1,1/1,1,1 ,2) (S)												;		
Ē																		Ē		
						D22 5.75												-		
ŀ																		- 6		
ŀ																		E		
ŀ						U23 6.50												F		
E						D25 6.70			6.70	X	316	Soft to firm	brown	slightly san	dy slightly	y silty laminate	d CLAY	-		
-						D24 6.95				x	<u>sika</u>	with large p	JUNCI	S OI GAIN DIO	withbrou	is peat.		- 7		
-						D26 7.25				x pilax	<u>sika</u>							F		
F										X	316							Ē		
ļ										x sil4	<u>sika</u>							F		
8.00	ו					B28 8.00 D27 8.00				×	<u>ale</u>							- 8		
ļ						N=8 (1,1/1,2,2			5.80)	×— ilc <u> </u>	<u>. 16</u>							ŀ		
F						(S)			5.50)	x— sila—x	<u>sika</u>							Ē		
ļ.						D29 8.75				X	<u>316</u>							<b> </b>		
ŀ										X	<u>sh.</u>							- 9		
[										X Sild X	<u>3165</u>							E		
ŀ						U30 9.50				×—	<u>316</u>							• -		
[										×— alc <u>×</u>	<u>3163</u>							Ē		
Ļ	ļ					D31 9.95				X— ail4 — —	<u>811/3</u>							+ 10		
	Sta	rt & En	d of Sh	ift Obse	ervations		В	orehole	Diame	ter	Casi	ing Diameter	Ren	Continue narks:	d next shee	et				
Date 29-08-2	018	Time 00.00	Dept 18	h (m) (	Casing (m) 18 00	Water (m	i) De	pth (m) 12.90	Dia (n 200	nm) Do	epth 12 9	(m) Dia (mm	) Insp	ection pit du	ig to 1.20	m. Groundwat	er enco	untered	at 12.50	m.
30-08-2	018	00:00	21	.90	21.58	9.60		21.90	150	5	21.8	0 150	Bor	enoie backfil	iea with l	pentonite grout	on com	pietion.		
00-09-2	010	50.00	50	. 10		20.10							Ch-1	(m) C	(m) C	Water Stri	Res	(m) D	arke	
							$\bot$		L,	not-l' i	-		Stril	e (m) casing	(m) seale	a (m) nine (mińs)	NUSE TO	(iii) Rem	dINS	
Top (m)	Base (I	Flu m) Flus	isn info sh Type	e Re	n eturn	Flush Colou	ur To	op (m)	li Base	istallat (m)	ion Typ	e Dia (mm	)							
										T			Fract	ure Index report	ed as numb	er per metre. TCR, S	SCR and F	RQD repor	ted in %	
				1									HBS	RC Issue Nu	imber: 3	Issue Date: 10/05/16	3			

						Contra	ct Name:					Clien	nt:					Boreho	le ID:	
P		4 N	FA	R M	ER	Flixbol	rough EF	W Plar	nt, Scun	thorp	e			So	olar 21	21.1			BH2	
	А	550			LO	Contra	CUNUMBER	: Dat	e Started	1: 010	LO		C	necked By:		Status:			0112	
	00	0 5				Eacting	51004	Nor	29/00/2	010		SP/CL		PC		FINAL Drint Date:		Sheet 2	2 of 4	
	Dri	& F illinc	kota 1 L o	ry C a	ore	Lasung	<b>j</b> .	NO	unny.		G	OUTIU LEVEI.				18/10/20	18	Stale.	1:50	
	0.1		, 20	9										SP	T Ham	mer: ALMC1 E	nerav R	Ratio: 51	1%	
		Sam	ples (	& In S	itu Test	ting						St	rata De	tails			3)		Groun	dwater
Dept	th	TC	RS	CR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness	) Leg	end			Strata Des	cription				Water Strike	Backfill/ Installation
										X	<u>əlc</u>							• •		
ł							10.25			X								-		
Ē										X	<u>əh</u>							Ē		
-										X								-		
- 11.0	00						B34 11.00 D33			X		At 11.00mbgl peat	t content inc	reasing				- 11		
-							11.00 N=9 (1.1/2.2.2			X	<u>. 16</u>							÷		
ŀ							.3) (S)			X	<u>. 16</u>							-		
E							D35 11.75			X	<u>. 16</u> × —							E		
ŀ										X	× —							- 12		
ł										X— M	×							-		
- 12.5	<b>0</b>						B39 12.50		12.50	×		Loose becom	ning me	edium dense	light gr	ey slightly grav	velly	+		
ŧ							12.50 D37					fine to mediu to coarse of o	m SAN guartzit	ND. Gravel is te, flint, muds	angula tone a	r to subrounde nd coal.	d fine	Ē		
F							12.50 EW38 12.50											- 13		
ŧ							N=5 (1,0/0,1,2											Ē		
ł.							(S) D40 12.25			0								-		
ŀ							13.20			0								-		
- 14.0	00						B42 14.00			0								- 14		
ŀ							D41 14.00 N=8		(3.70)	°								-		
F							(0,0/0,2,3 ,3) (S)		()	0										
ł							D43 14.75													
F										0								- 15		
ł																		-		
15.5	<b>0</b>						B45 15.50			0		Medium dense at	15.50m.					E		
-							D44 15.50 N=14											+		
F							(1,1/2,3,4											- 16		
ł							(5) D46 16.25		16.20			Medium dens	se light	brown to bro	wn gra	velly fine to co	arse	-		
-							10.20					SAND. Grave mudstone flir	elisan ntoua	gular to round intrite and occ	ded fin casiona	e to coarse of		÷		
ł													nı, quu			ar obtail				
- 17.0	00						B48		(1.40)									- 17		
ł							D47 17.00													
-							N=16 (1,2/2,3,5 .6)											-		
Ē							(S) D49 17.60		17.60			Firm red brow	vn mot	tled grey slig	htly gra	avelly slightly s	andy	-		
ŀ							D50 17.75					mudstone an	d quar	tzite			IIII,	- 18		
ł										-								Ē		
ŀ							B51													
E							18.50		(4 20)									E		
- 19.0	00						B53		(4.20)	-		Becoming still at 4	19.00m					- 19		
ł							19.00 D52 19.00			-								-		
É							N=18 (2,3/3,5,5											[ ]		
<b> </b>							.5) (S) D54			-										
E							19.75											- 20		
L	St	art &	End	of Shi	ft Obse	ervations		Boreh	ole Diam	eter	Casi	ing Diameter	Rema	Continued ne	ext shee	t		20		
Date	2010	Tin		Depth 10	n (m) C	Casing (m)	) Water (m	) Depth	(m) Dia (	mm) [	Depth 12.0	(m) Dia (mm)	Inspe	ction pit dug t	0 1.20	m. Groundwate	er encou	untered	at 12.50	m.
30-08-2	018	00:	00	21.	90	21.58	9.60	21.9	0 15	50	21.8	80 150	Boreh	ole backfilled	l with b	entonite grout	on com	pletion.		
00-09-2	00-03-2018 00:00 30.10 2							1					Chrilton		Sector	Water Strik	(es	(m) D	orke	
Flush Information							<u> </u>		Inst- "	ntia-		Surke	(III) Casing (m)	, seale	a (m) nime (mins)	NUSE TO (	(III) Rem	ans		
Top (m)	Base	(m) F	lush	i into Type	Re	eturn	Flush Colou	r Top (r	n) Base	installa e (m)	auon Typ	e Dia (mm)								
		T						1		T			Fracture	e Index reported a	is numbe	r per metre. TCR, S	CR and R	OD repor	ted in %	
								1					HBSI R	C Issue Numb	er: 3 ls	sue Date: 10/05/16	1			

					Contrac	ct Name:						Client	t:	_				Boreho	le ID:	
F	IA	IN F	CLA	MER TES	Flixbor	rough EF	-W PI	ant,	Scunt	horpe	)  -		-	So	lar 21				BH2	
	A	330	CIAL	LES	Contrac		r: D	ate S	started:	40	Lo	ogged By:	Che	ecked By:		Status:			DIIZ	
						31554		29	/08/20	18		SP/CL		PC		FINA	-	Sheet 3	3 of 4	
	CP	& Ro	otary (	Core	Easting		N	Iorthir	ng:		G	round Level:				Print Date: 18/10/20	118	scale:	1.20	
	DI	iiiig i	LUY				_							SD.	THam	mer: ALMC1 E		Datio: 51	%	
		Sampl	es & In :	Situ Tes	ting							Str	ata Detai	s	1 Halli		Lifergy r	auo. J	Groun	dwater
Dept	th	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOI	а с) (Т	epth (m) hickness)	Lege	nd			Strata Desc	cription				Water Strike	Backfill/ Installation
																		-		
E																		E		
- 20.5	0					B56 20.50												F		
E						20.50 N=16												Ē		
F.						(2,2/3,3,4 ,6) (S)												- 21		
ŀ						D57 21.25					_							-		
F											_							E		
21.8	0					D58			21.80			Light blue / gr		weathered				-		
21.9	0					21.80 D59 21.80		1	21.90			veins.	cengre	weathered				/- 22		
						50 (25 for 37mm/50 for						Very weak to with very close	weak re ely and	d brown an closely spa	d gree ced lai	n grey MUDS ninations, ver	TONE y thin	-		
- 22.00	0 -	100	90	34	11	97mm) (S)						and occasional	al thin be	eds of gyps	um. Di	scontinuities:		-		
23.1	U					21.90 50 (25 for						spaced, plana	ar smoot	h.	y clos		,	[		
ŀ					<b>N</b>	29mm/50 for 28mm)		(	2.00)									- 23		
:					NR	(S)												Ē		
- 23.10	0 -	66	27	0	24	-						From 23.50m to 23	.57m: Gypsun					È I		
24.0	0	00	21	ľ	NI													Ē		
·					M				24.00							10.07.01/5		- 24		
24.00	0 -	00		50		C1 24.18						closely to med	wn, Ioca dium spa	lly green gr aced lamina	ations a	and very thin t	n very beds of	-		
24.6	0	92	92	52	11							gypsum. Disc	ontinuiti dium spa	es: Horizon aced plana	tal and r and i	subhorizonta	l, very			
					NR	$\neg$						clobely to met	alain op i	iood, piana		, on		-		
Ŀ																		- 25		
																		- 20		
24.60	0	87	87	63	9			(	2.80)									Ē		
ł																				
ł																		-		
						-												- 26		
i.					11	C2 26.34												+		
Ē					l													Ē		
26.10	0 - 0	100	100	67		-		1	26.80		_	Weak grey, lo	cally red	brown, MU	JDSTC	ONE with very	closely	+		
-	-				3							to medium spa Discontinuities	aced lar s: Horizo	ninations ar Intal and su	nd very ubhoriz	y thin beds of contal, very clo	gypsum. oselv to	- 27		
												medium space	ed, plan	ar and undu	ulating	, smooth.		Ę		
					27	C3 27.60					_							F		
E					4													-		
F					30			(	2.60)									- 28		
27.60	0 -	97	92	69	-Mi													Ē		
- 23.1	U																	-		
E					5													E		
<u> </u>					4	C4 29 14												- 29		
ŀ									00 40		_									
- 29.10	0-	100	100	80				1	29.40		_	Weak red bro	wn MUE nd thin b	STONE wi	th clos	sely spaced s	paced	7		
	0				13			(	0.60)			Horizontal and	d subho	izontal, pla	inar sn	nooth.		-		
F						+		:	30.00					Continued re	ext sheet	t		- 30		
	Sta	rt & Er	nd of Sh	nift Obs	ervations		Bor	rehole	Diame	ter	Cas	ing Diameter	Remark	S:						I
Date 29-08-2	9 018	00:00	Dept 18	th (m) ( 3.00	Casing (m) 18.00	Water (m 16.90	) Dep 12	th (m) 2.90	Dia (m 200	<u>1m)  D</u> )	epth 12.9	(m) Dia (mm) 90 200	Inspecti Borehol	on pit dug t e backfilled	o 1.20	m. Groundwat	ter enco	untered	at 12.50	m.
30-08-2 06-09-2	018 018	00:00 00:00	21 30	.90 ).10	21.58	9.60 28.10	21	.90	150	ו	21.8	80 150				give give				
													Strike (n	n) Casing (m)	) Seale	Water Str d (m) Time (mins	kes Rose to	(m) Rem	arks	
<u> </u>		FI	ush Info	ormatio	n		+		  r	nstalla	tion									
Top (m)	Base (	(m) Flu	sh Type	e R	eturn	Flush Colou	ır Top	o (m)	Base	(m)	Тур	e Dia (mm)		<u> </u>						
													Fracture In	dex reported a	is numbe	r per metre. TCR,	SCR and R	QD repor	ted in %	
													HBSI RC	Issue Numbe	er: 3 ls	sue Date: 10/05/1	6			

LASS PARAME         Pickoncogni E-V Marti, Scuttiforia         Solid 21         BH2           31354         31354         2000/2016         SPCL         PC         FIAU         Sted 6 is 4           CP & Rodary Core         2000/2016         SPCL         PC         FIAU         Sted 6 is 4         1:0           Line         CP & Rodary Core         Early         Norming         Ground Level         PC         FIAU         Sted 6 is 4         1:0           Line         CP & Rodary Core         Early         Norming         Ground Level         PC         FIAU         Sted 6 is 1:0         FIAU         1:0         FIAU         Sted 6 is 1:0         FIAU         FIA					Contrac	t Name:				Clien	it:					Boreho	le ID:	
Bit I Subject I A Lize         Contract Number         Descende Dyr.         Statuti         Difficiency         Contract Number         Statution           CP & Robury Core         Basing         Nerthing         Corona Lovet         Image: Statution		AN F	ARM	1ER TES	Flixbor	rough Ef	-W Pla	nt, Scunt	horpe			So	lar 21				BH2	
	A	330	CIAI	113	Contrac		r: Da	e Started:		Logged By:	Che	ecked By:		Status:				
CP R Rotary Core         Desting Core         Print Date         Scale         150           Samples & In Stat Testing         South Core         South						31554		29/08/20	018	SP/CL		PC		FI	NAL	Sheet 4	4 of 4	
During Log         Image Sub Testing         Spect Name: Addit Elementy Falls: Site           Open         CA         Ext Red         Fr         Spect Name: Addit Elementy Falls: Site         Spect Name: Addit Elements         Spect Name: Addit Elem	CF	% Ro illing I	tary (	Core	Easting		NO	rtning:	ľ	Ground Level:				Print Date 18/10	:: 1/2018	scale:	1.20	
Supple 1.0         Depth         TOR         DOC         I         Test with methods         Depth         Depth         Test with methods         Depth         Depth         Test with methods         Depth         Depth </td <td></td> <td>ining L</td> <td>Jog</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>en</td> <td>[ Llom</td> <td>mor: ALM</td> <td></td> <td>Datio: 51</td> <td>1.50</td> <td></td>		ining L	Jog									en	[ Llom	mor: ALM		Datio: 51	1.50	
Depth         TOR         SOR         ROD         Fit many         Logend         Stab Description         Note:         National state           Image: Stab Description         Image: Stab Desc		Sample	es&In	Situ Test	tina					Str	rata Detail	s SPI		ITTEL ALIVI	CT Ellergy F	cauo. o	Groun	dwater
Start & Led of Skit Observatives         Bookada Diameter         Casing Diameter         Find of Boendoe at 30.00m         Start & Led of Skit Observatives         Skit Observatives         Skit Observatives	Depth	TCR	SCR	RQD	FI	Samples /	Level (mAOD)	Depth (m)	Legend			Strata Desc	ription				Water	Backfill/
Set # End of Set Discretation         Set-bit Deareter         Cost of Data Set A from         -31						100	(IIXOD)	(THICKNESS)			End	of Boroholo	at 30 1	100m		+	Suike	Installation
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Surf E of 39th Characteries         Joseph I (1990)         Joseph I (1990) <t< td=""><td>-</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>- 31</td><td></td><td></td></t<>	-															- 31		
Set 6 Field of Sel Deurodece         Forthal Deurodece         Forthal Deurodece	-															-		
Image: Start & Evid of Staft Observations         Reembed During in Staff & Staft Staff																Ē		
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Start & End of Shift Otherstations         Exercise 1         Casing Diameter         Remarks:	-															-		
Image: Start & End of Shift Observations         Berehole Dameter         Casing Dameter         -36           Image: Start & End of Shift Observations         Berehole Dameter         Casing Dameter         -37           Image: Start & End of Shift Observations         Berehole Dameter         Casing Dameter         Casing Dameter           Image: Start & End of Shift Observations         Berehole Dameter         Casing Dameter         Casing Dameter           Image: Start & End of Shift Observations         Berehole Dameter         Casing Dameter         Casing Dameter           Image: Start & End of Shift Observations         Berehole Dameter         Casing Dameter         Casing Dameter           Image: Start & End of Shift Observations         Berehole Dameter         Casing Dameter         Casing Dameter           Image: Start & End of Shift Observations         Berehole Dameter         Casing Dameter         Casing Dameter           Image: Start & End of Shift Observations         Berehole Dameter         Casing Dameter         Casing Compareton pit dug to 120           Image: Start & End of Shift Observations         Berehole Dameter         Casing Compareton pit dug to 120         Casing Compareton pit dug to 120           Image: Start & I	-															-		
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35         -35           -36         -37           -37         -38           -38         -37           -38         -38           -38         -38           -38         -38           -38         -38           -38         -38           -38         -38           -38         -38           -38         -38           -38         -39           -39         -39           -30         -38           -38         -39           -39         -39           -30         -38           -38         -38           -38         -39           -39         -39           -39         -39           -39         -39           -39         -39           -39         -39           -39         -39           -39         -39           -39         -39           -39         -39           -39         -39           -39         -39           -39         -39           -39         -39           -39	-															-		
Surt & End of Shift Observations         Borehole Dameter         Casing Dameter           23-06-2018         00:00         21:00         15:00         12:00           23-06-2018         00:00         18:00         16:50         12:90         20:00         12:90           23-06-2018         00:00         18:00         18:00         16:50         12:90         20:00         12:90	-															-		
Surt 8 End of Shift Observations         Bootholds Dameter         Casing Diameter         -36           Surt 8 End of Shift Observations         Bootholds Dameter         Casing Diameter         -38           -30         -38         -38         -38           -30         -38         -39         -40           -30         -38         -39         -40           -30         -38         -39         -40           -30         -30         -40         -40																		
Start & End of Shift Observations         Borehole Diameter         Cesing Diameter         Remarks:           23:08 2018         00:00         12:00	-															- 35		
Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           39	-															-		
Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           23:06:2018         00:00         21:05         25:00         21:00         12:00         200           23:06:2018         00:00         21:05         25:00         21:00         12:00         200           0:00:00         21:05         28:10         15:00         12:00         200         200           0:00:00         21:05         28:10         15:00         12:00         200         200           0:00:00         21:00         15:00         12:00         200         15:00	-															-		
Start 8. End of Shift Observations         Borehole Dameter         Casing Dameter         Remarks:           398-2018         00:00         31.00         15.88         9.60         12.90																E		
Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           39         -33         -33         -33         -33           Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           040         Time         Depth (m) Casing (m) Water (m) Depth (m) Dia (mm)         Depth (m) Diameter         Inspection pit dug to 1.20m. Groundwater encountered at 12.50m.           06-09-2018         00:00         18.40         18.90         12.90         21.00         150         12.90         150           Fush Information         Inspection pit dug to 1.20m. Groundwater encountered at 12.50m.         Strike (m) Casing (m) Sealed (m) Time (mina)Ploces to (m) Remarks         Strike (m) Casing (m) Sealed (m) Time (mina)Ploces to (m) Remarks           Fush Information         Inspection pit dug to 1.20m. Groundwater encountered at 12.50m.         Strike (m) Casing (m) Sealed (m) Time (mina)Ploces to (m) Remarks           Top (m) Base (m) Flush Type         Return         Flush Information         Inspection Time (mina)Ploces to (m) Remarks           Hold Information         Inspection Type         Dia (mm)         Fracture Index reported as number per metre. TCR, SCR and RCD reported in %           HBSI RC         Issue Numer: 3         Issue Numer: 3         Issue Numer: 1008/10	[															- 36		
	-															1		
Start & End of Shift Observations         Borehole Diameter         Casing Diameter         -37           Start & End of Shift Observations         Borehole Diameter         Casing Diameter         -38           Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           Start & End of Shift Observations         15.50	-															-		
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Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           29:08-2018         00:00         18:00         18:00         19:00         10:00           30:08-2018         00:00         21:50         21:50         21:50         150         21:80         150           Top (m) Base (m) Flush Information         Installation         Installation         Fracture Index reported as number per metre. TCR, SCR and RQD reported in %           Hits I RC         Installation         Fracture Index reported as number per metre. TCR, SCR and RQD reported in %	-															- 37		
	-															-		
Start & End of Shift Observations       Borehole Diameter       Casing Diameter       Remarks:         29:08:2018       00:00       18:00       16:90       12:90       200         30:08:2018       00:00       18:00       16:90       12:90       200         06:09:2018       00:00       21:58       9:60       12:90       200         150       21:90       21:90       150       21:80       150         150       150       21:80       150       150       150         150       150       21:80       150       150       150         150       150       21:80       150       150       150         150       150       150       150       150       150         150       150       150       150       150       150         150       150       150       150       150       150       150         150       150       150       150       150       150       150       150         150       150       150       150       150       150       150       150       150         150       150       150       150       150 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>E</td><td></td><td></td></t<>																E		
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Image: Start & End of Shift Observations       Borehole Diameter       Casing Diameter       Remarks:         Image: Date       Time       Depth (m) Casing (m) Water (m) Depth (m) Dia (mm)       Depth (m) Dia (mm)       Depth (m) Dia (mm)         Image: Date       Time       Depth (m) Casing (m) Water (m) Depth (m) Dia (mm)       Depth (m) Dia (mm)       Depth (m) Dia (mm)       Depth (m) Dia (mm)         Image: Date       Time       Depth (m) Casing (m) Water (m)       Depth (m) Dia (mm)       Depth (m) Dia (mm)       Depth (m) Dia (mm)       Depth (m) Dia (mm)         Image: Date       Time       Depth (m) Casing (m)       Valuer (Time (minis) Rose to (m) Remarks       Depth (m) Casing (m) Remarks       Depth (m) Casing (m) Remarks         Image: Date       Time       Time (minis) Rose to (m) Remarks       Time (minis) Rose to (m) Remarks         Image: Date       Time       Time (minis) Rose to (m) Remarks       Time (minis) Rose to (m) Remarks         Image: Date       Time       Time (minis) Rose to (m) Remarks       Time (minis) Rose to (m) Remarks         Image: Date       Time       Time (minis) Rose to (m) Remarks       Time (minis) Rose to (m) Remarks         Image: Date       Time       Time (minis) Rose to (m) Remarks       Time (minis) Rose to (m) Remarks         Image: Date       Time       Time (minis) Rose to (m) Rose to (m) Rose to (m) Rose to (m) Rose to	-															- 38		
Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           Date         Time         Depth (m) Casing (m) Water (m) Depth (m) Dia (mm)         Depth (m) Dia (mm)         Depth (m) Casing (m)         Hore and a start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           29-08-2018         00:00         18.00         16.90         12.90         200         12.90         200         150         Inspection pit dug to 1.20m. Groundwater encountered at 12.50m.           30-08-2018         00:00         21.90         21.90         150         21.80         150         Inspection pit dug to 1.20m. Groundwater encountered at 12.50m.           06-09-2018         00:00         30.10         21.58         9.60         21.90         150         150           Top (m) Base (m) Flush Information         Installation         Installation         Water reported as number per metre. TCR, SCR and RQD reported in %           HBSI RC         Issue Number: 3         Issue Date: 1005/16         150/16	E															Ē		
Start & End of Shift Observations         Borehole Diameter         Casing Diameter         Remarks:           29-08-2018         00:00         18:00         16:90         12:90         200         12:90         200           30-08-2018         00:00         21:90         21:90         150         21:80         150         150           06-09-2018         00:00         30:10         28:10         Installation         Water Strikes           Flush Information           Top (m) Base (m) Flush Type         Return         Flush Colour         Top (m)         Base (m)         Type         Dia (mm)           Flush Information           Flush Information           Flush Information           Flush Colour         Top (m)         Base (m)         Type         Dia (mm)           Flush Information           Flush Colour         Top (m)         Base (m)         Type         Dia (mm)           Flush Information           Flush Information           Flush Information         Fracture Index reported as number per metre. TCR, SCR and RQD reported in %           HBSI RC          Issue Number: 3	-																	
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Start & End of Shift Observations       Borehole Diameter       Casing Diameter       Remarks:         Date       Time       Depth (m) Casing (m)       Water (m) Depth (m)       Dia (mm)         29-08-2018       00:00       18:00       16:00       12:90       200         30-08-2018       00:00       21:58       9.60       21:90       21:90       150         06-09-2018       00:00       30:10       21:80       21:90       150       21:80         Top (m)       Base (m)       Flush Information       Installation       Water Strikes         Strike (m)       Flush Information       Installation       Fracture Index reported as number per metre. TCR, SCR and RQD reported in %         HBSI RC       Issue Number: 3       Issue Date: 1005/16	-															-		
Start & End of Shift Observations       Borehole Diameter       Casing Diameter       Remarks:         Date       Time       Depth (m) Casing (m)       Water (m)       Depth (m)       Dia (mm)       Depth (m)       Dia (mm)       Depth (m)       Dia (mm)       Inspection pit dug to 1.20m. Groundwater encountered at 12.50m.         29-08-2018       00:00       18.00       16.90       12.90       200       12.90       200       150       Borehole backfilled with bentonite grout on completion.         06-09-2018       00:00       30.10       21.58       9.60       21.90       150       150       150       Strike (m)       Casing (m)       Sealed (m)       Time (mins)       Rose to (m)       Remarks:         Flush Information       Installation         Top (m)       Base (m)       Flush Colour       Top (m)       Base (m)       Type       Dia (mm)       Fracture Index reported as number per metre. TCR, SCR and RQD reported in %         HBSI RC       Issue Number: 3       Issue Date: 10/05/16       Issue Date: 10/05/16       Issue Date: 10/05/16	-															- 39		
Start & End of Shift Observations       Borehole Diameter       Casing Diameter       Remarks:         Date       Time       Depth (m) Casing (m) Water (m) Depth (m) Dia (mm) De	-															[ ]		
Start & End of Shift Observations       Borehole Diameter       Casing Diameter       Remarks:         Date       Time       Depth (m)       Casing (m)       Water (m)       Dia (mm)       Depth (m)       Dia (mm)         29-08-2018       00:00       18.00       18.00       16.90       12.90       200       12.90       200       12.90       200       150       Start & (m)       Mater Strikes       Borehole backfilled with bentonite grout on completion.         06-09-2018       00:00       30.10       21.58       9.60       21.90       150       21.80       150       150         Flush Information       Installation         Top (m)       Base (m)       Flush Type       Return       Flush Colour       Top (m)       Base (m)       Type       Dia (mm)         Fracture Index reported as number per metre.       TCR, SCR and RQD reported in %       HBSI RC       Issue Number: 3       Issue Date: 10/05/16	-															-  -		
Start & End of Shift Observations       Borehole Diameter       Casing Diameter       Remarks:         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       200       Depth (m)       Dia (mm)       Depth (m)       Dia (mm)       Dia (mm) <td< td=""><td>-</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>	-																	
Start & End of Shift (m) Casing (m) Water (m) Depth (m) Dia (mm) Depth (m) Dia (mm) Depth (m) Dia (mm)       Remarks:         Date       Time       Depth (m) Casing (m) Water (m) Depth (m) Dia (mm) Depth (m) Dia (mm)       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       100       100       100       100       100       100       100       100       100       100       100       100       100       12.90       200       12.90       200       12.90       200       100	F					+										- 40		
Date         Time         Depth (m)         Casing (m)         Water (m)         Depth (m)         Dia (mm)         Dia (mm)         Dia (mm)         Dia (mm)         Dia (mm)         Dia (mm)         Inspection pit dug to 1.20m. Groundwater encountered at 12.50m.           29-08-2018         00:00         18.00         18.00         16.90         12.90         200         12.90         200         12.90         200         12.90         200         150         00:00         21.90         21.58         9.60         21.90         150         150         150         150         150         00:00         30.10         28.10         150         21.80         150 <td< td=""><td>St</td><td>art &amp; En</td><td>d of Sl</td><td>nift Obse</td><td>ervations</td><td></td><td>Bore</td><td>nole Diame</td><td>ter Ca</td><td>asing Diameter</td><td>Remark</td><td>S:</td><td></td><td></td><td></td><td></td><td></td><td></td></td<>	St	art & En	d of Sl	nift Obse	ervations		Bore	nole Diame	ter Ca	asing Diameter	Remark	S:						
30-08-2018       00:00       21.90       21.58       9.60       21.90       150       21.80       150       Derence Dacklined with Dentonite group on completion.         06-09-2018       00:00       30.10       21.80       21.90       150       21.80       150       Environment on the provided with Dentonite group on completion.         Water Strikes         Strike (m) Casing (m) Sealed (m) Time (mins) Rose to (m) Remarks         Top (m) Base (m) Flush Type       Return       Flush Colour       Top (m)       Base (m)       Type       Dia (mm)         Fracture Index reported as number per metre. TCR, SCR and RQD reported in %         HBSI RC Issue Number: 3 Issue Date: 10/05/16	Date 29-08-2018	Time 00:00	Dept 18	th (m) C 3.00	casing (m) 18.00	Water (m 16.90	Depth 12.9	(m) Dia (n 0 200	nm) Dep ) 12	th (m) Dia (mm) 2.90 200	Inspectio	on pit dug to	0 1.20	m. Ground	Iwater enco	untered	at 12.50	n.
Water Strikes       Strike (m)     Casing (m)     Sealed (m)     Time (mins)     Rose to (m)       Flush Information     Installation       Top (m)     Base (m)     Flush Colour     Top (m)     Base (m)     Type     Dia (mm)       Flush Information     Flush Colour     Top (m)     Base (m)     Type     Dia (mm)       Figure 1     Flush Colour     Top (m)     Base (m)     Type     Dia (mm)       Figure 2     Flush Colour     Flush Colour     Top (m)     Base (m)     Type     Dia (mm)       Figure 2     Flush Colour     Flush Colour     Top (m)     Base (m)     Type     Dia (mm)       Figure 2     Flush Colour     Flush Colour     Top (m)     Base (m)     Type     Dia (mm)       Figure 2     Flush Colour     Flush Colour     Top (m)     Base (m)     Type     Dia (mm)       Figure 2     Flush Colour     Flush Colour     Top (m)     Base (m)     Type     Dia (mm)       Figure 2     Figure 2     Figure 2     Figure 2     Figure 2     Figure 2       Figure 2     Figure 2     Figure 2     Figure 2     Figure 2     Figure 2       Figure 2     Figure 2     Figure 2     Figure 2     Figure 2       Figure 2     Figure 2<	30-08-2018	00:00	21	.90	21.58	9.60	21.9	0 150	21	.80 150	DUIENDI	Dackilled	wiui D	entonite g	TOUL OF COM	pieuon.		
Flush Information     Installation       Top (m) Base (m) Flush Type     Return       Flush Colour     Top (m)       Base (m)     Flush Colour       Flush     Flush Colour       Top (m)     Base (m)       Flush     Flush Colour       Flush     Flush	00-03-2010	50.00	50			20.10					Of siles to	Carine to 1	Cart	Water	Strikes	(m) D	arks	
Flush Information       Installation         Top (m)       Base (m)       Flush Type       Return       Flush Colour       Top (m)       Base (m)       Type       Dia (mm)         Image: Image			1.								Sulke (n	ij Casing (m)	Seale	u (m) Time (i	mins) Rose to	(m) Kem	arks	
Fracture Index reported as number per metre. TCR, SCR and RQD reported in % HBSI RC Issue Number: 3 Issue Date: 10/05/16	Top (m) Base	Flue (m) Flue	ush Info sh_Type	ormation	n eturn	Flush Color	ur Top (	m) Base	nstallation (m) Ti	n ype Dia (mm)	1							
HBSI RC Issue Number: 3 Issue Date: 10/05/16											Fracture In	dex reported a	s numbe	er per metre. T	CR, SCR and F	RQD repor	ted in %	
											HBSI RC	Issue Numbe	er: 3 le	ssue Date: 10	/05/16			

					Contra	ct Name:					Client	t					Boreho	le ID:	
P		N F	ARM CIAT	ER	Flixbol	rough EF		ant, Scun	thorpe	Loga	rod Pur		So Shookod Bur	lar 21	Status:			BH3	5
	211			20	Contrac	31554	. De	30/08/2	018	Logg	SP/CL	,	PC		FINAL	_	Sheet 1	1 of 4	
	CP	& Ro	tary C	Core	Easting	<b>j</b> :	No	orthing:		Grou	Ind Level:				Print Date:		Scale:		
	Dril	ling L	og												18/10/20	)18		1:50	
					-								SP	T Ham	mer: ALMC1 E	Energy R	Ratio: 51	1%	
Dept	h i	TCR	SCR	RQD	ting FI	Samples /	Level	Depth (m)	Legend	1	Stra	ata De	strata Des	cription				Grour Water	Backfill/
						lests	(mAOD)	(Thickness)		⊗ M/	ADE GROUI	ND: 1	Tarmac/concre	ete.			-	Strike	Installation
						D1 0.20 ES2 0.30		0.15		8 M/ 8 co	ADE GROUI	ND:L	light grey brov lag Sand is fi	wn san ne to c	ndy GRAVEL w coarse Gravel	/ith high is	7	$\mathbf{T}$	
F						B4 0.50 ES3 0.50				an	ngular to sub	angu	lar fine to coa	rse sla	ag, concrete, fl	int and	E		
:										s m	udstone. Col	obbies	s are angular s	siag.			ŧ		
-						ES5 1.00				8							-1		
								(1.95)		8							E		
-										8							F		
ŀ										8							E		
ŀ										8							-2		- 0 *
						B8 2.10 D6 2.10		2.10		Sc	oft grey brow	vn slig	ghtly sandy sli	ghtly g	ravelly, locally		+ -		H
E .						072.10					parse flint and	ay. G Id mu	dstone.	artos	ubrounded line	eio	E		8
						D9.2.75											F		8
- - 30	,					B10.2.00											E,		8
	<b>`</b>					N=3 (1,1/0,1,1		(2.00)											- F :
ŀ						.1) (S)											ŀ		E.
Ē																	E		E.
ļ						D11 3.75											-		E.
Ē						U12 4.00		4.10	×	Sc	oft light grev	brow	n slightly san	dv siltv	laminated slid	ahtiv			$\square$
ŀ						D12.4.45			NIG X	- or	ganic CLAY	with	inclusions of p	péat.		, ,	t l		
÷						0101.10			× <u></u>	-							Ē		
[						D14 4.75			xx								E		
- 5.00	)					B16 5.00 D15 5.00 N=5			x								- 5		
[						(1,1/1,1,2		(2.60)	×								E		
-						(5)		(2.00)	×	+ . 9 - 1							÷		
E						D17 5.75				-							E		
F										-							- 6		
ŀ										÷							E		
F						U18 6.50				-							E		
:						D20 6.70		6.70	51115 × 1115	i Br	rown fibrous	PEA	T with pockets	s of bro	own slightly sa	ndy silty	+		
F						D19 6.95			atio atra ta atra at		ganic clay.						7		
;						D21 7.25			alka alka ka alka a	ja) Re							:		
ŀ									astra astra ta astra as	i) Re							Ē		
									astra astra ta astra as	a) Ite							È I		
- 8.00	ו					B23 8.00			asha asha A asha as	ja) Re							8		
<u> </u>						N=8 (1,1/2,2,2		(5.60)	<u>ashea ashea</u> da ashea as	j. Na									
Ē						(S)		(0.00)	<u>, siles</u> (c siles - si (c siles - si	n. Re							E		
ŀ						D24 8.75			31165 3116 6 31166 31	h.							E		
F									<u>alita alita</u> la alita al	h.							- 9		
[									is stra stilla la stilla sti	h.							E		
ŀ						U25 9.50			ianna anna Ia anna an	h.							<b> </b>		
[									in stress stress	ji ji ka							E		
ŀ						D26 9.95			<u>, anna , anna</u> Ia , anna , anna	he he							- 10		
<u> </u>	Sta	rt & En	d of Sh	ift Obse	ervations		Bore	hole Diame	eter C	asing	Diameter	Rema	Continued ne arks:	ext shee	t				
Date 30-08-2	018	Time 00:00	Dept 3	h (m) 45	casing (m) 2.90	) Water (m	) Depti 13	n (m) Dia (n 00 20	nm) Dep 0 1	oth (m 3.00	n) Dia (mm)   200	Inspe	ction pit dug t	0 1.20	m. Water enco	untered	at 0.35	im in ins	pection
31-08-2	018	00:00	18	00	16.90	8.10 2.30	18.	00 15	0 2	1.00	150	pit. G 3.90n	n. Standpipe i	nke at nstalle	d to 12.00m. wate	r level o	n comp	ieuon of	Dorenole,
05-09-2	018	00:00	30	00	21.00	2.90						Strike	(m) Casing (m)	Seele	Water Stri	kes Bose to f		arke	
L		CI-	ish lef-	motio					netallatia	n	⊥ <sup>†</sup>	0.3	30	, Juano	0	6 00	, itell	ano	
Top (m)	Base (	m) Flus	sh Type	Re	eturn	Flush Colou	r Top	(m) Base	(m) T	уре	Dia (mm)	12.	50		20	0.00			
							2.0	0 2.0	DO SLC	DTTE	D	Fractur	e Index reported a	s numbe	er per metre. TCR, S	SCR and R	QD repor	ted in %	
1				1			1				1	HBSI R	C Issue Numb	er: 3 ls	ssue Date: 10/05/16	8			

				Contrac	ct Name:				Clier	nt:				l	Boreho	le IC	):	
$\Gamma$	AN F	ARM CIAT	IER	Flixbor	rough EF	-W Plan	nt, Scunt	thorpe	Logged Dur	Ch	S0	lar 21	Nature:			в	нз	
	550	CIAI	20	Contrac		r: Dat	e started 20/09/20	019		Che		2	Status:			2		
				Eacting	51554	Nor	30/00/20	010	SP/CL Cround Loval:		PC		FINAL	- 9	Sheet 2	2 of	4	
	' & R0 illing I	tary C	core	Casung		NO	uning.		GIOUNU Level.			ľ	18/10/20	18	Stale.	1	·50	
	ining i	Jog									SPI	r Hamn	ner: Al MC1 F	nergy R	atio: 51			
	Sample	es&In S	Situ Tes	ting					St	rata Detai	ls					(	Ground	iwater
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legend	i		Strata Desc	ription				W St	ater rike	Backfill/ Installation
:								مادي مالاي د مالا ما	j.s) Juz						• •			
					10.25			منابع منابع. لد منابع ما	) d the						÷			
-								منادي منادي. لد منادي ما	) d the						F			
[								منادي منادي. له منادي ما	) d the						[			
- 11.00					B29 11.00			منادي منادي لد منادي ما	) d the						- 11			
ł					11.00 N=9			مادي مالاي د مالاي ما	р. Ф.						Ē			
-					(1,1/2,2,2 ,3) (S)			مادی ماند. اد ماند ما	ja) Jug						-			
					D30 11.75			مالد مالد. لد مالد ما	j d Re						E			
-								astro astro to astro as	j il Re						- 12			
-					D31 12 30		12.30	<u>مالدہ</u> مالاہ ۲	् ि Loose becom	nina med	ium dense l	light gre	ev slightly silty	/ slightly	÷	5	$\overline{}$	
12.50					EW36 12.30			$\mathbf{x} \times \mathbf{x}$	gravelly fine	to coarse	SAND. Gra	avel is a	angular to	, ongina j	E			
;					12.50 D32			$\mathbf{x} \in \mathbf{x}$			arse sanusi	tone an	a muasione.		-			
F					12.50 N=6 (1,0/0,1,2			× × × ×							- 13			
-					.3) (S) D34			× × ×							F			
F					13.25			$\mathbf{x}^{\mathbf{x}}$							F			
								× × ×							÷			
14.00					B37			$\mathbf{x}^{\mathbf{x}}$	Medium dense be	low 14.00m.					- 14			
					D35 14.00		(3.90)	× × ×							-			
-					(0,0/0,3,3 ,5)			× × ×							-			
[					(S) D38										E			
-					14.75										- 15			
ŀ															Ē			
- 15.50					B40			XXXX							È I			
:					15.50 D39 15.50			XXXX							-			
-					N=13 (1,2/2,3,3			××××							- 16			
-					0 D41		16.20	× × ×	Medium dens	e red br	own slightly	cilty ve	ny gravelly fin	ne to	- · · ·			
[					16.25			$\mathbf{x} \mathbf{x} \mathbf{x}$	coarse SANE	Grave	l is angular	to subr	ounded fine t	0	E			
								××××	coarse sands	stone and	i mudstone.				÷			
17.00					B43			× × ×							- 17			
					17.00 D42			× × ×							: "			
					N=17 (2,3/3,3,5			× × ×							E			
					.6) (S) D44		(2.90)	××××										
					17.50 D45 17.75			× ×							1			
Ē								××××	2 2						E 10			
40.50								×							-			
06.81					18.50 D46			××××							E			
ļ.					18.50 N=20 (2,2/3.5.5			×××							<b> </b>			
-					.7) (S)		19.10	×	Eirm light red	brown n	nottled arev	sandv	CLAY.		- 19			
					19.10										÷			
Ē							(1.80)		10 11						E			
									년 전									
					840 20.00						Continued ne	xt sheet			20			
St Date	art & En Time	d of Sh Dept	ift Obs h (m)	ervations Casing (m)	Water (m	Boreh Depth	ole Diame (m) Dia (r	eter C mm) Der	asing Diameter oth (m) Dia (mm)	Remark	S:	0 1 20m	) Water enco	untered	at 0.25	im in	iner	ection
30-08-2018 31-08-2018	00:00	3.	45 .00	2.90 16.90	8,10	13.0	0 20 0 15	0 1 0 2	3.00 200 1.00 150	pit. Grou	undwater sti	rike at	12.30m. water	r level or	n comp	letio	n of b	orehole,
03-09-2018	00:00	21	.25	21.00	2.30			-   <b>^</b>	100	3.90m. \$	standpipe ir	nstalled	Vater Stri	kes				
03-03-2010	50.00	50			2.50					Strike (n	n) Casing (m)	Sealed	(m) Time (mins)	Rose to (r	m) Rem	arks		
Tan (m) In	Fl	ush Info	rmatio	n turr	Eluction 1			nstallatio	n In	12.30			20	<b>6.80</b>				
lop (m) Base	(m) Flu	sn Type	R	eturn	riush Colou	10p (r	n) Base 2.0	(m)   )0   P	ype Dia (mm) LAIN	Fracture In	idex reported as	s number	per metre. TCR. S	SCR and R	QD repor	ted in	%	
						2.00	12.	UO SLO	DITED	HBSI RC	Issue Numbe	er: 3 lss	ue Date: 10/05/16	8				
						_												

						Contrac	t Name:						Client	t:		0				В	oreho	le ID:	
P		AN SS(	FAR	ME	CR CS	Flixbor	rough El	-W Pla	ant, S	Scunt	norpe		aged Dur		Chaol	S0	lar 21	Otatua		_		BH3	
	21	550				Contrac	31554	r. Di	ale Si 30/	08/20	18	LO	SP/CL	(	Check	PC		Status. FIN/	AL.	s	heet 3	of 4	
	CP	& F	lotary	Со	re	Easting	1	N	orthin	g:		Gr	ound Level:					Print Date:		S	cale:		
	Dri	illing	Log															18/10/2	2018			1:50	
		_														SP	r Ham	mer: ALMC1	Energy	y Rat	tio: 51	%	
Dept	th	Sam TCF	Ples & I	n Situ	OD	ing Fl	Samples /	Level	Dej	pth (m)	Leger	nd	Stra	ata De	etails S	trata Desc	ription					Groun Water	dwater Backfill/
							lests	(mAOD	) (Thi	ickness)												Strike	Installation
-												_									:		
20.5	5 <b>0</b>						D50 20.50					_											
:							N=15 (2,2/3,3,4					_									:		
ŀ							(S) D51		20	0.90			Light grey wea	athere	ed Ml	JDSTON	E with	inclusions o	f		- 21		
21.2	20						20.75 D52 20.90					_	gypsum.										
- 21.2	0						D53 21.20 D54		(0	1.90)											-		
							21.20 50 (25 for		2	1 80													
-						33	58mm/50 for 55mm)		2	1.00			Weak red brow closely and clo	wn, lo oselv	cally spac	green gr ed lamin	ey, MU ations	IDSTONE w and very this	ith very n beds o	of	- 22		
-						6	(S) D55 21.25						gypsum. Disco	ontinu	uities:	Horizon	tal to s	ubhorizonta	l very				
21.80	0 - )0	100	) 77		59	NI	50 (25 for 32mm/50					_	planar smooth	seiy sj 1.	paceo	I, OCCASIO	onally	nedium spa	cea,				
						10	for 47mm) (S)					_											
ŀ							C1 21.98 C2 22.59					_											
:							=														- 23		
:						- 20	╡					_											
- 23.00	n _								(3	3.38)		_											
20.00	50	100	) 83	17	75		C3 23.80					_											
ŀ																					- 24		
ŀ																							
				-																	-		
:							C4 24.70																
F																					- 25		
24.50	0 -	100	100		95	6			2	5.18		=	Weak green g	jrey N	NUDS	TONE, IC	ocally g	grading to si	tstone,				
- 20.0												_	with very close thin beds of a	ely ar vosur	nd Clo m Dis	sely spa	ced lar	ninations an prizontal and	d very		-		
E												_	subhorizontal,	, close	ely ar	nd mediu	m spa	ed, planar s	smooth.				
·							C5 26.00					_									- 26		
ŀ																							
Ł									(2	2.32)													
26.00	0 -	100	07		07																:		
27.5	<b>0</b>		, , ,,		51																07		
Ē						NI	╡														- 21		
-						6																	
:						14	08 27 71		2	7.50			Weak red brow	wn, Io	cally	green gr	ey, ML	IDSTONE w	ith very	of			
:							0021.11						gypsum. Disco	ontinu	uities:	Horizon	tal to s	ubhorizonta	l very		:		
27.50	n _												From 27.50m to 27.	Sely S	paceo eak red br	d, planar own fine grained	SMOOt d sandstone	h.			- 28		
29.0	00	100	100		78	8																	
-																							
ŀ									(2	2.50)													
		-		+		NI						Ę	Below 20.00m: Pred	dominant	fly recover	red none intact.	Driller note	s fractured mari.			- 29		
29.00	9.00 - 100 42 33 NI 19.60 100 42 10																						
- 23.0	9 60																				-		
29.60	0 -	88	0		0		1																
- 30.0 	)0 )0	-		+			+		3	0.00		-			0	ontinued re-	vt eboci				- - 30		
	Sta	art & I	End of S	Shift (	Obse	rvations		Bor	ehole I	Diame	ter	Casi	ing Diameter	Rema	arks:	anunueu ne	AL SHEEL						l
Date 30-08-2	Date         Time         Depth (m)         Casing (m)         Wa           H08-2018         00:00         3.45         2.90         -08-2018         00:00         18.00         16.90           H08-2018         00:00         21.25         21.00         21.25         21.00						Water (m	n) Dept 13	h (m) .00	Dia (m 200	nm) De	epth 13.0	(m) Dia (mm) 0 200	Inspe	ection	pit dug te	o 1.20i rike at	n. Water en	counter	ed a	t 0.35	m in insp etion of	borehole
31-08-2 03-09-2	3U-U8-2018         00:00         3.45         2.90           31-08-2018         00:00         18.00         16.90           03-09-2018         00:00         21.25         21.00           05-09-2018         00:00         30.00         -					8.10 2.30	18.	.00	150	)   :	21.0	0 150	3.90n	n. Sta	andpipe in	nstalle	d to 12.00m						
03-09-2018 00:00 21.25 21.00 05-09-2018 00:00 30.00					2.90							Strike	e (m)	Casing (m)	Sealer	Water S	trikes ns) Rose	to (m	Rem	arks			
			Flush	form	ation			+		ŀ	Istallati	on		0.3	35			0	6	80			
Top (m)	Base	(m) F	lush Ty	pe	Re	turn	Flush Colo	ur Top	(m)	Base	(m)	Тур	e Dia (mm)	12.	50			20	0.0	00			
								0. 2.	00	2.00	J F O SL	PLAI	IN FED	Fractur	re Index	x reported as	s numbe	r per metre. TCF	R, SCR an	d RQI	) report	ed in %	
								1					1	HBSI R	RC Is	ssue Numbe	er: 3 Is	sue Date: 10/05	/16				

					Contrac	t Name:						Client	t:						Boreho	le ID:	
L	$\mathbf{P}_{A}^{L}$	AN F	ARM CIA'	IER TES	Flixbor	ough El	-WF	Plant,	Scunt	horpe	0000	d Dur	Ch	Sc ookod Bur	olar 21	Ctatuo				BH3	
E	А	550	CIAI	1 2 5	Contrac		r: I	Date S		19	Logge	a By:	Ch	ECKED BY:		Status				Dillo	
$\vdash$	00		toni	0.050	Fasting		_	Northi	ng.		Groun	d Level:		FC		Print D	FINA	-	Sheet 4	4 of 4	
	Dr	' & RO illina I	ary on	Core	Lasung	-	ľ	NOTUTI	iig.	ſ	Gioun	u Level.				18	3/10/20	018	State.	1:50	
$\vdash$	Di	ining i	-09											SP	T Ham	mer: A	MC1	Energy R	atio: 51	%	
		Sample	es&In	Situ Tes	ting							Str	ata Deta	ils						Groun	dwater
	Depth	TCR	SCR	RQD	FI	Samples / Tests	Lev (mAC	rel D DD) (T	Depth (m) Thickness)	Legend				Strata Des	cription					Water Strike	Backfill/ Installation
E						50 (17,8/50 for							En	d of Borehole	e at 30.(	000m			-		
ŧ						75mm) (C)													F		
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F	St Date	art & En Time	d of Sh Dept	th (m)	ervations Casing (m)	Water (n	Bo 1) Dep	prehole pth (m)	Diame Dia (m	ter Ca nm) Dept	asıng [ th (m)	Diameter Dia (mm)	Remark Inspect	ks: ion pit dua	to 1.20	m, Wat	erenco	ountered	at 0.35	in in insp	ection
30 31	0-08-2018 1-08-2018	00:00 00:00	3. 18	.45 3.00	2.90 16.90	8.10	1	3.00 8.00	200 150	) <u>13</u> ) 21	3.00 .00	200 150	pit. Gro	undwater s	trike at	t 12.30r	n. wate	r level o	n comp	letion of t	orehole,
0:	3-09-2018 5-09-2018	00:00	21 30	.25 ).00	21.00	2.30 2.90							5.90M.	запарре	mstalle	-u t0 12	ater Str	ikes			
				-					1				Strike (r	n) Casing (m	n) Seale	d (m) Tir	ne (mins 0	) Rose to (	m) Rem	arks	
То	n (m) Base	Flue (m) Flue	ush Info sh Type	ormation	n etum li	Flush Colo	ur To	n (m)	In Base (	nstallation (m) T	1 /De	Dia (mm)	12.30				20	6.80			
ľ	- 111 0436		on rype		- smill			0.00	2.00				Fracture I	ndex reported a	as numbe	er per met	tre. TCR,	SCR and R	QD repor	ted in %	
								2.00	12.0	JU SLU	TED		HBSI RC	Issue Numb	ber: 3 l	ssue Date	: 10/05/1	6			

				Contrac	t Name:						Clien	t:					Boreho	de ID:	
	AN	FARM	MER TES	Flixbor	rough El	-WP	Plant, S	Scunt	horpe				So	olar 21				RH4	
A	330	CIA	IES	Contrac	t Numbe	r: [	Date St	tarted:		Logged B	y:	Ch	ecked By:		Status:				
			_	Track	31554	_	22/	08/20	J18	SP	/CL		PC		FINA	L	Sheet	1 of 3	
CF	P&R	otary (	Core	Easting		ľ	Northin	g:		Ground Le	evel:				Print Date: 18/10/2	018	Scale:	1.20	
	ming	LUY				-							eD.	THam	mer: ALMC1	Energy E	Datio: 5	1.00	
	Samo	les & In	Situ Tes	tina							Str	ata Deta	ils	Паш	ITTEL ALIVICT	Ellergy r	auo. 5	Groun	dwater
Depth	TCR	SCR	RQD	FI	Samples / Tests	Leve (mAO	el De DD) (Th	pth (m)	Legen	d			Strata Des	cription				Water Strike	Backfill/
					D1 0.10		(	0.05		MADE	GROU	IND: Tar	macadam.			0	1		
					ES2 0.30		((	).55)		🔅 MADE	GROU Ilar to r	ounded	fine to coar	ntiy sa rse of (	dolerite, hard	Gravei core, slag	Ē		
-					ES3 0.50 B4 0.60			0.60		and co	ncrete.	Sand i	s fine to coa	arse.	an de clichthe	are cells :	+		
•											Gravel	is angu	lar to subro	unded	fine to coars	e of coal,	F		
F					ES5 1.00		(0	0.80)		💥 mudsto	one and	d brick.					- 1		
1.20					B8 1.20 D6 1.20					**							-		
					(1,1/1,2,2 ,3)			1.40		Very so	oft to so	oft light l	brown slight	tly grav	velly sandy C	LAY.	7		
					(S) D7 1.40			J.45) 1.95		mudsto	ne and	d possib	le brick		coarse or co	ai,			
-					D11 2.00			2.00		: Soft ligi 조 Gravel	ht brov	vn slight ular to s	ly silty sligh	itly gra fine to	velly sandy C	CLAY. ndstone	-2		
					0102.00				×	and mu	idstone	e.					/E		
-									×	- Son ligi -∞ Iaminat	ted CL	vn motu AY.	ed grey slig	nuy sii	ty siightiy sar	iay	Ļ		
					D12 2.75		0	1.20)	×	-1 -X							Ē		
- 3.00					B15 3.00				×	+ 							-3		
-					D13 3.00 N=5 (1.1/1.1.1		:	3.20	×-	- Soft lig	ht arev	/ slightly	sandy CLA	Y			4		
					.2) (S)						in groy	Signay	Sundy OE/				E		
-					D16 3 75												Ļ		
-					1174.00												Ē,		
					011 4.00					1							-4		
-					D18 4.45					1							ŧ		
-							(2	2.90)		1							Ē		
					D19 4.75					1							-		
- 5.00 [					B21 5.00 D20 5.00 N=6					1							- 5		
					(1,1/1,1,2					1							E		
-					(3)					1							F		
					D22 5.75					1							E		
-					D23 6.10			5.10		ti. We Coff do	ek beau	un olighi		the cor	du alayou fib		- 6		
									alto Xalta to Xalta		with lar	ge wood	d fragments	and p	lant matter.	ious	E		
-					U24 6.50				alto Xalta to Xalta	she Na							÷	-	
•									alto Xalta to Xalta	she Na							F		
-					D25 6.95				alis Xali is Xalis	and the second s							-7		
					D26 7.25				alto Xalta to Xalta	$\frac{1}{2}$							ţ.		
-									alis Xali is Xalis	she X							È		
ŀ									$\frac{   _{\mathcal{S}} \times   _{\mathcal{S}} \times   _{\mathcal{S}}}{  _{\mathcal{S}} \times   _{\mathcal{S}}}$	भेषेत्र अन्							Ē		
- 8.00					B28 8.00		(	5.20)	alis Xalis k Xalis	and She							- 8		
-					N=9 (1,1/2,2,2			/	$\frac{1}{16} \times \frac{1}{16} \times \frac{1}{16}$	She No							F		
-					,3) (S)				$\frac{1}{16} \times \frac{1}{16} \times \frac{1}{16}$	nine Ma							Ļ		
E					D29 8.75				$\frac{1}{16} \times \frac{1}{16} \times \frac{1}{16}$	nine Ma							E		
-									$\frac{1}{16} \times \frac{1}{16} \times \frac{1}{16}$	nine Ma							- 9		
ŀ									$\frac{1}{6} \times \frac{1}{2} \frac{1}{2} \times \frac{1}{2} $	Nr. No.							Ē		
ŀ					U30 9.50				$\frac{1}{6} \times \frac{1}{2} \frac{1}{2} \times \frac{1}{2} $	ntre Ma							E		
-									alis Xalis R Xalis	$\frac{4}{3}$							ŧ		
-					D31 9.95				$\frac{\lambda h_{s} \times \lambda}{\lambda_{s}} \times \frac{\lambda}{\lambda_{s}}$	भेद अर्थ							- 10		
	tart 0 F	nd of C	ift Ob-	opyoticana		D-	robele	Diare	tor	aning Dia	otor	Domest	Continued ne	ext shee	t		10		
Date	Time	Dep	th (m)	Casing (m)	Water (m	) Dep	oth (m)	Diame Dia (n	nm) De	pth (m) Dia	ieier (mm)	Inspect	ion pit dua t	0 1.20	m. Groundwa	ater enco	untered	at 12.30	m.
22-08-2018 23-08-2018	00:0	0 8 0 22	.45 2.70	7.80 22.50	7.45	12	2.50 2.70	200		2.50 2 2.50 1	200 150	Boreho	le backfilled	l with b	entonite grou	ut.			
															Water St	rikes			
												Strike (r 12.30	n) Casing (m) 12.20	) Seale	d (m) Time (min 20	s) Rose to 6.70	(m) Rem	narks	
Top (m) Base	F (m) Fl	lush Info ush Tvre	ormatio e R	n eturn I	Flush Colo	IT TO	p (m)	Base	nstallatio (m)	on Type I Dia	(mm)								
isp (iii) buo							P 100	2000				Fracture In	ndex reported a	is numbe	er per metre. TCR	, SCR and F	QD repo	rted in %	
												HBSI RC	Issue Numb	er: 3 ls	ssue Date: 10/05/	16			

						Contra	ct Name:						Clien	t:		_				Boreh	ole I	D:	
F		4N	FA	R M	ER	Flixbo	rough EF	W Plar	nt, Scun	thorp	e .					So	olar 21				F	ан⊿	
	A	330		AI	LO	Contra		: Dat	e Starteo	l:		oggeo	d By:	C	heck	(ed By:		Status:					
				C market			31554		22/08/2	018			SP/CL	-+		PC		FINA	L	Sheet	2 of	3	
	CP	& R	lota	ry C	ore	Easung	].	Nor	ining:		G	Found	d Level:					Print Date: 18/10/2	018	scale:		1.20	
	DI	iiiiiy		y				_								SD.	THam	mer: ALMC1	Energy E	Datio: 5	19/	1.00	
		Sam	ples (	& In S	itu Test	ting							St	rata De	tails	or	TTAIII	IICI. ALIVICI	Lifergy r	auo. J	1/0	Ground	lwater
Dept	th	TCF	R S	CR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness	Leg	jend				S	trata Des	cription				W S	/ater trike	Backfill/ Installation
ł										لا مرادی راد × مر	<u>(alia</u> ja) a. Sila									Ŀ	Π		
-							D32 10.25			الاريماني. الذاخيم	<u>Calic</u> ia to:::::::to:									È			
ŀ										لا مناند. الد × ما	<u>Calici</u> a to::::::::::::::::::::::::::::::::::::									F			
ł										لا مناند. الد × ما	<u>Calici</u> a to::::::::::::::::::::::::::::::::::::									E			
- 11.0	0						B34 11.00			لا مرادی ارد × مر	<u>(alia)</u> a. alia									- 11			
E							11.00 N=7			الارماني. بارد × ما	<u>(alici</u> )) ta: islite									Ē			
È.							(1,1/1,1,2 .3) (S)			Kalita Kalita Ka	<u>(alici</u> a) a istro									F			
ŀ							D35 11.75			لا مرائد <u>.</u> الد × مرا	<u>(alta)</u> a a alta									Ē			
F										لا مرادی اند × مرا	<u>(alta)</u> a a. Alta									- 12			
-							D36		12.30	× مانۍ • × -	ester s	Ven	/ loose Li	abt are	w sliv	abtly ara	velly fir	e and mediu	m	4	Ľ	$\bigtriangledown$	
12.5	0						B38 12.50					SAN	ND. Grave	el is an	gular	r to subro	ounded	fine to coars	se of	F			
							D37 12.50			2		mud	istone, fiir	nt and	coal.					ţ.			
F							(2,1/0,0,1			2										- 13			
ł							(5) D39 13.25		(1.80)	0										Ē			
ŀ							13.23			0										F			
E										0										E			
- 14.0	0						B42			•										- 14			
È							14.00 D40 14.00		14.10	•		Loo	se to med	dium de	ense	light gre	ey brow	n slightly gra	velly to	Ŧ			
ŀ							EW41 14.00 N=9			•		coar	rse of san	idstone	e, mu	idstone,	, flint a	nd some coa	e 10 I.	Ę			
ŀ							(1,/1,2,2, 4)			•										F			
Ŀ							(3) D43 14.75													- 15			
-										•										1			
15.5	0						B45													E			
10.0	ju ju						15.50 D44		(2.20)				ledium dense at 1	15.50m.						E			
ł							15.50 N=15 (1,1/2,4,4		(3.30)											-			
Ē							.5) (S)			•										E 16			
ł							16.25													ŧ			
ŀ																				E			
-										•										E			
- 17.0	0						B48 17.00 D47													- 17			
[							17.00 N=18		17.40											F			
È.							(1,23,5,5 ,5) (S)					Gra	fium dens vel is ang	ie light ular to	subr	wn grave rounded	fine to	to coarse S/ coarse of sai	AND. ndstone,	F			
[							D49 17.40 D50			2		flint,	mudston	e and	coal.					E			
F							17.75		(1.10)	2										- 18			
ŧ										0										Ē			
- 18.5	0						B51 18.50		18.50			Med	lium dens	e light	brov	VN SANE	) and G	RAVEL. Gra	vel is	-			
ŀ							N=17 (2,2/3,3,4 .7)			9 a		ang	ular to sul Istone flir	bround	led fi coal	ne to co Sand is	arse of	sandstone, coarse		F			
F							(S)		(0.90)	9 a				an ru	200 <b>1</b> .	Cana 13				- 19			
ŀ							D52 19,25			9 a										ţ			
F							D53 19.40		19.40		<u> </u>	Firm	n to stiff lig	ght bro	wn n	nottled g	rey slig	htly gravelly	slightly	Ŧ			
<u> </u>												mud	istone, co	al and	flint.	uiai io s	unionu		uaise of	F			
- 20.0	20.00									<u></u>	<u> </u>						and of the state			+ 20			
	Start & End of Shift Observations							Boreh	ole Diam	eter	Cas	l sing D	liameter	Rema	rks:	munued ne	ext sheet						
Date 22-08-2	Date         Time         Depth (m)         Casing (m)         W           22-08-2018         00:00         8.45         7.80							) Depth 12.5	(m) Dia ( ) 20	mm)	Depth 12	n (m) 50	Dia (mm) 200	Inspe	ction	pit dug t	to 1.20r	n. Groundwa	ater enco	untered	1 at 1	12.30r	n.
23-08-2	23-08-2018 00:00 22.70 22.50						7.45	22.7	0 19	0	22.	50	150	Boreh	ole b	acknilled	i with b	enionite grou	IL.				
														Strike	(m)	Casing (m	Sector	Water St	rikes	(m) Do-	nork		
	Flush Information									net-"	ation			12.3	(in) 90	12.20	Jealed	20	6.70	(in) rten	neli KS		
Flush Information Top (m) Base (m) Flush Type Return						eturn	Flush Colou	r Top (r	n) Base	install (m)	ation Typ	pe	Dia (mm)										
		Γ										T		Fracture	Index	reported a	as number	r per metre. TCR	SCR and F	QD repo	rted in	n %	
								1	1					HBSI R	C Is	ssue Numb	er:3 Is	sue Date: 10/05/	16				

					Contrac	ct Name:			_			Client	t:	_			I	Boreho	le ID:	
F	IAI	V F	ARM	IER FFS	Flixbor	rough El	-WP	lant,	Scunt	norpe				Sc	olar 21				RH4	
	AS	500	, I A I	LS	Contrac	ct Numbe	r: C	ate S	Started:	40	Log	ged By:	Ch	ecked By:		Status:			FIID	
						31554		22	/08/20	18		SP/CL		PC		FINAL	-	Sheet	3 of 3	
	CP 8	Rot	tary (	Core	Easting	):		Iorthi	ng:		Gro	und Level:				Print Date: 19/10/20	110	Scale:	1.50	
<u> </u>	DIIII	ng L	og				_							0.0	Tillam			atia: Et	1.50	
	S	ample	s & In 9	Situ Tes	tina							Str	ata Detai	ils SP	THam	THEF. ALMUTE	Energy R	auo. o	Groun	dwater
Dept	h T	ICR	SCR	RQD	FI	Samples /	Leve		epth (m)	Leger	nd	04	ata Deta	Strata Des	cription				Water	Backfill/
						D54 20.00	(MAO	<b>b)</b> (1	nickness)	×								+	ounce	Installation
-						N=23 (2,2/4,5,6				<u> </u>	÷.							F		
F						,8) (S)					-							E		
						D56				<u>×</u> _×								E		
F						20.15				<u> </u>	-							- 21		
ļ.									0.00	<u>, i</u>	- <u>×</u>							F		
E						B57			3.20)	<u> </u>	TX T							E		
-						21.50					Ť.							ŧ.		
-										<u>i</u> z								-		
Ē										<u> </u>	-× -							- 22		
ł						D58 22.25				<u></u>	Ť							[		
-	0				NI	D59			22.60	×	ž	ight grow wo	athorod	MUSTONE				+		
22.7	0					22.60 D60 22.60			22.70		∃t	ery weak to	weak gr	ey MUDST	ONE w	ith very closel	y and	1		
- 22.60	) - (	100	90	68	9	50 (10,14/50						losely space vosum Disc	d very ti ontinuiti	hin beds an es: Subhor	id thin la izontal a	aminations of and horizontal	white I verv	- 23		
20.0						78mm) (S)					C	losely and cl	osely sp	aced, som	e poosi	ble drilling	,	ţ.		
·					NR	50 (22 for 57mm/50 for					="	From 22.70m to 22 From 22.77m to 22	.74m: Gypsun .80m: Gypsun	none disce	midle.			F		
-					9 NI	24mm) (S)			2.14)			23.06m to 23.11m:	Gypsum.					E		
- 23 50	) -					C2 22.88 C3 23.10						From 23.96m to 24	.06m: Gypsun	n.				- 24		
24.7	0	84	84	28	11	4 23.60						From 24.04m to 24	.12m: Gypsun	n				F		
E												1101124.201110.24	STIL Gypaun					E		
-					L						⊒⊨	From 24.57m to 24	.58m: Gypsun	n.				t I		
-					14 NI	-		(	224,7804)		١v	ery weak to	weak re	d brown M	UDSTO	NE with very	closely	÷		
Ē					13						a	nd closely sp	ontinuiti	ery thin bed	is and li	aminations of and horizontal		- 25		
24.70	) -			05		=					-c	losely and cl	osely sp	aced, undu	ulating a	and planar, sm	nooth.	E		
26.2	0		84	30							ľ	Veathering: N From 23.96m to 24	None dis	scernible.				F		
ŀ					7							From 24.04m to 24 From 24.25m to 24 From 24.57m to 24	.31m: Gypsun .58m: Gypsun	n. n. n.				E		
F												From 25.00m to 25 From 25.00m to 25 From 25.00m to 25	.37m: Gypsun .37m: Gypsun .64m: GYpsun	n. n. n.				- 26		
					11	-		:	26.20		R	Red and grey	MARL 1	with gypsur	n band	s (DRiller's		†		
ŀ					NR			(	(0.60)		d	ESCRIPTION, N From 26.37m to 26	O COFE F	ecovery). m.				F		
[									26 80									F		
- 26.20	) - 0	60	49	7		=			20.00			Veak red bro cally green (	wn and grey I wi	locally great ith very clos	en grey selv and	MUDSTONE	and ed verv	- 27		
ŀ					NI						tt	nin beds and	laminat	ions of gyp	sum. D	iscontinuities:	, '	E		
E					17						s	paced, undu	lating ar	nd planar, s	mooth.	iy and closely		E		
27.7	ρ				NI	50 (25 for						From 27.08m to 27.	.12m: Gypsun	n				È I		
27.70	0	100	0	0	29	- 140mm/5 0 for 75mm)												F		
					NI	(C)												20		
28.00	) -								(3.20)									F		
29.0	0	100	83	52	7													Ē		
-																		E		
-					19													- 29		
																		Ē		
30.0	0	100	85	51	9													E		
					9	1												F		
<b> </b>					ļ ,			:	30.00		₹		End	of Borehole	e at 30.0	00m		- 30		
	Start	d of Sh	ift Obse	ervations		Во	rehole	Diame	ter	Casing	g Diameter	Remark	(S:						I	
Date 22-08-20	Date         Time         Depth (m)         Casing (m)         W           2-08-2018         00:00         8.45         7.80							th (m) 2.50	Dia (m 200	nm) De )	epth (n 12.50	n) Dia (mm) 200	Inspecti	ion pit dug t	to 1.20r	n. Groundwat	er encou	ntered	at 12.30	m.
23-08-20	3-08-2018 00:00 22.70 22.50						22	2.70	150	)   :	22.50	150	Dorenol	e Dackfilleo	a with D	entonne grout	-			
													OL: L			Water Stri	kes		adus	
									<u> </u>				12.30	12.20	) sealed	20	6.70	n) Kem	arks	
Top (m)	Base (m	Flu Flus	isn Info <u>h Typ</u> e	ermatio	n eturn	Flush Colo	ur To	o (m)	Ir Base	nstallati (m)	on Type	Dia (mm)								
							Γ						Fracture Ir	ndex reported a	as number	r per metre. TCR, S	SCR and R	QD repor	ted in %	
							1		1				HBSI RC	Issue Numb	er:3 Is	sue Date: 10/05/16	8			

				Contrac	ct Name:						Clier	nt:		0				В	oreho	le ID:	
	AN	FARM	IER TFS	Flixbor	rough El	-W PI	lant, S	cunt	horpe					S0	lar 21					BH5	
		CIA.	1 2 5	Contrac	ct Numbe 31554	r: D	Date St 03/	arted: 09/20	)18	Log	Igea By: SP/CI	C	Check	Red By: PC		Status: FI	NAI		h t /	Dilo	
CE	2 & D	otany (	Core	Easting		N	Iorthin	1:		Gro	und Level:			10		Print Date	;	s	cale:	013	
D	rilling	Log			,			,								18/1	0/2018			1:50	
														SPT	r Ham	mer: ALM	C1 Energ	gy Ra	itio: 51	%	
	Samp	les & In	Situ Tes	ting	0				1		S	strata De	etails							Groun	dwater
Depth	TCR	SCR	RQD	FI	Samples / Tests	(mAOE	D) (Thi	th (m) kness)	Legen	d			S	trata Desc	ription					Water Strike	Backfill/ Installation
:					D1 0.20		0	.15			MADE GRO	UND: L	_ight (	grey and	dark b	prown san	dy GRAV	VEL.			
E Contraction of the second se					B4 0.50		(0	.35) 50			Gravel is and concrete	gular to	o subr	rounded	fine to	coarse sla	ag, brick	and	E		
-					ES3 0.50			50)			MADE GRO	UND: F	Red b	rown slig	htly si	Ity sandy	GRAVEL	-	-		
					B4a 0.85		1	.00)		₿ a	and mudstor	guiar to ne. Cot	bles	of brick a	also no	coarse br oted.	ICK WITH S	siag	Ē,		
1.20					B7 1.20			.00		S	Soft/very sof	ft light l	orowr	n, locally	mottle	d grey sar	Idy CLAY	Y.			
:					D6 1.20 N=5 (1.0/1.1.1														-		
[					,2) (S)																
-					D8 1.85		(1	.70)											-		
					B10 2.00 U9 2.00					-									-2		
										-											
-								70		-									-		
-					011 2.70			.70		×s	Soft/very sof	ft grey I	browr	n slightly	sandy	silty lamir	nated CL	AY.			
- 3.00					B13 3.00 D12 3.00					×									- 3		
ł					(1,1/1,1,1 .1)					×									Ē		
-					(S)					×									-		
:					D14 3.75				$\overline{-x}$	×									-		
F					U15 4.00					×									-4		
-									$\overline{-x}$	×									-		
ŀ					D16 4.45		(3	.50)	$\overline{-x}$	×									-		
					D17 4.75				$\hat{\underline{-x}}$	×											
- 5.00					B19 5.00					×									- 5		
					N=6 (1,1/1,1,2				$\overline{\overline{}}$	×											
-					,2) (S)				$\overline{\overline{}}$	×									-		
-					D20 5.75				$\overline{\overline{}}$	×									E		
-										<u>×</u>									- 6		
ł					D21 6.20		6	.20		- <u>×</u> 	Soft occasio	onally f	irm d	lark brow	n sliah	ntly sandy	organic				
[					U22 6.50				514 <u>-</u>	Ċ	CLAY with in	nclusion	ns of t	fibrous pe	eat.	ing carray	organio		[		
-									sila <u>x</u>										-		
E					D23 6.95				sila <u>x</u>										- 7		
					D24 7 25				alia <u>x</u>										· '		
ŀ									alia <u> </u>										-		
									sil4 <u> </u>										-		
					B28.0.00				514 <u>-</u> X	1.5									:		
- 0.00					D25 8.00 N=8		(6	.00)	sila <u> </u>										- °		
					(1,1/1,2,2 ,3) (S)				sila <u> </u>										-		
									ali <u>a — x</u> — a												
					D27 8.75				514 <u></u>										-		
									Sil <u>a — X</u>										-9		
									NIG <u>-</u> X-	1.5									-		
E E					B29 9.50 U28 9.50				NIG <u>X</u>	L.									E		
									× <sup>11/2</sup> × -	L.									[ ]		
È									511/4 <u>* - 7</u> -				Co	ontinued ne	xt sheet	t			- 10		
Date	tart & E	nd of Sh	hift Obs th (m) (	ervations Casing (m)	Water (m	Bor Dept	rehole I th (m)	)iame Dia (n	ter ( nm) De	Casin oth (r	g Diameter m) Dia (mm)	Rema	arks:	pit 4.00-	0 14/	01 000000		0m :	incra	tion rit	Water
03-09-2018	0:00	0 8	.45	7.90	6 30	13	3.00	200		3.00	200	strike	at 12	2.20m. Bo	n. wat prehole	er seepag e backfille	d with be	entoni	inspe ite gro	ut.	vvater
0	00.0	~   <sup>2</sup>		20.00	0.50			150			150					W/ato	Strikes				
												Strike	e (m)	Casing (m)	Sealed	d (m) Time (	mins) Rose	e to (m	Rem	arks	
	F	lush Infe	ormatio	n	1	1_		lr	nstallati	on		1									
lop (m) Base	e (m) Fl	ush Type	e Ri	eturn	Flush Color	ur Top	o (m)	Base	(m)	Гуре	Dia (mm)	) Fractur	e Index	x reported a	s numbe	r per metre 1	TCR, SCR =	and RO	D repor	ted in %	
												HBSLB	C le	ssue Numbe	er: 3 le	sue Date: 10	/05/16				
			1									- Born	- 6		(S	Fase. 10					

				Contrac	t Name:					Client	t:	_				Boreho	le ID:	
	ANI	FARM	1ER	Flixbor	ough Ef	-W Plar	nt, Scunt	horpe			-	So	lar 21				RH5	
A	330	CIAL	LS	Contrac		r: Dat	e Started	:	Logg	jed By:	Che	cked By:		Status:			DIIS	
				3	31554		03/09/2	018	_	SP/CL		PC		FINA	L	Sheet 2	2 of 3	
CF	8 Ro	otary (	Core	Easting	1	Nor	thing:		Grou	ind Level:				Print Date: 18/10/2	018	Scale:	1.20	
	ming	LOg										en	T Llom	10/10/2	Enormy F	latio: Ef	1.50	
	Samp	les & In :	Situ Tes	tina						Str	ata Detail	s SP		ITTEL ALMUT	Ellergy F	auo. o	Groun	dwater
Depth	TCR	SCR	RQD	FI	Samples / Tests	Level (mAOD)	Depth (m) (Thickness)	Legen	nd			Strata Desc	ription				Water	Backfill/
								X	11/2							-		
					D30 10.25			×								E		
ŀ								×	11/2							÷.		
								NIG X -	16							F		
- 11.00					B32			NIG	14							- 11		
[					D31 11.00				10							E		
-					N=0 (1,1/1,2,1 _2)			x								-		
-					(S) D33											F		
-					11.75			x								- 12		
-					D34		12.20	sila <u>x</u>		odium dono	o and los	oo light ge	ov brou	un ailt fina t	0.000700			
12.50					EW45 12.20			× ××	S, S,	AND.		ose light gr	cy bio	wit sity line t	U CUAISC	Ē		
12.00					D35 12.50 D36			× ××	×							-		
-					12.50 N=11			× × × ×	×							-		
E I					(0,0/1,3,3 ,4) (S)			× ×	×							- 13		
-					D37 13.25			× ×	×									
-								× ×	×							-		
[								× × × ×	×							Ē		
- 14.00					B39 14.00			× × × ×	×							- 14		
:					D38 14.00 N=9		(4.10)	× × × ×	×							-		
ŀ					(1,0/0,2,2			× × × ×	×							E		
-					(3) D40 14.75			× ×	×									
-								× ×	×							- 15		
-								× ×	×									
- 15.50					B42			×××	×							Ł		
					15.50 D41 15.50			x x	×							1		
Ŀ					N=14 (1,2/2,2,5			× ×	×							10		
ł					,5) (S)			× ×	×									
					D43 16.30		16.30	x, X,	× G	rey brown sl	lightly sil	ty gravelly	fine to	coarse SAN	D. Gravel	+		
Ē							(0.80)	xî X x	is qu	angular to s Jartzite.	subround	ied fine to c	coarse	mudstone ar	na	E		
							(0.00)	xî X x	X							-		
- 17.00					B47 17.00 D44		17.10		ें। चाहा	rm becomin	a stiff rea	d and grev	sandv	slightly grave	ellv CLAY	- 17		
[					17.00 N=14				G	ravel is suba	angular r	nudstone.	oundy	onginiy gran	,			
-					(1,2/2,3,4 ,5) (S)											÷		
ł					D46 17.10 D48											Ē		
-  -		1			17.75											- 18		
ŀ		1							-							<b>F</b>		
- 18.50		1			B50		(3.00)		-							Ē		
ł		1			D49 18.50				-							<b>k</b>		
-					(2,3/3,5,5				-							- - 19		
ł					(S) D51				-							Ē		
					19.25											-		
ŀ		1														<b>F</b>		
- 20.00					854											- 20		
20.00	art 9 F	nd of C		nutices	20.00	Beer	olo Diarro		Capito	Diamata	Domest	Continued ne	ext sheet	t		20		
Date	Time	Dept	th (m)	Casing (m)	Water (m	) Depth	(m) Dia (r	nm) De	epth (m	) Dia (mm)	Inspection	s. on pit 1.20r	n. Wat	er seepade a	at 0.60m i	n inspe	ction pit.	Water
03-09-2018 04-09-2018	00:00	0 8. 0 21	45 .05	7.90 20.60	6.30	13.0 21.0	u 20 5 15	U   7 0   2	13.00 21.05	200 150	strike at	12.20m. B	orehole	e backfilled w	ith bento	nite gro	ut.	
														Water St	rikes			
											Strike (m	) Casing (m)	Sealed	d (m) Time (min	s) Rose to	(m) Rem	arks	
Flush Information						IT Top /	n)   Baa-	nstallati	on Type	Dia (mm)								
Top (m) Base (m) Flush Type Return Flush					rusti Colol	- 10p (I	ii) Dase	(11)	туре	Dia (mm)	Fracture In	dex reported a	s numbe	er per metre. TCR	, SCR and F	QD repor	ted in %	
											HBSI RC	Issue Numbe	er: 3 Is	ssue Date: 10/05/	16			

						Contrac	t Name:						Client	t:	_				Boreho	le ID:	
F	IA	1 N	FA	R M	ER	Flixbor	rough EF	-W P	lant, S	Scunt	horpe				Sc	olar 21	<b>a</b> ( )			RH5	
	A	550		AI	LS	Contrac		r: D	ate St	tarted:		Log	ged By:	С	hecked By:		Status:			DHS	
						3	31554		03/	09/20	)18		SP/CL		PC		FINAL	-	Sheet 3	3 of 3	
	CP	& F	lota	ry C	ore	Easting	E	N	lorthin	<b>g</b> :		Gro	und Level:				Print Date:	10	Scale:	4.50	
	Dri	lling		g				_									10/10/20	10		1.30	
		Sam	plac	ln C	itu Toel	ling							Ctr	rata Dat	SP	'I Ham	mer: ALMC1 E	Inergy R	Ratio: 51	Group	dwator
Dept	th	TCF	R S		RQD	FI	Samples /	Level	l De	pth (m)	Lege	nd	Su	ala Del	Strata Des	cription				Water	Backfill/
							D52	(mAOL	) (In 2	(CKRess)				4.						Strike	Installation
							N=46 (5,8/9,11,		-	0.10			Grey brown w Vpsum,	veather	red MUDST(	ONE wi	ith inclusions o	of	1		
È							13,13) (S) D53			1 951		= `							F		
[							20.10 D55												E		
·							20.80 D57		2	1.05									- 21		
:						NR	20.95		2	1.20			led and grey	(MARL	with gypsur	m band	ls (Driller's des	cription,	7		
21.00	0 -	00		-1	0	NI	-						From 21.19m to 21	1.20m: Gyps	um. ONE with clo	oselv s	naced very thi	n heds	/		
22.0	00	00			U	15						a	nd thin lamin	nations	of gypsum.	Discon	tinuities: Horiz	contal,	E		
									(1	1.30)			ccasionally s ndulating sn	sub hoi mooth	rizontal, very	/ closel	y to closely sp	aced,	È I		
							C1 22.07					Ē	From 21.30m to 21 From 21.97m to 21	1.34m: Gyps 1.00m: Gyps	um. sum				- 22		
ŀ						6						≡∟	F10in 22.00in to 22	z.uzni. Gypa	um				F		
F							-		2	2.50		v	Veak red bro	wn, oc	casionally g	reen gr	ey, MUDSTON	E with	-{		
22.00	0 -	100	ן נ	00	74								ery closely a	and clos	sely spaced	very th	in beds and th	in tal ta	È I		
-						10						S	ubhorizontal	l, close	ly spaced, pl	lanar a	nd undulating,		- 23		
ŀ												S	mooth. From 22.72m to 22	2.735m: Gyp	osum.				E		
						28						E	From 22.80m to 22 From 23.12m to 23	2.875m: Gyp 3.125m: Gyp	isum. Isum.				E		
;																			È I		
							C2 23.90												-		
23.50	0 - 70	79	1	00	100														24		
:																			È I		
-													From 24.59m to 24	4.63m: Gyps	um.				-		
:						1													Ē		
F																			- 25		
ļ						6													¢ I		
24.70	0 -	100	) !	93	73														+		
20.5	50																		E		
Ŀ																			- 26		
ļ									G	7 50)									-		
						1				,									E		
[							C3 26.58												E		
	-						-												È I		
- 26.30 27.8	0 - 30	86		94	86	10													- 27		
ŀ																			E		
ļ.						6							From 27 Kom to An	/ GBm: Char	um				÷		
<u> </u>						N							From 27.80m to 27	7.87m: Gyps	um.						
F						7	-												- 28		
ł						NI															
- 27.80	0 -	100		51	20		-														
29.3	30		'   `		25	7													-		
Ĺ													FRom 28.80m to 2	28.80m: Gyp	sum.				- 29		
:						NI													23		
							1												F		
29.30	0 -	100	) 1	00	87	9													E		
30.0	UU																		E		
			+	+			+		3	0.00		1		Er	nd of Borehole	e at 30.0	000m		- 30		
Det	Sta	art & I	End	of Shi	ft Obse	ervations	Mata- /	Bo	rehole	Diame	ter	Casing	g Diameter	Rema	rks:					4.	
03-09-2	2018	00:0	1e 00	8.4	1 (m) C 15	7.90	vvater (m	13	un (m) 3.00	200 200		epin (n 13.00	200	Inspector strike	tion pit 1.20 at 12.20m. F	m. Wat Borehol	ter seepage at e backfilled wit	0.60m ii th bento	n inspe nite aro	ction pit. ut.	Water
04-09-2	2018	00:0	JU	21.	U5	20.60	6.30	21	.05	150	J	21.05	150						- 3.0		
														Strike	(m) Casing (m	n) Seale	Water Stri d (m) Time (mins	kes Rose to (	(m) Rem	arks	
			Flue	1 Info	matio	1		_		þ	nstallat	ion	⊥				,,				
Top (m)	Base	(m) F	lush	Туре	Re	eturn	Flush Colou	ır Top	o (m)	Base	(m)	Туре	Dia (mm)								
														Fracture	Index reported a	as numbe	er per metre. TCR,	SCR and R	QD repor	ted in %	
	1							1					1 1	HBSI RO	lissue Numb	ber: 3 l	ssue Date: 10/05/10	8			

				Contrac	t Name:						Client		_				Boreho	ole ID:	
	AN F	ARM	IER	Flixbor	ough EF	-W PI	ant, S	cunt	horpe	-			So	olar 21				рце	
A	3300	CIAI	ES	Contrac	t Numbe	r: D	ate Sta	rted		Logged B	<b>y</b> :	Ch	ecked By:		Status:			БПС	)
				3	31554		21/0	8/20	018	SP	/CL		PC		FINA	L	Sheet	1 of 4	
CP	° & Ro	tary C	Core	Easting	:	N	lorthing	-		Ground Lo	evel:				Print Date:		Scale:		
Dr	illing L	og													18/10/2	018		1:50	
													SP	T Ham	mer: ALMC1	Energy R	Ratio: 51	1%	
	Sample	s & In S	Situ Tes	ting	Samples /	l evel	Dept	h (m)			Stra	ata Deta	ls					Grour	ndwater Backfill/
Depth	ICR	SCR	RQD	FI	Tests D1 0.00	(mAOD	D) (Thic	iness)	Legen		CPOU		Strata Des	cription	ith dolomite k	ardcore		Strike	Installation
					552.0.20		(0.	30)			GROU	ND. Die				ardcorc.	F		
[					B4 0.50		(0.	30)			GROU	ND: Lig	ht grey san	dy GR	AVEL. Grave	l is te and	7		
-					ES3 0.50		0.	6 <b>0</b>	<u> </u>		adam,	Jounde			siag, concre		/		
							(0.	40)		Firm lig	pht brov Indular	vn sligh to subr	tly sandy sl ounded fine	lightly g e to me	ravelly CLAY	Gravel	-		
1.20					ES5 1.00		1.	00		and po	ssible t	orick.					Æ		
1.20					D6 1.20 N=4		0	051	<u> </u>	Soft to silty CL	tirm ligi _AY.	nt brow	n mottled g	rey slig	ntiy sandy si	ightiy	E		
-					(1,1/1,1,1 ,1)		(0.	63)	E	-							F		
-					D7 1.30		1	85									Ŀ		
F					U10 2.00				x	≦ Soft lig ⊠	htly gre	ey slight	ly sandy sil	ty CLA	Y.		-2		
																	Ł		
-					D11 2.45				×	- <u>-</u>							Ę		
-					D12 2.75				×	- <u>-</u>							F		
- 3.00					B14 3 00				×	-11 							E.a		H -
					D13 3.00 N=7				<u> </u>								1		E A
					(1,1/1,1,2 ,3) (S)		(2.	85)	<u> </u>								ţ.		E E :
Ē										1							Ē		Γ. F.
					D15 3.75												-		
-					U16 4.00				<u></u>	1							- 4		
-									<u> </u>								ŧ		
F.					D17 4.45				<u> </u>	<u>-</u>							E		
					D18 4.70		4.	70	یادی مالد.	Very so	oft occa	isionally	soft brown	n slightl	y sandy claye	ey fibrous	+		
- 5.00					B20 5.00				د مالاد م بنادر وبالار	DEAT v laminat	with larg ted.	ge wood	i matter and	d plant	matter. Clay	is locally	- 5		
Ē					N=5 (1,1/1,1,1				د ماند م براه ماند	she							E		
-					,2) (S)				te alte a	dia.							E		
					D21575				le alle a	she							1		
									to alter a	he.							F,		H
Ē									le aller a	uka Ala							E °	_	l A
									le alle a	she he							1		l A
-					U22 6.50				is alla is alla i	she S							F		
									<u>مالاء مالاد.</u> د مالاد م	hte N							E		
-					D23 6.95		(4.	80)	ماند ماند. د ماند م	hte N							- 7		
-					D24 7.25				astra astra ta astra as	she she							ŧ		
									ماند ماند د ماند م	she She							Ē		
ļ									ates ates e ates a	Ma							ŧ		
8.00					B26 8.00				ينادي مالار د مالاد م	stree							8		
E					N=6 (1,1/1.1.2				ينادي مالار د مالاد م	Stree							E		
ŀ					.2) (S)				ينادي منادي مادي ما	she She							Ł		
ŀ					D27 8 75				ينادي منادي مادي ما	she She							ŧ		
E					221 3.13				ينادي مادي باد ي	Mar							Ē,		
t -									ينادي مادي باد ي	Mar							-9		
							_		د معرفه مرادی مادی مرادی داد	ini Jaj							\$		
Ē					B29 9.50 U28 9.50		9.	Uc	د معرفه م مالای مالای الد م	Soft bla	ack slig	htly sar	dy slightly	silty cla	iyey amorpho	ous	ŧ		
ŀ									د معرفه م مالد مالد م	real. .∛							E		
F					+				പ്രിഡ് പ	inte			Continued ne	ext sheet	t		10		
St	art & En	d of Sh	ift Obse	ervations	Wata- (	Bor	ehole D	iame	eter (	asing Dian	neter	Remark	S:						•
21-08-2018	00:00	17	.45	16.90	10.50	12	2.00	200		2.00	200	Inspecti Standpi	on pit dug t pe installed	to 1.20	m. Groundwa 00m.	iter encou	untered	at 11.70	m.
22-08-2018 31-08-2018	00:00 00:00	21 23	.20 .10	21.00 22.00	13.10	21	.20	15	U 2	1.00	150								
03-09-2018	00:00	30	.00	22.00	22.30						F	Strike (r	n) Casina (m	) Sealer	Water St d (m) Time (min	rikes s) Rose to (	(m) Rem	arks	
	FI	ish Info	rmatio	n		-		J.	nstallativ	on .		11.70	11.50		20	6.30		_	
Top (m) Base	(m) Flue	sh Type	Re	eturn I	Flush Colou	Ir Top	) (m) E	Base	(m)	Type Dia	(mm)								
						0.	.00	1.0 12.0	U P 00 SL(	DTTED	ľ	Fracture In	ndex reported a	as numbe	r per metre. TCR,	SCR and R	OD repor	ted in %	
											1	HBSI RC	Issue Numb	er: 3 Is	sue Date: 10/05/	16			

					Contrac	t Name:						Client	t	-			l	Boreho	le ID:	
	ASS	FA OC	R M	ER	Flixbor	ough EF	W Pk	ant, S	Scunt	norpe	Loggod Pu		Ch	S0	olar 21	Ctatue:			BH6	
		0.0		20	Contrac	11554		ale 51 21/	aneu. 08/20	118		ICI	Ch	PC.		Sidius. FINA				
	ר פ ר	Doto		oro	Fasting		N	orthin	00/20	/10	Ground Le	vel:		10		Print Date:		Sheet 2 Scale <sup>:</sup>	of 4	
D	rilling	j Lo	g	ore	Lasting				9.							18/10/2	018		1:50	
		-	-											SP	T Ham	mer: ALMC1	Energy R	atio: 51	%	
	Sam	ples	& In S	itu Tes	ting	0			- ()			Str	ata Detai	ls					Groun	dwater
Depth	TC	RS	SCR	RQD	FI	Tests	(mAOD	)) (Thi	pun (m) ickness)	Legend	ا ا			Strata Des	cription				Strike	Installation
ŀ						D30				د عاد م عاد ماد	ne Ne							ΕI		
-						10.25				د عاد ه ماد ماد	Ne.							F		
ł										د عاد ه ماد ماد	Ne.							ΕI		
- 11.00						B32		(2	2.20)	د عاد م ماد ماد	ne N							- 11		
ļ.						11.00 D31 11.00				د عاده م ماد ماده	n.e. N							F		
-						N=7 (1,1/1,2,2 2)				د عاد م ماد ماد	he N							[ ]		
						(S) D33		1	1.70	is sila si X	k Noose h	rown	nrev slin	ahtly silty fir	ne to m	edium SAND		-	$\bigtriangledown$	
-						1.70				$\mathbf{x} \mathbf{x} \mathbf{x}$	3		groy ong	, nay only in				- 12		
:										× × ×	2							-		
- 12 50						B35		(1	.55)	× ×								EI		
						12.50 D34 12.50				×××								-		
Ĺ						N=5 (3,0/0,0,1				×××	3							- 13		
						(S) D36		1	3 25	×××	2									
È						13.25			0.20		Loose g	rey br Grave	own slig I is angu	phtly silty sli ular to subro	ightly ( ounded	gravelly fine to fine to coars	o coarse e of	ΕI		
											sandsto	ne, m	udstone	, flint, with	small ir	nclusions of w	ood.	<u> </u>		
14.00						829												E		
14.00						14.00 D37												- 14		
Ę						5 (2,1/,1,2,												ΕI		
						2) (S)		(2	2.85)									El		
:						14.75				2										
						15.00					-							<b>1</b> 5		
15.50																		; I		
- 15.50						15.50 D42												ΕI		
						15.50 N=9 (1,1/1,2,3												-		
Ē						.3) (S)		1	6.10		Medium	dens	e light g	rey red slig	htly cla	ivey gravelly f	fine to	- <sup>16</sup>		
						16.25					coarse	SAND stone	. Gravel flint m	is angular	to subi	rounded fine t	o coarse	F		
Ē								(1	.10)			,	,					ΕI		
17.00																				
- 17.00						17.00 D44		1	7 20									F"		
-						17.00 N=17 (2,3/3,4,5					Firm slig	ghtly s to sub	ilty sligh prounde	tly gravelly d fine to co	sandy arse of	CLAY. Grave	lis ne,	F		
						.5) (S)					quartzit	e and	occasio	nal coal.				El		
:						D46 17.75		(1	.30)									-		
																		- 18		
										· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·							F		
- 18.50						D47 18.50 N=15		1	ö.50		Medium		e light g	rey red slig	htly gra	avelly clayey f	fine to	τI		
<b>;</b>						(1,2/2,3,5 ,5) (S)		(0	).75)		of muds	stone,	flint and	quartzite.	อนม		S COAISC	<u> </u>		
-																		- 19		
ļ.						19.25		1	9.25		Light gr	ey red	sandy	CLAY.				7		
E								(1	.15)		<u>:</u>							E		
																		_		
- 20.00			-	8 OI		20.00	•	- h - !	Dice		anin - D'	ate -	Darr	Continued ne	ext sheet	t		20		
Date	Tin	End ne	of Shi Depth	n Obse n (m)	ervations asing (m)	Water (m	Bor Dept	enole h (m)	Diame Dia (m	ter C 1m) Dep	asing Diam th (m) Dia	eter (mm)	Remark Inspecti	s: on pit dua t	to 1.20	m. Groundwa	ter encou	ntered	at 11.70	m.
21-08-2018 22-08-2018	8-2018 00:00 17.45 16.90 8-2018 00:00 21.20 21.00 8-2018 00:00 23 10 22 00							.00 .20	200 150	12	2.00 2 1.00 1	00 50	Standpi	pe installed	l to 12.	00m.		-		
31-08-2018 03-09-2018	08-2018 00:00 23.10 22.00 09-2018 00:00 30.00 22.00 2															Water Str	ikes			
	Elush Information												Strike (n 11.70	n) Casing (m 11.50	) Sealed	d (m) Time (mins 20	s) Rose to (r 6.30	m) Rema	arks	
Top (m) Bas	Flush Information (m) Base (m) Flush Type Return Flush (						r Top	(m)	Ir Base	nstallatio (m) T	n ype Dia	(mm)								
							0.	00 00	1.00	D PI 10 SLC	.AIN TTED		Fracture Ir	ndex reported a	as numbe	r per metre. TCR,	SCR and R	QD report	ed in %	
													HBSI RC	Issue Numb	er: 3 ls	sue Date: 10/05/1	16			

					Contrac	t Name:						Client	t:		_					Boreho	ole ID:	
	IAN	FA	RM	ER	Flixbor	ough Ef	W P	lant,	Scunt	horpe					So	lar 21					рца	
	ASS	00	IAI	ES	Contrac 3	t Numbe 1554	r: [	Date S 21	Started: 1/08/20	)18	Logged By SP/	r: ICL	C	Checke	ed By: PC		Status: F	INAL		Sheet		)
	ם פ סר	Dote		`oro	Fasting		-	Northi	na:		Ground Le	vel					Print Da	te:		Scale:	5014	
	Drilling		ary c Da			-											18/	10/20	18		1:50	
		<u> </u>													SP	r Ham	mer: Al N	MC1 F	nerav F	Ratio: 5	1%	
	Sam	ples	& In S	itu Test	ting							Str	ata De	tails							Grou	ndwater
Depth	тс	R	SCR	RQD	FI	Samples / Tests	Leve (mAO	el [	Depth (m) Thickness)	Legen	d			Str	rata Desc	ription					Water Strike	Backfill/
		+				D51 20.00	(	-/ (.	,											-		
:						N=16 (2,2/3,4,4														F		
ŀ						,5) (S)			20.40		Light br	own cl	layey	grave	lly fine to	o coar	se SANE	). Gra	vel is	7		
[						20.40 D53			(U.4U) 20.80			to suc	bround	ded tin	ie to coa	arse of	mudsto	ne and	a fiint.	F		
- 21.00						20.75 D54 20.90			(0.30)		Firm lig	ht grey	y red s	slightly	gravell	y sand	ty CLAY	with lo	w r to	- 21		
21.20						D55 21.00			21.10	10 <del>10</del> 10		ided fi	ine to	coarse	e of muc	istone	, flint and	d quar	tzite.	<u>/</u> `'		
						50 (25 for 97mm/50					Light gr	ey slig	phtly w	veathe	red MU	DSTO	NE.			ŧ		
F						68mm) (S)			(0.90)											F		
-						D56 21.10														F		
[		_			NR	21.20 50 (25 for			22.00		Weak o	reen o	irev M	IUDST	TONE w	ith ver	v closelv	and	losely	- 22		
22.00 -	92	2	92	50	9	42mm/50 for					spaced	lamina	ations	and v	ery thin	beds	of gypsu	m		Ŀ		
. 22.00					ND	(S) C1 22.17			(1 10)			space	s: Hor d. pla	nzonta nar an	il and su Id undul	ating.	smooth.	ry cios	sely and	' <u> </u>		
22 50 -						1			(1.10)											ţ.		
23.10	88	3	88	32	11	C2 22.91														1		
		_				-			23.10		Red and	d arev	marl	with o	vosum ł	ands	(Driller's	descr	intion	- 23		
[					NR				(0.53)		no core	recov	ery).		Jpount	Janao		40001	puon,	E		
ŀ									) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) )											_		
23.10 -		_	45	17	31				23.05		Weak g	reen g	grey M	IUDST		ith occ	asional v	very tr	nin beds			
24.60	0.	1	43	"	<b>1</b> /2				23.90		planar s	mooth	h.	munuc	3. HUHZ	ontai,	very dos	сту эр	accu.	<u>/</u> -24		
Ē					NI	C3 24.26					Weak re	ed bro space	wn, Io d Iami	ination	grey, MU is and v	JDSTC erv thi	NE with	very	and	E		
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27 00					<b>⊨</b> ₩́						Predom	ONE inanth	with c	iosely vered	spaced none in	lamina tact	ations of	gypsi	ım.	Ē		
28.80	10	0	58	29	NI 8				(0.90)				,							E		
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F					NR	for 75mm) (C)					of gypsi disturba	um. Pr ince c	redom aused	inantl by Ci	y recove PT testir	ered no na)	one intac	t (Pro	bable	- 29		
28.80 -		,	9	Q					(1 20)							-3/-				E		
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	Start &	End	of Shi	ft Obse	ervations	1	Bo	rehole	e Diame	ter (	Lasing Diam	eter	Rema	Cor arks:	unued ne	xt sheet						1
Date		ne	Dept	n (m) C	Casing (m)	Water (m	) Dep	oth (m	) Dia (n	nm) De	pth (m) Dia	(mm)	Inspe	ction	pit dug t	0 1.20	m. Groui	ndwat	er encou	untered	at 11.70	)m.
21-06-201 22-08-201	8 00:	:00	21.	20	21.00	13.10	2	2.00 1.20	150		2.00 2	50	Stand	ipipe i	nstalled	to 12.	00m.					
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					Contra	ct Name:			o "		C	lient		•					Boreho	le ID:	
	IA	NF	ARM	IER FFS	Flixbol	rough El	-W I	Plant,	Scunt	norpe				So	lar 21	01.1				BH6	
	A	500	CIAI	125	Contra		r:	Date s	started:	10	Logged By:	4	Che	CKEC BY:		Status				Dilo	
						31554		21	1/08/20	18	SP/C	iL		PC		Deint D	FINAL	_	Sheet 4	l of 4	
	CP	& Roi ling I	tary (	Core	Casung			NOTUTI	ng.	ľ		ei.				18	ale. 3/10/20	018	SLAIE.	1:50	
<u> </u>	Dill		Jog											SP	r Ham	mer A		=nerav F	atio: 51	%	
		Sample	s & In \$	Situ Tes	ting							Stra	ata Details					_norgy r	auto. o	Groun	dwater
Dept	h	TCR	SCR	RQD	FI	Samples / Tests	Lev (mA)	vel D OD) (T	Depth (m) Thickness)	Legend				Strata Desc	ription					Water Strike	Backfill/ Installation
-						50 (18,7/50 for							End	of Borehole	at 30.0	)00m			-		
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Date	Sta	rt & En Time	d of Sh Dept	ntt Obse h (m)	ervations Casing (m)	Water (m	Bo n) De	orehole pth (m	) Dia (m	ter Ca nm) Dep	asıng Diamete th (m) Dia (n	er ( nm) (	Remarks Inspectio	: n pit dua t	0 1 20	m, Gro	undwat	terenco	Intered	at 11 70r	n.
21-08-2 22-08-2	018 018	00:00 00:00	17 21	.45 .20	16.90 21.00	10.50 13.10		12.00 21.20	200 150	12	.00 200 .00 150		Standpip	e installed	to 12.	00m.					
31-08-2 03-09-2	018 018	00:00 00:00	23 30	.10 .00	22.00 22.00	22.30			1			╞				W	ater Stri	ikes			
	-								1				Strike (m) 11.70	Casing (m) 11.50	Seale	d (m) Tir	me (mins 20	Rose to 6.30	(m) Rem	arks	
Ton (m)	Base /	Flu m) Flue	ush Info	ormatio	n eturn	Flush Color	ur Tr	op (m)	In Base	stallation	n /pe Dia /m	nm)									
			ype					0.00	1.00			F	Fracture Ind	ex reported a	s numbe	er per me	tre. TCR,	SCR and F	QD report	ted in %	
								1.00	12.0	U SLU		ŀ	HBSI RC	Issue Numbe	er: 3 ls	ssue Date	e: 10/05/1	6			

# PHOTOGRAPHS OF ROCK CORE
































































**GROUND GAS & GROUNDWATER MONITORING RECORDS** 

í	IAN F. ASSOC	A R M CIAT	E R E S										C	Gas and	l Ground	dwater	Monitoring Results
	Contract No:			31	1554												
C	ontract Name:			Flixb	orough												
	Date:			14/0	9/2018												
			02	% v/v		20.6		CO <sub>2</sub>	% v/v	1	1D	CH₄ °	% v/v		N/D		
Background	I Readings:					Weat	her Condi	tions									
					G	Fround Co	nditions (c	dry/wet et	c.)								
			<u> </u>			Atmosphe	ric Pressu	ure (Start)	:								
	-	_		-		Atmosphe	ric Pressu	re (Finish	):					1	1		
	Time	%	0 <sub>2</sub> v/v	C %	02 v/v	C  %	H <sub>4</sub> v/v	CO H₂S ppm ppm			VOCs ppm		Gas Flow Rate (I/hr)	SWL	Base of Pipe	Comments	
Hole No:	(hh:mm)	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Steady	mBGL	mBGL	
BH3																12.00	
BH6			-	-	-											12.00	
		1															
			-	-													
			<u> </u>														
					1												
Remarks:			1			I			1					1			
					N	ND = Below dete	ection limit of ir	nstrument. NR	= Not Recorde	d.							
																	4
F	Readings Take	n By:		PS	<b> </b>												4
	Checked B	y:						December 201									8

Ģ	IAN F. ASSOC	ARM CIAT	E R E S										C	Gas and	Groun	dwater	Monitoring Results
	Contract No:			31	554												
С	ontract Name:			Flixb	orough												
	Date:			28/0	9/2018												
			02	% v/v		20.8		CO <sub>2</sub>	% v/v	1	1D	CH4 % v/v N/D					
Background	d Readings:					Weat	ther Condi	tions						Sunny, Dry			
-	-				G	Fround Co	nditions (d	lry/wet etc	c.)					Dry			
						Atmosphe	eric Pressu	ure (Start)	:					1033mb			
	-	-				Atmosphe	ric Pressu	re (Finish	):					1033mb	-		
	Time	%	O₂ ₀ v/v	C %	O <sub>2</sub> v/v	C %	H₄ v/v	CO H₂S ppm ppm			VOCs ppm		Gas Flow Rate (I/hr)	SWL	Base of Pipe	Comments	
Hole No:	(hh:mm)	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	
	_																
						<u> </u>							<u> </u>				
remarks:					N	ND = Below det	ection limit of ir	nstrument. NR	= Not Recorde	d							
																	1
I	Readings Take	n By:		SP	L												
	Checked B	y:		CL				December 201									8

Ģ	IAN FA ASSOC	ARM CIAT	E R E S										C	Gas and	Groun	dwater	Monitoring Results
	Contract No:			31	554												
C	ontract Name:			Flixb	orough												
	Date:			09/1	0/2018												
			02	% v/v		20.8		CO2	% v/v	1	1D	CH4 % v/v N/D					
Background	Readings:					Weat	ther Condi	litions Sunny, Dry									
					G	iround Co	nditions (d	; (dry/wet etc.) Dry									
						Atmosphe	eric Pressu	ure (Start)	:					1015mb			
	T					Atmosphe	ric Pressu	re (Finish	):	1				1015mb		-	
	Time	%	O <sub>2</sub> 5 v/v	C %	O <sub>2</sub> v/v	C %	H <sub>4</sub> v/v	CO H <sub>2</sub> S ppm ppm			VOCs ppm		Gas Flow Rate (I/hr)	SWL	Base of Pipe	Comments	
Hole No:	(hh:mm)	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	
															-		
<u> </u>					1						1		<u> </u>				
	1		1	1	ł						ł		1				
Remarks:					Ň	ID = Below det	ection limit of ir	nstrument. NR	= Not Recorde	d.							
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F	Readings Take	n By:		SP													
	Checked B	y:		CL											De	cember 201	

Ģ	IAN F. ASSOC	ARM CIAT	E R E S										C	Gas and	Groun	dwater	Monitoring Results
	Contract No:			31	554												
С	ontract Name:			Flixb	orough												
	Date:			16/1	0/2018												
			02	% v/v		20.6		CO <sub>2</sub>	% v/v	1	1D	CH₄	% v/v		N/D		
Background	d Readings:					Weat	ther Condi	litions Clooudy, Dry							/		
					G	Fround Co	nditions (d	lry/wet etc	c.)					Slightly wet			
						Atmosphe	eric Pressu	ure (Start)	:					1019mb			
	-	1				Atmosphe	ric Pressu	re (Finish	):	1				1018mb	1	1	
	Time	%	0 <sub>2</sub> 5 v/v	C %	O <sub>2</sub> v/v	C %	H₄ v/v	CO H <sub>2</sub> S ppm ppm			VOCs ppm		Gas Flow Rate (I/hr)	SWL	Base of Pipe	Comments	
Hole No:	(hh:mm)	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	
	_																
													<u> </u>				
Kemarks:					N	ID = Below dete	ection limit of ir	nstrument. NR	= Not Recorde	d.							
																	1
-	Readings Take	n By:		SP													
	Checked B	y:		CL				December 2015									

**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**



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, S	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:



Quality Technician

Date: 26/09/2018

Page. 1



lan Farmer Associates (1998) Limited. Registered in England and Wales, No. 3661447. Registered Office: Spring Lodge 172 Chester Road, Helsby, Frodsham, England, WA6 0AR. Offices in: Cornwall (01872) 261775. Coventry (024) 7630 3422. Harpenden (01582) 460018. Llanelli (01554) 566566. Newcastle upon Tyne (0191) 482 8500. Motherwell (01698) 230231. Warrington (01925) 855440. Washington (0191) 482 8500.





Laboratory Test Report

31554

2

1464

Client: Solar 21

Site:

Flixborough EFW Plant, Scunthorpe

Job Number: Page:

			Detei	rminati and	ion of \ Deriva	Nater ( ation o	Content f Plasti	t, Liquio city and	d Limit d Liqui	and Pla dity Ind	astic L Iex	imit
Borehole / Trial Pit	Depth (m)	Sample	Natural / Sieved	Natural Water Content %	Sample 425 µn Percentage %	Passing n Sieve Water Content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Class	Description / Remarks
BH2	2.00	U10	Natural	28.9	99	29.0	52	25	27	0.15	СН	Brown sandy CLAY
BH2	19.00	D52	Natural	23.1	68	32.0	40	26	14	0.41	МІ	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	СН	Brown sandy organic CLAY
BH4	4.00	U17	Natural	44.5	99	45.0	63	31	32	0.43	СН	Brown sandy CLAY
BH4	20.00	D54	Sieved	37.4	77	47.0	49	34	15	0.88	МІ	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	МН	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	МІ	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	МН	Brown SILT (PEAT)





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



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





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



F	IAN ASS	N FAR Socia	MER ATES					Laboratory Test Report	31554 / 1	
	Site:	Flixboro	ugh EFW F	Plant, Scunthorpe	)			Job Nun	nber: 31554	
	Client:	Solar 21						F	Page: 6	
Unc	onsolid	ated Un	drained	single s	pecimen (De	Test w finitive	itho e Me	out measuremen ethod)	nt of pore pressure	e -
Bore	hole /	Depth (m)	Sample	Descriptior				,		
В	H2	2.00	U10	Brown slig	ntly gravelly sand	IY CLAY				
	Test Nur	nber		1		0	Devia	ator Stress v Axial	Strain	
ple	Original	Length (mr	n)	450.00	120 T				<b>20000000</b>	]
al Sam	Depth fro	om Top (m	m)	27.11	, 100 <b>-</b>					
Initia	Conditio	n		Undisturbed	ess • 08		ß	e e e e e e e e e e e e e e e e e e e		
	Orientati	on		Vertical	ator St	J	P			
Lei	ngth (mm)			209.24	d Devia	Ĵ				
Dia	Diameter (mm)			102.11	- 04 -					
Мс	bisture Cont	ent (%)		28.10	<sup>C</sup> 20 -	¢				
Bu	lk Density (	Mg/m3)		2.05	o <b>4</b>		5	10 1	15 20 2	25
Dry	y Density (N	/lg/m3)		1.60				Axial Strain %	6	
Me	embrane Th	ickness (m	ım)	0.3				Mohr Circle	S	
Me	embrane Ty	ре		Latex		<sup>150</sup> T				
Ra	te of Strain	(%/min)		1.9						
	Cell Pres	ssure (kPa)	)	40	ћ кРа	100				
	Axial Str	ain (%)		15	Strengt					
lesults	Membra	ne Corr. (k	Pa)	0.88	Shear	50 -				
Test F	Deviator (kPa)	Stress, (	σ1 - σ3 )f	108						
	Undraine cu = ½	ed Shear S ( σ1 - σ3 )	trength, f (kPa)	54		0 <b> </b> 0		50	100 150	
	Mode of	Failure		Compound				Normal Stresse	s kPa	

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 BS 1377:PT2:1990:7.2 Determination of density by linear measurement

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 ILSTING 1464

	Site: Client:	Flixborou Solar 21	ıgh EFW F	Plant, Scunthorpe				ļ	Job Nu	nber: Page:	31	554 7
Inc	onsolid	ated Un	drained	d Triaxial Co	mpressi	on Te	est wi	ithout	measureme	ent of p	ore pre	ssure
Boro	hole /	Denth		single s	pecimen	(Defi	nitive	Meth	od)			
Tria	al Pit	(m)	Sample	Description								
В	H3	2.10	U7	Brown grav	elly CLAY							
	Test Nu	nber		1			D	)eviato	r Stress v Axia	I Strain		
ple	Original	Length (mn	n)	400.00	70	Γ						
al Sam	Depth fro	om Top (mr	n)	40.00	06 م	+			~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	000000		
Initia	Conditio	n		Undisturbed	4 ssa 50	+	ð	200000				
	Orientati	on		Vertical	uts to	-						
Lei	ngth (mm)			204.10	05 Devia		l					
Diameter (mm)				102.19	orrected	ļ						
Мо	isture Cont	ent (%)		30.00	0 10	-						
Bu	lk Density (	Mg/m3)		2.11	0	<b>↓</b>			10	15	20	 25
Dry	y Density (N	/lg/m3)		1.62		0		J	Axial Strain	%	20	23
Me	embrane Th	ickness (m	m)	0.36					Mohr Circl	es		
Me	embrane Ty	ре		Latex		-	<sup>150</sup> T					
Ra	te of Strain	(%/min)		2.0								
	Cell Pres	ssure (kPa)		40		th kPa	LOO -					
	Axial Str	ain (%)		20		r Streng						
esults	Membra	ne Corr. (kł	Pa)	1.33		Shear	50					
Test R	Deviator (kPa)	Stress, ( c	σ1 - σ3 )f	63						$\overline{\}$		
	Undraine cu = ½	ed Shear St $\frac{1}{2}(\sigma 1 - \sigma 3)f$	rength, (kPa)	31			0 <b> </b> 0		50	100		50
	Mode of	Failure		Compound					Normal Stress	es kPa		

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 BS 1377:PT2:1990:7.2 Determination of density by linear measurement.

UKAS 1464

Method of Test:

BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)
F		SOCIA						Lab	oratory Test Report		31554 / 1			
	Site:	Flixborou	gh EFW F	Plant, Scunthorpe						Job N	umber	:	31554	1
Inc	Client:	Solar 21	drainac	Triavial C	mprocei	ion T	loct y	vithe	t m	oacurom	Page	: f noro	8 proce	
5110	onsonu		uramet	single s	pecimen	(Def	initiv	e M	ethoo	d)		n hoie	press	Suie
Bore Tria	hole / al Pit	Depth (m)	Sample	Description										
В	H3	4.00	U12	Brown slig	ntly gravelly	organ	nic CLA	Y						
	Test Nur	mber		1				Devi	ator S	tress v Axi	al Stra	in		
ple	Original	Length (mm	ו)	450.00	80	Γ								
al Sam	Depth fro	om Top (mr	n)	30.17	70 	1				2000000	<del></del>	<del></del>		
Initia	Conditio	n		Undisturbed	ess F				all	<b></b>				
	Orientati	on		Vertical	to St			g d d	<i>p</i>					
Length (mm)				208.78			J	5						
Dia	Diameter (mm)			102.44	orrected June 20		ļ —							
Мо	bisture Cont	ent (%)		44.60	10									
Bu	lk Density (	Mg/m3)		1.81	0	<b>↓</b> 0			;	10		15		 20
Dry	y Density (N	/lg/m3)		1.25						Axial Strair	ו %			
Me	embrane Th	ickness (mi	m)	0.31						Mohr Circ	les			
Me	embrane Ty	ре		Latex			150 -							
Ra	te of Strain	(%/min)		1.9										
	Cell Pres	ssure (kPa)		80		ith kPa	100 -							
	Axial Str	ain (%)		13		r Streng								
tesults	Membra	ne Corr. (kF	Pa)	0.82		Shear	50 -							
Test R	Deviator (kPa)	Stress, ( o	1 - σ3 )f	70							$\bigwedge$		$\backslash$	
	Undraine cu = ½	ed Shear St ε( σ1 - σ3 )f	rength, (kPa)	35			0 <del>-</del>	)		50	100	)	 150	
	Mode of	Failure		Plastic						Normal Stres	ses kP	а		

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 BS 1377:PT2:1000:7.2 Determination of departic buildings measurement



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)

Method of Test:

	AS	SOCIA	TES					Report	3	1554 / 1
	Site:	Flixborou	ıgh EFW F	Plant, Scunthorpe	•			Job Nun	nber:	31554
Jnc	onsolid	ated Un	drained	Triaxial Co	ompressi	on Test	with	out measureme	nt of pore	e pressure
				single s	pecimen	(Definit	ive N	lethod)		- p
Bore Tria	hole / al Pit	Depth (m)	Sample	Description						
В	H4	4.00	U17	Brown slig	ntly sandy C	LAY				
	Test Nur	nber		1			Dev	iator Stress v Axial	Strain	
ble	Original	Length (mn	n)	450.00	70					
al Sarr	Depth fro	om Top (mr	n)	42.62	60 ۾	1			0000000	<b>*</b>
Initi	Conditio	n		Undisturbed	05 kl	-		2000000		
	Orientati	on		Vertical	ts ato		- Solo	<i>p</i>		
Length (mm) 208.					Devis Devis	-	8			
Diameter (mm)				100.56	orrected 20					
Мо	isture Cont	ent (%)		30.60	0 10	\$				
Bu	lk Density (	Mg/m3)		1.82	0	0	5	10 1	5	20 25
Dry	y Density (N	/lg/m3)		1.39				Axial Strain %	)	
Ме	embrane Th	ickness (m	m)	0.29				Mohr Circle	s	
Ме	embrane Ty	ре		Latex		150	Γ			
Ra	te of Strain	(%/min)		1.9						
	Cell Pres	ssure (kPa)		80		001 a th kPa				
	Axial Str	ain (%)		16		r Streng				
cesults (	Membra	ne Corr. (kF	Pa)	0.94		Sheal Sheal				
Test R	Deviator (kPa)	Stress, (c	σ1 - σ3 )f	58				/		
	Undraine cu = ½	ed Shear St ε( σ1 - σ3 )f	trength, (kPa)	29		0	↓ 0	50	100	<b></b> 150
	Mode of	Failure		Plastic				Normal Stresse	s kPa	

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

Method of Preparation:

Method of Test:

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 BS 1377:PT2:1000:7.2 Determination of departic buildings measurement

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)



F		N FAR SOCIA	MER TES			Laboratory Test Report	31554 / 1							
	Site:	Flixborou	ugh EFW F	Plant, Scunthorpe		Job Nur	nber: 31554							
	Client:	Solar 21				F	Page: 10							
JUC	onsolia	ated Un	arainec	single s	becimen (Definitive I	Nethod)	nt of pore pressure -							
Bore Tria	ehole / al Pit	Depth (m)	Sample	Description										
В	H5	6.50	U22	Black orgar	janic CLAY with inclusions of peat.									
	Test Nur	nber		1	De	viator Stress v Axial	Strain							
ple	Original	Length (mr	n)	450.00	140									
al Sarr	Depth fro	om Top (mi	m)	42.18	120 <b>-</b>									
Initi	Conditio	n		Undisturbed		e e e e e e e e e e e e e e e e e e e								
	Orientati	on		Vertical	10 I I I I I I I I I I I I I I I I I I I									
Lei	ngth (mm)			209.18	00 peria									
Dia	ameter (mr	i)		102.67	40 June de la create									
Мс	bisture Cont	ent (%)		133.00	20									
Bu	lk Density (	Mg/m3)		1.23		4 6	8 10 12							
Dry	y Density (N	/lg/m3)		0.53	о <u>-</u>	Axial Strain S	%							
Me	embrane Th	ickness (m	m)	0.31		Mohr Circle	95							
Me	embrane Ty	pe		Latex	250									
Ra	te of Strain	(%/min)		1.9	200									
	Cell Pres	ssure (kPa)		120	면 소 150 -									
	Axial Str	ain (%)		8.6	Streng 100									
esults	Membra	ne Corr. (kl	Pa)	0.6	Shea									
Test R	Deviator (kPa)	Stress, ( d	σ1 - σ3 )f	118	50 -									
	Undraine cu = ½	ed Shear Si ( σ1 - σ3 )f	trength, (kPa)	59	0 <b> </b> 0	50 100 15	50 200 250							
	Mode of	Failure		Plastic		Normal Stresse	es kPa							

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Method of Preparation:

Method of Test:

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 PS 1377:PT3:1000:7.2 Determination of description by linear resources

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)



F	IAN AS	N FAR SOCIA	MER TES					Laboratory Test Report	31554 / 1		
	Site:	Flixborou	ugh EFW F	Plant, Scunthorpe	<b>;</b>			Job Nu	imber: 31554		
	Client:	Solar 21				<b>T</b> 4			Page: 11		
Unc	onsolia	ated Un	arainec	single s	pecimen (De	finitiv	e Me	ethod)	ent of pore pressure -		
Bore Tria	ehole / al Pit	Depth (m)	Sample	Description	<u> </u>						
В	H6	6.50	U22	Brown orga	anic SILT						
	Test Nu	nber		1			Devia	ator Stress v Axia	I Strain		
ple	Original	Length (mr	n)	450.00							
al Sam	Depth fro	om Top (mi	m)	41.17	60 <del>م</del>			~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			
Initis	Conditio	n		Undisturbed	<sup>4</sup> 50			A CONTRACTOR OF CONTON OF CONTO OF CONTRACTOR OF CONTRACTOR OF CONTRACTOR OF CONTRACTO			
	Orientati	on		Vertical	115 40 •		e de la compañía de la	-			
Lei	ngth (mm)			209.76	Devia 05						
Dia	ameter (mn	1)		102.50	orrected	<i>[</i>					
Мс	bisture Cont	ent (%)		97.80							
Bu	lk Density (	Mg/m3)		1.42	o 🖡			10	15 20		
Dry	y Density (N	/lg/m3)		0.72				Axial Strain	%		
Ме	embrane Th	ickness (m	ım)	0.28				Mohr Circl	es		
Me	embrane Ty	ре		Latex		200					
Ra	te of Strain	(%/min)		1.9		150 <b>-</b>					
	Cell Pres	ssure (kPa)	)	130	th kPa						
	Axial Str	ain (%)		13	. Streng	100 -					
tesults	Membra	ne Corr. (kl	Pa)	0.76	Shear	50 <b>-</b>					
Test R	Deviator (kPa)	Stress, ( d	σ1 - σ3 )f	60							
	Undraine cu = ½	ed Shear S ( σ1 - σ3 )f	trength, f (kPa)	30		0 -	) )	50 100	150 200		
	Mode of	Failure		Plastic				Normal Stress	ses kPa		

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 BS 1377:PT2:1990:7.2 Determination of density by linear measurement



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)

Method of Test:



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** 



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:



Quality Technician

Date: 01/10/2018

Page. 1



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Site: Flixborough EFW Plant, Scunthorpe

Laboratory Test Report

Job Number:

Page:

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31554R

Client: Solar 21

INIAXIAL	COMPRESSION	<b>TEST ON ROCK -</b>	SUMMARY O	F RESULTS

					Specime mensior	n is2	Bulk Densitu 2 Content		Unia	xial Com	pressio	n3	
Hole No.	Depth	Sample	Rock Type	Dia.	Length	H/D	Density2	1	Condition	Stress Rate	Mode of	UCS	Remarks
	m			mm	mm		Mg/m3	%		MPa/s	failure	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 conten	t at 105 ± 3 oC, specime	en as teste	ed for UCS		in ation of hull	, donoitu	*Denotes	length dia	ameter ra	tio outsic	le ISRM specification
3	ISRM p153 par	t 1, determinati	on of Uniaxial Compress	sive Stren	gth ( UCS )	) of Rock I	Materials	k density		S - Single	ilure : shear	MS - mult	iple shear
	above notes ap	oply unless anno	otated otherwise in the r	emarks						AC - Axial	cleavage	F - Fragm	nented
Meth	od of Prepar	ation: Interr Chara	national Society fo acterization Testin	r Rock Ig and N	Mechan ⁄Ionitorir	ics, The ng, 2007	e complete	ISRM sug	ggested m	ethods fo	or Rock		
	Method of	f Test: Interr Chara	national Society fo acterization Testin	r Rock Ig and N	Mechan ⁄Ionitorir	ics, The ng, 2007	e complete	ISRM su	ggested m	ethods fo	or Rock		



IAN FARMER ASSOCIATES

Site: Flixborough EFW Plant, Scunthorpe

Laboratory Test Report

31554R / 1

Job Number: Page: 31554R

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Client: Solar 21

Summary of Results															
			Dock Typo	Test see l	Type SRM	(N/A)		Dimer	nsions		Force	/alent ter, De	Point Strengt	Load h Index	Remarks
Borehole No.	Depth	Sample	and Test condition	Type , A, I, B)	irection , PD or U)	ailure Valid	Lne	w	Dps	Dps'	Р	Equiv diamet	Is	Is (50)	(including water content if measured)
	m			0	(PL	ш	mm	mm	mm	mm	kN	mm	MPa	MPa	
BH2	24.18	C1	Red/Brown MUDSTONE As received	Α	PD	YES		<mark>82</mark> .5	85.1	74.1	0.3	94.6	0.03	0.05	
BH2	27.6	СЗ	MUDSTON E	Α	PD	YES		<mark>85.8</mark>	90.5	<mark>68.5</mark>	0.9	<mark>99.5</mark>	0.09	0.13	
BH2	29.14	C4		Α	PD	YES		<mark>81</mark> .5	118.6	101.6	0.4	111.0	0.04	0.05	
BH3	24.7	C4	Red MUDSTON E	Α	PD	YES		<mark>85.1</mark>	106.6	91.6	0.4	107.5	0.03	0.05	
BH4	22.76	C1	Red MUDSTONE	Α	PD	YES		86.2	105.9	63.9	2.0	107.8	0.17	0.24	
BH4	22.88	C2	Grey MUDSTON E	Α	PD	YES		<mark>86.3</mark>	116.7	50.7	0.5	113.2	0.04	0.05	
BH5	26.58	C3	Grey MUDSTON E	Α	PD	YES		<mark>86.3</mark>	91.0	71.0	0.3	100.0	0.03	0.04	
BH6	22.17	C1	Grey MUDSTONE	Α	PD	YES		86.2	125.0	101.0	0.6	117.1	0.04	0.06	
BH6	22.91	C2	Grey MUDSTONE	Α	PD	YES		83.0	123.9	<mark>96.9</mark>	0.2	114.4	0.02	0.02	
Test Type D - Diametral, A Direction PL - Parallel to p PD - Perpendicul U - Unknown or r Dimensions Dps - Distance b Dps' - at failure ( Lne - Length from W - Width of sh Size factor, F = (	- Axial, I - Irre lanes of weal lar to planes random etween plate see ISRM no n platens to r ortest dimens (De/50)0.45	egular Lump, kness of weakness ns ( platen se te 6) hearest free e sion perpendi for all tests.	B - Block eparation ) nd icular to load, P	D	Diar	netral	De	tailed leg	D <sub>ps</sub>	Axial		ns, based B	d on ISR	M egular lu	P ↓ D <sub>ps</sub>

Point Load Strength Index Tests

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

IAN FARMER ASSOCIATES Site: PLASTICITY CLASSIFICATION CHART EFW Plant Flixborough near Scarborough Figure No. Contract No. 31554 A3.1



**APPENDIX 4** 

CHEMICAL TESTS

Certificate No. 18/07080



# FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: Issue Number: 18/07080 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:



Holly Neary-King Sales Executive

## Approved by:



Georgia King Admin & Client Services Supervisor





## Client Project Name: Flixborough EFW Plant

Lab Sample ID	18/07080/1	18/07080/2	18/07080/3	18/07080/4	18/07080/5			
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			<b>.</b>
Sample Type	Soil - ES			od re				
Sample Matrix Code	4A	4A	6AB	6	4A		Units	Meth
% Stones >10mm <sub>A</sub>	25.4	33.8	6.4	<0.1	26.5		% w/w	A-T-044
Cyanide (total) <sub>A</sub> <sup>M#</sup>	<1	<1	<1	4	-		mg/kg	A-T-042sTCN
Organic matter <sup>DM#</sup>	-	-	6.2	2.2	-		% w/w	A-T-032 OM
Arsenic <sub>D</sub> <sup>M#</sup>	<1	<1	10	<1	-		mg/kg	A-T-024s
Cadmium <sub>D</sub> <sup>M#</sup>	1.1	0.7	0.9	0.8	-		mg/kg	A-T-024s
Copper <sub>D</sub> <sup>M#</sup>	<1	2	34	16	-		mg/kg	A-T-024s
Chromium <sub>D</sub> <sup>M#</sup>	84	111	33	26	-		mg/kg	A-T-024s
Chromium (hexavalent) <sub>D</sub>	-	<1	<1	-	-		mg/kg	A-T-040s
Lead <sub>D</sub> <sup>M#</sup>	5	13	80	41	-		mg/kg	A-T-024s
Mercury <sub>D</sub>	<0.17	<0.17	<0.17	<0.17	-		mg/kg	A-T-024s
Nickel <sub>D</sub> <sup>M#</sup>	1200	381	41	47	-		mg/kg	A-T-024s
Selenium <sub>D</sub> #	1	3	<1	<1	-		mg/kg	A-T-024s
Zinc <sub>D</sub> <sup>M#</sup>	24	34	127	98	-		mg/kg	A-T-024s
Leachate Prep BS EN 12457-2 (10:1) <sub>A</sub>	-	-	*	-	*			A-T-001
Cyanide (total) (leachable) <sub>A</sub>	-	-	<0.005	-	<0.005		mg/l	A-T-042wTCN
Arsenic (leachable) <sub>A</sub> #	-	-	19	-	<1		µg/l	A-T-025w
Cadmium (leachable) <sub>A</sub> #	-	-	<1	-	<1		µg/l	A-T-025w
Copper (leachable) <sub>A</sub> #	-	-	7	-	1		µg/l	A-T-025w
Chromium (leachable) <sub>A</sub> #	-	-	<1	-	1		µg/l	A-T-025w
Lead (leachable) <sub>A</sub> #	-	-	16	-	<1		µg/l	A-T-025w
Mercury (leachable) <sub>A</sub> #	-	-	<0.1	-	<0.1		µg/l	A-T-025w
Nickel (leachable) <sub>A</sub> #	-	-	2	-	<1		µg/l	A-T-025w
Selenium (leachable) <sub>A</sub> #	-	-	1	-	4		µg/l	A-T-025w
Zinc (leachable) <sub>A</sub> #	-	-	23	-	4		µg/l	A-T-025w



## Client Project Name: Flixborough EFW Plant

Lab Sample ID	18/07080/1	18/07080/2	18/07080/3	18/07080/4	18/07080/5			
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		<i>"</i> о	od re				
Sample Matrix Code	4A	4A	6AB	6	4A		Units	Meth
Asbestos in Soil (inc. matrix)								
Asbestos in soil <sub>A</sub> #	NAD	-	NAD	-	-			A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	-	N/A	-	-			



## Client Project Name: Flixborough EFW Plant

Lab Sample ID	18/07080/1	18/07080/2	18/07080/3	18/07080/4	18/07080/5			
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			ب
Sample Type	Soil - ES			od re				
Sample Matrix Code	4A	4A	6AB	6	4A		Units	Meth
PAH-16MS								
Acenaphthene <sub>A</sub> <sup>M#</sup>	<0.01	0.03	2.66	<0.01	-		mg/kg	A-T-019s
Acenaphthylene <sub>A</sub> <sup>M#</sup>	<0.01	0.01	0.04	<0.01	-		mg/kg	A-T-019s
Anthracene <sub>A</sub> <sup>M#</sup>	<0.02	0.09	5.83	<0.02	-		mg/kg	A-T-019s
Benzo(a)anthracene <sub>A</sub> <sup>M#</sup>	0.14	0.47	9.65	<0.04	-		mg/kg	A-T-019s
Benzo(a)pyrene <sub>A</sub> <sup>M#</sup>	0.14	0.47	8.06	<0.04	-		mg/kg	A-T-019s
Benzo(b)fluoranthene <sub>A</sub> <sup>M#</sup>	0.17	0.58	7.69	<0.05	-		mg/kg	A-T-019s
Benzo(ghi)perylene₄ <sup>™</sup>	0.07	0.22	1.95	<0.05	-		mg/kg	A-T-019s
Benzo(k)fluoranthene <sub>A</sub> <sup>™#</sup>	0.07	0.22	3.07	<0.07	-		mg/kg	A-T-019s
Chrysene <sub>A</sub> <sup>M#</sup>	0.17	0.54	8.42	<0.06	-		mg/kg	A-T-019s
Dibenzo(ah)anthracene <sub>A</sub> <sup>M#</sup>	<0.04	0.07	0.69	<0.04	-		mg/kg	A-T-019s
Fluoranthene <sub>A</sub> <sup>M#</sup>	0.15	0.75	19.4	<0.08	-		mg/kg	A-T-019s
Fluorene <sub>A</sub> <sup>M#</sup>	<0.01	0.03	2.52	<0.01	-		mg/kg	A-T-019s
Indeno(123-cd)pyrene <sub>A</sub> <sup>M#</sup>	0.09	0.27	2.96	<0.03	-		mg/kg	A-T-019s
Naphthalene <sub>A</sub> <sup>M#</sup>	<0.03	<0.03	4.94	<0.03	-		mg/kg	A-T-019s
Phenanthrene <sub>A</sub> <sup>M#</sup>	0.06	0.33	16.7	<0.03	-		mg/kg	A-T-019s
Pyrene <sub>A</sub> <sup>M#</sup>	0.21	0.70	16.3	<0.07	-		mg/kg	A-T-019s
Total PAH-16MS₄ <sup>™#</sup>	1.27	4.78	111	<0.08	-		mg/kg	A-T-019s



## Client Project Name: Flixborough EFW Plant

Lab Sample ID	18/07080/1	18/07080/2	18/07080/3	18/07080/4	18/07080/5			
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			<b>.</b>
Sample Type	Soil - ES			od re				
Sample Matrix Code	4A	4A	6AB	6	4A		Units	Meth
PAH 16MS (leachable)								
Acenaphthene (leachable) <sub>A</sub>	-	-	0.20	-	0.03		µg/l	A-T-019w
Acenaphthylene (leachable) <sub>A</sub>	-	-	<0.02	-	<0.02		µg/l	A-T-019w
Anthracene (leachable) <sub>A</sub>	-	-	0.05	-	<0.02		µg/I	A-T-019w
Benzo(a)anthracene (leachable) <sub>A</sub>	-	-	0.07	-	<0.02		µg/l	A-T-019w
Benzo(a)pyrene (leachable) <sub>A</sub>	-	-	0.08	-	<0.02		µg/l	A-T-019w
Benzo(b)fluoranthene (leachable) <sub>A</sub>	-	-	0.07	-	<0.02		µg/l	A-T-019w
Benzo(ghi)perylene (leachable) <sub>A</sub>	-	-	0.05	-	<0.02		µg/l	A-T-019w
Benzo(k)fluoranthene (leachable) <sub>A</sub>	-	-	0.04	-	<0.02		µg/l	A-T-019w
Chrysene (leachable) <sub>A</sub>	-	-	0.09	-	<0.02		µg/l	A-T-019w
Dibenzo(ah)anthracene (leachable) <sub>A</sub>	-	-	<0.02	-	<0.02		µg/l	A-T-019w
Fluoranthene (leachable) <sub>A</sub>	-	-	0.23	-	0.06		µg/l	A-T-019w
Fluorene (leachable) <sub>A</sub>	-	-	0.06	-	<0.02		µg/I	A-T-019w
Indeno(123-cd)pyrene (leachable) <sub>A</sub>	-	-	0.05	-	<0.02		µg/l	A-T-019w
Naphthalene (leachable) <sub>A</sub>	-	-	<0.02	-	<0.02		µg/l	A-T-019w
Phenanthrene (leachable) <sub>A</sub>	-	-	0.02	-	<0.02		µg/l	A-T-019w
Pyrene (leachable) <sub>A</sub>	-	-	0.22	-	0.06		µg/l	A-T-019w
Total PAH 16MS (leachable) <sub>A</sub>	-	-	1.23	-	0.15		µg/l	A-T-019w
TPH Banded 13								
>C6-C8 <sup>AM#</sup>	<5	-	-	<5	-		mg/kg	A-T-007s
>C8-C10 <sub>A</sub> <sup>M#</sup>	<1	-	-	<1	-		mg/kg	A-T-007s
>C10-C12 <sub>A</sub> <sup>M#</sup>	<1	-	-	<1	-		mg/kg	A-T-007s
>C12-C16A <sup>M#</sup>	2	-	-	<2	-		mg/kg	A-T-007s
>C16-C21 <sub>A</sub> <sup>M#</sup>	13	-	-	<2	-		mg/kg	A-T-007s
>C21-C35 <sup>AM#</sup>	34	-	-	5	-		mg/kg	A-T-007s
>C35-C44 <sub>A</sub>	17	-	-	3	-		mg/kg	A-T-007s
Total TPH Banded 13 <sub>A</sub>	66	-	-	8	-		mg/kg	A-T-007s



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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 aliguot 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



# FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: Issue Number: 18/07187 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: Project Name: Project Ref: Order No: Date Samples Received: Date Instructions Received: Date Analysis Completed: Chris Lewis Fixborough EFW Plant 31554 93514 07/09/18 07/09/18 15/09/18

Prepared by:

Melanie Marshall Laboratory Coordinator Approved by:

Danielle Brierley Client Manager





Client Project Name: Fixborough EFW Plant

Lab Sample ID	18/07187/1					
Client Sample No	2					
Client Sample ID	ВНЗ					
Depth to Top	0.50					
Depth To Bottom						
Date Sampled	30-Aug-18					يو
Sample Type	Soil - ES					od re
Sample Matrix Code	5A				Units	Meth
% Stones >10mm <sub>A</sub>	4.9				% w/w	A-T-044
Cyanide (total) <sub>A</sub> <sup>M#</sup>	<1				mg/kg	A-T-042sTCN
Organic matter <sub>D</sub> <sup>M#</sup>	1.0				% w/w	A-T-032 OM
Arsenic <sub>D</sub> <sup>M#</sup>	2				mg/kg	A-T-024s
Cadmium <sub>D</sub> <sup>M#</sup>	1.0				mg/kg	A-T-024s
Copper <sub>D</sub> <sup>M#</sup>	7				mg/kg	A-T-024s
Chromium₀ <sup>M#</sup>	15				mg/kg	A-T-024s
Lead <sub>D</sub> <sup>M#</sup>	15				mg/kg	A-T-024s
Mercury <sub>D</sub>	0.20				mg/kg	A-T-024s
Nickel <sup>D<sup>M#</sup></sup>	12				mg/kg	A-T-024s
Selenium <sub>D</sub> #	<1				mg/kg	A-T-024s
Zinc <sub>D</sub> <sup>M#</sup>	43				mg/kg	A-T-024s



Client Project Name: Fixborough EFW Plant

Lab Sample ID	18/07187/1					
Client Sample No	2					
Client Sample ID	BH3					
Depth to Top	0.50					
Depth To Bottom						
Date Sampled	30-Aug-18					j.
Sample Type	Soil - ES					od re
Sample Matrix Code	5A				Units	Meth
Asbestos in Soil (inc. matrix)						
Asbestos in soil <sub>A</sub> #	NAD					A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A					



Client Project Name: Fixborough EFW Plant

Lab Sample ID	18/07187/1					
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					oq re
Sample Matrix Code	5A				Units	Meth
PAH-16MS						
Acenaphthene <sup>A<sup>M#</sup></sup>	0.01				mg/kg	A-T-019s
Acenaphthylene <sub>A</sub> <sup>M#</sup>	<0.01				mg/kg	A-T-019s
Anthracene <sub>A</sub> <sup>M#</sup>	0.06				mg/kg	A-T-019s
Benzo(a)anthracene <sub>A</sub> <sup>M#</sup>	0.21				mg/kg	A-T-019s
Benzo(a)pyrene₄ <sup>M#</sup>	0.16				mg/kg	A-T-019s
Benzo(b)fluoranthene <sub>A</sub> <sup>M#</sup>	0.20				mg/kg	A-T-019s
Benzo(ghi)perylene <sub>A</sub> <sup>M#</sup>	0.06				mg/kg	A-T-019s
Benzo(k)fluoranthene <sub>A</sub> <sup>M#</sup>	0.08				mg/kg	A-T-019s
Chrysene <sub>A</sub> <sup>M#</sup>	0.19				mg/kg	A-T-019s
Dibenzo(ah)anthracene <sub>A</sub> <sup>M#</sup>	<0.04				mg/kg	A-T-019s
Fluoranthene <sup>A<sup>M#</sup></sup>	0.44				mg/kg	A-T-019s
Fluorene <sup>A<sup>M#</sup></sup>	0.02				mg/kg	A-T-019s
Indeno(123-cd)pyrene <sup>A<sup>M#</sup></sup>	0.08				mg/kg	A-T-019s
Naphthalene <sub>A</sub> <sup>M#</sup>	<0.03				mg/kg	A-T-019s
Phenanthrene <sub>A</sub> <sup>M#</sup>	0.24				mg/kg	A-T-019s
Pyrene <sub>A</sub> <sup>M#</sup>	0.42				mg/kg	A-T-019s
Total PAH-16MS <sub>A</sub> <sup>M#</sup>	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 aliguot 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.

#### Kev:

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



# FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: Issue Number: 18/07299 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: Project Name: Project Ref: Order No: Date Samples Received: Date Instructions Received: Date Analysis Completed: Chris Lewis Flixborough EFW Plant 31554 93515 11/09/18 12/09/18 20/09/18

Prepared by:



## Approved by:



Georgia King Admin & Client Services Supervisor





## Client Project Name: Flixborough EFW Plant

					Client Pro	ject Ref: 31	554			
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		
Client Sample No	24	9	29	8	24	7	4	15		
Client Sample ID	BH2	внз	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		ž
Sample Type	Soil - D	Solid	Soil - D		od re					
Sample Matrix Code	6	6	6AE	3	6	6	7	6	Units	Meth
% Stones >10mm <sub>A</sub>	<0.1	<0.1	8.5	<0.1	<0.1	<0.1	<0.1	<0.1	% w/w	A-T-044
pH BRE <sub>D</sub> <sup>M#</sup>	-	-	-	-	-	8.13	12.63	8.48	рН	A-T-031s
Sulphate BRE (water sol 2:1) <sup>D<sup>M#</sup></sup>	-	-	-	-	-	44	41	398	mg/l	A-T-026s
Sulphate BRE (acid sol) <sub>D</sub> <sup>M#</sup>	-	-	-	-	-	-	0.76	-	% w/w	A-T-028s
Sulphur BRE (total)₀	-	-	-	-	-	-	0.28	-	% w/w	A-T-024s
Organic matter <sup>M#</sup>	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					
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					ية.
Sample Type	Soil - D	Soil - D				<i>"</i>	od re
Sample Matrix Code	6E	5A				Units	Meth
% Stones >10mm <sub>A</sub>	<0.1	<0.1				% w/w	A-T-044
pH BRE <sub>D</sub> <sup>M#</sup>	6.86	7.82				рН	A-T-031s
Sulphate BRE (water sol 2:1) <sup>D<sup>M#</sup></sup>	3450	418				mg/l	A-T-026s
Sulphate BRE (acid sol) <sub>D</sub> <sup>M#</sup>	1.48	-				% w/w	A-T-028s
Sulphur BRE (total)₀	6.52	-				% w/w	A-T-024s



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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. 18/07300



# FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: Issue Number:

18/07300

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:

Richard Wong Client Manager

# Approved by:



Gill Walker Director/Laboratory Manager





Client Project Name: Flixborough EFW Plant

Lab Sample ID	18/07300/1					
Client Sample No	41					
Client Sample ID	BH6					
Depth to Top	15.00					
Depth To Bottom						
Date Sampled	21-Aug-18					af.
Sample Type	Water - EW				<i>"</i>	er bo
Sample Matrix Code	N/A				Units	Meth
pH BRE (w) <sup>#</sup>	7.41				рН	A-T-031w
Sulphate BRE (w) <sub>A</sub> #	90				mg/l	A-T-026w



## **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.

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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:**

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Please contact us if you need any further information.

## **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  $\alpha$  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) Ks 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)
	Ks	=	a coefficient (see below)

		Ks			
Pile Type	δ	Rela	tive Density	<b>T</b> 1 D1	
		Low	High	1 ension Plies	
Steel	20°	0.5	1.5	0.5	
Concrete	0.75 <b>φ</b>	1.0	2.0	0.5	

The value of  $\phi$  may be interpreted from standard penetration tests.

For bored and cast-in-place piles,  $\delta=22^\circ$  and Ks = 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	=	γ'.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.

# **CONTAMINATION ASSESSMENT**

## 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	Oral Routes			Dermal Routes		Inhalation Routes			
Land Use	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	$\checkmark$	~	$\checkmark$	~	$\checkmark$	~	~	~	~
Residential without homegrown produce	~	x	х	~	$\checkmark$	~	~	~	~
Allotments	~	~	~	X	~	Х	~	~	~
Public open space – adjacent to dwellings	~	х	х	~	$\checkmark$	~	~	x	~
Public open space – parkland	~	Х	Х	х	$\checkmark$	х	~	х	~
Commercial	$\checkmark$	Х	х	~	Х	$\checkmark$	Х	~	Х

- 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:
  - 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
  - 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)	Guidance Value (mg/kg) 2 5% SOM	Guidance Value (mg/kg) 6% SOM	Primary Data Source
	Assessbeland	20000	20000	20000	LOM/CIEU SAU
	Acenaphthene	29000	30000	30000	LQM/CIEH S4UL
	Acenaphthylene	29000	30000	30000	LQM/CIEH S4UL
DAT	Anthracene	150000	150000	150000	LQM/CIEH S4UL
РАН	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

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Commercial	Determinant	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Primary Data Source
		1% SOM	2.5% SOM	6% SOM	
	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
	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
Metals	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)	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Primary Data Source
	1% SOM	2.5% SOM	6% SOM	
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

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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 <sup>1</sup>	EQS Saltwater <sup>1</sup>	Water Supply⁵
Alachlor	ug/l	0.7	0.7	
Abamectin	ug/l	0.03	0.01	
Acrylamide	ug/l			0.1
Aluminium	ug/l	10 <sup>3</sup>	25	200
Ammonia (unionised)	ug/l	15	21 <sup>2</sup>	
Ammonium (as NH4)	mg/l			0.5
Anthracene	ug/l	0.4	0.4	
Antimony	ug/l			5
Arsenic	ug/l	50 <sup>2</sup>	25 <sup>2</sup>	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 <sup>2</sup>	0.75 <sup>2</sup>	
Boron	mg/l	2	7	1
Brominated Diphenylether	ug/l	0.0005 <sup>2</sup>	0.0005 <sup>2</sup>	
Bromine	ug/l	5	10	
Bromoxynil	ug/l	1000	1000	
Cadmium	ug/l	0.45 <sup>3</sup>	0.2 <sup>2</sup>	5
Calcium	mg/l			250
Carbon Tetrachloride	ug/l	12 <sup>2</sup>	12 <sup>2</sup>	
Carbendazin	ug/l	0.15 <sup>2</sup>	-	
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 <sup>2</sup>	-	
Cyclodiene Pesticides (aldrin, Dieldrin, Endrin,		$\Sigma_{-0.01^2}$	$\Sigma_{-0.005^2}$	
Isodrin)	ug/I	2=0.01-	2=0.005*	
Chloride	mg/l	250	-	400
Chlorpropham	ug/l	40	40	
Chlortoluron	ug/l	20	-	
Chromium III	ug/l	4.7 <sup>2</sup>	-	50
Chromium VI	ug/l	3.4 <sup>2</sup>	0.6 <sup>2</sup>	
Cobalt	ug/l	100	100	
Copper	ug/l	12	3.76 <sup>2</sup>	2
Coumaphos	ug/l	0.1	0.1	
Cyanide (hydrogen cyanide)	ug/l	12	12	50
Cypermethrin	ug/l	0.12	0.12	
Cyfluthrin	ug/l	0.001	0.001	
1,2-Dichloroethane	ug/l			3
2,4-Dichlorophenoxyacetic acid (2,4-D)	ug/l	0.3 <sup>2</sup>	0.3 <sup>2</sup>	
2,4-Dichlorophenol	ug/l	4.2 <sup>2</sup>	0.042 <sup>2</sup>	
3,4-Dichloroaniline	ug/l	0.2 <sup>2</sup>	0.2 <sup>2</sup>	
DDT (total)	ug/l	0.025 <sup>2</sup>	0.025 <sup>2</sup>	
Diazinon	ug/l	0.01 <sup>2</sup>	0.01 <sup>2</sup>	
Dibutylphthalate (DBP)	ug/l	40	40	
Dichlorobenzenes (all isomers)	ug/l	200	200	
para, para-DDT	ug/l	0.01 <sup>2</sup>	0.01 <sup>2</sup>	
Diethylphthalate (DEP)	ug/l	1000	1000	
Dimethylphthalate (DMP)	ug/l	4000	4000	
Dioctylphthalate (DOP)	ug/l	40	40	
Dimethoate	ug/l	0.48 <sup>2</sup>	0.48 <sup>2</sup>	
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	34	15	1.5
Fluoranthene	ug/l	1	1	
Formaldehyde	ug/l	50	-	

Contaminant	Units	EQS Freshwater <sup>1</sup>	EQS Saltwater <sup>1</sup>	Water Supply⁵
Glyphosate	ug/l	196 <sup>2</sup>	196 <sup>2</sup>	
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 <sup>2</sup>	1000 <sup>2</sup>	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 <sup>2</sup>	7.22	10
Linuron	ug/l	0.5 <sup>2</sup>	0.52	
Malachite Green	ug/l	100	100	
Magnesium	mg/l	100]		50
Manganese	ug/l	1232	-	50
Mecoprop	ug/l	182	182	
Methiocarb	ug/l	0.012	-	
Mancozeb	ug/l	20	20	
Maneb	ug/l	30	30	
MCPA	ug/l	120°	800	
Methylphenols	ug/l	300	300	
Mevinphos	ug/l	0.02	-	
Monochlorophenols	ug/l	250	250	
Mercury Neglite lang	ug/l	0.07	0.07	1
Naphthalene Ni-1-1	ug/I	2.4	1.2	20
NICKEI	ug/1	20-	20-	20
NIA Nitrata (as N)	ug/1	10000	30000	50
Nitrite (as NO2)	mg/1			0.5
Nanulahanal (4 papulahanal)	mg/1	2	2	0.5
Oils/hydrocorthons	ug/1	2	2	10
Dendimethylin	ug/1	0.32		10
Permethrin	ug/1	0.0012	0.00022	
Polycyclic Aromatic Hydrocarbons (PAH)	ug/1	0.001	0.0002	0.1
- Benzo(a)pyrene	11g/1	01	0.1	0.01
- Benzo(h)fluoranthene	11g/1	0.1		0.01
- Benzo(k)fluoranthene	ug/1	$\Sigma = 0.03^{2}$	$\Sigma = 0.03^{2}$	
- Benzo(ghi)pervlene	ug/1			
- Indeno(123-cd)pervlene	ug/1	$\Sigma = 0.002^{2}$	Σ=0.002	
Pentachlorobenzene	ug/1	0.007 <sup>2</sup>	0.0007 <sup>2</sup>	
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 <sup>2</sup>	7.7 <sup>2</sup>	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 <sup>2</sup>	2.5 <sup>2</sup>	3

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Contaminant	Units	EQS Freshwater <sup>1</sup>	EQS Saltwater <sup>1</sup>	Water Supply⁵
Tetrachloroethylene (PCE)	ug/l	10 <sup>2</sup>	10 <sup>2</sup>	10
Tetrachloroethane	ug/l	140 <sup>2</sup>	-	
Trichloroethylene (TCE)	ug/l	10 <sup>2</sup>	10 <sup>2</sup>	10
Thiabendazole	ug/l	50	50	
Tin (inorganic)	ug/l	25 <sup>2</sup>	10 <sup>2</sup>	
Trihalomethanes	ug/l			100
Trichlorobenzenes	ug/l	0.4 <sup>2</sup>	0.4 <sup>2</sup>	
Toluene	ug/l	74 <sup>2</sup>	74 <sup>2</sup>	
Tributyl phosphate	ug/l	500	500	
Tributyltin	ug/l	0.0015	0.0015	
Trifluralin	ug/l	0.03 <sup>2</sup>	0.03 <sup>2</sup>	
Vanadium	ug/l	20 <sup>4</sup>	100	
Vinyl chloride	ug/l			0.5
Zinc	ug/l	11.9 <sup>2</sup>	7.9 <sup>2</sup>	5000

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

GAS GENERATION

# 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				
		Very low	Low	Moderate	High	Very high
ity of ment	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
nsitiv velop	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
Se de	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 (CH4 or CO2(1/hr) <sup>1</sup>	Additional factors	Typical source of generation
1	Very low risk	<0.07	Typically methane $\leq 1\%$ and/or carbon dioxide $\leq 5\%$ . 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	<ul> <li>a) Reinforced concrete cast in situ floor slab (suspended non- suspended or raft) with at least 1200g DPM and underfloor venting</li> <li>b) Beam and block or pre-cast concrete and 2000g DPM / reinforced gas membrane and underfloor venting</li> <li>All joints and penetrations sealed</li> </ul>	1 to 2	<ul> <li>a) Reinforced concrete cast in-situ floor slab (suspended non-suspended or raft) with at least 1200g DPM</li> <li>b) Beam and block or pre cast concrete slab and minimum 2000g DPM/reinforced gas membrane</li> <li>c) Possibly underfloor venting or pressurisation in combination with a) and b) depending on use</li> <li>All joints and penetrations seeled</li> </ul>	
2		All ( CO 1.1	1 ( 2	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.		All joints and penetration 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		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).	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 ventilated or positively pressurised underfloor sub-space, oversite capping and in ground venting wells or barriers		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<sup>3</sup> 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.