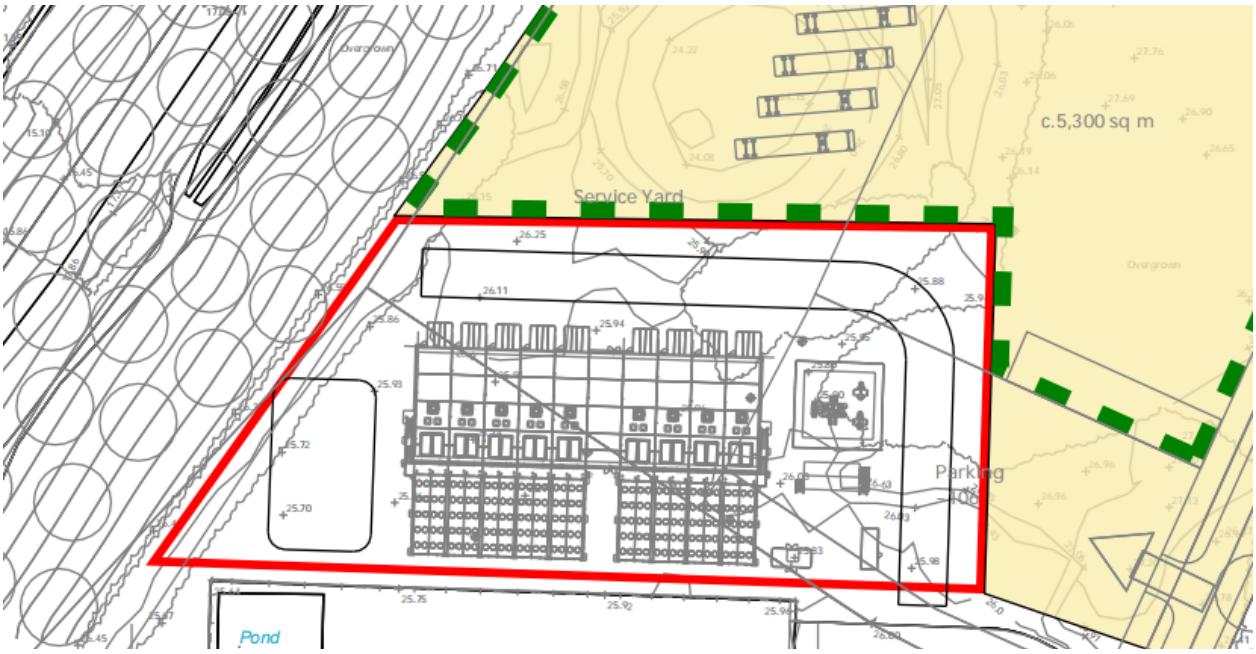

REMEDIATION & ENABLING WORKS STRATEGY

SHORT TERM OPERATING RESERVE FACILITY, LAND AT MANCHESTER ROAD, PEAKSNOOK, CARRINGTON, MANCHESTER. M31 4NW

17th August 2021
Report No. 189.00-1 Rev B

Developer:-

Forsa Energy

Clyde View (Suite F3)

Riverside Business Park

22 Pottery Street

Greenock

PA15 2UZ

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EXECUTIVE SUMMARY

Redstart Northwest Limited (Redstart) was commissioned to develop a remediation strategy for the redevelopment of land located to the west of Manchester Road, Peaksnook, Carrington, Manchester. The developer will be Forsa Energy. The remediation strategy is designed to mitigate risks posed by the site to future land users and the wider environment.

The proposed development area is made up of a single 1 ha parcel of land and the development area currently comprises a level area, part with clay and an area of stoned ground (both with sparse vegetation) and an area of rough grassland. The development area is within the former Peaksnook landfill site which was previously operated by Viridor Waste Management (WML 53703), but since closure the license has been surrendered back to the Environment Agency (EA). It is understood that the site was previously used as a landfill accepting inert, industrial, commercial and special waste (mainly asbestos) between 1988 and 1996.

Ground investigation works encountered clean cover over variable anthropogenic ground consistent with landfilling operations with the majority of this appearing to be construction and demolition wastes. Asbestos Containing Materials (ACMs) were locally identified. Boreholes identified the landfill waste to be approx. 11.5m in thickness with underlying sequence of Alluvium/Glaciofluvial/Till deposits being approx. 19.5m thick over the Wilmslow Sandstone encountered at approx. 31mbgl.

It is proposed to re-develop the site as a gas fired Short Term Operating Reserve (STOR) facility with ancillary infrastructure. Following development it is understood that the facility will not have personnel on site on a daily basis during operation. It will be operated remotely and that the site will be visited approximately once a week by 1-2 engineers for up to a day for general servicing and checks around the facility.

As part of the previous investigations, Generic Quantitative Risk Assessment (GQRA) has been undertaken using the proposed Industrial/commercial (S4UL/C4SL) end land use Generic Assessment Criteria. The GQRA identified that the Made Ground did not pose a significant risk to future site users however it was considered plausible that contamination is present on the site in areas and at depths not investigated during the investigation works. The relatively low potential risks posed by the Made Ground can be mitigated through the direct construction of the platform sub-base on the development formation and the use of inert construction materials above this.

It is considered unlikely that there is currently a significant risk is posed to controlled waters and the Site has not been identified as being affected by potential coal mining.

A ground gas risk assessment for the development concluded that Characteristic Situation of CS3 ground gas conditions apply and that meet a score of 2.5 is required for (building Type D) to 3 (building Type C). Therefore ground gas mitigation measures are required which needs to take into account of the specific nature of the buildings. The installation of gas protection measures will need to be independently validated.

With the site surface currently being level and generally having a relatively level surface of gravel there is a limited possibility of encountering asbestos for most of the development. However excavations for services could encounter asbestos. The procedures in the CL:AIRE document 'Control of Asbestos Regulations 2012 – Interpretation for Managing & Working with Asbestos in Soil and Construction & Demolition Materials - Industry Guidance" (CAR-SOIL) should be followed for all excavations into the existing ground at the site.

Limited enabling and remediation works are required other than removal of limited vegetation and construction of a piling mat. This requires;

- *Place geotextile separation layer; and*
- *Place granular capping (6F2) and sub-base for pile mat construction.*

During the build phase, any the groundworks, particularly any below ground service and drainage works could encounter asbestos or other contaminants and suitable procedures will be implemented. Gas protection measures are also required. ;

Both the enabling phase of work, and excavations into the landfill and the ground gas installation measures will be validated with separate reports produced for each stage to complete the overall verification works.

DOCUMENT CONTROL SHEET

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For Redstart Northwest Limited	17th August 2021

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Appendix B: TerraConsult: Ground Gas Monitoring

Appendix C: Site Plans

- *Carrington Generation Limited Gas and Electrical Easement: Proposed Lease Area and Layout Dwg. No. FE/017/372 22/02/2021*

Appendix D: Guidance on Ground Gas Risk Assessment

1 INTRODUCTION

A planning application is to be made for the erection of small scale gas fire energy reserve facility and ancillary infrastructure on land located to the West of Manchester Road, Carrington, Manchester.

The proposed development area is made up of a single 1 ha parcel of land. The site currently comprises an undulating area of rough grassland with areas of rough grass, shrub, trees and dense vegetation.

The development area is within the former Peaksnook landfill site which was previously operated by Viridor Waste Management (WML 53703), but since closure the license has been surrendered back to the Environment Agency (EA). It is understood that the site was previously used as a landfill accepting inert, industrial, commercial and special waste (mainly asbestos) between 1988 and 1996.

Redstart Northwest Limited (Redstart) has been instructed to develop a remediation strategy based on the findings of previous site investigations. The previous investigations provided information on the geo-environmental condition of underlying strata including the assessment of the potential for risks to the human health of future site users; potential risks posed by the site and development to the wider environment, risks posed by the former landfill and consideration of likely requirements for ground gas protection.

1.1 Previous Work

The following previous reports which cover or partially cover the site have been referred to and should be read in conjunction with this report:

Reports for this development area:

- TerraConsult : Project Gneiss Deep Drilling Site at Carrington: Phase 2 Site Investigation Report. Reference 4133/02 Issue 2 20th November 2018 – See Appendix A of this Report.
- TerraConsult : Additional ground gas monitoring for the Project Gneiss Deep Drilling Site at Carrington: for period up to March 2019 – See Appendix B of this Report.

Reports for the area immediately adjacent to the NE of the development area for this site.

- Redstart Northwest Limited For Forsa Energy Stability Risk Assessment : Short Term Operating Reserve Facility, Land At Manchester Road, Peaksnook, Carrington, Manchester. M31 4nw *Report No. 654.03-3 Rev A,* 9th November 2020 –
- Redstart Northwest Limited for Forsa Energy: Remediation & Enabling Works Strategy: Short Term Operating Reserve Facility, Land At Manchester Road, Peaksnook, Carrington, Manchester. M31 4NW *Report No. 654.03-1 Rev B,* 3rd November 2020
- Redstart Northwest: Peaksnook - Materials Management Plan (MMP) Form - October 2014 Reference :MMP V1 29-01-21
- RPS Consulting Services Ltd: Carrington Peaking Plant, Manchester Road, Carrington, Manchester, M31 4qr: Further Gas Monitoring And Gas Risk Assessment Ref: JER1086 14/11/2017
- RPS Consulting Services Ltd: Ground Investigation Factual And Interpretive Report: Carrington Peaking Plant On Behalf Of STOR 124 Ltd Ref: JER1086 November 2017

Report for other areas of the Peaksnook landfill site

- RSK Group Plc: Contamination Slope Stability and Settlement Assessment Report: Peaks Nook Landfill Reference 320430_RO1 October 2010
- RSK Group Plc: Report on Bulk Sampling for Asbestos Containing Materials and Reassurance Airborne Fibre Monitoring During Borehole Drilling: Peaks Nook Landfill Site, Carrington: Report number 320430-1(00) 28th September 2010.

1.2 Remediation & Enabling Works Strategy Scope

The objectives of this report are to:

- Summarise the previous site investigations which have been carried out at Peaksnook;
- Prepare an overview of Contaminated Land Remediation requirements;
- Ensure the safe, cost effective and regulatory compliant redevelopment of the site
- Assess the most appropriate earthworks solution to ensure the delivery of the optimum development platform;
- Define validation criteria to demonstrate the successful implementation of a site Remediation & Enabling works plan;
- Define Geotechnical Engineering Performance Requirements; and
- Set out the verification requirements for the ground gas protection measures.

2 THE SITE

2.1 Site Location

The site comprises a single 1 ha parcel of land located within the former Peaksnook Landfill which is to the to the west of Manchester Road, Carrington, Manchester and to the east of the Manchester Ship Canal. The site area and proposed development is presented below as Figure 1 below.

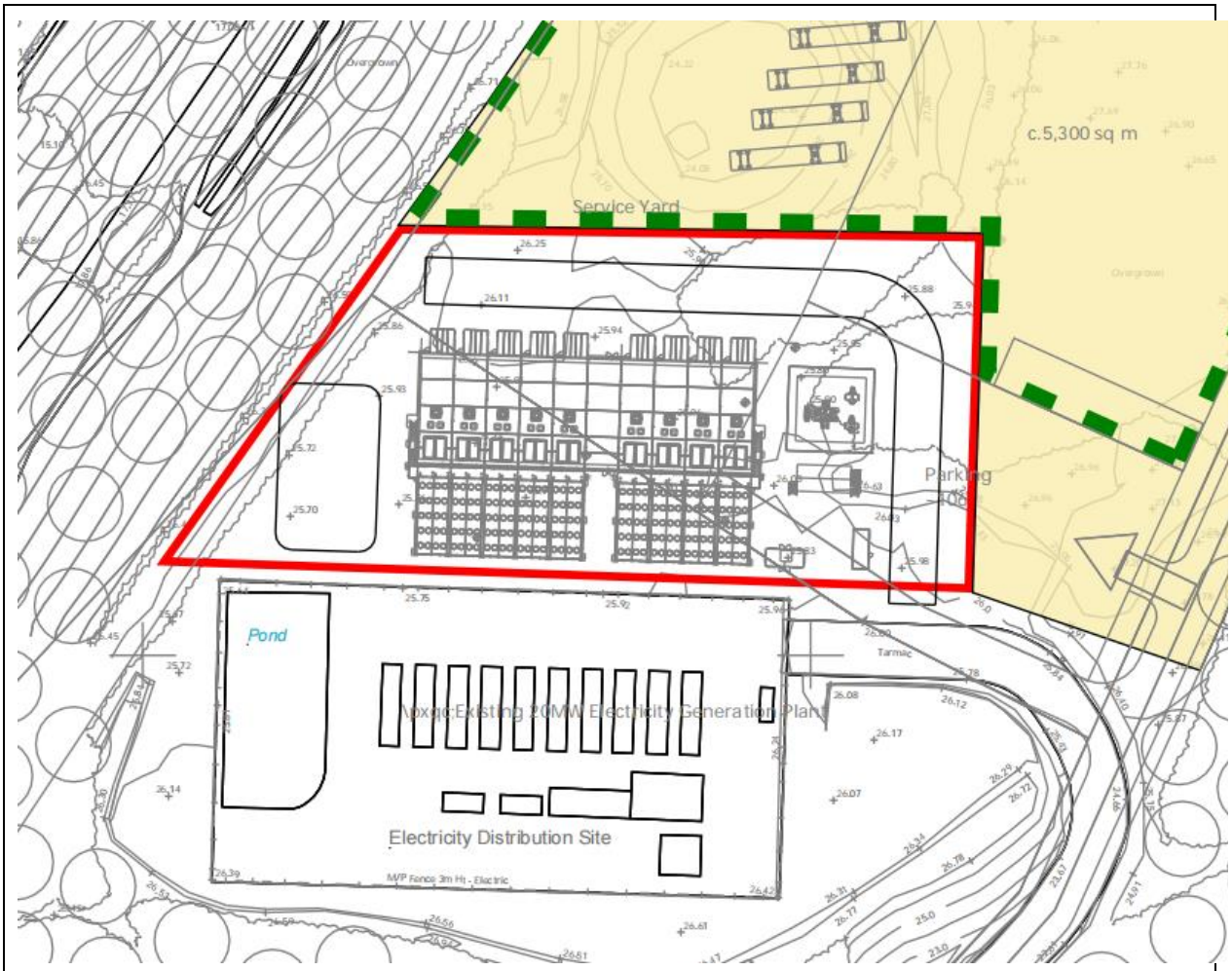


Figure 1 – Site Area and proposed layout (taken from Drawing Number FE/017/372 22/02/2021 included in Appendix C)

2.2 Site Description and Surrounding Area

The below information is taken from a recent site visit and the site can clearly be seen in the drone photograph from early July 2021.

2.2.1 Site Area, Shape and Topography

The development site is an area of relatively flat land comprising part with clay at the surface and an area of stoned ground (both with sparse vegetation) and an area of rough grassland. In the rough grassland there are rare pieces of plastic and metal were evident at the ground surface. These

deleterious materials are considered likely to be a result of the regrading of the fill materials previously placed at the Site rather than the recent importation of materials.

The area to the north of the site has planning permission for another energy facility. In early 2021 this area was cleared of vegetation and clay fill imported to form the development platform and then surcharge the area. The imported materials were placed in accordance with the CL:AIRE DoWCoP MMP system. The surcharge is yet to be removed.

Vegetation was also removed from the south eastern part of the development area and a geotextile separation layer placed and then a limited thickness of clay compacted to provide a clean cover over exposed landfill materials to leave the area safe after vegetation had been removed.

The area to the south of the site has been developed as a reserve gas powered electricity station similar to the proposed development at the site. Further south is a public footpath with the Saica Paper Mill beyond. To the east there is an area of pastured arable land with Manchester Road beyond. To the immediate West is a 16 m high slope down to the Manchester Ship canal and a warehouse / industrial area beyond.

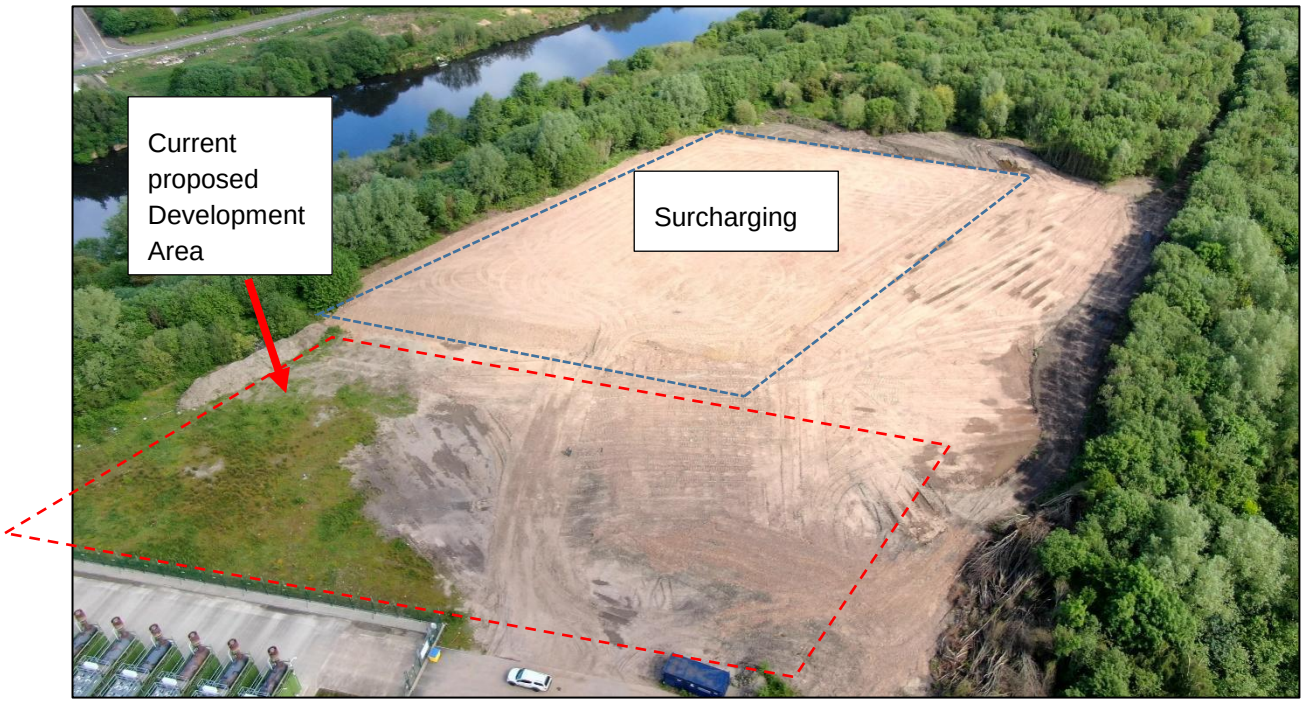


Figure 2: July 2021 view of site, looking North, with existing gas peaking plant in south west corner.

2.2.2 Site Access and Boundaries

The landfill boundary is fenced but the development area is currently not fenced. Access to the site is restricted and there are two sets of gates present between the public road to the southeast and the site entrance.

2.2.3 Current Use

The condition of the Site in relation to the surrounding environment appears to indicate that it has not been subject to recent use since the landfill was closed in 1996.

2.2.4 Summary of Relevant Interested Parties

Table 1 - Summary of Relevant Interested Parties

Party	Involvement
Trafford Council	Local Planning Authority
Environment Agency	Controlled Waters & Waste Regulator
Forsa Energy	Developer
Redstart Northwest Limited	Environmental Consultant
TBA	Enabling Works Contractor

2.3 Planning

Planning Permission has been granted by Trafford Council (Application Number: 89321/FUL/16) for the adjacent area to the northeast and this development has been commenced with enabling works having been carried out through the construction of the development platform and the placing of temporary surcharge.

A Planning Application is to be submitted for the proposed development.

2.4 Previous Site Investigation Reports – Development Area

The investigation reports for the current development are further discussed below.

- ***Project Gneiss - Deep Drilling Site At Carrington. Phase 2 Site Investigation Report. By TerraConsult Ltd. Dated 20th November 2018. Report No 4133/02 Issue 2 – Appendix A***

This investigation included 2 No. rotary boreholes and 12 No. trial pits. Findings of note include:

- *The ground profile was:*
  - *landfill waste to be approx. 11.5m; The material was described as a mixture of waste materials within a matrix of clay/sand/ash. The waste materials varied across the site and included brick, concrete, plastic bags, textiles, wire, metal, paper, cardboard, glass, ceramic tiles, timber, roots, tarmac and plastic. The exploratory holes did not encounter any lining material or distinct clay lining/layer below the wastes*
  - *an underlying sequence of Alluvium/Glaciofluvial/Till deposits being approx. 19.5m thick*
  - *Wilmslow Sandstone encountered at approx. 31mbgl.*
- *Asbestos was encountered in the landfill in seven out of the fourteen exploratory holes.*
- *Some benzo(a)pyrene and Dibenzo(ah)anthracene contamination was noted, along with elevated (with reference to plants) concentrations of phytotoxic metals.*
- *Monitoring indicated the presence of elevated methane within the landfill. Gas protection measures to meet CS3 Ground Gas Conditions were recommended for preliminary design purposes after only three rounds of ground gas monitoring.*

The GQRA identified that the Made Ground did not pose a significant risk to future site users, except for the presence of ACM, which could be addressed by implementing an Asbestos Working Plan during the groundworks.

Further ground gas monitoring was carried out and this is presented in Appendix 2. Nine rounds of ground gas monitoring were carried out from October 2018 to March 2019 (6 month period). Only one round of ground gas monitoring coincided with low air and falling pressure. Most of the wells indicated CS1 or CS2 ground gas conditions. One well in the site installed as part of a historic investigation (CEG BH02) again mainly indicated CS2 conditions but on two occasions this indicated CS3 conditions

with a maximum GSV of 1.16 l/hr. the limiting GSV for CS3 is 3.5 l/hr so this is well below this. This GSV in the CS3 range is typical for old landfills as stated in CIRIA Report C665.

2.5 Previous Site Investigation Reports – Adjacent Area to Northeast

The investigation reports for the adjacent area (as listed in Section 1 of this report) have previously been submitted to Trafford Council for discharge of Condition 14 of that planning permission. The submitted information was considered to be acceptable to discharge the condition. The remediation strategy for the adjacent area was also approved by the Council.

As part of the remediation works for the adjacent area, a CL:AIRE Definition of Waste Code of Practise (DoWCoP) compliant MMP will need to be prepared for the Direct Transfer of clean naturally occurring soils. As part of this process the Local Authority (LA) and Environment Agency (EA) are required to accept its use. The Investigation report details the use of the DoWCoP which the LA has accepted. The local EA Waste team has been informed of the intended use of DoWCoP.

Further discussion of the reports most relevant for the purposes of the current development are further discussed below.

- ***Ground Investigation Factual and Interpretive Report – Carrington Peaking Plant. By RPS on behalf of STOR 124 Ltd. Report Ref: JER1086 Dated November 2017.***

This investigation is located to the immediate north of the current development site and included the following works, to a maximum depth of 2m bgl, in the landfilled materials:

- *8No. trial pits;*
- *4No. continuous SPT Window Sample Boreholes; and*
- *3No. Dynamic Probe boreholes.*

The following testing was undertaken:

- *11No. samples of the Made Ground were taken for laboratory analysis including heavy metals, TPH (with banding C12-C35) and PAH (USEPA16);*
- *5No samples were taken for PCB 138 analysis;*
- *2No. samples taken for Carbazole and Di-n-butylphthalate (SVOC) analysis;*
- *14No. samples (including 5No. suspected bulk samples) were taken for Asbestos Analysis; and*
- *9No. Samples were taken for WAC analysis.*

The GQRA identified that the Made Ground did not pose a significant risk to future site users however it was considered plausible that contamination is present on the site in areas and at depths not investigated during the investigation works. The potential risks posed by the Made Ground can be mitigated through the inclusion of a separation layer (Geotextile) below the development formation and the use of inert / non-contaminated materials above this.

The RPS report reviewed a previous investigation report not seen by Redstart, this investigation was undertaken by GEG in June 2015 at Peaksnook. The report recommended that an inert cap of material of 300 mm minimum thickness was used to protect human health with respect to the proposed development, although it was considered that hardstanding placement may fulfil these requirements.

- ***Further Gas Monitoring and Gas Risk Assessment Letter Report – Carrington Peaking Plant. By RPS on behalf of STOR 124 Ltd. Report Ref: JER1086 Dated 14th November 2017.***

This report, for the area to the immediate north of the current proposals, details the results of the ground gas monitoring to enable quantitative analysis of ground gas risk, a total of 6No. ground gas monitoring rounds were undertaken upon completion of the intrusive ground investigation works. It was

concluded that gas protection measures are required for the proposed development to meet a score of 2.5 (building Type D) to 3(building Type C), corresponding to a Characteristic Situation of CS2 (this is what the report states but these scores are what is required for CS3 conditions). This report also stated that the ground gas mitigation measures will need to take account of the specific nature of the containerised buildings, and that verification of the gas protection measures will be required by an independent suitably qualified person who should create a verification report for submission to the regulators.

3 SITE SUMMARY

The following information is summarised from the reports identified in Section 1.1. For the avoidance of doubt these reports should be read in conjunction with this remediation strategy.

Table 2 - Site Description and Setting Summary

3.1 Site Description and Setting		
Environmental Setting	Made Ground	The site is underlain by varying depths (up to 11.5m) of landfilled Made Ground. The Made Ground is variable but generally comprised of clay bound gravel or gravelly clay with low to high cobble contents of brick, concrete, plastic, tarmac, asphalt, wood and metal and localised ACMs
	Drift Geology	Alluvial, Glaciofluvial and Glacial Till deposits made up of clay, silts, sand and gravels.
	Bedrock Geology	Wilmslow Sandstone Formation at around 31m bgl
	Hydrogeology	Aquifer (drift) – Secondary A Aquifer (solid) – Principal The soils are listed as having a high vulnerability to leaching. The site is not within a source protection zone around a groundwater abstraction borehole
	Hydrology	The Manchester Ship Canal is located at c. 100m to the west of the Site at its nearest point. This water course is designated by the EA as a Main (Primary) River.
	Flood Risk	The site is not located within an indicated flood zone (river or sea) on the Environment Agency flood Map
	Coal Mining	The Assessment Site in not identified as being affected by potential coal mining. A coal mining risk assessment has therefore not been undertaken.
	Radon	No specific precautions are required with respect to the potential risk from radon for the development.
Site History and Development	A historical landfill is indicated to be present across the Assessment Site. The Site address is Peaks Nook, off Manchester Road, Carrington. A waste licence was held between June 1988 and September 2003 under Environmental Permitting Regulations Ref. NR1/L/VWM002, accepting inert, industrial, commercial and special waste. The operator and licence holder was Viridor Waste Management Limited. The historical landfill also includes the surrounding area to the north / north-east. The Environment Agency website indicates that the Peaks Nook landfill site received waste between 1988 and 1996. It also indicates that gas control measures had been in place.	

Other Development Considerations	Ground Gas	A ground gas risk assessment has been undertaken by TerraConsult in 2018 as part of the GQRA. Conditions corresponding to Characteristic Situation CS3 (worst case) were recorded and further monitoring was proposed. This is confirmed by the additional gas monitoring data presented in Appendix 2. The site area to the immediate north investigated by RPS concluded that gas protection measures were required for the proposed development to meet a score of 2.5 (building Type D) to 3 (building Type C), corresponding to a Characteristic Situation of CS2.
	Underground Utilities	No live or existing underground services are expected to be present beneath the proposed re-development area. Limited excavations are to be undertaken during the redevelopment. A gas pipeline is known to be present along the Manchester Ship Canal, adjacent to the western edge of the site (see plan in Appendix C)

Table 3 - Summary of Ground Conditions

3.2 Summary of Ground Conditions		
Made Ground	Hardstanding	Limited hardstanding of gravel/hardcore was recorded within the proposed site.
	Landfill	The Landfill is up to 11.20 m thick. It is variable but generally comprised landfilled waste of clay bound gravel or gravelly clay with low to high cobble contents of brick, concrete, plastic, tarmac, asphalt, wood and metal and locally ACMs.
Topsoil	No topsoil that would be deemed suitable for re-use has been identified on site.	
Drift	The Drift deposits were recorded from approx. 11.5mbgl. It is not expected that any drift deposits will be encountered during the re-development works.	
Bedrock	The Bedrock deposits were recorded from approx. 31mbgl.	
Perched and Groundwater	Shallow perched water was encountered in two trial holes during the 2018 site investigation, and in several locations in the area investigated to the north of the current proposed development area in 2017. Deeper wells in boreholes indicate groundwater to be at a depth of about 8 m at about 18 mOD.	

4 CONTAMINATION ASSESSMENT

4.1 Area Investigated & Applicability of SI Report

TerraConsult site investigation report from 2018 (see Appendix A) presents a Tier 1 Generic Quantitative Contaminated Land Risk Assessment (GQRA) for covering the majority of the current proposed development area. There is an area to the southeast of the development area where there has been no site investigation works carried out. However, this is an area of landfill which was levelled in spring 2021, vegetation removed and a thin layer of clay placed to provide a clay cap over the landfill in exposed areas. The ground will be the same in this area apart from the thin clay cap based on the site assessment so no further investigation is required for this project.

The previous investigation was for a different scheme but this was similar in nature to the current investigation (i.e. both being power related developments with areas of hard standing and similar loadings). Therefore it is assessed that no further investigation works are required due to the change in development to the new scheme.

4.2 Active Pollutant Linkages (Human Health)

The GQRA identified no exceedances of the relevant SGV/GAC or pC4SL/S4ULs thresholds for metals. There were two samples exceeding the GAC threshold for benzo(a)pyrene which did not exceed the pC4SL threshold of 77mg/kg. There is therefore a limited risk of there being an active pollutant linkage.

However based on the historical land use of the Site as a landfill, it is considered plausible that contamination is present on the Site in areas and at depths not investigated.

The proposed development has limited penetration into the ground apart from the use of driven piles but these will not bring soils/landfill to the surface. There is potential for service and drainage excavations penetrate areas of contamination including asbestos. This should be mitigated through inclusion of a separation layer below the development formation, the use of inert / non contaminated materials above this plus appropriate management of excavation arisings. Appropriate controls during construction will be required to account for the likely presence of asbestos. Remediation requirements are detailed in Section 5

4.3 Active Pollutant Linkages (Controlled Waters)

With regards to controlled waters, previous ground investigations and assessments by GEG concluded that whilst some contamination was evident in groundwater and the receptors beneath the site were sensitive (superficial secondary A aquifer and principal bedrock) that the impact related the wider landfill and did not warrant specific migration for small developments within the landfill. It is considered that this conclusion remains valid for the current Site.

4.4 Ground Gas

A Ground Gas Risk Assessment has been carried out as part of TerraConsult's GQRA and is included within Appendix A with additional monitoring presented in Appendix B. In total, nine rounds of ground gas monitoring were carried out from October 2018 to March 2019 (6 month period). Only one round of ground gas monitoring coincided with low air and falling pressure.

Most of the wells indicated CS1 or CS2 ground gas conditions. One well in the site installed as part of a historic investigation (CEG BH02) again mainly indicated CS2 conditions but on two occasions this indicated CS3 conditions with a maximum GSV of 1.16 l/hr. The limiting GSV for CS3 is 3.5 l/hr so this is well below this limit. This GSV in the CS3 range is typical for old landfills as stated in CIRIA Report C665.

The report concluded that gas protection measures are required for the proposed development to meet a score of 2.5 (building Type D) to 3 (building Type C), corresponding to a Characteristic Situation of CS3. The requirement for these mitigation measures will need to take account of the specific nature of the containerised buildings. The installation of gas protection measures will need to be independently validated.

4.5 Invasive Plants

Growth of Himalayan Balsam had been noted to the northwest of the development area. The landowner (Peel L&P) has been carrying out herbicidal treatment of this growth in both during summer 2020 and 2021. There are no invasive weeds in the development area and its surrounding area is being actively managed. Further assessment and treatment of this invasive plant species will be required on adjacent areas to the site.

4.6 Asbestos Containing Material (ACMs)

During the investigation works red bags labelled “hazard asbestos” were recovered from one trial hole and further red bag fragments and pieces of asbestos were identified in a further six out of the fourteen exploratory locations. Asbestos analysis was undertaken on 15 samples, of which three confirmed that amosite and chrysotile fibre bundles were present and chrysotile cement. Total asbestos contents of 0.002, 0.002 and 0.588% were reported for the three samples.

Limited excavations into the Made Ground are required as part of the redevelopment works with only a minimal surface vegetation strip being required so it was proposed that the risks posed by the potential ACMs be appropriately controlled by implementing an Asbestos Working Plan in accordance with the Control of Asbestos Regulations 2012.

5 OUTLINE SITE REMEDIATION WORKS

As no active pollutant linkages other than the risk from ground gas and ACMs have been identified, the outline remediation measures presented below are designed to reduce and potential future risks to Human Health and the wider environment. The remediation works will be in two stages:

- Stage 1 Enabling Works Phase – Site clearance. Importing soils and construction of development platform
- Stage 2 Build Phase – Installation of Services and Drainage
- Stage 2 Build Phase – Installation of Ground Gas Protection Measures

The Stage 1 Enabling Works includes:

- Pre-commencement works including RAMS, submission of a U1 environmental permit exemption for the limited reuse of excavated soils in the development area;
- Removal of vegetation over part of the site;
- Placement of geotextile separation layer (Terram 1000 or similar);
- Import of suitable clean granular materials as capping and sub-base to create a working platform for piling rigs (this will be virgin aggregate or recycled WRAP produced aggregate);
- Import, placement, compaction and testing of suitable capping for pile mat construction.

Stage 2 (build phase) will include the installation of required ground gas protection measures.

5.1 Enabling Works Contractor's Site Management & Responsibility

The appointed Enabling Works contractor will take full and overarching responsibility for all methods of work required to complete the site earthworks and enabling operations. They will be expected to ensure the delivery of the site and the completion of the objectives set out in this strategy are completed in a safe, sustainable and legislative compliant manner.

The contractor will be required to provide site specific methods of work pertaining to the specific tasks.

The contractor is expected to be responsible for documenting each day's activities. This should include a full recorded schedule of works completed and information required to produce a remediation works validation report.

5.2 Pre-Commencement Regulatory Compliance

Prior to commencement of any works on-site, all works should be undertaken under relevant permits and permissions from statutory authorities. There will be limited earthworks for the development involving reuse of soils already on site. To ensure regulatory compliance a U1 environmental permit exemption will be submitted to cover the limited reuse of excavated soils in the development area.

5.3 Environment & Nuisance Control

The remediation contractor will be responsible for the management of all works so as to ensure that no environmental nuisance is created through potential Asbestos fibre release, dust emissions, noise or vibration levels.

In the event that a complaint is made in respect of dust emissions, noise or vibration levels, remedial measures and a programme of ongoing monitoring should be agreed with the local authority and

implemented on site. No specific environmental monitoring or mitigation measures are required as part of the development unless there are planned excavations into the landfill materials.

5.4 Identification, Isolation and Treatment of Invasive Plants

Himalayan Balsam has been noted growing adjacent to the development area. The landowner will continue herbicidal treatment of this plant on adjacent land to the development area and the plant has died back.

5.5 Site Clearance Operations

General site clearance & provision of welfare, offices and site security will be provided as per the contract requirements.

The site contains areas of vegetation; this material should be removed in a controlled manner. An ecological assessment of the site has previously been carried out and a further inspection was carried out by an ecologist in spring 2021. Other than the limited issues around the presence of Himalayan Balsam indicated above, there are no specific ecological mitigation measures required for the works as long as vegetation clearance is carried out during the winter months outside birds nesting season.

All vegetation will either be stockpiled at a pre-agreed location or alternatively removed from site in accordance with Waste Permitting Regulations.

5.6 Identified Asbestos Impact

Asbestos Containing Materials (ACMs) have been identified and caution should be taken during construction and excavation work. The procedures in the CL:AIRE document 'Control of Asbestos Regulations 2012 – Interpretation for Managing & Working with Asbestos in Soil and Construction & Demolition Materials - Industry Guidance" (CAR-SOIL) should be followed for all excavations into the existing ground at the site.

Excavations into the Made Ground are limited to a minimal vegetation strip for the redevelopment works so the potential risks posed by ACMs has been assessed as low. Furthermore the enabling works require the import of clean materials for up-filling further reducing the potential for risks posed by ACMs to future site users.

To further mitigate the risk the installation of a separation layer (following vegetation clearance works) is required below the development formation it is recommended that a Terram 1000 or similar is used.

Photographic evidence of the placement and surveying of the separation layer will be required for the remediation validation report.

5.6.1 Asbestos Fibre Release Reassurance Air Monitoring

If there are any planned excavations into the landfill materials then this should be classed as non-notifiable non licensed works. Any such works should be will be carried out in such a way that the exposure of workers to Asbestos will not exceed the legal (HSE) control limit of 0.1 asbestos fibres per cubic centimetre of air (0.1 f/cm^3) (averaged over a four hour period).

If there are any planned excavations into the landfill materials then it is recommended that during these works, background and personnel re-assurance air monitoring will be undertaken to monitor exposure levels and ensure that 'control limits' aren't being exceeded. This monitoring should be carried out in accordance with the requirements of HSG 248. The monitoring should be carried out by a suitably qualified person from a UKAS accredited laboratory.

Background re-assurance asbestos fibre air monitoring should be carried out at strategic locations (i.e. downwind of remediation activities and adjacent to any potential receptor boundaries). Personal monitoring should also be carried out on operatives undertaking the works.

The results of the monitoring should be made available to the contractor on the same day to demonstrate the deployment of the required control procedures and safe working methods are sufficient.

5.6.2 Emergency Procedures

The following procedure will be adopted should an unknown quantity or type of Asbestos be discovered on site which is not detailed in the SI report or the asbestos location plan.

- All work will cease in the location;
- Operatives to report the find to the site manager;
- The affected area will be wetted down if required under instruction and covered if required;
- The area will also be fenced off and clearly signed for no entry;
- The affected area may only be entered once a competent and qualified person has undertaken an appropriate risk assessment for the control and handling of the material;
- The material is to be tested and subsequently treated in line with the recommendations of a suitably qualified person; and
- Should the ACM be deemed suitable to remain on site (below appropriate cover) the location of the asbestos will be logged on a constraints drawing.

5.7 Previously Unidentified Contamination

When considering the prior land use, as yet unidentified potentially harmful contaminants cannot be discounted. The proposed remediation works include limited excavation within the made ground under the supervision of an experienced geo-environmental consultant.

In the event that any as yet unidentified contaminant is encountered, this will be the subject of further investigation including laboratory analysis and subsequent assessment of risk within the context of the remediation works and proposed development.

Where a theoretical risk to either human health, controlled waters or the wider environment is identified, appropriate contact should be made with overseeing consultant and the regulators with appropriate remediation works to be agreed and instigated.

5.7.1 Disposal of Unsuitable Materials

In the event soils are identified to be impacted with contaminants which render the material unsuitable for treatment and retention on site the materials should be disposed of off-site to a licensed waste facility under duty of care and waste disposal legislation. The remediation contractor shall be responsible for the safe disposal of any excess of unsuitable material found on the site.

5.8 Placement of Geotextile Separation Layer

Following vegetation clearance works a geotextile (Terram 1000) or similar is to be paced across the development formation to form a separation layer prior to constructing the piling mat.

5.9 Import of Materials

Import of suitable clean granular materials will be required for capping (e.g. 6F2) and sub-base to create a working platform for piling rigs. This will be virgin aggregate or recycled WRAP produced aggregate.

5.10 Controlled Waters

It has been assessed that no remediation works are required specifically for controlled waters.

Care should be taken to avoid runoff directly down the slope and into the Ship Canal but note that there is an edge bund along the top of the landfill slope which will prevent this occurring.

5.11 Watching Brief

An experienced geo-environmental watching brief should be undertaken during earthworks operations to inspect for Asbestos Containing Materials, previously unforeseen contamination, manage excavations and carry out validation testing on imported materials.

5.12 Toolbox talks

The remediation contractor should carry out regular toolbox talks to contractors involved with the works. The toolbox talks should be on a range of subjects throughout the works to ensure safety and working practise are kept to a high standard.

5.13 Validation Sampling Protocols For Any Soils Being Reused

No sampling or testing of soils currently on site is required as part of the development unless there is a change of plan and some excavated soils are to be removed from the site. If this is the case than this material will require to be tested to comply with the requirements of WM3 (Technical Guidance WM3: Waste Classification - Guidance on the classification and assessment of waste. Ref: LIT 10121).

It is therefore sampling and testing of soils will only be required if there is a change of plan. All samples will subsequently be stored in cooled boxes prior to submission to a UKAS / MCERTS accredited laboratory.

Samples will be obtained in broad compliance with BS5930:2015+A1:2020 – Code of practice for site investigations, and BS10175:2011+A2:2017 – Investigation of potentially contaminated sites – Code of Practice. All samples will be collected using appropriate PPE and sampling equipment that will be cleaned at each sampling location.

Laboratory chemical analysis results will be assessed. Where material is found to contain concentrations of potential contaminants at levels in excess of the site specific screening criteria (as detailed within Table 6), the material will not be returned to the donor site.

The sampling frequency for materials to be managed under the Remediation Strategy is presented on the below table:

Table 6 - Remediation Phase Validation Sampling Requirements

Material	Testing Frequency (m^3)	Analysis Required
Imported recycled aggregate	1 Sample per $1000m^3$	A / B / C / D / E
Imported Clean Naturally Occurring Materials	1 Sample per $1500m^3$	A / B / C / D / E
Previously Unidentified Heavy Metals/PAH/TPH/Asbestos Hotspot Validation Samples	1 Sample per $25m^2$ excavation face/base. 1 Sample per $250m^3$ excavated material	Dependant on identified contaminant - A and/or B and/or C and/or D and E
Notes – Suites of Analysis *A – PAH (US EPA 16)* *B – TPH Total – if this result is more than 100 mg/kg then also test TPH (UK CWG) inc. BTEX and MTBE* *C – Asbestos ID (Quantification if positive ID)* *D – Aqua regia soluble metals (As, Cd, Cu, Pb, Ni, Zn, Cr, Se, Hg* *E – pH, SOM%*		

Note –

The imported recycled aggregate will also be assessed as suitable prior to import. No chemical testing on virgin aggregate

The Clean naturally occurring materials will already be extensively characterised and proven to be clean prior to import.

5.14 Import Criteria (General Fill and Recycled Aggregates)

The results of chemical testing are to be compared with the site import/re-use criteria presented in Table 7. The values are screening criteria applicable for clean natural soils (based on published GAC criteria for Residential Without Vegetable Uptake Land-use). If any of these thresholds are exceeded the material shall be considered to be unsuitable and should not be imported or if the soils have been imported they should be returned to the donor site.

Table 7 - Import Criteria

Contaminant	GAC (mg/kg)		Contaminant	GAC (mg/kg)
Arsenic (As)	35		**Acenaphthene**	84000 (57)
Cadmium (Cd)	17.7		**Acenaphtylene**	83000 (86.1)
Chromium (CrIII/Total)	301		**Anthracene**	520,000
Copper (Cu)	135		**Benzo[a]anthracene**	170
Lead (Pb)	330		**Benzo[a]pyrene**	77 (C4SL)
Mercury – Total Inorg. (Hg)	238		**Benzo[b]fluoranthene**	44
Nickel (Ni)	59		**Benzo[ghi]perylene**	3,900
Selenium (Se)	595		**Benzo[k]fluoranthene**	1,200
Zinc (Zn)	300		**Chrysene**	350
			Dibenzo[ah]anthracene	3.5
			Fluoranthene	23,000
Benzene	0.38		**Fluorene**	63000 (30.9)
Toluene	88		**Indeno[123-cd]pyrene**	500
Ethylbenzene	8.3		**Naphthalene**	190 (76.4)
m & p-Xylene	7.9		**Phenanthrene**	22,000

o-Xylene	8.8		**Pyrene**	54,000
Aliphatic TPH >C5-C6	42		**Aromatic TPH >C5-C7**	37
Aliphatic TPH >C6-C8	100		**Aromatic TPH >C7-C8**	86
Aliphatic TPH >C8-C10	27		**Aromatic TPH >C8-C10**	47
Aliphatic TPH >C10-C12	130		**Aromatic TPH >C10-C12**	25
Aliphatic TPH >C12-C16	110		**Aromatic TPH >C12-C16**	180**
Aliphatic TPH >C16-C21	650**		**Aromatic TPH >C16-C21**	190**
Aliphatic TPH >C21-C35	650**		**Aromatic TPH >C21-C35**	190**
Aliphatic TPH >C35-C44	650**		**Aromatic TPH >C35-C44**	190**
	*			
Asbestos	<0.001% w/w		**pH**	5 to 9

Note - ** Means CLEA1.071 derived value divided by a factor of 10 or more based on judgement for clean natural soils. Note that TPH can be encountered in some natural soils from breakdown of organic matter.

5.15 Criteria For Soils Reused on Site

Whilst it is not currently envisaged that there will be any significant earthworks involving soils already on site, if this is required then no testing is required for soils relocated and placed more than 600 mm below final ground level. If soils already on site are to be reused within the upper 600 mm of the final development level then the results of chemical testing are to be compared with the following GAC criteria presented in Table 8 (these are based on the development being for Commercial/Industrial land-use).

If any of these thresholds are exceeded the material shall be considered to be unsuitable and should be placed below a depth of 600 mm the finished development level..

Table 8 – Criteria for Soils Reused on Site

Contaminant	GAC (mg/kg)		Contaminant	GAC (mg/kg)
Arsenic (As)	640 (C4SL)		**Acenaphthene**	84000 (57)
Cadmium (Cd)	7,500		**Acenaphtylene**	83000 (86.1)
Chromium (CrIII/Total)	22,000		**Anthracene**	520,000
Copper (Cu)	12		**Benzo[a]anthracene**	170
Lead (Pb)	240,000		**Benzo[a]pyrene**	77 (C4SL)
Mercury – Total Inorg. (Hg)	420 (C4SL)		**Benzo[b]fluoranthene**	44
Molybdenum (Mo)	49 (C4SL)		**Benzo[ghi]perylene**	3,900
Nickel (Ni)	8,600		**Benzo[k]fluoranthene**	1,200
Selenium (Se)	68,000		**Chrysene**	350
Zinc (Zn)	2,200 (C4SL)		**Dibenzo[ah]anthracene**	3.5
	25.8		**Fluoranthene**	23,000
Benzene	17,000		**Fluorene**	63000 (30.9)
Toluene	980		**Indeno[123-cd]pyrene**	500

Ethylbenzene	12,000		**Naphthalene**	190 (76.4)
m & p-Xylene	730,000		**Phenanthrene**	22,000
o-Xylene	730,000		**Pyrene**	54,000
Aliphatic TPH >C5-C6	3,200 (304)		**Aromatic TPH >C5-C7**	26,000 (1,220)
Aliphatic TPH >C6-C8	7,800 (144)		**Aromatic TPH >C7-C8**	56,000 (869)
Aliphatic TPH >C8-C10	2,000 (78)		**Aromatic TPH >C8-C10**	3,500 (613)
Aliphatic TPH >C10-C12	9,700 (48)		**Aromatic TPH >C10-C12**	16,000 (364)
Aliphatic TPH >C12-C16	59,000 (24)		**Aromatic TPH >C12-C16**	36,000 (169)
Aliphatic TPH >C16-C21	1,600,000		**Aromatic TPH >C16-C21**	28,000
Aliphatic TPH >C21-C35	1,600,000		**Aromatic TPH >C21-C35**	28,000
Aliphatic TPH >C35-C44	3,200 (304)		**Aromatic TPH >C35-C44**	28,000
Asbestos	<0.001% w/w		**pH**	5 to 9

Note - Where bracketed numbers are given the GAC exceeds the saturation limits (vapour or solubility), which could indicate free phase product

6 BUILD PHASE REMEDIATION WORKS

A second phase of remedial actions are required following the remediation & enabling works to ensure that any remaining pollutant linkage from ground gas risk is mitigated and the development is compliant with UK Building Regulations and the Local Authority Planning requirements.

6.1 Stage 2 – Installation of Services and Drainage

Where these works penetrate the landfill materials there is a risk that contamination and in particular asbestos is encountered. All such works shall follow the procedures set out in Section 5.6 and other pertinent aspects in Section 5 will be implemented.

6.2 Stage 3 -Gas Protection Measures – amend if have TCL gas appendix

A Ground Gas Risk Assessment has been carried out as detailed in Section 2.4 and 4.4. The report concluded that gas protection measures are required for the proposed development to meet a score of 2.5 (building Type D) to 3 (building Type C), corresponding to a Characteristic Situation of CS3. The requirement for these mitigation measures will need to take account of the specific nature of the containerised buildings.

In order to achieve this score, measures will need to be designed into the buildings as detailed below.

- Gas resistant membrane – 2 points.

  and / or

- Passive sub floor dispersal layer (such as a clear void or with a void former) with good performance – 1.5 points.

  and / or

- Cast in-situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations (must be well reinforced and have minimal penetrations cast in) – 1.5 points

The buildings will all be on piled slabs gaining 1.5 points from the “reinforced cast in situ suspended floor slab with minimal penetrations.” The slab will also incorporate a proprietary methane membrane which provides a further 2 points and these together meet the requirements for both Type C and D buildings.”

The installation of gas protection measures will need to be independently validated as detailed in Section 8.4.

7 ENVIRONMENTAL MONITORING & MITIGATION MEASURES

The remediation works proposed are not considered likely to give rise to any significant problems associated with dust, noise or odour. Nonetheless, the monitoring and mitigation measures outlined below may be required if dust, vapour or odour become noticeable.

7.1 Control, Monitoring and Reporting of General Aerial Emissions; Dusts and Particulates

The soils at the site are generally cohesive Made Ground and have a moisture content unlikely to give rise to dust. There are no planned crushing or screening operations that have the potential to give rise to dust during the works. If during the remediation operations associated machine movements generate visible dust then the following should be implemented:

7.1.1 Damping Down of Soils – Mitigate Particulate (Dust) Emission

If, during any excavation or material engineering works, dust is observed, the material will require to be damped down using water to control the generation of dust (this may also comprise precipitation).

- Where necessary, haul road, work areas and stockpiles will be damped down with water spray;
- The application of water to haul roads, work areas and stockpiles should be closely monitored by the resident engineer to ensure that soils are not saturated and therefore the potential for water run-off is appropriately mitigated;
- Once completed, any stockpiles will be sealed by compacting at the surface; and,
- Vehicle speeds and movements on site will be kept to a minimum (<5mph) during excavation works to reduce the potential to generate dust.

If necessary, monitoring for dust in air will be carried out by the remediation contractor, during the excavation works. Monitoring should be undertaken at the up-wind and down-wind locations at the site boundaries. Dust monitoring using a ‘real time’ dust monitor or similar should be undertaken as required. Dust levels should be recorded on a daily record sheet.

7.2 Monitoring of Local Weather Conditions

The site manager should record prevailing wind directions, weather conditions. Daily/weekly weather forecasts should be monitored and works carefully planned taking into account expected weather conditions. Should adverse weather conditions be encountered and/or the above measures prove insufficient to ensure satisfactory dust control the works generating dust should be suspended until conditions improve.

Visual monitoring of aerial emissions shall be carried out by site staff supervising materials handling operations. Visual monitoring should also be undertaken by the Site Manager or Supervisor, at least twice per day, at the site boundary situated downwind of the engineering operations, and shall be recorded in the site diary

7.3 Noise monitoring

It is anticipated that there will be short noisy intervals when concrete is broken out or machinery for crushing of concrete is in operation. The siting of construction plant and timing of operations should be planned to limit nuisance.

Works should be carried out by the least noisy plant, or working method, where feasible. All plant and machinery should be well maintained and operated in accordance with the manufacturers' instructions.

If deemed necessary, noise monitoring should be carried out by the remediation contractor, during the remediation works. This monitoring will be undertaken at the site boundaries at areas where receptors are closest and compared with site specific thresholds. Should the thresholds be exceed noise mitigation may be required.

Trigger levels for noise will be set in compliance with The Control of Noise at Work Regulations 2005 (the Noise Regulations) which came into force on 6 April 2006. A review of all applicable planning conditions for the site should be undertaken to determine if there are any site specific requirements that need to be incorporated into the noise monitoring regime. The minimum noise monitoring trigger values are:

Lower Exposure action values:

- Average exposure of 80dB(A) and peak sound pressure of 135dB(C); and
- Action at which employers must assess the risk to workers' health.

Upper Exposure action values:

- Average exposure of 85dB(A) and peak sound pressure of 137dB(C); and
- Action at which employers must provide hearing protection and hearing protection zones.

Exposure limits NOT to be exceeded are:

- Average exposure of 87dB(A) and peak sound pressure of 140dB(C).

7.4 Fires and Accidental Spillages

No fires will be allowed on site unless appropriate exemptions are in place; suitable fire extinguishers will be kept on site in case of a fire.

The remediation contractors fuel bowsers should be bunded with the bund being impermeable to oil and water, have no direct outlet and have a capacity of at least 110% of the maximum capacity of the fuel tank. All ancillary equipment associated with the tank shall be stored within the bund. If the fill pipe for the tank is outside the tank bund, then a drip tray shall be used on delivery of fuel to collect accidental drips of fuel. A competent person shall supervise deliveries of fuel to help avoid spillages, prevent damage to the environment and save loss of fuel.

The fuel bowser shall be locked when not in use. A competent person shall inspect the bowser and bunding regularly to detect leaks or damage that may lead to a spill. In areas where fuel or other polluting substances are stored, validation samples will be taken from the surface directly below where the materials have been stored. The appropriate action will be taken based on the findings. Drip trays or plant "nappies" will be placed under all static equipment storing fuel (compressors / generators).

Spill kits comprising hydrophobic & oil absorbent booms, pads and granules should be kept permanently on site in close proximity to areas of fuel storage.

All mechanical equipment to be used at the site will be regularly maintained in good working order and will undergo daily checks.

7.5 Odour Monitoring

During previous ground investigation the soils encountered did not give rise to significant odours. If deemed necessary, olfactory monitoring for odour nuisance will be undertaken at the site boundary down-wind of the excavation area during all excavation works.

If deemed necessary odour monitoring will be carried out at the start of each day. In addition, a PID will be used for volatile monitoring in the air. At each monitoring event, the odour level will be subjectively classified as none, slight, moderate, or high, where:

A slight odour level is detectable but not particularly noticeable;

- A moderate odour level is noticeable but not offensive; and
- A high odour level is offensive.

If high odour levels are detected in the same location on more than two occasions during any three-day period, then works should be halted until odour suppression units are installed and used. However, based on investigations to date, it is not anticipated that there will be any odour problems during the excavation works.

8 VERIFICATION

8.1 General

It is anticipated that remedial works will be completed in two stages with the associated verification also in two stages:

- Stage 1 Enabling Works Phase – Site clearance. Importing soils and construction of development platform
- Stage 2 Build Phase – Installation of Services and Drainage
- Stage 3 Build Phase – Installation of Ground Gas Protection Measures

All remediation and enabling works completed will be documented within a Validation Report which will eventually make part of the overall verification report for the site. The Validation report is required to be compiled in general accordance with the Environment Agency document 'Land Contamination: Risk Management' LCRM - 2020

8.2 Stage 1 Enabling Works

The Stage 1 verification report will include:

- Confirmation that Works Specification has been met;
- Details of remediation works carried out and any deviation from the Remediation Strategy;
- A Soil Audit detailing any reuse on site and placement;
- Drawings (as-built levels, natural ground/separation layer levels, piling platform materials, etc.);
- Validation evidence including laboratory geotechnical/chemical analysis, photographic evidence and field testing where required;
- Regulatory correspondence; and
- Records of Environmental Monitoring.

8.3 Stage 2 Build Phase - Installation of Services and Drainage

Following completion of remedial works in Stage 1, the Installation of Services and Drainage will remaining to be completed and this could encounter the landfill materials. A short report with the same scope as set out in Stage 1 above will be required.

8.4 Stage 3 Build Phase - Gas Protection: Installation Verification

Based on the ground gas risk assessment which has recommended that Ground Gas Mitigation Measures would need to be installed in line with the requirements of a Characteristic Gas Situation 3 (CS3) scenario across the whole site.

In line with requirements set out in BS8485:2015+A1:2019 the proposed development is required to meet a score of 2.5 (building Type D) to 3 (building Type C) or greater. The BS8485 point system is based on three Gas Protection Parameters with the following two parameters being used for this development:

- Structural Barriers – piled slab/ reinforced cast in situ suspended floor slab with minimal penetrations; and
- Gas Resistant Membranes with verification of installation.

The gas resistant membrane shall be a proprietary methane membrane which meets all of the following criteria:

- Have limited service penetrations which are sealed;
- Sufficiently impervious to gases with a methane gas transmission rate <40.0 ml/day/m2/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method)
- Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;
- Sufficiently strong to withstand in-service stresses;
- Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, dropping tools etc); and to withstand in-service stresses;
- Capable, after installation, of providing a complete barrier to the entry of the relevant gas; and
- Installation verified in accordance with CIRIA C735

Note that:

- A methane gas transmission rate of <40.0 ml/day/m2/atm (average) for sheet and joints (tested in accordance with the manometric method in BS ISO 15105- 1:2007) is usually considered sufficient. Guidance on the durability and strength of plastic membranes used as VOC vapour barriers is provided in CIRIA C748. There are many gas resistant membrane types available and membrane choice should be made according to the resistance of the material to the passage methane and the resistance to site damage during and after installation in the designed position. The designer specifying the membrane should consider the combination of a particular membrane's properties to assess whether it is suitable in any given situation. The specified membrane and the reasons for its selection should be described in the design stage report.
- Further advice on membrane selection is given in BS8485:2015+A1:2019 Annex C.
- The installation and subsequent protection of the membrane are key factors in its performance. A poorly installed membrane cannot perform, however well detailed and irrespective of the performance of the material.

A number of different combinations could be used to meet the required score. Further details on ground gas risk assessment and section of protection measures can be found in Appendix D.

8.4.1 Gas Membrane Validation/Inspection Requirements

The verification process is now described in CIRIA C735 and as such, confidence in the installed solution can be measured. The process removes the uncertainty of unqualified or inexperienced installation operatives by requiring a verification plan to be drawn up prior to the installation. The validation inspection is to be undertaken following installation of each unit by an independent and competent person and is to include verification of the items below:

Table 9 - Gas Membrane Validation/Inspection Requirements

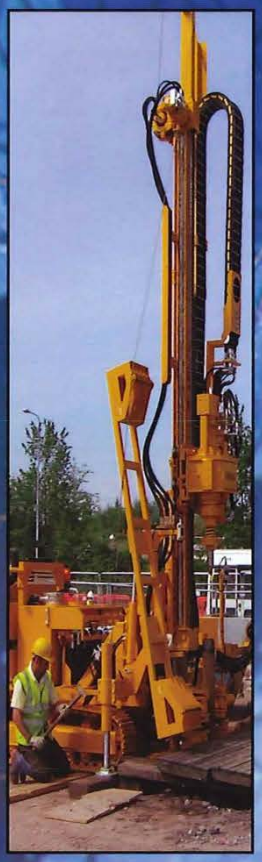
Inspection	Method
Product Verification	Confirmation that suitable products have been installed to consist of photographs of product types, labels on packaging and delivery tickets.
Wall Cavity Inspection	Confirmation that gas membrane spans the external wall cavity above the periscopic vents.
General Condition	The membrane is to be inspected to ensure there are no tears, punctures or rips.
Jointing	The engineer is to check the overlaps between membranes are correctly sealed with sufficient overlaps.
Service Entry Points	Verification of the presence of preformed top-hats (or similar) sealed to the pipe and membrane as per the construction detail.
Passive Venting Systems	The engineer should verify the presence of vents of the external walls. Verification of the stone venting layer and presence of pipes to be supplied by photographic records from site.

8.4.2 Verification Reporting of Gas Membrane Validation/Inspection

It is envisaged that there will be three site visits to inspect the ground gas membranes and a relatively short report produced summarising the verification works as set out in Table 9.

Appendix A:

TerraConsult Investigation Report



TerraConsult

20th November 2018
Report No 4133/02 Issue 2

PROJECT GENSSIS
DEEP DRILLING SITE AT CARRINGTON

PHASE 2 SITE INVESTIGATION REPORT

Carried out for: **MARRIOTT DRILLING GROUP**

Site Investigation Contractor: **SM Associates**

TerraConsult

PROJECT GENSSIS
DEEP DRILLING SITE AT CARRINGTON

PHASE 2 SITE INVESTIGATION REPORT

Date: 20/11/2018

Report No 4133/02 Issue 2

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2	Final Report	**20/11/2018**	**Checked By:** J Thorburn FGS BSc	J Thorburn	**19/11/2018**
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DISCLAIMER

This report should be read with the Service Constraints Report Limitations & Planning Requirements set out in Appendix A.

PROJECT GENSSIS
DEEP DRILLING SITE AT CARRINGTON

PHASE 2 SITE INVESTIGATION REPORT

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PROJECT GENSSIS
DEEP DRILLING SITE AT CARRINGTON

PHASE 2 SITE INVESTIGATION REPORT

1. INTRODUCTION

1.1 Background Information

1.1.1 TerraConsult Limited was commissioned by SM Associates (Site Investigation Contractor) acting on behalf of the Client, Marriott Drilling Group, to carry out a site investigation for an area of land off Manchester Road, A6144, in Carrington, Greater Manchester. The purpose of the report is to provide information on conditions at the site for a proposed industrial development for an energy storage facility.

1.1.2 This report has been devised to generally comply with the relevant principles and requirements of a range of guidance including:

- Part IIA of the Environment Protection Act, 1990;
- Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, April 2012);
- National Planning Policy Framework (HCA, July 2018);
- BS5930:2015: “Code of practice for site investigations”;
- BS10175: 2011 +A2:2017 “Investigation of Potentially Contaminated Sites - Code of Practice”;
- The Building Regulations 2010. Part C (HM Government 2013)
- DEFRA/Environment Agency (2004) Report CLR11 “Model Procedures for the Management of Land Contamination”;
- Environment Agency (2011) Report GPLC1 “Guiding Principles for Land Contamination”;
- Environment Agency (2017) “The Environment Agency’s Approach to Groundwater Protection” November 2017 Version 1.1

1.1.3 TerraConsult’s service constraints and report limitations are presented in Appendix A and a description of environmental risk assessment methodology and terminology is presented in Appendix B.

1.2. Development Proposals

1.2.1 The project has the acronym GENSSIS, (Gravitational Energy Storage & Synchronous Inertial Stability), and is part of a detailed coordinated study into the feasibility of developing a technology based on storage of electricity using a gravitational potential energy concept and its potential to provide zero emission ancillary grid balancing services to National Grid Electricity Transmission plc.

1.2.2 The proposed development is connected with an energy storage facility comprising the construction of a deep large diameter (1.5 m) borehole to a depth of 1,000 m or 1,500 m. It is understood that a heavy weight is lowered or lifted within this borehole depending on the energy demand to smooth the energy availability.

1.2.3 It is understood that the project will comprise two phases, with an initial phase comprising a temporary development to facilitate the drilling of the deep boreholes. This requires a concrete slab for the drilling platform and associated ancillaries which will be circa 55m x 80m in plan. It is understood that the final facility will comprise a:

- Building is expected to be around 25m by 17m in plan to house equipment as illustrated in Figure 1.
- Other auxiliary buildings (electricity transformers etc.).
- External hard standing.

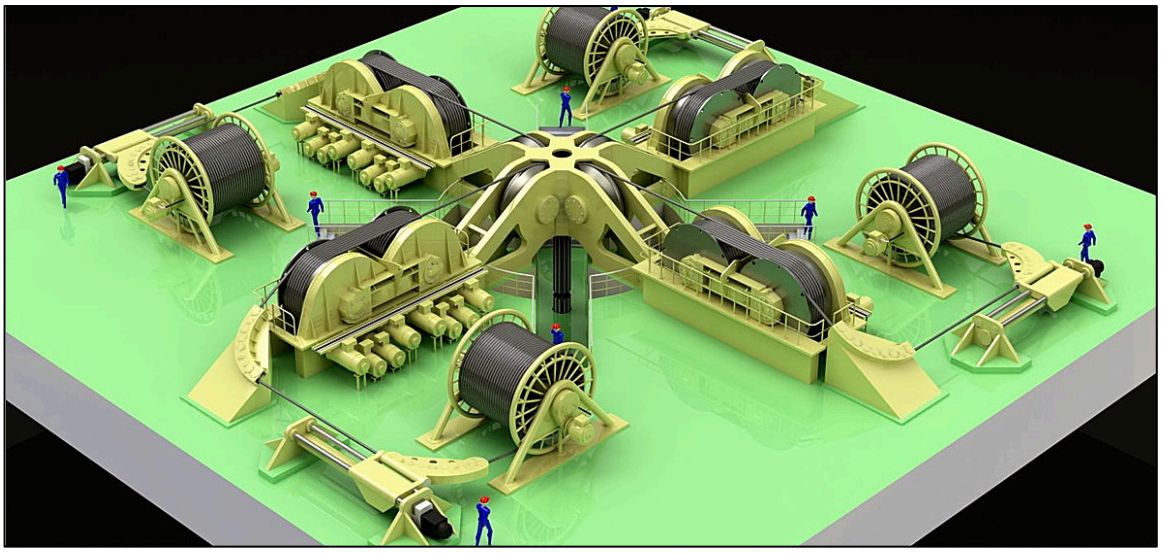


Figure 1: Concept Design (Taken from https://www.energysrs.com).

1.2.4 The ground investigation is required for two reasons:

- To investigate the near surface materials with regard to the foundation design for the facility building;
- To investigate the deposits to bedrock and the characteristics of the shallow bedrock (to depths of about 30 m) in relation to drilling the large diameter borehole to assist with the design of the casings and similar near surface works for large scale drilling.

1.2.5 The findings and conclusions of the risk assessments have been set out and recommendations given for the proposed industrial end use. If there is a subsequent change in the proposed land the risk assessments and conclusions should be reviewed to determine whether they are still applicable for the revised end use.

1.3. Planning Status & Requirements

1.3.1 This report is designed to comply with the requirements of The National Planning Policy Framework (NPPF, 2018) and is intended to be used by the developer as part of the submission to gain planning for the works.

1.4 Scope of the Investigation

1.4.1 The scope of the investigation were to meet the requirements to provide information for planning purposes and for design of the development. The specific activities carried out are as follows:

- carry out an intrusive investigation comprising of two rotary boreholes and machine excavated trial pits with associated sampling;
- ground gas and groundwater monitoring;
- laboratory testing for potential contaminants and geotechnical purposes;
- assess the general nature and extent of contamination at the site and carry out a contamination risk assessment to determine if the site poses a risk to potential receptors;
- to monitor the ground gas conditions at the site and undertake a ground gas risk assessment;
- should the investigation indicate that remediation of contaminants be required, provide recommendations of feasible remedial measures to facilitate development of the site for residential end use;
- provide preliminary geotechnical information on the ground conditions for foundation and floor slab design.

1.5. Previous Investigations

1.5.1 Three reports on previous investigations and other relevant information has been provided by the Client for the site. The available reports are:

- RSK October 2010: Contamination, Slope Stability and Settlement Assessment Report: Peaks Nook Landfill. Reference 320430_R01
- GEG August 2015: Phase II Geo-Environmental Assessment: Land at Peaks Nook Landfill, Manchester Road, Carrington M31 4QN. Reference GEG-15-387-PII.
- RPS August 2016: Desk Study and Preliminary Risk Assessment: Area West of Manchester Road, Carrington, Greater Manchester. Reference JER6922.

1.5.2 TerraConsult has carried out a Phase 1 desk study for this development which includes a review of these earlier reports: Project Genssis, Carrington - Phase 1 Site Investigation Report No 4133/01-1 of 5th October 2018.

1.5.3 The reports by RSK and GEG are for a site located adjacent to the south of the current area of investigation, approximately 40m away. The RSK report was for the purposes of designing four conductor pipes to be drilled into the underlying Coal Measures strata, for coal bed methane extraction. The GEG report states that the proposed development is for a standby gas powered electricity generation facility.

1.5.4 The report by RPS includes Groundsure information and covers the proposed development site. The report was written for the purposes of designing a Short Term Operating Reserve (STOR) Electricity Peaking Plant. A location plan of the existing information is provided in Figure 2.

1.5.5 The site immediately south of the current proposed development area (and the subject of the RSK and GEG reports) has since been developed, sometime after the RPS report of 2016.

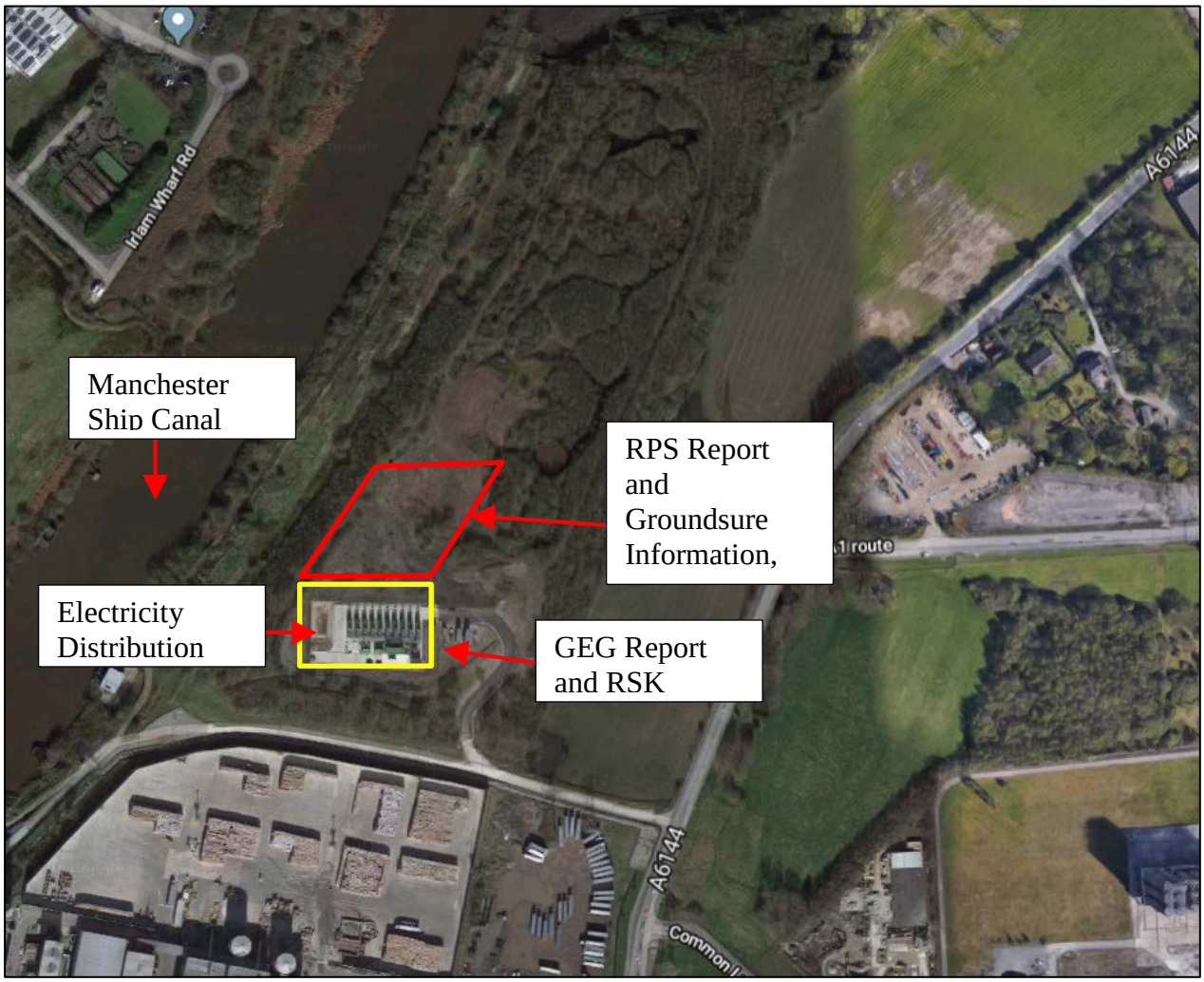


Figure 2: Location of Existing Information

2. SITE LOCATION AND DESCRIPTION

2.1 Site Location

2.1.1 The site is indicated in Figure 3, below, and the site location is summarised in Table 1:

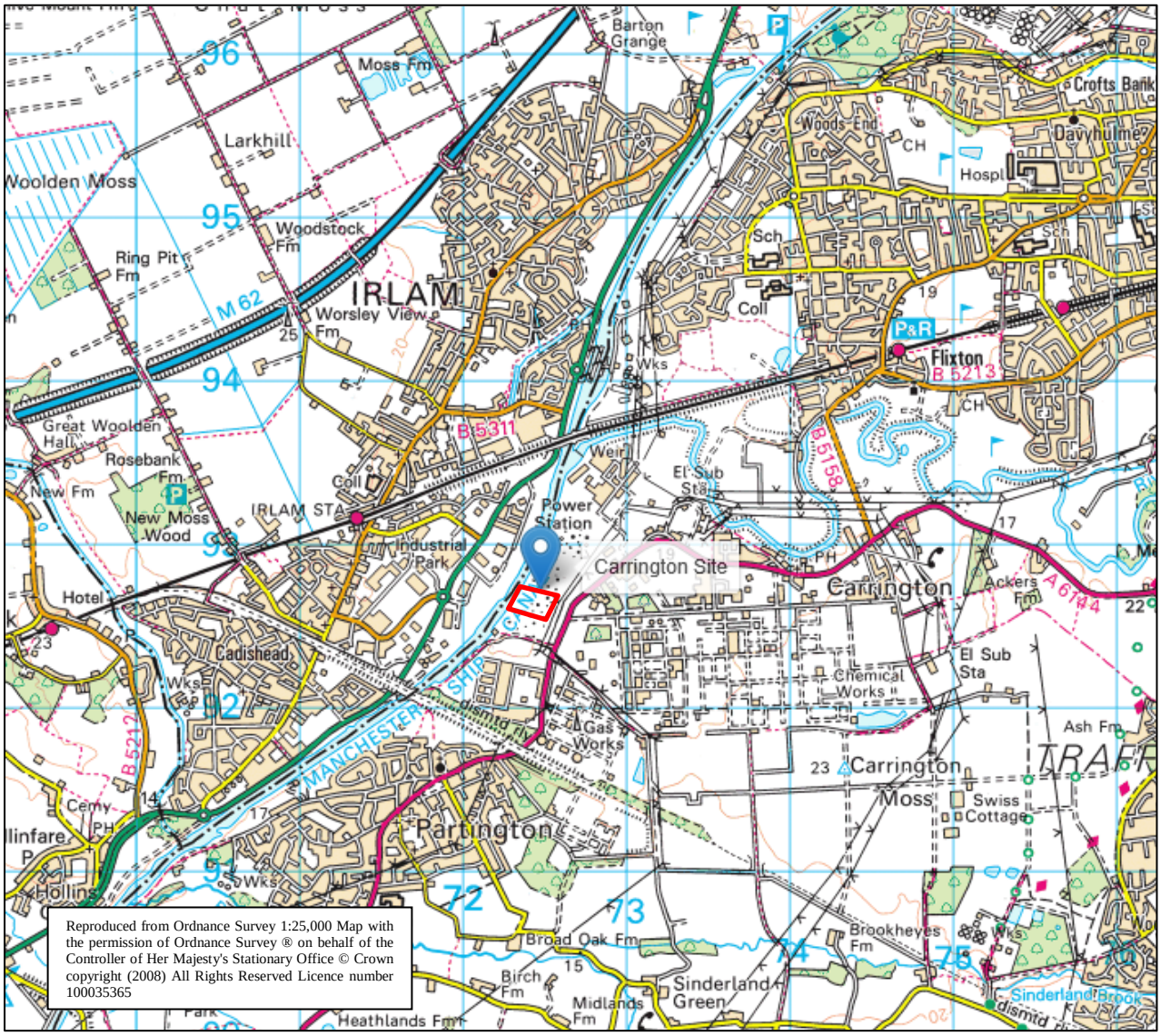


Figure 3: Site Location

Table 1: Summary of Site Location	
Location	Approximately 2.7 km southwest of Flixton Railway Station in Carrington, South Manchester, between the A6144 Manchester Road and the Manchester Ship Canal.
Grid Reference	SJ 723 925
Post Code	M31 4QN
Site Area	1.0 ha (approx.)
Site Shape	The site has maximum plan dimensions of around 150m by 60m and is roughly rectangular in shape.
Topography	The elevation is at approximately 26 mOD.

2.2 Site Description

2.2.1 A site visit was undertaken on 13th September 2018. Photographs of the site are presented in Appendix C.

Table 2: Summary of Description of the Site and its Environs	
Current Use:	Not currently occupied. Open land.
Access	Via access road adjacent to Manchester Road (A6144) (north of Saica Paper UK)
Existing Buildings& Structures	No current buildings or structures on site.
Site Surface	Rough vegetation overlying gravel and clay sub-soil. Slight surface depression located in the northern/central area, which was dry during site visit.
Vegetation	Generally long field vegetation.
Storage Tanks	Below Ground Tanks: No evidence/none suspected. Above Ground Tanks: None present.
Services	No services noted
Asbestos	No potential Asbestos Containing Materials (ACMs) noted on the ground surface. However the landfill does contain ACM materials thought to be between 2.4 and 3.7 m bgl.
Waste Disposal/ Materials Storage	No storage of waste material currently on site.
Surrounding Area	Area is surrounded by open grass and woodland of remediated historic landfill. Beyond this to the west is the Manchester Ship Canal and to the east Manchester Road and industrial areas. Immediately along the southern boundary there is the newly constructed Electricity Distribution Site and to the north the Manchester Ship Canal, and industrial areas.
Ecology	There is no evidence of protected burrowing animals (e.g. badgers) or habitats suitable for protected amphibians (e.g. Great Crested Newts). The disused buildings on site could be suitable habitats for bats. Trees are present on the site and these should not be cut down during the nesting season. There is evidence of Japanese Knotweed adjacent to about a 15 m length of the access route to the site (see Photo 5) but there are no invasive plant species noted within the main site perimeter. *These comments on the ecology are for initial preliminary assessment. They are based on the assessment of personnel who are **not** trained ecologists and does **not** constitute a Phase I Habitat Survey or similar.*
Local / Background Knowledge	Site is an historic landfill.

2.3 Site Ownership

2.3.1 The site is understood to be owned by Peel Holdings Ltd.

3. FIELDWORK

3.1 General Observations

3.1.1 The fieldwork was carried out between 25th September and 8th October 2018. TerraConsult personnel were present to supervise all work, describe the ground encountered, carry out in situ testing and decide on the depths and response zones of monitoring wells. A services search was carried out prior to the site work and a CAT scan performed at the location of each exploratory hole location. Fieldwork procedures were undertaken in accordance with the relevant sections of:

- British Drilling Association "Guidance for Safe Intrusive Activities on contaminated or Potentially Contaminated Land" (2008);
- BS5930:2015 "Code of Practice for Site Investigations;"
- BS10175:2011 + A2:2017 "Investigation of potentially contaminated sites – Code of practice."

3.1.2 The investigation comprised the following fieldwork scope:

- 2 No. rotary boreholes carried out using a truck mounted drilling rig using open hole and rotary coring drilling methods with water flush;
- 12 No. trial pits using a wheeled hydraulic excavator;
- Installation of 2 No. Gas and groundwater monitoring wells (all 51 mm internal diameter HDPE with slotted sections having a 250 µm geotextile filter wrap);
- Sampling and testing of soils and groundwaters;
- Description of the ground encountered in accordance with BS5930:2015 "Code of Practice for Site Investigations;"
- Gas and groundwater monitoring.

3.1.3 Note that all personnel were wearing appropriate PPE and RPF for the investigation works in the landfill given the anticipated risks of encountering asbestos and other contaminants.

3.1.4 A summary of the exploratory holes are given below:

Table 3: Summary of Exploratory Hole Information

Location ID	Date Start	Date End	Easting	Northing	Ground Level	Final Depth	Termination Reason
BH18-01	02/10/2018	08/10/2018	372390.24	392537.57	25.97	31.00	Target depth reached
BH18-02A	25/09/2018	01/10/2018	372366.47	392530.15	25.93	31.00	Target depth reached
TP18-01	02/10/2018	26/09/2018	372460.79	392505.67	26.60	2.40	Refusal
TP18-02	26/09/2018	26/09/2018	372444.08	392524.65	27.11	3.00	Refusal
TP18-03	26/09/2018	26/09/2018	372405.55	392512.25	26.02	3.00	Refusal
TP18-04	27/09/2018	27/09/2018	372422.77	392562.19	26.09	3.20	Target depth reached
TP18-05	01/10/2018	01/10/2018	372402.81	392533.08	26.23	3.20	Refusal
TP18-06	01/10/2018	01/10/2018	372384.59	392573.89	24.04	3.50	Target depth reached
TP18-07	27/09/2018	27/09/2018	372380.25	392513.38	26.00	3.20	Refusal
TP18-08	27/09/2018	27/09/2018	372373.53	392548.95	26.07	2.10	ACM encountered
TP18-09	27/09/2018	27/09/2018	372360.71	392573.61	26.31	2.00	ACM encountered
TP18-10	27/09/2018	27/09/2018	372353.23	392547.71	26.10	3.20	Refusal
TP18-11	27/09/2018	27/09/2018	372341.87	392516.05	25.78	2.20	ACM encountered
TP18-12	27/09/2018	27/09/2018	372332.08	392539.97	26.00	3.00	Refusal/ACM

Note ACM = Asbestos Containing Materials

3.2 Trial Pits (and Trenches)

3.2.1 Twelve trial pits were excavated using an 8 tonne wheeled hydraulic excavator across the site to depths of between 2.0 (TP18-09) and 3.5 mbgl (TP18-06). Three trial pits TP18-8, TP18-09 and TP18-11 were abandoned at 2.00m to 2.20 m due to encountering asbestos containing materials including material within red bagged material with asbestos warning.

3.2.2 The trial pit logs and photographs are presented in Appendix D, please note no pictures of the three abandoned trial pits, mentioned above, were taken due to asbestos concerns.

3.3 Rotary Boreholes

3.3.1 Two rotary open holes (BH18-01 to BH18-02A) were completed to maximum depths of 31.00 m, using a Comacchio 405 rig. The holes were commenced using auger methods, to 10.0 m though the Made Ground, followed by a duplex drill-and-case system through the drift deposits which produced a 140 mm fully cased hole. The drilling in the bedrock carried out using a down-the-hole hammer using air-mist flush to produce a 125 mm diameter hole.

3.3.2 BH18-01 was installed with 31.00 m of 19 mm diameter piezometer with a response zone at 30.50 - 31.00 mbgl. This was duel installed with a 51 mm diameter standpipe to 13.00

mbgl with the response zone set at 10.00 to 13.00 mbgl. The borehole was sealed with bentonite at the base and from 0.50 to 10.00 and 13.00 to 30.50 mbgl.

3.3.3 BH18-02A was installed with a 51 mm diameter standpipe to a depth of 9.00 mbgl with the response zone set at 2.00 to 9.00 mbgl. The hole was sealed with bentonite at the base and from 0.50 to 2.00 mbgl.

3.3.4 The response zones were lined with filter gravels and the top 0.50 m of each hole was filled with gravel for drainage and capped with a raised cover sealed in place with concrete.

3.4 CBR Tests

3.4.1 Eight in situ plate bearing tests were carried out in accordance with BS 1377: Part 9: 1990 and IAN 73/06 rev.1 to provide the Modulus of Subgrade Reaction and CBR value of the ground. The plate bearing tests were undertaken in cohesive Made Ground at 0.30m. The results of the plate bearing tests are presented in Appendix F.

Table 4: Summary of CBR tests

Location	Test Date	Ground Level (mOD)	Test Depth (m)	Kentledge
TP18-03	01/10/2018	26.02	0.30	8T JCB 3CX
TP18-04	01/10/2018	26.09	0.30	8T JCB 3CX
TP18-05	01/10/2018	26.23	0.30	8T JCB 3CX
TP18-07	01/10/2018	26.00	0.30	8T JCB 3CX
TP18-08	01/10/2018	26.07	0.30	8T JCB 3CX
TP18-09	01/10/2018	26.31	0.30	8T JCB 3CX
TP18-10	01/10/2018	26.10	0.30	8T JCB 3CX
TP18-12	01/10/2018	26.00	0.30	8T JCB 3CX

3.5 Insitu Air Monitoring

3.5.1 Insitu air monitoring was carried out during the fieldwork by asbestos monitoring specialists Nichol Associates Limited. The results of the monitoring were presented in Appendix F.

3.5.2 Airborne fibre concentrations have been recorded on four separate occasional during the fieldworks. The monitoring included recording airborne fibres on the 1st Driller, 2nd Driller and at two site locations. A summary is also shown in Section 6.

3.6 Samples and Sample Containers

3.6.1 Soil samples for chemical analysis each comprised a pair of samples: a plastic tub for metals and inorganics, and an amber glass jar for organics.

3.6.2 Prior to taking any water samples, the wells were developed and three well volumes of water were purged from the wells using dedicated disposable bailers (also called a grab sampler). If recharge was relatively slow and not sufficient to allow a purged sample from being taken then a sample was taken of the water during the purging and the volume of purged water was noted.

3.6.3 A range of different sample containers were used for sampling groundwater:

- 1 litre plastic bottles metals and inorganics;
- 1 litre glass bottles for SVOC's
- Amber glass vial for VOC's

3.6.4 Water samples and soil samples for organic analysis were stored in a cool box, with plastic tubs stored in a plastic crate directly to the testing laboratory.

3.7 Monitoring

3.7.1 The Phase 1 desk study has identified the site as high risk gas source and has recommended 12 monitoring visits over 6 months. The monitoring will record groundwater levels and ground gas concentrations. Ground gas monitoring was carried out in accordance with BS8576:2013 and comprised measurement of:

- Landfill gases using a GasData GFM435 infra-red meter to measure gas flow rate, methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide.

3.7.2 The monitoring results to date are presented in Appendix E, together with details of the instrumentation specifications.

3.7.3 It should be noted that no free phase hydrocarbons were encountered in any of the monitoring wells.

3.8 Topographical Survey

3.8.1 The location and level of each exploratory position was surveyed to National Grid Co-ordinates and Ordnance Datum and are shown on the exploratory logs in the Appendix D.

4. LABORATORY TESTING

4.1 Chemical Laboratory Testing

4.1.1 The samples were submitted to ELab in Hastings and DETS in Maidstone who are UKAS accredited in accordance with ISO17025 and are also MCERTS accredited for soil analysis in accordance with the Environment Agency's scheme. The laboratory carries out Quality Assurance and Quality Control in accordance with BS ISO 17025 and participate in external laboratory comparison and quality control schemes. Details of the accreditation and the methods of analysis are provided on the relevant test reports.

4.1.2 The selection of samples for laboratory testing and analytes to be determined were made based on the Phase 1 assessment, the excavation records and other observations during the investigations. The sample selection rational was as follows:

- to gain a good coverage across the site and of the various material types and strata encountered;
- to characterise samples which had visual or olfactory evidence of contamination;
- to characterise samples from the interface of permeable and less permeable horizons within the ground;
- to characterise soils samples located at groundwater level;
- to characterise the groundwater.

4.1.3 The selected soil and groundwater samples were tested for a range of typical contamination indicators including specific tests for contaminants suspected as being present from the desk study and from observations made on site. Tests were also performed which were used to support the modelling of contaminant transport and impacts (e.g. TOC) and for waste classification purposes.

4.1.4 The results of the laboratory analysis are presented in Appendix G. The various suites of analysis for the soil, leachate and water were as follows:

Table 5: Suites of Analysis for Soil and Water Samples

Determinand	Soil Suite 1	Soil Suite 2	Water Suite
Number of Samples	4	10	2
Index Tests			
Asbestos Screen	15 No		-
pH	✓	✓	✓
Metals			
As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn (all totals)	✓	✓	✓
Inorganics			
Ammonium	-	✓	✓
Cyanide - Total	✓	✓	✓
Chloride (2:1 extract on soil samples)	✓	✓	✓
Fluoride (2:1 extract on soil samples)	-	✓	✓
Nitrate (2:1 extract on soil samples)	-	✓	✓
Sulfate (2:1 extract on soil samples)	✓	✓	✓
Organics			
Phenols - Total (monohydric)	✓	✓	✓
Total Organic Carbon (TOC)	✓	✓	-
PAH (Speciated USEPA 16)	✓	✓	✓
TPH (C_8 to C_{36})	✓	✓	✓
Mineral Oil (C_{10} to C_{40})	-	✓	
Benzene, Toluene, Ethyl Benzene, Xylenes (BTEX);	-	✓	✓
Volatile Organic Compounds (VOCs) and Chlorinated Solvents	-	✓	✓
Poly Chlorinated Biphenyls (PCBs)	-	-	-

NOTE

✓ = Test carried out on all samples **= Test required on selected samples only
2. All soil samples to be tested and reported in accordance with EA MCERTS for Soils Scheme
3. In addition to the above, 15 samples were also tested for the presence of Asbestos fibres.

4.2 Geotechnical Laboratory Testing

4.2.1 Samples were submitted to PSL Limited in Doncaster who are UKAS accredited in accordance with ISO17025. The following geotechnical testing was undertaken with the results of this testing presented in Appendix H:

- 6 No. natural moisture contents;
- 3 No. liquid and plastic (Atterberg) limits;
- 1 No. particle size distribution wet sieve analyses, three with pipette analyses;
- 2 No, quick undrained triaxial shear strength tests (70 mm dia specimens);

5. GROUND CONDITIONS

5.1 General

5.1.1 The site investigations have allowed the site specific ground conditions to be described and this information was used to provide an improved conceptual ground model. The geology encountered during the site investigations was generally consistent with that anticipated from the desk study. A summary of the general strata encountered across the site is provided in the Table 6 below, with more detailed description given in the following sub sections.

Table 6: Summary of Strata Encountered

Geological Strata	Maximum Depth Below Ground Level to Base of Strata (m)	Strata Thickness (m)
Topsoil	0.30	0.10 – 0.30
Made Ground (Landfill Waste)	11.50	11.50
Alluvium	19.90	7.20 – 8.40
Glaciofluvial Deposits	23.50	3.60 – 2.80
Glacial Till	26.50	3.00 – 5.00
Wilmslow Sandstone Formation	> 31.00	> 4.50

5.2 Anthropogenic Materials

5.2.1 Landfill was present across the site to depths of 11.50 m. The site is a former landfill, containing highly heterogeneous material.

5.2.2 The fieldwork has shown a general sequence of dark brown gravelly clay (Topsoil) varying in thickness from 0.1m to 0.4m. Below the topsoil the landfill is comprised of clay bound gravel or gravelly clay with low to high cobble contents of brick, concrete, plastic, tarmac, asphalt, wood and metal and locally ACMs. The gravelly clay matrix varies from 0.0% to 50 % of the landfill constituents.

5.2.3 Potential indicators of contamination were observed during the fieldwork as follows:

- TP18-8,9,11 and 12 at 2.0 - 3.0 m: ACM
- TP18-02 at 1.70 m: Clinker
- Olfactory hydrocarbon was noted in all the trial pits. There were thin sporadic hydrocarbon visual pockets / lenses noted within the landfill, however there were no evidence of heavily contaminated zones.
- Hydrocarbon impacted soils were encountered in BH18-01 between 10.0m and 15.0m within the natural alluvial deposits.

5.3 Drift Deposits

Alluvial Deposits

5.3.1 Encountered between a depth of 11.5 & 19.9m (BH18-01) and 11.5 & 18.7m (BH18-02A). Soft becoming firm grey sandy/silty clays with occasional thin lenses of fibrous organic matter and odour. SPT N values range from 10 to 26.

Glaciofluvial Deposits

5.3.2 Underlying the alluvial deposits is medium dense grey brown fine to coarse grained sand ranging from 19.9 to 23.5m (BH18-01) and 18.7 to 21.5m (BH18-02A) with N-values from 24 to >50.

Glacial Till

5.3.3 Firm to stiff reddish brown slightly sandy slightly gravelly clay from 23.5 to 25m in BH18-01 and from 21.5 to 26.5m in BH18-02A.

5.3.4 Underlying the clay is dense to very dense sandy fine to coarse sub-angular, sub-rounded Gravel ranging from 25.0m-26.5m (BH18-01) and 23.5m to 26.5m (BH18-02A).

5.4 Solid Geology

5.4.1 The Wilmslow Sandstone Formation was encountered from 26.50 m proven to 31.0m. The sandstone is highly weathered recovered as a very dense reddish brown fine to medium sand. In BH18-01 from 28.23 m recorded extremely weak fine to medium grained sandstone interbedded within bands of completely weathered sand.

5.5 Groundwater

5.5.1 During the field work groundwater was encountered in TP18-04 and TP18-06 at a depth of 1.2m and 1.50 m respectively.

5.5.2 Post fieldwork groundwater monitoring is ongoing but a summary of results so far is displayed below in Table 7.

Table 7: Summary of Groundwater Monitoring

Borehole	Date	Response Zone mbgl.	Water Level mbgl.	Stratum
BH18-01 (Deep)	19/10/2018	30.00 – 30.50	15.63	Sandstone
	22/10/2018		15.74	
BH18-01	19/10/2018	10.00 - 13.00	8.06	Alluvium
	22/10/2018		8.55	
BH18-02A	19/10/2018	2.00 – 9.00	3.25	Landfill
	22/10/2018		3.40	

6. GENERIC QUANTITATIVE RISK ASSESSMENT

6.1 Introduction

6.1.1 The assessment of contamination has been carried out in accordance with the overall guidance presented in CLR11 Model Procedures for the Management of Land Contamination using the procedures as indicated in Appendix B.

6.1.2 Generic risk assessment is a two stage process. Firstly, in the Risk Estimation stage, the measured contaminant concentrations are compared to the relevant GACs or C4SLs/S4ULs where they have been published. Where there is a suitable dataset, this is done after carrying out statistical analysis to determine the upper confidence limit on the true mean. Otherwise, maximum or specific data points are compared directly. The second stage, Risk Evaluation, comprises an authoritative review of the findings with other pertinent information, in cases where the C4SLs or GACs are exceeded, in order to consider if exceedance may be acceptable in the particular circumstances.

6.1.3 The aspects of risk from substances in the ground considered below are as follows:

- human health;
- plant life;
- pollution of Controlled Waters;
- water supply pipes
- below ground concrete; and
- ground gases.

6.2 Assessment for the Protection of Human Health

6.2.1 The Generic Qualitative Risk Assessment (GQRA) is based on a soil with a Soil Organic Matter of 1% was carried in accordance with the methodology for assessing soil samples set out in Appendix B based on a commercial end use. A full summary of the chemical test results is presented in Appendix I. Exceedance of applicable Generic Assessment Criteria (GAC) threshold concentrations are indicated in yellow. A discussion on the various exceedances is presented below.

Metals

6.2.2 There were no samples with metals concentrations higher than the SGV/GAC or pC4SL/S4ULs thresholds.

PAHs

6.2.3 Fourteen samples were analysed for speciated PAH. Two samples exceeded the GAC (14mg/kg) for benzo(a)pyrene for commercial/industrial landuse. TP18-03 (1.20 m) and TP18-10 (1.70 m) had concentrations of 25.4 and 25.9 mg/kg respectively. The same two samples exceeded the LQM/CIEH threshold for Dibenzo(ah)anthracene.

6.2.4 The two samples exceeding the GAC threshold for benzo(a)pyrene have been compared to pC4SL. Both samples do not exceed the pC4SL threshold of 77mg/kg.

6.2.5 For the remaining PAH contaminants there were no exceedances of SGV/GAC or pC4SL/S4UL thresholds for any of the samples taken.

Petroleum Hydrocarbons (PHC)

6.2.6 TP18-08 recorded Total (>C_5-C_{40}) Aliphatic and Aromatic of 6,240 mg/kg. The majority of the TPH were between C_{21}-C_{44}. No samples exceeded the relevant GAC for commercial landuse.

6.2.7 No BTEX compounds were detected above the laboratory limit of detection in any of the twelve samples analysed; except for benzene in BH18-02A at 5.0 m which exceeded the detection limit of 0.01 mg/kg by 0.0003 mg/kg. Therefore the applicable GACs were not exceeded and comparison to pC4SL is not necessary.

Asbestos

6.2.8 The Phase 1 desk study identified that Asbestos Containing Materials (ACMs) had been encountered on the site during a previous investigation.

6.2.9 Airborne fibre concentrations have been recorded on four separate occasional during the field. The monitoring included recording airborne fibres on the 1st Driller, 2nd Driller and at two site locations.

Table 8: Asbestos air monitoring at BH18-02A (personal and general) carried out by Nichol Associates Limited

Date	Location	Time started	Time Stopped	Number of fibres detected	Calculated concentration f/ml
25/09/2018	Excavation site AQ000475	10:14	11:14	1	0.0005
	Excavation site AQ000476	10:15	11:15	0	0.0000
	Kieron Blackwell	11:00	12:00	1	0.0041
	Paul Stanesby	11:01	12:01	2	0.0083
26/09/2018	Excavation site AQ000480	10:00	12:00	0	0.0000
	Excavation site AQ000481	10:01	12:01	1	0.0005
	Kieron Blackwell	09:59	11:59	1	0.0020
	Paul Stanesby	09:58	11:58	1	0.0020
27/09/2018	Excavation site AQ000485	09:49	11:49	1	0.0005
	Excavation site AQ000486	09:50	11:50	0	0.0000
	Kieron Blackwell	10:15	12:15	2	0.0020
	Paul Stanesby	10:14	12:14	2	0.0020
28/09/2018	Excavation site AQ000490	09:24	11:24	1	0.0005
	Excavation site AQ0004891	09:25	11:25	0	0.0000
	Kieron Blackwell	10:00	12:00	0	0.0000
	Paul Stanesby	09:59	11:59	0	0.0000

6.2.10 Nichol Associates Limited stated that all the site air monitoring results were satisfactory.

6.2.11 Asbestos can be present in soil as fragments of bulk Asbestos Containing Materials (ACMs) (e.g. asbestos cement sheeting) and also as discrete asbestos fibres within the soil matrix. This investigation has carried out assessments to determine whether both bulk fragments of asbestos and discrete fibres are present in the soil at the site. The asbestos assessment commenced on site with inspection of the Made Ground by our site staff for the presence of bulk ACMs.

6.2.12 During the fieldwork four of the trial pits (TP18-8, 09, 11 and 12) and BH18-02A showed visual evidence for the presence of bulk ACMs. Red bags labelled 'hazard asbestos' were recovered in TP18-09 at approximately 1.5 to 2.0 m. White fibrous tiles and red bag fragments were recovered in TP18-08, 11 and 12 at depths of 2.1 to 3.0 m. BH18-02A recovered red plastic bags entangled within the drill bit whilst drilling through the made ground at approximately 2.5 m.

6.2.13 Two different types of laboratory assessments were carried out in order to confirm the site assessment that ACMs were present:

- 15 samples underwent laboratory assessment to determine whether asbestos fibres or ACMs are present. Asbestos fibres were found in three of the samples (20% of samples tested) - note that the laboratory quantification limit for these samples is 0.001%.
- Where asbestos was found to be present in a sample then full asbestos quantification and composition analysis was carried out.

6.2.14 The laboratory analysis confirmed that the following three samples contained asbestos fibres:

- TP18-10 (3.20 m) contained amosite fibre bundles and had total asbestos content of 0.002%
- TP18-05 (1.20 m) contained chrysotile fibre bundles and had a total asbestos content of 0.002%.
- BH18-02A (4.0 m) contained a chrysotile cement fragment giving it a total asbestos content of 0.588%.

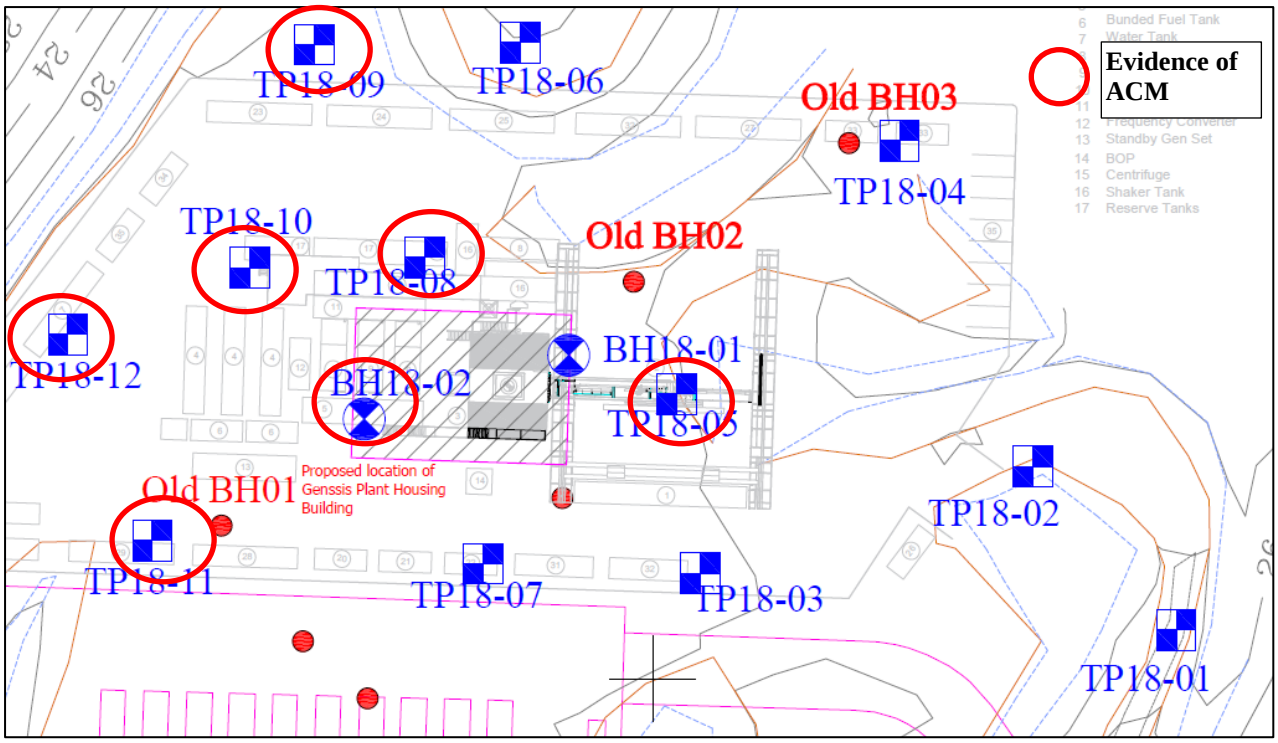


Figure 4: Plan showing exploratory holes that encountered ACM

6.2.15 The fieldwork and analysis of the landfill material have shown that there is a risk from ACM within the soils as well as red bagged asbestos. Seven of the fourteen exploratory holes encountered some type of ACM (red bagged ACM or ACM in soil). It is likely that ACMs will be locally present across a range of depths within the landfill. The quantification results reinforce that asbestos will be present throughout the landfill. Any future redevelopment of the site will need to take this into consideration, especially with regards to possible piling (and the arisings that would be a result of it) as well as health and safety issues regarding asbestos becoming airborne during any significant earthworks / cut and fill exercises that may be required.

6.2.16 Currently there is little to no capping material on the site. It is likely that after redeveloping the site there will be a significant amount of hardstanding and clean cover in its final design, and the isolated presence of asbestos at that the site will not pose a significant risk to end users.

Summary of Risk to Human Health

6.2.17 Generic Qualitative Assessment Criteria have been used where appropriate to assess the risk to potential end-uses based on the currently proposed commercial/industrial end use for the redevelopment. The assessment of the samples tested indicates that the landfill materials do not pose a significant risk to human health for a commercial end use, except for the presence of ACM. This risk will only be present during the groundworks stage of the construction and not during the use of the site.

6.2.18 The principal risk to human health is from asbestos during groundworks but the risk from this can be appropriately controlled by implementing an Asbestos Working Plan in accordance with the Control of Asbestos Regulations 2012.

6.2.19 Due to the recorded ground gas conditions there is a potential risk during the re-development works for personnel entering excavations. Entry into all below ground excavations should be carried out in accordance with The Confined Spaces Regulations (1997) and The Management of Health and Safety Regulations (1999).

6.2.20 It is recommended that the appointed Contractor consult with the Local Authority Air Quality Officer to determine whether a programme of asbestos and nuisance dust monitoring is required for the duration of the works.

6.3 Risk to Plant Life

6.3.1 Concentrations of the phytotoxic metals zinc, copper and nickel have been recorded in Landfill in excess of the guideline values for the protection of plants as presented in the MAFF document "Code of Good agricultural practice for the protection of soil"(1998). The results of the phytotoxic screening are presented in the tables below. It is acknowledged that the MAFF guidelines are based on the averaging area pH value, and that some pHs at the site have been recorded at significantly higher values than these.

Table 9: Phytotoxic Risk of Landfill

Determinand	Number of samples	Trigger Value* (mg/kg)	Results Exceeding Trigger Concentration (mg/kg)	Exceeds Tier 1 Screening (Y/N)
Copper	14	200	-	N
Chromium	14	400	-	N
Nickel	14	110	-	N
Zinc	14	300	One sample only 519 TP18-07 @ 1.0 m	Y

***Trigger value from MAFF "Code of Good agricultural practice for the protection of soil" October 1998 at average pH 7.0**

6.3.2 Within the Landfill material, a single zinc concentration is elevated with regards to the phototoxic risk they could present (but not above commercial/industrial GAC or C4SL concentrations). Detriment to plant life is hard to quantify as many of the GACs are based on agricultural crop yields rather than serious harm of death of a species. As the vegetation at surface across the site appears to be in good condition, the effects of these elevated concentrations do not appear to have a detrimental effect on surface vegetation on the landfill, at least not at the time of the site investigation. This may not be the case throughout the year, and any discolouration or poor growth may be noted, if present, during the subsequent years' worth of monitoring that is being undertaken at the site and will be reported in a future report. It is possible that some effects on the surrounding vegetation may be being caused, however this is beyond the scope of the work within this report.

6.3.3 If any future proposed redevelopment at the site which may require planting of some description, then further consideration is required with regards to risk to plants will need to be required. Especially with regards to trees and other plants which require deep root systems. It may be necessary to utilise soft cover systems or barriers or raised bedding o reduce the possibility for detrimental impacts on plant life / end users.

6.4 Assessment for the Protection of Controlled Waters

6.4.1 The risks to controlled waters (groundwater and surface waters) from contaminants on-site have been assessed in accordance with the EA documents "The Environment Agency's Approach to Groundwater Protection" (2017) and Remedial Targets Methodology (RTM, 2006). Pollutant inputs from contaminated land sites are considered as passive inputs under the European Water Framework Directive (2000/60/EC) (WFD) and its daughter Directives, and as such are regulated under the Agency's 'limit' pollution objective. Acceptable water quality targets (WQT) are defined for protection of human health (based on Drinking Water Standards (DWS)) and for protection of aquatic ecosystems (Environmental Quality Standards (EQS)).

6.4.2 The results of the remedial targets methodology assessment are presented in Appendix J and are summarised in the following Table.

Table 10: Summary of Exceedances of Generic Assessment Criteria for Controlled Waters

Chemical of Potential Concern	Water Quality Target (µg/l)	Basis for Water Quality Target	BH18-01. (µg/l) (Alluvium)	BH18-02A. (µg/l) (Landfill)	No. Samples Exceeding Target
pH	-	-	6.6	8.5	-
Calcium	250	DWS	**29,400**	**91,100**	2
Magnesium	50	DWS	**5,770**	**9,580**	2
Total Cyanide	5	EQS	**25**	**7**	2
Benzo[b]fluoranthene	0.03	EQS	**0.11**	**1.3**	2
Benzo[k]fluoranthene	0.03	EQS	**0.14**	**1.68**	2
Benzo[a]pyrene	0.01	DWS	**0.16**	**2.03**	2
Aliphatic (C_5 - C_{40})	10	DWS	**14.7**	**283**	2
Aromatic (C_5 - C_{40})	10	DWS	< 5.0	**682**	1
Total TPH (C_{10}-C_{40})	10	DWS	**172**	**3920**	2
Chloroform	2.5	EQS	**12**	< 1	1

6.4.3 Two samples were taken from the monitoring wells, one installed within the landfill and one from the monitoring well installed within alluvial clay deposits, which showed hydrocarbon impact during the fieldwork.

6.4.4 In general elevated and exceedances of the UK DWS for some of the major metal cations (magnesium, potassium) were noted within both the landfill and alluvial deposits.

Groundwater within Landfill Materials

6.4.5 BH18-02A was analysed from groundwater within landfill materials. Exceedances against EQS and DWS for Calcium, Total Cyanide, PAHs and TPHs were noted. No VOC compounds were present above detection limits.

6.4.6 It should be noted that the EQS values for Benzo[a]pyrene, Benzo[b]fluoranthene and Benzo[k]fluoranthene are very conservative. The results from the BH18-02A have exceed by a factor of 100.

Groundwater within Alluvium

6.4.7 During the fieldwork BH18-01, hydrocarbon impact was noted within Alluvium deposits (silty clays) from 10.0m to 15.0m. A monitoring well was installed within this zone. The groundwater has been analysed and have shown lower concentrations of TPH than recorded within the landfill, but the results do exceed the DWS.

6.4.8 The results also show exceedances against EQS and DWS for Calcium, Total Cyanide and PAHs were noted. Chloroform was the only VOC compound recorded above detection limits.

Discussion

6.4.9 The data indicates that relevant water quality targets are exceeded, for landfill groundwaters and groundwaters within the alluvium. As expected from the age of the un-lined landfill, the exploratory boreholes did not encounter any lining material or distinct clay lining / layer below the landfill material at the site. It is likely that any groundwater identified within the landfill as perched water, is in hydraulic continuity with the underlying alluvium deposits below the site. Underlying the alluvium is stiff glacial clay which is likely to form natural attenuation.

6.4.10 It should also be noted that the groundwaters are not abstracted for drinking water purposes within 1km of the site and the site lies further than 2km from any Source Protection Zones (SPZs), so in terms of risk to human health and a direct pathway to human drinking water supplies, the risk level is low.

6.4.11 The proposed construction will comprise a floor slab and external hard standing with new drainage which will reduce the infiltration of rainfall into the site in future.

6.4.12 Due to the presence of low permeability alluvium and Glacial Till, it is considered that it is unlikely that there is currently a significant risk is posed to controlled groundwater within the bedrock aquifer. However, the drilling of large diameter wells through the base of the landfill potentially creates a new and much larger pathway for the migration of contaminants into the Principal Aquifer. The well design will have to consider ways to prevent migration of landfill leachate.

6.4.13 TerraConsult recommends that discussion with the Environment Agency is entered into at the earliest opportunity.

6.5 Water Supply Pipe Material Assessment

6.5.1 Plastic pipe materials are potentially vulnerable to attack from elevated levels of hydrocarbons, which can potentially lead to contamination of potable water supplies and water supply companies also require the risk to their workers from other contaminants in the ground to be assessed. The assessment has been completed in accordance with the current UK Guidance for the Specification of Water Supply Pipes to be used in Brownfield Sites (UK Water Industry Research Ltd. UKWIR, 2014) together with

guidance from United Utilities. This guidance provides threshold concentrations for different pipe material for various chemical groups.

6.5.2 The pipeline materials considered by the guidance are PE, PVC, wrapped steel, wrapped ductile iron or copper pipe and barrier pipe. PE are assessed using threshold concentrations for various chemical groups including volatile organic compounds (VOC) with tentatively identified compounds (TICs), semi-volatile organic compounds (SVOC) with TICs, mineral oils, aldehydes, ketones etc. Wrapped steel, wrapped ductile iron and copper pipe are assessed using corrosive properties. The default recommendation for water supply pipes is to use PE with other types of pipework only used if the limits for PE pipes are exceeded. When assessing the ground for water supply pipes the suite of potential contaminants to be tested only needs to be those contaminants that are potentially present on site based on the desk study.

6.5.3 A detailed assessment has not been undertaken at this stage, however based on the concentrations (particularly TPH) and the presence of asbestos containing Materials (ACM) within the landfill materials; it is unlikely that standard PE pipework will be accepted by without remediation. It is recommended that if a redevelopment for the site is moved forward, then discussions with United Utilities are undertaken in order to assess the ground for water supply pipes the suite of potential contaminants to be tested. An assessment of the chemical test results may indicate that special consideration of pipe materials for water supply pipes will be required and that all pipes are laid in trenches backfilled with clean sand due to the presence of Asbestos Containing Materials (ACM).

6.6 Chemical Attack on Below Ground Concrete

6.6.1 Below ground concrete structures are potentially at risk in areas of elevated sulphates and where there is low pH. An assessment of the soil and groundwater data (following the protocol established in BRE Special Digest 1, 2005) indicates that ACEC Class AC-1s conditions prevail. Therefore no special precautions are required at the site for the design of concrete in terms of the durability and structural performance.

6.6.2 Gross hydrocarbon contamination can also have an adverse impact on the setting of concrete, which may affect foundation construction and piling. Based on the measured concentrations of hydrocarbons at the site there is no risk of these affecting the setting of concrete.

6.7 Permanent Ground Gases

Measured Gas Concentrations

6.7.1 Two round of gas monitoring (proposed 12 No over 6 months) have been carried out to date by TerraConsult in new monitoring wells and existing monitoring wells. The highest flow rates, methane and carbon dioxide concentrations, together with the lowest oxygen levels (i.e. a combination of the worst case temporal conditions recorded) from the monitoring visits are summarised in the table below:

Table 11: Summary of Ground Gas Monitoring

Borehole	Response Zone mbgl		No. of monitoring occasions	Steady State Flow (l/hr)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (% v/v)	Carbon Monoxide (ppm)	Hydrogen sulphide (ppm)	Water Level mbgl	Atmospheric pressure readings mb
BH18-01	10.0 -13.0	Alluvium	2	0.6-0.1	0.1 – 2.4	0.1 – 0.3	18.4	1	1	8.06-8.71	1013-1038
BH18-02A	2.0 – 9.0	Landfill	3	0.3	**12.4 – 13.1**	1.5 – 1.6	**0.1**	1	1	3.25-3.50	1013-1038
BH02 GEG (2015)	1.0 - 9.0	Landfill	3	0.1-1.6	**6.4-48.3**	2.5-3.2	**0.1 – 8.3**	1	1	7.43-7.86	1013-1038
OLDBH02	Base 2.87	-	2	0.1	0.1	2.0 – 1.8	8.5-13.1	1	1	2.16	1013-1021
OLDBH03	Base 4.54	-	2	0.1	0.1 – 1.6	0.9 – 4.9	5.1-16.9	1	1	2.53-2.64	1013-1020

Ground Gas Assessment

6.7.2 Background information relating to the origin and production of landfill and ground gases are presented in Appendix E, together with current guidance on the assessment of ground gases. In accordance with this approach and the above measured ground gas levels, it is considered that the worst case temporal conditions may not have been measured during the monitoring period.

6.7.3 From Table 8.5 of CIRIA C665 the worst case Characteristic Situation of the site are as follows:

Table 12: Characteristic Gas Situations

Borehole Number	Steady State Flow	CH_4			CO_2		
	l/h	% v/v	GSV (l/hr)	Characteristic Situation	% v/v	GSV (l/hr)	Characteristic Situation
BH18-01	0.6	0.1	0.0006	1	0.1	0.0031	1
BH18-02A	0.3	13.1	0.0393	2	1.6	0.0048	1
BH02 GEG (2015)	1.6	48.3	0.7728	3	3.2	0.0496	1
OLDBH02	0.1	0.1	0.0001	1	0.1	0.0001	1
OLDBH03	0.1	1.6	0.0016	1	4.9	0.0049	1

6.7.4 Further monitoring is required for the complete ground gas risk assessment, however a preliminary assessment has been carried out from the results to date. The final gas risk assessment will be presented within a separate report on completion of the gas monitoring.

6.7.5 Based on the Ground Gas Assessment it can be seen that the methane conditions at the site are the main risk driver regarding the gas conditions. The highest GSV has recommended that Characteristic Situation 3 gas protection measures are adopted for the

development in line with BS8485:2015 but a higher level of ground gas protection may be required following further monitoring.

6.7.6 For Characteristic Situation 3 From BS8485:2015 Table 3 the new building can be classed as a Building Type D (large commercial/industrial with full control over any structural alterations) and from Table 4 of this standard a Score of 2.5 points of protection will be required. The standard does not provide set requirements but it provides a menu of different options which in combination can be used to provide an appropriate Score as set out in Table 4 of this standard. An example of appropriate protection measures are:

- Floor Slab:
  - Block and beam ground floor slab – Score 0, or
  - Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement) – Score 0.5; or
  - Cast in situ monolithic reinforced ground-bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations (with only nominal mesh reinforcement– Score 1.0;
- Passive sub floor dispersal layer
  - Very good performance– Score 2.5;
  - Good performance– Score 1.5;
    Media used to provide the dispersal layer are:
    - Clear void
    - Polystyrene void forming blanket
    - Geocomposite void former blanket
    - No-fines gravel layer with gas drains
    - No-fines gravel layer
- gas resistant membrane meeting all of the following criteria – Score 2.0:
  - Sufficiently impervious to gases with a methane gas transmission rate <40.0 ml/day/m^2/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method);
  - Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;
  - Sufficiently strong to withstand in-service stresses (e.g. settlement if placed below a floor slab);
  - Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, dropping tools etc);
  - capable, after installation, of providing a complete barrier to the entry of the relevant gas; and
  - verified in accordance with CIRIA C735.

6.7.7 The gas protection measures should be detailed and installed in accordance with BRE 414 (2001). The Principal Contractor must ensure that the gas membrane is suitably protected from damage by follow on trades.

4.1.1 To reduce the monitoring period, it may be prudent to carry out continuous gas monitoring within monitoring wells. This monitoring is in accordance with the procedures set out in CL:AIRE document RB16 (2017). The monitoring would include:

- Continuous monitoring using GasClam® instrumentation to record at 60 minute intervals for the contracted period of monitoring:

- atmospheric pressure;
- temperature;
- methane (CH_4);
- carbon dioxide (CO_2);
- oxygen (O_2); and
- trace gases including hydrogen sulphide (H_2S) and carbon monoxide (CO).

6.8 Updated Conceptual Site Model

6.8.1 The conceptual site model initially developed from the desk study and walk-over survey has been updated using the findings of the Phase 2 ground investigation.

6.8.2 The site investigation revealed the following general downward succession:

Table 13: Summary of Strata Encountered

Geological Strata	Maximum Depth Below Ground Level to Base of Strata (m)	Strata Thickness (m)
Topsoil	0.30	0.10 – 0.30
Made Ground (Landfill Waste)	11.50	11.50
Alluvium	19.90	7.20 – 8.40
Glaciofluvial Deposits	23.50	3.60 – 2.80
Glacial Till	26.50	3.00 – 5.00
Wilmslow Sandstone Formation	> 31.00	-

6.8.3 The results of site investigation and laboratory analysis indicates that overall there is low concentrations of potential contaminants at the site except for the widespread presence of asbestos containing material on the site. However, with relevant precautions carried out during the construction phase the risks can be appropriately managed. There are no potential off-site sources that will affect the development. Therefore there is a negligible risk to:

(i) human health during use of the site,
(ii) controlled waters,
(iii) property (existing or proposed) including buildings, crops, livestock, pets, woodland and service lines and pipes,
(iv) adjoining land,
(v) ecological systems, and
(vi) archaeological sites and ancient monuments.

6.8.4 Further gas monitoring will be carried out to complete the ground gas assessment. However the results to date indicate that Characteristic Situation 3 gas protection measures are required for the proposed development but a higher ground gas risk level could be encountered during the required monitoring period. The final gas risk

assessment will be presented within a separate report on completion of the gas monitoring.

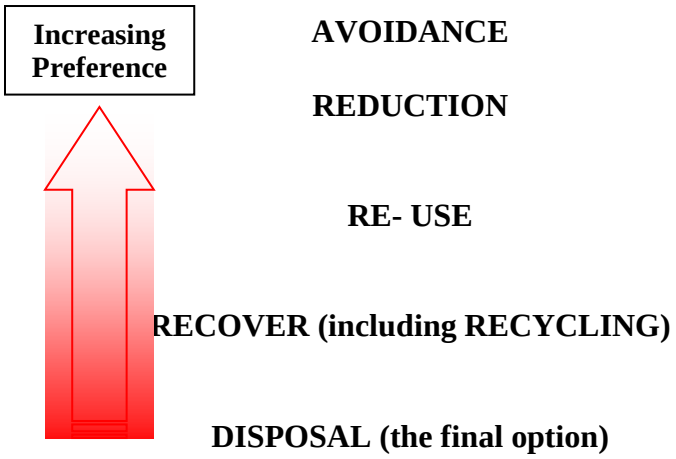
6.8.5 No specific precautions are required with respect to hydrocarbons or the potential risk from radon for the development. Protection measures will also not be required due to the potential risk from radon. All below ground concrete should be designed to meet the requirements of ACEC Class AC-1s.

6.8.6 The risk assessments have concluded that no remediation measures are required to address risks to any potential receptors other than for asbestos in groundworks and for ground gas. However, as with any project on a Brownfield site there is the possibility of encountering unexpected contamination. If this occurs then the procedures set out in Appendix M should be implemented.

7 WASTE ASSESSMENT

7.1 Waste Hierarchy

7.1.1 In accordance with government guidance, it is required that the production and disposal of waste is managed in accordance with the following hierarchy of preference:



7.1.2 As with most developments, there will be waste materials produced from excavations for drainage/services/foundations and at this site excavations into the landfill may be required for SuDS attenuation features. Where possible, the arisings from the clay cap should be incorporated into soft landscaping.

7.1.3 Arisings from excavation into the waste deposits will need to be processed before there is any re-use or before off-site disposal. This material could be processed on site to remove deleterious materials such as plastic, wood, metal and fabrics with the clay and brick/concrete reused on site. It is recommended that that this material will require quantification, separation into a number of waste types on site so as to enable recovery/recycling of materials to minimise off-site disposal along the following lines:

- Metal – recover and sell as scrap.
- Timber – recover and sent to be processed.
- Plastic & polystyrene – send to landfill or preferably waste to energy plant.
- Concrete, tarmac, bricks, gravel and tiles – crush and use as hardcore.
- Asbestos Containing Materials – separate out from landfill and send off-site to landfill as hazardous waste.
- Clay Soils - use in soft landscaping, if these have ‘moderate’ levels of contamination they can be capped with ‘clean’ materials from the site or adjacent area to north.

7.2 Waste Characterisation and Classification

7.2.1 If there is a portion of excess soil this will then have to be sent to a suitable landfill site. A summary of current relatively complex guidance on categorising waste from

earthworks is presented in Appendix N. A two phase approach is required comprising comprises:

- Waste Characterisation; and
- Waste Classification (Waste Acceptance Criteria).

Waste Characterisation

7.2.2 The results of the total concentrations from the chemical testing on soil samples have been assessed to determine whether or not they are hazardous in terms of waste classification.

7.2.3 The results of this assessment show six of the twenty two samples are classified as hazardous:

- TP18-04– 2.20 m bgl; - PAH >100mg/kg
- BH18-02A – 5.0m; - PAH >100mg/kg
- TP18-03 – 1.2m; - PAH >100mg/kg
- TP18-08 – 1.3m; - PAH >100mg/kg & TPH (C_6 - C_{40}) > 1000mg/kg
- TP18-10 – 1.7m; - PAH >100mg/kg
- BH18-02A – Asbestos > 0.1%

7.2.4 In addition to the results above, the locations where red bagged ACM were identified will also classified as hazardous.

Waste Classification

7.2.5 In order to determine whether soils can be sent to a licensed landfill for disposal further testing is required comprising landfill Waste Acceptance Criteria (WAC) analysis for both total concentrations for certain chemicals and for leachate analysis. No WAC testing was carried out as part of this investigation. Should it be proposed to dispose any excess soil at a landfill site then WAC testing will have to be carried out to confirm the landfill waste classification and if any pre-treatment is required.

7.2.6 Note that the above assessment should only be seen as an initial guide. Defining the class of waste is carried out on the actual waste being disposed of and the destination landfill site will have the final decision on acceptability of the waste. Therefore, it is recommended that if soils are to be removed from the site, the appointed contractor should approach a landfill site with the available chemical data and seek a formal waste characterisation.

7.3 Materials Management and Reuse of Arisings On-site

7.3.1 When soil is excavated it is technically a waste and it is the responsibility of the holder of a material to form their own view on whether or not it is waste. This includes determining when waste that has been treated in some way can cease to be classed as waste for a particular purpose. Soils can only be re-used if it fulfils the following requirements:

- There is a planned use for the material;
- There is planning permission for the proposed re-use;
- The material when re-used will not be a risk to flora, fauna or controlled waters;
- Appropriate procedures are followed to demonstrate the above criteria are met and the re-use of materials is recorded in a systematic way and appropriate permissions/permits are gained and relevant procedures followed.

7.3.2 As soil is technically a waste when it has been excavated, it cannot be re-used on site unless one of the following four procedures are implemented:

- the procedures are followed in the CL:AIRE Code of Practice 'The Definition Of Waste: Development Industry Code of Practice' Version 2 (2011).' If these procedures are followed, excavated arisings can be re-used without them being defined as waste "where it is certain that the material will be used for the purposes of construction in its natural state on the site from which it was excavated." However, landfilled materials cannot be re-used under the CL:AIRE protocol unless they are first treated to remove wastes (e.g. plastic, wood, metal and asbestos) and only the gravelly clay and concrete/brick could be re-used under the CL:AIRE protocol. The treatment/segregation of materials would have to be carried out in accordance with an environmental permit (a mobile treatment permit); or
- the site registers a waste exemption with the Environment Agency in accordance with The Environmental Permitting (England and Wales) Regulations 2016 (as amended) so the material can be placed without an Environmental Permit (note that the rules for permit exemptions have been changed and the maximum quantity covered by a permit exemption for re-using soil is 1,000 T), or;
- the site applies for a full Environmental Permit (either a standard rules permit or a bespoke permit) from the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2016 (as amended); or
- WRAP 'Quality Protocol: Aggregates from inert waste.' Only granular aggregates (e.g. Class 1 or Class 6 materials etc. apply, Class 2 materials are not covered by the WRAP Protocol).

7.3.3 The length of time taken for the above regimes also need to be considered:

- CL:AIRE Code of Practice (CoP) takes between 7 and 28 days to gain approval and fees of £40.00 plus £0.01 per m^3 of soil used is payable to CL:AIRE;
- An Environmental Permit exemption typically takes up to 7 days to gain approval and there are no fees due;
- Allow a minimum of 12 weeks to develop a Waste Recovery Plan and gain approval or the Environmental Permit from the Environment Agency and there are significant costs preparing an application and for the fees payable to the Agency (typically in excess of £7,000) for the permit.

- There are no fees to pay for the WRAP Aggregates protocol and there are no notice periods or statutory liaison required.

7.3.4 TerraConsult recommend that the CL:AIRE CoP is implemented for this development and a Materials Management Plan is used for the site to allow the re-use of soils at the site but all wastes (plastic, wood, metal, asbestos etc.) will have to be sent off site to landfill or other permitted waste treatment centre. The treatment/segregation of materials on site should have to be carried out in accordance with an environmental permit (a mobile treatment permit) and two months should be allowed to get agreement from the EA for deployment for this type of mobile permit.

8 GEOTECHNICAL ASSESSMENT & RECOMMENDATIONS

8.1 Fieldwork and Laboratory Data Review

8.1.1 Geotechnical laboratory testing is not complete at the time of this report. The results and findings will be included in the final report.

8.1.2 In general, the sequence below the site comprised.

Table 14: Summary of Strata Encountered

Geological Strata	Maximum Depth Below Ground Level to Base of Strata (m)	Strata Thickness (m)
Topsoil	0.30	0.10 – 0.30
Landfill / Waste	11.50	11.20
Alluvium	19.90	7.20 – 8.40
Glaciofluvial Deposits	23.50	3.60 – 2.80
Glacial Till	26.50	3.00 – 5.00
Wilmslow Sandstone Formation	> 31.00	-

8.1.3 The landfill/waste material was encountered in the majority of the exploratory hole locations across the site. The material was described as brown and a mixture of waste materials within a matrix of clay or sandy clay or ashy clay matrix. The waste materials varied across the site and included brick, concrete, plastic bags, textiles, wire, metal, paper, cardboard, glass, ceramic tiles, timber, roots, tarmac, plastic, fabrics, rubble with the main materials being timber, plastic, brick/concrete, glass and metal.

8.1.4 The landfill material presents a significant geotechnical risk because it will be of variable compressibility, still undergoing self-weight settlement, biological/chemical degradation. No construction can proceed without significant ground improvement and mitigation measures.

8.1.5 SPT N-values were recorded throughout each borehole and are summarised below for the three main strata encountered. The listed N-values have been corrected to the standard Energy Ratio of 60% and are therefore reported below as N_{60} values:

Table 15: Summary of SPT N_{60}-Values					
Hole No	**Test Depth (m)**	**SPT Values**	**SPT N60-Values**	**Stratum**	**Estimated Shear Strength kPa**
BH18-01	11.00	24	30.4	Made Ground	-
	12.50	14	17.7	Alluvium	63
	16.00	15	19.0	Alluvium	68
	19.00	26	32.9	Alluvium	117
	20.50	24	30.4	Glacial Sand	
	26.50	50	>50	Sandstone	
	29.50	50	>50	Sandstone	
	31.00	50	>50	Sandstone	
BH18-02A	11.00	10	12.7	Made Ground	
	13.00	10	12.7	Alluvium	45
	16.00	15	19.0	Alluvium	68
	17.50	12	15.2	Glacial Sand	
	20.50	16	20.3	Glacial Sand	
	23.50	50	>50	Glacial Gravel	
	26.50	50	>50	Sandstone	
	29.50	50	>50	Sandstone	

8.1.6 Classification test were carried out within the alluvium and Glacial Till stratums. The results are summarised below:

Table 16: Summary of Geotechnical Laboratory Classification Testing									
Hole	**Depth (m)**	**Moisture Content (%)**	**% passing 425um sieve**	**Liquid Limit (%)**	**Plastic Limit (%)**	**Plasticity Index**	**Modified Plasticity Index**	**Plasticity**	**Volume Change Potential**
BH18-01	12.00	55							
	14.50	32	100	76	32	44	44.0	Very high CV	High
	16.50	31	100	69	29	40	40.0	High CH	High
	23.50	20							
BH18-02A	12.00	53							
	14.50	31							
	18.25	26							
	22.00	12	93	27	14	13	12.1	Low CL	Low

8.1.7 The classification tests show that the Alluvium has very variable water contents ranging between 55% and 26% and high/very high plasticity and high volume change potential within the alluvial clays. The water contents generally reduces with depth.

8.1.8 The shear strength within the alluvial deposits appear to be highly variable. The triaxial test results range from 121kPa at 14.5m and 56kPa at 16.5m. The shear strength estimated from the SPT N values range from 45 to 117kPa with the upper 2 m of the Alluvium having a lower strength than the lower 6 m of this stratum.

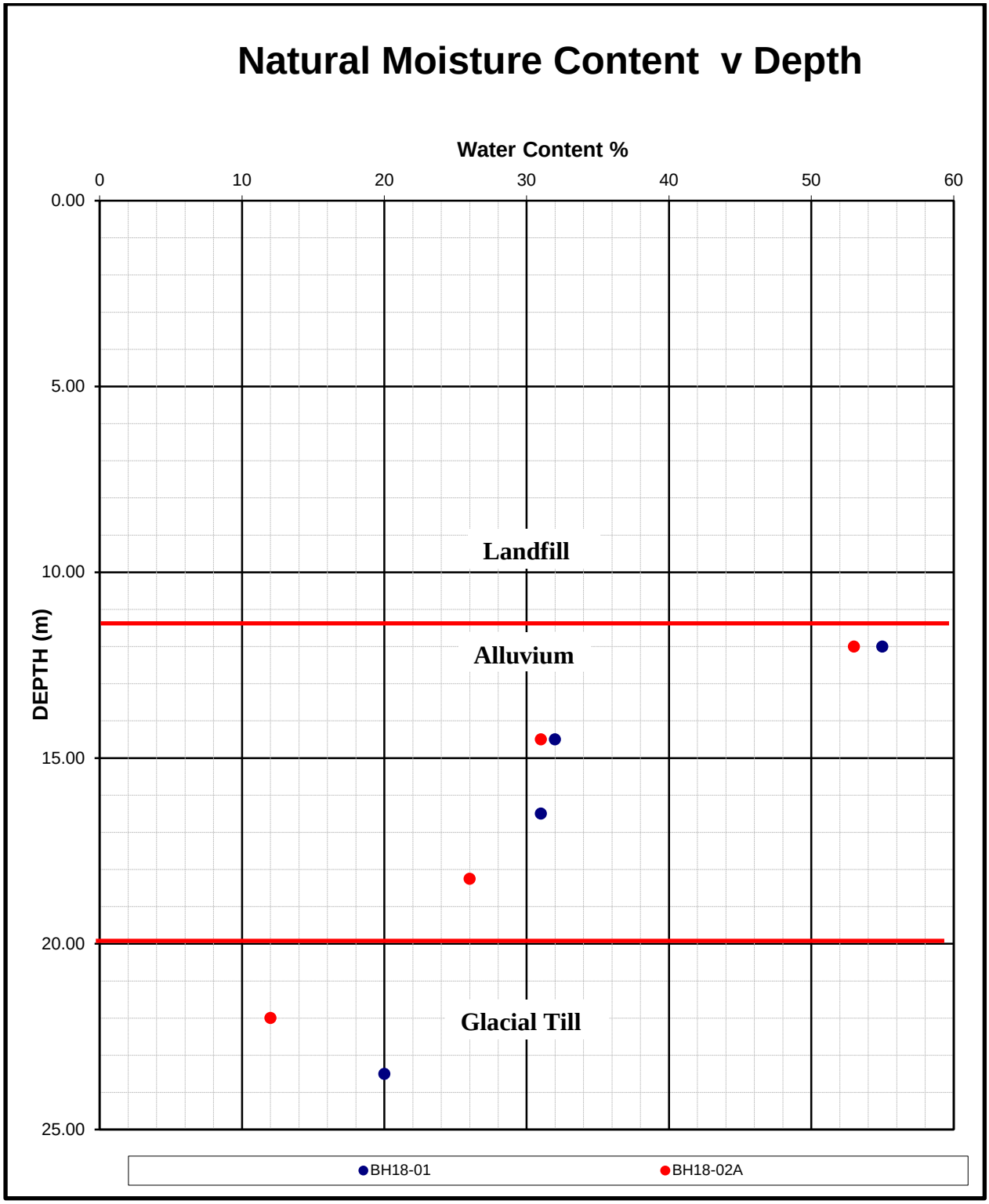


Figure 5: Summary of water content % vs Depth Graph

8.1.9 The Glacial Till shows low plasticity and low volume potential with relatively low moisture content.

8.2 Foundation Recommendations

8.2.1 Due to the nature of the landfill (variability, and compressible nature and the underlying Alluvium Deposits also being of low strength and compressible, shallow foundations will not be suitable for most structures. It is possible that some lightweight structures with a small plan size could be founded on rafts, but this is not advised as these could undergo unacceptable differential settlement. It will be possible for temporary portacabin type buildings to be used at the site, but these should not be double stacked and will need to be periodically re-levelled.

8.2.2 Ground Improvement by Vibro Stone Columns (VSC) is also not considered appropriate for foundations due to the ground conditions at this site.

8.2.3 Therefore it is proposed that all permanent structures will have to be founded on piled foundations. Piles should be designed to penetrate through the landfill and the Alluvium Deposits and extend a suitable depth into the underlying granular glacial deposits or Glacial Till. Consideration could be given to piling into the bedrock but this would need careful assessment to ensure that the piles do not form a pathway for contaminants to migrate into the sandstone principal aquifer.

8.2.4 A specialist piling contractor should be contacted with regards to the selection of appropriate pile design and construction method. Geotechnical information within this report should be provided to give design parameters.

8.2.5 Either bored and cast in situ CFA (continuous flight auger) piles, or driven preformed piling techniques are considered suitable for the ground conditions at the site. Care should be taken for bored and cast in situ piles taken through the landfill, as voids could cause the collapse of the pile shaft before the concrete has set and could lead to 'necking' of the pile. Overall it is TerraConsult's assessment that driven precast concrete or driven tubular steel piles would be best suited to this site. The localised presence of concrete boulders should be noted. The use of driven displacement piles also has the advantage that no potentially contaminated spoil, which could contain asbestos, will be brought to the surface reducing the risk of release of asbestos.

8.2.6 When designing piles appropriate allowance should be made for negative skin friction (down-drag) on the piles due to settlement of the landfill / platform fill and the Alluvium Deposits relative to the piles.

8.2.7 Any piling works undertaken from existing ground levels will require a suitable piling mat/platform constructed in accordance with BRE Report 470 (2004) and given that this will be placed on landfill of variable density and composition a relatively thick or well reinforced platform will be required. A geotextile may be incorporated into the platform to reduce the required thickness and the platform could be designed as part of the engineering fill required for any earthworks to alter final site levels.

Piling and Risk to Groundwater

8.2.8 Piled foundations have the potential to form a pathway for contaminants to migrate between different groundwater bodies. The EA will require that a Piling Risk

Assessment be undertaken prior to piling, taking account of the following Environment Agency documents:

- *"Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention" (Ref: NC/99/73, 2001);*
- *"Piling into contaminated sites" (2002);and*
- *"Piling in Layered Ground: risks to groundwater and archaeology" (SC020074SR,2006).*

8.2.9 Consideration has to be given to piles penetrating through the landfill into the Alluvium Deposits with the pile base in Glacial Till, particularly if the pile base is within the granular glacial deposits at depth. The groundwater levels indicate that there is a vertical hydraulic gradient downwards and there has been some migration of contaminants into the Alluvium Deposits. Given that the Alluvium Deposits are predominantly cohesive and is of high plasticity it is assessed that these strata will remould as they are installed to form a low permeability zone around piles, the installation of piles are unlikely to create a pathway for contaminant migration in the into the ground below the Alluvium Deposits. The remoulding and process of installing the piles will actually make the clay around the pile be of lower permeability than the un-remoulded strata. Similarly the relatively thick upper clay stratum of the Glacial Till is cohesive and is of intermediate to high plasticity. This will again remould as piles are installed to form a low permeability zone around piles. Therefore with all of the holes showing more than 10 m of clay (Alluvium Deposits and Glacial Till) the installation of piles are unlikely to create a pathway for contaminant migration from the landfill to the granular glacial deposits or the bedrock aquifer at depth with the piles being a lower permeability zone compared to the natural existing pathways.

8.2.10 Research undertaken by the Environment Agency 'Piling in Layered Ground: Risks to groundwater and Archaeology' (SCHO0906BLLU-E-P) has explored the sealing potential of clay rich stratum around piles. This work has shown that for displacement piles, cylindrical and square cross sectional piles both seal as well as each other. The research has also shown that well-constructed bored piles will adequately seal if the clay thickness is at least twice the pile diameter.

8.3 Ground Floor Slab Recommendations

8.3.1 It is recommended that piled floor slabs with suspended concrete slabs incorporating appropriate ground gas protection measures are adopted for the buildings.

8.3.2 An alternative which could be considered would be to pile the building foundations and those for the main items of plant e.g. the drill, the winches etc. and to construct a reinforced concrete ground floor slab but allow for on-going maintenance to repair/re-level the slab as settlement occurs. If the concrete floor was constructed with a number of different separate individual slabs with movement joints between the slabs. When settlement occurs these slabs could be re-levelled by pressure grouting below the slabs to bring the individual slabs back to the required profile. The slabs would have cast into them locations for remedial pressure grouting

8.3.3 A third alterative would be to pile the building foundations and those for the main items of plant but have a floor from a reinforced granular hard standing (e.g. using a relatively thick geogrid reinforced sub-base) on which plant can operate. This would be the lowest cost flooring and it would also have the lowest maintenance costs for repairing any settlement.

8.3.4 The latter two alternatives are unconventional and the ground gas protection measures would also have to be considered. If the third option was used then if any offices/welfare areas were constructed on piled slabs and given full gas protection measures then it the rest of the building could be kept appropriately ventilated to prevent any build-up of methane within what is proposed to be a relatively large open area where there is considerable capacity for dilution and dispersion of any ground gases migrating into the building..

8.4 Groundwater & Excavations

8.4.1 Note that perched groundwater was encountered in one of the holes at 3.40 m but the main water table is deeper. Therefore it is not expected that groundwater will be encountered in any excavations at this site other than in piles and the main shaft.

8.4.2 All excavations should be carried out in accordance with CIRIA Report 97 “Trenching Practice” and BS6031: 2009: Code of Practice for Earthworks and the Control of asbestos Regulations (2012).

8.5 Buried Concrete and Pipework

8.5.1 The results of laboratory pH and sulphate content indicate that ACEC Class AC-1s conditions prevail in accordance with BRE Special Digest 1, 2005 (the Design Concrete Class). Therefore no special precautions are required at the site for the design of concrete in terms of the durability and structural performance.

8.6 Pavement Design

8.6.1 The results of in situ CBR tests varied from 3.5 to 110% indicating variable conditions ranging from poor quality ground to well compacted granular strata. However, the landfill material presents a significant geotechnical risk to hard standing because it will be of variable compressibility and that it will still be undergoing self-weight settlement, biological/chemical degradation.

8.6.2 It is recommended that a flexible pavement be used with the design based on a CBR value of 3% and that the sub-base includes at least one layer of high strength geogrid reinforcement in order to minimise the risk from differential settlement and the variable nature of the subgrade. All exposed formations should be proof rolled and any soft spots revealed should be excavated and replaced with suitable compacted granular fill.

9 CONCLUSION

9.1 Ground Profile

9.1.1 The site investigation revealed the following general downward succession:

Topsoil:	0.1 to 0.3 m thick
Landfill:	11.20 m thick
Alluvium:	7.20 – 8.40 m thick
Glaciofluvial Deposits	3.60 – 2.80 m thick
Glacial Till (clay):	3.00 – 5.00 m thick
Bedrock:	Sherwood Sandstone, relatively thick layer of weathered bedrock

9.2 Environmental Risk Assessment

9.2.1 A preliminary risk assessment had previously been carried out by TerraConsult (see Report 4133/01-1) and this was based on the contaminant-pathway-receptor model as defined in Statutory Guidance to Part IIA of the Environment Protection Act, 1990, and in accordance with BS 10175: 2011 +A2 2017 "Investigation of Potentially Contaminated Sites – Code of Practice". In order to make a more detailed assessment of the potential hazards this Phase 2 intrusive investigation was carried out to develop a more comprehensive conceptual ground model of the site. This detailed the characteristic ground conditions and elements of the surrounding environment and has assisted with identifying the potential contaminants of concern, the potential receptors of the contamination and the potential pathways between them.

9.2.2 The risk assessments have concluded that no remediation measures are required to address the long term risks to any potential receptors other than the risk due to ground gas. Only limited gas monitoring has been carried out to date but this indicates that methane conditions at the site are the main risk driver regarding the gas conditions. At this stage it is recommended that Characteristic Situation 3 gas protection measures are adopted for the development in line with BS8485:2015 but a higher level of ground gas protection may be required following further monitoring. A further ten rounds of monitoring is required over the next five months. For Characteristic Situation 3 From BS8485:2015 Table 3 the new building can be classed as a Building Type D and a 'Score of 2.5 points' of protection will be required. The standard does not provide set requirements but it provides a menu of different options which in combination can be used to provide an appropriate Score. Protection measures can be adopted based on a combination of two of: Floor Slab type, sub-floor dispersal system and use of gas resistant membrane. The final gas risk assessment will be presented within a separate report on completion of the gas monitoring.

9.2.3 However, asbestos is present in the landfill and all groundworks will need to take this into consideration. There is a risk from ACM within the soils as well as the presence of red bagged asbestos. Seven of the fourteen exploratory holes encountered some type of ACM (red bagged ACM or ACM in soil). It is likely that ACMs will be locally present across a range of depths within the landfill. The quantification results reinforce that

asbestos will be present throughout the landfill. Any future redevelopment of the site will need to take this into consideration including possible piling (and the arisings that would be a result of it) as well as health and safety issues regarding asbestos becoming airborne during any significant earthworks / cut and fill exercises that may be required.

9.2.4 The risk form ACM will only be present during the groundworks stage of the construction and not during the use of the site. The principal risk to human health is from asbestos during groundworks but the risk from this can be appropriately controlled by implementing an Asbestos Working Plan in accordance with the Control of Asbestos Regulations 2012.

9.2.5 As with any project on a Brownfield site there is the possibility of encountering unexpected contamination. If this occurs then the procedures set out in Appendix M should be implemented.

9.3 Geotechnical Design

9.3.1 The landfill/waste material was encountered in the majority of the exploratory hole locations across the site. The material was described as brown and a mixture of waste materials within a matrix of clay or sandy clay or ashy clay matrix. The waste materials varied across the site and included brick, concrete, plastic bags, textiles, wire, metal, paper, cardboard, glass, ceramic tiles, timber, roots, tarmac, plastic, fabrics, rubble with the main materials being timber, plastic, brick/concrete, glass and metal.

9.3.2 The landfill material presents a significant geotechnical risk because it will be of variable compressibility, still undergoing self-weight settlement, biological/chemical degradation. No construction can proceed without significant ground improvement and mitigation measures.

Foundation Recommendations

9.3.3 Due to the nature of the landfill (variability, and compressible nature and the underlying Alluvium Deposits also being of low strength and compressible, shallow foundations will not be suitable for most structures. It is possible that some lightweight structures with a small plan size could be founded on rafts, but this is not advised as these could undergo unacceptable differential settlement. It will be possible for temporary portacabin type buildings to be used at the site, but these should not be double stacked and will need to be periodically re-levelled.

9.3.4 Ground Improvement by Vibro Stone Columns (VSC) is also not considered appropriate for foundations due to the ground conditions at this site.

9.3.5 Therefore it is proposed that all permanent structures will have to be founded on piled foundations. Piles should be designed to penetrate through the landfill and the Alluvium Deposits and extend a suitable depth into the underlying granular glacial deposits or Glacial Till. Consideration could be given to piling into the bedrock but this would need careful assessment to ensure that the piles do not form a pathway for contaminants to migrate into the sandstone principal aquifer.

9.3.6 Either bored and cast in situ CFA (continuous flight auger) piles, or driven preformed piling techniques are considered suitable for the ground conditions at the site. Care should be taken for bored and cast in situ piles taken through the landfill, as voids could cause the collapse of the pile shaft before the concrete has set and could lead to 'necking' of the pile. Overall it is TerraConsult's assessment that driven precast concrete or driven tubular steel piles would be best suited to this site. The localised presence of concrete boulders should be noted. The use of driven displacement piles also has the advantage that no potentially contaminated spoil, which could contain asbestos, will be brought to the surface reducing the risk of release of asbestos.

9.3.7 Piled foundations have the potential to form a pathway for contaminants to migrate between different groundwater bodies. The EA will require that a Piling Risk Assessment be undertaken prior to piling. Consideration has to be given to piles penetrating through the landfill into the Alluvium Deposits with the pile base in Glacial Till, particularly if the pile base is within the granular glacial deposits at depth. The groundwater levels indicate that there is a vertical hydraulic gradient downwards and there has been some migration of contaminants into the Alluvium Deposits. Given that the Alluvium Deposits are predominantly cohesive and is of high plasticity it is assessed that these strata will remould as they are installed to form a low permeability zone around piles, the installation of piles are unlikely to create a pathway for contaminant migration into the ground below the Alluvium Deposits.

9.3.8 When designing piles appropriate allowance should be made for negative skin friction (down-drag) on the piles due to settlement of the landfill / platform fill and the Alluvium Deposits relative to the piles.

9.3.9 Any piling works undertaken from existing ground levels will require a suitable piling mat/platform constructed in accordance with BRE Report 470 (2004) and given that this will be placed on landfill of variable density and composition a relatively thick or well reinforced platform will be required. A geotextile may be incorporated into the platform to reduce the required thickness and the platform could be designed as part of the engineering fill required for any earthworks to alter final site levels.

Ground Floor Slab Recommendations

9.3.10 It is recommended that piled floor slabs with suspended concrete slabs incorporating appropriate ground gas protection measures are adopted for the buildings.

9.3.11 An alternative which could be considered would be to pile the building foundations and those for the main items of plant e.g. the drill, the winches etc. and to construct a reinforced concrete ground floor slab but allow for on-going maintenance to repair/re-level the slab as settlement occurs. If the concrete floor was constructed with constructed in a number of different separate individual slabs with movement joints between the slabs. When settlement occurs these slabs could be re-levelled by pressure grouting below the slabs to bring the individual slabs back to the required profile. The slabs would have cast into them locations for remedial pressure grouting

9.3.12 A third alterative would be to pile the building foundations and those for the main items of plant but have a floor from a reinforced granular hard standing (e.g. using a relatively thick geogrid reinforced sub-base) on which plant can operate. This would be the lowest

cost flooring and it would also have the lowest maintenance costs for repairing any settlement.

9.3.13 The latter two alternatives are unconventional and the ground gas protection measures would also have to be considered. If the third option was used then if any offices/welfare areas were constructed on piled slabs and given full gas protection measures then it the rest of the building could be kept appropriately ventilated to prevent any build-up of methane within what is proposed to be a relatively large open area where there is considerable capacity for dilution and dispersion of any ground gases migrating into the building..

Groundwater & Excavations

9.3.14 Note that perched groundwater was encountered in one of the holes at 3.40 m but the main water table is deeper. Therefore it is not expected that groundwater will be encountered in any excavations at this site other than in piles and the main shaft.

Buried Concrete and Pipework

9.3.15 The results of laboratory pH and sulphate content indicate that ACEC Class AC-1s conditions prevail in accordance with BRE Special Digest 1, 2005 (the Design Concrete Class). Therefore no special precautions are required at the site for the design of concrete in terms of the durability and structural performance.

Pavement Design

9.3.16 The results of in situ CBR tests varied from 3.5 to 110% indicating variable conditions ranging from poor quality ground to well compacted granular strata. However, the landfill material presents a significant geotechnical risk to hard standing because it will be of variable compressibility and that it will still be undergoing self-weight settlement, biological/chemical degradation. It is recommended that a flexible pavement be used with the design based on a CBR value of 3% and that the sub-base includes at least one layer of high strength geogrid reinforcement in order to minimise the risk from differential settlement and the variable nature of the subgrade.

9.4 Recommendations for Further Works

9.4.1 Note that this report is only draft requiring the results of geotechnical laboratory testing and further ground gas monitoring is also required to confirm the required design criteria for ground gas protection measures.

Regulatory Liaison

9.4.2 Any proposals to remediate or develop the site should be agreed with the relevant authorities (e.g. local authority environmental health officer, Environment Agency etc) to obtain Planning Permission prior to commencement of the works. It is recommended that discussions are held with the EA and the Council at an early stage prior to submitting a planning application because they will view any development on a former landfill site as being a high risk development and may require further studies to be carried out.

Re-use of Soil on site and Importation of Fill

9.4.3 See Section 7.3 for full details. However, it should be noted that it is recommended that the development implements the procedures in the CL:AIRE document ‘The Definition

of Waste: Development Industry Code of Practice,' Version 2 (2011) to enable legal re-use of soils at the site. Note that any excavated waste (e.g. plastic, metal, asbestos etc.) cannot be re-used on site and will have to be sent off site to landfill or processing. In order to recover any soils/concrete/brick for re-use, this treatment/segregation of materials would have to be carried out in accordance with an environmental permit (a mobile treatment permit) and two months should be allowed to get agreement from the EA for deployment for this type of mobile permit.

Other items:

- Discussions with United Utilities to confirm initial assessment with regards to potable water supply pipes contained in this report.
- Ecological assessment and treatment of Japanese Knotweed along the access road.
- Discussions with piling contractors.

9.5 Health and Safety

9.5.1 As outlined within the HSE publication "Successful Health and Safety Management – HSG65" this report should inform your development of safe systems of work and information as an input into the safety management system. The contents of this report may be used to supplement the contents of the Health and Safety File as required under the Construction Design and Management (CDM) Regulations 2015. All risk control measures should be in accordance with the guidelines laid down within the Management of Health and Safety at Work Regulations 1999.

9.5.2 In accordance with the Construction Design and Management (CDM) Regulations 2015, TerraConsult has acted in the role of Principal Contractor and as Principal Designer for the works as described in this report. With issue of this report TerraConsult has discharged and completed all contractual and legal requirements for these positions and we have no further involvement with the project.

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Statutory Instruments: 2012: Environmental Protection, England. Contaminated Land (England) (Amendment) Regulations 2012 No. 263 coming into force 6th April 2012.

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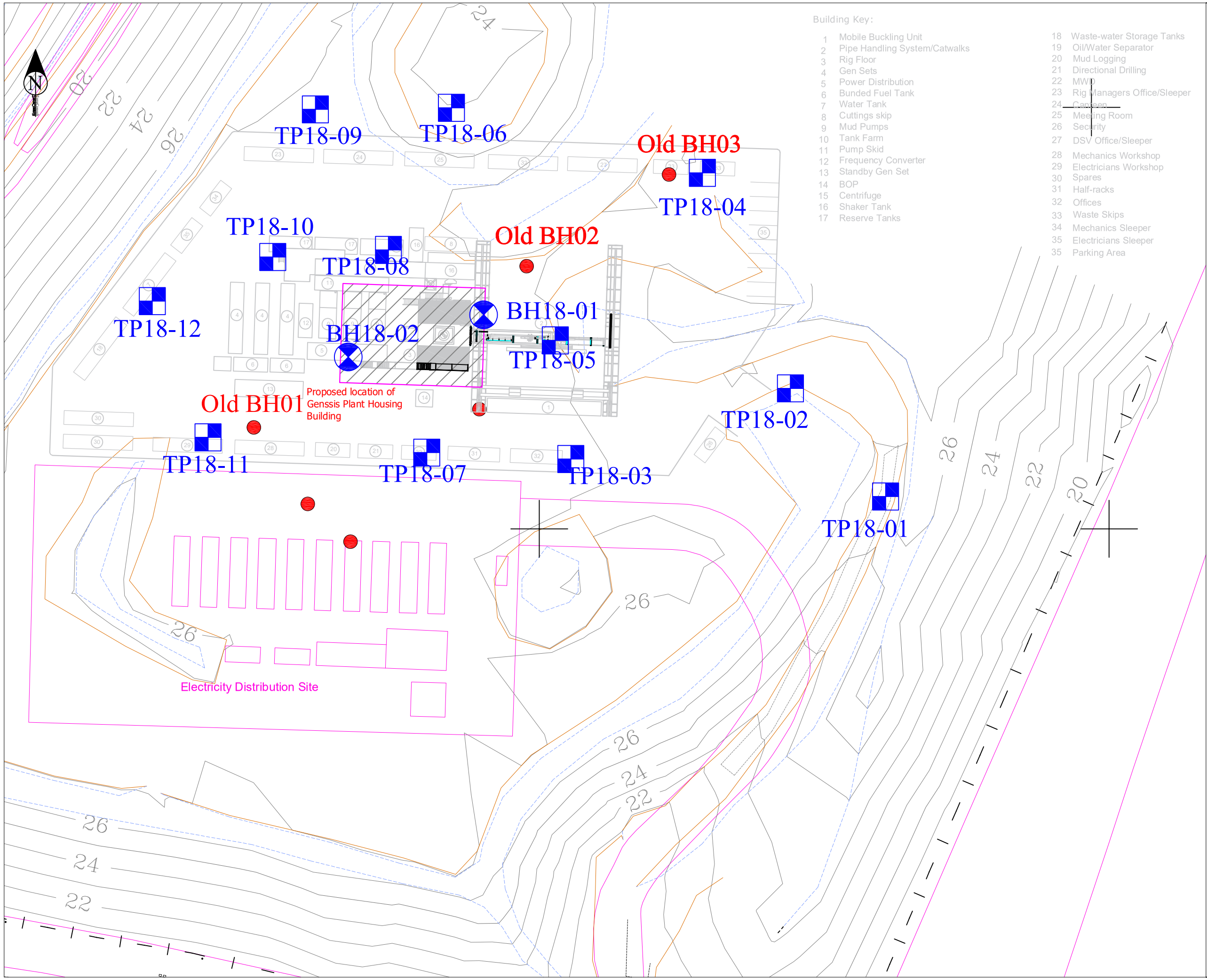
UK Technical Advisory Group on the Water Framework Directive: 2012 : Updated Recommendations on Environmental Standards River Basin Management (2015-21). Draft (SR3 – 2012), 26th April 2012

UKWIR: 2010: Guidance for the selection of Water Supply Pipes to be Used in Brownfield Sites. Report Ref No 10/WM/03/21. UK Water Industry Research Limited

DRAWINGS

List of Drawings

4133/1/001	**Exploratory Hole Location Plan**
4133/1/002	**Cross Section**



Key

TCL Explotary Holes 2018
TP18-01

Old BH02
Historical Monitoring wells

TerraConsult

Bold Business Centre, Bold Lane, Sutton, St Helens WA9 4TX

Client
Marriott Drilling Group

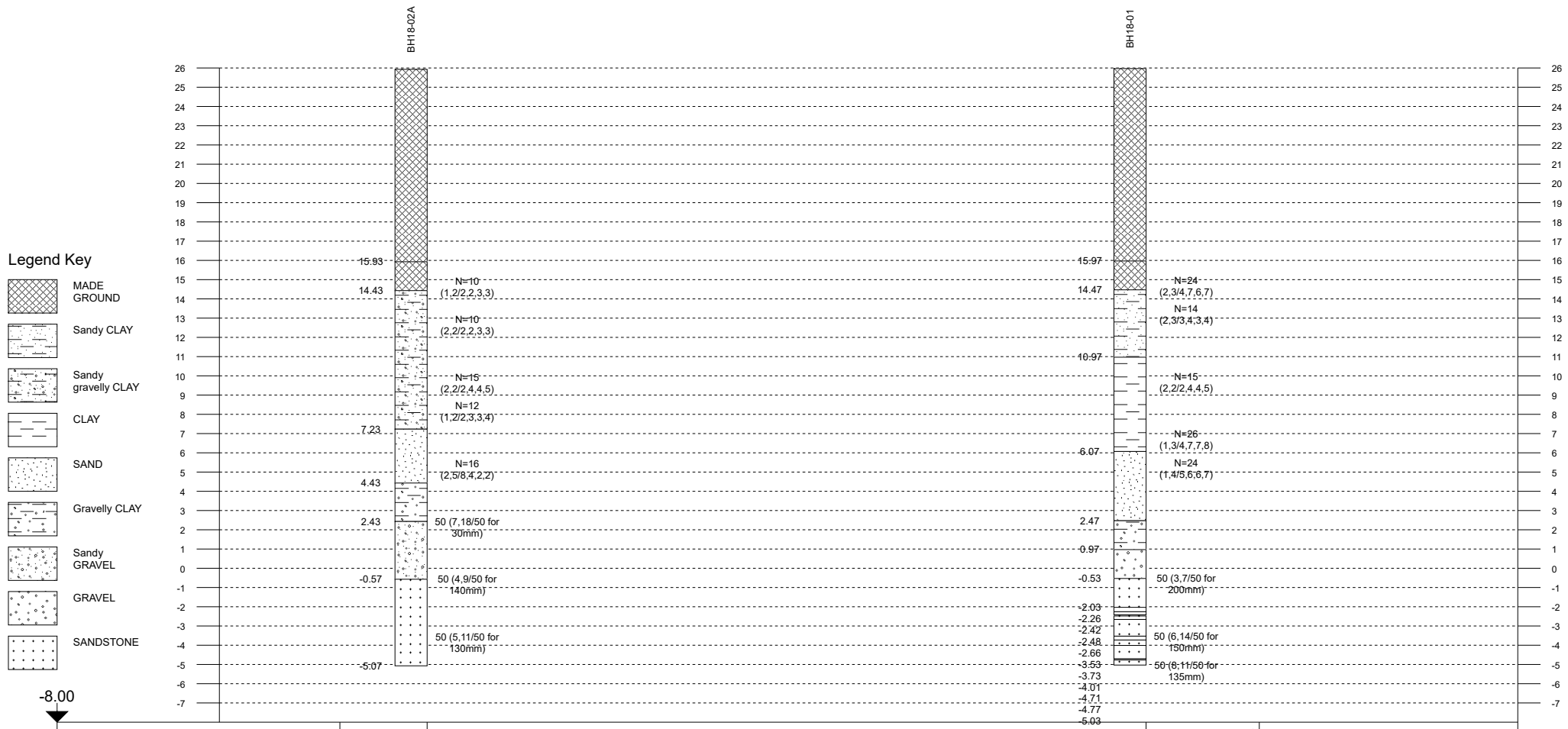
Site
Project GENSSIS, Carrington

Title
Exploratory Hole Location Plan

Scale	Not to scale	@ A3
Drawing No.	4133/1/001	
Rev	Date	Description
File	4133-1-001 - Project GENSSIS, Carrington	
Date 11/18	Engineer JT	
Drawn PP GH	Checked DRAFT	

Section line 1

TerraConsult



Chainage (m)	0.00	3.02		27.92	31.84	
Offset (m)		0.09		0.44		
Elevation (mAOD)		25.93		25.97		

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in meters.

Remarks:
None

Issue:	Open	Project:	Project GENSSIS, Carrington	Drawing No:
Drawn by:	Geo	Project No:	4133	**4133-2-001 - Cross Section**
Vertical scale:	1:300	Client:	Marriott Drilling Group	
Horizontal scale:	1:200			

APPENDICES

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APPENDIX A

Service Constraints, Report Limitations & Planning

Service Constraints, Report Limitations & Planning Requirements

This consultancy contract, report and the site investigation (together comprise the "Services") were compiled and carried out by TerraConsult Limited (TCL) for Peel Holdings (the "client") on the basis of a defined programme and scope of works and the terms of a contract between TCL and the "client." The Services were performed by TCL with all reasonable skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by TCL taking into account the limits of the scope of works required by the client, the prevailing site conditions, the time scale involved and the resources, including financial and manpower resources, agreed between TCL and the client. TerraConsult Ltd cannot accept responsibility to any parties whatsoever, following the issue of this report, for any matters arising which may be considered outwith the agreed scope of works.

Other than that expressly contained in the above paragraph, TCL provides no other representation or warranty whether express or implied, is made in relation to the Services. Unless otherwise agreed this report has been prepared exclusively for the use and reliance of the client in accordance with generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon, or transferred to, by any other party without the written agreement of a Director of TCL. If a third party relies on this report, it does so wholly at its own and sole risk and TCL disclaims any liability to such parties.

It is TCL's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without TCL 's review and advice shall be at the client's sole and own risk.

The information contained in this report is protected by disclosure under Part 3 of the Environmental Information Regulations 2004 pursuant to the provisions of Regulation 12(5) without the consent in writing of a Director of TerraConsult Limited.

The report was written in November 2018 and should be read in light of any subsequent changes in legislation, statutory requirements and industry practices. Ground conditions can also change over time and further investigations or assessment should be made if there is any significant delay in acting on the findings of this report. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of TCL. In the absence of such written advice of TCL, reliance on the report in the future shall be at the client's own and sole risk. Should TCL be requested to review the report in the future, TCL shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between TCL and the client.

The observations and conclusions described in this report are based solely upon the Services that were provided pursuant to the agreement between the client and TCL. TCL has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report. TCL is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, TCL did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, radon gas or other radioactive or hazardous materials.

The Services are based upon TCL's observations of existing physical conditions at the site gained from a walkover survey of the site together with TCL's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst TerraConsult Ltd have no reason to doubt the accuracy and that it has been provided in full from those it was requested from, the items relied on have not been verified. No responsibility can be accepted for errors within third party items presented in this report. Further TCL was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. TCL is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to TCL and including the doing of any independent investigation of the information provided to TCL save as otherwise provided in the terms of the contract between the client and TCL.

Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions can also be variable and as investigation excavations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this report. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and TCL] based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

The groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The normal speed of investigation usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions and higher groundwater levels may occur at other times of the year than were recorded during this investigation.

Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site.

Throughout the report the term ‘geotechnical’ is used to describe aspects relating to the physical nature of the site (such as foundation requirements) and the term ‘geoenvironmental’ is used to describe aspects relating to ground-related environmental issues (such as potential contamination). However, it should be appreciated that this is an integrated investigation and these two main aspects are inter-related. The geoenvironmental sections are written in broad agreement with BS 10175:2011+A2 2017. For the geotechnical aspects of the report, the general requirements of Eurocode 7 (BS EN 1997-2:2007) are to produce a Ground Investigation Report (GIR) which shall form part of the Geotechnical Design Report (GDR). The geotechnical section of this report is intended to fulfil the general requirements of the GIR as outlined in BS EN 1997-2, Section 6. The GIR contains the factual information including geological features and relevant data, and a geotechnical evaluation of the information stating the assumptions made in the interpretation of the test results. This report shall not be considered as being a GDR.

Planning Requirements

The National Planning Policy Framework (NPPF, 2018) emphasises the presumption in favour of sustainable development. Paragraph 11, which defines the presumption in favour of sustainable development, has two similar clauses which related to potentially contaminated land and sensitive receptors:

11 Plans and decisions should apply a presumption in favour of sustainable development.

*For **plan-making** this means that:*

b) strategic policies should, as a minimum, provide for objectively assessed needs for housing and other uses, as well as any needs that cannot be met within neighbouring areas, unless:

i) the application of policies in this Framework that protect areas or assets of particular importance provides a strong reason for restricting the overall scale, type or distribution of development in the plan area;

*For **decision-taking** this means:*

d) where there are no relevant development plan policies, or the policies which are most important for determining the application are out-of-date, granting permission unless:

ii) the application of policies in this Framework that protect areas or assets of particular importance provides a clear reason for refusing the development proposed

In accordance with the NPPF, areas or assets of particular importance are defined as:

habitats sites (and those sites listed in paragraph 176 – potential Special Protection Areas and Possible Areas of Conservation; listed or proposed Ramsar sites; and sites identified, or required, as compensatory measures for adverse effects on habitats sites, potential Special Protection Areas, possible Special Areas of Conservation, and listed or proposed Ramsar sites) and/or designated as Sites of Special Scientific Interest; land designated as Green Belt, Local Green Space, an Area of Outstanding Natural Beauty, a National Park (or within the Broads Authority) or defined as Heritage Coast; irreplaceable habitats; designated heritage assets (and other heritage assets of archaeological interest referred to in footnote 63 (Non-designated heritage assets of archaeological interest, which are demonstrably of equivalent significance to scheduled monuments, should be considered subject to the policies for designated heritage assets.); and areas at risk of flooding or coastal change.

Paragraph 118 states that planning policies and decisions should:

- *give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land;*

Paragraph 170 clarifies that enhancing the natural environment includes:

> *Planning policies and decisions should contribute to and enhance the natural and local environment by:*
> - *protecting and enhancing valued landscapes, sites of biodiversity or geological value and soils (in a manner commensurate with their statutory status or identified quality in the development plan);*
> - *recognising the intrinsic character and beauty of the countryside, and the wider benefits from natural capital and ecosystem services – including the economic and other benefits of the best and most versatile agricultural land, and of trees and woodland;*
> - *maintaining the character of the undeveloped coast, while improving public access to it where appropriate;*
> - *minimising impacts on and providing net gains for biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures;*
> - *preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and*
> - *remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.*

Paragraph 180 of NPPF states that planning policies and decisions should ensure the following:

> - *Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development.*

Paragraph 178 of NPPF states that planning policies and decisions for developments should also ensure that:

> *a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);*
>
> *b) after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and*
>
> *c) adequate site investigation information, prepared by a competent person, is available to inform these assessments.*

Paragraph 179 states that where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.

This report has been prepared and authorised by staff that are competent as defined in the NPPF.

Unexploded Ordnance

Clients have a legal duty under the CDM 2015 Regulations to provide designers and contractors with project-specific health and safety information needed to identify hazards and risks. This includes the possibility of unexploded ordnance (UXO) being encountered on the site. Further details are given in CIRIA Report C681 (Stone et al 2009). A non-UXO specialist screening exercise has been carried out for the site by considering any evidence of UK defence activities on or near the site evident from the gathered desk study information and the unexploded aerial delivered bomb (UXB) regional risk maps produced by Zetica. Other data sources are available, but as a first stage screening exercise the freely available Zetica maps have been used. The level of risk stated is that determined by Zetica, a company experience in the desk study, field investigation and clearance of UXO/UXB.

APPENDIX B

Environmental Risk Assessment Methodology & Terminology

ENVIRONMENTAL RISK ASSESSMENT METHODOLOGY & TERMINOLOGY

LEGISLATION OVERVIEW

This report includes hazard identification and environmental risk assessment in line with the risk-based methods referred to in relevant UK legislation and guidance. Government environmental policy is based upon a "suitable for use approach," which is relevant to both the current use of land and also to any proposed future use. The contaminated land regime is the statutory regime for remediation of contaminated land that causes an unacceptable level of risk and is set out in Part 2A of the Environmental Protection Act 1990 ("EPA 1990"). The main objective of introducing the Part IIA regime is to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health or the wider environment given the current use and circumstances of the land. Part IIA provides a statutory definition of contaminated land under Section 78A(2) as:

> *"any 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."*

In order to assist in establishing if there is a "*significant possibility of significant harm*" there must be a "*contaminant linkage"* for potential harm to exist. That means there must be a source(s) of contamination, sensitive receptors present and a connection or pathway between the two. This combination of contaminant-pathway-receptor is termed a "contaminant linkage or CPR linkage."

Part IIA of The Environmental Protection Act 1990 is supported by a substantial quantity of guidance and other Regulations. Key implementing legislation of the Part 2A regime includes the Contaminated Land (England) Regulations 2006 (SI 2006/1380) as amended by the overarching legislation for the contaminated land regime, which implements the provisions of Part IIA of the Environmental Protection Act 1990 (as inserted by section 57 of the Environment Act 1995), came into force on 14th July 2000 together with recent amended regulations: Contaminated Land (England) (Amendment) Regulations 2012 (SI 2012/263). Revised Contaminated Land Statutory Guidance was published by DEFRA in April 2012. Part IIA defines the duties of Local Authorities in dealing with it. Part IIA places contaminated land responsibility as a part of planning and redevelopment process rather than Local Authority direct action except in situations of very high pollution risk.

In the planning process guidance is provided by National Planning Policy Framework (NPPF) of July 2018 which requires that a site which has been developed shall not be capable of being determined "contaminated land" under Part IIA. In practice, Planning Authorities require sites being developed to have a lower level of risk post development than the higher level of risk that is required in order to determine a site as being contaminated in accordance with Part IIA. This is to ensure that there is a suitable zone of safety below the level for Part IIA determination and prevent recently developed sites becoming reclassified as contaminated land if there are future legislative

or technical changes (e.g. a substance is subsequently found to be more toxic than previously assessed this increases its hazard).

The criteria for assessing concentrations of contaminants and hence determining whether a site represents a hazard are based on a range of techniques, models and guidance. Within this context it is relevant to note that Government objectives are:

(a) to identify and remove unacceptable risks to human health and the environment;
(b) to seek to bring damaged land back into beneficial use;
(c) to seek to ensure that the cost burdens faced by individuals, companies and society as a whole are proportionate, manageable and economically sustainable.

These three objectives underlie the "suitable for use" approach to risk management and remediation of contaminated land. The "suitable for use" approach focuses on the risks caused by land contamination. The approach recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Risks therefore should be assessed on a site-by-site basis.

The "suitable for use" approach then consists of three elements:

(a) *ensuring that land is suitable for its current use* - in other words, identifying any land where contamination is causing unacceptable risks to human health and the environment, assessed on the basis of the current use and circumstances of the land, and returning such land to a condition where such risks no longer arise ("remediating" the land); the contaminated land regime provides the regulatory mechanisms to achieve this;

(b) *ensuring that land is made suitable for any new use, as planning permission is given for that new use* - in other words, assessing the potential risks from contamination, on the basis of the proposed future use and circumstances, before official permission is given for the development and, where necessary to avoid unacceptable risks to human health and the environment, remediating the land before the new use commences; this is the role of the town and country planning and building control regimes; and

(c) *limiting requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to the current use or future use of the land for which planning permission is being sought* - in other words, recognising that the risks from contaminated land can be satisfactory assessed only in the context of specific uses of the land (whether current or proposed), and that any attempt to guess what might be needed at some time in the future for other uses is likely to result either in premature work (thereby running the risk of distorting social, economic and environmental priorities) or in unnecessary work (thereby wasting resources).

The mere presence of contaminants does not therefore necessarily warrant action, and consideration must be given to the scale of risk involved for the use that the site has, and will have in the future.

OVERALL METHODOLOGY

The work presented in this report has been carried out in general accordance with recognised best practice as detailed in guidance documents such as in the CLR 11 Model Procedures for the Management of Land Contamination (Environment Agency, 2004), and BS10175:2011+A2 2017. Important aspects of the risk assessment process are transparency and justification. The particular rationale behind the risk assessments presented is given in this appendix.

The first stage of a two-staged investigation and assessment of a site is the Preliminary Investigation (BS 10175:2011), often referred to as the Phase 1 Study, comprising desk study and walk-over survey, which culminates in the Preliminary Risk Assessment. A preliminary conceptual site model (CSM) is developed which identifies potential geotechnical and geo-environmental hazards and the qualitative degree of risk associated with them. From the geo-environmental perspective, the Hazard Identification process uses professional judgement to evaluate all the hazards in terms of potential contaminant linkages (of contaminant source-pathway-receptor). Potential contaminant linkages are potentially unacceptable risks in terms of the current contaminated land regime legal framework and require either remediation or further assessment. These are normally addressed via intrusive ground investigation and generic risk assessment.

The second stage is the Ground Investigation, Generic Risk Assessment and Geotechnical Interpretation. This represents the further assessment mentioned above. The scope of the Ground Investigation is based on the findings of the Preliminary Risk Assessment and is designed to reduce uncertainty in the geotechnical and geoenvironmental hazard identification. The Ground Investigation comprises fieldwork, laboratory testing and usually also on-site monitoring. The Ground Investigation may include the Exploratory, Main and Supplementary Investigations described in BS 10175:2011+A2 2017. The results of the Ground Investigation reduces uncertainty in the geotechnical and geoenvironmental risks. Depending on the findings more detailed investigations or assessments may be required.

PRELIMINARY RISK ASSESSMENT

Current practice recommends that the determination of potential liabilities that could arise from land contamination be carried out using the process of risk assessment, whereby “risk” is defined as:

> *“(a) The probability, or frequency, or occurrence of a defined hazard; and*
>
> *(b) The magnitude (including the seriousness) of the consequences.”*

The UK’s approach to the assessment of environmental risk is set out in by the Department of the Environment Transport and the Regions (2000) publication “A Guide to Risk Assessment and Risk

Management for Environmental Protection" (also called Greenleaves II). This established an iterative, systematic staged process which comprises:

(a) Hazard identification;
(b) Hazard assessment;
(c) Risk estimation;
(d) Risk evaluation;
(e) Risk assessment;

At each stage during the development process, the above steps are repeated as more detailed information becomes available for the site.

For an environmental risk to be present, all three of the following elements must be present:

- Source/Contaminant: hazardous substance that has the potential to cause adverse impacts;
- Receptor: target that may be affected by contamination: examples include human occupants/users of site, water resources (rivers or groundwater), or structures;
- Pathway: a viable route whereby a hazardous substance may come into contact with the receptor.

The absence of one or more of each component (contaminant, pathway, receptor) would prevent a contaminant linkage being established and there would be no significant environmental risk.

The identification of potential contaminant linkages is based on a Conceptual Model of the site, which is subject to continual refinement as additional data becomes available. As part of a Preliminary Risk Assessment (Desk Study and site walk over) a Preliminary Conceptual Site Model (PCSM) is formed. Based on the PCSM, potential contaminant linkages can be assessed. If the PCSM and hazard assessment indicate that a contaminant linkage is not of significance then no further assessment or action is required for this linkage. For each significant and potential linkage a risk assessment is carried out. The linkages which potentially pose significant risks may require a variety of responses ranging from immediate remedial action or risk management or, more commonly, further investigation and risk assessment. This next stage is termed a Phase II Main Site Investigation and should provide additional data to allow refinement of the Conceptual Site Model and assess the level of risk from each contaminant linkage.

Definition of Risk Assessment Terminology

The criteria used for risk assessment are broadly based on those presented in DETR's "A Guide to Risk Assessment and Risk Management for Environmental Protection" (2000). The Severity of the risk is classified according to the criteria in Table B.1 below:

Table B.1 Severity/Consequence of Risk	
Severe	Acute risks to human health. Catastrophic damage to buildings/property (e.g. by explosion). Direct pollution of sensitive water receptors or serious pollution of other controlled water (watercourses or groundwater) bodies.
Medium	Harm to human health from long-term exposure. Slight pollution of sensitive controlled waters (surface waters or aquifers) or pollution of other water bodies. Significant effects on sensitive ecosystems or species.
Mild	No significant harm to human health in either short or long term. No pollution of sensitive controlled waters, no more than slight pollution of non-sensitive waters. Significant damage to buildings or structures. Requirement for protective equipment during site works to mitigate health effects.
Negligible	Damage to non-sensitive ecosystems or species. Minor damage to buildings or structures. No harm or pollution of water.

The probability of the risk occurring is classified according to criteria given in Table B.2 below:

Table B.2: Probability of Risk Occurring	
High likelihood	Contaminant linkage may be present, and risk is almost certain to occur in the long term, or there is evidence of harm to the receptor.
Medium/Reasonably Foreseeable	Contaminant linkage may be present, and it is probable that the risk will occur over the long term.
Low/Unlikely	Contaminant linkage may be present and there is a possibility of the risk occurring, although there is no certainty that it will do so.
Negligible/ Not credible	Contaminant linkage may be present but the circumstances under which harm would occur are improbable.

An overall evaluation of the level of risk is gained from a comparison of the severity and probability, as shown in Table B.3 below:

Table B.3: Comparison of Severity and Probability					
		Severity			
		Severe	**Medium**	**Mild**	**Negligible**
Probability	**High likelihood**	Very High Risk	High Risk	Medium/Low Risk	Low Risk
	Medium/Reasonably Foreseeable	High Risk	Medium Risk	Low Risk	Near Zero
	Low/Unlikely	High/Medium Risk	Medium/Low Risk	Low Risk	Near Zero
	Negligible/ Not credible	Medium/Low Risk	Low Risk	Low Risk	Near Zero

The various risk rankings provide guidance for recommended actions, whether this is:

AR - Action Required, Remediation or mitigation or site investigation works required
SIR - Site Investigation Required, further assessment is required.
NAR - No Action Required.

A description of the evaluated risk is as follows:

Table B.4 – Description of the Classified Risks and Likely Action Required	
Evaluated Risk	**Recommended Actions**
Very High Risk	AR: There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High Risk	AR: Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the long term.
Medium Risk	SI: It is possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low Risk	NAR: It is possible that harm could arise to a designated receptor from an identified hazard, but there is a low likelihood of this hazard occurring and if realised, harm would at worst normally be mild.
Near Zero	NAR: There is a negligible possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

GENERIC QUANTITATIVE RISK ASSESSMENT

In the following sections the current UK guidance on risks to the following receptors are discussed: human health, plant life and controlled waters

- **Human Health**
  The overall methodology for assessing the risk to human health from potential contaminants in soil is set out in the Environment Agency's guidance "Using Soil Guideline Values" SC050021/SGV Introduction, March 2009 and using the CLEA 1.06 model software (and CLEA 1.071 for nickel). The generic assessment criteria are in accordance with the following:

  - Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil;
  - Science Report SC050021/SR3: Updated technical background to the CLEA model;
  - Science Report SC050021/SR4: CLEA Software (Version 1.071, 2014) & Handbook;
  - Toxicological reports and SGV technical notes;
  - Toxicological data published by LQM/CIEH (2009) and CL:AIRE/EIC/AGS (2009)
  - DEFRA Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010 (December 2013).
  - LQM/CIEH Suitable 4 Use Levels (S4ULs) for Human Health Risk Assessment
  - Toxicology review published by the European Food Safety Authority for nickel (2015)

In March 2014 six 'proposed' Category 4 Screening Levels (pC4SL) were issued by Defra. These screening values are considered to be within Category 4 as defined in the Contaminated Land Statutory Guidance and indicate safe levels for new developments passing through the planning system. The SGV for lead has been withdrawn, and the pC4SL for lead has been derived using current best practice. In January 2015 LQM/CIEH published S4ULs for 89 contaminants in accordance with the C4SL methodology.

Note that groundwater contamination may pose a risk to human health but that there are no relevant generic assessment criteria available for comparison. TerraConsult has derived our own assessment criteria for this.

- **Phytotoxic Risks**
  Generic assessment of phytotoxicity is by comparison with guideline values presented in the British Standard for Topsoil and the MAFF document "Code of Good agricultural practice for the protection of soil", October 1998. This is in accordance with CLR's reference to DEFRA notice CLAN 4/04.
- **Controlled Waters**
  Risks to controlled waters (groundwater and surface waters) from contaminants are assessed in accordance with the EA documents "The Environment Agency's Approach to Groundwater Protection" (2017) and Remedial Targets Methodology (RTM, 2006). Pollutant inputs from contaminated land sites are considered as passive inputs under the European Water Framework Directive (2000/60/EC) (WFD) and its daughter Directives, and as such are regulated under the Environment Agency's 'limit' pollution objective. Acceptable water quality targets (WQT) are defined for protection of human health (based on Drinking Water Standards (DWS)) and for protection of aquatic ecosystems (Environmental Quality Standards (EQS)). The risk posed to controlled waters from total soil concentrations cannot be directly assessed. The risk is assessed either by comparison of results of leachate tests carried out on soil samples, or from the direct testing of samples of groundwater to screening criteria. Leachate testing generally forms a conservative assessment and is not appropriate for organic contaminants.

CURRENT GUIDANCE ON INTERPRETATION OF CHEMICAL ANALYSIS OF SOILS

Contaminated land is defined under law through Part IIA of the Environmental Protection Act 1990, implemented through Section 57 of the Environment Act 1995. This supports a 'suitable for use' based approach to the risk assessment of potentially contaminated land. The site specific risk assessment is based upon assessment of plausible contaminant linkages, referred to as the contaminant-pathway- receptor model, based upon the current or proposed use of the site.

Before undertaking a risk assessment a conceptual site model is devised in order to identify the potential contaminants, pathways and receptors. The individual contaminants, pathways and receptors then need to be further investigated in order to refine the initial assessment and risk assessment undertaken.

In March 2002, the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency published the Contaminated Land Exposure Assessment (CLEA) Model and

a series of related reports. These were designed to provide a scientifically based framework for the assessment of chronic risks to human health from contaminated land. These reports (CLR7-10) together with associated "SGV" documents were withdrawn and the following documents have been published as revised guidance to the CLEA assessment:

- Environment Agency : 2008: Using Soil Guideline Values SC050021/SGV Introduction, March 2008.
- Environment Agency : 2008: Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil.
- Environment Agency : 2008: Science Report SC050021/SR3: Updated technical background to the CLEA model.
- Environment Agency : 2008 : Compilation of Data for Priority Organic Contaminants for Derivation of Soil Guideline Values Science report SC050021/SR7
- Environment Agency : Science Report SC050021/SR4: CLEA Software (Version 1.071, 2015) & Handbook.
- DEFRA Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010 (December 2013).
- LQM/CIEH Suitable 4 Use Levels for Human Health Risk Assessment

Additional guidance on statistical assessment replacing CLR 7 is partly provided in:

- CL:AIRE: 2009: Guidance on Comparing Data With a Critical Concentration

A different approach to the statistical appraisal of data is required depending on whether the assessment of risk is to assess whether land is Contaminated Land in accordance with regulations, or whether the assessment is to assess whether the site is suitable for new development in according with Planning guidance. This is discussed further in CL:AIRE: 2009 "Guidance on Comparing Data With a Critical Concentration".

The introduction of the Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, 2012) reassessed the CLEA Model and the derived SGVs (and associated GACs calculated using the model). This re-assessment concluded that the SGVs/GACs were conservative screening criteria for determining the suitability of soil with regard to the risk to human health under the planning regime and defined a new upper limit for planning purposes which is the boundary between the new Category 3 and 4. In March and September 2014 DEFRA issued guidance on these new Category 4 Screening Levels (C4SL) and these are discussed further below.

Soil Guideline Values

A program for the derivation of SGVs based on the above guidance is provided by the Environment Agency and is entitled "CLEA Software Version 1.06". These reports, together with supporting toxicology reviews ("Tox" or Supplementary Information Reports) for individual substances (which will be gradually updated), Soil Guideline Value Reports and other guidance referred to in the above documents, provide guidance and the scientific basis for assessing the risk to human health from potential contaminants. Soil Guideline Value Reports (SGV Reports) have

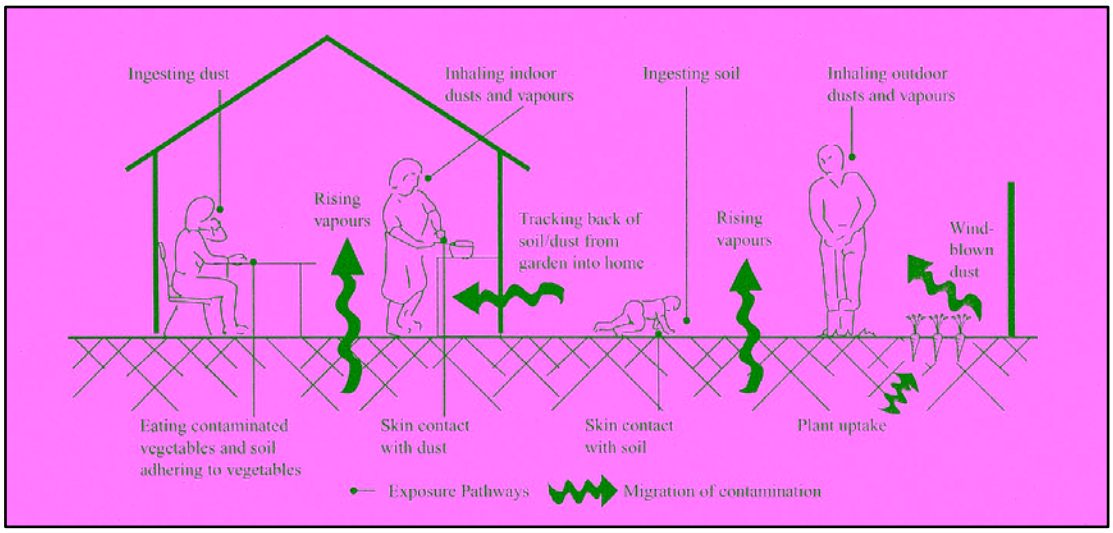
been published for a number of contaminants and these are published on the Environment Agency website. Eventually the reports will include SGVs for:

- heavy metals and other inorganic compounds: arsenic, cadmium, chromium, cyanide, lead (now withdrawn), mercury nickel (now withdrawn), and selenium;
- benzene, ethylbenzene, toluene and xylenes;
- phenol;
- dioxins and dioxin-like polychlorinated biphenyls (PCBs);
- polycyclic aromatic hydrocarbons (PAHs) – 11 substances.

In September 2015, CLEA was re-issued as 'CLEA Version 1.071'. Currently, the software has been used to produce an in-house GAC for nickel, following with withdrawal of the SGV.

In addition CIEH through LQM and the EIC have published generic assessment criteria (GACs) for a wide variety of other parameters including metals, hydrocarbons, chlorinated aliphatic compounds, PAHs and explosive substances for three standard land uses. These have been produced to supplement the Environment Agency guidance. These GACs will be replaced by SGVs when or if the Environment Agency publishes any more SGVs.

The CLEA model has been developed to calculate an estimated tolerable daily soil intake (TDSI) for site users given a set 'default' exposure pathways. Ten human exposure pathways are covered in the CLEA model as presented below:



- **Ingestion**
  - ingestion of outdoor soil;
  - ingestion of indoor dust;
  - ingestion of home grown vegetables;
  - ingestion of soil attached to home grown vegetables.
- **Dermal Contact**
  - dermal contact with outdoor soil;
  - dermal contact with indoor dust.

- **Inhalation**
  - inhalation of outdoor dust;
  - inhalation of indoor dust;
  - inhalation of outdoor soil vapour;
  - inhalation of indoor soil vapour.

It should be noted that there are other potential exposure pathways on some sites not included in the CLEA model e.g. certain organic compounds can pass through plastic water pipes into drinking water supply.

The presence and/or significance of each of the above exposure pathways are dependent on the type of land use being considered and the nature of the contaminant under scrutiny. Accordingly, the CLEA model considers for principle 'default' land use types and makes a series of 'default' assumptions with regard to human exposure frequency, duration and critical human target groups for each land use considered:

- residential land use;
- allotments;
- commercial and industrial land use.

The land use categories defined in the CLEA are detailed below.

Residential: This land use category assumes that people live in a variety of dwellings including terraced, detached and semi-detached houses up to two storeys high. The structure of buildings varies. Default parameters for building materials and building design are included in CLEA documents to calculate the relevant multi-layer diffusion coefficients for vapour intrusion and to model indoor vapour intrusion. The CLEA model assumes that regardless of the style of housing the residents will have access to either a private garden or community open space nearby, and that soil tracked into the home will form indoor dust. It allows for the ingestion pathways from home grown vegetables.

Allotments: The CLEA model incorporates an assessment of land provided by local authorities specifically for people to grow fruit and vegetables for their own consumption. Consumption of such fruit and vegetables present several exposure pathways; plants absorb contaminants mainly via water uptake through roots, the contaminants move to edible portions of plants via translocation and contaminated soil particles become trapped in the skin and between leaves. At present the model fails to account for exposure through the consumption of animals, and their products (e.g. eggs), which have been reared on contaminated land.

Commercial/Industrial: Although there are a wide variety of workplaces and work-related activities, the CLEA assessment of this land-use assumes that work occurs in a permanent, three-storey structure, where employees spend most time indoors, conducting office-based or light physical work. The model assumes employees sit outside during breaks for most of the year. Limitations in applying this land-use to different industries is detailed in EA publication "Updated technical background to the CLEA model" (2011). The generic model assumes that the site would not be covered by hard standing. Risk of

exposure to contaminants would be clearly less where commercial land is essentially all buildings and hard standing.

Based on the assumptions of each land use and the associated applicable exposure pathways, a 'Soil Guideline Value' (SGV) may be calculated for each contaminant under consideration for a particular land use in order to determine whether certain contaminant soil concentrations pose a significant risk to human health. The primary purpose of the CLEA SGVs are as 'trigger values' – indicators to a risk assessor that soil concentrations below this level require no further assessment as it can be assumed that the soil is suitable for the proposed use. Where soil concentrations occur above the SGV then further assessment of the results is required. The Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, 2012) which came into force in early April 2012 provides new clarity on the assessment of risk where soil concentrations exceed the SGV. The guidance introduces a four stage classification system relating to concentration of contaminants and the assessed risk which indicates appropriate actions. Category 1 and 2 sites are classified as "Contaminated Land" as defined in Part IIA of The Environmental Protection Act (1990). Category 3 and 4 sites are not considered as "Contaminated Land" in accordance with the Act. This can be explained using the figure on the following page.

There are also difficulties in establishing soil concentrations of contaminants beyond which risks from exposure to these contaminants would be 'unacceptable' and that they would lead to "significant possibility of significant harm" as defined in Part IIA of The Environmental Protection Act (1990) and determine that the land is "contaminated." This ultimately requires detailed 'toxicological' information of the health effects of individual contaminants and also a scientific judgement on what constitutes an 'unacceptable' risk. It is for local authorities or the Environment Agency to determine whether a particular site is contaminated land and it is for local Planning Authorities to determine whether land affected by contamination can be redeveloped.

Given the SGVs have been derived only for a limited number of contaminants and there was little prospect of further SGVs being published, two professional groupings have produced Generic Assessment Criteria (GACs) in accordance with the CLEA model for a large number of additional contaminants. These GACs were recognised in the new Contaminated Land Statutory Guidance (DEFRA, 2012) and have been produced as follows:

LQM/CIEH : 2009 Nathaniel CP, McCaffrey C, Ashmore MH, Cheng NPS GROUP, Gillett A, Ogden R & Scott D : 2009 . The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition). Land Quality Press, Nottingham.

CL:AIRE/EIC/AGS: 2009 : Soil Generic Assessment Criteria (GAC) for Human Health Risk Assessment. Contaminated Land: Applications in Real Environments, Environment Industries Commission & Association of Geotechnical and Environmental Specialists. December 2009.

Category 4 Screening Levels and LQM/CIEH Suitable 4 Use Levels

For new developments progressing through the planning regime, it is desirable that the soil concentrations are within Category 4 where there is a valid contaminant linkage. The upper boundary between Category 4 and 3 is not defined in the guidance. This boundary can also be better defined by carrying out a Detailed Quantified Risk Assessment (DQRA) and this is discussed later in this appendix.

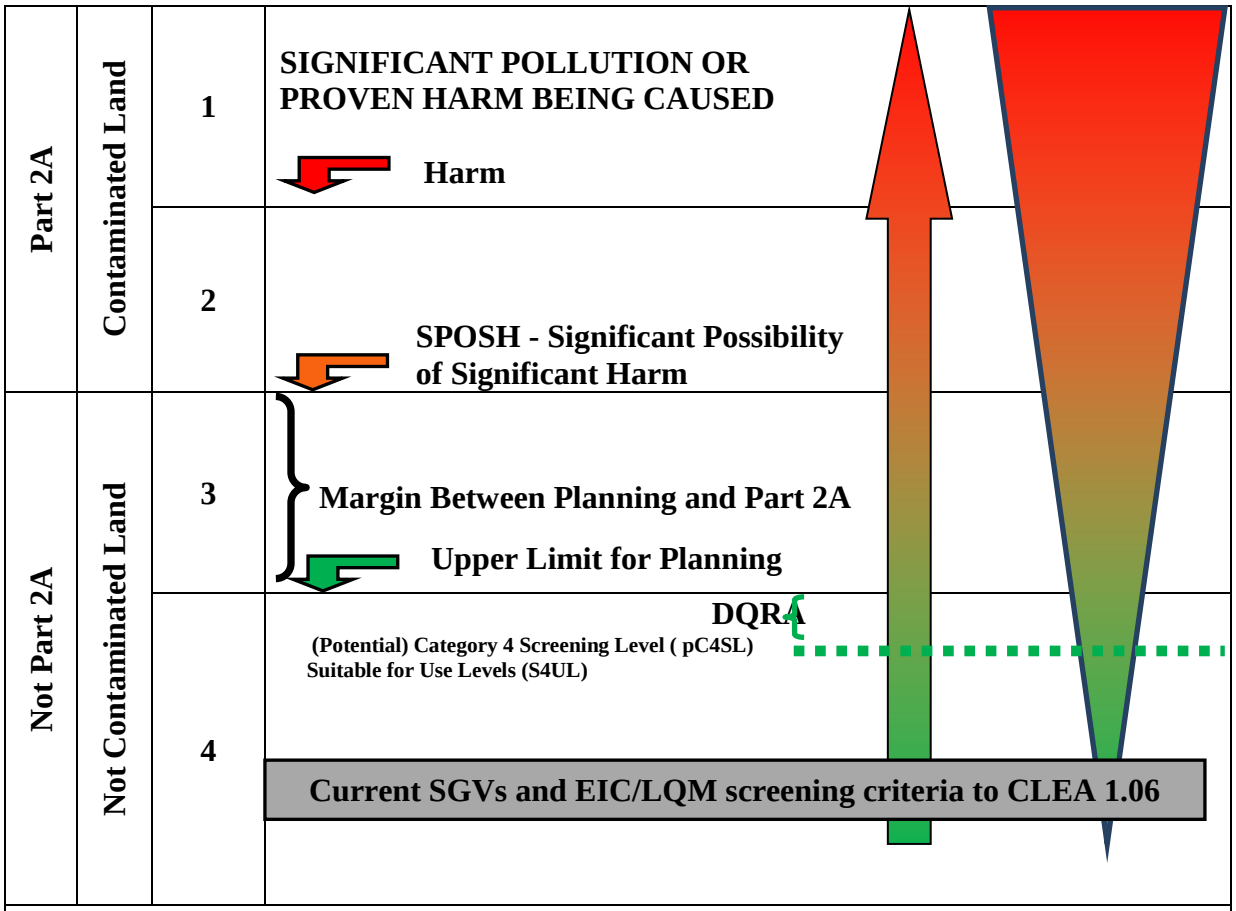
In December 2013 Defra issued the findings of a research project undertaken by CL:AIRE to set out the framework by which potential Category 4 Screening Levels (pC4SL) may be derived. The report was not designed to produce 'final' C4SL as the steering group producing the report believes that final C4SL should be set by a 'relevant authority' (e.g. Defra), the toxicological framework proposed has not been reviewed by the Committee on Toxicity and the document has yet to be subject to peer review.

In March 2014, appendices to the main Defra report were published detailing the derivation of pC4SL for 6 contaminants and other appendices regarding a review of the CIEH/CL:AIRE statistics guidance and sensitivity analysis. For each contaminant, a range of pC4SL have been produced relating to modifying toxicological parameters only, modifying exposure parameters only or by modifying both. It should be noted that the pC4SL produced for lead (the SGV was withdrawn in 2011) has undertaken a relatively large toxicological review in relation to modelling blood lead concentrations. pC4SL have been produced for:

- Arsenic;
- Benzene;
- Benzo(a)pyrene (as a surrogate marker for PAHs);
- Cadmium;
- Chromium (VI); and
- Lead

As previously discussed the values were initially published as 'potential' C4SL but have become 'final' following DEFRA having issued a policy decision letter indicating that they are to be used in the planning regime (letter of 3rd September 2014). It is considered that the pC4SL provide a simple test for deciding whether land is suitable for use without any remediation. The pC4SL represent a new set of screening levels that are more pragmatic (but strongly precautionary) compared to the existing soil guideline values (SGVs and the other GACs calculate in accordance with the existing CLEA methodology). The pC4SL provide cautious estimates of contaminant concentrations in soil that are still considered to present an acceptable level of risk, within the context of Part 2A, by combining information on toxicology, exposure assessment and normal levels of exposure to these contaminants. pC4SL values should not be seen as 'SPOH values.' Exceeding a pC4SL means that further investigation is required, not that the land is necessarily contaminated. In January 2015, LQM published Suitable 4 Use Levels (S4ULs) for a further 89 contaminants using the Defra C4SL methodology. In a similar manner to the pC4SLs, no authoritative review has been undertaken although the approach and quality of the work undertaken is widely accepted as being of high quality.

Relationship Between Contaminant Concentration, Risk and Screening Values			
Category	**Increasing**	**Increasing** **Contaminant Concentration**	**Risk**



Note:
The vertical scale should not be considered as being linear and will be site and contaminant specific.

- SPOSH concentrations could be 10 to 100 times the SGV/EIC/LQM screening concentration.
- C4SL were issued as 'potential' but have become 'final' following DEFRA having issued a policy decision letter indicating that they are to be used in the planning regime (letter of 3rd September 2014).

Lead

The SGV for lead was withdrawn in 2011 and is not used in this report. The pC4SL for lead provides a technically robust and conservative assessment tool using significantly updated toxicological modelling in line with current scientific understanding of lead toxicology.

Nickel

The SGV for nickel was withdrawn in 2015 and is not used in this report. In-house GACs for nickel have been produced using the updated toxicological review by the EFSA and the CLEA 1.071 software.

Public Open Space

The Defra report (December 2013) has also introduced exposure scenarios for two other commonly occurring land uses which require assessment (under the planning and Part 2A regimes) on a relatively frequent basis. These exposure scenarios are:

- Public Open Space – Space Near Residential Housing (POS_{resi}); and
- Public Open Space – Public Park (POS_{park}).

Potential use of pC4SL relating to Public Open Space (POS) require care due to the significant variability in exposure characteristics. For example, POS may include:

- Children's play areas, public parks where children practise sport several times a week and teenagers only once a week;
- Grassed areas adjacent to residential properties which are rarely used;
- Dedicated sports grounds where exposure is only to players and groundworkers; and
- Nature reserves or open ground with low level activity (for example, dog walking).

Within the Defra report (December 2013) the following exposure scenarios have been modelled as these are considered the most important for potential exposure for the critical receptor i.e. young children:

- Green open space close to housing, including tracking back of soil (POS_{resi}); and
- Park-type scenario where distance is considered sufficient to discount tracking back of soil (POS_{park}).

Detailed Quantified Risk Assessment (DQRA)

SGVs, GACs, pC4SL and S4ULs are based on a number of basic assumptions. There are two main options for developing Site Specific Assessment Criteria (SSAC) by adjusting the CLEA model so that they have greater relevance to the site:

- **Simple adjustment of the generic SGV / C4SL model**. Such adjustment is restricted to the choice of exposure routes selected for the generic land use, building type, soil type and soil organic matter content within the CLEA software.

- **Detailed adjustment.** It may be relevant to make greater modifications to the model due to the specific use of the land in question. This can include modification to any parameter value, including exposure assumptions, building parameters, and the choice and application of fate and transport models. This is equally relevant to site-specific modifications of existing generic land uses, the development of new land uses, and the inclusion of additional exposure pathways. Much of this can be undertaken using the CLEA software. Depending on the complexity of the detailed adjustments required, it may be necessary to use other tools either alone or in conjunction with the CLEA software. Both options should

follow established protocols for DQRA and require sufficient justification and supporting information for the adjustments made. Detailed adjustments are likely to require substantially greater technical justification and supporting documentation, especially if modifications are based on information not contained within the SGV framework documents.

The two choices present the risk assessor with three options/decisions:

(1) Use a published SGV/GAC/pC4SL/S4UL if it can be demonstrated that the assumptions inherent in the value are appropriate to the site in question. If they are not, proceed to either option 2 or 3 below.

(2) Make simple site-specific adjustments to the generic exposure model used to derive the SSAC. Three examples of when this could be appropriate are:

   a. High density residential development with no exposed contaminated soil at surface. It is appropriate in this case to consider the relevance of direct contact pathways and consumption of homegrown produce.

   b. Soil type is significantly different (specifically when soil type is likely to be less protective e.g. made ground) to that assumed in the SGV/GAC/pC4SL/S4UL.

   c. Soil organic matter content is significantly different to that assumed in the derivation of the SGV/GAC/pC4SL/S4UL.

(3) If simple adjustments are not sufficient to reflect site conditions, undertake a DQRA. This may be undertaken using the CLEA software or by using an alternative risk assessment methodology that is relevant, appropriate, authoritative and scientifically based. Changes to toxicological end points may also be considered, although this should only be undertaken by an toxicology expert. In the context of this guidance, simple adjustments of a generic land use scenario for soil type or SOM content for example are not considered sufficient to be classed as a DQRA.

DQRAs should be conducted with the agreement of the local authority (or the Environment Agency) since it is the authority that determines whether land is Contaminated Land or whether Planning Permission for a new development may be granted.

Representative Data

The type, quantity and quality of the available soil data influence the method chosen to obtain a site representative soil concentration that is compared with a SGV/GAC/pC4SL/S4UL in the screening process. The soil data should be representative of the exposure scenario being considered. This can include factors such as:

- averaging area over which exposure occurs;
- sample depth;
- heterogeneity of soil

where the 'averaging area' is defined as:

> *That area (together with a consideration of depth) of soil to which a receptor is exposed or which otherwise contributes to the creation of hazardous conditions'.*

Site investigations take discrete samples from a given area (and to a certain depth). It has to be assumed that these samples are to some degree representative of the contaminant concentration throughout that volume of soil. The critical soil volume (taking into account area and depth) which might be usefully compared with a SGV/GAC/pC4SL/S4UL is a site-specific decision, but a starting point is the generic land use scenarios used in the derivation of the SGV/GAC/pC4SL/S4UL. The critical soil volume depends on two factors:

- Contaminant distribution and vertical profile (bands of highly contaminated material or lateral hot spots should not necessarily be averaged out with more extensive cleaner areas of soil without justification)
- Contribution to average exposure underpinning the SGV. Direct contact exposure pathways depend on the adult or child coming into contact with near-surface soils and the area over which that exposure occurs is usually important (i.e. the averaging area). Vapour pathways are less dependent on surface area, for example vapour intrusion may result from a highly concentrated hot spot beneath a building leading to elevated average indoor air concentrations. For the three standard land uses for which SGVs are derived, relevant considerations are:
- For the standard **residential or allotment land use**, the critical soil volume is the area of an individual garden, communal play area or working plot from the surface to a depth of between 0.5m and 1.0m. This is the ground over which children are most likely to come into contact with soil or from which vegetable and fruit produce will be harvested. In the case of volatile contaminants, it may also be appropriate to consider the volume of soil underneath the footprint of the building although vapour intrusion may be driven by a soil volume much smaller than this if the contaminant source is highly concentrated.
- For the standard **commercial land use**, the critical soil volume has to be decided on a case-by- case basis due to the wide range of possible site layouts. However, for non-volatile contaminants, landscaped and recreational areas around the perimeter of office buildings are likely to be most important. For volatile contaminants, the footprint occupied by the building itself should also be considered.
- For **most exposure pathways**, the contamination is assumed to be at or within one metre of the surface.

The use of averaging areas must be justified on the basis of relevance to the exposure scenario. SGVs are relevant only when the exposure assumptions inherent in them are appropriate for the identified exposure averaging area. Further guidance on critical soil volumes and the consideration of averaging exposure areas can be found in:

- *Secondary model procedure for the development of appropriate soil sampling strategies for land contamination (Environment Agency, 2000);*

- *Guidance on comparing soil contamination data with a critical concentration (CIEH/CL:AIRE, 2009); and*
- *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Appendix I (Defra December 2013, March 2014)*

It is the mean soil concentration for the individual contaminant within an individual averaging area, which is compared to the SGV. However, as contaminant concentrations vary across a site, and sampling and analysis will introduce measurement errors, the comparison between measured mean concentration and the SGV must take this uncertainty into account.

There are two principal options available to obtain site representative soil concentrations from a site investigation dataset; statistical and non-statistical methods. Data objectives, quality and quantity are likely to determine which approach is most appropriate. If statistical methods such as those presented in CIEH/CL:AIRE (2011) are to be used, sufficient data need to be available or obtained. No one single statistical approach is applicable to all sites and circumstances. The wider range of robust statistical techniques developed by organisations including the US Environmental Protection Agency (USEPA) are also important tools. Risk assessors should choose an appropriate statistical approach on the basis of the specific site and the decision that is being made. For further guidance on the appropriate use of statistical approaches, refer to USEPA 2006 or good environmental monitoring statistics textbooks.

When statistical approaches are inappropriate (this will depend on the objectives of the site investigation), individual or composite samples should be compared directly to the SGV. Guidance on use of alternative data handling approaches such as the use of composite sampling can be found in documents such as:

- *Verification of remediation of land contamination* (Environment Agency, 2010);
- *Sampling and testing of wastes to meet landfill Waste Acceptance Criteria* (Environment Agency, 2005);
- *Guidance on choosing a sampling design for environmental data collection* (USEPA, 2002);
- *Soil Quality – Sampling, ISO 10381 series* (ISO, 2002–2007).

The statistical tests should not be used as arbiters for decisions under Part 2A. They are an additional, useful line of evidence to assist in decision-making. The implications of the basis for the derivation of the site representative soil concentration must be taken into account in any decision-making process and clearly documented.

Where the statistical tests are conducted in accordance with the method described in CL:AIRE 2009:

- For the Planning situation, it has to be demonstrated that the concentration of contaminants is low compared to the pC4SL/S4UL or SSAC. All of the test data should be below the screening criteria and no statistical analysis is required or if there are exceedances of the criteria then a statistical assessment is required. For the statistical assessment this decision is based on whether there is at least a 95% confidence level that the true mean of the dataset is lower than the screening criteria.

- For the Part 2A scenario the regulator needs to determine whether the concentration of contaminants is greater than the SGV/GAC/pC4SL/S4UL or SSAC. This decision is based on whether there is at least a 95% confidence level that the true mean of the dataset is higher than the SSAC. However, the regulator may proceed with determination if there is just a 51% probability, "on the balance of probabilities."

If the screening levels are exceeded then more sophisticated quantitative risk assessment can be undertaken or remedial action may be taken to break the contaminant linkages. The benefits of undertaking a quantitative risk assessment must be weighed against the likelihood that it will bring about cost savings in the proposed remediation. Further information about the use of soil guideline values is provided in Environment Agency : 2008: Using Soil Guideline Values SC050021/SGV Introduction, March 2008.

GENERIC RISK ASSESSMENT CRITERIA FOR RISK TO PLANTS

Soil contaminants, if present at sufficient concentrations, can have an adverse effect on the plant population. Phytotoxic effects can be manifested by a variety of responses, such as growth inhibition, interference with plant processes, contaminant-induced nutrient deficiencies and chlorosis (yellowing of leaves). All chemicals are probably capable of causing phytotoxic effects. Thus the phytotoxic potential of substances is dependent on the concentrations capable of having adverse effects on plants and the concentrations likely to be found at contaminated sites. Phytotoxicity is a difficult parameter to quantify given that experimental techniques vary widely and variations exist in plant tolerances, soil effects and synergistic/antagonistic reactions between chemicals. Contaminants may be taken up and accumulated by plants through a range of mechanisms. The principal pathways are active and/or passive uptake through the plant root, adsorption to root surfaces and volatilisation from the soil surface followed by foliar uptake. After plant uptake, contaminants may be metabolised or excreted, or they may be bioaccumulated and this is highly species dependant. Many of the substances capable of adversely affecting vegetation exert this effect because of their water solubility, a characteristic that could result in their transport from contaminated sites into adjacent locations where the chemical may generate a phytotoxic response. This could be important if, for example, the adjacent site has important conservation status.

The concentration in soil at which substances become phytotoxic depend on a range of factors including plant type, soil type, pH, the form and availability of the contaminant and other vegetation stress factors that may be present (such as drought). Some plants (including some rare plants will only grow in soils where there are relatively high concentrations which would be phytotoxic to other species. Whilst many contaminants may be phytotoxic, data are limited. Some heavy metals are essential as trace elements for plant growth but may become toxic at higher concentrations.

TerraConsult has carried out a review of a number of current and former guidance documents and other texts on phytotoxicity. It is not possible to produce a definitive list of phytotoxic substances on account of the variables mentioned above. However, a number of metals are repeatedly cited as commonly occurring priority pollutants. As a result, the following list is adopted by TerraConsult as indicators of the potential for phytotoxicity: As, Cr, Cu, Ni and Zn (note that Boron has been excluded from this list because the more modern studies do not assess this).

As the CLEA framework is a risk based approach, applied to humans, an alternative strategy is required to assess the risk to plants from substances that are phytotoxic. Reference to published criteria and background concentrations can help put site data into context. Published assessment criteria for the protection of plant life from a number of countries are given in the following Table. The most authoritative source is the British Standard for topsoil, but this only lists three elements. CLR 11 states that the ICRCL Guidance Note 70/90 can be used for initial screening criteria. This approach has been adopted by TerraConsult where BS3882 is lacking, but where an ICRCL 70/90 criterion is lacking, the lowest criterion in Table below from, firstly UK, and, secondly, European and then other worldwide criteria. The adopted criteria are highlighted in the table 3.8. The MAFF value of 250 mg/kg has been chosen for As over the ICRCL value of 50 mg/kg as MAFF explains the 50 is applicable to vegetables and human health, whereas 250 is applicable to the plants themselves.

Table B.5: Published Assessment Criteria for Phytotoxic Elements (mg/kg)							
Reference	**As**	**CR (Total)**	**Cr (III)**	**Cr (VI)**	**Cu**	**Ni**	**Zn**
British Standard for topsoil (BS3882:2007)	-	-	-	-	200 (pH >7) 135 (pH 6-7) 100 (pH 5.5-6.0)	110 (pH >7) 75 (pH 6-7) 60 (pH 5.5-6.0)	300 (pH >7) 200 (pH 6-7) 200 (pH 5.5-6.0)
MAFF Code of Good Agricultural Practice for the Protection of Soil (1998)	250	-	400 for sites containing sewage and sludge	-	500 (grass) but may fall to 250 for clover and sensitive species (at pH>6)	110 (pH>7) 75 (pH 6-7) 60 (pH 5.5-6.0)	1000 (clover & grass at pH 6), may fall to 300 for sensitive species (at pH 6-7)
ICRCL 59/83 (1987) now withdrawn for human health assessment	-	-	-	-	130	70	300
ICRCL 70/90 (1990) threshold trigger value	50	-	-	25 *	250	-	1000
Dutch ecotoxicological intervention value (Swartjes 1993 & 1994)	40	230	-	7	190	-	-
Australian Guideline B(1) (1999), Interim Urban Ecological Investigation Level (EIL). Soils not generally considered phytotoxic below these EILs.	20	-	400	1	100	60	200
New Zealand guidelines for timber treatment sites (1977), estimated based on Cu bioavailability *	-	-	-	-	500 - 1000 clay soils	-	-
New Zealand guidelines for timber treatment sites (1977), soil criteria for protection of plant life (residential/ agricultural setting)	10-20	-	600	25	130	-	-
Note: * Cr (VI) is only likely to be present in as a significant proportion of total Cr where pH >12 so this does not routinely need to be tested for regarding plant health.							

CURRENT GUIDANCE FOR CONTROLLED WATERS RISK ASSESSMENT

Summary of Regulatory Context

Government policy is based upon a "suitable for use approach," which is relevant to both the current use of land and also to any proposed future use. When considering the current use of land, Part IIA of the Environment Protection Act 1990 [4] (EPA 1990) provides the regulatory regime, which was introduced by Section 57 of the Environment Act 1995 [5], which came into force in England on 1 April 2000. The main objective of introducing the Part IIA regime is to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health, controlled waters or the wider environment given the current use and circumstances of the land. Part IIA provides a statutory definition of contaminated land under Section 78A(2) as:

> *"any 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."*

Part IIA provides a statutory definition of the pollution of controlled waters under Section 78A(9) as:

> *"the entry into controlled waters of **any** poisonous, noxious or polluting matter or **any** solid waste matter"*

Part IIA is supported by a substantial quantity of guidance and other Regulations, especially for England, The Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, 2012) which came into force in early April 2012. The document re-confirms the duties of Enforcing Authorities in dealing with contamination including the role of the Environment Agency which has powers under Part 7 of The Water Resources Act (1991) to take action to prevent or remedy the pollution of controlled waters, including circumstances where the pollution arises from contamination in the land.

Part IIA introduces the concept of a contaminant linkage; where for potential harm to exist there must be a connection between the source of the hazard and the receptor via a pathway. Risk assessment in contaminated land is therefore directed towards identifying the contaminants, pathways and receptors that can provide contaminant linkages. This is known as the contaminant-pathway-receptor link (CPR or contaminant linkage).

Part IIA places contaminated land responsibility as a part of the planning and redevelopment process rather than Local Authority or Environment Agency taking direct action except in situations of very high pollution risk or where harm is occurring. In the planning process guidance is provided by National Planning Policy Framework (NPPF) of March 2012. This requires that a site which has been developed shall not be capable of being determined "contaminated land" under

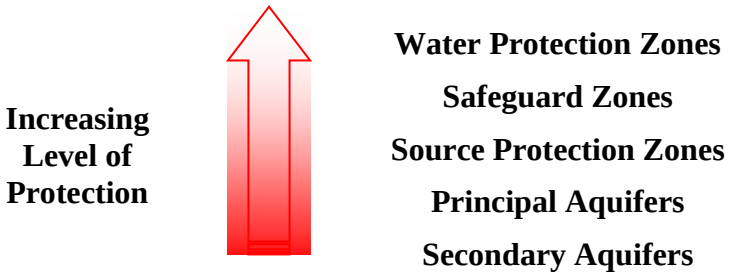
Part IIA. Therefore, appropriate risk-based investigation is required to identify the contaminant linkages that can then be assessed, and then mitigated using methods that can be readily agreed with the planners.

Environment Agency Guidance

Legislation and guidance surrounding the protection of controlled waters in the UK is numerous and can be complex. The Environment Agency's overall position on groundwater is *"To protect and manage groundwater resources for present and future generation in ways that are appropriate for the risks that we identify"* (The Environment Agency's Approach to Groundwater Protection, 2017). In brief, the core objectives of the existing legislation serve to enforce this position.

In 1992, the National Rivers Authority published their Policy and Practice for the Protection of Groundwater (PPPG), this document was influential as it provided a focus for key developments such as Source Protection Zones (SPZs) and Groundwater Vulnerability Maps. The Policy was then revised in 1998, since which there have been substantial changes in legislation, driven by Europe. Key European Directives relating to groundwater include the Groundwater Directive (80/68/EEC) and the Water Framework Directive (2000/60/EC). Aspects of these directives are controlled by primary UK legislation such as the Water Resources Act 1991 as amended by the Water Act 2003. Further to legislative changes, gaps identified in the 1998 PPPG required addressing. These changes are reflected in the Environment Agency Policy document *The Environment Agency's Approach to Groundwater Protection"* of March 2017.

The Environment Agency follows a tiered, risk based approach to drinking water protection and this should be taken into account when carrying out controlled waters risk assessment:



Tools available for Risk Assessment of Controlled Waters

In order for a developer of a potentially contaminated site to fulfil their obligations under the legislation, a site assessment would be required to be undertaken in order to identify any potential risks to controlled waters and to derive suitable clean-up criteria if necessary to ensure the protection of controlled waters. A number of tools are available for this purpose.

Three main stages apply to any risk assessment of controlled waters, these are:

i) Risk Screening (devise Conceptual Site Model, making reference to groundwater vulnerability maps, site setting etc)
ii) Generic Risk Assessment (using the EA Remedial Targets Methodology – Tier 1 - Comparison of groundwater data with relevant standards)

iii) Detailed Quantitative Risk Assessment (Consideration of aquifer properties and site specific parameters, using the EA Remedial Targets Methodology - Tiers 2 & 3)

The process is summarised below (Taken from the Environment Agency GP3 consultation document, 2006):

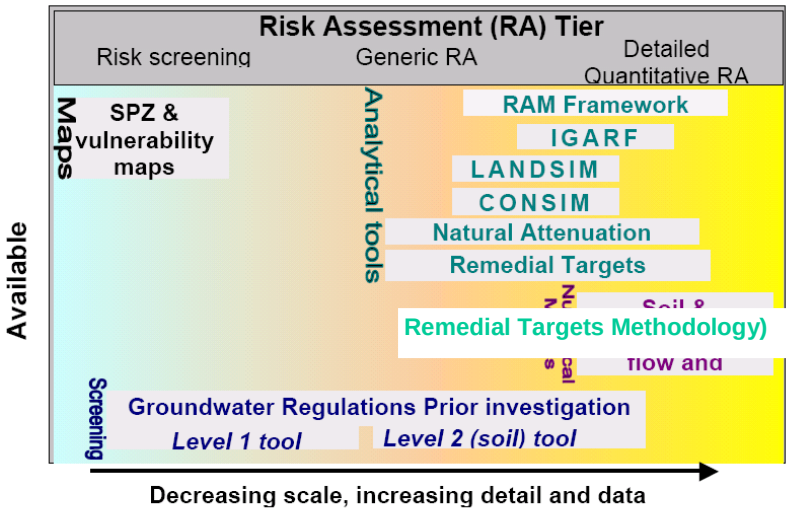


Figure 1-1 Environment Agency groundwater assessment tools, mapped against the different levels of risk assessment.

When assessing groundwater impact the Environment Agency advocate the application of their framework methodology "Remedial Targets Methodology – Hydrogeological Risk Assessment for Land Contamination" Environment Agency (2006). The methodology has four tiers of assessment:

Tier 1 utilises either a soil concentration (calculation of pore water concentrations based on partitioning calculations), leaching test or pore-water concentration of perched water as a source concentration input and these are contrasted directly to water quality standards. No dilution or attenuation is considered at Level 1.

Tier 2 (groundwater) considers dilution of the contaminant within the underlying receiving groundwater or surface water body. To determine a dilution factor the infiltration rate of pore water and the discharge of groundwater beneath the source must be determined. Level 2 Assessment is comprises a comparison between measured groundwater concentrations with to water quality standards.

Tier 3 considers natural attenuation in the form of dispersion, retardation and degradation of the contaminant. As the levels are progressed, the assessment becomes increasingly more detailed and less conservative as the data requirements are increased with each successive tier. The Environment Agency has released Excel Worksheets to carry out basic calculations using a conservative approach up to Tier 3. However, in this case the conceptual model is a simple one and assumes there is a simple migration of contaminants from the source zone into the aquifer receptor. Using these worksheets requires a sensitivity analysis showing how by varying each parameter, what effect it might have on the outcome of the assessment. Groundwater conceptual models are not always this simple.

Tier 4 is for more complex conceptual models where multiple sources, multiple pathways, multiple receptors and complex water balances can be assessed.

The Environment Agency developed a spreadsheet based code to support the Remedial Target Methodology, and the code is capable of undertaking assessments for Tiers 1 to 3. Tier 4 assessment is not supported by the spreadsheet based code.

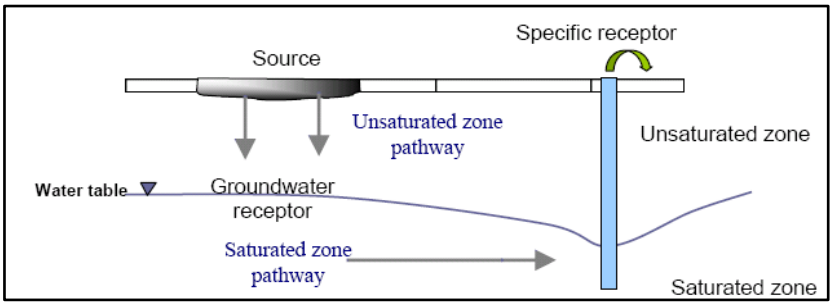
A more advanced code, ConSim 2, developed on behalf of the Environment Agency to support the Remedial Targets Methodology, allows for the introduction of additional geological horizons and is used mainly to determine the concentrations reaching a receptor and the timescales over which this may happen.

The codes assess only the dissolved phase contaminants. There are many further codes commercially available for use in controlled waters risk assessment, particularly for more complex situations, however, these should be used with caution and only once agreement has been obtained from the Environment Agency. All have the overall aim of the estimation of risk from contaminant linkages and the protection of controlled waters.

General notes on each stage of the controlled waters risk assessment process

Risk Screening

The understanding of the Conceptual Site Model (CSM) is the key to assessing any site. Using a robust CSM, potential pathways or receptors may be screened out from any further assessment at an early stage. For example if the pathway through the unsaturated zone is blocked by the presence of a significant thickness of low permeability clay. A greater understanding of the CSM is achieved with each tier of risk assessment. An example of a basic Source-Pathway-Receptor concept is given below (taken from the Environment Agency GP3, 2006):



Generic Risk Assessment

When undertaking the Generic Hydrogeological Risk Assessment (EA Remedial Targets Methodology Tier 1), comparison of chemical analytical results is made with screening criteria. Published values of screening criteria with which chemical test results can be compared are published in the following guidance:
There is a hierarchy of screening criteria which is as follows:

- Updated Recommendations on Environmental Technical Standards, River Basin Management (2015-21), April 2012 by the UK Technical Advisory Group on the Water Framework Directive;

- Environmental Quality Standards (EQS) for freshwaters based on The EC Dangerous Substances Directive (76/464/EEC and Daughter Directives);
- Surface Waters (Abstraction for Drinking Water)(Classification) Regulations (1996)
- Surface Waters (Fishlife) (Classification) Regulations (1997)
- UK Drinking Water Standards (DWS) (Water Supply (Water Quality) Regulations 2000);
- Dutch Ministry of Housing, Spatial Planning and Environment (2001) Intervention Values and Target Values – soil quality standards;
- World Health Organisation Guidelines for Drinking Water (2004)

Should the Level 1 or 2 assessments indicate threshold levels to be exceeded, then there are three alternative ways in which to proceed:

- To devise suitable remedial solutions;
- To carry out more investigation, sampling and analysis;
- To conduct a site-specific Detailed Quantitative Risk Assessment (DQRA) to whether or not the soil materials are suitable for their site-specific intended use or to devise a site-specific clean-up level.

Detailed Quantitative Risk Assessment (DQRA)

The decision to carry out a DQRA will be dependent on the extent and implications of the initial qualitative and generic assessment. The scope of any such assessment will be accurately defined by the outcomes of the former two stages. The CSM will be sufficiently refined by this stage that only certain contaminants of concern, certain pathways and certain receptors will require further assessment, the remainder having been screened out.

Additional site specific data is normally required for this stage of assessment, as explained above, more processes that are capable of affecting contaminant concentrations are considered (such as dilution and attenuation).

Remediation criteria derived will therefore be specific to each site and will be based on a detailed assessment of the potential impact at the identified receptor or *compliance point*. A greater level of confidence can be placed on the predicted impact on the compliance point following a DQRA.

Definition of Controlled Waters

The term ‘controlled waters’ is defined in Section 104 of the Water Resources Act 1991 as:

> *“Territorial Waters…which extend seawards for three miles…, coastal waters…, inland freshwaters, waters in any relevant lake or pond or of so much of any relevant*

river or watercourse as is above the freshwater limit, and ground waters, that is to say, any waters contained in underground strata."

Note that the definition of groundwater under the Water Resources Act 1991 includes all water within underground strata (including soil / pore water in the unsaturated zone). The definition of groundwater under the Groundwater Directive however is limited to water in the saturated zone. For the purposes of Part IIA of the Environmental Protection Act 1990, the Environment Agency recommends that the groundwater within the saturated zone only is considered as the receptor (rather than soil / pore water).

Environment Agency's Aquifer Designations

The Environment Agency have classified different types of aquifer from which groundwater can be extracted. The aquifer designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) but also their role in supporting surface water flows and wetland ecosystems. The aquifer designation data is based on geological mapping provided by the British Geological Survey.

The maps are split into two different types of aquifer designation:

- **Superficial (Drift)** – permeable unconsolidated (loose) deposits.
- **Bedrock (Solid)**– solid permeable formations e.g. sandstone, chalk, limestone.

The aquifer designations displayed on the Environment Agency maps are as follows:

- **Principal Aquifers (formerly termed Major Aquifers) –** These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as a major aquifer.
- **Secondary Aquifers (formerly termed Minor Aquifers) –** These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types:
    - **Secondary A** - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers;
    - **Secondary B** - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.
    - **Secondary Undifferentiated** - has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor

and non-aquifer in different locations due to the variable characteristics of the rock type.

- **Unproductive Strata (formerly termed Non-Aquifer) –** These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Hazardous and Non Hazardous Substances

The Groundwater (England and Wales) Regulations 2009 control the disposal to the hydrogeological environment of potentially polluting substances which are divided into Hazardous Substances and Non-hazardous Contaminants (this roughly approximates to the former List 1 and List 2 substances).

Hazardous Substances are the most damaging and toxic and must be prevented from directly or indirectly entering the groundwater environment. Hazardous Substances include mineral oils and hydrocarbons, pesticides, biocides, herbicides, solvents and some metals. Discharge of Hazardous Substances to Controlled Waters must be prevented.

Non-hazardous Pollutants are any contaminants other than Hazardous Substances. Non-hazardous Pollutants are potentially toxic but are less harmful than Hazardous Substances, but their direct discharge to groundwater is generally not permitted and any indirect discharge to groundwater must be limited and be controlled by technical precautions in order to prevent pollution. Non-hazardous Pollutants include ammonia and nitrites, many metals and fluorides.

MANAGEMENT OF CONTAMINATED LAND

When risk assessment of the site has been completed and this indicates that remedial works are required, the main guidance in managing this process is set out in the DEFRA/EA publication CLR11 (2004) "Model Procedures for the Management of Land Contamination." The stages of managing remediation are as follows:

(a) Options Appraisal and develop Remediation Strategy;
(b) Develop Implementation Plan and Verification Plan;
(c) Remediation, Verification and Monitoring.

The Remediation Strategy sets out the remediation targets, identifies technically feasible remedial solutions and presents an evaluation of the options so that these can be assessed enabling that the most suitable solution is adopted. An outline of the proposed remedial method should be presented. Agreement should be sought of the appropriate statutory bodies for the Remediation Strategy before proceeding to the next stage.

The Implementation Plan is a detailed method statement setting out how the remediation is to be carried out including stating how the site will be managed, welfare procedures, health and safety considerations together with practical measures such as details of temporary works, programme of

works, waste management licences and regulatory consents required. Agreement should again be sought of the appropriate statutory bodies for this Plan.

The Verification Plan sets out the requirements for gathering data to demonstrate that the remediation has met the required remediation objectives and criteria. The Verification Plan presents the requirements for a wide range of issues including the level of supervision, sampling and testing regimes for treated materials, waste and imported materials, required monitoring works during and post remediation, how compliance with all licenses and consents will be checked etc. Agreement should again be sought of the appropriate statutory bodies for the Verification Plan. On completion of the remediation a Verification Report should be produced to provide a complete record of all remediation activities on site and the data collected as required in the Verification Plan. The Verification Report should demonstrate that the remediation has met the remedial targets to show that the site is suitable for the proposed use.

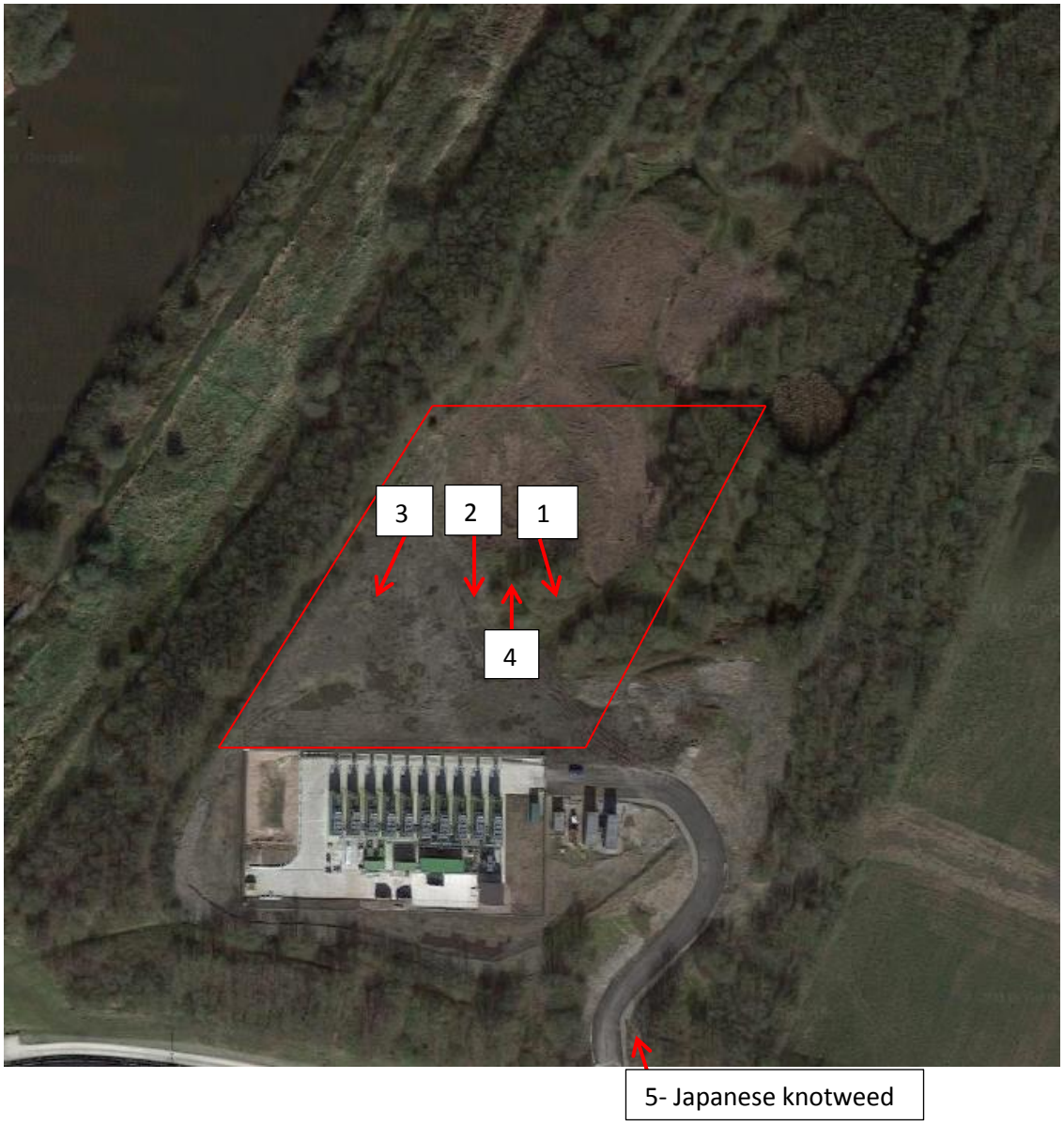
GLOSSARY

TERMS		UNITS	
AST	Above Ground Storage Tank	m	Metres
BGS	British Geological Survey	km	Kilometres
BSI	British Standards Institute	%	Percent
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes	%v/v	Percent volume in air
CIEH	Chartered Institute of Environmental Health	mb	Milli Bars (atmospheric pressure)
CIRIA	Construction Industry Research Association	l/hr	Litres per hour
CLEA	Contaminated Land Exposure Assessment	ha	Hectare (10,000 m^2)
CSM	Conceptual Site Model	µg/l	Micrograms per Litre (parts per billion)
DNAPL	Dense Non-Aqueous Phase Liquid (chlorinated solvents, PCB)	ppb	Parts Per Billion
DWS	Drinking Water Standard	mg/kg	Milligrams per kilogram (parts per million)
EA	Environment Agency	ppm	Parts Per Million
EQS	Environmental Quality Standard	mg/m^3	Milligram per metre cubed
GAC	General Assessment Criteria	Mg/m^3	Megagram per metre cubed
GL	Ground Level	$µg/m^3$	Microgram per metre cubed
GSV	Gas Screening Value	m bgl Level	Metres Below Ground
HCV	Health Criteria Value	m bcl	Metre Below Cover Level
LNAPL	Light Non-Aqueous Phase Liquid (petrol, diesel)	mOD	Metres Above Ordnance Datum (sea level)
ND	Not Detected	kN/m^2	Kilo Newtons per metre squared
LMRL	Lower Method Reporting Limit	kPa kN/m^2	Kilo Pascal – same as
NR	Not Recorded	µm	Micro metre
OD	Ordnance Datum		
PAH	Poly Aromatic Hydrocarbon		
PCB	Poly-Chlorinated Biphenyl		
PID	Photo Ionisation Detector		
PCSM	Preliminary Conceptual Site Model		
SGV	Soil Guideline Value		
TPH (CWG)	Total Petroleum Hydrocarbon (Criteria Working Group)		
SPT	Standard Penetration Test		
SVOC	Semi Volatile Organic Compound		
UST	Underground Storage Tank		
VCCs	Vibro Concrete Columns	VSCs	Vibro Stone Columns
VOC	Volatile Organic Compound		

APPENDIX C

Site Photographs

Photograph Location Plan (Base map from Google Maps ©2018)



Photograph 1: Looking south east towards access road.

Photograph 2: Look south at power station.

Photograph 3: Looking south along western boundary.

Photograph 4: Looking north towards pond

Photograph 5: Japanese Knotweed noted on edge of access road

APPENDIX D

Exploratory Hole Records

SPT Hammer Calibration Certificate

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

ARCHWAY ENGINEERING (UK) LTD
AINLEYS INDUSTRIAL ESTATE
ELLAND
WEST YORKSHIRE
HX5 9JP

SPT Hammer Ref:	AR2470
Test Date:	21/09/2018
Report Date:	21/09/2018
File Name:	AR2470.spt
Test Operator:	SH

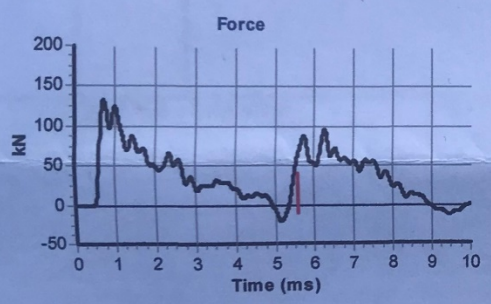
Instrumented Rod Data

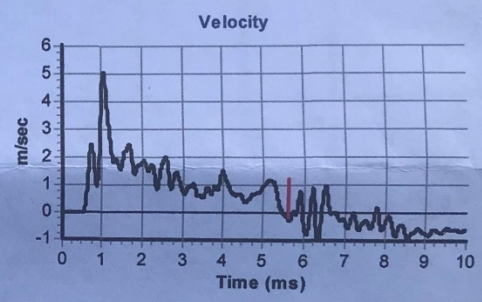
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.3
Assumed Modulus E_a (GPa):	200
Accelerometer No.1:	7080
Accelerometer No.2:	11609

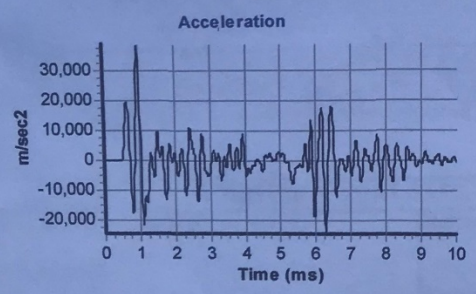
SPT Hammer Information

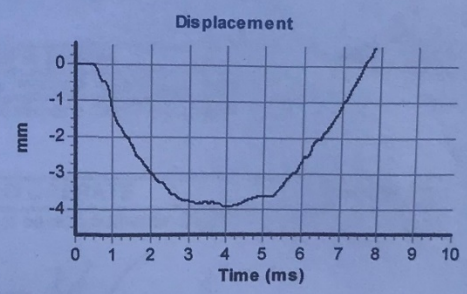
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	10.0

Comments / Location









Calculations

Area of Rod A (mm2):	944
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	359

Energy Ratio E_r (%): 76

Signed: M.GARDNER
Title: FITTER

The recommended calibration interval is 12 months

SPTMAN ver.1.93 All rights reserved, Testconsult ©2010

Borehole Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill bit:	Logger:	Logged:	Remarks:
RO	0.00	10.00	02-10-18	08-10-18	PS	Comacchio 405			BA	08-10-18	
WS	10.00	11.00									
WS	11.50	12.50									
WS	15.00	16.00									
WS	19.50	20.50									

Location details:

mE: 372390.24
mN: 392537.57
mAOD: 25.97
Grid: OSGB

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks/ samples
					Landfill recovered as: Grey clayey silty slightly sandy GRAVEL . Sand is fine to coarse and brown. Gravel is fine to coarse, sub rounded to angular of wood, concrete, brick, plastic and metal. Larger constituents of landfill not recovered, see trial pit logs. (MADE GROUND)						
				(10.00)							
											9.00 - 10.00 B1
	(50) Inst (Ø)		15.97	10.00		Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks

Groundwater entries:
Struck: Rose to: Casing: Sealed:

Diameter & casing:
Dia (mm): Depth: Casing:

Depth related remarks:
From to: Remarks:

Flush details:
Depth: Type: Return: Colour:

AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in meters.

Log issue: DRAFT
Scale: 1:50

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:
BH18-01

Borehole Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill bit:	Logger:	Logged:	Remarks:
RO	0.00	10.00	02-10-18	08-10-18	PS	Comacchio 405			BA	08-10-18	
WS	10.00	11.00									
WS	11.50	12.50									
WS	15.00	16.00									
WS	19.50	20.50									

Location details:

mE: 372390.24
mN: 392537.57
mAOD: 25.97
Grid: OSGB

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks/ samples
					Grey brown slightly gravelly silty SAND. Sand is fine to coarse. Gravel is fine to medium, sub angular to sub rounded of brick and concrete. Hydrocarbon staining and odour present. (MADE GROUND)						10.50 ES2
				(1.50)		3.00	10.00	11.00 - 11.45 S			N=24 (2,3/4,7,6,7) 11.00 D6
			14.47	11.50	Dark grey mottled black soft sandy CLAY. Sand is fine to medium. Hydrocarbon staining and odour present throughout clay. Occational natural organic fibres present. (ALLUVIUM)						11.50 - 13.00 B3
											11.80 ES4
											12.00 D5
						3.00	10.00	12.50 - 12.95 S			N=14 (2,3/3,4,3,4) 12.50 D7
	SP (50)										13.00 - 13.45 B8
				(3.50)							
											14.50 - 15.00 U9
			10.97	15.00	Soft grey mottled brown CLAY. Natural organic odour and occasional fibres present. No hydrocarbon stains or odour . (ALLUVIUM)						15.20 - 15.40 D10
						3.00	10.00	16.00 - 16.45 S			N=15 (2,2/2,4,4,5) 16.00 D11
											16.00 - 17.50 B12
											16.50 - 17.00 U19
				(4.90)	*17.50 - 19.90 m: Clay becomes sandy (fine to medium). No organic matter present.*						17.50 - 19.00 B13
						3.00	10.00	19.00 - 19.45 S			N=26 (1,3/4,7,7,8) 19.00 D14
			6.07	19.90							19.90 - 20.20 D15
	Inst (Ø)					Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks

Samples & In Situ Testing

Groundwater entries:
Struck: Rose to: Casing: Sealed:

Diameter & casing:
Dia (mm): Depth: Casing:

Depth related remarks:
From to: Remarks:

Flush details:
Depth: Type: Return: Colour:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in meters.

Log issue: DRAFT
Scale: 1:50

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:
BH18-01

Borehole Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill bit:	Logger:	Logged:	Remarks:
RO	0.00	10.00	02-10-18	08-10-18	PS	Comacchio 405			BA	08-10-18	
WS	10.00	11.00									
WS	11.50	12.50									
WS	15.00	16.00									
WS	19.50	20.50									

Location details:

mE: 372390.24
mN: 392537.57
mAOD: 25.97
Grid: OSGB

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks/ samples
					Greyish brown SAND. Sand is fine to coarse (GLACIOFLUVIAL DEPOSITS)	3.00	10.00	20.50 - 20.95 S			N=24 (1,4/5,6,6,7)
				(3.60)							22.00 - 23.50 B16
			2.47	23.50	Firm reddish brown gravelly CLAY. Gravel is fine to coarse, sub angular to sub rounded of mixed lithologies. (GLACIAL TILL)						23.50 D17 23.50 - 25.00 B18
				(1.50)							
			0.97	25.00	Grey GRAVEL. Gravel is fine to coarse, sub rounded to sub angular of mixed lithologies. (GLACIAL TILL)						
				(1.50)							
			-0.53	26.50	Weathered sandstone recovered as brownish red clayey silty slightly gravelly SAND. Sand is fine to medium. Gravel is fine to coarse, sub angular to sub rounded of sandstone. (WILMSLOW SANDSTONE FORMATION)	3.00	10.00	~~26.50 - 26.85~~ S			50 (3,7/50 for 200mm)
				(1.50)				26.50 - 28.00	100 n/a n/a		
			-2.03	28.00	Weathered Sandstone recovered as: reddish brown gravelly slightly clayey fine-medium SAND. Gravel is sub angular of sandstone						
			-2.26	28.23	Extremely weak reddish brown fine to medium grained SANDSTONE						
			-2.48	28.45	Extremely weak reddish brown fine to medium grained SANDSTONE (WILMSLOW SANDSTONE FORMATION)						
			-2.66	28.63	Completely weathered very thinly to thickly laminated SANDSTONE - Reddish brown slightly clayey fine to medium SAND (WILMSLOW SANDSTONE FORMATION)			28.00 - 29.50	100 23 17		
				(0.87)	*28.63 - 28.69 m: Sand is grey*						
			-3.53	29.50	AZCL	5.00	10.00	~~29.50 - 29.80~~ S			50 (6,14/50 for 150mm)
			-3.73	29.70	Extremely weak reddish brown fine to medium grained SANDSTONE (WILMSLOW SANDSTONE FORMATION)						
			-4.01	29.98							
	Inst (Ø)					Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks

Groundwater entries:
Struck: Rose to: Casing: Sealed:

Diameter & casing:
Dia (mm): Depth: Casing:

Depth related remarks:
From to: Remarks:

Flush details:
Depth: Type: Return: Colour:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in meters.

Log issue: DRAFT
Scale: 1:50

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:
BH18-01

Borehole Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill bit:	Logger:	Logged:	Remarks:
RO	0.00	10.00	02-10-18	08-10-18	PS	Comacchio 405			BA	08-10-18	
WS	10.00	11.00									
WS	11.50	12.50									
WS	15.00	16.00									
WS	19.50	20.50									

Location details:

mE: 372390.24
mN: 392537.57
mAOD: 25.97
Grid: OSGB

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks/ samples
				(0.70)	Weathered sandstone recovered as: reddish brown slightly clayey fine-medium SAND. (WILMSLOW SANDSTONE FORMATION)			29.50 - 31.00	87 31 19		
			-4.71	30.68	Extremely weak reddish brown fine to medium grained SANDSTONE						
			-4.77	30.74	Weathered sandstone recovered as: reddish brown slightly clayey fine to medium SAND. (WILMSLOW SANDSTONE FORMATION)						
	SPIE (19)		-5.03	31.00		5.20	10.00	31.00 - 31.28 C			50 (8,11/50 for 135mm)

Borehole ends at 31.00 m (Termination reason: Target depth reached)

Inst (Ø)	Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks

Groundwater entries:
Struck: Rose to: Casing: Sealed:

Diameter & casing:
Dia (mm): Depth: Casing:

Depth related remarks:
From to: Remarks:

Flush details:
Depth: Type: Return: Colour:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in meters.

Log issue: DRAFT
Scale: 1:50

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:
BH18-01

Borehole Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill bit:	Logger:	Logged:	Remarks:
RO	0.00	10.00	25-09-18	01-10-18	PS	Comacchio 405			BA	01-10-18	
WS	10.00	19.00									
RC	19.00	20.50									
WS	20.50	21.50									
RC	21.50	23.50									

Location details:

mE: 372366.47
mN: 392530.15
mAOD: 25.93
Grid: OSGB

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks/ samples
					Landfill recovered as: Grey clayey silty slightly sandy GRAVEL . Sand is fine to coarse and brown. Gravel is fine to coarse, sub rounded to angular of concrete, brick, plastic and metal. Cobble sized lumps of brown firm clay. Larger constituents of landfill not recovered, see trial pit logs. (MADE GROUND)						
	(50)										
					2.50 m: Asbestos bags						
											4.00 ES1
				(10.00)							5.00 ES2
											6.00 ES3
											7.00 ES4
	(50)										
	Inst (Ø)		15.93	10.00		Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks

Samples & In Situ Testing

Groundwater entries:

Struck: Rose to: Casing: Sealed:

Diameter & casing:

Dia (mm): Depth: Casing: 10.00

Depth related remarks:

From to: Remarks:

Flush details:

Depth: Type: Return: Colour:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in meters.

Log issue: DRAFT
Scale: 1:50

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:

BH18-02A

Borehole Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill bit:	Logger:	Logged:	Remarks:
RO	0.00	10.00	25-09-18	01-10-18	PS	Comacchio 405			BA	01-10-18	
WS	10.00	19.00									
RC	19.00	20.50									
WS	20.50	21.50									
RC	21.50	23.50									

Location details:

mE: 372366.47
mN: 392530.15
mAOD: 25.93
Grid: OSGB

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks/ samples
					Grey slightly sandy GRAVEL. Sand is fine to coarse. Gravel is sub angular to sub rounded, fine to coarse of concrete and brick. (MADE GROUND)						
					10.50 - 11.50 m: Black hydrocarbon staining in patches						
				(1.50)		4.20	10.00	11.00 - 11.45 S			N=10 (1,2/2,2,3,3)
			14.43	11.50	Soft grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is sub angular to sub rounded, fine of mixed lithologies. (ALLUVIUM)						11.50 - 13.00 B5
											12.00 - 12.10 D6
					13.00 - 17.50 m: Clay becoming very soft to soft in places	5.90	10.00	13.00 - 13.45 S			N=10 (2,2/2,2,3,3) 13.00 D7
					13.00 - 18.70 m: Fibrous organic matter present						13.00 - 14.50 B8
											14.50 D9 14.50 - 16.00 B10
				(7.20)							
						5.90	10.00	16.00 - 16.45 S			N=15 (2,2/2,4,4,5) 16.00 D11
											16.90 - 17.10 D12
					17.45 - 18.70 m: Clay becoming soft with a natural organic odour and no sand or gravel	5.70	10.00	17.50 - 17.95 S			17.45 D13 N=12 (1,2/2,3,3,4)
											18.25 - 18.45 D14
			7.23	18.70	Brown SAND. Sand is fine to coarse. (GLACIOFLUVIAL DEPOSITS)						
								19.00 - 20.50	0 n/a n/a		
	Inst (Ø)					Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks

Groundwater entries:

Struck: Rose to: Casing: Sealed:

Diameter & casing:

Dia (mm): Depth: Casing: 10.00

Depth related remarks:

From to: Remarks:

Flush details:

Depth: Type: Return: Colour:

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in meters.

Log issue: DRAFT
Scale: 1:50

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:

BH18-02A

Borehole Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill bit:	Logger:	Logged:	Remarks:
RO	0.00	10.00	25-09-18	01-10-18	PS	Comacchio 405			BA	01-10-18	
WS	10.00	19.00									
RC	19.00	20.50									
WS	20.50	21.50									
RC	21.50	23.50									

Location details:

mE: 372366.47
mN: 392530.15
mAOD: 25.93
Grid: OSGB

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks/ samples
				(2.80)		5.70	10.00	~~20.50 - 20.95~~ S			N=16 (2,5/8,4,2,2) 20.50 - 21.05 B15
			4.43	21.50	Firm to stiff red brown gravelly CLAY. Gravel is sub rounded to sub angular, fine to coarse of mixed lithologies. (GLACIAL TILL)			21.50 - 22.00	40 n/a n/a		21.50 - 22.00 B16
				(2.00)				22.00 - 23.50	87 n/a n/a		22.00 - 22.10 D17 23.00 - 23.10 D18
			2.43	23.50	Slightly sandy GRAVEL. Sand is fine to coarse. Gravel is sub angular to sub rounded, fine to coarse of mixed lithologies. (GLACIAL TILL)	5.70	10.00	~~23.50 - 23.68~~ S			50 (7,18/50 for 30mm) 23.50 D19 23.50 - 25.00 B20
				(3.00)							25.00 - 26.50 B21
			-0.57	26.50	Weathered sandstone recovered as: Reddish brown slightly gravelly silty SAND. Sand is fine to coarse. Gravel is sub rounded, fine to medium of sandstone. (WILMSLOW SANDSTONE FORMATION)	5.70	10.00	26.50 - 26.79 S			50 (4,9/50 for 140mm) 26.50 D23 26.50 - 28.00 B22
											28.00 - 29.50 B24
				(4.50)							
						5.00	10.00	29.50 - 29.78 S			50 (5,11/50 for 130mm) 29.50 D25 29.50 - 31.00 D26
	Inst (Ø)					Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks

Groundwater entries:
Struck: Rose to: Casing: Sealed:

Diameter & casing:
Dia (mm): Depth: Casing: 10.00

Depth related remarks:
From to: Remarks:

Flush details:
Depth: Type: Return: Colour:

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in meters.

Log issue: DRAFT
Scale: 1:50

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:
BH18-02A

Borehole Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill bit:	Logger:	Logged:	Remarks:
RO	0.00	10.00	25-09-18	01-10-18	PS	Comacchio 405			BA	01-10-18	
WS	10.00	19.00									
RC	19.00	20.50									
WS	20.50	21.50									
RC	21.50	23.50									

Location details:

mE: 372366.47
mN: 392530.15
mAOD: 25.93
Grid: OSGB

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks/ samples
	SP		-5.07	31.00	Borehole ends at 31.00 m (Termination reason: Run out of casing)						
	Inst (Ø)					Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks

Groundwater entries:

Struck: Rose to: Casing: Sealed:

Diameter & casing:

Dia (mm): Depth: Casing: 10.00

Depth related remarks:

From to: Remarks:

Flush details:

Depth: Type: Return: Colour:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in meters.

Log issue: DRAFT
Scale: 1:50

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:

BH18-02A

TerraConsult
PROJECT
GENSSIS, CARRINGTON
PROJECT NO
16094
BH
18-01
DEPTH (M)
28.00-31.00
BOX
1 OF 1
100
200
300
400
500
600
700
800
900
1000

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	BA	Method:	Machine Excavated Trial Pit	Width:	0.90	mE:	372460.79	Start:	02/10/2018
Checked by:				Length:	2.40	mN:	392505.67	End:	
		Plant:	JCB 3CX	**Orientation:**		mAOD:	26.60	Logged:	26/09/2018
		Shoring:		Bearing = 340		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			(1.00)	Dark brown sandy gravelly CLAY. Gravels are fine to coarse, angular to sub rounded of concrete and brick. High cobble content of sub angular to sub rounded brick and concrete. (MADE GROUND)	0.50 0.50	B1 ES1	
			25.60 1.00	Grey GRAVEL. Gravel is sub angular to sub rounded, fine to coarse of concrete. (MADE GROUND)	1.00 1.00	B2 ES2	
			25.50 1.10	Landfill recovered as bricks, concrete, plastic, metal, wood, fabric and carpet in a dark brown sandy gravelly clay matrix (40%). High cobble and boulder content. (MADE GROUND)			
			(1.30)		2.00 2.00	B3 ES3	
			24.20 2.40	Trial pit ends at 2.40m (Refusal)			

Groundwater entries:			Depth related remarks:			General remarks:
Depth:	Rose to:	Remarks:	From	to:	Remarks:	Weather:
						Stability:
						Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in metres.

Log issue: DRAFT
Scale: 1:25

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:

TP18-01

Sheet 1 of 1

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	BA	Method:	Machine Excavated Trial Pit	Width:	1.10	mE:	372444.08	Start:	26/09/2018
Checked by:				Length:	3.00	mN:	392524.65	End:	26/09/2018
		Plant:	JCB 3CX	**Orientation:**		mAOD:	27.11	Logged:	26/09/2018
		Shoring:		Bearing = 88		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			(1.10)	Dark brown sandy gravelly CLAY. Gravels are fine to coarse, angular to sub rounded of concrete and brick. High cobble content of sub angular to sub rounded brick and concrete. (MADE GROUND)	0.70 0.70	B1 ES1	
			26.01 1.10	Grey GRAVEL. Gravel is sub angular to sub rounded, fine to coarse of concrete. (MADE GROUND)			
			25.81 1.30	Landfill recovered as bricks, concrete, plastic, metal, wood and tarmac in a dark brown sandy gravelly clay matrix (30%). High cobble and boulder content. (MADE GROUND) *1.50 - 3.00 m: Black hydrocarbon staining and odour*	1.70 1.70	B2 ES2	
			(1.00)				
			24.81 2.30	Soft grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to medium, sub angular to sub rounded of concrete. High cobble content of sub angular to sub rounded concrete. (MADE GROUND)	2.40 2.40	B3 ES3	
			(0.70)				
			24.11 3.00	Trial pit ends at 3.00m (Refusal)	3.00 3.00	B4 ES4	

Groundwater entries:			Depth related remarks:			General remarks:
Depth:	Rose to:	Remarks:	From	to:	Remarks:	Weather:
						Stability:
						Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in metres.

Log issue: DRAFT

Scale: 1:25

Project: Project GENSSIS, Carrington

Project No: 4133

Client: Marriott Drilling Group

Exploratory position reference:

TP18-02

Sheet 1 of 1

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	BA	Method:	Machine Excavated Trial Pit	Width:	0.90	mE:	372405.55	Start:	26/09/2018
Checked by:				Length:	2.90	mN:	392512.25	End:	26/09/2018
		Plant:	JCB 3CX	**Orientation:**		mAOD:	26.02	Logged:	27/09/2018
		Shoring:		Bearing = 298		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			(0.30)	Grey GRAVEL. Gravel is sub angular to sub rounded, fine to coarse of concrete. (MADE GROUND)			
			25.72 0.30	Landfill recovered as bricks, concrete, plastic, metal, wood, tarmac and tiles in a dark brown sandy gravelly clay matrix (40%). High cobble and boulder content. (MADE GROUND)			
				0.30 - 3.00 m: Hydrocarbon odour and sporadic staining.	0.60	B1	
					1.20	B2	
					1.20	ES1	
			(2.10)				
			23.62 2.40	Grey clayey gravel. Gravel is sub angular to sub rounded, fine to coarse of concrete, brick and plastic. Medium cobble content of sub angular to sub rounded concrete. (MADE GROUND)	2.40	B3	
			(0.60)				
				2.90 - 3.00 m: Wet	2.90	B4	
					2.90	ES2	
			23.02 3.00	Trial pit ends at 3.00m (Refusal)			

Groundwater entries:			Depth related remarks:			General remarks:
Depth:	Rose to:	Remarks:	From	to:	Remarks:	Weather:
						Stability:
						Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in metres.

Log issue: DRAFT
Scale: 1:25

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:

TP18-03

Sheet 1 of 1

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	BA	Method:	Machine Excavated Trial Pit	Width:	1.00	mE:	372422.77	Start:	27/09/2018
Checked by:				Length:	2.60	mN:	392562.19	End:	27/09/2018
		Plant:	JCB 3CX	**Orientation:**		mAOD:	26.09	Logged:	01/10/2018
		Shoring:		Bearing = 49		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			(0.30)	Dark brown gravelly CLAY. Gravel is fine to medium, sub angular to sub rounded of brick and concrete. Abundant rootlets present. (TOPSOIL)	0.10 0.10	B1 ES1	
			25.79 0.30	Landfill recovered as concrete, brick, plastic and wood in a dark brown sandy gravelly clay matrix (30%). High cobble and boulder content. (MADE GROUND) *0.30 - 3.20 m: Hydrocarbon odour and sporadic staining.*	1.40 1.40	B2 ES2	
			(2.90)	*1.50 - 3.20 m: Ground water - high inflow*	2.20 2.20	B3 ES3	
			22.89 3.20	Trial pit ends at 3.20m (Target depth reached)	3.00 3.00	B4 ES4	

Depth	Type & No	Results

Groundwater entries:

Depth:	Rose to:	Remarks:

Depth related remarks:

From	to:	Remarks:

General remarks:
Weather:
Stability:
Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in metres.

Log issue: DRAFT
Scale: 1:25

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:
TP18-04

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	BA	Method:	Machine Excavated Trial Pit	Width:	1.00	mE:	372402.81	Start:	01/10/2018
Checked by:				Length:	2.60	mN:	392533.08	End:	01/10/2018
		Plant:	JCB 3CX	**Orientation:**		mAOD:	26.23	Logged:	01/10/2018
		Shoring:		Bearing = 222		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			(0.30) 25.93 0.30	Dark brown gravelly CLAY. Gravel is fine to medium, sub angular to sub rounded of brick and concrete. Abundant rootlets present. (MADE GROUND)			
			(1.20) 24.73 1.50	Dark brown clayey GRAVEL. Gravel is angular to sub rounded, fine to coarse of brick and conrete. High cobble content of sub angular brick and concrete. (MADE GROUND) *0.30 - 3.20 m: Hydrocarbon odour and sporadic staining.*	0.50 0.50 1.20 1.20	B1 ES1 B2 ES2	
			(1.50) 24.53 1.70	Grey gravelly CLAY. Gravel is fine to coarse, sub angular to sub rounded of concrete and brick. (MADE GROUND)			
			23.03 3.20	Dark brown clayey GRAVEL. Gravel is angular to sub rounded, fine to coarse of brick and conrete. High cobble content of sub angular brick and concrete. (MADE GROUND)	2.60 2.60 3.10 3.10	B3 ES3 B4 ES4	
				Trial pit ends at 3.20m (Refusal)			

Groundwater entries:			Depth related remarks:			General remarks:
Depth:	Rose to:	Remarks:	From	to:	Remarks:	Weather:
						Stability:
						Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in metres.

Log issue: DRAFT

Scale: 1:25

Project: Project GENSSIS, Carrington

Project No: 4133

Client: Marriott Drilling Group

Exploratory position reference:

TP18-05

Sheet 1 of 1

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	BA	Method:	Machine Excavated Trial Pit	Width:	1.60	mE:	372384.59	Start:	01/10/2018
Checked by:				Length:	2.90	mN:	392573.89	End:	01/10/2018
		Plant:	JCB 3CX	**Orientation:**		mAOD:	24.04	Logged:	27/09/2018
		Shoring:		Bearing = 51		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			23.84 0.20	Dark brown gravelly CLAY. Gravel is fine to medium, sub angular to sub rounded of brick and concrete. Abundant rootlets and wood chippings present. (TOPSOIL)			
			(1.00)	Landfill recovered as metal, concrete, brick, tarmac and wood in a grey sandy gravelly clay matrix (40%). High cobble and boulder content (MADE GROUND) *0.20 - 3.50 m: Hydrocarbon odour and sporadic staining.*			
			22.84 1.20	Grey clayey GRAVEL. Gravel is sub angular to sub rounded, fine to coarse of concrete. (MADE GROUND) *1.20 - 3.50 m: Ground water - high inflow*	1.20 1.20	B1 ES1	
			(0.80)				
			22.04 2.00	Landfill recovered as glass, concrete, brick, tarmac and wood in a brownish grey sandy gravelly clay matrix (30%). High cobble and boulder content (MADE GROUND)	2.00 2.30	B2 B3	
			(1.50)				
			20.54 3.50	Trial pit ends at 3.50m (Target depth reached)	3.50 3.50	B4 ES2	

Groundwater entries:			Depth related remarks:			General remarks:
Depth:	Rose to:	Remarks:	From	to:	Remarks:	Weather:
						Stability:
						Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in metres.

Log issue: DRAFT
Scale: 1:25

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:

TP18-06

Sheet 1 of 1

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	BA	Method:	Machine Excavated Trial Pit	Width:	1.00	mE:	372380.25	Start:	27/09/2018
Checked by:				Length:	2.90	mN:	392513.38	End:	27/09/2018
		Plant:	JCB 3CX	**Orientation:**		mAOD:	26.00	Logged:	27/09/2018
		Shoring:		Bearing = 0		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			25.90 0.10	Grey gravelly CLAY. Gravel is fine to coarse, sub angular to sub rounded of concrete and brick. Abundant rootlets present. (TOPSOIL)			
			(1.10)	Landfill recovered as tarmac, concrete, brick, metal, wood and plastic in a dark brown gravelly sandy clay matrix (50%). With a high cobble and boulder content. (MADE GROUND) *0.10 - 3.20 m: Hydrocarbon odour and sporadic staining.*	1.00 1.00	B1 ES1	
			24.80 1.20	Red GRAVEL and COBBLES. Gravel is fine to coarse, angular to sub rounded of brick. Cobbles are sub angular to sub rounded of brick. Brick boulders present (MADE GROUND)			
			(0.80)				
			24.00 2.00	Landfill recovered as plastic, metal, wood, brick in a dark brown sandy gravelly clay matrix (40%). (MADE GROUND) *2.00 - 3.20 m: Clay matrix content decreses with depth to pure landfill at base of hole consisting of metal, wood and plastic*	2.00 2.00	B2 ES2	
			(1.20)				
			22.80 3.20	Trial pit ends at 3.20m (Refusal)			

Depth	Type & No	Results

Groundwater entries:

Depth:	Rose to:	Remarks:

Depth related remarks:

From	to:	Remarks:

General remarks:
Weather:
Stability:
Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in metres.

Log issue: DRAFT
Scale: 1:25

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:
TP18-07

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	BA	Method:	Machine Excavated Trial Pit	Width:	1.40	mE:	372373.53	Start:	27/09/2018
Checked by:				Length:	3.30	mN:	392548.95	End:	27/09/2018
		Plant:	JCB 3CX	**Orientation:**		mAOD:	26.07	Logged:	27/09/2018
		Shoring:		Bearing = 30		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			25.92 0.15	Grey gravelly CLAY. Gravel is fine to medium, sub angular to sub rounded of brick and concrete. Abundant rootlets present. (TOPSOIL)			
			(0.75)	Clayey sandy GRAVEL. Sand is fine to coarse. Gravel is fine to medium, sub angular to sub rounded of concrete and brick. (MADE GROUND) *0.15 - 2.10 m: Hydrocarbon odour and sporadic staining.*	0.50	B1	
			25.17 0.90	Landfill recovered as metal, asphalt, concrete, brick, tarmac and wood in a dark brown sandy gravelly clay matrix (40%). High cobble and boulder content. ACM material encountered as white fibrous tiles and red bag fragments. (MADE GROUND) *0.90 - 2.10 m: Decrease in clay matrix and increase in cobble and boulder content with depth*	1.30 1.30	B2 ES1	
			(1.20)				
			23.97 2.10	Trial pit ends at 2.10m (ACM encountered)			

Groundwater entries:			Depth related remarks:			General remarks:
Depth:	Rose to:	Remarks:	From	to:	Remarks:	Weather:
						Stability:
						Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in metres.

Log issue: DRAFT

Scale: 1:25

Project: Project GENSSIS, Carrington

Project No: 4133

Client: Marriott Drilling Group

Exploratory position reference:

TP18-08

Sheet 1 of 1

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	BA	Method:	Machine Excavated Trial Pit	Width:		mE:	372360.71	Start:	27/09/2018
Checked by:				Length:		mN:	392573.61	End:	27/09/2018
		Plant:	JCB 3CX	**Orientation:**		mAOD:	26.31	Logged:	27/09/2018
		Shoring:		Bearing = 329		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			26.06 0.25	Dark brown gravelly CLAY. Gravel is fine to medium, sub angular to sub rounded of brick and concrete. Abundant rootlets present. (MADE GROUND)			
			(1.75)	Landfill recovered as plastic, metal, concrete, brick, tarmac and wood in a dark brown sandy gravelly clay matrix (30%). ACM encountered in labelled red hazard bags. (MADE GROUND) *0.25 - 1.00 m: Hydrocarbon odour and sporadic staining.* *1.50 - 2.00 m: ACM hazard bags.*	1.00 1.00	B1 ES1	
			24.31 2.00	Trial pit ends at 2.00m (ACM encountered)			

Depth	Type & No	Results

Groundwater entries:

Depth:	Rose to:	Remarks:

Depth related remarks:

From	to:	Remarks:

General remarks:
Weather:
Stability:
Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in metres.

Log issue: DRAFT
Scale: 1:25

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:
TP18-09

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	BA	Method:	Machine Excavated Trial Pit	Width:	1.20	mE:	372353.23	Start:	27/09/2018
Checked by:				Length:	3.00	mN:	392547.71	End:	27/09/2018
		Plant:	JCB 3CX	**Orientation:**		mAOD:	26.10	Logged:	27/09/2018
		Shoring:		Bearing = 107		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			25.95 0.15	Grey gravelly CLAY. Gravel is fine to medium, sub angular to sub rounded of brick an concrete. Abundant rootlets present. (TOPSOIL)			
			(2.05)	Landfill recovered as plastic, brick, wood, tarmac, concrete, metal in a dark brown sandy gravelly clay matrix (40%). High cobble and boulder content. (MADE GROUND) *0.15 - 3.20 m: Hydrocarbon odour and sporadic staining.*	0.80	B1	
					1.70	B2	
					1.70	ES1	
			23.90 2.20	Landfill recovered as plastic, metal and wood. (MADE GROUND)			
			(0.60)				
			23.30 2.80	Landfill recovered as plastic, brick, wood, tarmac, concrete, metal in a dark brown gravelly sandy clay matrix (40%). High cobble and boulder content. (MADE GROUND) *3.00 - 3.20 m: Wet*	2.80	B3	
			(0.40)				
			22.90 3.20	Trial pit ends at 3.20m (Refusal)	3.20	B4	
					3.20	ES2	

Depth	Type & No	Results

Groundwater entries:

Depth:	Rose to:	Remarks:

Depth related remarks:

From	to:	Remarks:

General remarks:
Weather:
Stability:
Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in metres.

Log issue: DRAFT
Scale: 1:25

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:
TP18-10

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	BA	Method:	Machine Excavated Trial Pit	Width:	1.20	mE:	372341.87	Start:	27/09/2018
Checked by:				Length:	3.00	mN:	392516.05	End:	27/09/2018
		Plant:	JCB 3CX	**Orientation:**		mAOD:	25.78	Logged:	27/09/2018
		Shoring:		Bearing = 12		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			25.68 0.10	Dark brown gravelly CLAY. Gravel is fine to medium, sub angular to sub rounded of brick and concrete. Abundant rootlets present. (TOPSOIL)			
			(0.50)	Dark brown clayey GRAVEL. Gravel is fine to medium, sub angular to sub rounded of brick, concrete, tarmac. Medium cobble content of sub rounded to sub angular brick, concrete and tarmac. Carpet fragments present (MADE GROUND)			
				0.10 - 2.20 m: Hydrocarbon odour and sporadic staining.			
			25.18 0.60	Landfill recovered as plastic, brick, tarmac, asphalt, concrete and carpet in a dark brown sandy gravelly clay matrix (40%). High cobble and boulder content. Suspected ACM encountered, red bags and white fibrous tiles. (MADE GROUND)	0.60 0.60	B1 ES1	
			(1.60)		1.50 1.50	B2 ES2	
			23.58 2.20	Trial pit ends at 2.20m (ACM encountered)			

Groundwater entries:			Depth related remarks:			General remarks:
Depth:	Rose to:	Remarks:	From	to:	Remarks:	Weather:
						Stability:
						Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in metres.

Log issue: DRAFT

Scale: 1:25

Project: Project GENSSIS, Carrington

Project No: 4133

Client: Marriott Drilling Group

Exploratory position reference:

TP18-11

Sheet 1 of 1

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	BA	Method:	Machine Excavated Trial Pit	Width:	1.20	mE:	372332.08	Start:	27/09/2018
Checked by:				Length:	3.20	mN:	392539.97	End:	27/09/2018
		Plant:	JCB 3CX	**Orientation:**		mAOD:	26.00	Logged:	27/09/2018
		Shoring:		Bearing = 263		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			(0.40) 25.60 0.40	Dark brown gravelly CLAY. Gravel is fine to medium, sub angular to sub rounded of brick and concrete. Abundant rootlets present. (TOPSOIL)			
			(0.40) 25.20 0.80	Dark brown clayey GRAVEL. Gravel is fine to medium, sub angular to sub rounded of brick, concrete, tarmac, plastic and wood. Medium cobble content of sub rounded to sub angular brick, concrete and tarmac. (MADE GROUND)	0.50 0.50	B1 ES1	
			(0.40) 24.80 1.20	Red GRAVEL and COBBLES. Gravel is fine to coarse, angular to sub rounded of brick. Brick boulders present (MADE GROUND)			
			(1.00) 23.80 2.20	*1.15 - 3.00 m: Ground water - steady inflow* Dark brown clayey GRAVEL. Gravel is fine to medium, sub angular to sub rounded of brick, concrete, tarmac, plastic and wood. Medium cobble content of sub rounded to sub angular brick, concrete and tarmac. (MADE GROUND)	1.20	B2	
			(0.80) 23.00 3.00	Landfill recovered as plastic, metal, concrete, brick, fabric and wood. Possible ACM encountered red bag fragments and white fibrous tiles. (MADE GROUND)	2.20 2.20	B3 ES2	
				Trial pit ends at 3.00m (Refusal/ACM)			

Groundwater entries:			Depth related remarks:			General remarks:
Depth:	Rose to:	Remarks:	From	to:	Remarks:	Weather:
						Stability:
						Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in metres.

Log issue: DRAFT
Scale: 1:25

Project: Project GENSSIS, Carrington
Project No: 4133
Client: Marriott Drilling Group

Exploratory position reference:
TP18-12

TP18-01
TerraConsult
26/9/18
PROJECT
GENESIS, CARRINGTON
PROJECT NO
16094
TP
TP18-01
DEPTH (M)
2.40m
FACE

TP18-01
TerraConsult
26/9/18
PROJECT
GENESIS, CARRINGTON
PROJECT NO
16094
TP
TP18-01
DEPTH (M)
2.40m
FACE

TP18-02

TP18-02
TerraConsult
26 / 9 / 18
PROJECT
GENESIS, CARRINGTON
PROJECT NO
16094
TP
TP18-02
DEPTH (M)
3.0 m
FACE

TP18-03
TerraConsult
PROJECT
PROJECT NO
16094
TP
TP18-03
DEPTH (M)
3.0 M
FACE

TP18-03
TerraConsult
27/9/18
PROJECT
PROJECT NO
TP
DEPTH (M)
FACE

TP18-04
TerraConsult
PROJECT
PROJECT NO
TP
DEPTH (M)
FACE

TP18-04
TerraConsult
1/10/
PROJECT
PROJECT NO
1694
TP
DEPTH (M)
3.2 m
FACE

TP18-05
TerraConsult
1/10/18
PROJECT
GENESIS, CARRINGTON
PROJECT NO
1694
TP
T18-05
DEPTH (M)
3.2 m
FACE

TP18-05
TerraConsult
1/15/18
PROJECT
PROJECT NO
TP
DEPTH (M)
FACE
GENESIS, CARRINGTON
16094
T18-05
3.2 M

TP18-06
TerraConsult
PROJECT
PROJECT NO
TP
DEPTH (M)
FACE
3.5 M

TP18-06
TerraConsult
PROJECT
PROJECT NO
TP
DEPTH (M)
FACE

TP18-07
27/9/18
GENESIS, CARRINGTON
16094
TP18-07
3.20M

TP18-07
TerraConsult
27/9/18
PROJECT
GENESIS, CARRINGTON
PROJECT NO
16094
TP
TP18-07
DEPTH (M)
3.20M
FACE

TP18-10
TerraConsult
27/9/18
PROJECT
GENESIS, CARRINGTON
PROJECT NO
16094
TP
TP18-10
DEPTH (M)
3.20M
FACE

TP18-10
TerraConsult
27/9/18
PROJECT
GENESIS, CARRINGTON
PROJECT NO
16094
TP
TP18-10
DEPTH (M)
3.20M
FACE

TP18-12
TerraConsult
27/9/18
PROJECT
GENESIS, CARRINGTON
PROJECT NO
160914
TP
TP18-12
DEPTH (M)
3.00M
FACE

TP18-12
TerraConsult
27/9/18
PROJECT
GENESIS, CARRINGTON
PROJECT NO
16094
TP
TP18-12
DEPTH (M)
3.00M
FACE

APPENDIX E

Gas and Groundwater Monitoring

No: 4133

GROUNDWATER AND GROUND GAS MONITORING

TerraConsult

Site: Carrington

Location	Date	Monitored by	Well Details		Groundwater		Gas												Weather		Serial No.
			Standpipe diameter (mm)	Depth to Base (m bgl)	Water Depth (m bgl)	Water Sample Taken?	Atmospheric Pressure (mbar)	Atmospheric Pressure Comment	Relative Pressure (mb)	Flow (l/h)	Peak Flow (l/h)	CH_4 (% v/v)	GSV CH_4 (l/hr)	CO_2 (% v/v)	GSV CO_2 (l/hr)	O_2 (% v/v)	CO (ppm)	H2S (ppm)	Conditions	Ambient Temp °C	
BH18-01	19/10/18	BA	25	30.00	15.63	N	Piezometer only														
	22/10/18	LM	25	30.00	15.74	N	Piezometer only														
	08/11/18	GB	25	30.00	15.13	N	Piezometer only												Overcast	10	11380
BH18-01	19/10/18	BA	51	13.13	8.06	Y															
	22/10/18	LM	51	13.13	8.55	N	1038	Steady	0.04	0.6	0.6	0.1	0.0006	0.1	0.0006	18.4	1	1	Sunny	11	12417
	08/11/18	GB	51	12.84	8.71	N	1013	Steady	0.01	0.1	0.1	2.4	0.0024	0.3	0.0003	15.5	1	1	Overcast	10	11380
													0.0000		0.0000						
													0.0000		0.0000						
BH18-02A	19/10/18	BA	51	8.72	3.25	Y															
	22/10/18	LM	51	8.72	3.40	N	1038	Steady	0.02	0.3	0.3	12.4	0.0372	1.5	0.0045	0.1	1	1	Sunny	11	12417
	08/11/18	GB	51	8.80	3.50	N	1013	Steady	0.01	0.1	0.1	13.1	0.0131	1.6	0.0016	0.7	1	1	Overcast	10	11380
													0.0000		0.0000						
													0.0000		0.0000						
													0.0000		0.0000						
GEG BH01 (2015 Historic BH)	22/10/18	LM	51		Blocked	N													Sunny	14	12417
	08/11/18	GB	BH appears grouted up to ground level				1013	Steady	0.01	0.1	0.1	13.1	0.0131	0.5	0.0005	19.5	1	1	Overcast	10	11380
GEG BH02 (2015 Historic BH)	02/10/18	BA	51		7.86	N	1021	Steady	0.04	1.6	3.1	48.3	0.7728	3.1	0.0496	0.1	1	1	Sunny	14	12417
	22/10/18	LM	51		7.43	N	1038	Steady	0.01	0.1	0.1	6.4	0.0064	2.5	0.0025	8.3	1	1	Sunny	11	12417
	08/11/18	GB	51	8.40	7.67	N	1013	Steady	0.02	0.6	0.6	13.6	0.0816	3.2	0.0192	3.0	1	1	Overcast	10	11380
													0.0000		0.0000						
													0.0000		0.0000						
OLDBH02	02/10/18	BA	19	-	2.16	N	1021	Steady	0.01	0.1	0.1	0.1	0.0001	2.0	0.0020	13.1	1	1	Sunny	14	12417
	08/11/18	GB	19	2.87	2.16	N	1012	Steady	0.01	0.1	0.1	0.1	0.0001	1.8	0.0018	8.5	1	1	Overcast	10	11380
													0.0000		0.0000						
													0.0000		0.0000						
													0.0000		0.0000						
OLDBH03	02/10/18	BA	19	-	2.53	N	1020	Steady	0.01	0.1	0.1	0.1	0.0001	0.9	0.0009	16.9	1	1	Sunny	14	12417
	08/11/18	GB	19	4.54	2.64	N	1012	Steady	0.01	0.1	0.1	1.6	0.0016	4.9	0.0049	5.1	1	1	Overcast	10	11380
													0.0000		0.0000						
													0.0000		0.0000						
													0.0000		0.0000						

10.5

NOTES:
NM = Not Measured.
(x) = Peak value recorded.
[grey] = Below detection limit.

GSV (l/HR) = [gas concentration (%v/v)] x [gas well flow rate (l/hr)]
100

TEST DATE AND CONDITIONS		
Date	25/06/18	
Atmospheric Pressure	1008	mB
Ambient Temperature	21.7	°C
Environics Serial No.	5089	

GAS DATA LTD
Unit 4, Fairfield Court
Seven Stars Estate
Wheler Rd
Coventry
CV3 4LJ
Tel 02476303311 Fax 02476307711

GFM435 Final Inspection & Calibration Check Certificate

Customer	Terraconsult Ltd
Certificate Number	120264
Order Number	320071

Serial Number	11380
Software Version	G435-00.0024/0004

Recalibration DUE Date
25/06/19

Instrument Checks					
Keyboard	✓		Display Contrast	✓	
Pump Flow In	500	Accept > 200 cc/min	Pump Flow @ -200mB	200	Accept > 200 cc/min
Clock Set / Running	✓		Labels Fitted	✓	

Gas Checks						
	CH_4		CO_2		O_2	
	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %
Sensor	59.7	60	39.4	40	20.9	20.9
	Accept ±3.0		Accept ±3.0		Accept ±0.5	
	4.9	5	4.9	5	6	6
	Accept ±0.3		Accept ±0.3		Accept ±0.3	
Zero Reading 100% N2	0	0	0	0	0	0
	Accept ±0.0		Accept ±0.0		Accept ±0.1	

Optional Gas Checks						
Applied Gas & Range		Concentration Tested @ (ppm)	Instrument Readings (ppm)			
Gas Type	Range (ppm)		Zero Reading		Instrument Gas Reading	
H2S	5000	1500	0	Accept ±0.0	1500	Accept ±5.0
CO	2000	1000	0	Accept ±0.0	1000	Accept ±5.0
Hexane	2.0%	2.0%	0	Accept ±0.0	1.99	Accept ±10.0

TEST DATE AND CONDITIONS		
Date	03/04/18	
Atmospheric Pressure	973	mB
Ambient Temperature	22.3	°C
Environics Serial No.	5089	

GAS DATA LTD
Unit 4, Fairfield Court
Seven Stars Estate
Wheler Rd
Coventry
CV3 4LJ
Tel 02476303311 Fax 02476307711

GFM436 Final Inspection & Calibration Check Certificate

Customer	Terraconsult Ltd
Certificate Number	120054
Order Number	318572

Serial Number	12417
Software Version	G436-00.0027/0009

Recalibration DUE Date
03/04/19

Instrument Checks					
Keyboard	✓		Display Contrast	✓	
Pump Flow In	400	Accept > 200 cc/min	Pump Flow @ -200mB	250	Accept > 200 cc/min
Clock Set / Running	✓		Labels Fitted	✓	

Gas Checks						
	CH_4		CO_2		O_2	
	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %
Sensor	59.9	60	39.4	40	20.9	20.9
	Accept ±3.0		Accept ±3.0		Accept ±0.5	
	5	5	4.9	5	6	6
	Accept ±0.3		Accept ±0.3		Accept ±0.3	
Zero Reading 100% N2	0	0	0	0	0	0
	Accept ±0.0		Accept ±0.0		Accept ±0.1	

Optional Gas Checks						
Applied Gas & Range		Concentration Tested @ (ppm)	Instrument Readings (ppm)			
Gas Type	Range (ppm)		Zero Reading		Instrument Gas Reading	
H2S	5000	1500	0	Accept ±0.0	1500	Accept ±5.0
CO	2000	1000	0	Accept ±0.0	999	Accept ±5.0
Hexane	2.0%	2.0%	0	Accept ±0.0	1.99	Accept ±10.0

NOTES:
NM = Not Measured.
(x) = Peak value recorded.
[grey] = Below detection limit.

GSV (l/HR) = [gas concentration (%v/v)] x [gas well flow rate (l/hr)]
100

Instrumentation Specifications

Gas Monitoring – Permanent Gases

Gas monitoring for permanent gases (e.g. methane, carbon dioxide, oxygen etc) at TerraConsult is carried out using a GasData GFM 400 series gas analyser with flow meter which measures borehole flow rates, bulk gas concentrations (methane, carbon dioxide and oxygen), barometric and differential pressure.

The specification range of the GFM 400 series is as follows:

Feature	Method/Type	Range	Resolution
Methane	Infrared	0 - 100%v/v	0.1%
Lower Detection Limit (LEL)	Infrared	0 - 100%v/v	0.1%
Carbon Dioxide	Infrared	0 - 100%v/v	0.1%
Oxygen	Electrochemical	0 - 25%v/v	0.1%
Hydrogen Sulphide	Electrochemical	0 - 5,000ppm	1ppm
Carbon monoxide	Electrochemical	0 – 2,000ppm	1ppm
Atmospheric Pressure	Absolute Pressure Sensor	800 – 1,200mb	1mb
Differential Pressure	Thermal Dissipation	±1,250Pa	0.1Pa
Temperature	Bi-metal	-10ºC to +100ºC	1ºC
Flow	Thermal Dissipation	-60 – 100 l/hr	0.1 l/hr

Volatile Organic Compounds

TerraConsult uses a PhoCheck Tiger Photo Ionisation Detector (PID) to detect a large range of Volatile Organic Compounds (VOCs) which are potentially dangerous from both a poisoning and/or an explosive perspective.

The sensor specification is as follows:

Feature	Method/Type	Range	Resolution
Total VOCs	PID	1ppb – 10,000ppm & 1ppb to 20,000ppm for specific gases	+/- 5% displayed reading +/- one digit

Calibration

Measuring equipment owned by TerraConsult is maintained in good condition and regularly inspected to ensure that it is capable of accurate and effective operation and is calibrated in line with the manufacturer's recommendations. When equipment is hired for use, the hirer will be required to provide a calibration certificate with the equipment.

In accordance with TerraConsult's ISO 9001:2008 accreditation, the process of calibrating and maintenance of TerraConsult's own measuring equipment is carried out in accordance with our quality system procedures and a register of all measuring equipment is maintained and calibration certificates collated and stored accordingly.

Prior to the use of any measuring equipment, the user will undertake suitable checks to ensure that it is fit for use and within the calibration tolerances specified.

Should a copy of the relevant calibration certificate be required, please contact TerraConsult directly to request a copy.
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APPENDIX F

In Situ Test Results

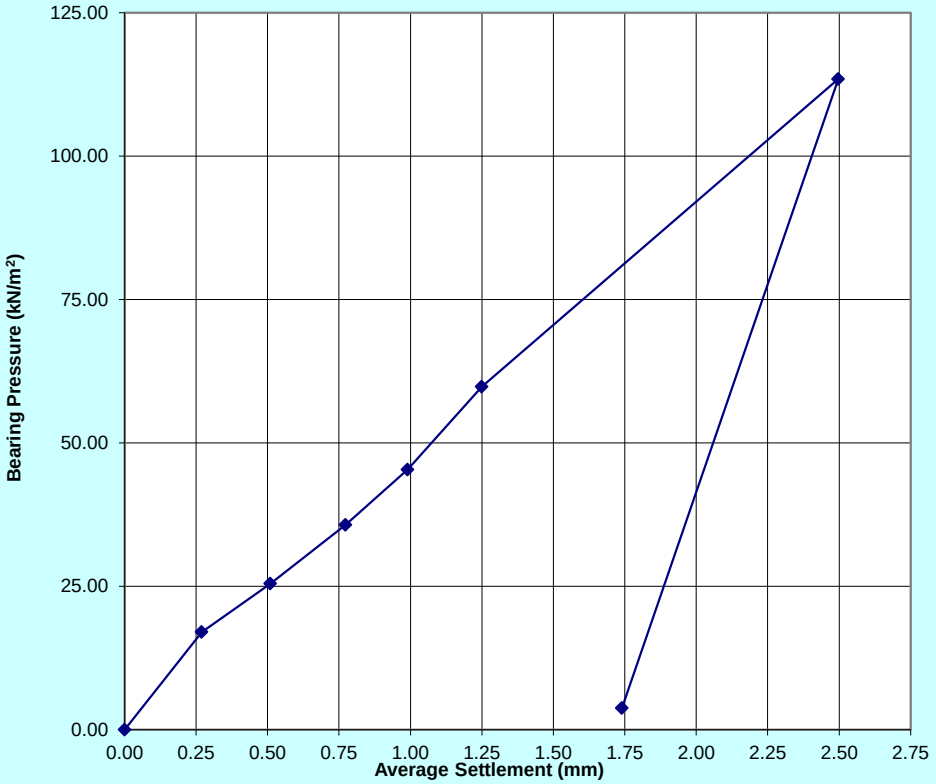
Plate Bearing Test

TerraConsult

Project: **Project Genssis** **Client:** **Marriot Drilling**
Project No: **4133**

Test Method: **BS1377:1990 Part 9 and IAN 73/06 rev.1**

Location	Test No	Date	Weather	Description of Material	Diameter of Plate (mm)	Reaction Load
TP18-03	1	01/10/2018	Dry	Dark brown gravelly CLAY	460	8T JCB 3CX



Applied Bearing Pressure (kN/m^2)	Settlement at Applied Bearing Pressure (mm)			
	1	2	3	**Mean**
0.00	0.00	0.00	0.00	0.00
17.03	0.24	0.31	0.26	0.27
25.46	0.50	0.53	0.50	0.51
35.70	0.76	0.79	0.77	0.77
45.34	0.98	1.00	0.99	0.99
59.80	1.24	1.26	1.25	1.25
113.42	2.50	2.52	2.47	2.50
3.78	1.76	1.71	1.75	1.74

Modulus of Subgrade Reaction K^{762} (kN/m^2/m)
2.98E+04

CBR Value %
3.5

Notes:

Carried out by:	BA
Checked by:	0

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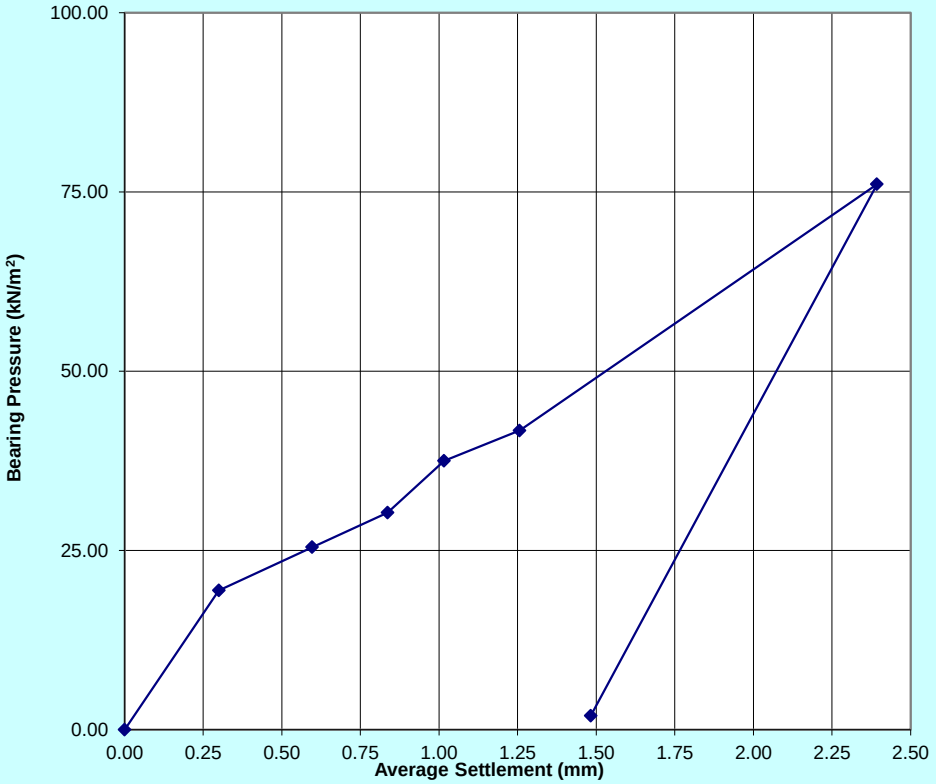
Plate Bearing Test

TerraConsult

Project: **Project Genssis** **Client:** **Marriot Drilling**
Project No: **4133**

Test Method: **BS1377:1990 Part 9 and IAN 73/06 rev.1**

Location	Test No	Date	Weather	Description of Material	Diameter of Plate (mm)	Reaction Load
TP18-04	1	01/10/2018	Dry	Dark brown gravelly CLAY	460	8T JCB 3CX



Applied Bearing Pressure (kN/m^2)	Settlement at Applied Bearing Pressure (mm)				Modulus of Subgrade Reaction K^{762} (kN/m^2/m)
	1	2	3	**Mean**	
0.00	0.00	0.00	0.00	0.00	**3.05E+04**
19.44	0.27	0.43	0.20	0.30	
25.46	0.53	0.73	0.53	0.60	
30.28	0.75	0.95	0.81	0.84	
37.51	0.91	1.11	1.03	1.02	
41.73	1.10	1.35	1.32	1.26	CBR Value %
76.07	2.14	2.41	2.63	2.39	
1.97	1.82	1.15	1.48	1.48	**3.6**

Notes:

Carried out by:	BA
Checked by:	0

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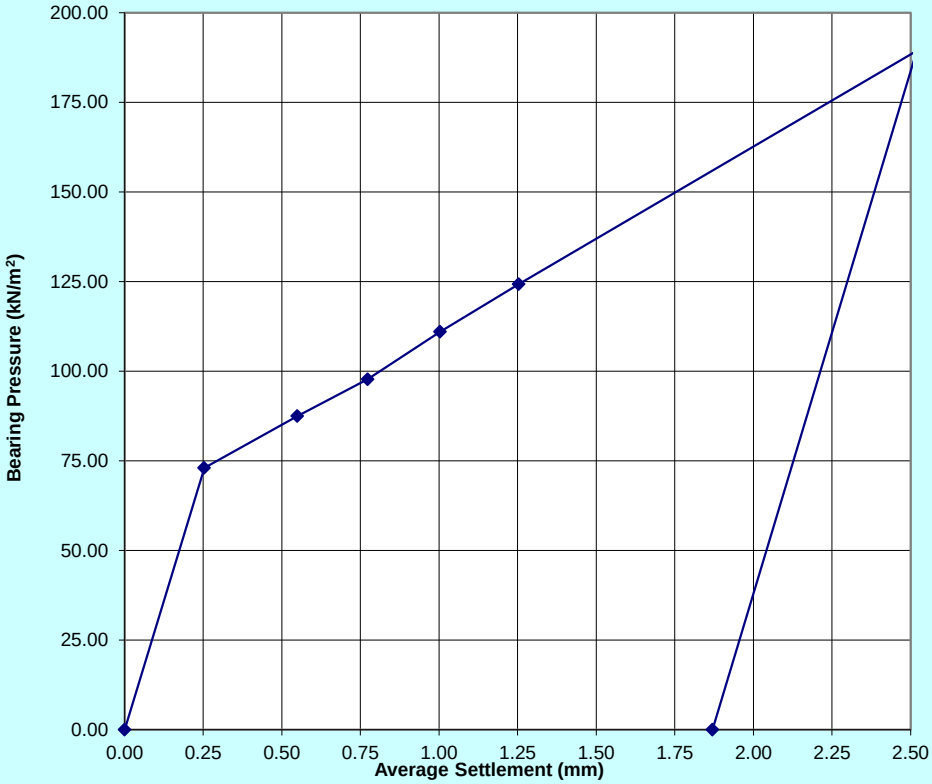
Plate Bearing Test

TerraConsult

Project: **Project Genssis** **Client:** **Marriot Drilling**
Project No: **4133**

Test Method: **BS1377:1990 Part 9 and IAN 73/06 rev.1**

Location	Test No	Date	Weather	Description of Material	Diameter of Plate (mm)	Reaction Load
TP18-05	1	19/09/2018	Dry	Dark brown gravelly CLAY	460	8T JCB 3CX



Applied Bearing Pressure (kN/m^2)	Settlement at Applied Bearing Pressure (mm)				Modulus of Subgrade Reaction K^{762} (kN/m^2/m)
	1	2	3	**Mean**	
0.00	0.00	0.00	0.00	0.00	**6.79E+04**
73.05	0.27	0.25	0.24	0.25	
87.51	0.60	0.55	0.50	0.55	
97.75	0.81	0.76	0.75	0.77	
111.01	1.04	1.00	0.97	1.00	
124.26	1.25	1.25	1.26	1.25	CBR Value %
189.32	2.52	2.50	2.54	2.52	
0.00	1.87	1.85	1.89	1.87	**14.0**

Notes:

Carried out by:	JL
Checked by:	DD

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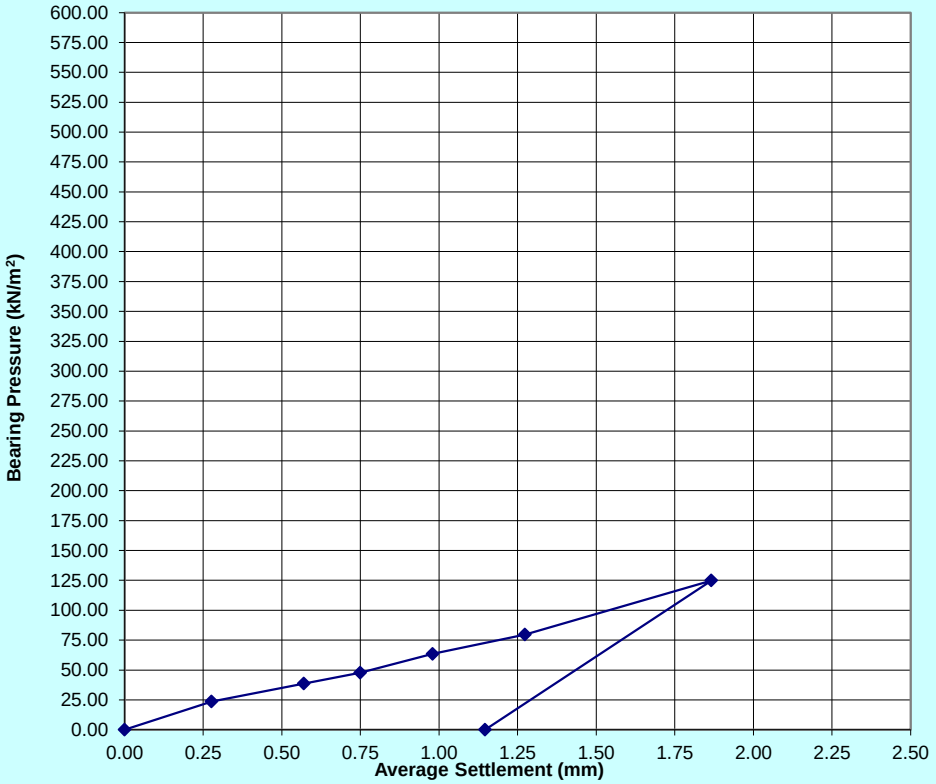
Plate Bearing Test

TerraConsult

Project: **Project Genssis** **Client:** **Marriot Drilling**
Project No: **4133**

Test Method: **BS1377:1990 Part 9 and IAN 73/06 rev.1**

Location	Test No	Date	Weather	Description of Material	Diameter of Plate (mm)	Reaction Load
TP18-07	1	01/10/2018	Dry	Dark brown gravelly CLAY	460	8T JCB 3CX



Applied Bearing Pressure (kN/m^2)	Settlement at Applied Bearing Pressure (mm)				Modulus of Subgrade Reaction K^{762} (kN/m^2/m)
	1	2	3	**Mean**	
0.00	0.00	0.00	0.00	0.00	**2.19E+05**
23.66	0.23	0.36	0.24	0.28	
38.72	0.57	0.63	0.51	0.57	
47.75	0.75	0.80	0.70	0.75	
63.42	0.98	1.03	0.93	0.98	
79.68	1.27	1.34	1.21	1.27	CBR Value %
124.86	1.86	1.92	1.82	1.87	
0.00	1.18	0.96	1.30	1.15	**110.0**

Notes: **Run out of extension on jack, so could not reach 2.50 mm increment**

Carried out by:	BA
Checked by:	0

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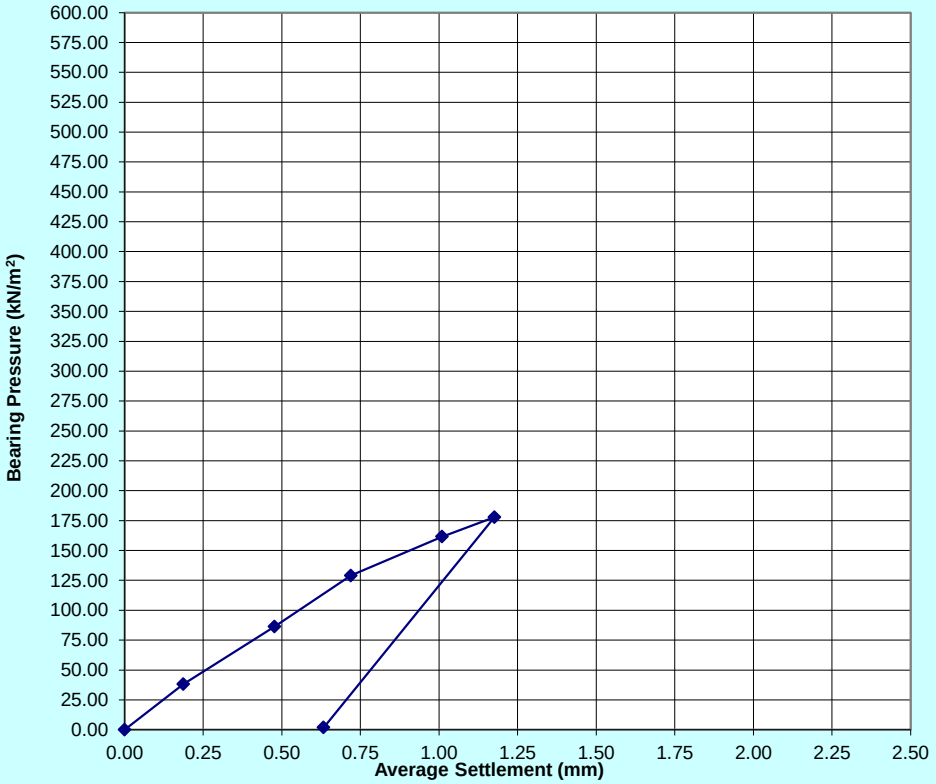
Plate Bearing Test

TerraConsult

Project: **Project Genssis** **Client:** **Marriot Drilling**
Project No: **4133**

Test Method: **BS1377:1990 Part 9 and IAN 73/06 rev.1**

Location	Test No	Date	Weather	Description of Material	Diameter of Plate (mm)	Reaction Load
TP18-08	1	01/10/2018	Dry	Dark brown gravelly CLAY	460	8T JCB 3CX



Applied Bearing Pressure (kN/m^2)	Settlement at Applied Bearing Pressure (mm)				Modulus of Subgrade Reaction K^{762} (kN/m^2/m)
	1	2	3	**Mean**	
0.00	0.00	0.00	0.00	0.00	**2.19E+05**
38.11	0.21	0.14	0.21	0.19	
86.31	0.55	0.47	0.41	0.48	
129.08	0.78	0.73	0.65	0.72	
161.61	0.94	0.91	1.18	1.01	
177.87	1.06	1.04	1.43	1.18	CBR Value %
1.97	0.68	0.60	0.62	0.63	
0.00	0.00	0.00	0.00	0.00	**110.0**

Notes: **Lifting machine at 29.2 kN/1.25 mm increment.**

Carried out by:	BA
Checked by:	0

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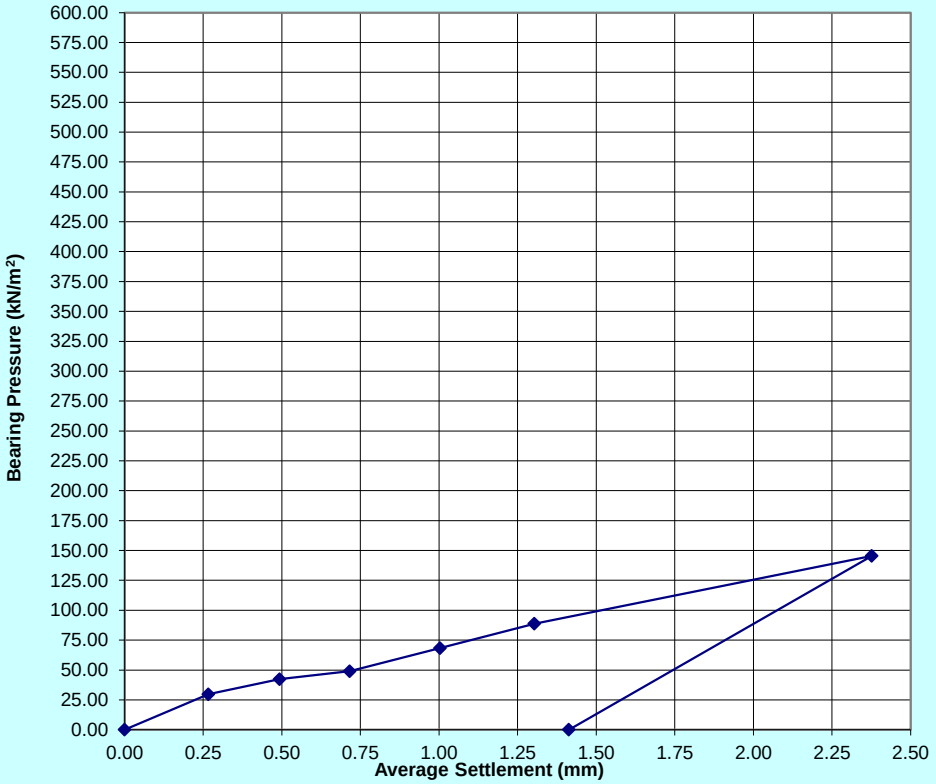
Plate Bearing Test

TerraConsult

Project: **Project Genssis** **Client:** **Marriot Drilling**
Project No: **4133**

Test Method: **BS1377:1990 Part 9 and IAN 73/06 rev.1**

Location	Test No	Date	Weather	Description of Material	Diameter of Plate (mm)	Reaction Load
TP18-09	1	01/10/2018	Dry	Dark brown gravelly CLAY	460	8T JCB 3CX



Applied Bearing Pressure (kN/m^2)	Settlement at Applied Bearing Pressure (mm)				Modulus of Subgrade Reaction K^{762} (kN/m^2/m)
	1	2	3	**Mean**	
0.00	0.00	0.00	0.00	0.00	**2.19E+05**
29.68	0.17	0.22	0.41	0.27	
42.33	0.33	0.38	0.77	0.49	
48.96	0.60	0.64	0.91	0.72	
68.24	0.80	0.87	1.34	1.00	
88.72	1.14	1.12	1.65	1.30	CBR Value %
145.34	2.18	2.14	2.81	2.38	
0.00	1.08	1.05	2.11	1.41	**110.0**

Notes:

Carried out by:	BA
Checked by:	0

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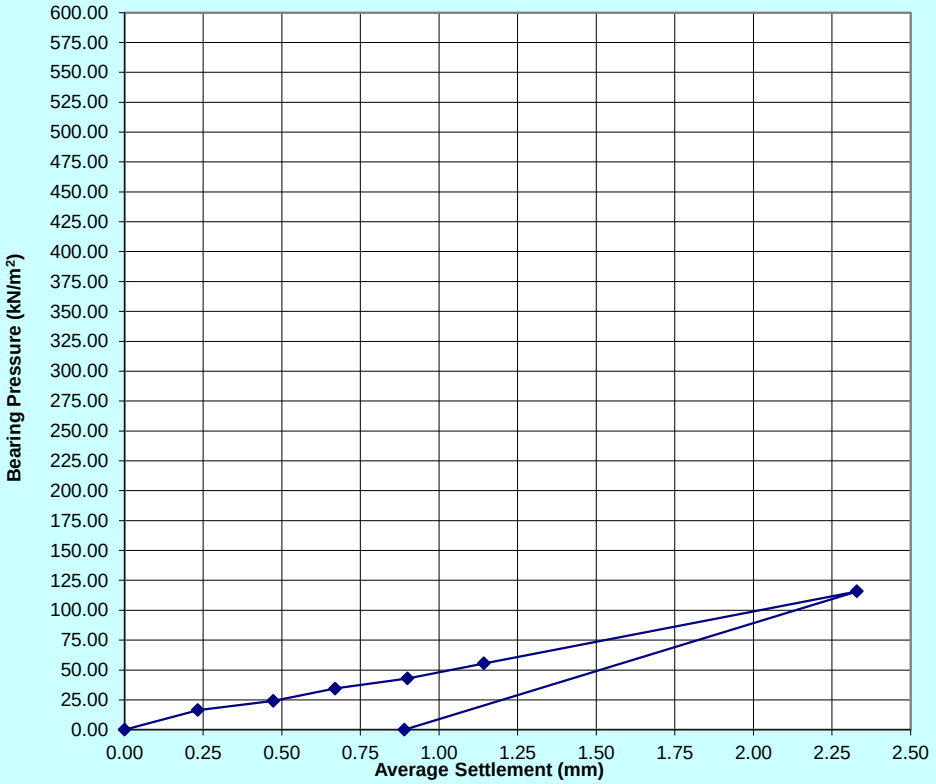
Plate Bearing Test

TerraConsult

Project: **Project Genssis** **Client:** **Marriot Drilling**
Project No: **4133**

Test Method: **BS1377:1990 Part 9 and IAN 73/06 rev.1**

Location	Test No	Date	Weather	Description of Material	Diameter of Plate (mm)	Reaction Load
TP18-10	1	01/10/2018	Dry	Dark brown gravelly CLAY	460	8T JCB 3CX



Applied Bearing Pressure (kN/m^2)	Settlement at Applied Bearing Pressure (mm)				Modulus of Subgrade Reaction K^{762} (kN/m^2/m)
	1	2	3	**Mean**	
0.00	0.00	0.00	0.00	0.00	**2.19E+05**
16.43	0.26	0.26	0.18	0.23	
24.26	0.54	0.56	0.32	0.47	
34.50	0.74	0.80	0.47	0.67	
42.93	0.98	1.05	0.67	0.90	
55.58	1.21	1.34	0.88	1.14	CBR Value %
115.83	2.31	2.58	2.10	2.33	
0.00	0.14	1.46	1.07	0.89	**110.0**

Notes:

Carried out by:	BA
Checked by:	0

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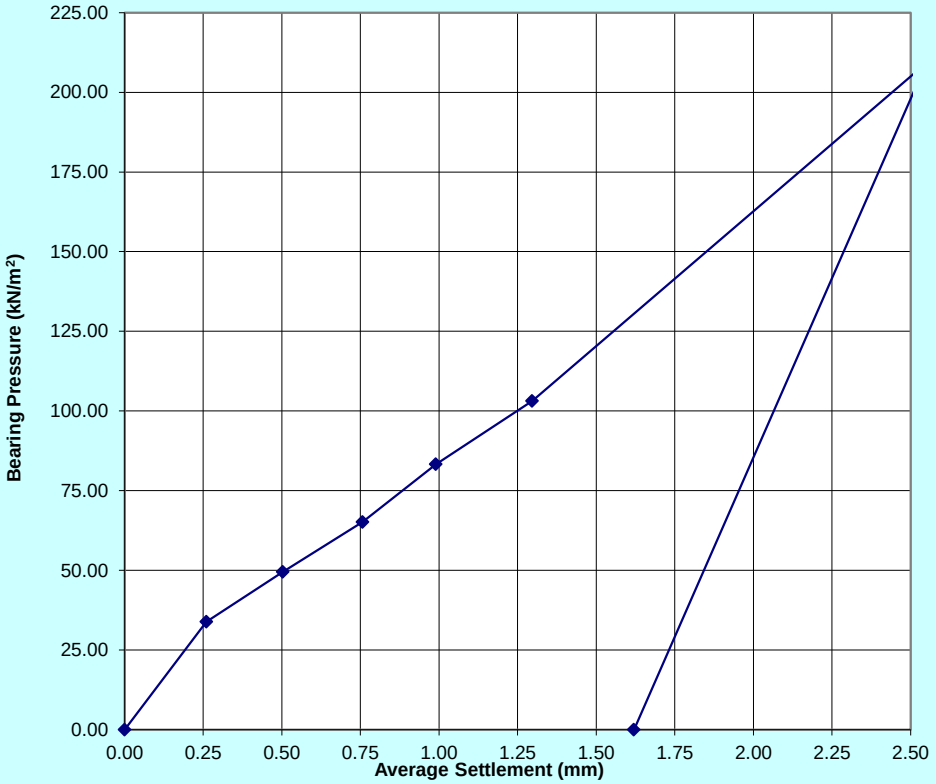
Plate Bearing Test

TerraConsult

Project: **Project Genssis** **Client:** **Marriot Drilling**
Project No: **4133**

Test Method: **BS1377:1990 Part 9 and IAN 73/06 rev.1**

Location	Test No	Date	Weather	Description of Material	Diameter of Plate (mm)	Reaction Load
TP18-12	1	29/08/2018	Dry	Dark brown gravelly CLAY	460	8T JCB 3CX



Applied Bearing Pressure (kN/m^2)	Settlement at Applied Bearing Pressure (mm)			
	1	2	3	**Mean**
0.00	0.00	0.00	0.00	0.00
33.90	0.26	0.27	0.25	0.26
49.56	0.50	0.53	0.48	0.50
65.22	0.75	0.79	0.73	0.76
83.30	0.94	1.02	1.01	0.99
103.17	1.25	1.31	1.33	1.30
209.20	2.52	2.66	2.47	2.55
0.00	1.62	1.60	1.64	1.62

Modulus of Subgrade Reaction K^{762} (kN/m^2/m)

4.74E+04

CBR Value %

7.7

Notes:

Carried out by:	BA
Checked by:	0

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UKAS TESTING 4502

SITE DETAILS & EQUIPMENT LOG

Certificate No.	AQ01	Project No.	J040719/AQ01	Date or Date Range	25 Sep 2018
Client Name	S M Associates				
Site Address	Manchester Road, Carrington, Manchester				
Contractors Details	Four Winds Farm Buildings, A46 Gloucester Road, Swainswick, Bath				
Location of Works	Excavation Site				

Flowmeter No.*	NAL-98	Barometer No.	NAL156	Tally Counters	Calibration due
Calibration Factor	Quarterly	Thermometer No.		1: NAL-36	2018-09-26
Calibration due	2018-12-07	Calibration due		2: NAL-37	2018-09-26
Filter batch No.	N/A	Timepiece No.	NAL-33	Acetone Vapouriser	NAL 102
Date checked	N/A	Calibration due	2018-09-26	Service due	2018-09-26
Microscope No.	MIC-003	Stage Micrometer	NAL-107	NPL test slide	NALTS-02
Service due	2019-07-05	Calibration Factor	Yearly	Band 5 observed	Yes
Measured graticule	100	Calibration due	2019-03-29	Calibration due	2018-10-02

Cowl Inspection	Cowl Body	Filter Body	PTFE ,O, Ring	Connector	Blank Cap
Effective Filter Diameter **22.4**	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes

NUMBER OF MEASUREMENTS (CLEARANCE SAMPLING)

Area/m^2 (For enclosures <3m high)	Vol/m^3 (For enclosures >3m high)	Samples of 480 litres	(Tick)	Area/m^2 (For enclosures <3m high)	Vol/m^3 (For enclosures >3m high)	Samples of 480 litres	(Tick)
	<10	1		512 - 738	1536 - 2186	7	
<63	10 - 191	2		739 - 999	2187 - 2999	8	
64 - 124	192 - 374	3		1000 - 1330	3000 - 3992	9	
125 - 215	375 - 647	4		1331 - 1727	3993 - 5183	10	
216 - 342	648 - 1028	5		1728 - 2196	5184 - 6590	11	
343 - 511	1029 - 1535	6		2197 - 2743	6591 - 8231	12	
				Other			

* If more than 1 flowmeter used complete details of all flowmeters used.					
Flowmeter No.	N/A	Calibration Factor	Quarterly	Calibration Due	2018-12-07
When completing personal air monitoring on QF84b, please complete the following.					
Type of RPE Used		Activity being performed	Background Monitoring	Length of exposure	333 mins

All testing completed in the QF84 series is completed in accordance with HSE guidance.
HSG 248 Asbestos: The analysts, guide for sampling analysis and clearance procedures

Opinions and interpretations expressed herein are outside the Scope of UKAS Accreditation.
NOTE: Strike through items that are not applicable.
Note: It is only necessary to use the thermometer/barometer if the temperature/pressure is outside normal operating conditions i.e. freezing or very hot.
Therefore do not records thermometer/barometer details if not used.

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UKAS TESTING 4502

AIRBORNE FIBRE CONCENTRATION RECORDS

Certificate No.	AQ01	Project No.	J040719/AQ01	Issue Date	25 Sep 2018	Analysis Date	25 Sep 2018

Location	Sample No	Head No	Pump No	Temp (°C)**	Pressure (HPa)**	Time Started	Time Stopped	Sample Duration (mins)	Initial Flow Rate(l/min)	Final Flow Rate(l/min)	Corrected Flow Rate (l/min)	Volume Sampled (litres)	No Fibres	No Fields	Calculated Conc. f/ml 3 dec places	Limit of Quantification <3 dec places	Result f/ml<0.01 or3 dec places
Excavation Site	AQ000475	NAL-130	NAL-138	N/A	Pressure	10:14	11:14	60	8.0	8.0	8.0	480	1	200	0.0005	0.01	<0.01
Excavation Site	AQ000476	NAL-131	NAL-139	N/A	Pressure	10:15	11:15	60	8.0	8.0	8.0	480	0	200	0.0000	0.01	<0.01
Field Blank	AQ000477	NAL 78	N/A	N/A	Pressure	N/A	N/A	N/A	N/A	N/A	N/A	N/A			N/A	0.000	

Comments: Air Monitoring Satisfactory

Signed Sampler: Print Name:Simon Mitchell Date:25 Sep 2018 Time:15:32

Fibre concentration = $1000ND^2/Vnd^2$ Fibres / millilitre (f/ml) V= volume, N=fibres, D^2 = exposed filter diameter, d^2 = graticule diameter (refer to HSG248)

Intermediate examination of slide to include low power scanning for approx. 30 sec. *Corrected flow rate is the average measured flow

If the number of rejected fields exceeds 10% of the No. accepted or the slide is deemed uncountable, record the no. of fields and write "**SLIDE REJECTED**" over the remaining three columns

Options and interpretations expressed herein are outside the scope of UKAS accreditation

NOTE: Strike through items that are not applicable.

Note: ** It is only necessary to use the thermometer/Barometer if the temperature/pressure is outside normal operating conditions i.e. freezing or very hot. Therefore do not record thermometer/barometer details if not used

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UKAS TESTING 4502

SITE DIAGRAM

Certificate No : J040719/AQ01 Date: 25 Sep 2018
Project No.:

When drawing diagrams for COR illustrations must include sizes of enclosure(S)

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UKAS TESTING 4502

PERSONAL SAMPLING REPORT FORM & EQUIPMENT LOG

Certificate No.	AQ02	Project No.	J040719/AQ02	Date or Date Range	25 Sep 2018
Persons Name	Kieron Blackwell				
Persons Job Title	2nd Man Driller				
National Insurance No.	PA591330C				
Site Address	Manchester Road, Carrington, Manchester				
Contractors Details	S M Associates, Four Winds Farm Buildings, A46 Gloucester Road, Swainswick, Bath, BA1 8EA				
Sampling Start Time	11:00				
Sampling Finish Time	12:00				
Type of work carried out by individual during sampling period	Drilling into Ground				
Duration of each type of work activity	[NIC_PER_S0Fhttp://teams/images/getphoto.asp?id=368812&rndID=1539008080_8187]				
Type of Asbestos product being removed or worked on	Crocilidite, Amosite and Chrysotile				
Asbestos Removal Method	N/A				
Control Method Used	Catogory 3 Type 5 Coveralls				
Type of RPE worn	Half Mask P3 Filter				
Opinion on the effectiveness of controls	Satisfactory				
Any other factors which may affect the result	N/A				
Photos of work area (through viewing panels if applicable)					

Photos of work area (through viewing panels if applicable)	

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Flowmeter No.*	NAL-94	Barometer No.	NAL156	Tally Counters	Calibration due
Calibration Factor	Quarterly	Thermometer No.		1: NAL-36	2018-09-26
Calibration due	2018-12-07	Calibration due		2: NAL-37	2018-09-26
Filter batch No.	N/A	Timepiece No.	NAL-33	Acetone Vapouriser	NAL 102
Date checked	N/A	Calibration due	2018-09-26	Service due	2018-09-26
Microscope No.	MIC-003	Stage Micrometer	NAL-107	NPL test slide	NALTS-02
Service due	2019-07-05	Calibration Factor	Yearly	Band 5 observed	Yes
Measured graticule	100	Calibration due	2019-03-29	Calibration due	2018-10-02

Equipment & Reagents complete before and during job	Equipment decontamination (where applicable) Complete
Yes	Yes

Cowl Inspection	Cowl Body	Filter Body	PTFE ,O, Ring	Connector	Blank Cap
Effective Filter Diameter **22.4**	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes

* If more than 1 flowmeter used complete details of all flowmeters used.					
Flowmeter No.	N/A	Calibration Factor		Calibration Due	
When completing personal air monitoring on QF84b, please complete the following.					

All testing completed in the QF84 series is completed in accordance with HSE guidance.
HSG 248 Asbestos: The analysts, guide for sampling analysis and clearance procedures

Opinions and interpretations expressed herein are outside the Scope of UKAS Accreditation.
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Therefore do not records thermometer/barometer details if not used.

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Monkton Business Park South, Hebburn, Tyne and Wear, NE31 2ES
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UKAS TESTING 4502

AIRBORNE FIBRE CONCENTRATION RECORDS

Certificate No.	AQ02	Project No.	J040719/AQ02	Issue Date	25 Sep 2018	Analysis Date	25 Sep 2018

Location	Sample No	Head No	Pump No	Temp (^{0}C)**	Pressure (HPa)**	Time Started	Time Stopped	Sample Duration (mins)	Initial Flow Rate(l/min)	Final Flow Rate(l/min)	Corrected Flow Rate (l/min)	Volume Sampled (litres)	No Fibres	No Fields	Calculated Conc. f/ml 3 dec places	Limit of Quantification <3 dec places	Result f/ml<0.01 or3 dec places
Kieron Blackwell/Excavation Site	AQ000478	NAL-77	NAL-145	N/A	Pressure	11:00	12:00	60	2.0	2.0	2.0	120	1	100	0.0041	0.080	<0.08

Comments: Air Monitoring Satisfactory

Signed Sampler: Print Name:Simon Mitchell Date:25 Sep 2018 Time:15:35

Fibre concentration = $1000ND^2/Vnd^2$ Fibres / millilitre (f/ml) V= volume, N=fibres, D^2 = exposed filter diameter, d^2 = graticule diameter (refer to HSG248)

Intermediate examination of slide to include low power scanning for approx. 30 sec. *Corrected flow rate is the average measured flow

If the number of rejected fields exceeds 10% of the No. accepted or the slide is deemed uncountable, record the no. of fields and write "**SLIDE REJECTED**" over the remaining three columns

Options and interpretations expressed herein are outside the scope of UKAS accreditation

NOTE: Strike through items that are not applicable.

Note: ** It is only necessary to use the thermometer/Barometer if the temperature/pressure is outside normal operating conditions i.e. freezing or very hot. Therefore do not record thermometer/barometer details if not used

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UKAS TESTING 4502

PERSONAL SAMPLING REPORT FORM & EQUIPMENT LOG

Certificate No.	AQ03	Project No.	J040719/AQ03	Date or Date Range	25 Sep 2018

Persons Name	Paul Stanesby
Persons Job Title	Lead Driller
National Insurance No.	NH250070B
Site Address	Manchester Road, Carrington, Manchester
Contractors Details	S M Associates, Four Winds Farm Buildings, A46 Gloucester Road, Swainswick, Bath, BA1 8EA
Sampling Start Time	11:01
Sampling Finish Time	12:01
Type of work carried out by individual during sampling period	Drilling into Ground
Duration of each type of work activity	[NIC_PER_S0Fhttp://teams/images/getphoto.asp?id=368813&rndID=1539008170_2440]
Type of Asbestos product being removed or worked on	Crocilidite, Amosite and Chrysotile
Asbestos Removal Method	N/A
Control Method Used	Catogory 3 Type 5 Coveralls
Type of RPE worn	Half Mask P3 Filter
Opinion on the effectiveness of controls	Satisfactory
Any other factors which may affect the result	N/A
Photos of work area (through viewing panels if applicable)	

Photos of work area (through viewing panels if applicable)		

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Flowmeter No.*	NAL-94	Barometer No.	NAL156	Tally Counters	Calibration due
Calibration Factor	Quarterly	Thermometer No.		1: NAL-36	2018-09-26
Calibration due	2018-12-07	Calibration due		2: NAL-37	2018-09-26
Filter batch No.	N/A	Timepiece No.	NAL-33	Acetone Vapouriser	NAL 102
Date checked	N/A	Calibration due	2018-09-26	Service due	2018-09-26
Microscope No.	MIC-003	Stage Micrometer	NAL-107	NPL test slide	NALTS-02
Service due	2019-07-05	Calibration Factor	Yearly	Band 5 observed	Yes
Measured graticule	100	Calibration due	2019-03-29	Calibration due	2018-10-02

Equipment & Reagents complete before and during job	Equipment decontamination (where applicable) Complete
Yes	Yes

Cowl Inspection	Cowl Body	Filter Body	PTFE ,O, Ring	Connector	Blank Cap
Effective Filter Diameter **22.4**	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes

* If more than 1 flowmeter used complete details of all flowmeters used.					
Flowmeter No.	N/A	Calibration Factor		Calibration Due	
When completing personal air monitoring on QF84b, please complete the following.					

All testing completed in the QF84 series is completed in accordance with HSE guidance.
HSG 248 Asbestos: The analysts, guide for sampling analysis and clearance procedures

Opinions and interpretations expressed herein are outside the Scope of UKAS Accreditation.
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Note: It is only necessary to use the thermometer/barometer if the temperature/pressure is outside normal operating conditions i.e. freezing or very hot.
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AIRBORNE FIBRE CONCENTRATION RECORDS

Certificate No.	AQ03	Project No.	J040719/AQ03	Issue Date	25 Sep 2018	Analysis Date	25 Sep 2018

Location	Sample No	Head No	Pump No	Temp (°C)**	Pressure (HPa)**	Time Started	Time Stopped	Sample Duration (mins)	Initial Flow Rate(l/min)	Final Flow Rate(l/min)	Corrected Flow Rate (l/min)	Volume Sampled (litres)	No Fibres	No Fields	Calculated Conc. f/ml 3 dec places	Limit of Quantification <3 dec places	Result f/ml<0.01 or3 dec places
Paul Stanesby/Excavation Site	AQ000479	NAL-79	NAL-144	N/A	Pressure	11:01	12:01	60	2.0	2.0	2.0	120	2	100	0.0083	0.080	<0.08

Comments: Air Monitoring Satisfactory

Signed Sampler: Print Name:Simon Mitchell Date:25 Sep 2018 Time:15:39

Fibre concentration = $1000ND^2/Vnd^2$ Fibres / millilitre (f/ml) V= volume, N=fibres, D^2 = exposed filter diameter, d^2 = graticule diameter (refer to HSG248)

Intermediate examination of slide to include low power scanning for approx. 30 sec. *Corrected flow rate is the average measured flow

If the number of rejected fields exceeds 10% of the No. accepted or the slide is deemed uncountable, record the no. of fields and write "**SLIDE REJECTED**" over the remaining three columns

Options and interpretations expressed herein are outside the scope of UKAS accreditation

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UKAS TESTING 4502

SITE DETAILS & EQUIPMENT LOG

Certificate No.	AQ01	Project No.	J040720/AQ01	Date or Date Range	26 Sep 2018
Client Name	S M Associates				
Site Address	Manchester Road, Carrington, Manchester				
Contractors Details	Four Winds Farm Buildings, A46 Gloucester Road, Swainswick, Bath				
Location of Works	Excavation Site				

Flowmeter No.*	NAL-98	Barometer No.	NAL156	Tally Counters	Calibration due
Calibration Factor	Quarterly	Thermometer No.		1: NAL-36	2019-09-26
Calibration due	2018-12-07	Calibration due		2: NAL-37	2019-09-26
Filter batch No.	N/A	Timepiece No.	NAL-33	Acetone Vapouriser	NAL 102
Date checked	N/A	Calibration due	2019-09-26	Service due	2019-09-26
Microscope No.	MIC-003	Stage Micrometer	NAL-107	NPL test slide	NALTS-02
Service due	2019-07-05	Calibration Factor	Yearly	Band 5 observed	Yes
Measured graticule	100	Calibration due	2019-03-29	Calibration due	2018-10-02

Cowl Inspection	Cowl Body	Filter Body	PTFE ,O, Ring	Connector	Blank Cap
Effective Filter Diameter **22.4**	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes

NUMBER OF MEASUREMENTS (CLEARANCE SAMPLING)

Area/m^2 (For enclosures <3m high)	Vol/m^3 (For enclosures >3m high)	Samples of 480 litres	(Tick)	Area/m^2 (For enclosures <3m high)	Vol/m^3 (For enclosures >3m high)	Samples of 480 litres	(Tick)
	<10	1		512 - 738	1536 - 2186	7	
<63	10 - 191	2		739 - 999	2187 - 2999	8	
64 - 124	192 - 374	3		1000 - 1330	3000 - 3992	9	
125 - 215	375 - 647	4		1331 - 1727	3993 - 5183	10	
216 - 342	648 - 1028	5		1728 - 2196	5184 - 6590	11	
343 - 511	1029 - 1535	6		2197 - 2743	6591 - 8231	12	
				Other			

* If more than 1 flowmeter used complete details of all flowmeters used.

Flowmeter No.	N/A	Calibration Factor	Quarterly	Calibration Due	2018-12-07

When completing personal air monitoring on QF84b, please complete the following.

Type of RPE Used		Activity being performed	Reassurance	Length of exposure	334 mins

All testing completed in the QF84 series is completed in accordance with HSE guidance.
HSG 248 Asbestos: The analysts, guide for sampling analysis and clearance procedures

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AIRBORNE FIBRE CONCENTRATION RECORDS

Certificate No.	AQ01	Project No.	J040720/AQ01	Issue Date	26 Sep 2018	Analysis Date	26 Sep 2018

Location	Sample No	Head No	Pump No	Temp (°C)**	Pressure (HPa)**	Time Started	Time Stopped	Sample Duration (mins)	Initial Flow Rate(l/min)	Final Flow Rate(l/min)	Corrected Flow Rate (l/min)	Volume Sampled (litres)	No Fibres	No Fields	Calculated Conc. f/ml 3 dec places	Limit of Quantification <3 dec places	Result f/ml<0.01 or3 dec places
Excavation Site	AQ000480	NAL-130	NAL-138	N/A	Pressure	10:00	12:00	120	4.0	4.0	4.0	480	0	200	0.0000	0.01	<0.01
Excavation Site	AQ000481	NAL-131	NAL-139	N/A	Pressure	10:01	12:01	120	4.0	4.0	4.0	480	1	200	0.0005	0.01	<0.01
Field Blank	AQ000482	NAL 78	N/A	N/A	Pressure	N/A	N/A	N/A	N/A	N/A	N/A	N/A			N/A	0.000	

Comments: Air Monitoring Satisfactory

Signed Sampler: Print Name:Simon Mitchell Date:26 Sep 2018 Time:15:17

Fibre concentration = $1000ND^2/Vnd^2$ Fibres / millilitre (f/ml) V= volume, N=fibres, D^2 = exposed filter diameter, d^2 = graticule diameter (refer to HSG248)

Intermediate examination of slide to include low power scanning for approx. 30 sec. *Corrected flow rate is the average measured flow

If the number of rejected fields exceeds 10% of the No. accepted or the slide is deemed uncountable, record the no. of fields and write "**SLIDE REJECTED**" over the remaining three columns

Options and interpretations expressed herein are outside the scope of UKAS accreditation

NOTE: Strike through items that are not applicable.

Note: ** It is only necessary to use the thermometer/Barometer if the temperature/pressure is outside normal operating conditions i.e. freezing or very hot. Therefore do not record thermometer/barometer details if not used

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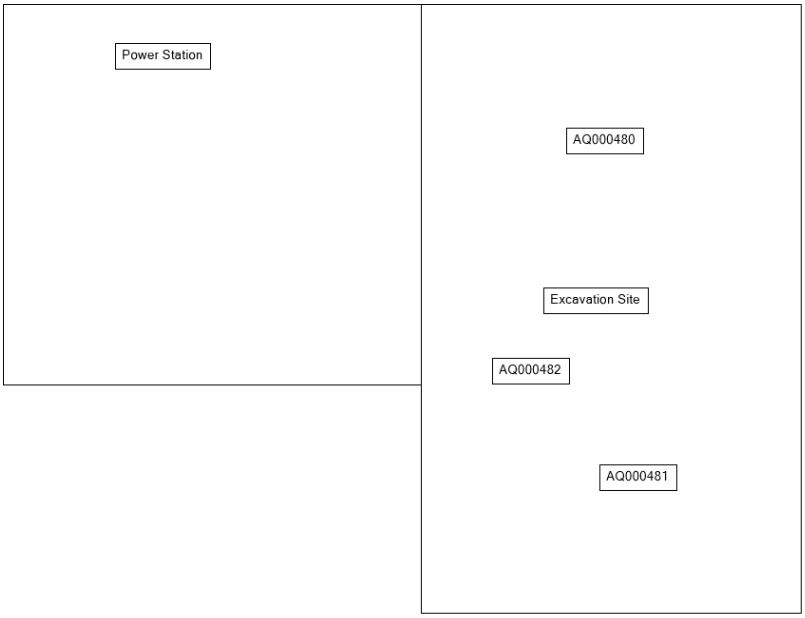
SITE DIAGRAM

Certificate No : J040720/AQ01 Date: 26 Sep 2018
Project No.:

When drawing diagrams for COR illustrations must include sizes of enclosure(S)



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UKAS TESTING 4502

PERSONAL SAMPLING REPORT FORM & EQUIPMENT LOG

Certificate No.	AQ02	Project No.	J040720/AQ02	Date or Date Range	26 Sep 2018

Persons Name	Paul Stanesby
Persons Job Title	Lead Driller
National Insurance No.	NH250070B
Site Address	Manchester Road, Carrington, Manchester
Contractors Details	S M Associates, Four Winds Farm Buildings, A46 Gloucester Road, Swainswick, Bath, BA1 8EA
Sampling Start Time	09:58
Sampling Finish Time	11:58
Type of work carried out by individual during sampling period	Drilling into Ground
Duration of each type of work activity	[NIC_PER_S0Fhttp://teams/images/getphoto.asp?id=369035&rndID=1539008248_8334]
Type of Asbestos product being removed or worked on	Crocilidite, Amosite and Chrysotile
Asbestos Removal Method	N/A
Control Method Used	Catogory 3 Type 5 Coveralls
Type of RPE worn	Half Mask P3 Filter
Opinion on the effectiveness of controls	Satisfactory
Any other factors which may affect the result	N/A
Photos of work area (through viewing panels if applicable)	

Photos of work area (through viewing panels if applicable)		

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Flowmeter No.*	NAL-94	Barometer No.	NAL156	Tally Counters	Calibration due
Calibration Factor	Quarterly	Thermometer No.		1: NAL-36	2019-09-26
Calibration due	2018-12-07	Calibration due		2: NAL-37	2019-09-26
Filter batch No.	N/A	Timepiece No.	NAL-33	Acetone Vapouriser	NAL 102
Date checked	N/A	Calibration due	2019-09-26	Service due	2019-09-26
Microscope No.	MIC-003	Stage Micrometer	NAL-107	NPL test slide	NALTS-02
Service due	2019-07-05	Calibration Factor	Yearly	Band 5 observed	Yes
Measured graticule	100	Calibration due	2019-03-29	Calibration due	2018-10-02

Equipment & Reagents complete before and during job	Equipment decontamination (where applicable) Complete
Yes	Yes

Cowl Inspection	Cowl Body	Filter Body	PTFE ,O, Ring	Connector	Blank Cap
Effective Filter Diameter **22.4**	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes

* If more than 1 flowmeter used complete details of all flowmeters used.					
Flowmeter No.	N/A	Calibration Factor		Calibration Due	
When completing personal air monitoring on QF84b, please complete the following.					

All testing completed in the QF84 series is completed in accordance with HSE guidance.
HSG 248 Asbestos: The analysts, guide for sampling analysis and clearance procedures

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NOTE: Strike through items that are not applicable.
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UKAS TESTING 4502

AIRBORNE FIBRE CONCENTRATION RECORDS

Certificate No.	AQ02	Project No.	J040720/AQ02	Issue Date	26 Sep 2018	Analysis Date	26 Sep 2018

Location	Sample No	Head No	Pump No	Temp (°C)**	Pressure (HPa)**	Time Started	Time Stopped	Sample Duration (mins)	Initial Flow Rate(l/min)	Final Flow Rate(l/min)	Corrected Flow Rate (l/min)	Volume Sampled (litres)	No Fibres	No Fields	Calculated Conc. f/ml 3 dec places	Limit of Quantification <3 dec places	Result f/ml<0.01 or3 dec places
Paul Stanesby/Excavation Site	AQ000483	NAL-79	NAL-145	N/A	Pressure	09:58	11:58	120	2.0	2.0	2.0	240	1	100	0.0020	0.040	<0.04

Comments: Air Monitoring Satisfactory

Signed Sampler: Print Name:Simon Mitchell Date:26 Sep 2018 Time:15:21

Fibre concentration = $1000ND^2/Vnd^2$ Fibres / millilitre (f/ml) V= volume, N=fibres, D^2 = exposed filter diameter, d^2 = graticule diameter (refer to HSG248)

Intermediate examination of slide to include low power scanning for approx. 30 sec. *Corrected flow rate is the average measured flow

If the number of rejected fields exceeds 10% of the No. accepted or the slide is deemed uncountable, record the no. of fields and write "**SLIDE REJECTED**" over the remaining three columns

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NOTE: Strike through items that are not applicable.

Note: ** It is only necessary to use the thermometer/Barometer if the temperature/pressure is outside normal operating conditions i.e. freezing or very hot. Therefore do not record thermometer/barometer details if not used

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PERSONAL SAMPLING REPORT FORM & EQUIPMENT LOG

Certificate No.	AQ03	Project No.	J040720/AQ03	Date or Date Range	26 Sep 2018

Persons Name	Kieron Blackwell
Persons Job Title	2nd Man Driller
National Insurance No.	PA591330C
Site Address	Manchester Road, Carrington, Manchester
Contractors Details	S M Associates, Four Winds Farm Buildings, A46 Gloucester Road, Swainswick, Bath, BA1 8EA
Sampling Start Time	09:59
Sampling Finish Time	11:59
Type of work carried out by individual during sampling period	2nd Man Driller
Duration of each type of work activity	[NIC_PER_S0Fhttp://teams/images/getphoto.asp?id=369036&rndID=1539008459_8006]
Type of Asbestos product being removed or worked on	Crocilidite, Amosite and Chrysotile
Asbestos Removal Method	N/A
Control Method Used	Catogory 3 Type 5 Coveralls
Type of RPE worn	Half Mask P3 Filter
Opinion on the effectiveness of controls	Satisfactory
Any other factors which may affect the result	N/A
Photos of work area (through viewing panels if applicable)	

Photos of work area (through viewing panels if applicable)		

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Flowmeter No.*	NAL-94	Barometer No.	NAL156	Tally Counters	Calibration due
Calibration Factor	Quarterly	Thermometer No.		1: NAL-36	2019-09-26
Calibration due	2018-12-07	Calibration due		2: NAL-37	2019-09-26
Filter batch No.	N/A	Timepiece No.	NAL-33	Acetone Vapouriser	NAL 102
Date checked	N/A	Calibration due	2019-09-26	Service due	2019-09-26
Microscope No.	MIC-003	Stage Micrometer	NAL-107	NPL test slide	NALTS-02
Service due	2019-07-05	Calibration Factor	Yearly	Band 5 observed	Yes
Measured graticule	100	Calibration due	2019-03-29	Calibration due	2018-10-02

Equipment & Reagents complete before and during job	Equipment decontamination (where applicable) Complete
Yes	Yes

Cowl Inspection	Cowl Body	Filter Body	PTFE ,O, Ring	Connector	Blank Cap
Effective Filter Diameter **22.4**	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes

* If more than 1 flowmeter used complete details of all flowmeters used.					
Flowmeter No.	N/A	Calibration Factor		Calibration Due	
When completing personal air monitoring on QF84b, please complete the following.					

All testing completed in the QF84 series is completed in accordance with HSE guidance.
HSG 248 Asbestos: The analysts, guide for sampling analysis and clearance procedures

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AIRBORNE FIBRE CONCENTRATION RECORDS

Certificate No.	AQ03	Project No.	J040720/AQ03	Issue Date	26 Sep 2018	Analysis Date	26 Sep 2018

Location	Sample No	Head No	Pump No	Temp (°C)**	Pressure (HPa)**	Time Started	Time Stopped	Sample Duration (mins)	Initial Flow Rate(l/min)	Final Flow Rate(l/min)	Corrected Flow Rate (l/min)	Volume Sampled (litres)	No Fibres	No Fields	Calculated Conc. f/ml 3 dec places	Limit of Quantification <3 dec places	Result f/ml<0.01 or3 dec places
Kieron Blackwell/Excavation Site	AQ000484	NAL-77	NAL-144	N/A	Pressure	09:59	11:59	120	2.0	2.0	2.0	240	1	100	0.0020	0.040	<0.04

Comments: Air Monitoring Satisfactory

Signed Sampler: Print Name:Simon Mitchell Date:26 Sep 2018 Time:15:31

Fibre concentration = $1000ND^2/Vnd^2$ Fibres / millilitre (f/ml) V= volume, N=fibres, D^2 = exposed filter diameter, d^2 = graticule diameter (refer to HSG248)

Intermediate examination of slide to include low power scanning for approx. 30 sec. *Corrected flow rate is the average measured flow

If the number of rejected fields exceeds 10% of the No. accepted or the slide is deemed uncountable, record the no. of fields and write "**SLIDE REJECTED**" over the remaining three columns

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SITE DETAILS & EQUIPMENT LOG

Certificate No.	AQ01	Project No.	J040721/AQ01	Date or Date Range	27 Sep 2018
Client Name	S M Associates				
Site Address	Manchester Road, Carrington, Manchester				
Contractors Details	Four Winds Farm Buildings, A46 Gloucester Road, Swainswick, Bath				
Location of Works	Excavation Site				

Flowmeter No.*	NAL-98	Barometer No.	NAL156	Tally Counters	Calibration due
Calibration Factor	Quarterly	Thermometer No.		1: NAL-36	2019-09-26
Calibration due	2018-12-07	Calibration due		2: NAL-37	2019-09-26
Filter batch No.	N/A	Timepiece No.	NAL-33	Acetone Vapouriser	NAL 102
Date checked	N/A	Calibration due	2019-09-26	Service due	2019-09-26
Microscope No.	MIC-003	Stage Micrometer	NAL-107	NPL test slide	NALTS-02
Service due	2019-07-05	Calibration Factor	Yearly	Band 5 observed	Yes
Measured graticule	100	Calibration due	2019-03-29	Calibration due	2018-10-02

Cowl Inspection	Cowl Body	Filter Body	PTFE ,O, Ring	Connector	Blank Cap
Effective Filter Diameter **22.4**	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes

NUMBER OF MEASUREMENTS (CLEARANCE SAMPLING)							
Area/m^2 (For enclosures <3m high)	Vol/m^3 (For enclosures >3m high)	Samples of 480 litres	(Tick)	Area/m^2 (For enclosures <3m high)	Vol/m^3 (For enclosures >3m high)	Samples of 480 litres	(Tick)
	<10	1		512 - 738	1536 - 2186	7	
<63	10 - 191	2		739 - 999	2187 - 2999	8	
64 - 124	192 - 374	3		1000 - 1330	3000 - 3992	9	
125 - 215	375 - 647	4		1331 - 1727	3993 - 5183	10	
216 - 342	648 - 1028	5		1728 - 2196	5184 - 6590	11	
343 - 511	1029 - 1535	6		2197 - 2743	6591 - 8231	12	
				Other			

* If more than 1 flowmeter used complete details of all flowmeters used.					
Flowmeter No.	N/A	Calibration Factor	Quarterly	Calibration Due	2018-12-07
When completing personal air monitoring on QF84b, please complete the following.					
Type of RPE Used		Activity being performed	Reassurance	Length of exposure	329 mins

All testing completed in the QF84 series is completed in accordance with HSE guidance.
HSG 248 Asbestos: The analysts, guide for sampling analysis and clearance procedures

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AIRBORNE FIBRE CONCENTRATION RECORDS

Certificate No.	AQ01	Project No.	J040721/AQ01	Issue Date	27 Sep 2018	Analysis Date	27 Sep 2018

Location	Sample No	Head No	Pump No	Temp (°C)**	Pressure (HPa)**	Time Started	Time Stopped	Sample Duration (mins)	Initial Flow Rate(l/min)	Final Flow Rate(l/min)	Corrected Flow Rate (l/min)	Volume Sampled (litres)	No Fibres	No Fields	Calculated Conc. f/ml 3 dec places	Limit of Quantification <3 dec places	Result f/ml<0.01 or3 dec places
Excavation Site	AQ000485	NAL-130	NAL-138	N/A	Pressure	09:49	11:49	120	4.0	4.0	4.0	480	1	200	0.0005	0.01	<0.01
Excavation Site	AQ000486	NAL-131	NAL-139	N/A	Pressure	09:50	11:50	120	4.0	4.0	4.0	480	0	200	0.0000	0.01	<0.01
Field Blank	AQ000487	NAL 78	N/A	N/A	Pressure	N/A	N/A	N/A	N/A	N/A	N/A	N/A			N/A	0.000	

Comments: Air Monitoring Satisfactory

Signed Sampler: Print Name:Simon Mitchell Date:27 Sep 2018 Time:15:02

Fibre concentration = $1000ND^2/Vnd^2$ Fibres / millilitre (f/ml) V= volume, N=fibres, D^2 = exposed filter diameter, d^2 = graticule diameter (refer to HSG248)

Intermediate examination of slide to include low power scanning for approx. 30 sec. *Corrected flow rate is the average measured flow

If the number of rejected fields exceeds 10% of the No. accepted or the slide is deemed uncountable, record the no. of fields and write "**SLIDE REJECTED**" over the remaining three columns

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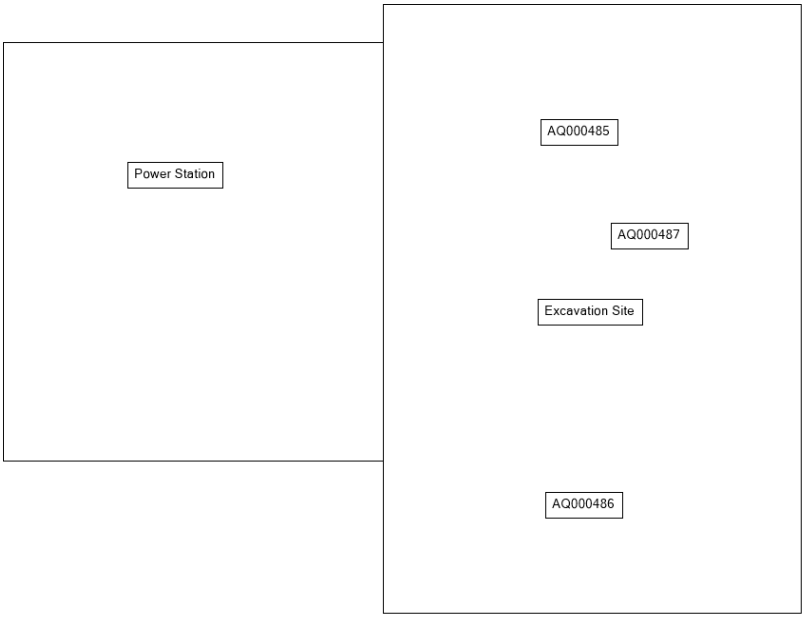
SITE DIAGRAM

Certificate No : J040721/AQ01 Date: 27 Sep 2018
Project No.:

When drawing diagrams for COR illustrations must include sizes of enclosure(S)



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UKAS TESTING 4502

PERSONAL SAMPLING REPORT FORM & EQUIPMENT LOG

Certificate No.	AQ02	Project No.	J040721/AQ02	Date or Date Range	27 Sep 2018

Persons Name	Paul Stanesby
Persons Job Title	Lead Driller
National Insurance No.	NH250070B
Site Address	Manchester Road, Carrington, Manchester
Contractors Details	S M Associates, Four Winds Farm Buildings, A46 Gloucester Road, Swainswick, Bath, BA1 8EA
Sampling Start Time	10:14
Sampling Finish Time	12:14
Type of work carried out by individual during sampling period	Drilling into Ground
Duration of each type of work activity	[NIC_PER_S0Fhttp://teams/images/getphoto.asp?id=369172&rndID=1539008560_9532]
Type of Asbestos product being removed or worked on	Crocilidite, Amosite and Chrysotile
Asbestos Removal Method	N/A
Control Method Used	Catogory 3 Type 5 Coveralls, Water Surpression
Type of RPE worn	Half Mask P3 Filter
Opinion on the effectiveness of controls	Satisfactory
Any other factors which may affect the result	N/A
Photos of work area (through viewing panels if applicable)	

Photos of work area (through viewing panels if applicable)		

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UKAS TESTING 4502

Flowmeter No.*	NAL-94	Barometer No.	NAL156	Tally Counters	Calibration due
Calibration Factor	Quarterly	Thermometer No.		1: NAL-36	2019-09-26
Calibration due	2018-12-07	Calibration due		2: NAL-37	2019-09-26
Filter batch No.	N/A	Timepiece No.	NAL-33	Acetone Vapouriser	NAL 102
Date checked	N/A	Calibration due	2019-09-26	Service due	2019-09-26
Microscope No.	MIC-003	Stage Micrometer	NAL-107	NPL test slide	NALTS-02
Service due	2019-07-05	Calibration Factor	Yearly	Band 5 observed	Yes
Measured graticule	100	Calibration due	2019-03-29	Calibration due	2018-10-02

Equipment & Reagents complete before and during job	Equipment decontamination (where applicable) Complete
Yes	Yes

Cowl Inspection	Cowl Body	Filter Body	PTFE ,O, Ring	Connector	Blank Cap
Effective Filter Diameter **22.4**	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes

* If more than 1 flowmeter used complete details of all flowmeters used.					
Flowmeter No.	N/A	Calibration Factor		Calibration Due	
When completing personal air monitoring on QF84b, please complete the following.					

All testing completed in the QF84 series is completed in accordance with HSE guidance.
HSG 248 Asbestos: The analysts, guide for sampling analysis and clearance procedures

Opinions and interpretations expressed herein are outside the Scope of UKAS Accreditation.
NOTE: Strike through items that are not applicable.
Note: It is only necessary to use the thermometer/barometer if the temperature/pressure is outside normal operating conditions i.e. freezing or very hot.
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UKAS TESTING 4502

AIRBORNE FIBRE CONCENTRATION RECORDS

Certificate No.	AQ02	Project No.	J040721/AQ02	Issue Date	27 Sep 2018	Analysis Date	27 Sep 2018

Location	Sample No	Head No	Pump No	Temp (°C)**	Pressure (HPa)**	Time Started	Time Stopped	Sample Duration (mins)	Initial Flow Rate(l/min)	Final Flow Rate(l/min)	Corrected Flow Rate (l/min)	Volume Sampled (litres)	No Fibres	No Fields	Calculated Conc. f/ml 3 dec places	Limit of Quantification <3 dec places	Result f/ml<0.01 or3 dec places
Paul Stanesby/Excavation Site	AQ000488	NAL-77	NAL-144	N/A	Pressure	10:14	12:14	120	2.0	2.0	2.0	240	2	200	0.0020	0.020	<0.02

Comments: Air Monitoring Satisfactory

Signed Sampler: Print Name:Simon Mitchell Date:27 Sep 2018 Time:15:13

Fibre concentration = $1000ND^2/Vnd^2$ Fibres / millilitre (f/ml) V= volume, N=fibres, D^2 = exposed filter diameter, d^2 = graticule diameter (refer to HSG248)

Intermediate examination of slide to include low power scanning for approx. 30 sec. *Corrected flow rate is the average measured flow

If the number of rejected fields exceeds 10% of the No. accepted or the slide is deemed uncountable, record the no. of fields and write "**SLIDE REJECTED**" over the remaining three columns

Options and interpretations expressed herein are outside the scope of UKAS accreditation

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UKAS TESTING 4502

PERSONAL SAMPLING REPORT FORM & EQUIPMENT LOG

Certificate No.	AQ03	Project No.	J040721/AQ03	Date or Date Range	27 Sep 2018

Persons Name	Kieron Blackwell
Persons Job Title	2nd Man Driller
National Insurance No.	PA591330C
Site Address	Manchester Road, Carrington, Manchester
Contractors Details	S M Associates, Four Winds Farm Buildings, A46 Gloucester Road, Swainswick, Bath, BA1 8EA
Sampling Start Time	10:15
Sampling Finish Time	12:15
Type of work carried out by individual during sampling period	Drilling into Ground
Duration of each type of work activity	[NIC_PER_S0Fhttp://teams/images/getphoto.asp?id=369173&rndID=1539008660_6154]
Type of Asbestos product being removed or worked on	Crocilidite, Amosite and Chrysotile
Asbestos Removal Method	N/A
Control Method Used	Catogory 3 Type 5 Coveralls, Water Surpression
Type of RPE worn	Half Mask P3 Filter
Opinion on the effectiveness of controls	Satisfactory
Any other factors which may affect the result	N/A
Photos of work area (through viewing panels if applicable)	

Photos of work area (through viewing panels if applicable)		

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Flowmeter No.*	NAL-94	Barometer No.	NAL156	Tally Counters	Calibration due
Calibration Factor	Quarterly	Thermometer No.		1: NAL-36	2019-09-26
Calibration due	2018-12-07	Calibration due		2: NAL-37	2019-09-26
Filter batch No.	N/A	Timepiece No.	NAL-33	Acetone Vapouriser	NAL 102
Date checked	N/A	Calibration due	2019-09-26	Service due	2019-09-26
Microscope No.	MIC-003	Stage Micrometer	NAL-107	NPL test slide	NALTS-02
Service due	2019-07-05	Calibration Factor	Yearly	Band 5 observed	Yes
Measured graticule	100	Calibration due	2019-03-29	Calibration due	2018-10-02

Equipment & Reagents complete before and during job	Equipment decontamination (where applicable) Complete
Yes	Yes

Cowl Inspection	Cowl Body	Filter Body	PTFE ,O, Ring	Connector	Blank Cap
Effective Filter Diameter **22.4**	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes

* If more than 1 flowmeter used complete details of all flowmeters used.					
Flowmeter No.	N/A	Calibration Factor		Calibration Due	
When completing personal air monitoring on QF84b, please complete the following.					

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HSG 248 Asbestos: The analysts, guide for sampling analysis and clearance procedures

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UKAS TESTING 4502

AIRBORNE FIBRE CONCENTRATION RECORDS

Certificate No.	AQ03	Project No.	J040721/AQ03	Issue Date	27 Sep 2018	Analysis Date	27 Sep 2018

Location	Sample No	Head No	Pump No	Temp (°C)**	Pressure (HPa)**	Time Started	Time Stopped	Sample Duration (mins)	Initial Flow Rate(l/min)	Final Flow Rate(l/min)	Corrected Flow Rate (l/min)	Volume Sampled (litres)	No Fibres	No Fields	Calculated Conc. f/ml 3 dec places	Limit of Quantification <3 dec places	Result f/ml<0.01 or3 dec places
Kieron Blackwell/Excavation Site	AQ000489	NAL-79	NAL-145	N/A	Pressure	10:15	12:15	120	2.0	2.0	2.0	240	2	200	0.0020	0.020	<0.02

Comments: Air Monitoring Satisfactory

Signed Sampler: Print Name:Simon Mitchell Date:27 Sep 2018 Time:15:27

Fibre concentration = $1000ND^2/Vnd^2$ Fibres / millilitre (f/ml) V= volume, N=fibres, D^2 = exposed filter diameter, d^2 = graticule diameter (refer to HSG248)

Intermediate examination of slide to include low power scanning for approx. 30 sec. *Corrected flow rate is the average measured flow

If the number of rejected fields exceeds 10% of the No. accepted or the slide is deemed uncountable, record the no. of fields and write "**SLIDE REJECTED**" over the remaining three columns

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UKAS TESTING 4502

SITE DETAILS & EQUIPMENT LOG

Certificate No.	AQ01	Project No.	J040722/AQ01	Date or Date Range	28 Sep 2018
Client Name	S M Associates				
Site Address	Manchester Road, Carrington, Manchester				
Contractors Details	Four Winds Farm Buildings, A46 Gloucester Road, Swainswick, Bath				
Location of Works	Excavation Site				

Flowmeter No.*	NAL-98	Barometer No.	NAL156	Tally Counters	Calibration due
Calibration Factor	Quarterly	Thermometer No.		1: NAL-36	2019-09-26
Calibration due	2018-12-07	Calibration due		2: NAL-37	2019-09-26
Filter batch No.	N/A	Timepiece No.	NAL-33	Acetone Vapouriser	NAL 102
Date checked	N/A	Calibration due	2019-09-26	Service due	2019-09-26
Microscope No.	MIC-003	Stage Micrometer	NAL-107	NPL test slide	NALTS-02
Service due	2019-07-05	Calibration Factor	Yearly	Band 5 observed	Yes
Measured graticule	100	Calibration due	2019-03-29	Calibration due	2018-10-02

Cowl Inspection	Cowl Body	Filter Body	PTFE ,O, Ring	Connector	Blank Cap
Effective Filter Diameter **22.4**	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes

NUMBER OF MEASUREMENTS (CLEARANCE SAMPLING)

Area/m^2 (For enclosures <3m high)	Vol/m^3 (For enclosures >3m high)	Samples of 480 litres	(Tick)	Area/m^2 (For enclosures <3m high)	Vol/m^3 (For enclosures >3m high)	Samples of 480 litres	(Tick)
	<10	1		512 - 738	1536 - 2186	7	
<63	10 - 191	2		739 - 999	2187 - 2999	8	
64 - 124	192 - 374	3		1000 - 1330	3000 - 3992	9	
125 - 215	375 - 647	4		1331 - 1727	3993 - 5183	10	
216 - 342	648 - 1028	5		1728 - 2196	5184 - 6590	11	
343 - 511	1029 - 1535	6		2197 - 2743	6591 - 8231	12	
				Other			

* If more than 1 flowmeter used complete details of all flowmeters used.

Flowmeter No.	N/A	Calibration Factor	Quarterly	Calibration Due	2018-12-07

When completing personal air monitoring on QF84b, please complete the following.

Type of RPE Used		Activity being performed	Reassurance	Length of exposure	368 mins

All testing completed in the QF84 series is completed in accordance with HSE guidance.
HSG 248 Asbestos: The analysts, guide for sampling analysis and clearance procedures

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UKAS TESTING 4502

AIRBORNE FIBRE CONCENTRATION RECORDS

Certificate No.	AQ01	Project No.	J040722/AQ01	Issue Date	28 Sep 2018	Analysis Date	28 Sep 2018

Location	Sample No	Head No	Pump No	Temp (°C)**	Pressure (HPa)**	Time Started	Time Stopped	Sample Duration (mins)	Initial Flow Rate(l/min)	Final Flow Rate(l/min)	Corrected Flow Rate (l/min)	Volume Sampled (litres)	No Fibres	No Fields	Calculated Conc. f/ml 3 dec places	Limit of Quantification <3 dec places	Result f/ml<0.01 or3 dec places
Excavation Site	AQ000490	NAL-130	NAL-138	N/A	Pressure	09:24	11:24	120	4.0	4.0	4.0	480	1	200	0.0005	0.01	<0.01
Excavation Site	AQ000491	NAL-131	NAL-139	N/A	Pressure	09:25	11:25	120	4.0	4.0	4.0	480	0	200	0.0000	0.01	<0.01
Field Blank	AQ000492	NAL 78	N/A	N/A	Pressure	N/A	N/A	N/A	N/A	N/A	N/A	N/A			N/A	0.000	

Comments: Air Monitoring Satisfactory

Signed Sampler: Print Name:Simon Mitchell Date:28 Sep 2018 Time:15:23

Fibre concentration = $1000ND^2/Vnd^2$ Fibres / millilitre (f/ml) V= volume, N=fibres, D^2 = exposed filter diameter, d^2 = graticule diameter (refer to HSG248)

Intermediate examination of slide to include low power scanning for approx. 30 sec. *Corrected flow rate is the average measured flow

If the number of rejected fields exceeds 10% of the No. accepted or the slide is deemed uncountable, record the no. of fields and write "**SLIDE REJECTED**" over the remaining three columns

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NOTE: Strike through items that are not applicable.

Note: ** It is only necessary to use the thermometer/Barometer if the temperature/pressure is outside normal operating conditions i.e. freezing or very hot. Therefore do not record thermometer/barometer details if not used

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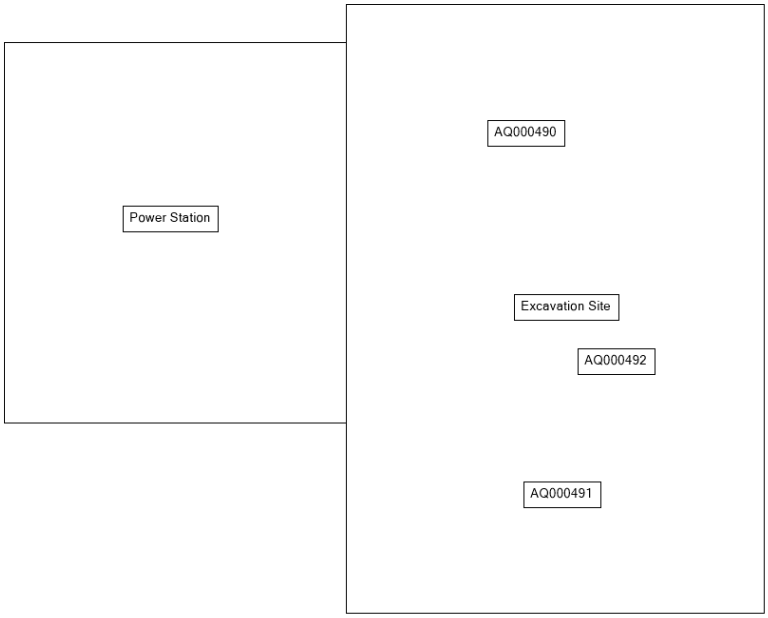
UKAS TESTING 4502

SITE DIAGRAM

Certificate No : J040722/AQ01 Date: 28 Sep 2018
Project No.:

When drawing diagrams for COR illustrations must include sizes of enclosure(S)



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PERSONAL SAMPLING REPORT FORM & EQUIPMENT LOG

Certificate No.	AQ02	Project No.	J040722/AQ02	Date or Date Range	28 Sep 2018

Persons Name	Paul Stanesby
Persons Job Title	Lead Driller
National Insurance No.	NH250070B
Site Address	Manchester Road, Carrington, Manchester
Contractors Details	S M Associates, Four Winds Farm Buildings, A46 Gloucester Road, Swainswick, Bath, BA1 8EA
Sampling Start Time	09:59
Sampling Finish Time	11:59
Type of work carried out by individual during sampling period	Drilling into Ground
Duration of each type of work activity	[NIC_PER_S0Fhttp://teams/images/getphoto.asp?id=369436&rndID=1539008729_1654]
Type of Asbestos product being removed or worked on	Crocilidite, Amosite and Chrysotile
Asbestos Removal Method	N/A
Control Method Used	Catogory 3 Type 5 Coveralls, Water Surpression
Type of RPE worn	Half Mask P3 Filter
Opinion on the effectiveness of controls	Satisfactory
Any other factors which may affect the result	N/A
Photos of work area (through viewing panels if applicable)	

Photos of work area (through viewing panels if applicable)		

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Flowmeter No.*	NAL-94	Barometer No.	NAL156	Tally Counters	Calibration due
Calibration Factor	Quarterly	Thermometer No.		1: NAL-36	2019-09-26
Calibration due	2018-12-07	Calibration due		2: NAL-37	2019-09-26
Filter batch No.	N/A	Timepiece No.	NAL-33	Acetone Vapouriser	NAL 102
Date checked	N/A	Calibration due	2019-09-26	Service due	2019-09-26
Microscope No.	MIC-003	Stage Micrometer	NAL-107	NPL test slide	NALTS-02
Service due	2019-07-05	Calibration Factor	Yearly	Band 5 observed	Yes
Measured graticule	100	Calibration due	2019-03-29	Calibration due	2018-10-02

Equipment & Reagents complete before and during job	Equipment decontamination (where applicable) Complete
Yes	Yes

Cowl Inspection	Cowl Body	Filter Body	PTFE ,O, Ring	Connector	Blank Cap
Effective Filter Diameter **22.4**	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes

* If more than 1 flowmeter used complete details of all flowmeters used.					
Flowmeter No.	N/A	Calibration Factor		Calibration Due	
When completing personal air monitoring on QF84b, please complete the following.					

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UKAS TESTING 4502

AIRBORNE FIBRE CONCENTRATION RECORDS

Certificate No.	AQ02	Project No.	J040722/AQ02	Issue Date	28 Sep 2018	Analysis Date	28 Sep 2018

Location	Sample No	Head No	Pump No	Temp (°C)**	Pressure (HPa)**	Time Started	Time Stopped	Sample Duration (mins)	Initial Flow Rate(l/min)	Final Flow Rate(l/min)	Corrected Flow Rate (l/min)	Volume Sampled (litres)	No Fibres	No Fields	Calculated Conc. f/ml 3 dec places	Limit of Quantification <3 dec places	Result f/ml<0.01 or3 dec places
Paul Stanesby/Excavation Site	AQ000493	NAL-77	NAL-144	N/A	Pressure	09:59	11:59	120	2.0	2.0	2.0	240	0	100	0.0000	0.040	<0.04

Comments: Air Monitoring Satisfactory

Signed Sampler: Print Name:Simon Mitchell Date:28 Sep 2018 Time:15:25

Fibre concentration = $1000ND^2/Vnd^2$ Fibres / millilitre (f/ml) V= volume, N=fibres, D^2 = exposed filter diameter, d^2 = graticule diameter (refer to HSG248)

Intermediate examination of slide to include low power scanning for approx. 30 sec. *Corrected flow rate is the average measured flow

If the number of rejected fields exceeds 10% of the No. accepted or the slide is deemed uncountable, record the no. of fields and write "**SLIDE REJECTED**" over the remaining three columns

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UKAS TESTING 4502

PERSONAL SAMPLING REPORT FORM & EQUIPMENT LOG

Certificate No.	AQ03	Project No.	J040722/AQ03	Date or Date Range	28 Sep 2018

Persons Name	Kieron Blackwell
Persons Job Title	2nd Man Driller
National Insurance No.	PA591330C
Site Address	Manchester Road, Carrington, Manchester
Contractors Details	S M Associates, Four Winds Farm Buildings, A46 Gloucester Road, Swainswick, Bath, BA1 8EA
Sampling Start Time	10:00
Sampling Finish Time	12:00
Type of work carried out by individual during sampling period	Drilling into Ground
Duration of each type of work activity	[NIC_PER_S0Fhttp://teams/images/getphoto.asp?id=369437&rndID=1539008795_6657]
Type of Asbestos product being removed or worked on	Crocilidite, Amosite and Chrysotile
Asbestos Removal Method	N/A
Control Method Used	Catogory 3 Type 5 Coveralls, Water Surpression
Type of RPE worn	Half Mask P3 Filter
Opinion on the effectiveness of controls	Satisfactory
Any other factors which may affect the result	N/A
Photos of work area (through viewing panels if applicable)	

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Photos of work area (through viewing panels if applicable)		

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Flowmeter No.*	NAL-94	Barometer No.	NAL156	Tally Counters	Calibration due
Calibration Factor	Quarterly	Thermometer No.		1: NAL-36	2019-09-26
Calibration due	2018-12-07	Calibration due		2: NAL-37	2019-09-26
Filter batch No.	N/A	Timepiece No.	NAL-33	Acetone Vapouriser	NAL 102
Date checked	N/A	Calibration due	2019-09-26	Service due	2019-09-26
Microscope No.	MIC-003	Stage Micrometer	NAL-107	NPL test slide	NALTS-02
Service due	2019-07-05	Calibration Factor	Yearly	Band 5 observed	Yes
Measured graticule	100	Calibration due	2019-03-29	Calibration due	2018-10-02

Equipment & Reagents complete before and during job	Equipment decontamination (where applicable) Complete
Yes	Yes

Cowl Inspection	Cowl Body	Filter Body	PTFE ,O, Ring	Connector	Blank Cap
Effective Filter Diameter **22.4**	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes	Satisfactory Yes

* If more than 1 flowmeter used complete details of all flowmeters used.					
Flowmeter No.	N/A	Calibration Factor		Calibration Due	
When completing personal air monitoring on QF84b, please complete the following.					

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UKAS TESTING 4502

AIRBORNE FIBRE CONCENTRATION RECORDS

Certificate No.	AQ03	Project No.	J040722/AQ03	Issue Date	28 Sep 2018	Analysis Date	28 Sep 2018

Location	Sample No	Head No	Pump No	Temp (^{0}C)**	Pressure (HPa)**	Time Started	Time Stopped	Sample Duration (mins)	Initial Flow Rate(l/min)	Final Flow Rate(l/min)	Corrected Flow Rate (l/min)	Volume Sampled (litres)	No Fibres	No Fields	Calculated Conc. f/ml 3 dec places	Limit of Quantification <3 dec places	Result f/ml<0.01 or3 dec places
Kieron Blackwell/Excavation Site	AQ000494	NAL-79	NAL-145	N/A	Pressure	10:00	12:00	120	2.0	2.0	2.0	240	0	100	0.0000	0.040	<0.04

Comments: Air Monitoring Satisfactory

Signed Sampler: Print Name:Simon Mitchell Date:28 Sep 2018 Time:17:19

Fibre concentration = $1000ND^2/Vnd^2$ Fibres / millilitre (f/ml) V= volume, N=fibres, D^2 = exposed filter diameter, d^2 = graticule diameter (refer to HSG248)

Intermediate examination of slide to include low power scanning for approx. 30 sec. *Corrected flow rate is the average measured flow

If the number of rejected fields exceeds 10% of the No. accepted or the slide is deemed uncountable, record the no. of fields and write "**SLIDE REJECTED**" over the remaining three columns

Options and interpretations expressed herein are outside the scope of UKAS accreditation

NOTE: Strike through items that are not applicable.

Note: ** It is only necessary to use the thermometer/Barometer if the temperature/pressure is outside normal operating conditions i.e. freezing or very hot. Therefore do not record thermometer/barometer details if not used

APPENDIX G

Laboratory Chemical Test Results

Unit A2
Windmill Road
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St Leonards on Sea
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THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number:	18-20054
Issue:	1
Date of Issue:	17/10/2018
Contact:	Jimmy Thorburn
Customer Details:	TerraConsult Ltd Bold Business Centre Unit 20, Bold Lane St Helens Merseyside WA9 4TX
Quotation No:	Q18-01061
Order No:	PO-003814
Customer Reference:	16094/TCL4133
Date Received:	02/10/2018
Date Approved:	17/10/2018
Details:	Gensiss
Approved by:	

Mike Varley, Technical Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

Sample Summary

Report No.: 18-20054

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
153360	BH18-02A ES1 4.00	25/09/2018	12/10/2018		
153361	BH18-02A ES2 5.00	25/09/2018	12/10/2018	Loamy sand	g
153362	BH18-02A ES3 6.00	25/09/2018	12/10/2018		
153363	BH18-02A ES4 7.00	25/09/2018	12/10/2018	Sandy loam	g
153364	TP18-01 ES1 0.50	26/09/2018	12/10/2018	Loamy sand	
153365	TP18-01 ES2 1.00	26/09/2018	12/10/2018		
153366	TP18-01 ES3 2.00	26/09/2018	12/10/2018		
153367	TP18-02 ES1 0.70	26/09/2018	12/10/2018		
153368	TP18-02 ES2 1.70	26/09/2018	12/10/2018	Sand + stones	g
153369	TP18-02 ES3 2.40	26/09/2018	12/10/2018		
153370	TP18-02 ES4 3.00	26/09/2018	12/10/2018		
153371	TP18-03 ES1 1.20	27/09/2018	12/10/2018	Loamy sand	g
153372	TP18-03 ES2 2.90	27/09/2018	12/10/2018		
153373	TP18-06 ES1 1.20	27/09/2018	12/10/2018	Sand + stones	
153374	TP18-06 ES2 3.50	27/09/2018	12/10/2018		
153375	TP18-07 ES1 1.00	27/09/2018	12/10/2018	Loamy sand	g
153376	TP18-07 ES2 2.00	27/09/2018	12/10/2018		
153377	TP18-08 ES1 1.30	27/09/2018	12/10/2018	Loamy sand	g
153378	TP18-09 ES1 1.00	27/09/2018	12/10/2018	Loamy sand	g
153379	TP18-10 ES1 1.70	27/09/2018	12/10/2018	Sandy loam	g
153380	TP18-10 ES2 3.20	27/09/2018	12/10/2018		
153381	TP18-11 ES1 0.60	27/09/2018	12/10/2018		
153382	TP18-11 ES2 1.50	27/09/2018	12/10/2018		
153383	TP18-12 ES1 0.50	27/09/2018	12/10/2018		
153384	TP18-12 ES2 2.20	27/09/2018	12/10/2018		
153385	TP18-08 0.50	27/09/2018	12/10/2018		

Results Summary

Report No.: 18-20054

			ELAB Reference	153361	153363	153364	153368	153371	153373
			Customer Reference	ES2	ES4	ES1	ES2	ES1	ES1
			Sample ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sample Location	BH18-02A	BH18-02A	TP18-01	TP18-02	TP18-03	TP18-06
			Sample Depth (m)	5.00	7.00	0.50	1.70	1.20	1.20
			Sampling Date	25/09/2018	25/09/2018	26/09/2018	26/09/2018	27/09/2018	27/09/2018
Determinand	**Codes**	**Units**	**LOD**						
Metals									
Arsenic	M	mg/kg	1	9.2	8.5	10.9	^ 20.1	17.6	^ 3.5
Cadmium	M	mg/kg	0.5	< 0.5	< 0.5	0.6	^ 0.6	0.6	^ < 0.5
Chromium	M	mg/kg	5	23.8	21.3	21.2	^ 23.1	21.6	^ 12.0
Copper	M	mg/kg	5	40.1	35.9	47.4	^ 100	71.7	^ 12.0
Lead	M	mg/kg	5	90.6	71.6	89.1	^ 145	116	^ 34.3
Mercury	M	mg/kg	0.5	< 0.5	< 0.5	< 0.5	^ < 0.5	< 0.5	^ < 0.5
Nickel	M	mg/kg	5	25.1	19.1	19.8	^ 32.7	27.7	^ 8.5
Selenium	M	mg/kg	1	< 1.0	< 1.0	8.9	^ < 1.0	< 1.0	^ < 1.0
Zinc	M	mg/kg	5	103	104	105	^ 157	187	^ 32.3
Anions									
Water Soluble Sulphate	M	g/l	0.02	0.15	0.12	0.11	^ 0.81	0.20	^ 0.19
Inorganics									
Total Cyanide	M	mg/kg	1	< 1.0	< 1.0	< 1.0	^ < 1.0	< 1.0	^ < 1.0
Acid Soluble Sulphate (SO4)	U	%	0.02	0.06	0.05	n/t	0.12	0.06	n/t
Miscellaneous									
Moisture Content	N	%	0.1	19.1	20.4	11.3	21.3	14.6	10.2
pH	M	pH units	0.1	9.5	9.3	8.3	^ 7.6	7.9	^ 8.6
Soil Organic Matter	U	%	0.1	3.4	3.7	3.2	4.2	1.4	7.3
Stones Content	N	%	0.1	37.9	41.5	48.2	31.8	31.0	63.2
Total Organic Carbon	N	%	0.01	1.7	1.5	1.7	8.2	3.0	1.7
Organics									
>C8-C10 BCB	N	mg/kg	1	g < 1.0	g < 1.0	n/t	g < 1.0	g < 1.0	n/t
>C10-C12 BCB	N	mg/kg	1	g < 1.0	g < 1.0	n/t	g < 1.0	g < 1.0	n/t
>C12-C16 BCB	N	mg/kg	1	g 5.5	g 8.1	n/t	g 1.7	g 15.2	n/t
>C16-C21 BCB	N	mg/kg	1	g 12.3	g 17.7	n/t	g 7.3	g 54.0	n/t
Diesel Range Organics (>C8-C21)	N	mg/kg	1	g 18	g 26	n/t	g 9	g 69	n/t
Phenols									
Total Monohydric Phenols	N	mg/kg	5	< 5	< 5	< 5	< 5	< 5	< 5
Polyaromatic hydrocarbons									
Naphthalene	M	mg/kg	0.1	2.4	0.7	3.1	^ 0.6	1.2	^ < 0.1
Acenaphthylene	M	mg/kg	0.1	0.5	0.3	0.2	^ 0.2	0.3	^ 0.1
Acenaphthene	M	mg/kg	0.1	6.1	2.0	0.8	^ 1.0	5.5	^ 0.2
Fluorene	M	mg/kg	0.1	4.2	1.5	0.7	^ 0.9	4.2	^ 0.3
Phenanthrene	M	mg/kg	0.1	42.9	5.6	3.9	^ 5.5	32.6	^ 0.2
Anthracene	M	mg/kg	0.1	14.0	1.9	1.2	^ 1.6	9.6	^ 0.2
Fluoranthene	M	mg/kg	0.1	59.0	7.1	10.2	^ 8.5	58.3	^ 0.9
Pyrene	M	mg/kg	0.1	46.5	6.2	10.0	^ 7.9	49.4	^ 1.2
Benzo(a)anthracene	M	mg/kg	0.1	26.4	2.6	5.5	^ 4.3	26.5	^ 0.6
Chrysene	M	mg/kg	0.1	26.1	3.0	5.8	^ 4.8	29.9	^ 2.4
Benzo (b) fluoranthene	M	mg/kg	0.1	20.4	2.0	5.1	^ 3.6	27.7	^ 1.1
Benzo(k)fluoranthene	M	mg/kg	0.1	16.4	2.1	4.2	^ 3.5	21.1	^ 1.2
Benzo (a) pyrene	M	mg/kg	0.1	17.6	2.0	4.6	^ 3.9	25.4	^ 0.6
Indeno (1,2,3-cd) pyrene	M	mg/kg	0.1	11.7	1.5	3.2	^ 3.0	18.8	^ 1.0
Dibenzo(a,h)anthracene	M	mg/kg	0.1	2.9	0.6	0.9	^ 0.8	4.3	^ 0.5
Benzo[g,h,i]perylene	M	mg/kg	0.1	10.2	1.5	4.1	^ 2.6	17.0	^ 0.8
Coronene	N	mg/kg	0.1	3.6	0.6	1.2	1.0	6.5	0.8
Total PAH(16)	M	mg/kg	0.4	307	40.8	63.3	^ 52.7	332	^ 11.4

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Results Summary

Report No.: 18-20054

			ELAB Reference	153361	153363	153364	153368	153371	153373
			Customer Reference	ES2	ES4	ES1	ES2	ES1	ES1
			Sample ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sample Location	BH18-02A	BH18-02A	TP18-01	TP18-02	TP18-03	TP18-06
			Sample Depth (m)	5.00	7.00	0.50	1.70	1.20	1.20
			Sampling Date	25/09/2018	25/09/2018	26/09/2018	26/09/2018	27/09/2018	27/09/2018
Determinand	**Codes**	**Units**	**LOD**						
BTEX									
Benzene	M	ug/kg	10	g 10.3	g < 10.0	n/t	g^ < 10.0	g < 10.0	n/t
Toluene	M	ug/kg	10	g < 10.0	g < 10.0	n/t	g^ < 10.0	g < 10.0	n/t
Ethylbenzene	M	ug/kg	10	g < 10.0	g < 10.0	n/t	g^ < 10.0	g < 10.0	n/t
Xylenes	M	ug/kg	10	g < 10.0	g < 10.0	n/t	g^ < 10.0	g < 10.0	n/t
MTBE	N	ug/kg	10	g < 10.0	g < 10.0	n/t	g < 10.0	g < 10.0	n/t
TPH CWG									
>C5-C6 Aliphatic	N	mg/kg	0.01	g < 0.01	g < 0.01	n/t	g < 0.01	g < 0.01	n/t
>C6-C8 Aliphatic	N	mg/kg	0.01	g < 0.01	g < 0.01	n/t	g < 0.01	g < 0.01	n/t
>C8-C10 Aliphatic	N	mg/kg	1	g < 1.0	g < 1.0	n/t	g < 1.0	g < 1.0	n/t
>C10-C12 Aliphatic	N	mg/kg	1	g < 1.0	g < 1.0	n/t	g < 1.0	g 1.5	n/t
>C12-C16 Aliphatic	N	mg/kg	1	g 6.5	g 4.5	n/t	g < 1.0	g 19.0	n/t
>C16-C21 Aliphatic	N	mg/kg	1	g 12.1	g 7.3	n/t	g 2.4	g 33.1	n/t
>C21-C35 Aliphatic	N	mg/kg	1	g 57.5	g 35.0	n/t	g 24.3	g 261	n/t
>C35-C40 Aliphatic	N	mg/kg	1	g 14.3	g 3.3	n/t	g 1.3	g 67.3	n/t
>C5-C7 Aromatic	N	mg/kg	0.01	g 0.01	g < 0.01	n/t	g < 0.01	g < 0.01	n/t
>C7-C8 Aromatic	N	mg/kg	0.01	g < 0.01	g < 0.01	n/t	g < 0.01	g < 0.01	n/t
>C8-C10 Aromatic	N	mg/kg	1	g < 1.0	g < 1.0	n/t	g < 1.0	g < 1.0	n/t
>C10-C12 Aromatic	N	mg/kg	1	g < 1.0	g < 1.0	n/t	g < 1.0	g 2.3	n/t
>C12-C16 Aromatic	N	mg/kg	1	g 13.5	g 8.5	n/t	g 3.0	g 28.8	n/t
>C16-C21 Aromatic	N	mg/kg	1	g 31.0	g 17.2	n/t	g 6.1	g 80.0	n/t
>C21-C35 Aromatic	N	mg/kg	1	g 111	g 86.0	n/t	g 62.5	g 490	n/t
>C35-C40 Aromatic	N	mg/kg	1	g 38.3	g 23.3	n/t	g 16.5	g 132	n/t
Total (>C5-C40) Ali/Aro	N	mg/kg	1	g 284	g 185	n/t	g 116	g 1110	n/t
Total Petroleum Hydrocarbons									
Mineral Oil	U	mg/kg	5	g 247	g 103	n/t	g 162	g 569	n/t

Results Summary

Report No.: 18-20054

			ELAB Reference	153375	153377	153378	153379
			Customer Reference	ES1	ES1	ES1	ES1
			Sample ID				
			Sample Type	SOIL	SOIL	SOIL	SOIL
			Sample Location	TP18-07	TP18-08	TP18-09	TP18-10
			Sample Depth (m)	1.00	1.30	1.00	1.70
			Sampling Date	27/09/2018	27/09/2018	27/09/2018	27/09/2018
Determinand	**Codes**	**Units**	**LOD**				
Metals							
Arsenic	M	mg/kg	1	16.2	6.3	7.7	12.4
Cadmium	M	mg/kg	0.5	0.7	< 0.5	< 0.5	< 0.5
Chromium	M	mg/kg	5	22.7	10.8	13.3	23.0
Copper	M	mg/kg	5	119	22.9	29.5	54.1
Lead	M	mg/kg	5	149	71.3	56.1	114
Mercury	M	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5
Nickel	M	mg/kg	5	25.3	10.4	14.4	19.9
Selenium	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0
Zinc	M	mg/kg	5	519	59.0	64.9	101
Anions							
Water Soluble Sulphate	M	g/l	0.02	0.03	0.08	0.20	0.20
Inorganics							
Total Cyanide	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0
Acid Soluble Sulphate (SO4)	U	%	0.02	0.03	0.02	0.05	0.04
Miscellaneous							
Moisture Content	N	%	0.1	20.6	6.7	12.1	15.6
pH	M	pH units	0.1	8.1	8.3	10.2	8.4
Soil Organic Matter	U	%	0.1	1.7	3.7	2.0	3.2
Stones Content	N	%	0.1	24.7	61.0	50.9	44.8
Total Organic Carbon	N	%	0.01	1.8	0.95	1.1	2.6
Organics							
>C8-C10 BCB	N	mg/kg	1	g < 1.0	g < 1.0	g < 1.0	g < 1.0
>C10-C12 BCB	N	mg/kg	1	g < 1.0	g 1.3	g < 1.0	g 2.4
>C12-C16 BCB	N	mg/kg	1	g < 1.0	g 28.4	g 11.0	g 31.9
>C16-C21 BCB	N	mg/kg	1	g < 1.0	g 183	g 38.7	g 106
Diesel Range Organics (>C8-C21)	N	mg/kg	1	g < 1	g 213	g 50	g 140
Phenols							
Total Monohydric Phenols	N	mg/kg	5	< 5	< 5	< 5	< 5
Polyaromatic hydrocarbons							
Naphthalene	M	mg/kg	0.1	< 0.1	0.2	0.7	1.6
Acenaphthylene	M	mg/kg	0.1	< 0.1	1.0	0.4	0.5
Acenaphthene	M	mg/kg	0.1	0.2	1.0	1.7	9.1
Fluorene	M	mg/kg	0.1	0.1	1.6	1.5	6.8
Phenanthrene	M	mg/kg	0.1	0.9	10.7	7.9	53.5
Anthracene	M	mg/kg	0.1	0.3	3.5	3.3	14.4
Fluoranthene	M	mg/kg	0.1	2.3	19.0	12.9	60.9
Pyrene	M	mg/kg	0.1	1.9	17.0	11.8	52.3
Benzo(a)anthracene	M	mg/kg	0.1	1.3	10.3	7.5	30.9
Chrysene	M	mg/kg	0.1	1.5	11.8	9.0	29.8
Benzo (b) fluoranthene	M	mg/kg	0.1	1.3	7.6	7.3	25.2
Benzo(k)fluoranthene	M	mg/kg	0.1	1.1	7.4	7.1	23.1
Benzo (a) pyrene	M	mg/kg	0.1	1.3	9.2	7.8	25.9
Indeno (1,2,3-cd) pyrene	M	mg/kg	0.1	1.0	6.9	6.3	17.0
Dibenzo(a,h)anthracene	M	mg/kg	0.1	0.3	2.6	1.8	4.5
Benzo[g,h,i]perylene	M	mg/kg	0.1	0.9	6.4	4.9	14.3
Coronene	N	mg/kg	0.1	0.4	0.4	1.8	5.0
Total PAH(16)	M	mg/kg	0.4	14.5	116	91.8	370

Results Summary

Report No.: 18-20054

			ELAB Reference	153375	153377	153378	153379
			Customer Reference	ES1	ES1	ES1	ES1
			Sample ID				
			Sample Type	SOIL	SOIL	SOIL	SOIL
			Sample Location	TP18-07	TP18-08	TP18-09	TP18-10
			Sample Depth (m)	1.00	1.30	1.00	1.70
			Sampling Date	27/09/2018	27/09/2018	27/09/2018	27/09/2018
Determinand	**Codes**	**Units**	**LOD**				
BTEX							
Benzene	M	ug/kg	10	g < 10.0	g < 10.0	g < 10.0	g < 10.0
Toluene	M	ug/kg	10	g < 10.0	g < 10.0	g < 10.0	g < 10.0
Ethylbenzene	M	ug/kg	10	g < 10.0	g < 10.0	g < 10.0	g < 10.0
Xylenes	M	ug/kg	10	g < 10.0	g < 10.0	g < 10.0	g < 10.0
MTBE	N	ug/kg	10	g < 10.0	g < 10.0	g < 10.0	g < 10.0
TPH CWG							
>C5-C6 Aliphatic	N	mg/kg	0.01	g < 0.01	g < 0.01	g < 0.01	g < 0.01
>C6-C8 Aliphatic	N	mg/kg	0.01	g < 0.01	g < 0.01	g < 0.01	g < 0.01
>C8-C10 Aliphatic	N	mg/kg	1	g < 1.0	g < 1.0	g < 1.0	g < 1.0
>C10-C12 Aliphatic	N	mg/kg	1	g < 1.0	g 1.5	g < 1.0	g < 1.0
>C12-C16 Aliphatic	N	mg/kg	1	g < 1.0	g 26.6	g 13.8	g 5.5
>C16-C21 Aliphatic	N	mg/kg	1	g < 1.0	g 127	g 34.7	g 15.2
>C21-C35 Aliphatic	N	mg/kg	1	g < 1.0	g 2150	g 177	g 185
>C35-C40 Aliphatic	N	mg/kg	1	g < 1.0	g 694	g 74.1	g 68.9
>C5-C7 Aromatic	N	mg/kg	0.01	g < 0.01	g < 0.01	g < 0.01	g < 0.01
>C7-C8 Aromatic	N	mg/kg	0.01	g < 0.01	g < 0.01	g < 0.01	g < 0.01
>C8-C10 Aromatic	N	mg/kg	1	g < 1.0	g < 1.0	g < 1.0	g < 1.0
>C10-C12 Aromatic	N	mg/kg	1	g < 1.0	g 1.4	g < 1.0	g < 1.0
>C12-C16 Aromatic	N	mg/kg	1	g < 1.0	g 23.1	g 16.4	g 8.5
>C16-C21 Aromatic	N	mg/kg	1	g < 1.0	g 136	g 70.0	g 30.0
>C21-C35 Aromatic	N	mg/kg	1	g 4.3	g 2350	g 297	g 342
>C35-C40 Aromatic	N	mg/kg	1	g < 1.0	g 734	g 134	g 145
Total (>C5-C40) Ali/Aro	N	mg/kg	1	g 4.3	g 6240	g 817	g 800
Total Petroleum Hydrocarbons							
Mineral Oil	U	mg/kg	5	g 41	g 4040	g 1050	g 693

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Results Summary

Report No.: 18-20054

			ELAB Reference	153361	153363	153368	153371	153375	153377	153378	153379
			Customer Reference	ES2	ES4	ES2	ES1	ES1	ES1	ES1	ES1
			Sample ID								
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sample Location	BH18-02A	BH18-02A	TP18-02	TP18-03	TP18-07	TP18-08	TP18-09	TP18-10
			Sample Depth (m)	5.00	7.00	1.70	1.20	1.00	1.30	1.00	1.70
			Sampling Date	25/09/2018	25/09/2018	26/09/2018	27/09/2018	27/09/2018	27/09/2018	27/09/2018	27/09/2018
Determinand	**Codes**	**Units**	**LOD**								
VOC											
Heptane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Octane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Nonane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Benzene	M	ug/kg	10	10.3	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Toluene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Ethylbenzene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
m+p-xylene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
o-xylene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
cis-1,2-dichloroethene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Chloroform	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Tetrachloromethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1,1-Trichloroethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Trichloroethylene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Tetrachloroethylene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1,1,2-Tetrachloroethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroetha	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Chlorobenzene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromobenzene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromodichloromethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Methylethylbenzene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloro-1-propene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Trans - 1-2 -dichloroethylene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2,2-Dichloropropane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromochloromethane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Dibromomethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloro-1-propene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloro-1-propene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,3-Dichloropropane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-dibromoethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Styrene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Propylbenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2-Chlorotoluene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2,4-Trimethylbenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
4-Chlorotoluene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
t-butylbenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,3,5-Trimethylbenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1-methylpropylbenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
p-cymene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,3-Dichlorobenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Butylbenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dibromo-3-chloropropane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Hexachlorobutadiene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1-2-3 - Trichlorobenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Naphthalene	N	ug/kg	10	82.8	74.7	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1-2-4 - Trichlorobenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,4-Dichlorobenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichlorobenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromoform	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0

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Results Summary

Report No.: 18-20054

Asbestos Results

Analytical result only applies to the sample as submitted by the client. Any comments, opinions or interpretations (marked #) in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client.

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
153360	4.00	BH18-02A ES1	Brown sandy soil,Stones,brick	Chrysotile (Cement fragment)	n/t	n/t	n/t	n/t
153361	5.00	BH18-02A ES2	Brown sandy soil,Stones	No asbestos detected	n/t	n/t	n/t	n/t
153362	6.00	BH18-02A ES3	Brown sandy soil,Stones	No asbestos detected	n/t	n/t	n/t	n/t
153363	7.00	BH18-02A ES4	Brown sandy soil	No asbestos detected	n/t	n/t	n/t	n/t
153368	1.70	TP18-02 ES2	Brown sandy soil,Clinker	No asbestos detected	n/t	n/t	n/t	n/t
153371	1.20	TP18-03 ES1	Brown sandy soil,Stones	No asbestos detected	n/t	n/t	n/t	n/t
153375	1.00	TP18-07 ES1	Brown sandy soil,Stones	No asbestos detected	n/t	n/t	n/t	n/t
153377	1.30	TP18-08 ES1	Brown sandy soil,Stones,tarmac	No asbestos detected	n/t	n/t	n/t	n/t
153379	1.70	TP18-10 ES1	Brown sandy soil,Stones	No asbestos detected	n/t	n/t	n/t	n/t
153380	3.20	TP18-10 ES2	Brown sandy soil,Stones	Amosite (Fibre bundles)	n/t	n/t	n/t	n/t
153381	0.60	TP18-11 ES1	Brown sandy soil	No asbestos detected	n/t	n/t	n/t	n/t

Method Summary

Report No.: 18-20054

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
pH	M	Air dried sample	16/10/2018	113	Electromeric
Acid Soluble Sulphate	U	Air dried sample	16/10/2018	115	Ion Chromatography
Total Petroleum Hydrocarbons in solids	U	As submitted sample	15/10/2018	117	GC-FID
Aqua regia extractable metals	M	Air dried sample	15/10/2018	118	ICPMS
Phenols in solids	N	As submitted sample	15/10/2018	121	HPLC
PAH (GC-FID)	M	As submitted sample	16/10/2018	133	GC-FID
Water soluble anions	M	Air dried sample	15/10/2018	172	Ion Chromatography
Low range Aliphatic hydrocarbons soil	N	As submitted sample	15/10/2018	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	15/10/2018	181	GC-MS
VOC in solids	M	As submitted sample	15/10/2018	181	GC-MS
BTEX in solids	M	As submitted sample	15/10/2018	181A	GC-MS
Total cyanide	M	As submitted sample	15/10/2018	204	Colorimetry
Total organic carbon/Total sulphur	N	Air dried sample	15/10/2018	210	IR
Aliphatic hydrocarbons in soil	N	As submitted sample	15/10/2018	214	GC-FID
Aliphatic/Aromatic hydrocarbons in soil	N	As submitted sample	16/10/2018	214	GC-FID
Aromatic hydrocarbons in soil	N	As submitted sample	15/10/2018	214	GC-FID
Basic carbon banding in soil	N	As submitted sample	15/10/2018	218	GC-FID
Diesel range organics in soil	N	As submitted sample	16/10/2018	257	GC-FID
Soil organic matter	U	Air dried sample	16/10/2018	BS1377:P3	Titrimetry
Asbestos identification	U	Air dried sample	15/10/2018	PMAN	Microscopy

Tests marked N are not UKAS accredited

Report Information

Report No.: 18-20054

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis (dried at < 30°C)
ELAB are unable to provide an interpretation or opinion on the content of this report.
The results relate only to the items tested
PCB congener results may include any coeluting PCBs
Uncertainty of measurement for the determinands tested are available upon request

Deviation Codes

a	No date of sampling supplied
b	No time of sampling supplied (Waters Only)
c	Sample not received in appropriate containers
d	Sample not received in cooled condition
e	The container has been incorrectly filled
f	Sample age exceeds stability time (sampling to receipt)
g	Sample age exceeds stability time (sampling to analysis)

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month
All water samples will be retained for 7 days following the date of the test report
Charges may apply to extended sample storage

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THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number:	18-20054
Issue:	2. Replaces Analytical Report number 18-20054; issue no.1
Date of Issue:	19/10/2018
Contact:	Jimmy Thorburn
Customer Details:	TerraConsult Ltd Bold Business Centre Unit 20, Bold Lane St Helens Merseyside WA9 4TX
Quotation No:	Q18-01061
Order No:	PO-003814
Customer Reference:	16094/TCL4133
Date Received:	02/10/2018
Date Approved:	19/10/2018
Details:	Gensiss
Approved by:	

Mike Varley, Technical Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

Sample Summary

Report No.: 18-20054

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
153360	BH18-02A ES1 4.00	25/09/2018	18/10/2018		
153361	BH18-02A ES2 5.00	25/09/2018	12/10/2018	Loamy sand	g
153362	BH18-02A ES3 6.00	25/09/2018	12/10/2018		
153363	BH18-02A ES4 7.00	25/09/2018	12/10/2018	Sandy loam	g
153364	TP18-01 ES1 0.50	26/09/2018	12/10/2018	Loamy sand	
153365	TP18-01 ES2 1.00	26/09/2018	12/10/2018		
153366	TP18-01 ES3 2.00	26/09/2018	12/10/2018		
153367	TP18-02 ES1 0.70	26/09/2018	12/10/2018		
153368	TP18-02 ES2 1.70	26/09/2018	12/10/2018	Sand + stones	g
153369	TP18-02 ES3 2.40	26/09/2018	12/10/2018		
153370	TP18-02 ES4 3.00	26/09/2018	12/10/2018		
153371	TP18-03 ES1 1.20	27/09/2018	12/10/2018	Loamy sand	g
153372	TP18-03 ES2 2.90	27/09/2018	12/10/2018		
153373	TP18-06 ES1 1.20	27/09/2018	12/10/2018	Sand + stones	
153374	TP18-06 ES2 3.50	27/09/2018	12/10/2018		
153375	TP18-07 ES1 1.00	27/09/2018	12/10/2018	Loamy sand	g
153376	TP18-07 ES2 2.00	27/09/2018	12/10/2018		
153377	TP18-08 ES1 1.30	27/09/2018	12/10/2018	Loamy sand	g
153378	TP18-09 ES1 1.00	27/09/2018	12/10/2018	Loamy sand	g
153379	TP18-10 ES1 1.70	27/09/2018	12/10/2018	Sandy loam	g
153380	TP18-10 ES2 3.20	27/09/2018	18/10/2018		
153381	TP18-11 ES1 0.60	27/09/2018	12/10/2018		
153382	TP18-11 ES2 1.50	27/09/2018	12/10/2018		
153383	TP18-12 ES1 0.50	27/09/2018	12/10/2018		
153384	TP18-12 ES2 2.20	27/09/2018	12/10/2018		
153385	TP18-08 0.50	27/09/2018	12/10/2018		

Results Summary

Report No.: 18-20054

			ELAB Reference	153361	153363	153364	153368	153371	153373
			Customer Reference	ES2	ES4	ES1	ES2	ES1	ES1
			Sample ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sample Location	BH18-02A	BH18-02A	TP18-01	TP18-02	TP18-03	TP18-06
			Sample Depth (m)	5.00	7.00	0.50	1.70	1.20	1.20
			Sampling Date	25/09/2018	25/09/2018	26/09/2018	26/09/2018	27/09/2018	27/09/2018
Determinand	**Codes**	**Units**	**LOD**						
Metals									
Arsenic	M	mg/kg	1	9.2	8.5	10.9	^ 20.1	17.6	^ 3.5
Cadmium	M	mg/kg	0.5	< 0.5	< 0.5	0.6	^ 0.6	0.6	^ < 0.5
Chromium	M	mg/kg	5	23.8	21.3	21.2	^ 23.1	21.6	^ 12.0
Copper	M	mg/kg	5	40.1	35.9	47.4	^ 100	71.7	^ 12.0
Lead	M	mg/kg	5	90.6	71.6	89.1	^ 145	116	^ 34.3
Mercury	M	mg/kg	0.5	< 0.5	< 0.5	< 0.5	^ < 0.5	< 0.5	^ < 0.5
Nickel	M	mg/kg	5	25.1	19.1	19.8	^ 32.7	27.7	^ 8.5
Selenium	M	mg/kg	1	< 1.0	< 1.0	8.9	^ < 1.0	< 1.0	^ < 1.0
Zinc	M	mg/kg	5	103	104	105	^ 157	187	^ 32.3
Anions									
Water Soluble Sulphate	M	g/l	0.02	0.15	0.12	0.11	^ 0.81	0.20	^ 0.19
Inorganics									
Total Cyanide	M	mg/kg	1	< 1.0	< 1.0	< 1.0	^ < 1.0	< 1.0	^ < 1.0
Acid Soluble Sulphate (SO4)	U	%	0.02	0.06	0.05	n/t	0.12	0.06	n/t
Miscellaneous									
Moisture Content	N	%	0.1	19.1	20.4	11.3	21.3	14.6	10.2
pH	M	pH units	0.1	9.5	9.3	8.3	^ 7.6	7.9	^ 8.6
Soil Organic Matter	U	%	0.1	3.4	3.7	3.2	4.2	1.4	7.3
Stones Content	N	%	0.1	37.9	41.5	48.2	31.8	31.0	63.2
Total Organic Carbon	N	%	0.01	1.7	1.5	1.7	8.2	3.0	1.7
Organics									
>C8-C10 BCB	N	mg/kg	1	g < 1.0	g < 1.0	n/t	g < 1.0	g < 1.0	n/t
>C10-C12 BCB	N	mg/kg	1	g < 1.0	g < 1.0	n/t	g < 1.0	g < 1.0	n/t
>C12-C16 BCB	N	mg/kg	1	g 5.5	g 8.1	n/t	g 1.7	g 15.2	n/t
>C16-C21 BCB	N	mg/kg	1	g 12.3	g 17.7	n/t	g 7.3	g 54.0	n/t
Diesel Range Organics (>C8-C21)	N	mg/kg	1	g 18	g 26	n/t	g 9	g 69	n/t
Phenols									
Total Monohydric Phenols	N	mg/kg	5	< 5	< 5	< 5	< 5	< 5	< 5
Polyaromatic hydrocarbons									
Naphthalene	M	mg/kg	0.1	2.4	0.7	3.1	^ 0.6	1.2	^ < 0.1
Acenaphthylene	M	mg/kg	0.1	0.5	0.3	0.2	^ 0.2	0.3	^ 0.1
Acenaphthene	M	mg/kg	0.1	6.1	2.0	0.8	^ 1.0	5.5	^ 0.2
Fluorene	M	mg/kg	0.1	4.2	1.5	0.7	^ 0.9	4.2	^ 0.3
Phenanthrene	M	mg/kg	0.1	42.9	5.6	3.9	^ 5.5	32.6	^ 0.2
Anthracene	M	mg/kg	0.1	14.0	1.9	1.2	^ 1.6	9.6	^ 0.2
Fluoranthene	M	mg/kg	0.1	59.0	7.1	10.2	^ 8.5	58.3	^ 0.9
Pyrene	M	mg/kg	0.1	46.5	6.2	10.0	^ 7.9	49.4	^ 1.2
Benzo(a)anthracene	M	mg/kg	0.1	26.4	2.6	5.5	^ 4.3	26.5	^ 0.6
Chrysene	M	mg/kg	0.1	26.1	3.0	5.8	^ 4.8	29.9	^ 2.4
Benzo (b) fluoranthene	M	mg/kg	0.1	20.4	2.0	5.1	^ 3.6	27.7	^ 1.1
Benzo(k)fluoranthene	M	mg/kg	0.1	16.4	2.1	4.2	^ 3.5	21.1	^ 1.2
Benzo (a) pyrene	M	mg/kg	0.1	17.6	2.0	4.6	^ 3.9	25.4	^ 0.6
Indeno (1,2,3-cd) pyrene	M	mg/kg	0.1	11.7	1.5	3.2	^ 3.0	18.8	^ 1.0
Dibenzo(a,h)anthracene	M	mg/kg	0.1	2.9	0.6	0.9	^ 0.8	4.3	^ 0.5
Benzo[g,h,i]perylene	M	mg/kg	0.1	10.2	1.5	4.1	^ 2.6	17.0	^ 0.8
Coronene	N	mg/kg	0.1	3.6	0.6	1.2	1.0	6.5	0.8
Total PAH(16)	M	mg/kg	0.4	307	40.8	63.3	^ 52.7	332	^ 11.4

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Results Summary

Report No.: 18-20054

			ELAB Reference	153361	153363	153364	153368	153371	153373
			Customer Reference	ES2	ES4	ES1	ES2	ES1	ES1
			Sample ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sample Location	BH18-02A	BH18-02A	TP18-01	TP18-02	TP18-03	TP18-06
			Sample Depth (m)	5.00	7.00	0.50	1.70	1.20	1.20
			Sampling Date	25/09/2018	25/09/2018	26/09/2018	26/09/2018	27/09/2018	27/09/2018
Determinand	**Codes**	**Units**	**LOD**						
BTEX									
Benzene	M	ug/kg	10	g 10.3	g < 10.0	n/t	g^ < 10.0	g < 10.0	n/t
Toluene	M	ug/kg	10	g < 10.0	g < 10.0	n/t	g^ < 10.0	g < 10.0	n/t
Ethylbenzene	M	ug/kg	10	g < 10.0	g < 10.0	n/t	g^ < 10.0	g < 10.0	n/t
Xylenes	M	ug/kg	10	g < 10.0	g < 10.0	n/t	g^ < 10.0	g < 10.0	n/t
MTBE	N	ug/kg	10	g < 10.0	g < 10.0	n/t	g < 10.0	g < 10.0	n/t
TPH CWG									
>C5-C6 Aliphatic	N	mg/kg	0.01	g < 0.01	g < 0.01	n/t	g < 0.01	g < 0.01	n/t
>C6-C8 Aliphatic	N	mg/kg	0.01	g < 0.01	g < 0.01	n/t	g < 0.01	g < 0.01	n/t
>C8-C10 Aliphatic	N	mg/kg	1	g < 1.0	g < 1.0	n/t	g < 1.0	g < 1.0	n/t
>C10-C12 Aliphatic	N	mg/kg	1	g < 1.0	g < 1.0	n/t	g < 1.0	g 1.5	n/t
>C12-C16 Aliphatic	N	mg/kg	1	g 6.5	g 4.5	n/t	g < 1.0	g 19.0	n/t
>C16-C21 Aliphatic	N	mg/kg	1	g 12.1	g 7.3	n/t	g 2.4	g 33.1	n/t
>C21-C35 Aliphatic	N	mg/kg	1	g 57.5	g 35.0	n/t	g 24.3	g 261	n/t
>C35-C40 Aliphatic	N	mg/kg	1	g 14.3	g 3.3	n/t	g 1.3	g 67.3	n/t
>C5-C7 Aromatic	N	mg/kg	0.01	g 0.01	g < 0.01	n/t	g < 0.01	g < 0.01	n/t
>C7-C8 Aromatic	N	mg/kg	0.01	g < 0.01	g < 0.01	n/t	g < 0.01	g < 0.01	n/t
>C8-C10 Aromatic	N	mg/kg	1	g < 1.0	g < 1.0	n/t	g < 1.0	g < 1.0	n/t
>C10-C12 Aromatic	N	mg/kg	1	g < 1.0	g < 1.0	n/t	g < 1.0	g 2.3	n/t
>C12-C16 Aromatic	N	mg/kg	1	g 13.5	g 8.5	n/t	g 3.0	g 28.8	n/t
>C16-C21 Aromatic	N	mg/kg	1	g 31.0	g 17.2	n/t	g 6.1	g 80.0	n/t
>C21-C35 Aromatic	N	mg/kg	1	g 111	g 86.0	n/t	g 62.5	g 490	n/t
>C35-C40 Aromatic	N	mg/kg	1	g 38.3	g 23.3	n/t	g 16.5	g 132	n/t
Total (>C5-C40) Ali/Aro	N	mg/kg	1	g 284	g 185	n/t	g 116	g 1110	n/t
Total Petroleum Hydrocarbons									
Mineral Oil	U	mg/kg	5	g 247	g 103	n/t	g 162	g 569	n/t

Results Summary

Report No.: 18-20054

			ELAB Reference	153375	153377	153378	153379
			Customer Reference	ES1	ES1	ES1	ES1
			Sample ID				
			Sample Type	SOIL	SOIL	SOIL	SOIL
			Sample Location	TP18-07	TP18-08	TP18-09	TP18-10
			Sample Depth (m)	1.00	1.30	1.00	1.70
			Sampling Date	27/09/2018	27/09/2018	27/09/2018	27/09/2018
Determinand	**Codes**	**Units**	**LOD**				
Metals							
Arsenic	M	mg/kg	1	16.2	6.3	7.7	12.4
Cadmium	M	mg/kg	0.5	0.7	< 0.5	< 0.5	< 0.5
Chromium	M	mg/kg	5	22.7	10.8	13.3	23.0
Copper	M	mg/kg	5	119	22.9	29.5	54.1
Lead	M	mg/kg	5	149	71.3	56.1	114
Mercury	M	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5
Nickel	M	mg/kg	5	25.3	10.4	14.4	19.9
Selenium	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0
Zinc	M	mg/kg	5	519	59.0	64.9	101
Anions							
Water Soluble Sulphate	M	g/l	0.02	0.03	0.08	0.20	0.20
Inorganics							
Total Cyanide	M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0
Acid Soluble Sulphate (SO4)	U	%	0.02	0.03	0.02	0.05	0.04
Miscellaneous							
Moisture Content	N	%	0.1	20.6	6.7	12.1	15.6
pH	M	pH units	0.1	8.1	8.3	10.2	8.4
Soil Organic Matter	U	%	0.1	1.7	3.7	2.0	3.2
Stones Content	N	%	0.1	24.7	61.0	50.9	44.8
Total Organic Carbon	N	%	0.01	1.8	0.95	1.1	2.6
Organics							
>C8-C10 BCB	N	mg/kg	1	g < 1.0	g < 1.0	g < 1.0	g < 1.0
>C10-C12 BCB	N	mg/kg	1	g < 1.0	g 1.3	g < 1.0	g 2.4
>C12-C16 BCB	N	mg/kg	1	g < 1.0	g 28.4	g 11.0	g 31.9
>C16-C21 BCB	N	mg/kg	1	g < 1.0	g 183	g 38.7	g 106
Diesel Range Organics (>C8-C21)	N	mg/kg	1	g < 1	g 213	g 50	g 140
Phenols							
Total Monohydric Phenols	N	mg/kg	5	< 5	< 5	< 5	< 5
Polyaromatic hydrocarbons							
Naphthalene	M	mg/kg	0.1	< 0.1	0.2	0.7	1.6
Acenaphthylene	M	mg/kg	0.1	< 0.1	1.0	0.4	0.5
Acenaphthene	M	mg/kg	0.1	0.2	1.0	1.7	9.1
Fluorene	M	mg/kg	0.1	0.1	1.6	1.5	6.8
Phenanthrene	M	mg/kg	0.1	0.9	10.7	7.9	53.5
Anthracene	M	mg/kg	0.1	0.3	3.5	3.3	14.4
Fluoranthene	M	mg/kg	0.1	2.3	19.0	12.9	60.9
Pyrene	M	mg/kg	0.1	1.9	17.0	11.8	52.3
Benzo(a)anthracene	M	mg/kg	0.1	1.3	10.3	7.5	30.9
Chrysene	M	mg/kg	0.1	1.5	11.8	9.0	29.8
Benzo (b) fluoranthene	M	mg/kg	0.1	1.3	7.6	7.3	25.2
Benzo(k)fluoranthene	M	mg/kg	0.1	1.1	7.4	7.1	23.1
Benzo (a) pyrene	M	mg/kg	0.1	1.3	9.2	7.8	25.9
Indeno (1,2,3-cd) pyrene	M	mg/kg	0.1	1.0	6.9	6.3	17.0
Dibenzo(a,h)anthracene	M	mg/kg	0.1	0.3	2.6	1.8	4.5
Benzo[g,h,i]perylene	M	mg/kg	0.1	0.9	6.4	4.9	14.3
Coronene	N	mg/kg	0.1	0.4	0.4	1.8	5.0
Total PAH(16)	M	mg/kg	0.4	14.5	116	91.8	370

Results Summary

Report No.: 18-20054

			ELAB Reference	153375	153377	153378	153379
			Customer Reference	ES1	ES1	ES1	ES1
			Sample ID				
			Sample Type	SOIL	SOIL	SOIL	SOIL
			Sample Location	TP18-07	TP18-08	TP18-09	TP18-10
			Sample Depth (m)	1.00	1.30	1.00	1.70
			Sampling Date	27/09/2018	27/09/2018	27/09/2018	27/09/2018
Determinand	**Codes**	**Units**	**LOD**				
BTEX							
Benzene	M	ug/kg	10	g < 10.0	g < 10.0	g < 10.0	g < 10.0
Toluene	M	ug/kg	10	g < 10.0	g < 10.0	g < 10.0	g < 10.0
Ethylbenzene	M	ug/kg	10	g < 10.0	g < 10.0	g < 10.0	g < 10.0
Xylenes	M	ug/kg	10	g < 10.0	g < 10.0	g < 10.0	g < 10.0
MTBE	N	ug/kg	10	g < 10.0	g < 10.0	g < 10.0	g < 10.0
TPH CWG							
>C5-C6 Aliphatic	N	mg/kg	0.01	g < 0.01	g < 0.01	g < 0.01	g < 0.01
>C6-C8 Aliphatic	N	mg/kg	0.01	g < 0.01	g < 0.01	g < 0.01	g < 0.01
>C8-C10 Aliphatic	N	mg/kg	1	g < 1.0	g < 1.0	g < 1.0	g < 1.0
>C10-C12 Aliphatic	N	mg/kg	1	g < 1.0	g 1.5	g < 1.0	g < 1.0
>C12-C16 Aliphatic	N	mg/kg	1	g < 1.0	g 26.6	g 13.8	g 5.5
>C16-C21 Aliphatic	N	mg/kg	1	g < 1.0	g 127	g 34.7	g 15.2
>C21-C35 Aliphatic	N	mg/kg	1	g < 1.0	g 2150	g 177	g 185
>C35-C40 Aliphatic	N	mg/kg	1	g < 1.0	g 694	g 74.1	g 68.9
>C5-C7 Aromatic	N	mg/kg	0.01	g < 0.01	g < 0.01	g < 0.01	g < 0.01
>C7-C8 Aromatic	N	mg/kg	0.01	g < 0.01	g < 0.01	g < 0.01	g < 0.01
>C8-C10 Aromatic	N	mg/kg	1	g < 1.0	g < 1.0	g < 1.0	g < 1.0
>C10-C12 Aromatic	N	mg/kg	1	g < 1.0	g 1.4	g < 1.0	g < 1.0
>C12-C16 Aromatic	N	mg/kg	1	g < 1.0	g 23.1	g 16.4	g 8.5
>C16-C21 Aromatic	N	mg/kg	1	g < 1.0	g 136	g 70.0	g 30.0
>C21-C35 Aromatic	N	mg/kg	1	g 4.3	g 2350	g 297	g 342
>C35-C40 Aromatic	N	mg/kg	1	g < 1.0	g 734	g 134	g 145
Total (>C5-C40) Ali/Aro	N	mg/kg	1	g 4.3	g 6240	g 817	g 800
Total Petroleum Hydrocarbons							
Mineral Oil	U	mg/kg	5	g 41	g 4040	g 1050	g 693

Tests marked N are not UKAS accredited.

Results Summary

Report No.: 18-20054

			ELAB Reference	153361	153363	153368	153371	153375	153377	153378	153379
			Customer Reference	ES2	ES4	ES2	ES1	ES1	ES1	ES1	ES1
			Sample ID								
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sample Location	BH18-02A	BH18-02A	TP18-02	TP18-03	TP18-07	TP18-08	TP18-09	TP18-10
			Sample Depth (m)	5.00	7.00	1.70	1.20	1.00	1.30	1.00	1.70
			Sampling Date	25/09/2018	25/09/2018	26/09/2018	27/09/2018	27/09/2018	27/09/2018	27/09/2018	27/09/2018
Determinand	**Codes**	**Units**	**LOD**								
VOC											
Heptane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Octane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Nonane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Benzene	M	ug/kg	10	10.3	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Toluene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Ethylbenzene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
m+p-xylene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
o-xylene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
cis-1,2-dichloroethene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Chloroform	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Tetrachloromethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1,1-Trichloroethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Trichloroethylene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Tetrachloroethylene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1,1,2-Tetrachloroethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroetha	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Chlorobenzene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromobenzene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromodichloromethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Methylethylbenzene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloro-1-propene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Trans - 1-2 -dichloroethylene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2,2-Dichloropropane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromochloromethane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Dibromomethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloro-1-propene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloro-1-propene	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,3-Dichloropropane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-dibromoethane	M	ug/kg	10	< 10.0	< 10.0	^ < 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Styrene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Propylbenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2-Chlorotoluene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2,4-Trimethylbenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
4-Chlorotoluene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
t-butylbenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,3,5-Trimethylbenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1-methylpropylbenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
p-cymene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,3-Dichlorobenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Butylbenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dibromo-3-chloropropane	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Hexachlorobutadiene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1-2-3 - Trichlorobenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Naphthalene	N	ug/kg	10	82.8	74.7	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1-2-4 - Trichlorobenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,4-Dichlorobenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichlorobenzene	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromoform	N	ug/kg	10	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0

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Results Summary

Report No.: 18-20054

Asbestos Results

Analytical result only applies to the sample as submitted by the client. Any comments, opinions or interpretations (marked #) in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client.

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
153360	4.00	BH18-02A ES1	Brown sandy soil,Stones,brick	Chrysotile (Cement fragment)	0.588	Cement (0.588)	< 0.001	0.588
153361	5.00	BH18-02A ES2	Brown sandy soil,Stones	No asbestos detected	n/t	n/t	n/t	n/t
153362	6.00	BH18-02A ES3	Brown sandy soil,Stones	No asbestos detected	n/t	n/t	n/t	n/t
153363	7.00	BH18-02A ES4	Brown sandy soil	No asbestos detected	n/t	n/t	n/t	n/t
153368	1.70	TP18-02 ES2	Brown sandy soil,Clinker	No asbestos detected	n/t	n/t	n/t	n/t
153371	1.20	TP18-03 ES1	Brown sandy soil,Stones	No asbestos detected	n/t	n/t	n/t	n/t
153375	1.00	TP18-07 ES1	Brown sandy soil,Stones	No asbestos detected	n/t	n/t	n/t	n/t
153377	1.30	TP18-08 ES1	Brown sandy soil,Stones,tarmac	No asbestos detected	n/t	n/t	n/t	n/t
153379	1.70	TP18-10 ES1	Brown sandy soil,Stones	No asbestos detected	n/t	n/t	n/t	n/t
153380	3.20	TP18-10 ES2	Brown sandy soil,Stones	Amosite (Fibre bundles)	0.002	Fibre bundles (0.002)	< 0.001	0.002
153381	0.60	TP18-11 ES1	Brown sandy soil	No asbestos detected	n/t	n/t	n/t	n/t

Method Summary

Report No.: 18-20054

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
pH	M	Air dried sample	16/10/2018	113	Electromeric
Acid Soluble Sulphate	U	Air dried sample	16/10/2018	115	Ion Chromatography
Total Petroleum Hydrocarbons in solids	U	As submitted sample	15/10/2018	117	GC-FID
Aqua regia extractable metals	M	Air dried sample	15/10/2018	118	ICPMS
Phenols in solids	N	As submitted sample	15/10/2018	121	HPLC
PAH (GC-FID)	M	As submitted sample	16/10/2018	133	GC-FID
Water soluble anions	M	Air dried sample	15/10/2018	172	Ion Chromatography
Low range Aliphatic hydrocarbons soil	N	As submitted sample	15/10/2018	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	15/10/2018	181	GC-MS
VOC in solids	M	As submitted sample	15/10/2018	181	GC-MS
BTEX in solids	M	As submitted sample	15/10/2018	181A	GC-MS
Total cyanide	M	As submitted sample	15/10/2018	204	Colorimetry
Total organic carbon/Total sulphur	N	Air dried sample	15/10/2018	210	IR
Aliphatic hydrocarbons in soil	N	As submitted sample	15/10/2018	214	GC-FID
Aliphatic/Aromatic hydrocarbons in soil	N	As submitted sample	16/10/2018	214	GC-FID
Aromatic hydrocarbons in soil	N	As submitted sample	15/10/2018	214	GC-FID
Basic carbon banding in soil	N	As submitted sample	15/10/2018	218	GC-FID
Diesel range organics in soil	N	As submitted sample	16/10/2018	257	GC-FID
Asbestos identification	U	Air dried sample	15/10/2018	260	Microscopy
Soil organic matter	U	Air dried sample	16/10/2018	BS1377:P3	Titrimetry
Asbestos identification	U	Air dried sample	15/10/2018	PMAN	Microscopy

Tests marked N are not UKAS accredited

Report Information

Report No.: 18-20054

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis (dried at < 30°C)
ELAB are unable to provide an interpretation or opinion on the content of this report.
The results relate only to the items tested
PCB congener results may include any coeluting PCBs
Uncertainty of measurement for the determinands tested are available upon request

Deviation Codes

a	No date of sampling supplied
b	No time of sampling supplied (Waters Only)
c	Sample not received in appropriate containers
d	Sample not received in cooled condition
e	The container has been incorrectly filled
f	Sample age exceeds stability time (sampling to receipt)
g	Sample age exceeds stability time (sampling to analysis)

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month
All water samples will be retained for 7 days following the date of the test report
Charges may apply to extended sample storage

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Bold Lane
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DETS Report No: 18-83562

Site Reference:	Project Gensiss, Carrington
Project / Job Ref:	16094/TCL4133
Order No:	PO-003818
Sample Receipt Date:	08/10/2018
Sample Scheduled Date:	12/10/2018
Report Issue Number:	1
Reporting Date:	18/10/2018

Authorised by:

Russell Jarvis
Associate Director of Client Services

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Soil Analysis Certificate						
DETS Report No: 18-83562	**Date Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
TerraConsult Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Project Gensiss, Carrington	**TP / BH No**	TP18-04	TP18-04	TP18-04	TP18-05	TP18-05
Project / Job Ref: 16094/TCL4133	**Additional Refs**	ES1	ES2	ES3	ES2	ES3
Order No: PO-003818	**Depth (m)**	0.10	1.40	2.20	1.20	2.60
Reporting Date: 18/10/2018	**DETS Sample No**	365964	365965	365966	365967	365968

Determinand	**Unit**	**RL**	**Accreditation**					
Asbestos Screen (S)	N/a	N/a	**ISO17025**		Not Detected		Detected	Not Detected
Sample Matrix (S)	Material Type	N/a	NONE				Bundle in soil	
Asbestos Type (S)	PLM Result	N/a	**ISO17025**				Chrysotile	
pH	pH Units	N/a	**MCERTS**	7.4		7.8	7.7	
Total Cyanide	mg/kg	< 2	NONE	< 2		< 2	< 2	
Total Sulphate as SO_4	mg/kg	< 200	NONE			570		
Total Sulphate as SO_4	%	< 0.02	NONE			0.06		
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	**MCERTS**	82		130	291	
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	**MCERTS**	0.08		0.13	0.29	
Organic Matter	%	< 0.1	**MCERTS**			3		
Total Organic Carbon (TOC)	%	< 0.1	**MCERTS**	3.1		1.8	1.9	
W/S Chloride (2:1)	mg/kg	< 1	**MCERTS**			13		
W/S Chloride (2:1)	mg/l	< 0.5	**MCERTS**			6.3		
Arsenic (As)	mg/kg	< 2	**MCERTS**	12		3	6	
Cadmium (Cd)	mg/kg	< 0.2	**MCERTS**	0.6		0.4	0.7	
Chromium (Cr)	mg/kg	< 2	**MCERTS**	19		18	35	
Copper (Cu)	mg/kg	< 4	**MCERTS**	45		50	83	
Lead (Pb)	mg/kg	< 3	**MCERTS**	99		71	159	
Mercury (Hg)	mg/kg	< 1	NONE	< 1		< 1	< 1	
Nickel (Ni)	mg/kg	< 3	**MCERTS**	11		17	22	
Selenium (Se)	mg/kg	< 3	NONE	< 3		< 3	< 3	
Zinc (Zn)	mg/kg	< 3	**MCERTS**	116		121	172	
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2		< 2	< 2	
DRO (C10 - C24)	mg/kg	< 6	**MCERTS**			422		
Oil (C25 - C40)	mg/kg	< 6	**MCERTS**			224		
Mineral Oil (C10 - C40)	mg/kg	< 10	**MCERTS**			21		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C
Subcontracted analysis (S)

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Soil Analysis Certificate						
DETS Report No: 18-83562	**Date Sampled**	None Supplied				
TerraConsult Ltd	**Time Sampled**	None Supplied				
Site Reference: Project Gensiss, Carrington	**TP / BH No**	TP18-05				
Project / Job Ref: 16094/TCL4133	**Additional Refs**	ES4				
Order No: PO-003818	**Depth (m)**	3.10				
Reporting Date: 18/10/2018	**DETS Sample No**	365969				

Determinand	**Unit**	**RL**	**Accreditation**					
Asbestos Screen (S)	N/a	N/a	**ISO17025**	Not Detected				
Sample Matrix (S)	Material Type	N/a	NONE					
Asbestos Type (S)	PLM Result	N/a	**ISO17025**					
pH	pH Units	N/a	**MCERTS**	7.7				
Total Cyanide	mg/kg	< 2	NONE	< 2				
Total Sulphate as SO_4	mg/kg	< 200	NONE	695				
Total Sulphate as SO_4	%	< 0.02	NONE	0.07				
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	**MCERTS**	190				
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	**MCERTS**	0.19				
Organic Matter	%	< 0.1	**MCERTS**	2.6				
Total Organic Carbon (TOC)	%	< 0.1	**MCERTS**	1.5				
W/S Chloride (2:1)	mg/kg	< 1	**MCERTS**	14				
W/S Chloride (2:1)	mg/l	< 0.5	**MCERTS**	7				
Arsenic (As)	mg/kg	< 2	**MCERTS**	< 2				
Cadmium (Cd)	mg/kg	< 0.2	**MCERTS**	0.3				
Chromium (Cr)	mg/kg	< 2	**MCERTS**	19				
Copper (Cu)	mg/kg	< 4	**MCERTS**	35				
Lead (Pb)	mg/kg	< 3	**MCERTS**	64				
Mercury (Hg)	mg/kg	< 1	NONE	< 1				
Nickel (Ni)	mg/kg	< 3	**MCERTS**	14				
Selenium (Se)	mg/kg	< 3	NONE	< 3				
Zinc (Zn)	mg/kg	< 3	**MCERTS**	80				
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2				
DRO (C10 - C24)	mg/kg	< 6	**MCERTS**	96				
Oil (C25 - C40)	mg/kg	< 6	**MCERTS**	112				
Mineral Oil (C10 - C40)	mg/kg	< 10	**MCERTS**	66				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C
Subcontracted analysis (S)

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Soil Analysis Certificate - Speciated PAHs							
DETS Report No: 18-83562		**Date Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	
TerraConsult Ltd		**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	
Site Reference: Project Gensiss, Carrington		**TP / BH No**	TP18-04	TP18-04	TP18-05	TP18-05	
Project / Job Ref: 16094/TCL4133		**Additional Refs**	ES1	ES3	ES2	ES4	
Order No: PO-003818		**Depth (m)**	0.10	2.20	1.20	3.10	
Reporting Date: 18/10/2018		**DETS Sample No**	365964	365966	365967	365969	
Determinand	**Unit**	**RL**	**Accreditation**				
Naphthalene	mg/kg	< 0.1	**MCERTS**	0.19	12.60	0.70	0.47
Acenaphthylene	mg/kg	< 0.1	**MCERTS**	< 0.1	0.45	0.13	< 0.1
Acenaphthene	mg/kg	< 0.1	**MCERTS**	< 0.1	5.74	2.08	0.54
Fluorene	mg/kg	< 0.1	**MCERTS**	0.20	7.11	2.03	0.43
Phenanthrene	mg/kg	< 0.1	**MCERTS**	1.46	31.20	9.52	3.96
Anthracene	mg/kg	< 0.1	**MCERTS**	0.35	7.14	2.68	0.89
Fluoranthene	mg/kg	< 0.1	**MCERTS**	2.61	22.70	12.60	6.26
Pyrene	mg/kg	< 0.1	**MCERTS**	2.39	21.20	10.40	5.34
Benzo(a)anthracene	mg/kg	< 0.1	**MCERTS**	1.37	6.76	4.45	2.66
Chrysene	mg/kg	< 0.1	**MCERTS**	1.38	8.02	5.12	2.90
Benzo(b)fluoranthene	mg/kg	< 0.1	**MCERTS**	1.73	6.58	5.32	3.18
Benzo(k)fluoranthene	mg/kg	< 0.1	**MCERTS**	0.52	2.32	1.59	1
Benzo(a)pyrene	mg/kg	< 0.1	**MCERTS**	1.37	5.64	4.31	2.42
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	**MCERTS**	1.12	2.88	2.56	1.72
Dibenz(a,h)anthracene	mg/kg	< 0.1	**MCERTS**	0.34	0.73	0.62	0.46
Benzo(ghi)perylene	mg/kg	< 0.1	**MCERTS**	1	2.48	2.21	1.46
Coronene	mg/kg	< 0.1	NONE	0.31	0.42	0.39	0.34
Total Oily Waste PAHs	mg/kg	< 1	**MCERTS**	7.8	32.9	24	14.3
Total Dutch 10 PAHs	mg/kg	< 1	**MCERTS**	11.4	102	45.7	23.7
Total EPA-16 PAHs	mg/kg	< 1.6	**MCERTS**	16	144	66.3	33.7
Total WAC-17 PAHs	mg/kg	< 1.7	NONE	16.3	144	66.7	34

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C

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Soil Analysis Certificate - TPH CWG Banded							
DETS Report No: 18-83562		**Date Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	
TerraConsult Ltd		**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	
Site Reference: Project Gensiss, Carrington		**TP / BH No**	BH18-01	BH18-01	TP18-04	TP18-05	
Project / Job Ref: 16094/TCL4133		**Additional Refs**	ES2	ES4	ES3	ES4	
Order No: PO-003818		**Depth (m)**	10.50	11.80	2.20	3.10	
Reporting Date: 18/10/2018		**DETS Sample No**	365962	365963	365966	365969	
Determinand	**Unit**	**RL**	**Accreditation**				
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Aliphatic >C8 - C10	mg/kg	< 2	**MCERTS**	< 2	< 2	< 2	< 2
Aliphatic >C10 - C12	mg/kg	< 2	**MCERTS**	< 2	< 2	< 2	< 2
Aliphatic >C12 - C16	mg/kg	< 3	**MCERTS**	< 3	< 3	< 3	< 3
Aliphatic >C16 - C21	mg/kg	< 3	**MCERTS**	4	14	< 3	< 3
Aliphatic >C21 - C34	mg/kg	< 10	**MCERTS**	53	113	21	61
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	57	128	21	61
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05
Aromatic >C8 - C10	mg/kg	< 2	**MCERTS**	< 2	< 2	< 2	< 2
Aromatic >C10 - C12	mg/kg	< 2	**MCERTS**	< 2	18	< 2	27
Aromatic >C12 - C16	mg/kg	< 2	**MCERTS**	15	81	6	95
Aromatic >C16 - C21	mg/kg	< 3	**MCERTS**	64	287	28	203
Aromatic >C21 - C35	mg/kg	< 10	**MCERTS**	152	537	160	348
Aromatic (C5 - C35)	mg/kg	< 21	NONE	230	923	194	673
Total >C5 - C35	mg/kg	< 42	NONE	287	1050	216	735

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C

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Soil Analysis Certificate - BTEX / MTBE							
DETS Report No: 18-83562		**Date Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	
TerraConsult Ltd		**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	
Site Reference: Project Gensiss, Carrington		**TP / BH No**	BH18-01	BH18-01	TP18-04	TP18-05	
Project / Job Ref: 16094/TCL4133		**Additional Refs**	ES2	ES4	ES3	ES4	
Order No: PO-003818		**Depth (m)**	10.50	11.80	2.20	3.10	
Reporting Date: 18/10/2018		**DETS Sample No**	365962	365963	365966	365969	
Determinand	**Unit**	**RL**	**Accreditation**				
Benzene	ug/kg	< 2	**MCERTS**	< 2	< 2	5	< 2
Toluene	ug/kg	< 5	**MCERTS**	< 5	< 5	< 5	< 5
Ethylbenzene	ug/kg	< 2	**MCERTS**	< 2	< 2	21	< 2
p & m-xylene	ug/kg	< 2	**MCERTS**	< 2	< 2	35	< 2
o-xylene	ug/kg	< 2	**MCERTS**	< 2	< 2	20	< 2
MTBE	ug/kg	< 5	**MCERTS**	< 5	< 5	< 5	< 5

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C

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Soil Analysis Certificate - Volatile Organic Compounds (VOC)								
DETS Report No: 18-83562		**Date Sampled**	None Supplied	None Supplied				
TerraConsult Ltd		**Time Sampled**	None Supplied	None Supplied				
Site Reference: Project Gensiss, Carrington		**TP / BH No**	TP18-04	TP18-05				
Project / Job Ref: 16094/TCL4133		**Additional Refs**	ES3	ES4				
Order No: PO-003818		**Depth (m)**	2.20	3.10				
Reporting Date: 18/10/2018		**DETS Sample No**	365966	365969				
Determinand	**Unit**	**RL**	**Accreditation**					
Dichlorodifluoromethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
Vinyl Chloride	ug/kg	< 5	**MCERTS**	< 5	< 5			
Chloromethane	ug/kg	< 10	**MCERTS**	< 10	< 10			
Chloroethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
Bromomethane	ug/kg	< 10	**MCERTS**	< 10	< 10			
Trichlorofluoromethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,1-Dichloroethene	ug/kg	< 5	**MCERTS**	< 5	< 5			
MTBE	ug/kg	< 5	**MCERTS**	< 5	< 5			
trans-1,2-Dichloroethene	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,1-Dichloroethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
cis-1,2-Dichloroethene	ug/kg	< 5	**MCERTS**	< 5	< 5			
2,2-Dichloropropane	ug/kg	< 5	**MCERTS**	< 5	< 5			
Chloroform	ug/kg	< 5	**MCERTS**	< 5	< 5			
Bromochloromethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,1,1-Trichloroethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,1-Dichloropropene	ug/kg	< 10	**MCERTS**	< 10	< 10			
Carbon Tetrachloride	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,2-Dichloroethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
Benzene	ug/kg	< 2	**MCERTS**	5	< 2			
1,2-Dichloropropane	ug/kg	< 5	**MCERTS**	< 5	< 5			
Trichloroethene	ug/kg	< 5	**MCERTS**	< 5	< 5			
Bromodichloromethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
Dibromomethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
TAME	ug/kg	< 5	**MCERTS**	< 5	< 5			
cis-1,3-Dichloropropene	ug/kg	< 5	**MCERTS**	< 5	< 5			
Toluene	ug/kg	< 5	**MCERTS**	< 5	< 5			
trans-1,3-Dichloropropene	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,1,2-Trichloroethane	ug/kg	< 10	**MCERTS**	< 10	< 10			
1,3-Dichloropropane	ug/kg	< 5	**MCERTS**	< 5	< 5			
Tetrachloroethene	ug/kg	< 5	**MCERTS**	< 5	< 5			
Dibromochloromethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,2-Dibromoethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
Chlorobenzene	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,1,1,2-Tetrachloroethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
Ethyl Benzene	ug/kg	< 2	**MCERTS**	21	< 2			
m,p-Xylene	ug/kg	< 2	**MCERTS**	35	< 2			
o-Xylene	ug/kg	< 2	**MCERTS**	20	< 2			
Styrene	ug/kg	< 5	**MCERTS**	< 5	< 5			
Bromoform	ug/kg	< 10	**MCERTS**	< 10	< 10			
Isopropylbenzene	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,1,2,2-Tetrachloroethane	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,2,3-Trichloropropane	ug/kg	< 5	**MCERTS**	< 5	< 5			
n-Propylbenzene	ug/kg	< 5	**MCERTS**	< 5	< 5			
Bromobenzene	ug/kg	< 5	**MCERTS**	< 5	< 5			
2-Chlorotoluene	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,3,5-Trimethylbenzene	ug/kg	< 5	**MCERTS**	< 5	< 5			
4-Chlorotoluene	ug/kg	< 5	**MCERTS**	< 5	< 5			
tert-Butylbenzene	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,2,4-Trimethylbenzene	ug/kg	< 5	**MCERTS**	8	< 5			
sec-Butylbenzene	ug/kg	< 5	**MCERTS**	< 5	< 5			
p-Isopropyltoluene	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,3-Dichlorobenzene	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,4-Dichlorobenzene	ug/kg	< 5	**MCERTS**	< 5	< 5			
n-Butylbenzene	ug/kg	< 5	**MCERTS**	< 5	< 5			
1,2-Dichlorobenzene	ug/kg	< 5	**MCERTS**	< 5	< 5			
,2-Dibromo-3-chloropropane	ug/kg	< 10	**MCERTS**	< 10	< 10			
Hexachlorobutadiene	ug/kg	< 5	**MCERTS**	< 5	< 5			

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Soil Analysis Certificate - Sample Descriptions	
DETS Report No: 18-83562	
TerraConsult Ltd	
Site Reference: Project Gensiss, Carrington	
Project / Job Ref: 16094/TCL4133	
Order No: PO-003818	
Reporting Date: 18/10/2018	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
^ 365962	BH18-01	ES2	10.50	16	Black sandy clay
^ 365963	BH18-01	ES4	11.80	23.6	Black sandy clay
^ 365964	TP18-04	ES1	0.10	19.8	Black sandy clay with vegetation
^ 365966	TP18-04	ES3	2.20	14.2	Black sandy clay with stones
^ 365967	TP18-05	ES2	1.20	14.3	Black sandy clay with brick and concrete
^ 365969	TP18-05	ES4	3.10	16.6	Brown sandy clay with stones

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

^ no sampling date provided; unable to confirm if samples are within acceptable holding times

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Soil Analysis Certificate - Methodology & Miscellaneous Information
DETS Report No: 18-83562
TerraConsult Ltd
Site Reference: Project Gensiss, Carrington
Project / Job Ref: 16094/TCL4133
Order No: PO-003818
Reporting Date: 18/10/2018

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10 C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

4480

Jimmy Thorburn
TerraConsult Ltd
Bold Business Centre
Bold Lane
Sutton
St Helens
Merseyside
WA9 4TX

DETS Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410
russell.jarvis@dets.co.uk

DETS Report No: 18-83822

Site Reference:	Project Gensiss, Carrington
Project / Job Ref:	16094/TCL4133
Order No:	None Supplied
Sample Receipt Date:	08/10/2018
Sample Scheduled Date:	19/10/2018
Report Issue Number:	1
Reporting Date:	24/10/2018

Authorised by:

Russell Jarvis
Associate Director of Client Services

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

UKAS TESTING
4480

Soil Analysis Certificate						
DETS Report No: 18-83822	**Date Sampled**	None Supplied				
TerraConsult Ltd	**Time Sampled**	None Supplied				
Site Reference: Project Gensiss, Carrington	**TP / BH No**	TP18-05				
Project / Job Ref: 16094/TCL4133	**Additional Refs**	ES2				
Order No: None Supplied	**Depth (m)**	1.20				
Reporting Date: 24/10/2018	**DETS Sample No**	367087				

Determinand	**Unit**	**RL**	**Accreditation**					
Asbestos Quantification (S)	%	< 0.001	**ISO17025**	0.005				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C
Subcontracted analysis (S)

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate - Methodology & Miscellaneous Information
DETS Report No: 18-83822
TerraConsult Ltd
Site Reference: Project Gensiss, Carrington
Project / Job Ref: 16094/TCL4133
Order No: None Supplied
Reporting Date: 24/10/2018

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10 C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

APPENDIX H

Laboratory Geotechnical Test Results

LABORATORY REPORT

4043

Contract Number: PSL18/5768

Report Date: 13 November 2018

Client's Reference: 4133

Client Name: TerraConsult
Bold Business Centre
Bold Lane
Sutton
St Helens
WA9 4TX

For the attention of: Jimmy Thorburn

Contract Title: Carrington

Date Received: 6/11/2018
Date Commenced: 6/11/2018
Date Completed: 13/11/2018

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson (Director)	A Watkins (Director)	R Berriman (Quality Manager)
S Royle (Laboratory Manager)	S Eyre (Senior Technician)	L Knight (Senior Technician)

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SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
BH18-01	5	D	12.00		Dark brown sandy CLAY with some organic material.
BH18-01	9	U	14.50	15.00	Stiff brown CLAY.
BH18-01	19	U	16.50	17.00	Firm brown CLAY.
BH18-01	15	D	19.90	20.00	Brown slightly gravelly silty SAND.
BH18-01	17	D	23.50		Brown slightly gravelly sandy CLAY.
BH18-02a	6	D	12.00	12.10	Dark brown sandy CLAY with some organic material.
BH18-02a	9	D	14.50		Brown slightly sandy CLAY.
BH18-02a	14	D	18.25	18.45	Brown slightly sandy CLAY.
BH18-02a	17	D	22.00	22.10	Brown slightly gravelly very sandy CLAY.

SUMMARY OF SOIL CLASSIFICATION TESTS

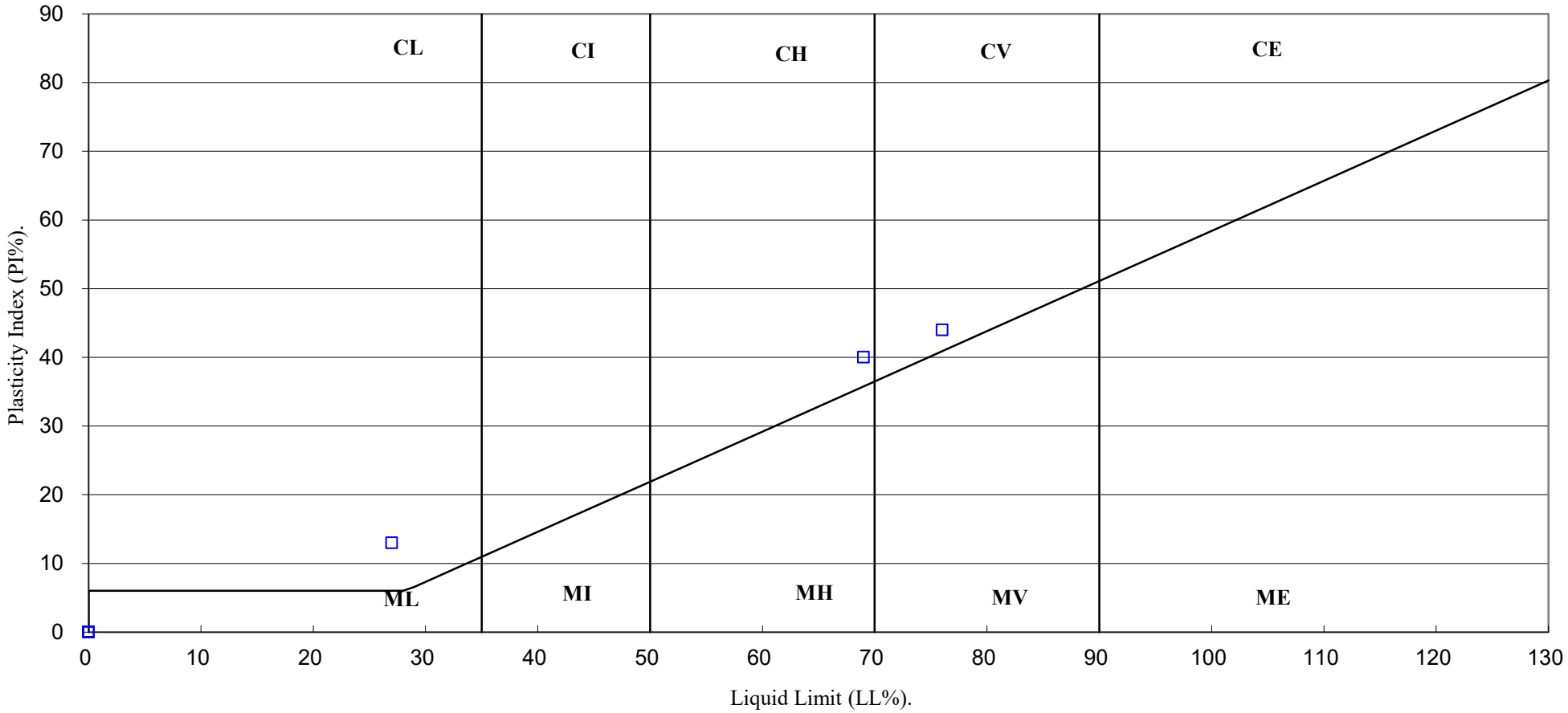
(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
BH18-01	5	D	12.00		55							
BH18-01	9	U	14.50	15.00	32			76	32	44	100	Very high plasticity CV.
BH18-01	19	U	16.50	17.00	31			69	29	40	100	High plasticity CH.
BH18-01	17	D	23.50		20							
BH18-02a	6	D	12.00	12.10	53							
BH18-02a	9	D	14.50		31							
BH18-02a	14	D	18.25	18.45	26							
BH18-02a	17	D	22.00	22.10	12			27	14	13	93	Low plasticity CL.

SYMBOLS : NP : Non Plastic *** : Liquid Limit and Plastic Limit Wet Sieved.**

UKAS TESTING 4043	PSL Professional Soils Laboratory	Carrington	Contract No: PSL18/5768
			Client Ref: 4135

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



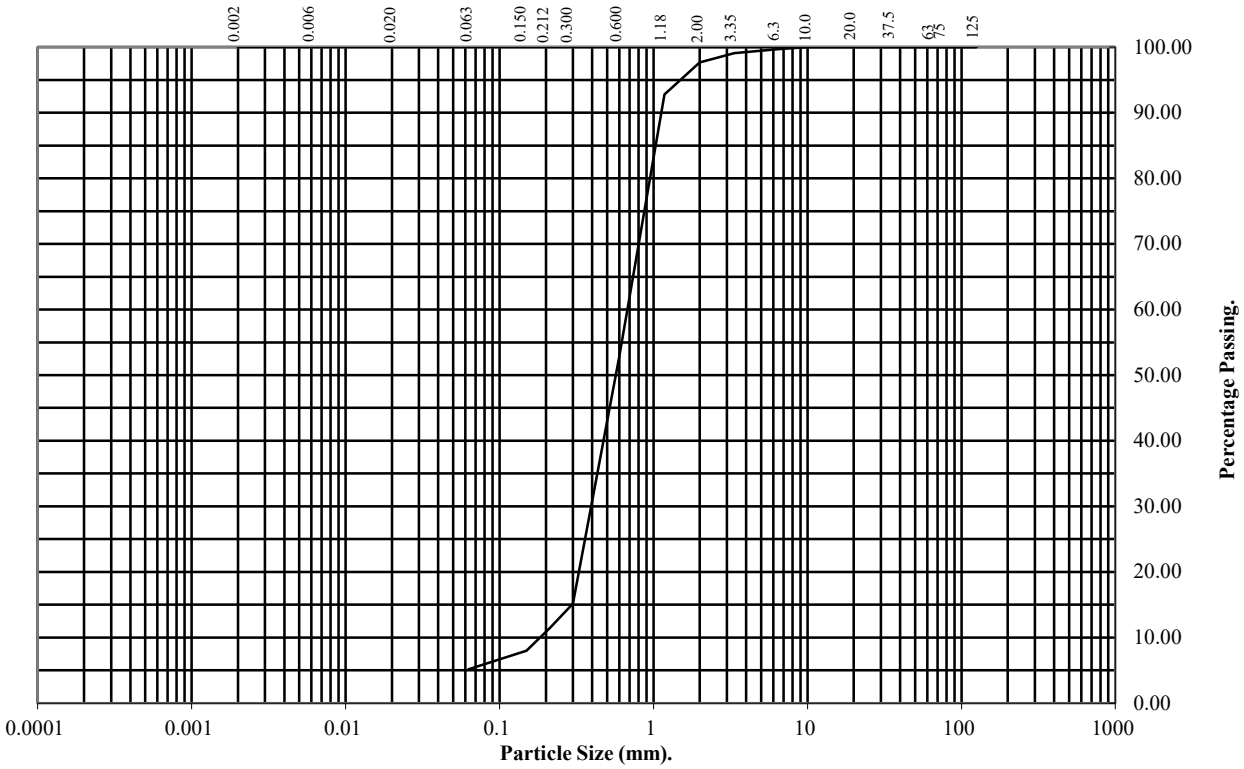
UKAS TESTING 4043	PSL Professional Soils Laboratory	Carrington	Contract No: PSL18/5768
			Client Ref: 4135

PARTICLE SIZE DISTRIBUTION TEST

BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number:	**BH18-01**	**Top Depth (m):**	**19.90**
Sample Number:	**15**	**Base Depth(m):**	**20.00**
Sample Type:	**D**		



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	100
6.3	100
3.35	99
2	98
1.18	93
0.6	53
0.3	15
0.212	11
0.15	8
0.063	5

Soil Fraction	Total Percentage
Cobbles	0
Gravel	2
Sand	93
Silt/Clay	5

Remarks:
See Summary of Soil Descriptions

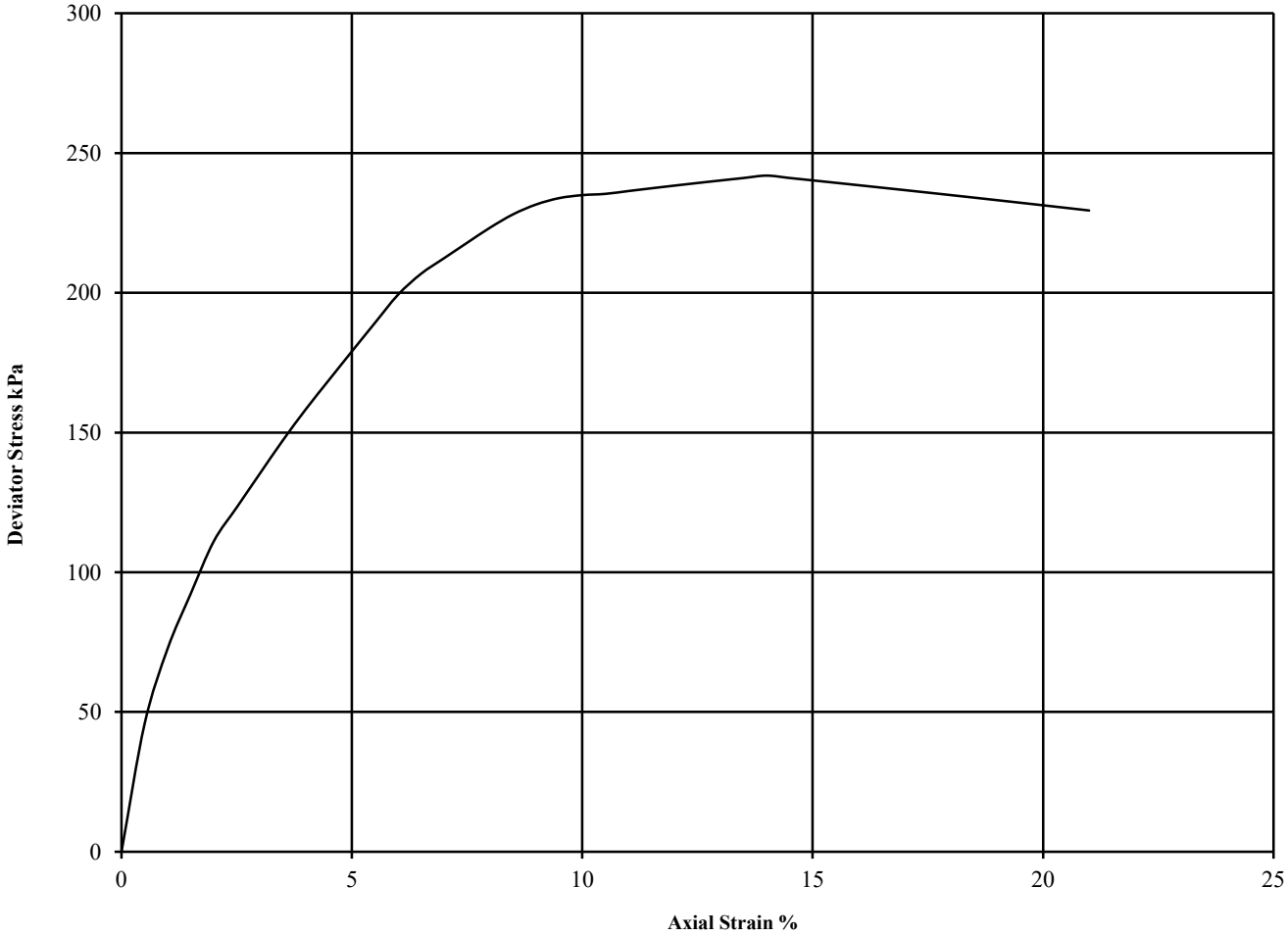
UKAS TESTING 4043	PSL Professional Soils Laboratory	**Carrington**	**Contract No:** PSL18/5768
			Client Ref: 4135

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**BH18-01**	**Top Depth (m):**	**14.50**
Sample Number:	**9**	**Base Depth (m):**	**15.00**
Sample Type	**U**		



Diameter (mm):		71.0	Height (mm):		142.0	Test:	UU Single Stage		Remarks:
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.48
1	32	1.89	1.43	290	242	121	14.0	Plastic	See summary of soil descriptions

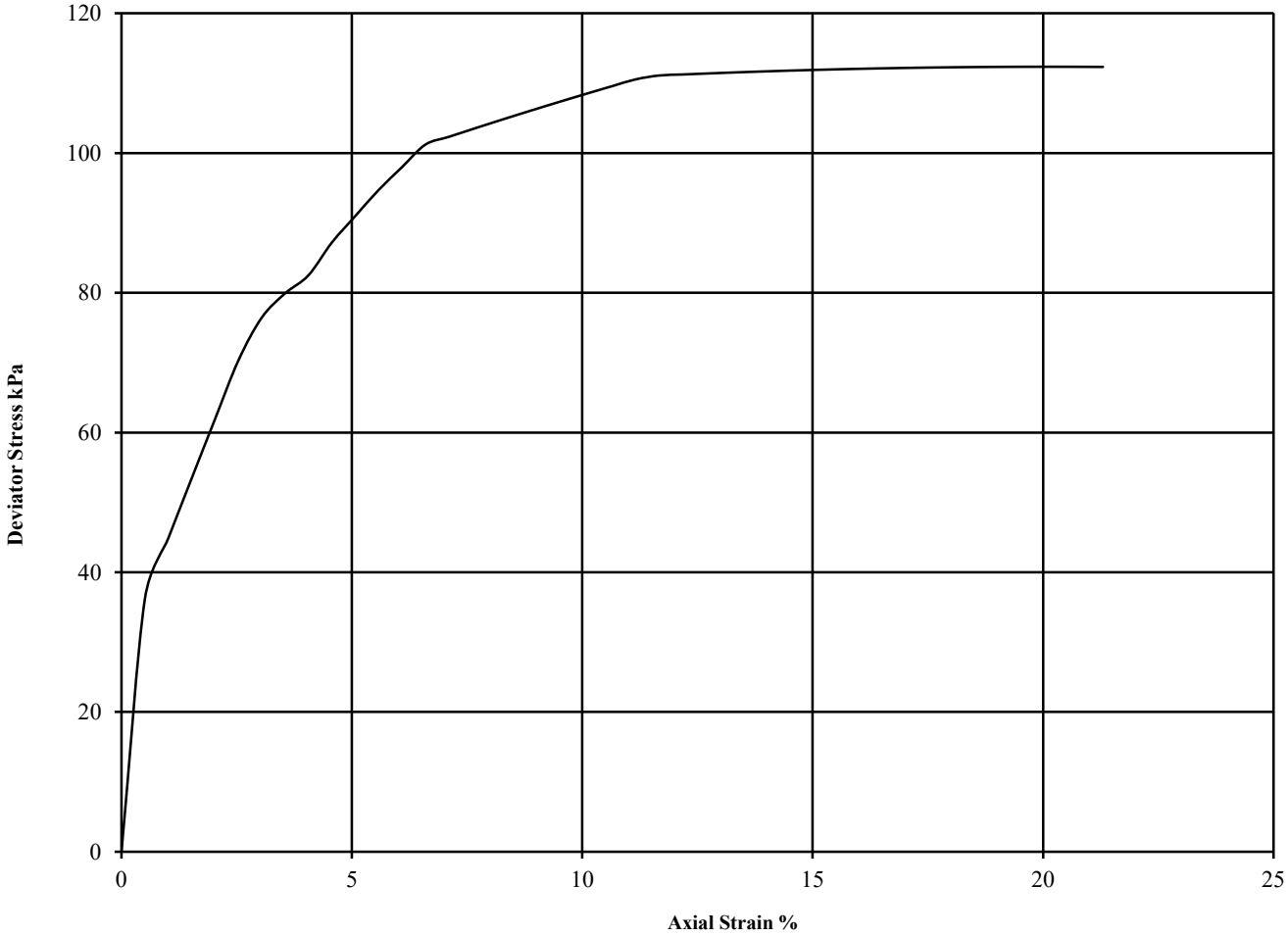
UKAS TESTING 4043	PSL Professional Soils Laboratory	**Carrington**	**Contract No:** PSL18/5768
			Client Ref: 4135

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**BH18-01**	**Top Depth (m):**	**16.50**
Sample Number:	**19**	**Base Depth (m):**	**17.00**
Sample Type	**U**		



Diameter (mm):		71.0	Height (mm):		140.0	Test:	UU Single Stage		Remarks:
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.45
1	31	1.99	1.52	330	112	56	20.3	Plastic	See summary of soil descriptions

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Carrington**	**Contract No:** PSL18/5768
			Client Ref: 4135

APPENDIX I

Summary of Chemical Test Results of Soil Samples

TerraConsult

Site: Project GENESISS

CHEMICAL STATISTICAL ANALYSIS - based on CLEA v1.07 (Sandy Loam 1% SOM)

Job No: 4133

Analyte	Limit of Detection	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult	TerraConsult
		Brown sandy soil,Stones, brick	Brown sandy soil,Stones, brick	Brown sandy soil,Stones	Brown sandy soil	Brown sandy soil,Stones, brick	Brown sandy soil,Clinker	Brown sandy soil,Stones	Brown sandy soil,Stones, brick	Brown sandy soil,Stones	Brown sandy soil,Stones, tarmac	Brown sandy soil,Stones, brick	Brown sandy soil,Stones	Brown sandy soil,Stones, brick	Brown sandy soil,Stones, brick	Black sandy clay with vegetation	Brown sandy soil,Stones,brick	Black sandy clay with stones	Black sandy clay with brick and concrete	Brown sandy soil,Stones,brick	Brown sandy clay with stones	Black sandy clay	Black sandy clay
		25/09/18	25/09/18	25/09/18	25/09/18	26/09/18	26/09/18	27/09/18	27/09/18	27/09/18	27/09/18	27/09/18	27/09/18	25/09/18	25/09/18								
		BH18-02A	BH18-02A	BH18-02A	BH18-02A	TP18-01	TP18-02	TP18-03	TP18-06	TP18-07	TP18-08	TP18-09	TP18-10	TP18-10 ES2	TP18-11 ES1	TP18-04	TP18-04	TP18-04	TP18-05	TP18-05	TP18-05	BH18-01	BH18-01
		5.00	4.00	6.00	7.00	0.50	1.70	1.20	1.20	1.00	1.30	1.00	1.70	3.20	0.60	0.10	1.40	2.20	1.20	2.60	3.10	10.50	11.80
Stone Content	<0.1 %	37.90			41.50	48.20	31.80	31.00	63.20	24.70	61.00	50.90	44.80										
Asbestos Screen	Positive / Negative	No asbestos detected	Chrysotile (Cement fragment)	No asbestos detected	No asbestos detected		No asbestos detected	No asbestos detected		No asbestos detected	No asbestos detected		No asbestos detected	Amosite (Fibre bundles)	No asbestos detected		Not Detected		Chrysotile (Fibre bundle)	Not Detected	Not Detected		
Asbestos Quantification	>0.001%		0.588											0.002					0.005				
Metals																							
Arsenic (total)	<2 mg/kg	9.2			8.5	10.9	20.1	17.6	3.5	16.2	6.3	7.7	12.4			12.0		3.0	6.0		2.0		
Cadmium (total)	<0.5 mg/kg	0.5			0.5	0.6	0.6	0.6	0.5	0.7	0.5	0.5	0.5			0.6		0.4	0.7		0.3		
Chromium (hexavalent)	<0.1 mg/kg	0.0			0.017	0.002	0.000	0.001	0.002	0.001	0.001	0.084	0.002			0.0002		0.0005	0.0007		0.0004		
Chromium (total) (III for S4ULs)	<2 mg/kg	24			21	21	23	22	12	23	11	13	23			19		18	35		19		
Copper (total)	<4 mg/kg	40			36	47	100	72	12	119	23	30	54			45		50	83		35		
Lead (total)	<3 mg/kg	90.6			71.6	89.1	145.0	116.0	34.3	149.0	71.3	56.1	114.0			99.0		71.0	159.0		64.0		
Mercury (total inorganic)	<0.5 mg/kg	0.5			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5			1.0		1.0	1.0		1.0		
Nickel (total)	<3 mg/kg	25.1			19.1	19.8	32.7	27.7	8.5	25.3	10.4	14.4	19.9			11.0		17.0	22.0		14.0		
Selenium (total)	<1 mg/kg	1			1	9	1	1	1	1	1	1	1			3		3	3		3		
Zinc (total)	<3 mg/kg	103			104	105	157	187	32	519	59	65	101			116		121	172		80		
Inorganic																							
pH Value	pH Units	9.5			9.3	8.3	7.6	7.9	8.6	8.1	8.3	10.2	8.4			7.4		7.8	7.7		7.7		
Cyanide (total)	<1 mg/kg	1.0			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1			2.0		2.0	2.0		2.0		
Chloride (2:1)	<0.5 mg/l																	13.0			14.0		
Sulphate (2:1)	<0.005 g/l	0.150			0.120	0.110	0.810	0.200	0.190	0.030	0.080	0.200	0.200					130			190		
Sulphate (total)	<200 mg/kg																	570			695		
Organic																							
Soil Organic Matter	<0.1 %	3.40			3.70	3.20	4.20	1.40	7.30	1.70	3.70	2.00	3.20					3.0			2.6		
TOC	<0.1 %	1.7			1.5	1.7	8.2	3.0	1.7	1.8	1.0	1.1	2.6					1.8			1.5		
Phenol (Total Monohydric)	<5 mg/kg	5.0			5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0			2.0		2.0	2.0		2.0		
PAH																							
Naphthalene	<0.1 mg/kg	2.4			0.7	3.1	0.6	1.2	0.1	0.1	0.2	0.7	1.6			0.2		12.6	0.7		0.5		
Acenaphthylene	<0.1 mg/kg	0.5			0.3	0.2	0.2	0.3	0.1	0.1	1.0	0.4	0.5			0.1		0.5	0.1		0.1		
Acenaphthene	<0.1 mg/kg	6.1			2.0	0.8	1.0	5.5	0.2	0.2	1.0	1.7	9.1			0.1		5.7	2.1		0.5		
Fluorene	<0.1 mg/kg	4.2			1.5	0.7	0.9	4.2	0.3	0.1	1.6	1.5	6.8			0.2		7.1	2.0		0.4		
Phenanthrene	<0.1 mg/kg	42.9			5.6	3.9	5.5	32.6	0.2	0.9	10.7	7.9	53.5			1.5		31.2	9.5		4.0		
Anthracene	<0.1 mg/kg	14.0			1.9	1.2	1.6	9.6	0.2	0.3	3.5	3.3	14.4			0.4		7.1	2.7		0.9		
Fluoranthene	<0.1 mg/kg	59.0			7.1	10.2	8.5	58.3	0.9	2.3	19.0	12.9	60.9			2.6		22.7	12.6		6.3		
Pyrene	<0.1 mg/kg	46.5			6.2	10.0	7.9	49.4	1.2	1.9	17.0	11.8	52.3			2.4		21.2	10.4		5.3		
Benz(a)anthracene	<0.1 mg/kg	26.4			2.6	5.5	4.3	26.5	0.6	1.3	10.3	7.5	30.9			1.4		6.8	4.5		2.7		
Chrysene	<0.1 mg/kg	26.1			3.0	5.8	4.8	29.9	2.4	1.5	11.8	9.0	29.8			1.4		8.0	5.1		2.9		
Benzo(b)fluoranthene	<0.1 mg/kg	20.4			2.0	5.1	3.6	27.7	1.1	1.3	7.6	7.3	25.2			1.7		6.6	5.3		3.2		
Benzo(k)fluoranthene	<0.1 mg/kg	16.4			2.1	4.2	3.5	21.1	1.2	1.1	7.4	7.1	23.1			0.5		2.3	1.6		1.0		
Benzo(a)pyrene	<0.1 mg/kg	17.6			2.0	4.6	3.9	25.4	0.6	1.3	9.2	7.8	25.9			1.4		5.6	4.3		2.4		
Indeno(123cd)pyrene	<0.1 mg/kg	11.7			1.5	3.2	3.0	18.8	1.0	1.0	6.9	6.3	17.0			1.1		2.9	2.6		1.7		
Dibenzo(ah)anthracene	<0.1 mg/kg	2.9			0.6	0.9	0.8	4.3	0.5	0.3	2.6	1.8	4.5			0.3		0.7	0.6		0.5		
Benzo(ghi)perylene	<0.1 mg/kg	10.2			1.5	4.1	2.6	17.0	0.8	0.9	6.4	4.9	14.3			1.0		2.5	2.2		1.5		
Coronene	<0.1 mg/kg	3.6			0.6	1.2	1.0	6.5	0.8	0.4	0.4	1.8	5.0			0.3		0.4	0.4		0.3		
Total EPA-16 PAHs	<1.6 mg/kg	307.0			40.8	63.3	52.7	332.0	11.4	14.5	116.0	91.8	370.0			16.0		144.0	66.3		33.7		
BTEX Benzene	<0.01 mg/kg	0.0103			0.010		0.010	0.010		0.010	0.010	0.010	0.010					0.002			0.002	0.002	0.002
Toluene	<0.01 mg/kg	0.010			0.010		0.010	0.010		0.010	0.010	0.010	0.010					0.005			0.005	0.005	0.005
Ethyl Benzene	<0.01 mg/kg	0.010			0.010		0.010	0.010		0.010	0.010	0.010	0.010					0.021			0.002	0.002	0.002
Xylene	<0.01 mg/kg	0.010			0.010		0.010	0.010		0.010	0.010	0.010	0.010					0.055			0.002	0.002	0.002
MTBE	<0.001 mg/kg	0.01			0.01		0.01	0.01		0.01	0.01	0.01	0.01					0.002			0.002	0.002	0.002
Petroleum Hydrocarbons																							
DRO (C_{10} - C_{28})	<6 mg/kg	18			26		9	69		1.0	213	50	140					422			96		
Oil (C_{25} - C_{40})	<6 mg/kg																	224			112		
Mineral Oil (C_{10} - C_{40})	<6 mg/kg	247			103		162	569		41	4040	1050	693					21			66		
TPH (C_6 - C_{40})																		216.0			735	287.0	1050.0
Aliphatic >C_5 - C_6	<0.01 mg/kg	0.01			0.01		0.01	0.01		0.01	0.01	0.01	0.01					0.01			0.010	0.01	0.01
Aliphatic >C_6 - C_8	<0.01 mg/kg	0.01			0.01		0.01	0.01		0.01	0.01	0.01	0.01					0.05			0.050	0.05	0.05
Aliphatic >C_8 - C_{10}	<1 mg/kg	1.0			1.0		1.0	1.0		1.0	1.0	1.0	1.0					2.0			2.0	2.0	2.0
Aliphatic >C_{10} - C_{12}	<1 mg/kg	1.0			1.0		1.0	1.5		1.0	1.5	1.0	1.0					2.0			2.0	2.0	2.0
Aliphatic >C_{12} - C_{16}	<1 mg/kg	6.5			4.5		1.0	19.0		1.0	26.6	13.8	5.5					3.0			3.0	3.0	3.0
Aliphatic >C_{16} - C_{21}	<1 mg/kg	12.1			7.3		2.4	33.1		1.0	127.0	34.7	15.2					3.0			3.0	4.0	14.0
Aliphatic >C_{21} - C_{35}	<1 mg/kg	57.5			35.0		24.3	261.0		1.0	2150.0	177.0	185.0					21.0			61.0	53.0	113.0
Aliphatic >C_{35} - C_{44}	<1 mg/kg	14.3			3.3		1.3	67.3		1.0	694.0	74.1	68.9										
Total Aliphatic >C_5 - C_{35}	<6 mg/kg																	21			61	57	128
Aromatic C_5 - C_7	<0.01 mg/kg	0.010			0.010		0.010	0.010		0.010	0.010	0.010	0.010					0.010			0.010	0.010	0.010
Aromatic C_7 - C_8	<0.01 mg/kg	0.010			0.010		0.010	0.010		0.010	0.010	0.010	0.010					0.050			0.050	0.050	0.050
Aromatic >C_8 - C_{10}	<1 mg/kg	1.0			1.0		1.0	1.0		1.0	1.0	1.0	1.0					2.0			2.0	2.0	2.0
Aromatic >C_{10} - C_{12}	<1 mg/kg	1.0			1.0		1.0	2.3		1.0	1.4	1.0	1.0					2.0			27.0	2.0	18.0
Aromatic >C_{12} - C_{16}	<1 mg/kg	13.5			8.5		3.0	28.8		1.0	23.1	16.4	8.5					6.0			95.0	15.0	81.0
Aromatic >C_{16} - C_{21}	<1 mg/kg	31			17		6	80		1	136	70	30.0					28.0			203	64.0	287.0
Aromatic >C_{21} - C_{35}	<1 mg/kg	111			86		63	490		4	2350	297	342.0					160.0			348	152.0	537.0
Aromatic >C_{35} - C_{44}	<1 mg/kg	38			23		17	132		1	734	134	145.0										
Total Aromatic >C_5 - C_{35}	<6 mg/kg	284			185		116	1110		4	6240	817	800					194			673	230	923
Chlorinated Hydrocarbons																							
VOC - all under detection limit except certain PAH & BTEX	< 0.01 mg/kg	0.01			0.01		0.01	0.01		0.01	0.01	0.01	0.01					0.01			0.01		

Analyte	Statistical Analysis					SGV / GAC Statistical Results			SGV / GAC Criteria Source		pC4SL Screening Criteria		pC4SL Criteria Source		LQM/CIEH S4UL Screening Criteria		LQM/CIEH S4UL Criteria Source	
	n	Standard Deviation	Minimum	Average	Maximum	Maximum	Commercial & Industrial Tier 1 Screening Threshold	Pass/ Fail	Source of Screening Criteria	Source of Toxicological Data	Commercial	Pass / Fail	Source of Screening Criteria	Source of Toxicological Data	Commercial	Pass / Fail	Source of Screening Criteria	Source of Toxicological Data
Stone Content		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asbestos Screen	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asbestos Quantification		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals																		
Arsenic (total)	14	5.55	2	10	20	20.10	635	Pass	SC050021*	SC050021	640	Pass	CLEA v1.06	Defra 2014	640	Pass	CLEA v1.06	LQM/CIEH 2014
Cadmium (total)	14	0.11	0	1	1	0.70	230	Pass	SC050021*	SC050021	420	Pass	CLEA v1.06	Defra 2014	190	Pass	CLEA v1.06	LQM/CIEH 2014
Chromium (hexavalent)	14	0.02	0	0	0	0.08	35	Pass	CLEA v1.06	LQM 2009	52	Pass	CLEA v1.06	Defra 2014	33	Pass	CLEA v1.06	LQM/CIEH 2014
Chromium (total) (III for S4ULs)	14	6.01	11	20	35	35.00	30400	Pass	CLEA v1.06	LQM 2009	-	-	-	-	8600	Pass	CLEA v1.06	LQM/CIEH 2014
Copper (total)	14	30.18	12	53	119	119.00	71700	Pass	CLEA v1.06	LQM 2009	-	-	-	-	68000	Pass	CLEA v1.06	LQM/CIEH 2014
Lead (total)	14	37.45	34	95	159	159.00	N/A	-	-	-	6000	Pass	CLEA v1.06	Defra 2014	-		-	-
Mercury (total inorganic)	14	0.23	1	1	1	1.00	3640	Pass	SC050021*	SC050021	-	-	-	-	1100	Pass	CLEA v1.06	LQM/CIEH 2014
Nickel (total)	14	7.07	9	19	33	32.70	840	Pass	CLEA v1.071	EFSA	-	-	-	-	980	Pass	CLEA v1.06	LQM/CIEH 2014
Selenium (total)	14	2.15	1	2	9	8.90	13000	Pass	SC050021*	SC050021	-	-	-	-	120000	Pass	CLEA v1.06	LQM/CIEH 2014
Zinc (total)	14	117.93	32	137	519	519.00	662000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	730000	Pass	CLEA v1.06	LQM/CIEH 2014
Inorganic											-	-	-	-	-	-		
pH Value	14	0.81	7.4	8	10.2	10.20	-	-	-	-	-	-	-	-	-	-	-	-
Cyanide (total)	14	0.47	1	1	2.0	2.00	-	-	-	-	-	-	-	-	-	-	-	-
Chloride (2:1)	2	0.71	13.0	14	14.0													
Sulphate (2:1)	12	63.50	0.03	27	190	190.00	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate (total)	2	88.39	570.00	633	695	-	-	-	-	-	-	-	-	-	-	-	-	-
Organic											-	-	-	-	-	-		
Soil Organic Matter	12	1.53	1.4	3	7.30	7.30	-	-	-	-	-	-	-	-	-	-	-	-
TOC	12	1.94	1.0	2	8.20	8.20	-	-	-	-	-	-	-	-	-	-	-	-
Phenol (Total Monohydric)	14	1.41	2	4	5.0	5.00	24200	Pass	CLEA v1.06	SC050021	-	-	-	-	760	Pass	CLEA v1.06	LQM/CIEH 2014
PAH																		
Naphthalene	14	3.24	0.1	2	12.6	12.60	200	Pass	CLEA v1.06	LQM 2009	-	-	-	-	190	Pass	CLEA v1.06	LQM/CIEH 2014
Acenaphthylene	14	0.25	0.1	0	1.0	1.00	84000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	83000	Pass	CLEA v1.06	LQM/CIEH 2014
Acenaphthene	14	2.84	0.1	3	9.1	9.10	8500	Pass	CLEA v1.06	LQM 2009	-	-	-	-	84000	Pass	CLEA v1.06	LQM/CIEH 2014
Fluorene	14	2.38	0.1	2	7.1	7.11	64000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	63000	Pass	CLEA v1.06	LQM/CIEH 2014
Phenanthrene	14	17.45	0.2	15	53.5	53.50	22000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	22000	Pass	CLEA v1.06	LQM/CIEH 2014
Anthracene	14	4.95	0.2	4	14.4	14.40	530000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	520000	Pass	CLEA v1.06	LQM/CIEH 2014
Fluoranthene	14	22.08	0.9	20	60.9	60.90	23000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	23000	Pass	CLEA v1.06	LQM/CIEH 2014
Pyrene	14	18.25	1.2	17	52.3	52.30	54400	Pass	CLEA v1.06	LQM 2009	-	-	-	-	54000	Pass	CLEA v1.06	LQM/CIEH 2014
Benz(a)anthracene	14	10.45	0.6	9	30.9	30.90	92	Pass	CLEA v1.06	LQM 2009	-	-	-	-	170	Pass	CLEA v1.06	LQM/CIEH 2014
Chrysene	14	10.48	1.4	10	29.9	29.90	138	Pass	CLEA v1.06	LQM 2009	-	-	-	-	350	Pass	CLEA v1.06	LQM/CIEH 2014
Benzo(b)fluoranthene	14	9.05	1.1	8	27.7	27.70	100	Pass	CLEA v1.06	LQM 2009	-	-	-	-	44	Pass	CLEA v1.06	LQM/CIEH 2014
Benzo(k)fluoranthene	14	7.78	0.5	7	23.1	23.10	140	Pass	CLEA v1.06	LQM 2009	-	-	-	-	1200	Pass	CLEA v1.06	LQM/CIEH 2014
Benzo(a)pyrene	14	8.66	0.6	8	25.9	25.90	14	Fail	CLEA v1.06	LQM 2009	77	Pass	CLEA v1.06	Defra 2014	35	Pass	CLEA v1.06	LQM/CIEH 2014
Indeno(123cd)pyrene	14	5.99	1.0	6	18.8	18.80	60	Pass	CLEA v1.06	LQM 2009	-	-	-	-	500	Pass	CLEA v1.06	LQM/CIEH 2014
Dibenzo(ah)anthracene	14	1.47	0.3	2	4.5	4.50	13	Pass	CLEA v1.06	LQM 2009	-	-	-	-	3.5	Fail	CLEA v1.06	LQM/CIEH 2014
Benzo(ghi)perylene	14	5.23	0.8	5	17.0	17.00	650	Pass	CLEA v1.06	LQM 2009	-	-	-	-	3900	Pass	CLEA v1.06	LQM/CIEH 2014
Coronene	14	1.98	0.3	2	6.5	6.50	1900	Pass	CLEA v1.06	LQM 2009	-	-	-	-	-	-	-	-
Total EPA-16 PAHs	14	124.61	11.4	119	370.0	370.00	-	-	-	-	-	-	-	-	-	-	-	-
BTEX Benzene	12	0.00	0.002	0	0.010	0.01	43.6	Pass	CLEA v1.06	SC050021	100	Pass	CLEA v1.06	Defra 2014	27	Pass	CLEA v1.06	LQM/CIEH 2014
Toluene	12	0.00	0.005	0	0.010	0.01	86200	Pass	CLEA v1.06	SC050021	-	-	-	-	56000	Pass	CLEA v1.06	LQM/CIEH 2014
Ethyl Benzene	12	0.01	0.002	0	0.021	0.02	25000	Pass	CLEA v1.06	SC050021	-	-	-	-	5700	Pass	CLEA v1.06	LQM/CIEH 2014
Xylene	12	0.01	0.002	0	0.055	0.06	10,700	Pass	CLEA v1.06	SC050021	-	-	-	-	6600	Pass	CLEA v1.06	LQM/CIEH 2014
MTBE	12	0.00	0.002	0	0.010	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons																		
DRO (C_{10} - C_{28})	10	129.79	1	104	422	422	-	-	-	-	-	-	-	-	-	-	-	-
Oil (C_{25} - C_{40})	2	79.20	112	168	224	224	-	-	-	-	-	-	-	-	-	-	-	-
Mineral Oil (C_{10} - C_{40})	10	1222.19	21	699	4040	4040	-	-	-	-	-	-	-	-	-	-	-	-
TPH (C_6 - C_{40})	4	392.86	216	572	1050.0	1050.00	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatic >C_5 - C_6	12	0.00	0.01	0	0.0	0.01	3400	Pass	CLEA v1.06	LQM 2009	-	-	-	-	3200	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_6 - C_8	12	0.02	0.01	0	0.1	0.05	8300	Pass	CLEA v1.06	LQM 2009	-	-	-	-	7800	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_8 - C_{10}	12	0.49	1	1	2.0	2.00	2100	Pass	CLEA v1.06	LQM 2009	-	-	-	-	2000	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{10} - C_{12}	12	0.47	1	1	2.0	2.00	10000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	9700	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{12} - C_{16}	12	8.07	1	7	26.6	26.60	61000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	59000	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{16} - C_{21}	12	35.16	1	21	127.0	127.00	1600000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	160000	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{21} - C_{35}	12	600.00	1	262	2150.0	2150.00	1600000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	160000	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{35} - C_{44}	8	235.99	1	116	694.0	694.00	1600000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	160000	Pass	CLEA v1.06	LQM/CIEH 2014
Total Aliphatic >C_5 - C_{35}	4	44.62	21	67	128.0	128.00	-	-	-		-	-	-	-	-	-	-	
Aromatic C_5 - C_7	12	0.00	0	0	0.01	0.01	28000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	26000	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic C_7 - C_8	12	0.02	0	0	0.05	0.05	59000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	56000	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_8 - C_{10}	12	0.49	1	1	2.0	2.00	3700	Pass	CLEA v1.06	LQM 2009	-	-	-	-	3500	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{10} - C_{12}	12	8.46	1	5	27.0	27.00	17000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	16000	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{12} - C_{16}	12	30.64	1	25	95.0	95.00	36000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	36000	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{16} - C_{21}	12	87.76	1	79	287.0	287.00	28000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	28000	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{21} - C_{35}	12	633.61	4	412	2350.0	2350.00	28000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	28000	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{35} - C_{44}	8	242.06	1	153	734.0	734.00	28000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	28000	Pass	CLEA v1.06	LQM/CIEH 2014
Total Aromatic >C_5 - C_{35}	12	1701.16	4	965	6240.0	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorinated Hydrocarbons																		
VOC - all under detection limit except certain PAH & BTEX	10	0.00	0.01	0	0.01	0.01	0.71	Pass	CLEA v1.06	LQM 2009	-	-	-	-	0.67	Pass	CLEA v1.06	LQM/CIEH 2014

Below Detection Limits.
Exceeded GAC/SGV
Exceeded pC4SL / S4ULs
Assessment criteria for pH, Sulphide and Sulphate are not based on human health. Sulphate criteria assumes DS-1 ACEC classification for concrete.

Notes

1. Generic Qualitative Assessment Criteria have been used where appropriate based on the current CLEA 1.06 Model (default values, sandy loam 1%SOM). Where no CLEA generic guideline value has been calculated no assessment has been made. The results presented show maximum and mean concentrations. This is to provide a reasonable prediction of the range of data rather than to provide any detailed statistical appraisal.
2. Results lower than detection limit are shaded in grey.
3. When the test result is recorded as being less than the detection limit, the result used for the analysis is the detection limit.
4. Cyanide (total)*, in the absence of a GOAC based on current CLEA 1.06 Model, the Atrisk Soil Value for Cyanide (free) has been used.
5. For metals, where an SGV has been published, this value has been used. Note that the published SGVs do not include the residential without plant uptake scenario. CLEA v1.06 has therefore been used to derive GACs for this scenario. For organics, CLEA v1.06 has been used (as the SGV assumes 6% SOM)
6. pC4SL based on adjusted toxicology and exposure assumptions
7. pC4SL for benzene assumes 6% SOM

APPENDIX J

Summary of Chemical Test Results of Water & Leachate Samples

Job No: 4133
Site: Project Genssis, Carrington
Summary of Water Analysis - Tier 1 Screening

TerraConsult

Sample Location	Units	Drinking Water Standard	EQS Freshwater	Other	Pre-Commencement Monitoring	
					BH18-01	BH18-02A
					19/10/2018	19/10/2018
					8.06 m	3.24 m
Water Quality						
pH	pH units	-	-	-	6.6	8.50
Electricial Conductivity	uS/cm	-	-	-	727	841
Hardness	mg/l CaCO3	-	-	-	97	267
Metals						
Arsenic	ug/l	10	50	50	< 5	13
Cadmium	ug/l	5	5	5	< 1	< 1
Chromium (Total)	ug/l	50	200*	-	< 1	< 1
Copper	ug/l	2000	28*	28	< 5	< 5
Lead	ug/l	25	125*	-	< 1	< 1
Mercury	ug/l	1	1	-	< 0.1	< 0.1
Nickel	ug/l	20	150*	200	< 5	6
Selenium	ug/l	10	-	10	< 5	< 5
Zinc	ug/l	5000	250*	500	< 5	26
Calcium	ug/l	250	-	-	29400	91100
Magnesium	ug/l	50	-	-	5770	9580
Inorganic						
Chloride	mg/l	250	250	250	61	19.6
Nitrate as N	mg/l	50.00	50.00	50.00	3.4	< 0.5
Sulphate (as SO4)	mg/l	250	400	250	65	92.4
Ammonium (as NH4)	ug/l	500	1000	-	1.3	13
Total Cyanide	ug/l	50	5	70	25	7
Manganese	ug/l	50	-	300		
PAH						
Naphthalene	ug/l	10[2]	10	10	0.47	0.57
Acenaphthylene	ug/l	-	-	-	0.03	0.17
Acenaphthene	ug/l	-	-	-	0.12	0.57
Fluorene	ug/l	-	-	-	0.08	0.44
Phenanthrene	ug/l	-	-	-	0.34	2.27
Anthracene	ug/l	-	0.40	-	0.14	0.89
Fluoranthene	ug/l	-	1.00	0.10	0.41	4.43
Pyrene	ug/l	-	-	-	0.33	3.52
Benzo[a]anthracene	ug/l	-	-	-	0.17	2.03
Chrysene	ug/l	-	-	-	0.17	1.73
Benzo[b]fluoranthene	ug/l	-	0.03	-	0.11	1.3
Benzo[k]fluoranthene	ug/l	-	0.03	-	0.14	1.68
Benzo[a]pyrene	ug/l	0.01	0.10	0.70	0.16	2.03
indeno[1,2,3-cd]pyrene	ug/l	-	-	-	0.06	0.92
dibenzo[a,h]anthracene	ug/l	-	-	-	0.02	0.33
Benzo[ghi]perylene	ug/l	-	0.002	-	0.08	1.14
Total EPA-16 PAHs	ug/l	-	-	-	2.82	24
TPH						
Aliphatic >C5 - C6	ug/l	-	-	-	< 1.0	< 1.0
Aliphatic >C6 - C8	ug/l	-	-	-	< 1.0	< 1.0
Aliphatic >C8 - C10	ug/l	-	-	-	< 5.0	< 5.0
Aliphatic >C10 - C12	ug/l	-	-	-	< 5.0	< 5.0
Aliphatic >C12 - C16	ug/l	-	-	-	< 5.0	18.8
Aliphatic >C16 - C21	ug/l	-	-	-	< 5.0	26.3
Aliphatic >C21 - C34	ug/l	-	-	-	14.7	202
Aliphatic >C35 - C40	ug/l	-	-	-	< 5.0	36.7
Aliphatic (C5 - C40)	ug/l	10	-	-	14.7	283
Aromatic >C5 - C7	ug/l	-	-	-	< 1.0	< 1.0
Aromatic >C7 - C8	ug/l	-	-	-	1.2	1.1
Aromatic >C8 - C10	ug/l	-	-	-	< 5.0	< 5.0
Aromatic >C10 - C12	ug/l	-	-	-	< 5.0	< 5.0
Aromatic >C12 - C16	ug/l	-	-	-	< 5.0	31.2
Aromatic >C16 - C21	ug/l	-	-	-	< 5.0	64.7
Aromatic >C21 - C35	ug/l	-	-	-	< 5.0	479
Aromatic >C35 - C40	ug/l	-	-	-	< 5.0	107
Aromatic (C5 - C40)	ug/l	10	-	-	< 5.0	682
Total TPH Ali/Aro (C5 - C40)	ug/l	-	-	-	15.9	966
Total TPH (C10-C40)	ug/l	10	-	-	172	3920
BTEX						
Benzene	ug/l	1	30	10	< 1.00	< 1.00
Toluene	ug/l	-	50	700	1.22	1.07
EthylBenzene	ug/l	-	-	300	< 1.00	< 1.00
M/P Xylene	ug/l	-	30	500	< 1.00	< 1.00
O Xylene	ug/l	-	30	500	< 1.00	< 1.00
Phenols						
Total Monohydric Phenols	ug/l	-	-	-	< 1	< 1
VOC						
Chloroform	ug/l	-	2.50	300	12	< 1
Bromodichloromethane	ug/l	60	-	-	1	< 1
All other VOCs below <1 ug/l detection limit						

Note:

Fail: Above UK EQS

Fail: Above UK DWS

Result below Detection Limit

* EQS for substances based on >100-150 mg/l CaCO3 Hardness band and Cyprinid designation for receiving water

** Calculated from ammoniacal nitrogen and pH results using an assumed water temperature of 10 degrees.

Total of 4 Drinking Water Standard PAHs: Benzo[b]fluoranthene, Benzo[k]fluoranthene, Indeno[1,2,3-cd]pyrene, Benzo[ghi]perylene

APPENDIX K

Current Guidance for Ground Gas Risk Assessment

Current Guidance for Ground Gas Risk Assessment

Origin of Ground and Landfill Gases

When carrying out a ground gas risk assessment for permanent ground gases (e.g. methane and carbon dioxide), the origin or source of the gases is important as potential risks will vary depending on the source. This Appendix relates to the risk of the two main ground gases of concern: methane and carbon dioxide, and does not apply to other ground gases (e.g. radon or vapours from hydrocarbon spills). Methane and carbon dioxide are major constituents of landfill gas but can also occur from a variety of anthropogenic and natural sources, as summarised in Table G1 below:

Table G1. Potential Sources of Ground Gases

Gas	Source	Comments
Landfill Gas	Anaerobic decomposition of degradable waste within landfill sites. Typically 60% methane and 40% carbon dioxide during methanogenic phase.	Composition varies over time, particularly in early stages. Contains a range of minor constituents (particularly carbon monoxide and hydrogen sulphide).
Landfill Associated Gases	- Anaerobic degradation of leachate external to the site; - Degassing of dissolved gases in groundwater; - Evolution of gases following interaction between leachate and groundwater	Can result in secondary (external) production of methane or carbon dioxide.
Made Ground	Anaerobic degradation of organic components	Very variable depending on source
Sewer Gas, Cess Pits	Anaerobic degradation of organic components of sewage producing methane and carbon dioxide.	Often characterised by hydrogen sulphide odour.
Mains Gas	Leakage from underground pipework or storage tanks. Mainly methane but often contains higher alkanes.	An odouriser is added to permit detection of leaks. Typically 90% CH_4, but 1 to 27% C_2-C_4 alkanes, May also contain other trace gases e.g. CO, helium and CO_2 (from degradation of CH_4 in the ground).
Other Anthropogenic Sources	- Degradation of leaked or spilled hydrocarbons or other industrial chemicals; - Anaerobic degradation of organic contaminants in groundwaters (e.g. silage liquor); - Reactions between monitoring well construction components and environment; - Burial grounds/cemeteries.	Hydrocarbon spillages often have an 'oily' odour. Fuel spillages common – Petrol or Diesel and can contain a wide range of VOC's. Can degrade to produce methane / carbon dioxide.
Alluvium / Marsh / Peat Gas	Anaerobic microbial degradation of organic material (usually waterlogged vegetation / peat). Often associated with the presence of alluvial deposits or dredgings.	

Table G1. Potential Sources of Ground Gases		
Gas	**Source**	**Comments**
Geogenic Gas	Natural seepages of carbon dioxide and hydrocarbon gases derived from geologic sources such as coal seams and deep oil / gas source formations. Can be present in solution in groundwaters.	Methane most common but can contain carbon dioxide and higher alkanes.
Mine Gases	Various types. Most common is “fire damp” with high methane, produced by the desorption of gas trapped in coal. “Black damp” (Stythe gas) with high carbon dioxide and denser than air. “White damp” is high in carbon monoxide.	Methane most common. Can contain higher alkanes, carbon dioxide and carbon monoxide. Often low in oxygen.
Natural Shallow Ground Gas	Various types - high carbon dioxide formed by subsurface aerobic activity leading to depleted oxygen and elevated carbon dioxide; - chemical degradation of rocks (e.g. carbonates) producing carbon dioxide; - carbon dioxide production in root zone of soils by plants.	Gases can be emitted from ground under falling barometric pressure conditions.

This Appendix concentrates on the assessment of risk from methane and carbon dioxide. This Appendix does not provide guidance for the assessment of risk when other gases are present due to ‘Other Sources’ from the above table (particularly organic compounds such as BTEX and VOC’s or for the risk from radon or hydrogen sulphide).

To determine the origin of the gas a range of factors must be considered together, including;

1. Proximity of likely sources;
2. Ground conditions (geology, hydrogeology, anthropogenic pathways etc);
3. Properties of gases present including:
   - Chemical composition;
   - Physical properties;
   - Ratios of components e.g. methane : carbon dioxide.
4. Timeframe of activities such as infilling periods, capping works, installation of gas control systems etc.

Identification of the originating source may be problematic given that there may be more than one source present and trace gas analysis may be required. Identification of the sources of the gases encountered during monitoring is usually carried out through a process of eliminating the most unlikely potential sources (given the site setting) and selecting those which are the more likely candidates.

Hazards Associated with Presence of Ground Gases

Methane gas is combustible and potentially explosive. When the concentration of methane in air is between the limits of 5.0%v/v and 15.0%v/v an explosive mixture is formed. The Lower Explosive Limit (LEL) of methane is 5.0%v/v, which is equivalent to 100% LEL. The 15.0%v/v limit is known as the Upper Explosive Limit (UEL), but concentrations above this level cannot be assumed to represent safe concentrations. Further, the LEL and UEL will vary (up and down) depending upon the proportion of other

gases (including oxygen). However, the fact that methane is a colourless, odourless gas means that there is no simple indicator of the presence of the gas until such a time as explosive limits are reached and an incident occurs. Methane is lighter than air and has a low toxicity. However, at high concentrations it can result in asphyxiation due to oxygen displacement.

Carbon dioxide is a colourless, odourless gas, which, although non-flammable, is both toxic and an asphyxiant. As carbon dioxide is denser than air, it will collect in low points and depressions. The UK Health & Safety Executive (HSE) has published information relating to concentrations of carbon dioxide that humans may be exposed to, which uses concentrations contained in the Control of Substances Hazardous to Health Regulations 2002 (as amended). These are the Long Term Occupational Exposure Limit (LTOEL, 8 hour period) and the Short Term Occupational Exposure Limit (STOEL, 15 minute period), which are 0.5% and 1.5% carbon dioxide, respectively.

Parameters Influencing the Rate of Ground Gas Production

Figure G2 is taken from EA guidance document LFTGN 03 illustrates typical ground gas generation curves from biodegradable materials:

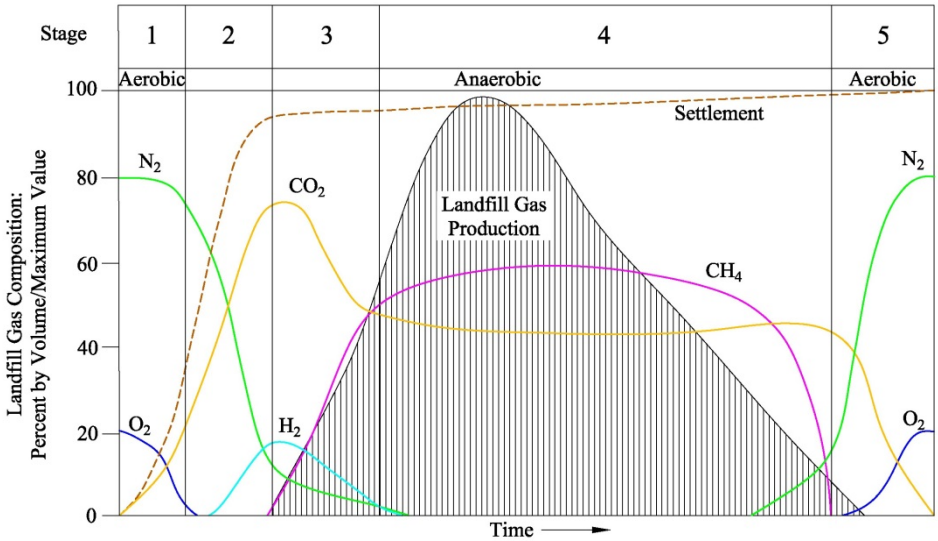


Figure G2. Idealised Representation of Landfill Gas Generation.

The production of methane and carbon dioxide at a landfill site may be expected to be considerable and ongoing. Concentrations of methane will eventually decrease, followed by concentrations of carbon dioxide, but the duration and rate of gas production can vary markedly between sites. Five distinct phases of gas production occur during the process which are, in order of event (as marked on Figure G2), as follows:

1. An aerobic phase involving oxygen depletion and temperature increase through aerobic respiration;
2. The establishment of anaerobic conditions and the evolution of carbon dioxide and hydrogen through acidogenic activity;
3. Commencement of methanogenic activity; the establishment of populations of methanogenic bacteria;
4. A phase of stable methanogenic activity, which may go on for many tens of years;
5. A phase of decreasing methanogenic activity, representing depletion of the organic material and a return to aerobic conditions.

The time scale for the return to the normal ground gas concentrations will be highly variable, depending upon the types and quantities of materials present. In addition, the optimum parameters influencing the rate of decomposition and ground gas production within the ground at a site are as follows:

- High water content with adequate rainfall and water infiltration to provide moisture content between approximately 20 to 26%;
- Conditions that either are or are very close to anaerobic;
- High proportion of biodegradable materials;
- A pH between 6.5 and 8.5, ideally verging slightly on the acidic between pH 6 to 7;
- Temperature between 25°C and 55°C;
- The ratio of the biochemical and chemical oxygen demands (BOD:COD);
- High permeability;
- Small particle size, as finer subsurface materials possess a greater surface area to provide a growing 'face' for the micro-organisms but high fines levels reduces permeability and reduces decomposition rate.

For this reason, it is vital that sources of methane and carbon dioxide are identified prior to the commencement of any work on a construction site, and that the ground gas regime is characterised at the worst temporal conditions a site may experience. From this, a risk assessment is carried out to identify the risk at the site from ground gases so that suitable protection measures can be designed and incorporated into a development to prevent a dangerous build-up of gas occurring.

Factors Influencing the Migration and Behaviour of Ground Gases

There are many factors that influence the migration of ground gases which can affect the risk from a gassing source:

- driving force – pressure differential along a pathway, diffusion and dissolved in solution;
- meteorological conditions – short term and seasonal conditions including atmospheric pressure changes (e.g. rapidly falling pressure causes gas to expand increasing emission rates), rainfall, frozen ground and thawing, temperature;
- geological and groundwater conditions – these can have the over-riding influence on the direction/pathways and quantity of migrating gas;
- anthropogenic influences – man-made pathways include mine shafts, service runs/drains, foundation piles, underground voids/pits/basements, foundation/building design/construction

Guidance Documents

Currently in the UK, there are no statutory threshold limits for hazardous gases in the ground as site specific variables mean that standard threshold values cannot be applied. The published guidance relating to development of sites where methane and carbon dioxide are present has been produced in response to building projects on or close to landfill sites, as both gases are principal constituents of landfill gas. Much of the historic guidance that has been produced on gas risk assessment focused on landfill sites and as a result there has previously been a lack of clarity when relating the process to gas conditions on non-landfill sites.

Statutory guidance regarding methane in the ground has previously taken a limiting concentration of 1.0 % by volume methane (equal to 20% of the lower explosive limit of methane in air) above which necessary actions will be appropriate. For carbon dioxide the limiting recommended trigger was 1.5 % by volume (the Long Term Exposure Limit for carbon dioxide). Above these concentrations the Building Regulations Approved Document C (1992) stated that consideration should be given to whether actions may be appropriate, whilst more specific solutions would be likely to be necessary at concentrations greater than 5% by volume of carbon dioxide (Building Regulations Approved Document C, 1992). However, the latest fully revised version of Approved Document C (DoE, 2004) no longer endorses this approach and instead requires the use of a risk-based approach in interpreting the findings of a gas monitoring survey. Further, the latest EA documentation on landfill gas (LFTGN 03, 2004) continues to sanction the use of a risk-based approach through a structured approach to the assessment of ground gases and links with the risk assessment process outlined within CLR 11 for soil contaminants.

With the above in mind, recent guidance has been produced in 2006 and 2007 with the aim of providing up to date advice in relation to residential and commercial development. The guidance does not address issues associated with gas derived from landfills, for this refer to *"Guidance on the Management of Landfill Gas"* (Environment Agency 2004) for an overview.

Recent guidance relevant to gas assessments for residential and commercial development includes;

- **Wilson *et al.* (CIRIA C665, December 2007) *"Assessing Risks Posed by Hazardous Ground Gases for Buildings."***

  This document provides up to date advice on all aspects of ground gas risk assessment such as investigation, monitoring programmes, data collection and interpretation. The guidance presents separate methodologies for the characterisation of:

  - **All development types except low rise housing with gardens and for Low Rise Buildings without a 150mm void** (Situation A) (Table 8.5 CIRIA C665)

  and;

  - **Low rise housing with gardens with a 150mm ventilated sub-floor void** (Situation B) (Table 8.7 CIRIA C665)
    (See below for further explanation of the methods of characterisation)

- **Boyle and Witherington (NHBC / RSK Group, Report 10627-R01(04) January 2007) *"Guidance on the Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present."***
  This document presents the "Traffic Lights System" detailed below and is relevant only for low rise properties (e.g. bungalows and town houses) that have a ventilated sub-floor void (i.e. Situation B as described in CIRIA C665).

- **Wilson and Card (CIEH, expected 2011) *"Ground Gas Handbook for Designers and Regulators"***
  This document is expected to provide practical guidance on ground gas assessments and the design and evaluation of protection measures.

- **British Standard (BS 8485, June 2015) *"Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings"***
  This document provides an overview of gas characterisation and assessment. The Standard is intended to be used by designers of gas protection measures and regulators involved in the assessment of design solutions. The Standard provides a framework in line with CLR11 allowing designers to judge the adequacy of ground gas and related site investigation data. The document provides an approach to determine appropriate ground gas parameters that can be used to identify a range of possible construction solutions mitigating against the presence of ground gas on a development site.

Each of these documents continues to highlight the importance of, and give further guidance towards, carrying out a tiered risk-based decision-making process in accord with government policy on dealing with contamination from historic or natural sources and highlight the importance of the Conceptual Model in site characterisation. These documents also stress the importance that the assessor should be confident that the ground gas monitoring results are representative of the likely worse case ground gas regime on a site and that the data collected from the site is sufficient. With this in mind, CIRIA C665 sets out ideal monitoring periods as below.

Idealised Frequency and Period of Monitoring (after Table 5.5a and 5.5b, CIRIA C665)						
		Generation Potential of Source				
		Very Low	Low	Moderate	High	Very High
Sensitivity of Development	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with Gardens)	6/3	9/6	12/6	24/12	24/24

Notes

1. First number is the number of readings and the second is the minimum period in months (e.g. 6/2 – six sets of readings over two months).

2. At least two sets of readings must be at low (preferably under 1,000 mb) and falling pressure.

3. High sensitivity end use on high or very high hazard site will not normally be acceptable unless the source is treated to reduce gassing potential.

Before the latest guidance, good practice for site characterisation had been based upon the method proposed by Wilson and Card (1999). CIRIA C665 (2007) effectively supersedes Wilson and Card (1999) and includes a modified version of the Wilson and Card method (Tables 8.5, 8.6 and Box 8.1). Gas concentrations and flow rates for either methane and/or carbon dioxide measured at a site to 'Characteristic Situations.' Appropriate protection measures are selected from Table 8.6 (if using modified Wilson & Card method) and from Box 8.4 from CIRIA C665 (if using the NHBC traffic lights method). Throughout the risk assessment process, strong regard must be given to the nature of the gassing source, the flow rates and the estimated surface emissions. Note that certain protection measures are stated in CIRIA Report 149 that are now considered wholly inappropriate to certain developments and consequently should not be used without modification. Throughout the process, it is important to remember that these tables are not intended to be used as a definitive design tool and have been prepared to show the typical scope of measures for gas control.

Both the NHBC (2007) and CIRIA (2007) guidance documents and BS 8485 (2015) propose that both ground gas concentrations and flow rates are used to calculate the limiting gas well gas volume flow rates for methane and carbon dioxide, based on the ground gas conditions monitored for during the worse-case temporal conditions. This limiting gas well volume flow rate is termed the Gas Screening Value (GSV, note that this was termed borehole gas volume flow), and is calculated as follows:

$$\textbf{GSV}\ (\text{l/hr}) = \frac{[\text{gas well gas concentration (\%v/v)}]\ \mathbf{x}\ [\text{gas well flow rate (l/hr)}]}{100}$$

These GSVs are then compared to generic 'Traffic Lights' contained within the NHBC guidance, which present typical maximum gas concentrations and limiting GSV's, for 'Situation B Development' (Low rise housing with gardens).

Table 8.7 NHBC Traffic light system for 150 mm void

Traffic Light	Methane [1]		Carbon Dioxide [2]	
	Typical max concentration [3] (% by volume)	Gas Screening Value [2,4] (litres/hour)	Typical max concentration [3] (% by volume)	Gas Screening Value [2,4] (litres/hour)
Green				
	1	0.13	5	0.78
Amber 1				
	5	0.63	10	1.6
Amber 2				
	20	1.60	30	3.10
Red				

Notes:
1. The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter will be the decider as to what Traffic Light is allocated;
2. Borehole Gas Volume Flow Rate, in litres per hour as defined in Wilson and Card (1999), is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered;
3. The Typical Maximum Concentrations can be exceeded in certain circumstances should the Conceptual Site Model indicate it is safe to do so;
4. The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

Box 8.4 of CIRIA C665 Gas protection measures for low-rise housing development based upon allocated NHBC Traffic light (Boyle and Witherington, 2007)

Traffic Light Classification	Protection Measures Required
Green	Negligible gas regime identified and gas protection measures are not considered necessary.
Amber 1	Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.
Amber 2	Intermediate to high gas regime identified, which requires high-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Membranes should always be fitted by a specialist Contractor. As with Amber 1, ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.
Red	High gas regime identified. It is considered that standard residential housing would not normally be acceptable without a further Gas Risk Assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

For a 'Situation A Development' (All development except low rise housing with gardens), the GSV value is used to derive the appropriate Characteristic Situation from Table 8.5 of CIRIA C665 (below):

Table 8.5 from CIRIA C665 Modified Wilson and Card Classification

Characteristic Situation (CIRIA R149)	Comparable Partners in Technology gas Regime (see Box 8.2)	Risk Classification	Gas Screening Value (CH_4 or CO_2) (l/hr)[1]	Additional Factors	Typical Source of Generation
1	A	Very low risk	<0.07	Typically methane ≤ 1% and/or carbon dioxide ≤ 5%. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" made ground
2	B	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	C	Moderate risk	<3.5		Old landfill, inert waste, mine working flooded
4	D	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mine working susceptible to flooding, completed landfill (WMP 26B criteria)
5	E	High risk	<70		Mine working unflooded inactive with shallow workings near surface
6	F	Very high risk	>70		Recent landfill site

It was intended in CIRIA C665 that the characteristic situation allocated to the development from the table above would then be used in Table 8.6 of CIRIA C665 in order to determine the level of gas protection the development requires. However, BS8485:2015 superseded this document and a different set of mitigation standards were put forward.

The recommended minimum gas protection score (points) be selected based on the building type (Table 3 which defines four building types) and the ground gas Characteristic Situation as detailed in Table 4 of BS8485:2015 (see below).

The first step in the decision making process is to obtain the level of gas protection necessary in the range 0 to 7.5 from Table 4. Then a combination of structural barriers (Table 5) ventilation protection measures (Table 6) and/or gas resistant membranes (Table 8)should be chosen to meet that requirement. The level of gas protection necessary should take into account the characteristic gas situation and a number of other factors. The whole decision making process should be made transparent, where all parties can see the approach being taken, can understand the various steps and decisions made and be confident that a risk-assessed solution has been designed and installed commensurate with the construction and site constraints.

Where the gas Characteristic Situation is 4 or more (and for NHBC Red situations according to CIRIA C665), the site requires a comprehensive risk assessment to confirm the scope of protection measures. These are higher risk sites and reliance on Table 4 alone is not sufficient.

BS8485:2015 Table 3 Building Types				
	Type A	**Type B**	**Type C**	**Type D**
Ownership	Private	Private or commercial/ public, possible multiple	Commercial / public	Commercial / industrial
Control (change of use, structural alterations, ventilation	None	Some but not all	Full	Full
Room sizes	Small	Small / medium	Small to large	Large industrial / retail park style

BS8485:2015 Table 4 Gas Protection Score by CS and Type of Building				
CS	**Required Gas Protection** **High risk** **Medium risk** **Low risk**			
	Type A	**Type B**	**Type C**	**Type D**
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6 (A)	5.5(A)	4.5	3.5
5	(B)	6.5(A)	5.5	4.5
6	(B)		7.5	6.5

a) Residential building should not be built on CS4 or higher sites unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.

b) The gas hazard is too high for this empirical method to be used to define the gas protection measures

NOTE 3 The NHBC has published guidance for use on residential developments, which utilise an alternative classification ("traffic light") system. This guidance typically applies to Type A buildings utilising beam and block floor constructions with clear void ventilation. The design choice variables are limited to decisions relating to the membrane specification and verification recommendations (see Table 7). Designers utilising this system would therefore need to refer to NHBC to assess compliance for specific recommendations [see 8485:2015 for further on this note]

NOTE4 The method of selecting the combination of these types of protection is given in section 7.2 of BS8485:2015. Once type of measures has been decided, the detailed design and specification of the measures should be undertaken (section 7.3)

Section 7.2 defines the order of selecting protective measures. The first choice is provided by structural barriers as defined in Table 5.

BS8485:2015 Table 5 Gas protection scores for structural barriers		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
Floor and substructure design		
Floor slabs		*General – score conditional that breaches of slab are sealed*
Block and beam floor slab	0	
Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)	0.5	
Cast in situ monolithic reinforced ground-bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations (with only nominal mesh reinforcement)	1 or 1.5	*To achieve 1.5, raft or suspended slab to be well reinforced to prevent cracking and minimal penetrations*
Basement floor and walls to BS 8102:2009, Grade 2 waterproofing	2	
Basement floor and walls to BS 8102:2009, Grade 3 waterproofing	2.5	*Conditional that waterproofing is not based on geosynthetic clay liner*

Ventilation methods are detailed in Table 6, and points can only be gained from using one of the five types

BS8485:2015 Table 6 Gas Protection Scores for Ventilation Protection Measures		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
a) Pressure relief pathway (usually formed by low fines gravel or with a thin geocomposite blanket with strips terminating in a gravel trench external to the building	0.5	*Whenever possible, a pressure pathway relief pathway (as a minimum) should be installed in all gas protection measures systems.* *If a layer has a low permeability and/or is not terminating in a venting trench (or similar), then the score is zero.*
b) Passive sub floor dispersal layer Very good performance Good performance Media used to provide the dispersal layer are: • Clear void • Polystyrene void forming blanket • Geocomposite void former blanket • No-fines gravel layer with gas drains • No-fines gravel layer	 2.5 1.5	*Performance criteria shown in Fig B.6 and B.7 of BS 8484:2015.[See Annex B]*
c) Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution layer, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers	1.5 to 2.5	*This system relies on continued serviceability of the pumps, therefore alarm and response systems should be in place. [See Annex B].*

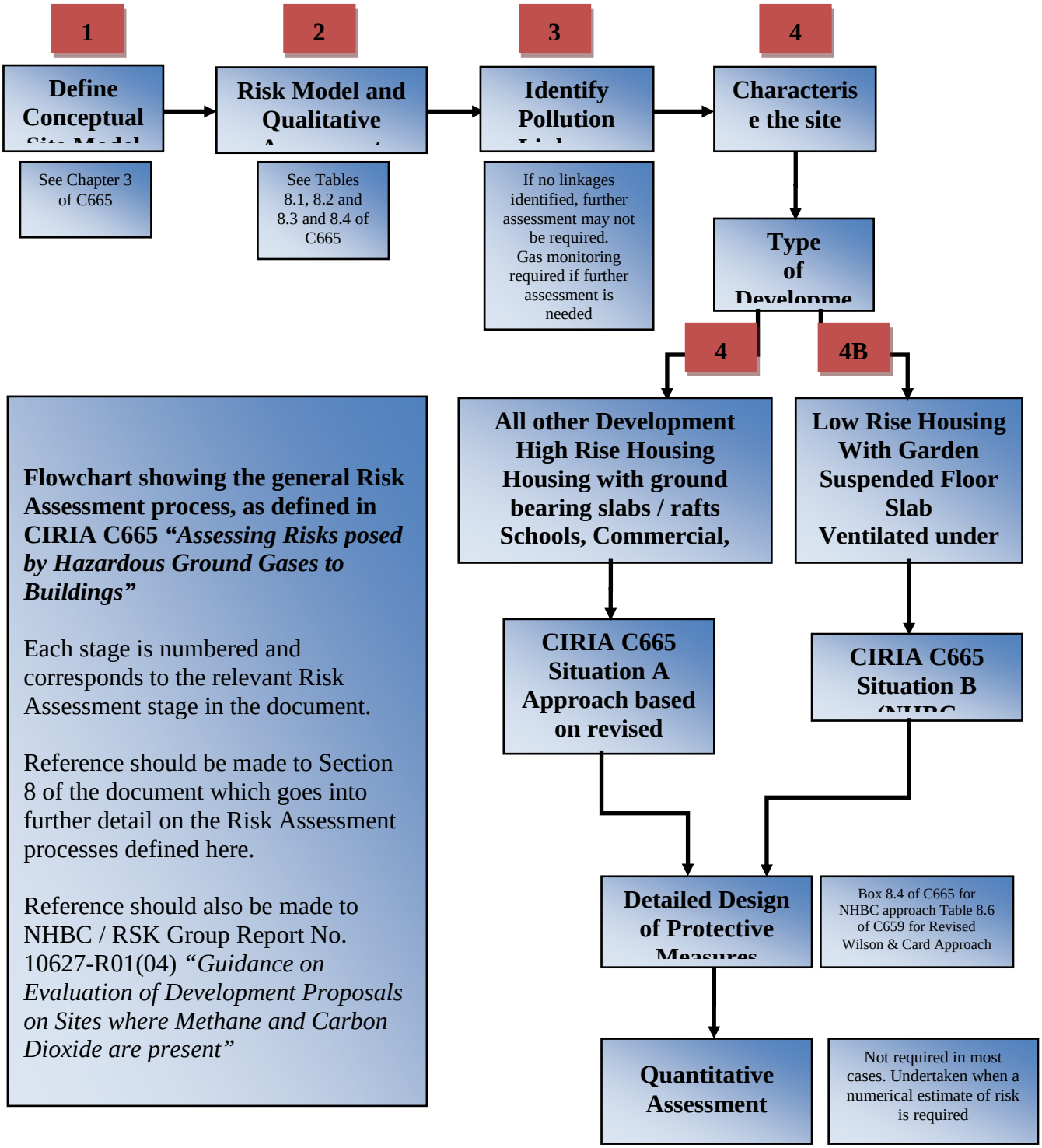
d) Active positive pressurisation by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket	1.5 to 2.5	*This system relies on continued operation of the pumps, therefore alarm and response systems should be in place. [See Annex B].*
e) Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or under croft)	4	*Assumes car park is vented , designed to Building Regulations 2000, Approved Document F.*

Membrane methods are detailed in Table 7.

BS8485:2015 Table 7 Gas protection score for gas resistant membrane		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
Gas resistant membrane meeting all of the following criteria: • Sufficiently impervious to gases with a methane gas transmission rate <40.0 ml/day/m^2/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method) • Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; • Sufficiently strong to withstand in-service stresses (eg settlement if placed below a floor slab); • Sufficiently strong to withstand the installation process and following trades until covered (eg penetration from steel fibres in fibre reinforced concrete, dropping tools etc); • capable, after installation, of providing a complete barrier to the entry of the relevant gas; and • verified in accordance with CIRIA C735	2	*The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints.* *If a membrane is installed that does not meet the criteria, then the score is zero.*

For a site which is impacted by migratory gases from an off-source, the development may be protected by imposing pathway intervention methods, which if successfully validated, could also remove the need for further analysis. It is essential that the gas regime in these circumstances has been fully characterised and that the only source impacting the site is located off site and that the pathway is clearly defined and its interception equally proven before construction commences. Pathway intervention methods may include vertical membrane installations, venting trenches, rows of stone columns, activated trenches and various proprietary systems. These systems are particularly relevant to domestic housing where there is limited scope for foundation type solutions.

Following the choice of protection measures, detailed design should be entered into [section 8 of BS 8485:2015].



Flowchart showing the general Risk Assessment process, as defined in CIRIA C665 *"Assessing Risks posed by Hazardous Ground Gases to Buildings"*

Each stage is numbered and corresponds to the relevant Risk Assessment stage in the document.

Reference should be made to Section 8 of the document which goes into further detail on the Risk Assessment processes defined here.

Reference should also be made to NHBC / RSK Group Report No. 10627-R01(04) *"Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are present"*

APPENDIX L

Summary of Guidance for Classification of Soil as a Waste Material

Guidance for Classification of Soil for Off Site Disposal at a Landfill Site

Many site developments create a portion of excess soils and Made Ground which if not re-usable, are required to be disposed off-site at a suitably licensed landfill site. The regulations and associated guidance published by the Environment Agency is relatively complex and lengthy. This guidance provides a summary of the following documents which should be referred to when assessing soil (and common constituents found within Made Ground on remediation sites) for off-site disposal:

- Guidance for Waste destined for disposal in landfills: Interpretation of the Waste Acceptance Requirements of the Landfill (England and Wales) Regulations 2002 (as amended) (EA, 2004);
- Guidance on Sampling and Testing of Wastes to Meet Landfill Waste Acceptance Procedures (EA, April 2005);
- WM3 - Hazardous Waste: Interpretation of the Definition and Classification of Hazardous Wastes (EA, May 2015);
- European Regulation No 1272/2008 on Classification, Labelling and Packaging of Substances 2015 (CLP 2015);
- Guidance on Waste Destined for Disposal in Landfill (EA, June 2006);
- Treatment of Non-hazardous wastes for Landfill (EA, February 2007).

It is important to distinguish between the waste classification system and the designation of materials as "suitable for use" on site. A material may be retained on site for an appropriate end use if that end-use is clearly designated and that a site-specific risk assessment ensures that it does not pose a risk to human health or controlled waters. However, if this material is excavated and sent for disposal, the material is then subject to waste management regulations and the two systems cannot be directly correlated. It is therefore important to note that classifying a material as hazardous (should it be excavated and become a waste) does not necessarily indicate that it might not be suitable to be kept on site for re-use. Separate guidance in the form of a Code of Practice (CL:AIRE Version 2, 2011) has been developed jointly between the development industry and the Environment Agency to provide best practice when assessing whether materials are wastes or not, and for determining when waste can cease to be waste for a particular use.

In accordance with the current waste regulations (or Landfill Directive, as they are more commonly known), from 30th October 2007 all waste materials produced from construction sites have to be pre-treated prior to disposal. Pre-treatment includes waste minimisation, recovery (e.g. separation of demolition waste to be used as hardcore) and separation of materials into different waste categories (e.g. separate inert waste from hazardous waste etc). Mixing of different waste types shall be avoided and intentional mixing of inert materials with hazardous waste to 'dilute it' and hence change its waste classification, is illegal.

The current waste regulations (based on the EU landfill directive) introduced a two tier classification system for waste materials, defining them as either being hazardous or non-hazardous. Landfills are licensed to take wastes based on a three tier classification system with the non- hazardous waste divided into two sub-categories:

- Non-Hazardous - inert;
- Non-Hazardous - non-hazardous;
- Hazardous.

Waste materials are categorised with a six figure numeric code in the European Waste Catalogue. Commonly found construction and demolition wastes including excavated soil from contaminated sites and Made Ground with their waste codes are summarised below (this is not a comprehensive list):

Waste Code	**What is it?**	**Likely Waste Category–**		
		Inert Waste	**Non-Hazardous**	**Hazardous Waste**
17 01 01 Concrete	Concrete, possibly with reinforcement (from Construction & Demolition)	✓		
17 01 02 Bricks		✓		
17 01 06* Mixtures of concrete, bricks, tiles & ceramics containing dangerous substances	These are not normally considered hazardous but if they are contaminated (e.g. by asbestos) then could be hazardous – see comment above			✓
17 01 07 Mixtures of concrete, bricks, tiles & ceramics other than those in 17 01 06	This is mixed inerts c.f. 17 09 04	✓		
17 05 03* soils and stones containing dangerous substances				✓
17 05 04 soils and stones other than those mentioned in 17 05 03	Soil and stones only (excluding top soil, peat, soil and stones from contaminated sites)	✓		
17 06 05* Construction materials containing asbestos	e.g. corrugated asbestos sheeting			✓
17 08 02 Gypsum-based construction materials other than those mentioned in 17 08 01	Plaster & plasterboard (although specific disposal requirements are required for high sulphate waste – see EA guidance 'Understanding the Landfill Directive' version 1.0 March 2010.		✓	
17 09 01* Construction & demolition wastes containing mercury				✓

17 09 02* Construction & demolition wastes containing PCBs	Waste with more than 50 mg/kg of PCB's are hazardous			✓
17 09 03* Other mixed construction & demolition wastes containing dangerous substances	Broad range of potentially (see notes below – if asterix the waste is hazardous) hazardous wastes			✓
17 09 04 Mixed construction & demolition wastes other than those mentioned in 17 09 01, 17 09 02 & 17 09 03	Mixed inerts with soil, tarmac, cables, vegetation, plaster, etc. (this waste can only be considered inert if it passes the waste acceptance criteria identified in the regulations).	✓	✓	

Note: all wastes with an asterix code are hazardous regardless of whether they are mirror or absolute entries in the EWC list the decision to with regard to composition must come before applying the code for mirror entries.

Some materials are classified as Inert Waste based in its origin (e.g. 17 01 01 Concrete, or glass) without any requirement for laboratory chemical analysis.

However, most soils will require laboratory testing to confirm whether they are classified as Hazardous Waste. The protocol for assessing these materials and the appropriate threshold values is complicated and are set out in the Environment Agency's "Technical Guidance *WM3* Hazardous Waste – Interpretation of the Definition and Classification of Hazardous Waste" (2015). If the test results for the waste indicates that it is not hazardous then further analysis of the waste is required to determine whether it is Inert Waste. If the waste does not meet the criteria for either Hazardous or Inert, then it is by default classified as Non-hazardous Waste.

As an alternative location to landfills for off-site disposal of inert and non-hazardous waste, there are a number of sites which have Waste Permit Exemptions that can accept certain categories of inert and non-hazardous wastes. Additionally some quarries can accept certain types of wastes to be used for quarry restoration material. For both alternatives to disposal at landfill sites the material still requires chemical testing as these sites have site specific acceptance criteria for wastes. It should also be noted that these types of site do not incur landfill tax which in the 2018/19 tax year is £2.80 for inactive waste (inert and some types of non-hazardous waste) and £88.95/Tonne for active waste (some types of non-hazardous waste and hazardous waste. Note that the Inland Revenue uses a different classification scheme for waste for tax purposes to the European Waste Classification scheme.

Waste Categorisation

The process of determining the category of wastes is a three stage process:

- Stage 1 – is the waste either Hazardous or Inert by definition without the requirement for chemical analysis (if it is then Stages 2 and 3 are not required);
- Stage 2 - Waste characterisation;
- Stage 3 - WAC classification.

Waste characterisation determines if a waste is hazardous or not. Excavated soil is characterised using a system based on the contaminants present and their hazardous properties. The system uses total concentrations of the contaminants. Thresholds (as a percentage of the waste) have been set for the various hazardous properties.

Fourteen hazardous properties together with other scenarios where material could cause a hazard have been defined:

- Hazardous properties: explosive, oxidising, highly flammable/flammable, irritant, harmful, toxic, carcinogenic, corrosive, infectious, toxic for reproduction, mutagenic and ecotoxic;
- Substances which can release toxic/very toxic gases in contact with water, acid or air;
- Substances which, after disposal, can yield another substance, e.g. a leachate, which possesses any of the above hazardous properties.

Some of the hazardous properties are sub-divided e.g. there are three categories of carcinogenic, mutagenic and toxic for reproduction substances. The hazardous properties were originally defined in the European Hazardous Waste Directive 91/689/EC. Should a waste contain a contaminant with one or more of the listed hazardous properties at a concentration equal to or above the threshold value for the particular property, then the waste is hazardous. The hazardous properties of a wide range of chemicals are sourced from CLP 2015.

There are many reasons why waste soil is classified as being hazardous but the majority of reasons can be divided into the following four groups:

- Hydrocarbons – this is probably the most common reason for the hazardous classification of soils. For most soils hydrocarbon analysis will be required for both Polycyclic Aromatic Hydrocarbons (PAH) and speciated Petroleum Hydrocarbons (PHCs) but depending on the site's history other groups of organic contaminants may also be is included in any analysis suite for soil samples;
- Metals – Particularly sites from former metal processing or mining sites and also some types of ash have metal concentrations that are sufficiently high to characterise materials requiring disposal as hazardous waste.
- Asbestos;
- Anions – e.g. sulphate in plasterboard (there are special disposal requirements for high sulphate waste and specific WAC requirements); it is possible that sulphate salts of metals and semi-metals could make the waste hazardous – the sulphate concentration could possibly be significant under H12, H13 and H14.

The characterisation of wastes with significant metal concentrations involves some processing of the analysis data. The chemical analysis results for inorganic substances are generally reported as total concentrations e.g. total lead, total arsenic, total sulphate etc. However, CLP 2015 deals with the hazardous properties of actual compounds e.g. lead sulphate, arsenic pentoxide, nickel carbonate. Therefore, the total metal results have to be converted into assessed chemical analysis results for the compound most likely to be present in the soil samples. For example, if the sample contains high total lead concentrations and high sulphate concentrations, then the lead is likely to be present in the soil as lead sulphate. The most likely compounds can often be determined from a desk study or previous site uses. If the site has been derelict for a number of years, consideration should be given as to whether water soluble compounds should or should not be chosen, as rainfall could have removed them from the soil (this does not apply if the soil has been

taken from below under a concrete slab etc). Chemical knowledge and common sense needs to be used in choosing a suitable compound.

If no data is available, then a worst case scenario has to be assumed and the most hazardous compound likely to be present has to be chosen. For example, metal chromates (lead chromate, nickel chromate) are often the most hazardous compounds formed by many metals, but if the chromium concentrations in the soil are low, chromates are unlikely to be present. It should also be noted that for many of the hazard categories, the cumulative hazard from different compounds is added (e.g. add the concentrations of the copper, lead and zinc compounds together to assess the Hazard Category H14 Ecotoxicity).

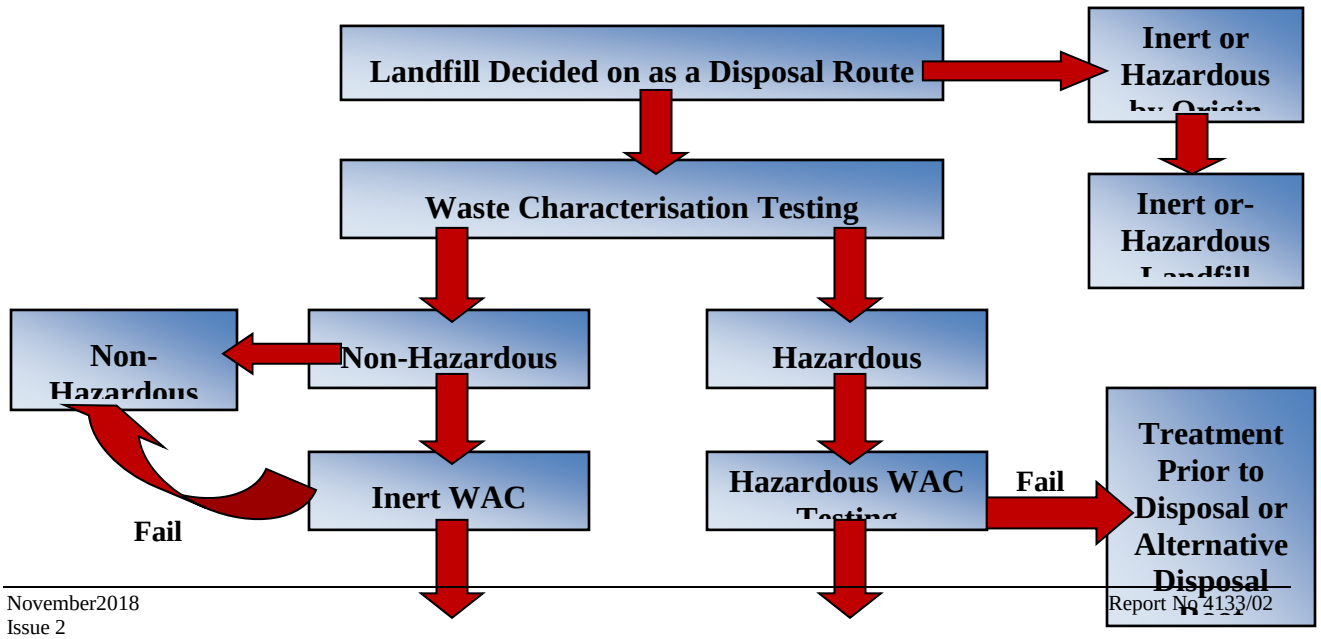
If the results of the above assessment determine that the waste is hazardous, it must then be analysed for the Waste Acceptance Criteria (WAC) analysis contained within appropriate Environmental Permitting Regulations (this comprises mainly leachate but also analysis for TOC and Loss on ignition). WAC limit values have been set for the listed determinands. If any of the determinands exceed their limit value, the waste must be pre-treated to reduce concentrations to below the limit values before the waste may be disposed of at a landfill site licensed to take hazardous waste.

For waste classified as not being hazardous, then there are two options available. Currently, waste correctly characterised as not being hazardous may be disposed of without WAC testing to a non-hazardous landfill. Alternatively WAC testing for Inert Waste can be carried out (this is similar to the list for hazardous waste with the addition of PAH's, BTEX and Mineral Oil). If the results pass the Inert WAC criteria it can be disposed of at an Inert Waste Landfill. If any of the WAC test results exceed the Inert WAC criteria the waste has to be disposed at a non- hazardous landfill. There are WAC limits for non-hazardous waste set for pH and TOC. If these two criteria are not met then the waste must be pre-treated to so that it meets the criteria before it can be disposed.

If materials fail the WAC criteria it may be possible to pre-treat the waste on-site or be taken to a soil treatment centre for pre-treatment to reduce the soil's hazardous properties (e.g. by bioremediation of hydrocarbons).

It should be noted that in order to dispose of Hazardous Waste, the site must register as a producer of Hazardous Waste with the Environment Agency. When disposing of waste materials to landfill sites the appropriate Duty of Care Waste Transfer procedures must be followed.

Landfilled Waste Decision Tree



Landfill Tax

It should be noted that HM Revenue and Customs (HMRC) classify wastes for tax purposes using a different scheme to the three fold landfill EU Landfill Directive scheme (i.e. the hazardous, non-hazardous and inert). HMRC have a two-fold system for landfill tax. The Standard Landfill Tax is currently £88.95/T and applies to all wastes unless they qualify for the reduced rate of landfill tax of £2.80/T. The wastes that qualify for the reduced rate of Landfill Tax are set out in The Landfill Tax (Qualifying Material) Order 2011 with supplementary information on the interpretation of these regulations in HMRS "Notice LFT1 – A General Guide to Landfill Tax" (May 2012) and HMRC Briefing Notes 15/12 and 18/12.

APPENDIX M

Unforeseen Ground Contamination

Unforeseen Ground Contamination

There is the potential for areas of previously unexpected contamination to be present, as is the case with any "brownfield" site. Any significant quantities of asbestos, significant ashy soils, unusual, brightly coloured or significantly oily or odorous material should be considered in this category. If unexpected contamination is found the following procedures should be adhered to:

1. All site works at the position of the suspected contamination will cease.
2. A suitably trained geo-environmental specialist should assess the visual and olfactory observations of the condition of the ground and the extent of contamination and the Client and the Local Authority should be informed of the discovery. Should the contamination be likely to affect controlled waters the Environment Agency shall also be informed.
3. The suspected contaminated material will be investigated and tested appropriately in accordance with the assessed risks. The investigation works will be carried out in the presence of a suitably qualified geo-environmental engineer. The investigation works shall commence to recover samples for testing and, using visual and olfactory observations of the condition of the ground, delineate the area over which contaminated materials are present.
4. The unexpected contaminated material will either be left in situ or be stockpiled whilst testing is carried out and suitable assessments completed to determine whether the material can be re-used on site or requires to be disposed as appropriate.
5. Where the material is left in situ awaiting results it will be reburied or covered with plastic sheeting.
6. Where the potentially contaminated material is to be temporarily stockpiled it will either be placed either on a prepared surface of Glacial Till, or on 2000 gauge Visqueen sheeting (or other impermeable surface) and covered to prevent dust and odour emissions.
7. Any areas where unexpected visual or olfactory ground contamination will be surveyed, a photographic record kept and testing results incorporated into the Verification Report.
8. A photographic recorded will be made of relevant observations.
9. The testing suite will be determined by the independent geo-environmental specialist on the basis of visual and olfactory observations.
10. Test results will be compared against current assessment criteria suitable for the future use of the area of the site affected.
11. The results of the investigation and testing of any suspect unexpected contamination will be used to determine the relevant actions. After consultation with the Local Authority and if necessary the Environment Agency, materials should either be:
    - re-used in areas where test results indicate that it meets compliance targets so it can be reused without treatment; or
    - treatment of material on site to meet compliance targets so it can be reused; or
    - removal from site to a treatment centre or to a suitably licensed landfill or permitted treatment facility.
12. Verification Report will be produced for the work.

Asbestos

Asbestos cement products and asbestos fibres have not been encountered in the soils at the site, but based on the age of the Made Ground material containing asbestos could be expected to be encountered. If non-notifiable asbestos (e.g. chrysotile asbestos cement board) is encountered in excavations then it will be dealt with in accordance with the Control of Asbestos Regulations 2012 (CAR 2012) and the HSE's ACoP for asbestos (2013). Finding non-notifiable asbestos is a very common occurrence on brownfield sites and is a relatively low risk activity and can be dealt with as a matter of routine. Therefore it is not proposed that the Council will be notified but an appropriate record will be kept of confirmatory testing and disposal. This will be included in remediation verification reports.

If suspect notifiable asbestos is encountered then the Council and the HSE will be notified. An appropriate action plan will be agreed with the Council and the HSE in accordance with CAR 2012. The action plan will include the preparation of the Risk Assessment and Plan of Work in accordance with CAR and other statutory requirements including:

- Site mobilisation;
- Excavation methodology;
- Handling, movement and storage on site of excavation arisings;
- Any processing of excavation arisings containing ACMs;
- Movement and placement of arisings to final destination;
- Placing of cover system over soils with and ACMs remaining on site;
- Off-site disposal of ACMs;
- Licences;
- PPE & RPE;
- Dust and fibre monitoring.

Potential mitigation measures that would be required include:

- Ensuring works are carried out by suitably trained and experienced personnel with working with asbestos;
- Site investigation and risk assessment;
- Removal or treatment of asbestos hotspots;
- Use of PPE and RPE by construction workers; and
- Compliance monitoring.

Unexpected Tanks

No buried underground fuel storage tanks have been encountered during the site investigation works; however, there remains a low risk that tanks are present on site. Should an underground tank be encountered, operations should cease in the area. Additionally there may be pipework associated with these tanks which could have oily residues. The following procedures are to be adhered to if tanks and pipework are identified:

1. All site works at the position of the tanks/pipework should stop.
2. A description of the tank should be made by the geo-environmental engineer including; condition and surround, along with visual and olfactory observations should any contents in the tank be apparent. A photographic recorded will also be made of relevant observations.
3. The tank's position and depth should be determined and marked on a plan of the site.
4. The independent geo-environmental engineer will inform Client and the Local Authority.
5. During the presence of the independent geo-environmental engineer, investigation works should be undertaken to obtain samples of any liquid or sludge contents and to establish dimensions of the tank.
6. Testing will be determined on the basis of visual and olfactory observations by independent geo-environmental engineer.
7. Test results will be compared against current assessment criteria and proposals for disposal of any contents determined in agreement with the appropriate Regulatory Parties.
8. Emptying the tank and disposal of contents to a suitable licenced disposal facility.
9. Degassing and removal of the tank by a suitably qualified contractor will be required, and a Naked Flame Certificate should be provided.
10. Once the tank has been emptied in accordance with the above proposals, it is to be removed for disposal to a licensed waste management facility. Copies of the relevant waste consignment notes are to be kept and included in the Verification Report.
11. Excavation and remediation of any contaminated soils around the tank will be carried out.
12. Samples of the base and sides of the resultant hole will be sampled and supervised by the independent geo-environmental engineer to confirm whether risks to human health or controlled waters.

All of the above information will be incorporated into the Verification Report and submitted to the regulatory parties, the Local Authority and the Environment Agency where groundwater may potentially have been impacted.

TerraConsult

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Appendix B:

TerraConsult Additional Ground Gas Monitoring

No: 4133 **GROUNDWATER AND GROUND GAS MONITORING** **TerraConsult**

Site: Carrington

Location	Date	Monitored by	Well Details		Groundwater		Gas												Weather		Serial No.
			Standpipe diameter (mm)	Depth to Base (m bgl)	Water Depth (m bgl)	Water Sample Taken?	Atmospheric Pressure (mbar)	Atmospheric Pressure Comment	Relative Pressure (mb)	Steady Flow (l/h)	Peak Flow (l/h)	CH_4 (% v/v)	GSV CH_4 (l/hr)	CO_2 (% v/v)	GSV CO_2 (l/hr)	O_2 (% v/v)	CO (ppm)	H2S (ppm)	Conditions	Ambient Temp °C	
BH18-01	19/10/18	BA	25	30.00	15.63	N	Piezometer only														
	22/10/18	LM	25	30.00	15.74	N	Piezometer only														
	08/11/18	GB	25	30.00	15.13	N	Piezometer only												Overcast	10	11380
	22/11/18	GB	25	30.00	15.26	N	Piezometer only												Cloudy	3	11380
	20/12/18	LM	25	30.00	15.86	N	Piezometer only												Overcast	4	11380
	04/01/19	SW	25	30.00	12.71	N	Piezometer only												Overcast	4	11380
	15/02/19	NA	25	30.00	12.89	N	Piezometer only												Sunny	13	11380
	28/02/19	PC	25	30.00	12.96	N	Piezometer only												Overcast	9	11380
	07/03/19	GB	25	30.00	16.17	N	Piezometer only												Overcast/Rain	5	11380
BH18-01	19/10/18	BA	51	13.13	8.06	Y															
	22/10/18	LM	51	13.13	8.55	N	1038	Steady	0.04	0.6	0.6	0.1	0.0006	0.1	0.0006	18.4	1	1	Sunny	11	12417
	08/11/18	GB	51	12.84	8.71	N	1013	Steady	0.01	0.1	0.1	2.4	0.0024	0.3	0.0003	15.5	1	1	Overcast	10	11380
	22/11/18	GB	51	12.84	8.78	N	1023	Steady	0.01	0.1	0.1	4.0	0.0040	15.1	0.0151	0.6	1	1	Cloudy	3	11380
	20/12/18	LM	51	12.84	8.77	N	1004	Falling	0.01	0.1	0.1	6.8	0.0068	1.3	0.0013	10.3	1	1	Overcast	4	11380
	04/01/19	SW	51	12.71	8.83	N	1040	Steady	-0.11	-1.9	-1.7	7.6	-0.1444	1.9	-0.0361	6.4	1	1	Overcast	4	11380
	15/02/19	NA	51	13.02	8.62	N	1030	Falling	0.02	0.6	2.5	20.2	0.1212	0.2	0.0012	0.6	1	1	Sunny	13	11380
	28/02/19	PC	51	13.00	8.68	N	1013	Steady	0.50	0.3	0.5	20.2	0.0606	0.4	0.0012	15.9	1	1	Overcast	9	11380
	07/03/19	GB	51	12.84	8.44	N	994	Falling	0.01	0.1	0.1	22.2	0.0222	0.4	0.0004	1.7	1	1	Overcast/Rain	5	
BH18-02A	19/10/18	BA	51	8.72	3.25	Y															
	22/10/18	LM	51	8.72	3.40	N	1038	Steady	0.02	0.3	0.3	12.4	0.0372	1.5	0.0045	0.1	1	1	Sunny	11	12417
	08/11/18	GB	51	8.80	3.50	N	1013	Steady	0.01	0.1	0.1	13.1	0.0131	1.6	0.0016	0.7	1	1	Overcast	10	11380
	22/11/18	GB	51	8.80	3.51	N	1023	Steady	0.03	0.7	0.7	13.8	0.0966	1.6	0.0112	0.2	1	1	Cloudy	3	11380
	20/12/18	LM	51	8.80	2.81	N	1005	Falling	0.01	0.1	0.1	14.8	0.0148	0.9	0.0009	0.8	1	1	Overcast	4	11380
	04/01/19	SW	51	8.80	3.71	N	1040	Steady	-0.12	-1.8	-1.9	14.8	-0.2664	0.6	-0.0108	-0.2	1	1	Overcast	4	11380
	15/02/19	NA	51	8.78	2.56	N	1027	Falling	0.03	0.7	1.2	17.1	0.1197	0.3	0.0021	0.2	1	1	Sunny	13	11380
	07/03/19	GB	51	8.80	2.71	N	995	Falling	0.14	3.1	3.1	6.8	0.2108	0.3	0.0093	10.7	1	1	Overcast/Rain	5	11380
GEG BH01 (2015 Historic BH)	22/10/18	LM	51		Blocked	N													Sunny	14	12417
	08/11/18	GB	BH appears grouted up to ground level				1013	Steady	0.01	0.1	0.1	0.1	0.0001	0.5	0.0005	19.4	1	1	Overcast	10	11380
	22/11/18	GB	BH appears grouted up to ground level				1023	Steady	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	19.7	1	1	Cloudy	3	11380
	20/12/18	LM				N	1004	Falling	0.01	0.1	0.1	0.1	0.0001	0.6	0.0006	18.3	1	1	Overcast	4	11380
	04/01/18	SW				N	1040	Steady	0.01	0.1	0.1	0.1	0.0001	0.5	0.0005	18.3	1	1	Overcast	4	11380
	15/02/19	NA				N	1027	Falling	0.01	0.1	0.1	0.1	0.0001	0.6	0.0006	18.3	1	1	Sunny	13	11380
	28/02/19	PC				N	1027	Falling	0.01	0.1	0.1	0.1	0.0001	0.5	0.0005	18.2	1	1	Overcast	9	11380
	07/03/19	GB	BH appears grouted up to ground level				996	Falling	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	19.7	1	1	Overcast/Rain	5	11380
GEG BH02 (2015 Historic BH)	02/10/18	BA	51		7.86	N	1021	Steady	0.04	1.6	3.1	48.3	0.7728	3.1	0.0496	0.1	1	1	Sunny	14	12417
	22/10/18	LM	51		7.43	N	1038	Steady	0.01	0.1	0.1	6.4	0.0064	2.5	0.0025	8.3	1	1	Sunny	11	12417
	08/11/18	GB	51	8.40	7.67	N	1013	Steady	0.02	0.6	0.6	13.6	0.0816	3.2	0.0192	3.0	1	1	Overcast	10	11380
	22/11/18	GB	51	8.40	7.89	N	1023	Steady	0.06	1.5	1.5	25.8	0.3870	2.9	0.0435	0.2	1	1	Cloudy	3	11380
	20/12/18	LM	51	8.40	7.54	N	1004	Falling	0.08	2.1	3.1	55.2	1.1592	1.8	0.0378	0.3	1	1	Overcast	4	11380
	04/01/19	SW	51	8.34	7.12	N	1040	Steady	-0.03	-0.6	0.0	43.3	-0.2598	2.0	-0.0120	0.0	1	1	Overcast	4	11380
	15/02/19	NA	51	8.39	6.29	N	1027	Falling	0.70	1.8	2.5	36.9	0.6642	1.6	0.0288	0.4	1	1	Sunny	13	11380
	28/02/19	PC	51	8.38	6..52	N	1013	Steady	0.09	1.4	1.8	38.2	0.5348	1.9	0.0266	0.3	1	1	Overcast	9	11380
	07/03/19	GB	51	8.40	6.37	N	995	Falling	0.01	0.3	0.3	29.3	0.0879	1.3	0.0039	4.4	1	1	Overcast/Rain	5	11380
OLDBH02	02/10/18	BA	19	-	2.16	N	1021	Steady	0.01	0.1	0.1	0.1	0.0001	2.0	0.0020	13.1	1	1	Sunny	14	12417
	08/11/18	GB	19	2.87	2.16	N	1012	Steady	0.01	0.1	0.1	0.1	0.0001	1.8	0.0018	8.5	1	1	Overcast	10	11380
	22/11/18	GB	19	2.87	2.19	N	1023	Steady	0.01	0.1	0.1	0.1	0.0001	2.1	0.0021	0.7	1	1	Cloudy	3	11380
	20/12/18	LM	19	2.87	2.18	N	1004	Falling	0.01	0.1	0.1	0.1	0.0001	1.4	0.0014	13.5	1	1	Overcast	4	11380
	04/01/19	SW	19	2.87	2.18	N	1040	Steady	-0.01	-1.8	-1.9	0.1	-0.0018	1.4	-0.0252	17.8	1	1	Overcast	4	11380
	15/02/19	NA	19	2.84	1.62	N	1025	Falling	0.01	0.1	0.1	0.1	0.0001	0.7	0.0007	18.9	1	1	Sunny	13	11380
	28/02/19	PC	19	2.88	1.81	N	1013	Steady	0.01	0.1	0.1	0.1	0.0001	0.9	0.0009	17.9	1	1	Overcast	9	11380
	07/03/19	GB	19	1.87	1.54	N	994	Falling	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	13.5	1	1	Overcast/Rain	5	11380
	02/10/18	BA	19	-	2.53	N	1020	Steady	0.01	0.1	0.1	0.1	0.0001	0.9	0.0009	16.9	1	1	Sunny	14	12417
	08/11/18	GB	19	4.54	2.64	N	1012	Steady	0.01	0.1	0.1	1.6	0.0016	4.9	0.0049	5.1	1	1	Overcast	10	11380

GSV (l/HR) = [gas concentration (%v/v)] x [gas well flow rate (l/hr)]
100

NOTES:
NM = Not Measured.
(x) = Peak value recorded.
[grey] = Below detection limit.

OLDBH03	22/11/18	GB	19	4.54	2.61	N	1023	Steady	0.01	0.1	0.1	1.4	0.0014	7.2	0.0072	2.4	1	1	Cloudy	3	11380
	20/12/18	LM	19	4.54	2.60	N	1004	Falling	0.01	0.1	0.1	1.0	0.0010	5.3	0.0053	6.1	1	1	Overcast	4	11380
	04/01/19	SW	19	4.54	2.62	N	1040	Steady	-0.12	-2.1	-1.8	0.1	-0.0021	1.1	-0.0231	17.6	1	1	Overcast	4	11380
	15/02/19	NA	19	0.67	-	N	1025	Falling	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	20.1	1	1	Sunny	13	11380
	28/02/19	PC	19	0.67	-	N	1013	Steady	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	19.9	1	1	Overcast	9	11380
	07/03/19	GB	19	4.54	0.09	N	994	Falling	0.01	0.1	0.1	0.1	0.0001	0.1	0.0001	20.0	1	1	Overcast/Rain	5	11380
			Couldn't get dip below 0.67m bgl																		

10.5

TEST DATE AND CONDITIONS		
Date	25/06/18	
Atmospheric Pressure	1008	mB
Ambient Temperature	21.7	°C
Environics Serial No.	5089	

GFM435 Final Inspection & Calibration Check Certificate

GAS DATA LTD
Unit 4, Fairfield Court
Seven Stars Estate
Wheler Rd
Coventry
CV3 4LJ
Tel 02476303311 Fax 02476307711

Customer	Terraconsult Ltd
Certificate Number	120264
Order Number	320071

Serial Number	11380
Software Version	G435-00.0024/0004

Recalibration DUE Date
25/06/19

Instrument Checks					
Keyboard	✓		Display Contrast	✓	
Pump Flow In	500	Accept > 200 cc/min	Pump Flow @ -200mB	200	Accept > 200 cc/min
Clock Set / Running	✓		Labels Fitted	✓	

Gas Checks						
	CH_4		CO_2		O_2	
	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %
Sensor	59.7	60	39.4	40	20.9	20.9
	Accept ±3.0		Accept ±3.0		Accept ±0.5	
	4.9	5	4.9	5	6	6
	Accept ±0.3		Accept ±0.3		Accept ±0.3	
Zero Reading 100% N2	0	0	0	0	0	0
	Accept ±0.0		Accept ±0.0		Accept ±0.1	

Optional Gas Checks						
Applied Gas & Range		Concentration Tested @ (ppm)	Instrument Readings (ppm)			
Gas Type	Range (ppm)		Zero Reading		Instrument Gas Reading	
H2S	5000	1500	0	Accept ±0.0	1500	Accept ±5.0
CO	2000	1000	0	Accept ±0.0	1000	Accept ±5.0
Hexane	2.0%	2.0%	0	Accept ±0.0	1.99	Accept ±10.0

TEST DATE AND CONDITIONS		
Date	03/04/18	
Atmospheric Pressure	973	mB
Ambient Temperature	22.3	°C
Environics Serial No.	5089	

GFM436 Final Inspection & Calibration Check Certificate

GAS DATA LTD
Unit 4, Fairfield Court
Seven Stars Estate
Wheler Rd
Coventry
CV3 4LJ
Tel 02476303311 Fax 02476307711

Customer	Terraconsult Ltd
Certificate Number	120054
Order Number	318572

Serial Number	12417
Software Version	G436-00.0027/0009

Recalibration DUE Date
03/04/19

Instrument Checks					
Keyboard	✓		Display Contrast	✓	
Pump Flow In	400	Accept > 200 cc/min	Pump Flow @ -200mB	250	Accept > 200 cc/min
Clock Set / Running	✓		Labels Fitted	✓	

Gas Checks						
	CH_4		CO_2		O_2	
	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %
Sensor	59.9	60	39.4	40	20.9	20.9
	Accept ±3.0		Accept ±3.0		Accept ±0.5	
	5	5	4.9	5	6	6
	Accept ±0.3		Accept ±0.3		Accept ±0.3	
Zero Reading 100% N2	0	0	0	0	0	0
	Accept ±0.0		Accept ±0.0		Accept ±0.1	

Optional Gas Checks						
Applied Gas & Range		Concentration Tested @ (ppm)	Instrument Readings (ppm)			
Gas Type	Range (ppm)		Zero Reading		Instrument Gas Reading	
H2S	5000	1500	0	Accept ±0.0	1500	Accept ±5.0
CO	2000	1000	0	Accept ±0.0	999	Accept ±5.0
Hexane	2.0%	2.0%	0	Accept ±0.0	1.99	Accept ±10.0

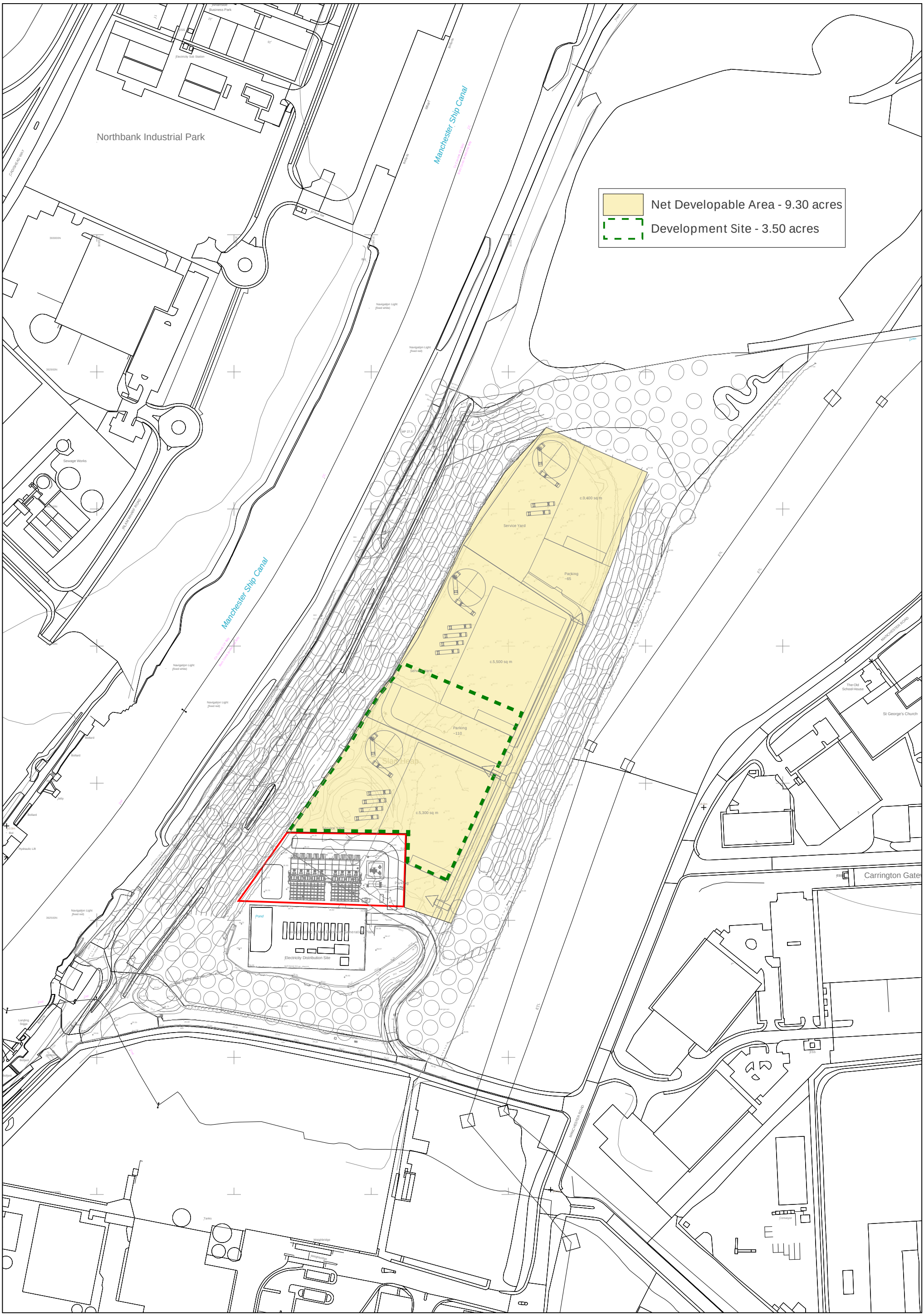
NOTES:
NM = Not Measured.
(x) = Peak value recorded.
[grey] = Below detection limit.

GSV (l/HR) = $\frac{\text{[gas concentration (\%v/v)] x [gas well flow rate (l/hr)]}}{100}$

Appendix C:

Site Plans

- *Carrington Generation Limited Gas and Electrical Easement: Proposed Lease Area and Layout Dwg. No. FE/017/372 22/02/2021*



Peel L&P
PART OF THE PEEL GROUP

Land at Carrington
General Layout Plan

N

Ordnance Survey

OS MasterMap Imagery Layer has been created using Ordnance Survey's own imagery and imagery from other suppliers. This data may contain imagery data sourced from Getmapping plc imagery data sourced from UK Perspectives Limited and/or imagery data sourced from InfoTerra Limited.
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Date: 03:02:21 Scale: 1:2500 @ A3

BDS: KT / Land at Carrington General Layout Plan v2 + Land at Carrington Topo Survey + Land at Carrington Proposed Development CAD

Ref: JG / KT

Appendix D:

Guidance on Ground Gas Risk Assessment

Current Guidance for Ground Gas Risk Assessment

Origin of Ground and Landfill Gases

When carrying out a ground gas risk assessment for permanent ground gases (e.g. methane and carbon dioxide), the origin or source of the gases is important as potential risks will vary depending on the source. This Appendix relates to the risk of the two main ground gases of concern: methane and carbon dioxide, and does not apply to other ground gases (e.g. radon or vapours from hydrocarbon spills). Methane and carbon dioxide are major constituents of landfill gas but can also occur from a variety of anthropogenic and natural sources, as summarised in Table G1 below:

Table G1. Potential Sources of Ground Gases

Gas	Source	Comments
Landfill Gas	Anaerobic decomposition of degradable waste within landfill sites. Typically 60% methane and 40% carbon dioxide during methanogenic phase.	Composition varies over time, particularly in early stages. Contains a range of minor constituents (particularly carbon monoxide and hydrogen sulphide).
Landfill Associated Gases	- Anaerobic degradation of leachate external to the site; - Degassing of dissolved gases in groundwater; - Evolution of gases following interaction between leachate and groundwater	Can result in secondary (external) production of methane or carbon dioxide.
Made Ground	Anaerobic degradation of organic components	Very variable depending on source
Sewer Gas, Cess Pits	Anaerobic degradation of organic components of sewage producing methane and carbon dioxide.	Often characterised by hydrogen sulphide odour.
Mains Gas	Leakage from underground pipework or storage tanks. Mainly methane but often contains higher alkanes.	An odouriser is added to permit detection of leaks. Typically 90% CH_4, but 1 to 27% C_2-C_4 alkanes, May also contain other trace gases e.g. CO, helium and CO_2 (from degradation of CH_4 in the ground).
Other Anthropogenic Sources	- Degradation of leaked or spilled hydrocarbons or other industrial chemicals; - Anaerobic degradation of organic contaminants in groundwaters (e.g. silage liquor); - Reactions between monitoring well construction components and environment; - Burial grounds/cemeteries.	Hydrocarbon spillages often have an 'oily' odour. Fuel spillages common – Petrol or Diesel and can contain a wide range of VOC's. Can degrade to produce methane / carbon dioxide.
Alluvium / Marsh / Peat Gas	Anaerobic microbial degradation of organic material (usually waterlogged vegetation / peat). Often associated with the presence of alluvial deposits or dredgings.	
Geogenic Gas	Natural seepages of carbon dioxide and hydrocarbon gases derived from geologic sources such as coal seams and deep oil / gas source formations. Can be present in solution in groundwaters.	Methane most common but can contain carbon dioxide and higher alkanes.
Mine Gases	Various types. Most common is "fire damp" with high methane, produced by the desorption of gas trapped in coal. "Black damp" (Stythe gas) with high carbon dioxide and denser than air. "White damp" is high in carbon monoxide.	Methane most common. Can contain higher alkanes, carbon dioxide and carbon monoxide. Often low in oxygen.
Natural Shallow Ground Gas	Various types - high carbon dioxide formed by subsurface aerobic activity leading to depleted oxygen and elevated carbon dioxide; - chemical degradation of rocks (e.g. carbonates) producing carbon dioxide; - carbon dioxide production in root zone of soils by plants.	Gases can be emitted from ground under falling barometric pressure conditions.

This Appendix concentrates on the assessment of risk from methane and carbon dioxide. This Appendix does not provide guidance for the assessment of risk when other gases are present due to 'Other Sources' from the above table (particularly organic compounds such as BTEX and VOC's or for the risk from radon or hydrogen sulphide).

To determine the origin of the gas a range of factors must be considered together, including;

1. Proximity of likely sources;
2. Ground conditions (geology, hydrogeology, anthropogenic pathways etc);
3. Properties of gases present including:
   - Chemical composition;
   - Physical properties;
   - Ratios of components e.g. methane : carbon dioxide.
4. Timeframe of activities such as infilling periods, capping works, installation of gas control systems etc.

Identification of the originating source may be problematic given that there may be more than one source present and trace gas analysis may be required. Identification of the sources of the gases encountered during monitoring is usually carried out through a process of eliminating the most unlikely potential sources (given the site setting) and selecting those which are the more likely candidates.

Hazards Associated with Presence of Ground Gases

Methane gas is combustible and potentially explosive. When the concentration of methane in air is between the limits of 5.0%v/v and 15.0%v/v an explosive mixture is formed. The Lower Explosive Limit (LEL) of methane is 5.0%v/v, which is equivalent to 100% LEL. The 15.0%v/v limit is known as the Upper Explosive Limit (UEL), but concentrations above this level cannot be assumed to represent safe concentrations. Further, the LEL and UEL will vary (up and down) depending upon the proportion of other gases (including oxygen). However, the fact that methane is a colourless, odourless gas means that there is no simple indicator of the presence of the gas until such a time as explosive limits are reached and an incident occurs. Methane is lighter than air and has a low toxicity. However, at high concentrations it can result in asphyxiation due to oxygen displacement.

Carbon dioxide is a colourless, odourless gas, which, although non-flammable, is both toxic and an asphyxiant. As carbon dioxide is denser than air, it will collect in low points and depressions. The UK Health & Safety Executive (HSE) has published information relating to concentrations of carbon dioxide that humans may be exposed to, which uses concentrations contained in the Control of Substances Hazardous to Health Regulations 2002 (as amended). These are the Long Term Occupational Exposure Limit (LTOEL, 8 hour period) and the Short Term Occupational Exposure Limit (STOEL, 15 minute period), which are 0.5% and 1.5% carbon dioxide, respectively.

Parameters Influencing the Rate of Ground Gas Production

Figure G2 is taken from EA guidance document LFTGN 03 illustrates typical ground gas generation curves from biodegradable materials:

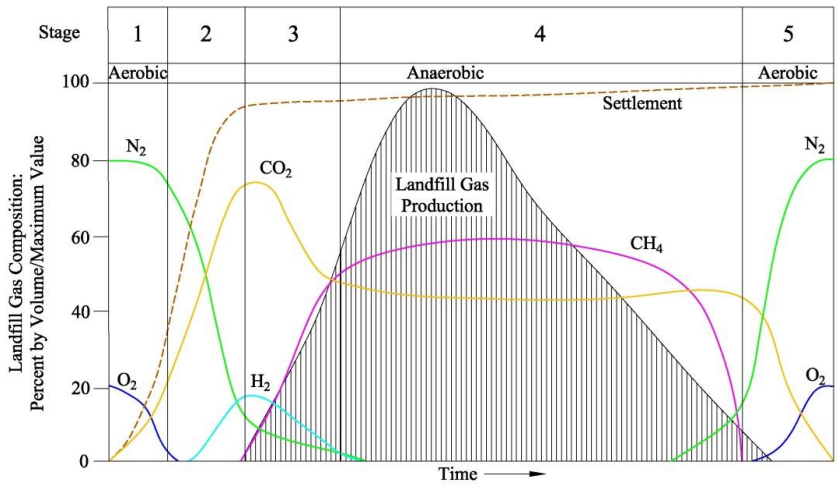


Figure G2. Idealised Representation of Landfill Gas Generation.

The production of methane and carbon dioxide at a landfill site may be expected to be considerable and ongoing. Concentrations of methane will eventually decrease, followed by concentrations of carbon dioxide, but the duration and rate of gas production can vary markedly between sites. Five distinct phases of gas production occur during the process which are, in order of event (as marked on Figure G2), as follows:

1. An aerobic phase involving oxygen depletion and temperature increase through aerobic respiration;
2. The establishment of anaerobic conditions and the evolution of carbon dioxide and hydrogen through acidogenic activity;
3. Commencement of methanogenic activity; the establishment of populations of methanogenic bacteria;
4. A phase of stable methanogenic activity, which may go on for many tens of years;
5. A phase of decreasing methanogenic activity, representing depletion of the organic material and a return to aerobic conditions.

The time scale for the return to the normal ground gas concentrations will be highly variable, depending upon the types and quantities of materials present. In addition, the optimum parameters influencing the rate of decomposition and ground gas production within the ground at a site are as follows:

- High water content with adequate rainfall and water infiltration to provide moisture content between approximately 20 to 26%;
- Conditions that either are or are very close to anaerobic;
- High proportion of biodegradable materials;
- A pH between 6.5 and 8.5, ideally verging slightly on the acidic between pH 6 to 7;
- Temperature between 25°C and 55°C;
- The ratio of the biochemical and chemical oxygen demands (BOD:COD);
- High permeability;
- Small particle size, as finer subsurface materials possess a greater surface area to provide a growing ‘face’ for the micro-organisms but high fines levels reduces permeability and reduces decomposition rate.

For this reason, it is vital that sources of methane and carbon dioxide are identified prior to the commencement of any work on a construction site, and that the ground gas regime is characterised at the worst temporal conditions a site may experience. From this, a risk assessment is carried out to identify the risk at the site from ground gases so that suitable protection measures can be designed and incorporated into a development to prevent a dangerous build-up of gas occurring.

Factors Influencing the Migration and Behaviour of Ground Gases

There are many factors that influence the migration of ground gases which can affect the risk from a gassing source:

- driving force – pressure differential along a pathway, diffusion and dissolved in solution;
- meteorological conditions – short term and seasonal conditions including atmospheric pressure changes (e.g. rapidly falling pressure causes gas to expand increasing emission rates), rainfall, frozen ground and thawing, temperature;
- geological and groundwater conditions – these can have the over-riding influence on the direction/pathways and quantity of migrating gas;
- anthropogenic influences – man-made pathways include mine shafts, service runs/drains, foundation piles, underground voids/pits/basements, foundation/building design/construction

Guidance Documents

Currently in the UK, there are no statutory threshold limits for hazardous gases in the ground as site specific variables mean that standard threshold values cannot be applied. The published guidance relating to development of sites where methane and carbon dioxide are present has been produced in response to building projects on or close to landfill sites, as both gases are principal constituents of landfill

gas. Much of the historic guidance that has been produced on gas risk assessment focused on landfill sites and as a result there has previously been a lack of clarity when relating the process to gas conditions on non-landfill sites.

Statutory guidance regarding methane in the ground has previously taken a limiting concentration of 1.0 % by volume methane (equal to 20% of the lower explosive limit of methane in air) above which necessary actions will be appropriate. For carbon dioxide the limiting recommended trigger was 1.5 % by volume (the Long Term Exposure Limit for carbon dioxide). Above these concentrations the Building Regulations Approved Document C (1992) stated that consideration should be given to whether actions may be appropriate, whilst more specific solutions would be likely to be necessary at concentrations greater than 5% by volume of carbon dioxide (Building Regulations Approved Document C, 1992). However, the latest fully revised version of Approved Document C (DoE, 2004) no longer endorses this approach and instead requires the use of a risk-based approach in interpreting the findings of a gas monitoring survey. Further, the latest EA documentation on landfill gas (LFTGN 03, 2004) continues to sanction the use of a risk-based approach through a structured approach to the assessment of ground gases and links with the risk assessment process outlined within CLR 11 for soil contaminants.

With the above in mind, recent guidance has been produced in 2006 and 2007 with the aim of providing up to date advice in relation to residential and commercial development. The guidance does not address issues associated with gas derived from landfills, for this refer to *"Guidance on the Management of Landfill Gas"* (Environment Agency 2004) for an overview.

Recent guidance relevant to gas assessments for residential and commercial development includes;

- **Wilson *et al.* (CIRIA C665, December 2007) *"Assessing Risks Posed by Hazardous Ground Gases for Buildings."***

  This document provides up to date advice on all aspects of ground gas risk assessment such as investigation, monitoring programmes, data collection and interpretation. The guidance presents separate methodologies for the characterisation of:

  - **All development types except low rise housing with gardens and for Low Rise Buildings without a 150mm void** (Situation A) (Table 8.5 CIRIA C665)

  and;

  - **Low rise housing with gardens with a 150mm ventilated sub-floor void** (Situation B) (Table 8.7 CIRIA C665)
    (See below for further explanation of the methods of characterisation)

- **Boyle and Witherington (NHBC / RSK Group, Report 10627-R01(04) January 2007) *"Guidance on the Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present."***
  This document presents the "Traffic Lights System" detailed below and is relevant only for low rise properties (e.g. bungalows and town houses) that have a ventilated sub-floor void (i.e. Situation B as described in CIRIA C665).

- **Wilson and Card (CIEH, expected 2011) *"Ground Gas Handbook for Designers and Regulators"***
  This document is expected to provide practical guidance on ground gas assessments and the design and evaluation of protection measures.

- **British Standard (BS 8485+A1, January 2019) *"Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings"***
  This document provides an overview of gas characterisation and assessment. The Standard is intended to be used by designers of gas protection measures and regulators involved in the assessment of design solutions. The Standard provides a framework in line with CLR11 allowing designers to judge the adequacy of ground gas and related site investigation data. The document provides an approach to determine appropriate ground gas parameters that can be used to identify a range of possible construction solutions mitigating against the presence of ground gas on a development site.

Each of these documents continues to highlight the importance of, and give further guidance towards, carrying out a tiered risk-based decision-making process in accord with government policy on dealing with contamination from historic or natural sources and highlight the importance of the Conceptual Model in site characterisation. These documents also stress the importance that the assessor should be confident that the ground gas monitoring results are representative of the likely worse case ground gas regime on a site and that the data collected from the site is sufficient. With this in mind, CIRIA C665 sets out ideal monitoring periods as below.

Idealised Frequency and Period of Monitoring (after Table 5.5a and 5.5b, CIRIA C665)

		Generation Potential of Source				
		Very Low	**Low**	**Moderate**	**High**	**Very High**
Sensitivity of Development	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with Gardens)	6/3	9/6	12/6	24/12	24/24

Notes

1. First number is the number of readings and the second is the minimum period in months (e.g. 6/2 – six sets of readings over two months).

2. At least two sets of readings must be at low (preferably under 1,000 mb) and falling pressure.

3. High sensitivity end use on high or very high hazard site will not normally be acceptable unless the source is treated to reduce gassing potential.

Before the latest guidance, good practice for site characterisation had been based upon the method proposed by Wilson and Card (1999). CIRIA C665 (2007) effectively supersedes Wilson and Card (1999) and includes a modified version of the Wilson and Card method (Tables 8.4, 8.5). Gas concentrations and flow rates for either methane and/or carbon dioxide measured at a site to 'Characteristic Situations.' Appropriate protection measures are selected from Table 8.5 (if using modified Wilson & Card method) and from Box 8.4 from CIRIA C665 (if using the NHBC traffic lights method). Throughout the risk assessment process, strong regard must be given to the nature of the gassing source, the flow rates and the estimated surface emissions. Note that certain protection measures are stated in CIRIA Report 149 that are now considered wholly inappropriate to certain developments and consequently should not be used without modification. Throughout the process, it is important to remember that these tables are not intended to be used as a definitive design tool and have been prepared to show the typical scope of measures for gas control.

Both the NHBC (2007) and CIRIA (2007) guidance documents and BS 8485+A1 (2019) propose that both ground gas concentrations and flow rates are used to calculate the limiting gas well gas volume flow rates for methane and carbon dioxide, based on the ground gas conditions monitored for during the worse-case temporal conditions. This limiting gas well volume flow rate is termed the Gas Screening Value (GSV, note that this was termed borehole gas volume flow), and is calculated as follows:

$$\textbf{GSV}\ (\text{l/hr}) = \frac{[\text{gas well gas concentration (\%v/v)}] \times [\text{gas well flow rate (l/hr)}]}{100}$$

These GSVs are then compared to generic 'Traffic Lights' contained within the NHBC guidance, which present typical maximum gas concentrations and limiting GSV's, for 'Situation B Development' (Low rise housing with gardens).

Table 8.7 NHBC Traffic light system for 150 mm void

Traffic Light	Methane [1]		Carbon Dioxide [2]	
	Typical max concentration [3] (% by volume)	Gas Screening Value [2,4] (litres/hour)	Typical max concentration [3] (% by volume)	Gas Screening Value [2,4] (litres/hour)
Green				
	1	0.13	5	0.78
Amber 1				
	5	0.63	10	1.6
Amber 2				
	20	1.60	30	3.10
Red				

Notes:
1. The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter will be the decider as to what Traffic Light is allocated;
2. Borehole Gas Volume Flow Rate, in litres per hour as defined in Wilson and Card (1999), is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered;
3. The Typical Maximum Concentrations can be exceeded in certain circumstances should the Conceptual Site Model indicate it is safe to do so;
4. The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

Box 8.4 of CIRIA C665 Gas protection measures for low-rise housing development based upon allocated NHBC Traffic light (Boyle and Witherington, 2007)

Traffic Light Classification	Protection Measures Required
Green	Negligible gas regime identified and gas protection measures are not considered necessary.
Amber 1	Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.
Amber 2	Intermediate to high gas regime identified, which requires high-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Membranes should always be fitted by a specialist Contractor. As with Amber 1, ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.
Red	High gas regime identified. It is considered that standard residential housing would not normally be acceptable without a further Gas Risk Assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

For a 'Situation A Development' (All development except low rise housing with gardens), the GSV value is used to derive the appropriate Characteristic Situation from Table 8.5 of CIRIA C665 (below):

Table 8.5 from CIRIA C665 Modified Wilson and Card Classification					
Characteristic Situation (CIRIA R149)	**Comparable Partners in Technology gas Regime (see Box 8.2)**	**Risk Classification**	**Gas Screening Value (CH_4 or CO_2) (l/hr)[1]**	**Additional Factors**	**Typical Source of Generation**
1	A	Very low risk	<0.07	Typically methane ≤ 1% and/or carbon dioxide ≤ 5%. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" made ground
2	B	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	C	Moderate risk	<3.5		Old landfill, inert waste, mine working flooded
4	D	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mine working susceptible to flooding, completed landfill (WMP 26B criteria)
5	E	High risk	<70		Mine working unflooded inactive with shallow workings near surface
6	F	Very high risk	>70		Recent landfill site

It was intended in CIRIA C665 that the characteristic situation allocated to the development from the table above would then be used in Table 8.6 of CIRIA C665 in order to determine the level of gas protection the development requires. However, BS8485:2015 superseded this document and a different set of mitigation standards were put forward.

The recommended minimum gas protection score (points) be selected based on the building type (Table 3 which defines four building types) and the ground gas Characteristic Situation as detailed in Table 4 of BS8485:2015+A1:2019 (see below).

The first step in the decision making process is to obtain the level of gas protection necessary in the range 0 to 7.5 from Table 4. Then a combination of structural barriers (Table 5) ventilation protection measures (Table 6) and/or gas resistant membranes (Table 8)should be chosen to meet that requirement. The level of gas protection necessary should take into account the characteristic gas situation and a number of other factors. The whole decision making process should be made transparent, where all parties can see the approach being taken, can understand the various steps and decisions made and be confident that a risk-assessed solution has been designed and installed commensurate with the construction and site constraints.

Where the gas Characteristic Situation is 4 or more (and for NHBC Red situations according to CIRIA C665), the site requires a comprehensive risk assessment to confirm the scope of protection measures. These are higher risk sites and reliance on Table 4 alone is not sufficient.

BS8485:2015+A1:2019 Table 3 Building Types				
	Type A	**Type B**	**Type C**	**Type D**
Ownership	Private	Private or commercial/ public, possible multiple	Commercial / public	Commercial / industrial
Control (change of use, structural alterations, ventilation	None	Some but not all	Full	Full
Room sizes	Small	Small / medium	Small to large	Large industrial / retail park style

BS8485:2015+A1:2019 Table 4 Gas Protection Score by CS and Type of Building				
CS	Required Gas Protection High risk	Medium risk		Low risk
	Type A	Type B	Type C	Type D
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6.5 (A)	5.5(A)	4.5	3.5
5	(B)	6A)	5.5	4.5
6	(B)	(B)	(B)	6

a) Residential building should not be built on CS4 or higher sites unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.

b) The gas hazard is too high for this empirical method to be used to define the gas protection measures

NOTE 3 The NHBC has published guidance for use on residential developments, which utilise an alternative classification ("traffic light") system. This guidance typically applies to Type A buildings utilising beam and block floor constructions with clear void ventilation. The design choice variables are limited to decisions relating to the membrane specification and verification recommendations (see Table 7). Designers utilising this system would therefore need to refer to NHBC to assess compliance for specific recommendations [see 8485:2015 for further on this note]

NOTE4 The method of selecting the combination of these types of protection is given in section 7.2 of BS8485:2015. Once type of measures has been decided, the detailed design and specification of the measures should be undertaken (section 7.3)

Section 7.2 defines the order of selecting protective measures. The first choice is provided by structural barriers as defined in Table 5.

BS8485+A1:2019 Table 5 Gas protection scores for structural barriers		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
Floor and substructure design		
Floor slabs Block and beam floor slab	0	*General – score conditional that breaches of slab are sealed*
Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)	0.5	
Cast in situ monolithic reinforced ground-bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations (with only nominal mesh reinforcement)	1 or 1.5	*To achieve 1.5, raft or suspended slab to be well reinforced to prevent cracking and minimal penetrations*
Basement floor and walls to BS 8102:2009, Grade 2 waterproofing – See notes in BS8485:2015+A1:2019	2	
Basement floor and walls to BS 8102:2009, Grade 3 waterproofing - See notes in BS8485:2015+A1:2019	2.5	*Conditional that waterproofing is not based on geosynthetic clay liner*

Ventilation methods are detailed in Table 6, and points can only be gained from using one of the five types

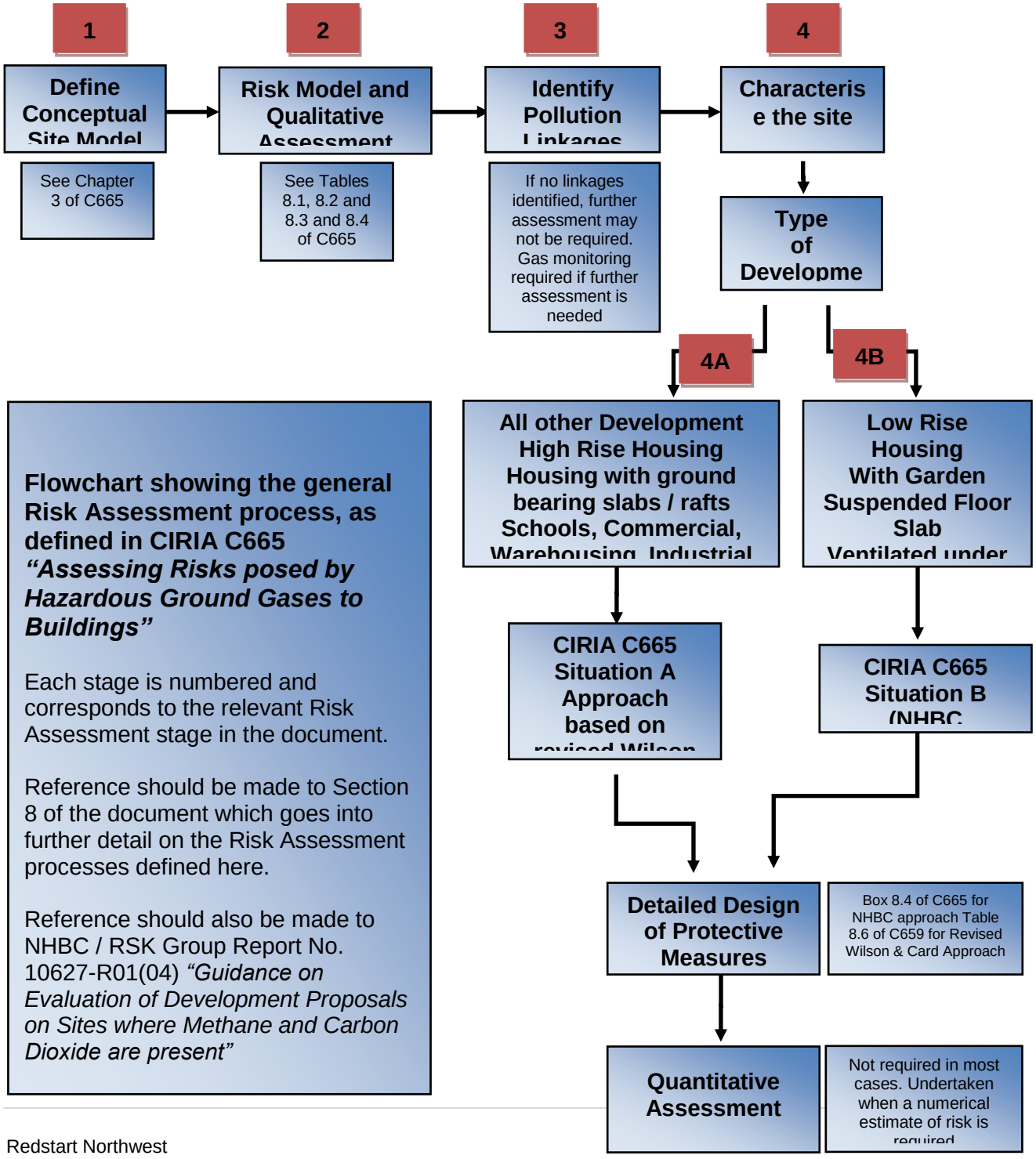
BS8485:2015+A1:2019 Table 6 Gas Protection Scores for Ventilation Protection Measures		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
a) Pressure relief pathway (usually formed by low fines gravel or with a thin geocomposite blanket with strips terminating in a gravel trench external to the building	0.5	*Whenever possible, a pressure pathway relief pathway (as a minimum) should be installed in all gas protection measures systems.* *If a layer has a low permeability and/or is not terminating in a venting trench (or similar), then the score is zero.*
b) Passive sub floor dispersal layer Very good performance Good performance Media used to provide the dispersal layer are: • Clear void • Polystyrene void forming blanket • Geocomposite void former blanket • No-fines gravel layer with gas drains • No-fines gravel layer	 2.5 1.5	*Performance criteria shown in Fig B.6 and B.7 of BS 8484:2015.[See Annex B]*
c) Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution layer, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers	1.5 to 2.5	*This system relies on continued serviceability of the pumps, therefore alarm and response systems should be in place. [See Annex B].*
d) Active positive pressurisation by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket	1.5 to 2.5	*This system relies on continued operation of the pumps, therefore alarm and response systems should be in place. [See Annex B].*
e) Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or under croft)	4	*Assumes car park is vented , designed to Building Regulations 2000, Approved Document F.*

Membrane methods are detailed in Table 7.

BS8485:2015+A1:2019 Table 7 Gas protection score for gas resistant membrane		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
Gas resistant membrane meeting all of the following criteria: • Sufficiently impervious to gases with a methane gas transmission rate <40.0 ml/day/m^2/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method) • Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; • Sufficiently strong to withstand in-service stresses (eg settlement if placed below a floor slab); • Sufficiently strong to withstand the installation process and following trades until covered (eg penetration from steel fibres in fibre reinforced concrete, dropping tools etc); and to withstand in-service stresses (e.g. settlement if placed below a floor slab) • capable, after installation, of providing a complete barrier to the entry of the relevant gas; and • verified in accordance with CIRIA C735	2	*The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints.* *If a membrane is installed that does not meet the criteria, then the score is zero.*
See notes in BS8485:2015+A1:2019 regarding membrane requirements		

For a site which is impacted by migratory gases from an off-source, the development may be protected by imposing pathway intervention methods, which if successfully validated, could also remove the need for further analysis. It is essential that the gas regime in these circumstances has been fully characterised and that the only source impacting the site is located off site and that the pathway is clearly defined and its interception equally proven before construction commences. Pathway intervention methods may include vertical membrane installations, venting trenches, rows of stone columns, activated trenches and various proprietary systems. These systems are particularly relevant to domestic housing where there is limited scope for foundation type solutions.

Following the choice of protection measures, detailed design should be entered into [Section 8 of BS 8485:2015+A1:2019].



Flowchart showing the general Risk Assessment process, as defined in CIRIA C665 *"Assessing Risks posed by Hazardous Ground Gases to Buildings"*

Each stage is numbered and corresponds to the relevant Risk Assessment stage in the document.

Reference should be made to Section 8 of the document which goes into further detail on the Risk Assessment processes defined here.

Reference should also be made to NHBC / RSK Group Report No. 10627-R01(04) *"Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are present"*

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END OF REPORT