



Phase II Ground Investigation Report

at

Land south of Burndell Road, Yapton, West Sussex BN18 0HR

for

Crayfern Homes Limited

Reference: 16707/GIR

January 2018

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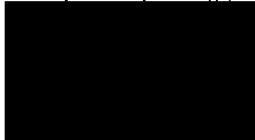
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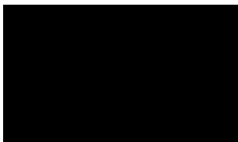
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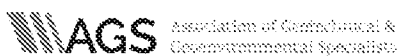
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Current regulations and good practice were used in the preparation of this report. The recommendations given in this report must be reviewed by an appropriately qualified person at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.



Commission

Soils Limited was commissioned by Crayfern Homes Limited to undertake a Phase II Ground Investigation on land south of Burndell Road, Yapton, West Sussex BN18 0HR. The scope of the investigation was outlined in the Soils Limited quotation reference Q19547, dated 3rd January 2018.

This document comprises the Phase II Ground Investigation Report and incorporates the results, discussion and conclusions to this intrusive works.

This Phase II report must be read in conjunction with the Phase I Desk Study undertaken on the above site by Soils Limited, Report ref: 16707/DS, dated December 2014.

Standards

The site works, soil descriptions and geotechnical testing was undertaken in accordance with the following standards:

- BS 5930:2015 and BS EN ISO 22476-2 2005+A1:2011 for WS/DP
- BS EN 1997-1:2004+A1:2013 Eurocode 7. Geotechnical design
- BS EN ISO 14688-1:2002+A1:2013 - Geotechnical investigation and testing - Identification and description
- BS EN ISO 14688-2:2004+A1:2013 - Geotechnical investigation and testing - Principles for a classification
- BS 10175:2011+A1:2013 - Investigation of potentially contaminated sites

The geotechnical laboratory testing was performed by GEO Site & Testing Services Ltd (GSTL) in accordance with the methods given in BS 1377:1990 Parts 1 to 8 and their UKAS accredited test methods.

For the preparation of this report, the relevant BS code of practice was adopted for the geotechnical laboratory testing technical specifications, in the absence of the relevant Eurocode specifications (ref: ISO TS 17892).

The chemical analyses were undertaken by QTS Environmental Limited in accordance with their UKAS and MCERTS accredited test methods or their documented in-house testing procedures. This investigation did not comprise an environmental audit of the site or its environs.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sample borehole implies the specific technique used to produce a trial hole.

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Section I Introduction

I.1 Objective of Investigation

Soils Limited was commissioned by Crayfern Homes Limited to undertake a Phase II Ground Investigation to supply the client and their designers with information regarding ground conditions, to assist in preparing a foundation scheme for development that was appropriate to the settings present on the site.

The investigation was to be undertaken to provide comment on appropriate foundation options for the proposed residential development. The investigation was to be made by means of in-situ testing and geotechnical laboratory testing undertaken on soil samples taken from the trial holes.

Soil samples were taken for chemical laboratory testing to enable recommendations for the safe redevelopment of the site and the protection of site workers, end-users and the public from any contamination identified as dictated by the Conceptual Site Model (CSM) in the Phase I Desk Study undertaken for the site by Soils Limited (Report ref: 16707/DS, January 2018) and/or the Revised Conceptual Site Model presented in Appendix D.1.

I.2 Location

The site was located at Land south of Burndell Road, Yapton, West Sussex BN18 0HR and had an approximate O.S Land Ranger Grid Reference of SU 985 028.

The site location plan is given in Figure 1.

I.3 Site Description

At the time of reporting, January 2018, the site comprised an open grassed field. No structures were present on site. The site was generally flat and level. The site was bounded to the west and south by agricultural land, separated from the site by semi-mature to mature trees and hedgerows, with a hedgerow to the eastern boundary. Residential buildings and Burndell Road bounded the site to the north.

An aerial photograph has been included in Figure 2.

I.4 Proposed Development

At the time of writing, the proposed development was understood to comprise 45 residential plots, both detached and semi-detached, with 14 double and 5 single garages. The development comprised soft landscaping, in the form of private gardens and public open space, and hard landscaping such as access roads, parking spaces and driveways.

In compiling this report reliance was placed on drawing number 10-1016-002 B, Dated

December 2017 which was prepared by Mildren Homes. Any change or deviation from the scheme outlined in the drawing could invalidate the foundation design and remediation recommendations presented within this report. Soils Limited must be notified about any such changes.

Development plans provided by the client are presented in Appendix E.

1.5 Anticipated Geology

The 1:50,000 BGS map showed the site to be located upon the bedrock White Chalk Subgroup with overlying superficial deposits of River Terrace Deposits (Undifferentiated).

1.5.1 River Terrace Deposits (Undifferentiated)

River Terrace Deposits are superficial deposits of Quaternary age that lie along the margins of rivers and are predominantly found in the southern part of West Sussex, along the coastal plain and are typically less than 10m thick. The composition of the River Terrace Deposits varies greatly, depending on the source material available in the river's catchment. Deposits generally consist of sands and gravels of roughly bedded flint or chert gravels commonly in a matrix of silts and clays. In West Sussex the rivers flow mainly south over the Weald Clay, which contains some sandstones and limestone that could be incorporated into the river gravel. The 1:50,000 BGS map described the River Terrace Deposits in the region of the site to comprise sand, silt and clay.

1.5.2 White Chalk Subgroup

The White Chalk Subgroup is the parent unit of the chalk formations shown to be present on site by the 1:50,000 BGS Map (The Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation (Undifferentiated)). The name "White Chalk Subgroup" has been adopted as a simplification. The White Chalk Subgroup is described within the BGS Lexicon as chalk with flints, with discrete marl seams, nodular chalk, and flint seams throughout. The White Chalk Subgroup is referred to as sponge-rich.

Occasional erosional features, such as pipes, swallow holes and solution cavities, usually in-filled with drift deposits, are found in the chalk within this area. These features sometimes manifest themselves at the surface, as shallow circular depressions.

1.6 Limitations and Disclaimers

This Phase II Ground Investigation Report relates to the site located at Land south of Burndell Road, Yapton, West Sussex BN18 0HR and was prepared for the sole benefit of Crayfern Homes Limited (The "Client"). The report was prepared solely for the brief described in Section 1.1 of this report.

Soils Limited disclaims any responsibility to the Client and others in respect of any matters outside the scope of the above.

This report has been prepared by Soils Limited, with all reasonable skill, care and diligence within the terms of the Contract with the Client, incorporation of our General Conditions of Contract of Business and taking into account the resources devoted to us by agreement with the Client.

The report is personal and confidential to the Client and Soils Limited accept no responsibility of whatever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report wholly at its own risk.

The Client may not assign the benefit of the report or any part to any third party without the written consent of Soils Limited.

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief. As such these do not necessarily address all aspects of ground behaviour at the site.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot by plot basis prior to the construction of foundations. Supplied site surveys may not include substantial shrubs or bushes and is also unlikely to have data on any trees, bushes or shrubs removed prior to or following the site survey.

Where trees are mentioned in the text this means existing trees, substantial bushes or shrubs, recently removed trees (approximately 20 years to full recovery on cohesive soils) and those planned as part of the site landscaping).

Ownership of land brings with it onerous legal liabilities in respect of harm to the environment. "Contaminated Land" is defined in Section 57 of the Environment Act 1995 as:

"Land which is in such a condition by reason of substances in, on or under the land that significant harm is being caused or that there is a significant possibility of such harm"

being caused or that pollution of controlled waters is being, or is likely to be caused”.

The investigation, analysis or recommendations in respect of contamination are made solely in respect of the prevention of harm to vulnerable receptors, using where possible best practice at the date of preparation of the report. The investigation and report do not address, define or make recommendations in respect of environmental liabilities. A separate environmental audit and liaison with statutory authorities is required to address these issues.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets remains with Soils Limited. License is for the sole use of the client and may not be assigned, transferred or given to a third party

Section 2 Site Works

2.1 Proposed Project Works

The proposed intrusive investigation was designed to provide information on the ground conditions and to aid the design of foundations for the proposed residential development. The intended investigation, as outlined within the Soils Limited quotation (Q19547, dated 3rd January 2018), was therefore to comprise the following items:

- 4No. 5m deep windowless sampler boreholes;
- 4No. 6m deep dynamic probes;
- Geotechnical laboratory testing;
- Contamination laboratory testing.

2.1.1 Actual Project Works

The actual project works were undertaken on 9th January 2018 and comprised:

- 4No. windowless sampler boreholes;
- 5No. super heavy dynamic probes;
- Geotechnical laboratory testing;
- Contamination laboratory testing;

In addition, five Dynamic Cone Penetrometer tests were completed on the 17th January 2018 for the purposes of informing the road pavement design.

Three windowless sampler boreholes (WS101 – WS103) were backfilled with gravel and bentonite. WS104 collapsed to 2.60m bgl and was backfilled with gravel and bentonite to ground level. All trial hole locations have been presented in Figure 3.

Following completion of site works, soil cores were logged and sub sampled so that samples could be sent to the laboratory for both contamination and geotechnical testing.

2.1.2 Previous Project Works

Soils Limited have previously attended the project site on behalf of another client in order to carry out a factual Ground Investigation. The aim of the investigation was to assist in preparing a drainage scheme. The project works were undertaken on 6th November 2015 and comprised:

- 3No. windowless sampler boreholes (WS1 – WS3);
- 3No. groundwater monitoring wells;
- 6No. machine excavated trial pits (TP1 – TP6);
- Infiltration testing (BRE DG365) within TP1 – TP4.

The three windowless sampler boreholes were backfilled with gravel and bentonite following the installation of groundwater monitoring wells. No laboratory or dynamic probe testing was carried out at this time, as it did not form part of the scope of the investigation.

2.2 Ground Conditions

On 9th January 2018, four windowless sampler boreholes (WS101 – WS104) were drilled, using a Premier 110 Compact drilling rig, to depths ranging between 4.00 and 5.00m below ground level (bgl) at locations selected by Soils Limited using a development plan provided by the client.

Four dynamic probes, super heavy, (DP101 – DP104) were driven prior and adjacent to their corresponding windowless sampler borehole to depths of 6.00m bgl. An additional dynamic probe test, DP105, was requested by the client on site, to investigate the ground conditions at depth. DP105 was driven to 11.00m bgl. The maximum depths of trial holes have been included in Table 2.1.

All trial holes were scanned with a Cable Avoidance Tool (C.A.T.) and GENNY prior to excavation to ensure the health and safety of the operatives.

Table 2.1 Final Depth of Trial Holes

Trial Hole	Depth (m bgl)	Probe Hole	Depth (m bgl)
WSI01	5.00	DPI01	6.00
WSI02	5.00	DPI02	6.00
WSI03	4.20	DPI03	6.00
WSI04	4.00	DPI04	6.00
		DPI05	11.00

The approximate trial hole locations are shown on Figure 3.

The soil conditions encountered were recorded and soil sampling commensurate with the purposes of the investigation was carried out. The depths given on the trial hole logs and quoted in this report were measured from ground level.

The soils encountered from immediately below ground surface have been described in the following manner. Where the soil incorporated an organic content such as either decomposing leaf litter or roots, or has been identified as part of the in-situ weathering profile, it has been described as Topsoil both on the logs and within this report. Where man has clearly either placed the soil, or the composition altered, with say greater than an estimated 5% of a non-natural constituent, it has been referred to as Made Ground both on the log and within this report.

For more complete information about the soils encountered within the general area of the site reference should be made to the detailed records given within Appendix A, but for

the purposes of discussion, the succession of conditions encountered in the trial holes in descending order can be summarised as:

Topsoil (TS)
River Terrace Deposits (Undifferentiated) (RTD)
White Chalk Subgroup (WCSG)

The ground conditions encountered in the trial holes are summarised in Table 2.2.

Table 2.2 Ground Conditions

Strata	Epoch	Depth Encountered (m bgl)		Typical Thickness (m)	Typical Description
		Top	Bottom		
TS	Anthropocene	0.00	0.45–0.55	0.55	Soft dark brown sandy silty to very silty CLAY.
RTD	Quaternary	0.45–0.55	2.5 –4.25	3.50	Soft orangish brown sandy silty, occasionally gravelly CLAY. Occasional fine roots and rootlets.
WCSG	Cretaceous	2.50–4.25	4.20 ¹ –5.00 ^{1 2}	1.70	Off-white to yellowish white weathered and structureless CHALK. Recovered as fine to medium sub-angular blocks in a clayey silty matrix. Occasional patches of clay. Frequent fine to coarse angular flint gravel.

Note: ¹ Final depth of trial hole. ² Base of strata not encountered

2.3 Ground Conditions Encountered in Trial Holes

The ground conditions encountered in trial holes have been described below in descending order. The engineering logs are presented in Appendix A.1.

2.3.1 Topsoil

Soils described as Topsoil were encountered in all four trial holes (WS101 – WS104) from ground level to depths ranging between 0.45 and 0.55m bgl.

The Topsoil comprised soft dark brown sandy silty to very silty CLAY with frequent fine to medium roots and rootlets.

The depth of Topsoil has been included in Table 2.3.

Table 2.3 Final Depth of Topsoil

Trial Hole	Depth (m bgl)
WS101	0.45
WS102	0.50

Trial Hole	Depth (m bgl)
WSI03	0.55
WSI04	0.55

2.3.2 River Terrace Deposits (Undifferentiated)

The River Terrace Deposits (Undifferentiated) were encountered in all four trial holes underlying the Topsoil, to depths ranging between 2.50 and 4.25m bgl.

The River Terrace Deposits (Undifferentiated) comprised soft orangish brown sandy silty, occasionally gravelly CLAY with occasional fine roots and rootlets.

The depth of River Terrace Deposits (Undifferentiated) has been included in Table 2.4.

Table 2.4 Final Depth of River Terrace Deposits (Undifferentiated)

Trial Hole	Depth (m bgl)
WSI01	4.25
WSI02	3.20
WSI03	2.50
WSI04	4.00 ¹
Note: ¹ Final depth of trial hole	

2.3.3 White Chalk Subgroup

Soils described as the White Chalk Subgroup were encountered in three of the four trial holes (WSI01 – WSI03) directly underlying the River Terrace Deposits.

The soils of the White Chalk Subgroup were described as off-white to yellowish white weathered and structureless CHALK. Recovered as fine to medium sub-angular blocks in a clayey silty matrix with occasional patches of clay. Frequent fine to coarse angular flint gravel was present.

The depth of White Chalk Subgroup has been included in Table 2.5.

Table 2.5 Final Depth of White Chalk Subgroup

Trial Hole	Depth (m bgl)	Trial Hole	Depth (m bgl)
WSI01	5.00 ¹	DPI02	6.00 ¹
WSI02	5.00 ¹	DPI03	6.00 ¹
WSI03	4.20 ¹	DPI04	6.00 ¹
DPI01	6.00 ¹	DPI05	11.00 ¹
Note: ¹ Final depth of trial hole.			

2.4 Roots

Roots were encountered in all four of the trial holes at depths ranging between 2.20 and 2.45m bgl. The depths of root penetration have been included in Table 2.6.

Table 2.6 Depth of Root Penetration

Trial Hole	Depth (m bgl)
WSI01	2.30
WSI02	2.20
WSI03	2.45
WSI04	2.20

Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs, for example near to site boundaries where semi-mature to mature trees and hedgerows were noted.

It must be emphasised that the probability of determining the maximum depth of roots from a narrow diameter borehole is low. A direct observation such as from within a trial pit is necessary to gain a better indication of the maximum root depth.

2.5 Groundwater

Groundwater was struck within all four trial holes at depths of between 2.00 and 2.60m bgl. Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in January (2018), when groundwater levels should be rising to their annual maximum (high) elevation, which typically occurs around March. The depths of groundwater strikes are presented within Table 2.7.

Groundwater monitoring was conducted within three standpipes installed on site as part of a previous investigation carried out by Soils Limited on behalf of others. Monitoring data from this report is available upon request.

Table 2.7 Groundwater Monitoring

Trial Hole	Depth to Water (m bgl)	
	Struck	Standing
WSI01	2.10	2.00
WSI02	2.00	2.00
WSI03	2.00	2.00
WSI04	2.60	2.60

Groundwater equilibrium conditions may only be conclusively established if a series of observations are made via groundwater monitoring wells.

Section 3 Discussion of Geotechnical In-Situ and Laboratory Testing

3.1 Dynamic Probe Tests

Dynamic probing (DPSH) was undertaken at five locations (DP101 to DP105) adjacent and prior to the drilling of WS101 – WS104; DP105 was requested by the client on site. Dynamic Probes were driven to depths of 6.00m bgl, with DP105 being progressed to 11.00m bgl to provide indicative information for a preliminary pile design.

The SPT “N60” values presented have been corrected in accordance with BS EN 22476 Part 3, to account for the rig efficiency, borehole depth, overburden factors etc. Further correction of the ‘N’ values should therefore not be necessary. Raw field data is archived within the Soils Limited project file and can be provided on request.

The results were converted to equivalent SPT “N60” values based on dynamic energy using commercial computer software (Geostru). The results were then interpreted based on the classifications outlined in Appendix B.1, Table B.1.1 to Table B.1.3.

The River Terrace Deposits (Undifferentiated) recorded equivalent SPT “N60” values between 0 and 25. This classifies the cohesive soils as very low to high strength, with inferred undrained cohesive strength of 0kPa to 125kPa. It should be noted that an equivalent “N60” value of 25 was only noted in DP101, at a depth of 4.20m bgl.

The soils of the River Terrace Deposits (Undifferentiated) were described as a gravelly fine to coarse sand between 1.65 and 3.60m bgl within WS104 only. This granular horizon was classified by dynamic probe testing to be very loose to medium dense relative density, having equivalent SPT “N60” values of between 0 and 21.

The White Chalk Subgroup recorded equivalent SPT “N60” values between 8 and 95. The White Chalk Subgroup was therefore classified as Structureless (Dc) to Structured Chalk (C5 – A1), based on the paper by T.R.M Wakeling correlating CIRIA C574 chalk classification to SPT “N60” value.

A full interpretation of the DPSH tests are outlined in Appendix B.2, Table B.2.1.

3.2 Dynamic Cone Penetrometer Tests

The Transport Research Laboratory (TRL), Dynamic Cone Penetrometer (DCP) was undertaken at five locations (DCP1 – DCP5). The results were interpreted based on the classification outlined in Appendix B.1.

The results from DCP testing indicated CBR values of between 2% and 11% for the soils encountered in the top 1.00m bgl.

The DCP results are presented in Appendix B.3.

3.3 Infiltration Testing from Previous Investigation

Infiltration testing was undertaken in four trial pits as part of the original site investigation carried out by Soils Limited in 2015, in order to provide guidance on the suitability of the ground for the adoption of a surface water drainage system.

The rates calculated varied between 2.49×10^{-4} m/sec and 2.56×10^{-6} m/sec. The infiltration in one of the trial pits was too slow to calculate, whereas the rate of 2.49×10^{-4} m/sec was attributed to the underlying Chalk formation. Based upon the recent dynamic probe tests, it is considered likely that the rapid infiltration was due to the soft spot encountered at the top of the chalk.

As a result of the potential for solution features such as pipes, swallow holes and solution cavities underlying the site, it is recommended that off-site disposal or deep borehole soakaways be utilised as a surface water disposal method.

3.4 Atterberg Limit Tests

Atterberg Limit tests were performed on five samples obtained from the cohesive part of the River Terrace Deposits (Undifferentiated). The results were classified in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

The cohesive soils of the River Terrace Deposits (Undifferentiated) were classified as having low to medium volume change potential in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

A full interpretation of the Atterberg Limit tests are outlined in Table B.2.2, Appendix B.2 and the laboratory report in Appendix B.3.

3.5 Sulphate and pH Tests

Two samples were taken from the River Terrace Deposits (Undifferentiated) (WS101:2.00 and WS104:1.50m bgl) and one from the White Chalk Subgroup (WS103:2.55m bgl) for water soluble sulphate (2:1) and pH testing in accordance with Building Research Establishment Special Digest 1, 2005, 'Concrete in Aggressive Ground'.

The tests recorded water soluble sulphate between <10mg/l (the detection limit of the test equipment) and 30mg/l with pH values of 7.2 to 8.3.

The significance of the sulphate and pH Test results are discussed in Section 4.4 and the laboratory report in Appendix B.3.

Section 4 Foundation Design

4.1 General

An engineering appraisal of the soil types encountered during the site investigation and likely to be encountered during the redevelopment of this site is presented. Soil descriptions are based on analysis of disturbed samples taken from the trial holes.

4.1.1 Topsoil

The BSI Code of Practice for Foundations, BS8004: 1986, Clause 2.2.2.3.4 Peat and organic soils, includes the caveat that 'all these soils are highly compressible, and even lightly loaded foundations will be subject to considerable settlements over a long period if placed on them. For this reason, these soils are not suitable for carrying the loads for important structures'.

Soils described as Topsoil were encountered in all four trial holes (WS101 – WS104) from ground level to depths of between 0.45 and 0.55m bgl. The Topsoil comprised soft dark brown sandy silty to very silty CLAY with frequent fine to medium roots and rootlets. Sand was fine. The depth of Topsoil has been included in Table 2.3.

A result of the inherent variability, particularly of uncontrolled Topsoil is that it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should therefore be taken through any Topsoil and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

4.1.2 River Terrace Deposits (Undifferentiated)

Soils described as River Terrace Deposits (Undifferentiated) were encountered in all four trial holes directly below the Topsoil and persisted to depths ranging between 2.50 and 4.25m bgl. The River Terrace Deposits (Undifferentiated) typically comprised soft orangish brown sandy silty, occasionally gravelly CLAY with occasional fine roots and rootlets. Sand was fine, gravel was fine to medium angular flint.

The results from DPSH testing inferred that the cohesive soils of the River Terrace Deposits (Undifferentiated) were of a **very low to high strength**, with undrained cohesions of between **0kPa and 125kPa**. High strength was only encountered in one location; in general the cohesive soils of the River Terrace Deposits (Undifferentiated) were of a **very low to low strength**.

The results from Atterberg Limits tests confirmed that the soils of the River Terrace Deposits (Undifferentiated) had **low to medium volume change potential** in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

Soils of the River Terrace Deposits (Undifferentiated) are normally consolidated

and are expected to display low bearing capacities with moderate to high settlement characteristics. The soils of the River Terrace Deposits (Undifferentiated) were not considered suitable for the proposed development due to persistent low strengths across the site, as well as the high settlement potential associated with areas of 0 blow counts at the interface between the River Terrace Deposits (Undifferentiated) and the White Chalk Subgroup.

4.1.3 White Chalk Subgroup

Soils described as the White Chalk Subgroup were encountered underlying the River Terrace Deposits (Undifferentiated) from 2.50m to 4.25m bgl and persisted to the full investigatory depth of 11.00m bgl. The chalk was recovered as structureless CHALK composed of fine to medium sub-angular blocks in a clayey silty matrix. Occasional patches of clay and frequent fine to coarse angular flint gravel.

The results from the dynamic probing inferred that the White Chalk Subgroup was typically **Structureless Dc to Structured (C5 – A1) Chalk**.

Chalk is a weak rock and as such the sampling process will affect the fabric and structure of the soil. In consequence the descriptions from windowless sampler boreholes are not in accordance with CIRIA C574 and are not representative of in-situ chalk. Generally, soils of the White Chalk Subgroup are structureless to weak rock.

4.1.4 Roots

Roots were encountered in all of the four trial holes at depths ranging between 2.20m bgl and 2.45m bgl. Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs, for example near the site boundaries where semi-mature to mature trees and hedgerows were observed.

4.1.5 Groundwater

Groundwater was encountered within all four trial holes and was struck at depths of between 2.00 and 2.60m bgl. Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in January 2018, when groundwater levels should be rising to their annual maximum (highest) elevation, which typically occurs around March.

Groundwater monitoring was conducted within the standpipes installed on site as part of site works completed by Soils Limited on behalf of others. The groundwater monitoring data is available within the Soils Limited Phase II Ground Investigation Report, reference 15276/GIR, which is available on request.

4.2 Foundation Scheme General

At the time of reporting, January 2018, the proposed development was understood to comprise 45 residential plots, both detached and semi-detached, with 14 double and five

single garages. The development comprised soft landscaping, in the form of private gardens and public open space, and hard landscaping such as access roads, parking spaces and driveways.

In compiling this report reliance was placed on drawing number 10-1016-002 B, Dated December 2017 which was prepared by Mildren Homes. Any change or deviation from the scheme outlined in the drawing could invalidate the foundation design and remediation recommendations presented within this report. Soils Limited must be notified about any such changes.

Development plans provided by the client are presented in Appendix E.

4.2.1 Guidance on Shrinkable Soils

The Building Research Establishment (BRE) Digests 240, 241 and 242 provide guidance on 'best practice' for the design and construction of foundations on shrinkable soils.

The results from Atterberg Limits Tests showed that the River Terrace Deposits (Undifferentiated) had **low to medium volume change potential** in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

Medium volume change potential must therefore be adopted where foundations pass through the River Terrace Deposits (Undifferentiated).

The BRE Digest 241 states: "An increasingly common, potentially damaging situation is where trees or hedges have been cut down prior to building. The subsequent long-term swelling of the zone of clay desiccated by the roots, as moisture slowly returns to the ground, can be substantial. The rate at which the ground recovers is very difficult to predict and if there is any doubt that recovery is complete then bored pile foundations with suspended beams and floors should be used".

The stated intention of the NHBC is to ensure that shrinkage and swelling of plastic soils does not adversely affect the structural integrity of foundations to such a degree that remedial works would be required to restore the serviceability of the building. It must be borne in mind that adherence to the NHBC tables and design recommendations may not, in all cases, totally prevent foundation movement and cracking of brickwork might occur.

The BRE Digest 240 suggests: "*Two courses of action are open:*

Estimate the potential for swelling or shrinkage and try to avoid large changes in the water content, for example by not planting trees near the foundations.

Accept that swelling or shrinkage will occur and take account of it. The foundations can be designed to resist resulting ground movements or the superstructure can be

designed to accommodate movement without damage.”

The design of foundations suitable to withstand movements is presented in BRE Digest 241 “Low-rise buildings on shrinkable clay soils: Part 2”.

4.3 Foundation Scheme

Foundations **must not** be constructed within any Topsoil and River Terrace Deposits (Undifferentiated) due to the likely variability and potential for large load induced settlements both total and differential.

Roots were encountered in all of the four trial holes at depths ranging between 2.20m bgl and 2.45m bgl. If roots are encountered during the construction phase foundations **must not be placed within any live root penetrated** or desiccated **cohesive soils or those with a volume change potential**. Should the foundation excavations reveal such materials, the excavations **must** be extended to greater depth in order to bypass these unsuitable soils. Excavations must be checked by a suitable person prior to concrete being poured.

Preliminary calculations for shallow foundation design were carried out in order to assess the feasibility of adopting shallow foundations, however these yielded very low bearing capacities of 30kPa.

Considering the low achievable bearing capacities and the thickness of very low to low strength River Terrace Deposits (Undifferentiated) encountered across the site, a shallow foundation solution was not considered suitable for the development. Therefore, a piled foundation with piles taken through the River Terrace Deposits and into the chalk are considered the most appropriate for this development.

4.3.1 Piled Foundations

If adopted, the piled foundations must be taken through any Topsoil and River Terrace Deposits (Undifferentiated) into suitable strength soils of the White Chalk Subgroup.

The construction of a piled foundation is a specialist job with the actual pile working load depending on the particular type of pile and installation method. Prior to finalising the foundation design the advice from a reputable contractor who is familiar with the ground and groundwater conditions present at the site should be sought.

The preliminary load capacities are provided for varying diameters and lengths of bored piles taken into the White Chalk Subgroup, based on SPT “N60” values and must only be used for preliminary design purposes. A factor of safety of 1.5 was applied to the shaft, with a factor of safety of ten applied to the base, and depicted by the design line outlined in Appendix C.1.

As the preliminary pile design is based on a single 11m deep dynamic probe test, it is recommended that further site investigation is undertaken, in the form of cable percussive boreholes to retrieve samples and carry out in-situ geotechnical tests to inform a more rigorous pile design.

The bearing values given in Appendix C.1. are applicable to single piles. Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of about 0.8 and a calculation made to check the factor of safety against block failure.

From ground level the upper 4m of the pile shaft has been ignored in the preliminary pile design given.

To prevent necking of the green concrete, temporary casing will be required where the pile passes through the River Terrace Deposits or White Chalk Subgroup and below the groundwater table. To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

No allowance has been made for negative skin friction that could be generated where piles pass through the Topsoil and River Terrace Deposits (Undifferentiated) deposits underlying the site. The negative skin friction must be applied to the pile working load and must not be factored.

4.4 Subsurface Concrete

Sulphate concentration measured in 2:1 water/soil extracts fell into Class **DS-1** of the BRE Special Digest 1 2005, *'Concrete in Aggressive Ground'*. Table C2 of the Digest indicated ACEC (Aggressive Chemical Environment for Concrete) site classifications of **AC-1**. The pH of the soils tested ranged between 7.2 and 8.3. The classification given was determined using the mobile groundwater case, in the view of groundwater being encountered. The laboratory results are presented in Appendix B.3.

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1 2005, *'Concrete in Aggressive Ground'* taking into account any possible exposure of potentially pyrite bearing natural ground and the pH of the soils.

4.5 Excavations

Shallow excavations in the Topsoil and River Terrace Deposits (Undifferentiated) are likely to be marginally stable in the short term at best.

Deeper excavations taken into the White Chalk Subgroup are unlikely to be stable in the short term, due to the thickness of overlying River Terrace Deposits (Undifferentiated) and the shallow groundwater encountered during the site investigation. Unsupported earth faces formed during excavation may be liable to collapse without warning and

suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported or battered back to a safe angle of repose before excavations are entered by personnel.

Excavations beneath the groundwater table are likely to be unstable and dewatering of foundation trenches may be necessary.

4.6 Pavements

The Transport Research Laboratory (TRL) Dynamic Cone Penetrometer (DCP) was undertaken at five locations on site (DCP101 – DCP105). The results from dynamic cone penetrometer tests indicated **CBR values of between 2% and 11%** for the soils encountered in the top 1.00m bgl.

When removing 500mm Topsoil the worst case CBR value was 3% which was considered suitable for design purposes for the majority of the road layout, provided that traffic is anticipated to be light, and pavements are lightly loaded.

As CBR values were highly variable due to changes in moisture content and ground conditions, **in-situ testing must be undertaken** immediately prior to the installation of pavements/roads. Prior to construction the formation level should be proof rolled. The soils of the River Terrace Deposits would not be anticipated to be frost susceptible, based on the plasticity index of a sample taken from WS104 at 0.80m bgl. The Atterberg Limits tests on samples taken from other locations were not considered in terms of frost susceptibility as the sample depths were greater than that which would be affected by frost.

4.7 Soakaways

Infiltration testing was carried out at the site as part of previous investigation by Soils Limited on behalf of others. The results of the infiltration testing are presented in the Phase II Ground Investigation report reference 15276/GIR, dated April 2016.

Indicative infiltration rates varied between 2.49×10^{-4} and 2.56×10^{-6} m/sec. Infiltration in one of the trial pits tested was too slow to calculate, and the rate of 2.49×10^{-4} m/sec was attributed to the soft spot encountered at the top of the chalk, where the dynamic probing recorded low blow counts.

Occasional erosional features, such as pipes, swallow holes and solution cavities, usually in-filled with drift deposits, are found in the chalk within this area. These features sometimes manifest themselves at the surface as shallow circular depressions.

Dissolution features can form due to man-made features such as deneholes. These features can then be reactivated or caused to collapse by the concentrated ingress of water from leaking drains or soakaways.

In line with current guidance (BRE Digest 365, NHBC and CIRIA C574) soakaways should be located remote from the proposed foundations, ideally greater than 20m away from the face of any existing or proposed footing.

In respect to the control of drainage CIRIA C574, Engineering in Chalk; 2002 states;

- “Concentrated ingress of water into the chalk can initiate new dissolution features, particularly in low-density chalk, and destabilise the loose backfill of existing ones. For this reason, any soakaways should be sited well away from foundations for structures, roads or railways, as indicated below:
- In areas where dissolution features are known to be prevalent, soakaways should be avoided if at all possible but, if unavoidable, should be sited at least 20m away from any foundations;
- Where the chalk is of low density, or its density is not known, soakaways should be sited at least 10m away from any foundations;
- Where the chalk is of medium density (or higher), the closest part of the soakaway should be at least 5m away from any foundations.
- For drainage systems, flexible jointed pipes should be used wherever possible; particular care should be taken for the avoidance of leaks in both water supply and drainage pipework.

As the Chalk is a vitally important aquifer, the Environment Agency and local authority must be consulted when planning soakaway installations where chalk lies below the site even where it is mantled with superficial deposits.

Consultation with the Environment Agency must be sought regarding any use which may have an impact on groundwater resources.

Section 5 Determination of Chemical Analysis

5.1 Site Characterisation and Revised Conceptual Site Model

The Phase I Desk Study undertaken by Soils Limited (report ref: 16707/DS dated January 2018) identified a very low to low risk of ground contamination from previous usage of the site and offsite sources.

Superficial deposits of River Terrace Deposits (Undifferentiated) were encountered underlying the Topsoil. Shallow groundwater was encountered within the River Terrace Deposits (Undifferentiated) between 2.00 and 2.60m bgl. The conceptual site model was updated to take account of the shallow groundwater encountered at the site and presented in Appendix D.1.

5.2 Soil Sampling

A non-targeted sampling strategy is appropriate when there is:

- No adequate information available regarding the likely locations of contamination;
- No sensitive areas where there is a need for a high degree of confidence.

A targeted sampling strategy is appropriate when there is:

- Adequate information available regarding the likely locations of contamination
- Sensitive areas where there is a need for a high degree of confidence.

The CSM identified potential sources and a targeted sampling pattern was adopted as appropriate to these sources. Table 5.1 outlines the sampling undertaken.

Table 5.1 Sampling Strategy

Sample	Strategy	Proposed Use
WSI01:0.20	Very low risk of pesticides and herbicides from crop farming on site	Residential garden
WSI01:0.50	To verify that the natural soils were free of contamination	Residential garden
WSI02:0.20	Very low risk of pesticides and herbicides from crop farming on site	Residential garden
WSI02:0.60	To verify that the natural soils were free of contamination	Residential garden
WSI03:0.20	Very low risk of pesticides and herbicides from crop farming on site	Residential garden
WSI03:0.80	To verify that the natural soils were free of contamination	Residential garden
WSI04:0.20	Very low risk of pesticides and herbicides from crop farming on site	Residential garden
WSI04:0.80	To verify that the natural soils were free of contamination	Residential garden

5.3 Determination of Chemical Analysis

The driver for determination of the analysis suite was the information obtained from the Phase I Desk Study and Phase II intrusive investigation.

Table 5.2 outlines the specification for each sample tested.

Table 5.2 Chemical Analysis Specification

Substance	Locations: Depths (m bgl)							
	WS101:0.20 ^s	WS101:0.50 ^s	WS102:0.20 ^s	WS102:0.60 ^s	WS103:0.20 ^s	WS103:0.80 ^s	WS104:0.20 ^s	WS104:0.80 ^s
Asbestos Screen	✓	✓	✓	✓	✓	✓	✓	✓
Total Phenols	✓	✓	✓	✓	✓	✓	✓	✓
Total Cyanide	✓	✓	✓	✓	✓	✓	✓	✓
Organic Matter	✓	✓	✓	✓	✓	✓	✓	✓
pH	✓	✓	✓	✓	✓	✓	✓	✓
Metals	✓	✓	✓	✓	✓	✓	✓	✓
Metalloids	✓	✓	✓	✓	✓	✓	✓	✓
Organics	✓	✓	✓	✓	✓	✓	✓	✓
PAHs	✓	✓	✓	✓	✓	✓	✓	✓
TPH-CWG								
BTEX								

Notes: **Metals:** Cd, Cr, Pb, Hg, Ni, Se, CN, S, Cu, Zn, Bo, V. **metalloids:** As. **organics:** USEPA 16 speciated PAH, TPH-CWG (speciated TPH), BTEX, VOC/SVOC **Asbestos screening** was undertaken in accordance with HSG 248. ^s = Soil sample. ^w = Water sample. ^l = Leachate.

Section 6 Qualitative Risk Assessment

6.1 Assessment Criteria

The assessment criteria used to determine risks to human health are derived and explained within Appendix D.3.

6.2 Representative Contamination Criteria - Soil

At the time of writing, the proposed development was understood to comprise 45 residential plots, both detached and semi-detached, with 14 double and 5 single garages. The development comprised soft landscaping, in the form of private gardens and public open space, and hard landscaping such as access roads, parking spaces and driveways.

In compiling this report reliance was placed on drawing number 10-1016-002 B, Dated December 2017, which was prepared by Mildren Homes. Any change or deviation from the scheme outlined in the drawing could invalidate the foundation design and remediation recommendations presented within this report. Soils Limited must be notified about any such changes.

The chemical laboratory results were compared against the representative contaminants concentration for human health receptor to Soil Guideline Values (SGV), Category 4 Screening Levels (C4SL's) or Suitable 4 Use Level (S4UL).

Table 6.1 outlines the samples that have exceeded their relevant assessment criteria. The full laboratory report is presented in Appendix D.2.

Table 6.1 Summary of Chemical Analysis of Soils Sample Exceedance

Substance	Sample locations where SGV, C4SL or S4UL adopted were exceeded for the 'Residential with home-grown produce' land-use scenario
-	None

The guideline values are assessed against the "Residential with home-grown produce" land-use scenario, which was considered the most appropriate land-use scenario, given the type of the proposed redevelopment.

To assess the potential toxicity to the human health receptor from the concentrations of organic compounds tested for, Soil Organic Matter (SOM) tests were undertaken on the samples submitted for chemical testing, which revealed SOM values of between 0.5% and 2.7%. For each soil sample tested, the Soil Organic Matter recorded was used to derive the appropriate guideline value for organic determinands.

In summary, none of the samples tested showed concentrations in excess of the relevant C4SL or S4UL for a residential land-use scenario.

None of the other substances tested recorded concentrations above the residential end-use screening values.

6.2.1 Asbestos

No Asbestos Containing Materials (ACM) were detected within any of the samples tested.

Despite no asbestos containing materials being identified on site, it is possible that asbestos is present in other areas of the site. If encountered, care must be taken to ensure any such material is separated and disposed of in an appropriate manner to a licensed waste facility.

6.3 Risk to Groundwater

No groundwater samples were retrieved as this did not form part of the scope of this investigation.

6.4 Tier I Quantitative Risk Assessment

Quantitative risk assessments are undertaken for the soil, groundwater and soil gas. The CSM has been updated to take account of the assessments below and presented in Appendix D.1. The full laboratory chemical report is presented in Appendix D.2.

6.4.1 Soils

None of the samples tested showed concentrations in excess of the relevant C4SL or S4UL for a residential land-use scenario. No asbestos or asbestos containing materials (ACM) were detected in any of the samples tested, nor were any identified by eye throughout site works.

The Tier 1 Quantitative risk assessment therefore established that there was **no risk to the human health receptors** of construction workers or future end-users.

6.4.2 Groundwater

The Groundwater Risk Assessment established that **there was no risk** to the groundwater receptor as the Phase II Ground Investigation found the superficial soils on site to be cohesive, thereby creating an impermeable barrier to the bedrock White Chalk Subgroup where the groundwater is located.

6.4.3 Soil Gas

The Phase I Desk Study identified a low risk of soil gas associated with an area of infilled land located to the south east of the site. As the Phase II intrusive investigation identified cohesive soils of thicknesses between 2.50 and 4.25m bgl across the site, it is considered unlikely that a pathway between the source and the receptors exists, as the cohesive soils would form a barrier between the source and the receptor. Furthermore, the scale of the infilled land reduces the soil gas risk as the source is a small pond.

It is therefore considered that the risk of soil gas on site was **negligible**.

6.5 Remedial Objective

Soil chemical analysis recorded no samples with substance levels over their representative guideline values. Groundwater chemical analysis did not form part of the scope of this investigation.

Therefore, there was no risk to the Human Health, Building Structures and Services and Groundwater receptor which would require a remediation strategy.

The remedial objective for the site is to ensure site clean-up removes any unacceptable risk to the identified receptors of Human Health, Building Structures and Services and Groundwater receptor.

In essence the remedial objective should sever any source-pathway-receptor pollutant linkages that have been established. Once this has been achieved, by whatever means, there can theoretically be no risk.

6.6 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust is generated as a result of construction activities. The site should be securely fenced at all times to prevent unauthorised access.

Washing facilities should be provided and eating restricted to mess huts.

6.7 Excavated Material

Excavated material must be classified with the Environment Agency for disposal at an appropriately licensed disposal facility. The requirements of Duty of Care and Health and Safety Guidance must be complied with.

Both Producers and Waste Management companies must ensure compliance with the new Waste Acceptance Criteria (WAC) prior to landfill in hazardous, stable non-reactive cells and inert sites. These regulations govern the operation of landfill in England and Wales. Basic characterisation is the responsibility of the waste producer and compliance checking is generally the responsibility of the landfill operator. Therefore, landfill operators will be unlikely to accept waste that does not meet the Waste Acceptance Criteria for their class of site.

There is an obligation to 'treat' all soils destined for landfill, including non-hazardous waste. This treatment must now be documented and presented to the landfill operator or waste may be refused entry. Note that all liquids are banned from landfill.

For the purposes of legal compliance, 'treatment' must comprise three things (the 'three-point test'):

1. It must be a physical, thermal, chemical or biological process.
2. It must change the characteristics of the waste.
3. It must do so in order to:
 - (a) reduce its volume, or
 - (b) reduce its hazardous nature, or
 - (c) facilitate its handling, or enhance its recovery.

WAC testing was not undertaken at this stage but may be necessary depending upon whether material is required to be taken off-site.

6.8 Re-use of Excavated Material On-site

The re-use of on-site soils may be undertaken either under the Environmental Permitting Regulations 2007 (EPR), in which case soils other than uncontaminated soils are classed as waste, or under the CL:AIRE Voluntary Code of Practice (CoP) which was published in September 2008 and is accepted as an alternative regime to the EPR.

Under the EPR, material that is contaminated but otherwise suitable for re-use is also classified as waste and its re-use should be in accordance with the Environmental Permitting Regulations 2007 (EPR). Environmental Permit Exemptions (EPE) are for the re-use of non-hazardous or inert waste only; hazardous waste cannot be re-used under a permit exemption. EPE apply only to imported inert waste materials; inert material arising on site and recovered on site is not classified as waste and does not require an exemption. It is possible that materials arising on-site will be classified as inert and would not need an exemption.

Environmental Permit Exemptions are only allowed for certain activities, placing controls on the quantities that can be stored and re-used. The re-use of waste shall be within areas and levels defined in planning applications and permissions for the development. An EPE requires a site-specific risk assessment for the receptor site to demonstrate that the materials are suitable for use, i.e. that they will not give rise to harm to human health or pollution of the environment.

Under the CL:AIRE voluntary code of practice (CoP) materials excavated on-site are not deemed contaminated if suitable for re-use at specified locations or generally within the site.

Material that may have been classified as hazardous waste under the EPR may be re-

used. The CoP regime requires that a 'Qualified Person' as defined under the CoP reviews the development of the Materials Management Plan, including review of Risk Assessments and Remediation Strategy/Design Statement together with documentation relating to Planning and Regulatory issues, and signs a Declaration which is forwarded to the Environment Agency and which confirms compliance with the CoP.

Should it be necessary to import materials from another site where materials are excavated and which is not material from a quarry or produced under a WRAP protocol, then an EPE would be necessary for the imported material whether the work was managed under the CoP or the EPR.

6.9 Imported Material

Any soil which is to be imported onto the site must undergo chemical analysis to permit classification prior to its importation and placement in order to ascertain its status with specific regard to contamination, i.e. to prove that it is suitable for the purpose for which it is intended.

6.10 Discovery Strategy

There may be areas of contamination not identified during the course of the investigation. Such occurrences may also be discovered during the demolition and construction phases for the redevelopment of the site.

Care should be taken during excavation works especially to investigate any soils, which appear by eye (e.g. such as fibrous materials, large amounts of ash and unusual discolouration), odour (e.g. fuel, oil and chemical type odours or unusual odours such as sweet odours or fishy odours) or wellbeing (e.g. light headedness and/or nausea, burning of nasal passages and blistering or reddening of skin due to contact with soil) to be contaminated or of unusual and/or different character to standard soils or those analysed.

In the event of any discovery of potentially contaminated soils or materials, this discovery should be quarantined and reported to the most senior member of site staff or the designated responsible person at the site for action. The location, type and quantity must be recorded and the Local Authority, and a competent and appropriate third-party Engineer/Environmental consultant notified immediately. An approval from the Local authority must be sought prior to implementing any proposed mitigation action.

The discovery strategy must remain on site at all times and must demonstrate a clear allocation of responsibility for reporting and dealing with contamination. A copy of the strategy must be placed on the health and safety notice board and /or displayed in a prominent area where all site staff are able to take note of and consult the document at any time. Any member of the workforce entering the site to undertake any excavation must be made aware of the potential to discover contamination and the discovery strategy

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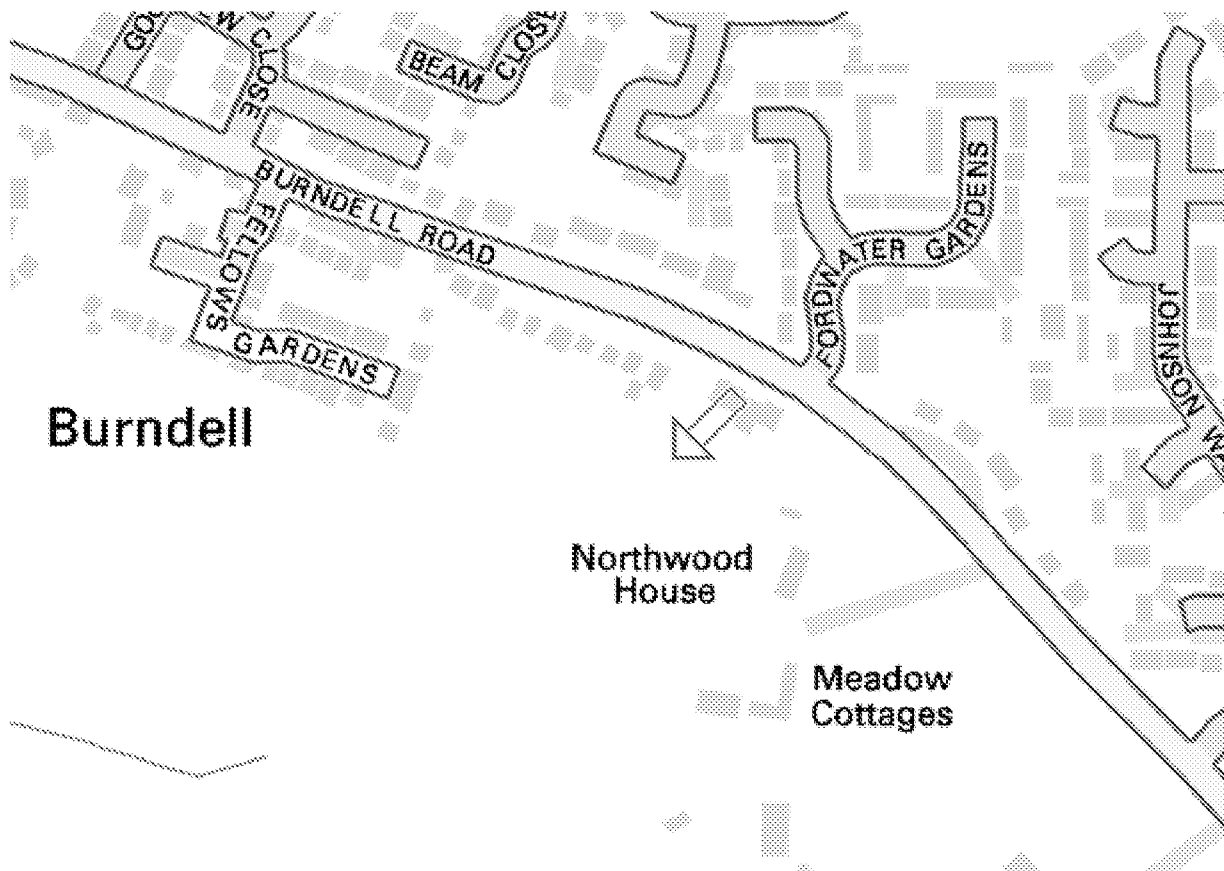
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Appendix E Information Provided by the Client

**Figure 1 – Site Location Map**

Job Number 16707	Project Land south of Burndell Road, Yapton, West Sussex BN18 0HR
Client Crayfern Homes Limited	Date January 2018



Figure 2 – Aerial Photograph

Project

Land south of Burndell Road,
Yapton, West Sussex BN18 0HR

Client

Crayfern Homes Limited

Date

January 2018

Job Number

16707





Figure 3 – Trial Hole Plan

Project

Land south of Burndell Road,
Yapton, West Sussex BN18 0HR

Client

Crayfern Homes Limited

Date

January 2018

Job Number

16707



Appendix A Field Work

Appendix A.1 Engineers Logs

Project Name: Land south of Burndell Road	Project No.: 16707	Co-ords:	Hole Type WS
Location: Yapton, West Sussex BN18 0HR		Level:	Scale 1:50
Client: Crayfern Homes Limited		Dates: 09/01/2018	Logged By

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (mAOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	J+D		0.45			Grass over soft brown sandy very silty CLAY. Sand is fine. Rare medium sub-angular flint gravel. Frequent fine roots and rootlets. Very rare fine brick. TOPSOIL	
		0.50	J+D					Soft orangish brown sandy silty CLAY. Sand is fine. Frequent black organic patches. Rare fine rootlets. RIVER TERRACE DEPOSITS	
		0.80	J+D					80% Recovery	1
		1.50	D		2.30			70% Recovery	2
		2.00	D					Soft orangish brown gravelly very sandy CLAY. Sand is fine to coarse, gravel is fine to coarse angular flint and chalk. RIVER TERRACE DEPOSITS	
		2.50	D					55% Recovery	3
		3.50	D		3.40			Very soft yellowish orange sandy gravelly CLAY. Sand is fine, gravel is fine to coarse angular to sub-angular flint and chalk. RIVER TERRACE DEPOSITS	
					4.25			75% Recovery	4
		4.50	D		5.00			Off-white to yellowish weathered and structureless CHALK. Recovered as fine to medium sub-angular blocks in a clayey silty matrix. Occasional patches of clay. Rare fine to medium angular flint. WHITE CHALK SUBGROUP	
								End of Borehole at 5.00m	5
									6
									7
									8
									9
									10

General Remarks:

Groundwater struck at 2.10m bgl, standing at 2.00m bgl. Roots encountered to 2.30m bgl.

Groundwater Remarks:
Borehole Type

 CP: Cable Percussive
 WS: Windowless Sampler
 RC: Rotary Cored

Sample Types

 D: Disturbed
 B: Bulk
 J: Jar
 W: Water
 U: Undisturbed

In-Situ Testing

 SPT: Split spoon - Standard Penetration Test
 CPT: Cone - Standard Penetration Test

Project Name: Land south of Burndell Road	Project No.: 16707	Co-ords:	Hole Type WS
Location: Yapton, West Sussex BN18 0HR		Level:	Scale 1:50
Client: Crayfern Homes Limited		Dates: 09/01/2018	Logged By

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (mAOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	J+D		0.50			Grass over soft dark greyish brown silty sandy CLAY. Sand is fine. Very rare fine brick. Frequent fine roots and rootlets. TOPSOIL 90% Recovery	
		0.60	J+D					Soft to firm orangish brown mottled light grey sandy silty CLAY. Sand is fine. Frequent black organic pathes. Rare fine roots and rootlets. RIVER TERRACE DEPOSITS	
		0.90	J+D					70% Recovery	1
		1.50	D		2.60				
		2.00	D					55% Recovery	2
		2.50	D						
		3.20			3.20			Very soft orangish brown sandy gravelly CLAY. Sand is fine to medium. Gravel is fine angular to sub-angular flint. RIVER TERRACE DEPOSITS 95% Recovery	3
		3.50	D					Off-white to yellowish weathered and structureless CHALK. Recovered as fine to coarse sub-angular blocks in a clayey silty matrix. Occasional patches of clay. Frequent fine to medium angular flint. Occasional black speckling. WHITE CHALK SUBGROUP 95% Recovery	4
		4.50	D						
		5.00			5.00			End of Borehole at 5.00m	5
									6
									7
									8
									9
									10

General Remarks: Groundwater struck at 2.00m bgl, standing at 2.00m bgl. Roots observed to 2.20m bgl.	Borehole Type CP: Cable Percussive WS: Windowless Sampler RC: Rotary Cored In-Situ Testing SPT: Split spoon - Standard Penetration Test CPT: Cone - Standard Penetration Test	Sample Types D: Disturbed B: Bulk J: Jar W: Water U: Undisturbed
Groundwater Remarks:		

**Soils Limited**

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Borehole Log

Borehole No.

WS103

Sheet 1 of 1

Project Name: Land south of Burndell Road	Project No.: 16707	Co-ords:	Hole Type WS
Location: Yapton, West Sussex BN18 0HR		Level:	Scale 1:50
Client: Crayfern Homes Limited		Dates: 09/01/2018	Logged By

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (mAOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	J+D					Grass over soft dark brown sandy very silty CLAY. Sand is fine. Rare fine angular flint. Frequent fine to medium roots and rootlets. TOPSOIL	
		0.50	J+D		0.55				
		0.80	J+D					Soft orangish brown slightly sandy silty gravelly CLAY. Sand is fine, gravel is fine to medium angular flint. Frequent black organic patches. Frequent fine roots and rootlets. RIVER TERRACE DEPOSITS	1
		1.50	D		1.25				
								Soft orangish brown mottled light grey sandy slightly gravelly CLAY. Sand is fine to medium, gravel is fine to medium angular rootlets. Rare fine roots and rootlets to 2.45m bgl. RIVER TERRACE DEPOSITS	2
		2.55	D		2.50				
								Yellowish white to bright white weathered and structureless CHALK. Recovered as fine to coarse sub-angular blocks in a clayey/silty matrix. Frequent fine to coarse angular flint gravel. WHITE CHALK SUBGROUP	3
		3.50	D						
		4.00 - 4.20	D		4.20			Recovered as a bulk bag due to split liner	4
								End of Borehole at 4.20m	
									5
									6
									7
									8
									9
									10

General Remarks: Groundwater struck at 2.00m bgl, standing at 2.00m bgl. Roots observed to 2.45m bgl.	Borehole Type CP: Cable Percussive WS: Windowless Sampler RC: Rotary Cored In-Situ Testing SPT: Split spoon - Standard Penetration Test CPT: Cone - Standard Penetration Test	Sample Types D: Disturbed B: Bulk J: Jar W: Water U: Undisturbed
Groundwater Remarks:		

**Soils Limited**

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Borehole Log

Borehole No.

WS104

Sheet 1 of 1

Project Name: Land south of Burndell Road	Project No.: 16707	Co-ords:	Hole Type WS
Location: Yapton, West Sussex BN18 0HR		Level:	Scale 1:50
Client: Crayfern Homes Limited		Dates: 09/01/2018	Logged By

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (mAOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	J+D		0.55			Grass over soft brown sandy silty CLAY. Sand is fine. Rare fine to medium angular flint. Frequent fine to medium roots and rootlets. TOPSOIL 75% Recovery	
		0.50	J+D					Soft orangish brown slightly sandy silty CLAY. Sand is fine. Occasional fine rootlets. Occasional organic patches. RIVER TERRACE DEPOSITS 75% Recovery	1
		0.80	J+D						
		1.50	D		1.65			Orangish brown slightly clayey gravelly fine to coarse SAND. Gravel is fine to coarse, angular to sub-angular flint. RIVER TERRACE DEPOSITS 70% Recovery	2
		2.50	D						3
		3.70	D		3.60			Firm dark yellowish brown gravelly sandy CLAY. Sand is fine to coarse. Gravel is fine to medium angular sub-angular flint and chalk. RIVER TERRACE DEPOSITS	4
					4.00			End of Borehole at 4.00m	4
									5
									6
									7
									8
									9
									10

General Remarks: Groundwater struck at 2.60m bgl, standing 2.60m bgl. Roots observed to 2.20m bgl. Groundwater Remarks:							Borehole Type CP: Cable Percussive WS: Windowless Sampler RC: Rotary Cored In-Situ Testing SPT: Split spoon - Standard Penetration Test CPT: Cone - Standard Penetration Test	Sample Types D: Disturbed B: Bulk J: Jar W: Water U: Undisturbed
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Appendix B Geotechnical In-Situ and Laboratory Testing

Appendix B.1 Classification

Classification based on SPT “N” values:

The inferred undrained strength of the cohesive soils was based on the SPT “N” blow counts, derived from the relationship suggested by Stroud (1974) and classified using Table B.1.1. (Ref: Stroud, M. A. 1974, “The Standard Penetration Test – its application and interpretation”, Proc. ICE Conf. on Penetration Testing in the UK, Birmingham. Thomas Telford, London.).

Table B.1.1 SPT “N” Blow Count Cohesive Classification

Classification	Undrained Cohesive Strength C_u (kPa)
Extremely low	<10
Very low	10 – 20
Low	20 – 40
Medium	40 – 75
High	75 – 150
Very high	150 – 300
Extremely high	> 300

Note: (Ref: BS EN ISO 14688-2:2004+A1:2013 Clause 5.3.)

The relative density of granular soils was classified based of the relationship given in Table B.1.2.

The *UK National Annex to Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing, NA 3.7 SPT test, BS EN 1997-2:2007, Annex F* states “Relative density descriptions on borehole records should also be based on uncorrected SPT N values, unless significantly disturbed, using the density classification in BS 5930:2015, Table 7.

Table B.1.2 SPT “N” Blow Count Granular Classification

Classification	SPT “N” blow count (blows/300mm)
Very loose	0 to 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very dense	Greater than 50

Note: (Ref: The Standard Penetration Test (SPT): Methods and Use, CIRIA Report 143, 1995)

Chalk samples recovered are disturbed by the sampling process. Therefore, it is difficult to assess an accurate chalk grade for in accordance with CIRIA C574 ‘Engineering in

Chalk'. In the absence of a standardised correlation between SPT "N60" values and chalk grade for the most recent chalk classification (CIRIA C574) a broad indication of the in-situ chalk grade can be assessed using a paper by T.R.M. Wakeling from a site in Mundford, Norfolk, which compares SPT "N" values to the old Spink & Norbury chalk classification. From the Spink & Norbury classification it is possible to infer a basic CIRIA Grade (structureless or structured), as outlined in Table B.1.3.

Table B.1.3 Interpretation of SPT "N" Blow Counts in Chalk

SPT "N60" Range	Value	Spink & Norbury Grade	Inferred CIRIA Grade
<8	VI		Structureless (Dm)
8 – 15	V		Structureless (Dc)
15 – 20	IV		Structured chalk (C5 – A1)
20 – 25	III		Structured chalk (C5 – A1)
25 – 35	II		Structured chalk (C5 – A1)
>35	I		Structured chalk (C5 – A1)

Note:

Classification of DCP results to CBR:

The DCP consists of a cone fixed to the bottom of a 575mm vertical rod. An 8kg weight is repeatedly lifted and dropped onto an anvil at the mid-height of the rod to deliver a 'blow'. A vertical scale alongside the rod is used to measure the depth of penetration of the cone. These measurements are then converted to CBR values using the following equation derived from the DTP Interim Advice Note 73/06 – Design Guidance for Road Pavement Foundations:

$$\text{Log}_{10}(\text{CBR}) = 2.48 - 1.057 \times \text{Log}_{10}(\text{mm/blow})$$

Appendix B.2 Interpretation

Table B.2.1 Interpretation of DPSH Blow Counts

DP	Strata	Equivalent SPT N60 Blow Counts	Inferred Cohesive Strength/Granular Density/Approximate CIRIA Chalk Grade
DPI01	RTD 0.50 – 2.20 Sandy Silty Clay	4 – 8	Low ($C_u = 20 - 40\text{kPa}$)
	RTD 2.20 – 3.40 Gravelly Sandy Clay	0 – 8	Extremely Low to Low ($C_u = <15 - 40\text{kPa}$)
	RTD 3.40 – 3.90 Void/Soft Spot	0	Extremely Low to Low ($C_u = <15\text{kPa}$)
	RTD 3.90 – 4.30 Sandy Gravelly Clay	4 – 25	Low to High ($C_u = 20 - 125\text{kPa}$)
	WCSG ¹ 4.30 – 6.00 Chalk	12 – 95	Structureless (Dc) to Structured Chalk (C5 – A1)
DPI02	RTD 0.50 – 2.60 Sandy Silty Clay	0 – 8	Extremely Low to Low ($C_u = <15 - 40\text{kPa}$)
	RTD 2.60 – 3.30 Soft Spot	0 – 4	Extremely Low to Low ($C_u = <15 - 20\text{kPa}$)
	WCSG 3.30 – 3.60 Chalk	8 – 16	Structureless (Dm) to Structureless (Dc)
	WCSG ¹ 3.60 – 6.00 Chalk	25 – 62	Structured Chalk (C5 – A1)
DPI03	RTD 0.60 – 1.30 Silty Gravelly Clay	0 – 4	Very low to low ($C_u = <15 - 20\text{kPa}$)
	RTD 1.30 – 2.60 Sandy Gravelly Clay	0 – 4	Very low to low ($C_u = <15 - 20\text{kPa}$)
	WCSG ¹ 2.70 – 6.00 Chalk	21 – 66	Structured Chalk (C5 – A1)
DPI04	RTD 0.60 – 1.70 Silty Clay	4 – 8	Low ($C_u = 20 - 40\text{kPa}$)
	RTD 1.70 – 2.60 Gravelly Sand	8 – 12	Loose
	RTD 2.60 – 3.30 Gravelly Sand	0 – 4	Very loose

DP	Strata	Equivalent SPT N60 Blow Counts	Inferred Cohesive Strength/Granular Density/Approximate CIRIA Chalk Grade
DPI05 ²	RTD 3.30 – 3.60 Gravelly Sand	16 – 21	Medium Dense
	WCSG 3.60 – 4.00 Chalk	8 – 21	Structureless (Dc) to Structured Chalk (C5 – A1)
	WCSG ¹ 4.00 – 6.00 Chalk	33 – 82	Structured Chalk (C5 – A1)
	RTD 0.50 – 2.70 No samples to log	0 - 4	Very low to low (C _u = <15 – 20kPa)
	RTD 2.70 – 3.80 No samples to log	0	Very low (C _u = <15kPa)
	RTD 3.80 – 4.20 No samples to log	0 – 4	Very low to low (C _u = <15 – 20kPa)
	WCSG 4.20 – 5.10 Chalk	8 – 12	Structureless (Dc)
	WCSG 5.10 – 6.00 Chalk	12 – 16	Structureless (Dc) to Structured Chalk (C5 – A1)
	WCSG 6.00 – 11.00	16 – 74	Structured Chalk (C5 – A1)

Note: ¹ Ground conditions inferred past the base of windowless sampler boreholes. ² Ground conditions inferred from blow counts due to lack of accompanying windowless sampler borehole

Table B.2.2 Interpretation of Atterberg Limit Tests

Stratum	Moisture Content (%)	Plasticity Index (%)	Passing 425µm Sieve (%)	Modified Plasticity Index (%)	Soil Classification	Volume Change Potential	
						BRE	NHBC
RTD	16 - 47	2 - 35	90 - 100	2 – 31.5	ML/CL - CI	Low - Medium	Low - Medium

Note: BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)

NHBC Volume Change Potential refers to NHBC Standards Chapter 4.2

Soils Classification based on British Soil Classification System

The most common use of the term clay is to describe a soil that contains enough clay-sized material or clay minerals to exhibit cohesive properties. The fraction of clay-sized material required varies, but can be as low as 1.5%. Unless stated otherwise, this is the sense used in Digest 240. The term can be used to denote the clay minerals. These are specific, naturally occurring chemical compounds, predominately silicates. The term is often used as a particle size descriptor. Soil particles that have a nominal diameter of less than 2 µm are normally considered to be of clay size, but they are not necessarily clay minerals. Some clay minerals are larger than 2 µm and some particles, 'rock flour' for example, can be finer than 2 µm but are not clay minerals.

(The Atterberg Limit Tests were undertaken in accordance with BS 1377:Part 2:1990 Clauses 3.2, 4.3 and 5)

Appendix B.3 Geotechnical In-Situ and Laboratory Results

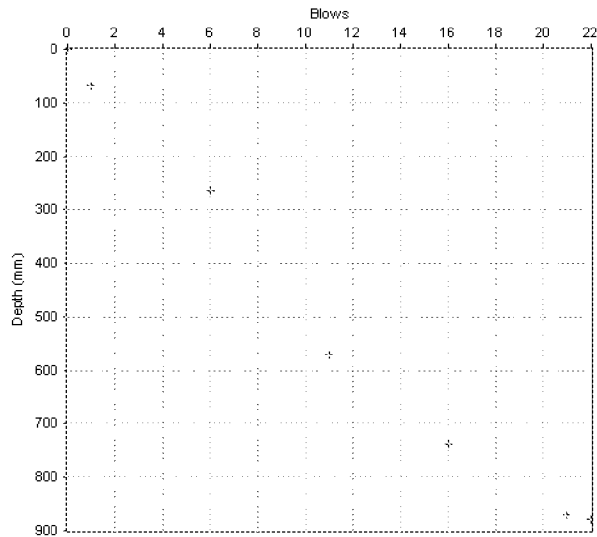
DCP Layer Strength Analysis Report

Project Name: 16707 Burndell Road DCP Logs

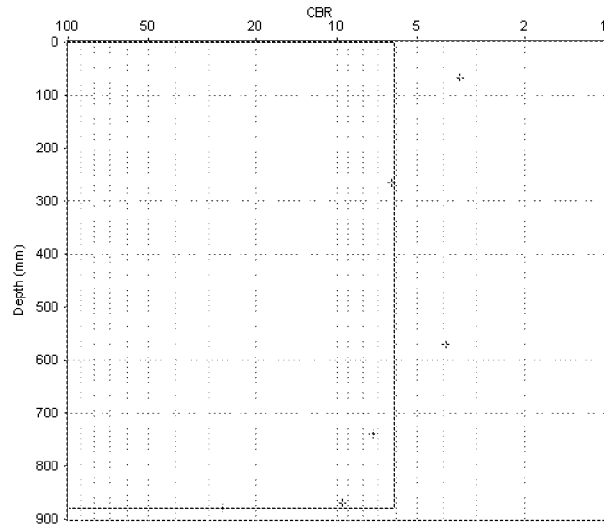
Chainage (km): 1.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 60
 Test Date: 17/01/2018

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 1.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)
1	40.00	6	880	880

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

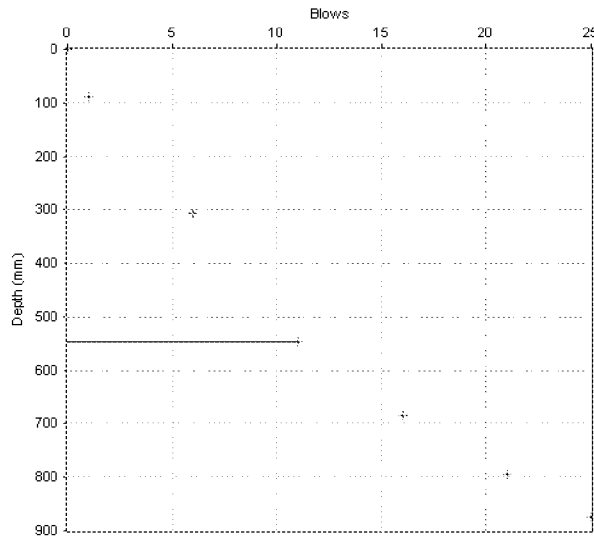
DCP Layer Strength Analysis Report

Project Name: 16707 Burndell Road DCP Logs

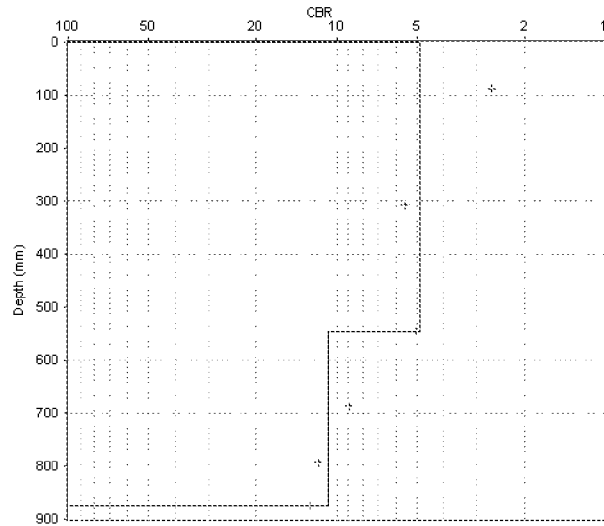
Chainage (km): 2.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 65
 Test Date: 17/01/2018

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 2.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)
1	49.64	5	546	546
2	23.50	11	329	875

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

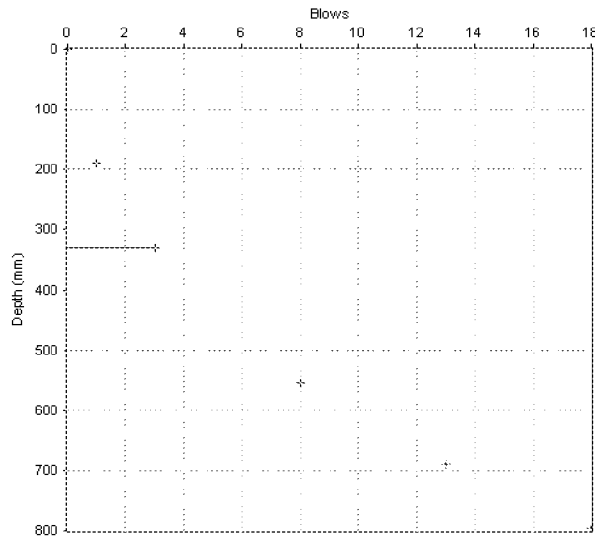
DCP Layer Strength Analysis Report

Project Name: 16707 Burndell Road DCP Logs

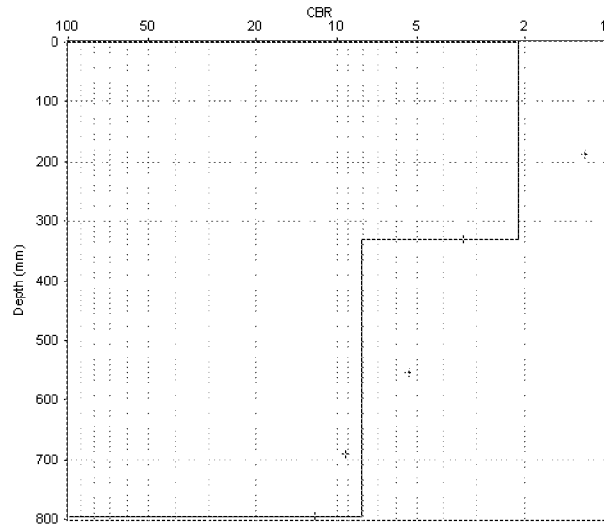
Chainage (km): 3.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 145
 Test Date: 17/01/2018

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 3.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)
1	110.00	2	330	330
2	31.00	8	465	795

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

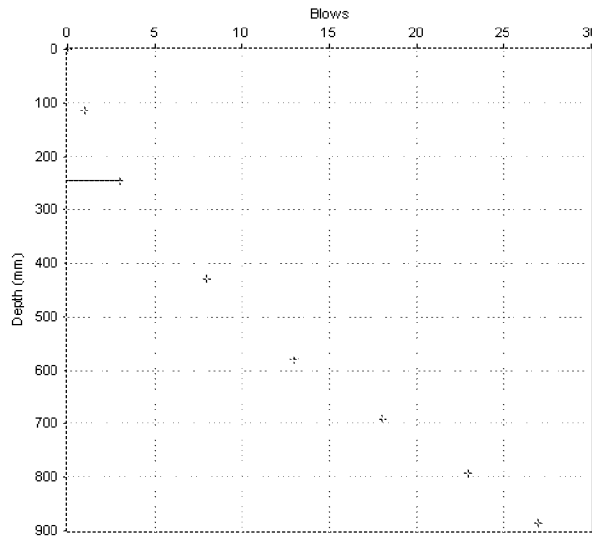
DCP Layer Strength Analysis Report

Project Name: 16707 Burndell Road DCP Logs

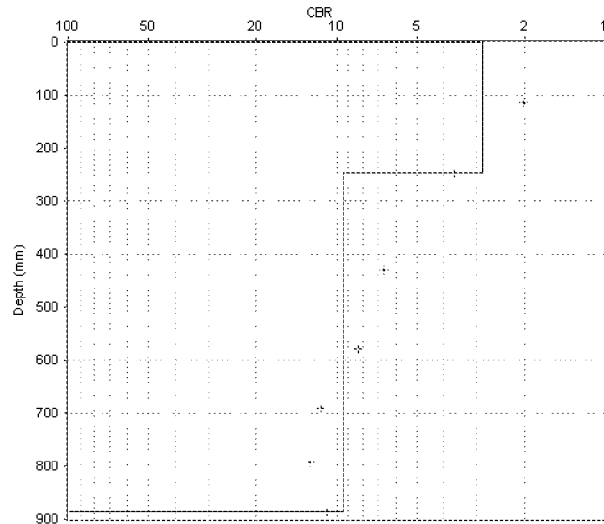
Chainage (km): 4.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 65
 Test Date: 17/01/2018

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 4.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)
1	82.00	3	246	246
2	26.63	9	639	885

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

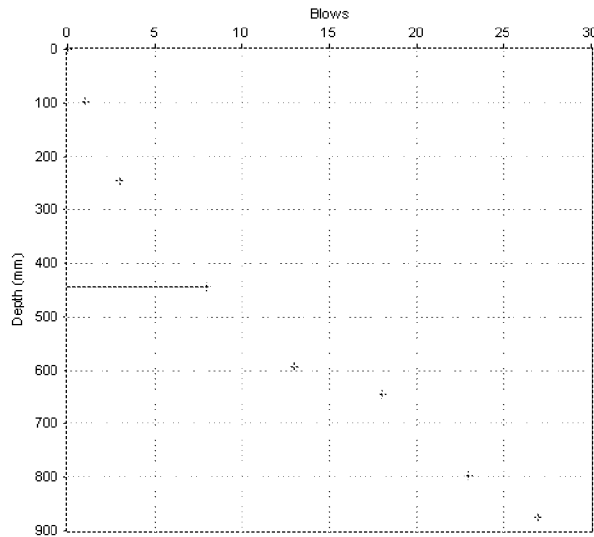
DCP Layer Strength Analysis Report

Project Name: 16707 Burndell Road DCP Logs

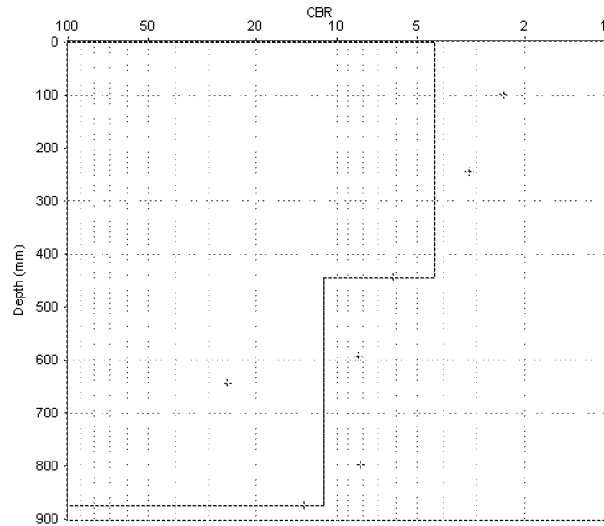
Chainage (km): 5.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 65
 Test Date: 17/01/2018

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 5.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)
1	55.50	4	444	444
2	22.68	11	431	875

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

Project Name:	Land south of Burndell Road	Project No.	16707	Co-ords:		Hole Type	DP
Location:	Yapton, West Sussex BN18 0HR	Level:	m AOD			Scale	1:50
Client:	Crayfern Homes Limited	Dates:	09/01/2018			Logged By	

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0					
0.1					
0.2					
0.3					
0.4					
0.5					
0.6					
0.7					
0.8					
0.9					
1					30
1.1					
1.2					
1.3					
1.4					
1.5					
1.6					
1.7					
1.8					
1.9					
2					25
2.1					
2.2					
2.3					
2.4					
2.5					
2.6					
2.7					
2.8					
2.9					
3					35
3.1					
3.2					
3.3					
3.4					
3.5					
3.6					
3.7					
3.8					
3.9					
4					10
4.1					
4.2					
4.3					
4.4					
4.5					
4.6					
4.7					
4.8					
4.9					
5					70
5.1					
5.2					
5.3					
5.4					
5.5					
5.6					
5.7					
5.8					
5.9					
6					100
6.1					
6.2					
6.3					
6.4					
6.5					
6.6					
6.7					
6.8					
6.9					
7					
7.1					
7.2					
7.3					
7.4					
7.5					
7.6					
7.7					
7.8					
7.9					
8					
8.1					
8.2					
8.3					
8.4					
8.5					
8.6					
8.7					
8.8					
8.9					
9					
9.1					
9.2					
9.3					
9.4					
9.5					
9.6					
9.7					
9.8					
9.9					
10					
Remarks	Fall Height mm		Cone Base Diameter mm		
	Hammer Weight kg		Final Depth 6m		
	Probe Type		Energy Ratio (Er) %		

Project Name:	Land south of Burndell Road	Project No.	16707	Co-ords:		Hole Type	DP
Location:	Yapton, West Sussex BN18 0HR	Level:	m AOD			Scale	1:50
Client:	Crayfern Homes Limited	Dates:	09/01/2018			Logged By	

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0					
0.1					
0.2					
0.3					
0.4					
0.5					
0.6					
0.7					
0.8					
0.9					
1					20
1.1					
1.2					
1.3					
1.4					
1.5					
1.6					
1.7					
1.8					
1.9					
2					20
2.1					
2.2					
2.3					
2.4					
2.5					
2.6					
2.7					
2.8					
2.9					
3					15
3.1					
3.2					
3.3					
3.4					
3.5					
3.6					
3.7					
3.8					
3.9					
4					20
4.1					
4.2					
4.3					
4.4					
4.5					
4.6					
4.7					
4.8					
4.9					
5					45
5.1					
5.2					
5.3					
5.4					
5.5					
5.6					
5.7					
5.8					
5.9					
6					50
6.1					
6.2					
6.3					
6.4					
6.5					
6.6					
6.7					
6.8					
6.9					
7					
7.1					
7.2					
7.3					
7.4					
7.5					
7.6					
7.7					
7.8					
7.9					
8					
8.1					
8.2					
8.3					
8.4					
8.5					
8.6					
8.7					
8.8					
8.9					
9					
9.1					
9.2					
9.3					
9.4					
9.5					
9.6					
9.7					
9.8					
9.9					
10					
Remarks	Fall Height mm		Cone Base Diameter mm		
	Hammer Weight kg		Final Depth 6m		
	Probe Type		Energy Ratio (Er) %		

Project Name:	Land south of Burndell Road	Project No.	16707	Co-ords:		Hole Type	DP
Location:	Yapton, West Sussex BN18 0HR	Level:	m AOD			Scale	1:50
Client:	Crayfern Homes Limited	Dates:	09/01/2018			Logged By	

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0					
0.1					
0.2					
0.3					
0.4					
0.5					
0.6					
0.7					
0.8					
0.9					
1					20
1.1					
1.2					
1.3					
1.4					
1.5					
1.6					
1.7					
1.8					
1.9					
2					20
2.1					
2.2					
2.3					
2.4					
2.5					
2.6					
2.7					
2.8					
2.9					
3					30
3.1					
3.2					
3.3					
3.4					
3.5					
3.6					
3.7					
3.8					
3.9					
4					50
4.1					
4.2					
4.3					
4.4					
4.5					
4.6					
4.7					
4.8					
4.9					
5					75
5.1					
5.2					
5.3					
5.4					
5.5					
5.6					
5.7					
5.8					
5.9					
6					100
6.1					
6.2					
6.3					
6.4					
6.5					
6.6					
6.7					
6.8					
6.9					
7					
7.1					
7.2					
7.3					
7.4					
7.5					
7.6					
7.7					
7.8					
7.9					
8					
8.1					
8.2					
8.3					
8.4					
8.5					
8.6					
8.7					
8.8					
8.9					
9					
9.1					
9.2					
9.3					
9.4					
9.5					
9.6					
9.7					
9.8					
9.9					
10					
Remarks	Fall Height mm		Cone Base Diameter mm		
	Hammer Weight kg		Final Depth 6m		
	Probe Type		Energy Ratio (Er) %		

Project Name:	Land south of Burndell Road	Project No.	16707	Co-ords:		Hole Type	DP
Location:	Yapton, West Sussex BN18 0HR	Level:	m AOD			Scale	1:50
Client:	Crayfern Homes Limited	Dates:	09/01/2018			Logged By	

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0					
0.1					
0.2					
0.3					
0.4					
0.5					
0.6					
0.7					
0.8					
0.9					
1					10
1.1					
1.2					
1.3					
1.4					
1.5					
1.6					
1.7					
1.8					
1.9					
2					10
2.1					
2.2					
2.3					
2.4					
2.5					
2.6					
2.7					
2.8					
2.9					
3					10
3.1					
3.2					
3.3					
3.4					
3.5					
3.6					
3.7					
3.8					
3.9					
4					70
4.1					
4.2					
4.3					
4.4					
4.5					
4.6					
4.7					
4.8					
4.9					
5					90
5.1					
5.2					
5.3					
5.4					
5.5					
5.6					
5.7					
5.8					
5.9					
6					90
6.1					
6.2					
6.3					
6.4					
6.5					
6.6					
6.7					
6.8					
6.9					
7					
7.1					
7.2					
7.3					
7.4					
7.5					
7.6					
7.7					
7.8					
7.9					
8					
8.1					
8.2					
8.3					
8.4					
8.5					
8.6					
8.7					
8.8					
8.9					
9					
9.1					
9.2					
9.3					
9.4					
9.5					
9.6					
9.7					
9.8					
9.9					
10					
Remarks	Fall Height mm		Cone Base Diameter mm		
	Hammer Weight kg		Final Depth 6m		
	Probe Type		Energy Ratio (Er) %		

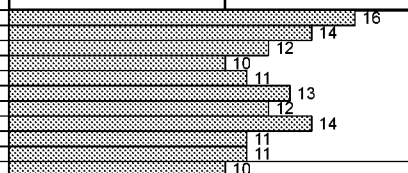
Project Name:	Land south of Burndell Road	Project No.	16707	Co-ords:		Hole Type	DP
Location:	Yapton, West Sussex BN18 0HR	Level:	m AOD			Scale	1:50
Client:	Crayfern Homes Limited	Dates:	09/01/2018			Logged By	

Depth (m)	Blows/100mm				Torque (Nm)
0	0	0	0	0	
0.1	1				
0.2	1				
0.3	1				
0.4	1				
0.5	1				
0.6	1				
0.7	1				
0.8	1				
0.9	1				
1.0	1				5
1.1	1				
1.2	1				
1.3	1				
1.4	1				
1.5	1				
1.6	1				
1.7	1				
1.8	1				
1.9	1				
2.0	1				5
2.1	1				
2.2	1				
2.3	1				
2.4	1				
2.5	1				
2.6	1				
2.7	1				
2.8	1				
2.9	1				
3.0	1				5
3.1	1				
3.2	1				
3.3	1				
3.4	1				
3.5	1				
3.6	1				
3.7	1				
3.8	1				
3.9	1				
4.0	1				5
4.1	1				
4.2	1				
4.3	1				
4.4	1				
4.5	1				
4.6	1				
4.7	1				
4.8	1				
4.9	1				
5.0	1				20
5.1	3				
5.2	2				
5.3	3				
5.4	3				
5.5	3				
5.6	3				
5.7	3				
5.8	3				
5.9	3				
6.0	3				20
6.1	3				
6.2	5				
6.3	6				
6.4	5				
6.5	7				
6.6	7				
6.7	4				
6.8	5				
6.9	7				
7.0	5				30
7.1	9				
7.2	8				
7.3	7				
7.4	5				
7.5	5				
7.6	5				
7.7	5				
7.8	5				
7.9	5				
8.0	8				40
8.1	10				
8.2	10				
8.3	11				
8.4	12				
8.5	9				
8.6	10				
8.7	11				
8.8	12				
8.9	16				
9.0	11				
9.1	10				
9.2	13				
9.3	18				60
9.4	13				
9.5	12				
9.6	12				
9.7	15				
9.8	11				
9.9	7				
10.0	14				
10.1	6				
10.2	11				

Remarks	Fall Height	mm	Cone Base Diameter	mm
	Hammer Weight	kg	Final Depth	11m
	Probe Type		Energy Ratio (Er)	%



Project Name:	Land south of Burndell Road	Project No.	16707	Co-ords:		Hole Type	DP
Location:	Yapton, West Sussex BN18 0HR	Level:	m AOD			Scale	1:50
Client:	Crayfern Homes Limited	Dates:	09/01/2018			Logged By	

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
					50
11					60
12					
13					
14					
15					
16					
17					
18					
19					
20					
Remarks	Fall Height mm		Cone Base Diameter mm		
	Hammer Weight kg		Final Depth 11m		
	Probe Type		Energy Ratio (Er) %		



Laboratory Report



Contract Number: 37875

Client Ref: **16707**

Report Date: **16-01-2018**

Client PO: **16707**

Client **Soils Limited**
Newton House
Cross Road
Tadworth
Surrey
KT20 5SR

Contract Title: **Burndell Road, Yapton**
For the attention of: **Lucy Philip**

Date Received: **15-01-2018**
Date Commenced: **15-01-2018**
Date Completed: **16-01-2018**

Test Description	Qty
Moisture Content BS 1377 : Part 2 : 3.2 - * UKAS	5
1 Point Liquid & Plastic Limit 1377 : 1990 Part 2 : 4.4 & 5.3 - * UKAS	5
Disposal of Samples on Project	1

Notes: Observations and Interpretations are outside the UKAS Accreditation

- * - denotes test included in laboratory scope of accreditation
- # - denotes test carried out by approved contractor
- @ - denotes non accredited tests

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 except in full, without the prior written approval of the laboratory.

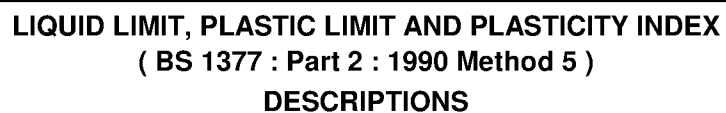
Approved Signatories:

Alex Wynn (Associate Director) - Ben Sharp (Contracts Manager) - Emma Sharp (Office Manager)
Paul Evans (Quality/Technical Manager) - Richard John (Advanced Testing Manager) - Sean Penn (Administrative Assistant)
Vaughan Edwards (Managing Director) - Wayne Honey (Administrative/Quality Assistant)

GEO Site & Testing Services Ltd

Unit 3-4, Heol Aur, Dafen Ind Estate, Dafen, Llanelli, Carmarthenshire SA14 8QN

ARUN DISTRICT COUNCIL 61018/DOC Tel: 01554 784040 Fax: 01554 784041 info@gstl.co.uk gstl.co.uk



37875

Burndell Road, Yapton

Operators	Checked	15/01/2018	Wayne Honey	
RO/MH	Approved	16/01/2018	Ben Sharp	



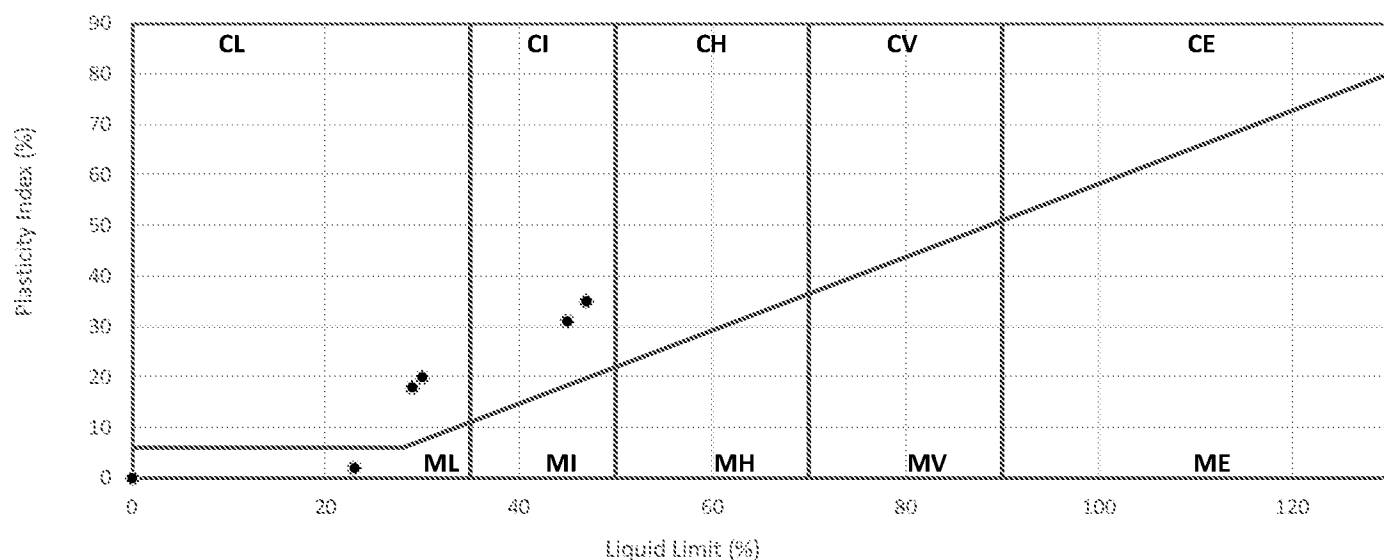
LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5)

Contract Number	37875	
Site Name	Burndell Road, Yapton	

[illegible]

Symbols: NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION



Operators	Checked	15/01/2018	Wayne Honey	
DB	Approved	16/01/2018	Ben Sharp	



Appendix C Foundation Design

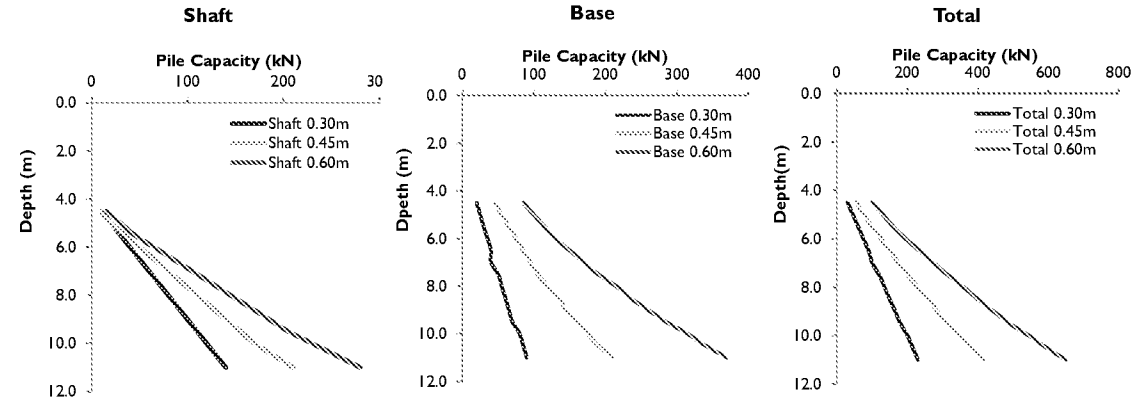
Appendix C.1 Preliminary Pile Design

Preliminary Pile Working Loads

Single Vertically Loaded Pile (kN)

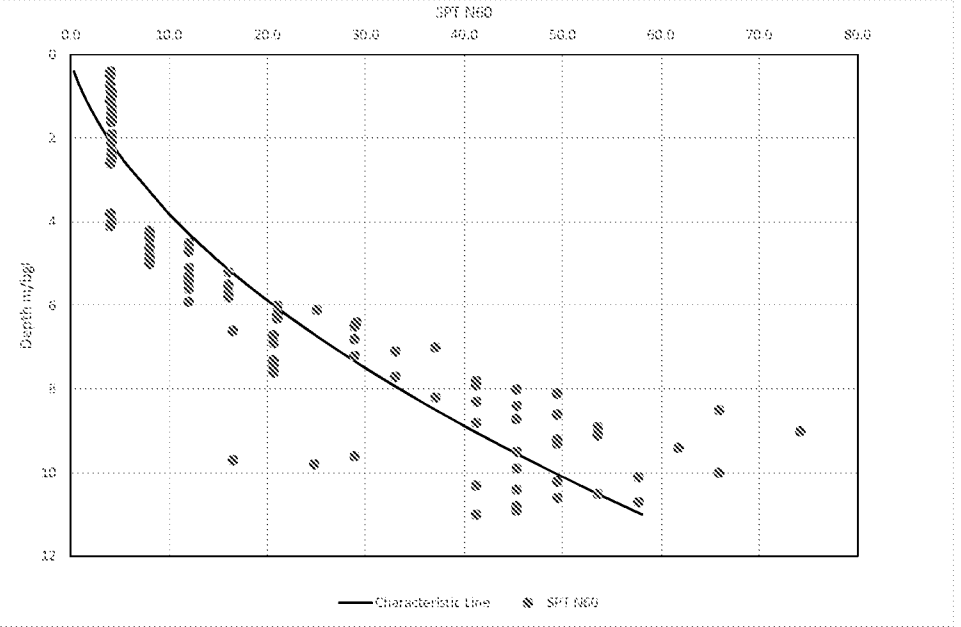
Name:	LP	Chain Density	12.5	Pile Start Depth:	4	FOS	
Job No:	16707	Depth of GW (m):	2	Pile Final Depth:	11	Shaft	Base
Date:	16.1.17			Pile Increment:	0.5	1.5	10

Notes:



Pile Diameter (m):

Pile Depth (m bgl)	0.30			0.45			0.60		
	Shaft	Base	Total	Shaft	Base	Total	Shaft	Base	Total
4.0									
4.5	10	20	30	10	45	55	15	85	100
5.0	20	25	45	20	55	75	30	100	130
5.5	30	30	60	35	65	100	45	115	160
6.0	40	35	75	50	75	125	65	130	195
6.5	50	40	90	65	85	150	85	150	235
7.0	60	40	100	80	95	175	105	170	275
7.5	70	50	120	95	105	200	125	190	315
8.0	80	55	135	110	120	230	145	215	360
8.5	90	60	150	125	135	260	165	235	400
9.0	100	65	165	140	145	285	185	260	445
9.5	110	70	180	155	160	315	205	285	490
10.0	120	80	200	170	175	345	230	315	545
10.5	130	85	215	190	190	380	255	340	595
11.0	140	90	230	210	210	420	280	370	650



Appendix D Chemical Laboratory Testing

Appendix D.1 Conceptual Site Model

Table D.I.I CSM Revised Pre Testing

Source (See Error! Reference source not found. and Error! Reference source not found.)	Potential Contaminant (See Error! Reference source not found.)	Exposure Pathway (See Error! Reference source not found.)	Receptor (See Error! Reference source not found.)	Initial Assessment from Desk Study Information			Comments	Proposed Investigation
				Severity	Probability	Risk		
Licensed Waste Management Facility - T J Waste & Recycling Limited (household waste) N 45m	Metals, semi-metals	Inhalation of dust	Site Workers/Site Maintenance	Mild	Low	Low	Recycling facility presents possible metals, semi-metals and organic compound contamination risk. Located within hydraulic gradient of the site.	Phase II ground investigation with targeted soil sampling to confirm the ground conditions present and allow for chemical testing prior to undertaking a generic quantitative risk assessment.
			End Users	Mild	Low	Low		
			Off-site Users	Mild	Unlikely	Very low		
	Organic compounds	Inhalation of Vapour/gases	Site Workers/Site Maintenance	Mild	Unlikely	Very low		
			End Users	Mild	Unlikely	Very low		
			Off-site Users	Mild	Unlikely	Very low		
			Off-site Users	Mild	Unlikely	Very low		
	Metals, semi-metals, organic compounds	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	Mild	Low	Low		
			End Users	Mild	Low	Low		
	Metals, semi-metals, organic compounds	Migration via surface runoff	Surface Water	n/a	n/a	None		
		Migration in solution via groundwater	Surface Water	n/a	n/a	None		
			Shallow Aquifer	Mild	Low	Low		
			Deep Aquifer	Mild	Low	Low		
	None	Direct contact with construction material	Buried structures	n/a	n/a	None		
			Buried Services	n/a	n/a	None		
	None	Migration of gases via permeable soils	Site Workers/Site Maintenance	n/a	n/a	None		
			End Users	n/a	n/a	None		
			Off-site Users	n/a	n/a	None		
			Building and confined spaces	n/a	n/a	None		
Potentially Infilled Land (Water) SE 21m	None	Inhalation of dust	Site Workers/Site Maintenance	n/a	n/a	None	Potentially infilled land present soil-gas risk, if infilled using putrescible materials. However, the source is of small scale.	Phase II ground investigation with well installations to allow for a period of prolonged soil-gas monitoring.
			End Users	n/a	n/a	None		
			Off-site Users	n/a	n/a	None		
	Soil-gas	Inhalation of Vapour/gases	Site Workers/Site Maintenance	Minor	Unlikely	Very low		
			End Users	Mild	Low	Low		
			Off-site Users	Mild	Unlikely	Very low		
	None	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	n/a	n/a	None		
			End Users	n/a	n/a	None		
	None	Migration via surface runoff	Surface Water	n/a	n/a	None		
		Migration in solution via groundwater	Surface Water	n/a	n/a	None		
			Shallow Aquifer	n/a	n/a	None		
			Deep Aquifer	n/a	n/a	None		
	None	Direct contact with construction material	Buried structures	n/a	n/a	None		
			Buried Services	n/a	n/a	None		
	Soil-gas	Migration of gases via permeable soils	Site Workers/Site Maintenance	Minor	Unlikely	Very low		
			End Users	Mild	Low	Low		
			Off-site Users	Mild	Low	Low		
			Building and confined spaces	Mild	Low	Low		

Table D.I.2 CSM Revised Post Testing

Source (See Error! Reference source not found. and Error! Reference source not found.)	Potential Contaminant (See Error! Reference source not found.)	Exposure Pathway (See Error! Reference source not found.)	Receptor (See Error! Reference source not found.)	Initial Assessment from Desk Study Information			Comments	Proposed Investigation
				Severity	Probability	Risk		
Licensed Waste Management Facility - T J Waste & Recycling Limited (household waste) N 45m	Metals, semi-metals	Inhalation of dust	Site Workers/Site Maintenance	Mild	Low	None	No samples recorded contaminant concentrations in excess of the relevant C4SL or S4UL for the proposed end-use	Phase II ground investigation with targeted soil sampling to confirm the ground conditions present and allow for chemical testing prior to undertaking a generic quantitative risk assessment.
			End Users	Mild	Low	None		
			Off-site Users	Mild	Unlikely	None		
	Organic compounds	Inhalation of Vapour/gases	Site Workers/Site Maintenance	Mild	Unlikely	None		
			End Users	Mild	Unlikely	None		
			Off-site Users	Mild	Unlikely	None		
	Metals, semi-metals, organic compounds	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	Mild	Low	None		
			End Users	Mild	Low	None		
	Metals, semi-metals, organic compounds	Migration via surface runoff	Surface Water	n/a	n/a	None		
		Migration in solution via groundwater	Surface Water	n/a	n/a	None		
			Shallow Aquifer	Mild	Low	None		
			Deep Aquifer	Mild	Low	None		
	None	Direct contact with construction material	Buried structures	n/a	n/a	None		
			Buried Services					
	None	Migration of gases via permeable soils	Site Workers/Site Maintenance	n/a	n/a	None		
			End Users					
			Off-site Users					
			Building and confined spaces					
Potentially Infilled Land (Water) SE 21m	None	Inhalation of dust	Site Workers/Site Maintenance	n/a	n/a	None	Potentially infilled land present soil-gas risk, if infilled using putrescible materials. However, the source is of small scale and <2m thick cohesive superficial deposits identified across the site prevent migration of soil gas.	Phase II ground investigation with well installations to allow for a period of prolonged soil-gas monitoring.
			End Users					
			Off-site Users					
	Soil-gas	Inhalation of Vapour/gases	Site Workers/Site Maintenance	Minor	Unlikely	None		
			End Users	Mild	Unlikely	None		
			Off-site Users	Mild	Unlikely	None		
	None	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	n/a	n/a	None		
			End Users					
	None	Migration via surface runoff	Surface Water	n/a	n/a	None		
		Migration in solution via groundwater	Surface Water	n/a	n/a	None		
			Shallow Aquifer					
			Deep Aquifer					
	None	Direct contact with construction material	Buried structures	n/a	n/a	None		
			Buried Services					
	Soil-gas	Migration of gases via permeable soils	Site Workers/Site Maintenance	Minor	Unlikely	None		
			End Users	Mild	Unlikely	None		
			Off-site Users	Mild	Unlikely	None		
			Building and confined spaces	Mild	Unlikely	None		

Appendix D.2 Chemical Laboratory Results



Lucy Philip
Soils Ltd
Thomas Telford House - Unit 11
Sun Valley Business Park
Winnall Close
Winchester
SO23 0LB

QTS Environmental Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410
russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 18-69092

Site Reference: Burndell Road, Yapton, West Sussex, BN18 0HR

Project / Job Ref: 16707

Order No: 15982

Sample Receipt Date: 11/01/2018

Sample Scheduled Date: 11/01/2018

Report Issue Number: 1

Reporting Date: 17/01/2018

Authorised by:

Russell Jarvis
Associate Director of Client Services

Authorised by:

Dave Ashworth
Deputy Quality Manager

QTSE is the trading name of DETS Ltd, company registration number 03705645



QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate						
QTS Environmental Report No: 18-69092	Date Sampled	None Supplied	None Supplied	None Supplied		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Burndell Road, Yapton, West Sussex, BN18 0HR	TP / BH No	WS101	WS103	WS104		
Project / Job Ref: 16707	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: 15982	Depth (m)	2.00	2.55	1.50		
Reporting Date: 17/01/2018	QTSE Sample No	309856	309857	309858		

Determinand	Unit	RL	Accreditation	(n)		
pH	pH Units	N/a	MCERTS	7.7	8.3	7.2
Total Sulphate as SO ₄	mg/kg	< 200	NONE	488	292	< 200
Total Sulphate as SO ₄	%	< 0.02	NONE	0.05	0.03	< 0.02
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	30	< 10	17
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.03	< 0.01	0.02
Total Sulphur	%	< 0.02	NONE	< 0.02	< 0.02	< 0.02
Ammonium as NH ₄	mg/kg	< 0.5	NONE	< 0.5	< 0.5	< 0.5
Ammonium as NH ₄	mg/l	< 0.05	NONE	< 0.05	< 0.05	< 0.05
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	19	16	51
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	9.5	8	25.4
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	< 3	MCERTS	5	< 3	< 3
Water Soluble Nitrate (2:1) as NO ₃	mg/l	< 1.5	MCERTS	2.7	< 1.5	< 1.5
W/S Magnesium	mg/l	< 0.1	NONE	1.5	1.2	2.4

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C

Subcontracted analysis (S)

(n) Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation



QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate - Sample Descriptions

QTS Environmental Report No: 18-69092

Soils Ltd

Site Reference: Burndell Road, Yapton, West Sussex, BN18 0HR

Project / Job Ref: 16707

Order No: 15982

Reporting Date: 17/01/2018

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
^ 309856	WS101	None Supplied	2.00	16.7	Brown clay
^ 309857	WS103	None Supplied	2.55	16.4	White chalk with stones
^ 309858	WS104	None Supplied	1.50	13	Brown sandy clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample ^{U/S}

Unsuitable Sample ^{U/S}

^ no sampling date provided; unable to confirm if samples are within acceptable holding times



QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate - Methodology & Miscellaneous Information

QTS Environmental Report No: 18-69092

Soils Ltd

Site Reference: Burndell Road, Yapton, West Sussex, BN18 0HR

Project / Job Ref: 16707

Order No: 15982

Reporting Date: 17/01/2018

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 diphenylcarbazine 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



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QTS Environmental Report No: 18-69093

Site Reference: Burndell Road, Yapton, West Sussex, BN18 0HR

Project / Job Ref: 16707

Order No: 15982

Sample Receipt Date: 11/01/2018

Sample Scheduled Date: 11/01/2018

Report Issue Number: 1

Reporting Date: 16/01/2018

Authorised by:

Russell Jarvis
Associate Director of Client Services

Authorised by:

Dave Ashworth
Deputy Quality Manager

QTSE is the trading name of DETS Ltd, company registration number 03705645



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Soil Analysis Certificate						
QTS Environmental Report No: 18-69093	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Burndell Road, Yapton, West Sussex, BN18 0HR	TP / BH No	WS101	WS101	WS102	WS102	WS103
Project / Job Ref: 16707	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: 15982	Depth (m)	0.20	0.50	0.20	0.60	0.20
Reporting Date: 16/01/2018	QTS Sample No	309859	309860	309861	309862	309863

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO 17025	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
pH	pH Units	N/a	MCERTS	6.8	6.7	6.5	6.8	6.7
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	14	< 10	17	15	13
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.01	< 0.01	0.02	0.02	0.01
Sulphide	mg/kg	< 5	NONE	< 5	< 5	< 5	< 5	< 5
Organic Matter	%	< 0.1	MCERTS	2.7	0.9	1.8	0.5	1.9
Total Organic Carbon (TOC)	%	< 0.1	MCERTS	1.6	0.5	1	0.3	1.1
Antimony (Sb)	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Arsenic (As)	mg/kg	< 2	MCERTS	6	6	5	2	5
Beryllium (Be)	mg/kg	< 0.5	NONE	< 0.5	0.6	< 0.5	0.5	< 0.5
W/S Boron	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS	19	23	19	19	20
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	10	10	9	5	10
Lead (Pb)	mg/kg	< 3	MCERTS	22	14	19	11	21
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	11	14	10	9	10
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3	< 3	< 3
Vanadium (V)	mg/kg	< 2	NONE	33	37	30	27	33
Zinc (Zn)	mg/kg	< 3	MCERTS	44	47	43	40	44
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2

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						
QTS Environmental Report No: 18-69093	Date Sampled	None Supplied	None Supplied	None Supplied		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Burndell Road, Yapton, West Sussex, BN18 0HR	TP / BH No	WS103	WS104	WS104		
Project / Job Ref: 16707	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: 15982	Depth (m)	0.80	0.20	0.80		
Reporting Date: 16/01/2018	QTS Sample No	309864	309865	309866		

Determinand	Unit	RL	Accreditation				
Asbestos Screen ^(S)	N/a	N/a	ISO 17025	Not Detected	Not Detected	Not Detected	
pH	pH Units	N/a	MCERTS	7.1	6.8	7.0	
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	< 10	14	12	
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	< 0.01	0.01	0.01	
Sulphide	mg/kg	< 5	NONE	< 5	< 5	< 5	
Organic Matter	%	< 0.1	MCERTS	0.7	2.6	0.7	
Total Organic Carbon (TOC)	%	< 0.1	MCERTS	0.4	1.5	0.4	
Antimony (Sb)	mg/kg	< 1	NONE	< 1	< 1	< 1	
Arsenic (As)	mg/kg	< 2	MCERTS	6	5	6	
Beryllium (Be)	mg/kg	< 0.5	NONE	0.7	< 0.5	0.7	
W/S Boron	mg/kg	< 1	NONE	< 1	< 1	< 1	
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2	< 0.2	< 0.2	
Chromium (Cr)	mg/kg	< 2	MCERTS	28	20	27	
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	
Copper (Cu)	mg/kg	< 4	MCERTS	11	10	10	
Lead (Pb)	mg/kg	< 3	MCERTS	10	21	12	
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1	
Nickel (Ni)	mg/kg	< 3	MCERTS	16	10	14	
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3	
Vanadium (V)	mg/kg	< 2	NONE	39	32	38	
Zinc (Zn)	mg/kg	< 3	MCERTS	48	44	48	
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2	

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						
QTS Environmental Report No: 18-69093	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Burndell Road, Yapton, West Sussex, BN18 0HR	TP / BH No	WS101	WS101	WS102	WS102	WS103
Project / Job Ref: 16707	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: 15982	Depth (m)	0.20	0.50	0.20	0.60	0.20
Reporting Date: 16/01/2018	QTSE Sample No	309859	309860	309861	309862	309863

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6

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 - Speciated PAHs						
QTS Environmental Report No: 18-69093	Date Sampled	None Supplied	None Supplied	None Supplied		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Burndell Road, Yapton, West Sussex, BN18 0HR	TP / BH No	WS103	WS104	WS104		
Project / Job Ref: 16707	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: 15982	Depth (m)	0.80	0.20	0.80		
Reporting Date: 16/01/2018	QTSE Sample No	309864	309865	309866		

Determinand	Unit	RL	Accreditation				
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	< 1.6	

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 - Sample Descriptions

QTS Environmental Report No: 18-69093

Soils Ltd

Site Reference: Burndell Road, Yapton, West Sussex, BN18 0HR

Project / Job Ref: 16707

Order No: 15982

Reporting Date: 16/01/2018

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
^ 309859	WS101	None Supplied	0.20	21.5	Brown sandy clay
^ 309860	WS101	None Supplied	0.50	16.2	Brown sandy clay
^ 309861	WS102	None Supplied	0.20	20.2	Brown sandy clay
^ 309862	WS102	None Supplied	0.60	15.9	Brown sandy clay
^ 309863	WS103	None Supplied	0.20	17.1	Brown sandy clay
^ 309864	WS103	None Supplied	0.80	16	Brown sandy clay
^ 309865	WS104	None Supplied	0.20	17.4	Brown sandy clay with stones
^ 309866	WS104	None Supplied	0.80	14.3	Brown sandy clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample ^{1/5}

Unsuitable Sample ^{1/5}

^ no sampling date provided; unable to confirm if samples are within acceptable holding times



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Soil Analysis Certificate - Methodology & Miscellaneous Information

QTS Environmental Report No: 18-69093

Soils Ltd

Site Reference: Burndell Road, Yapton, West Sussex, BN18 0HR

Project / Job Ref: 16707

Order No: 15982

Reporting Date: 16/01/2018

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 diphenylcarbazine 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 D.3 General Assessment Criteria

HUMAN HEALTH RISK ASSESSMENT

1.1 Introduction

Human Health Generic Quantitative Risk Assessment (GQRA) involves the comparison of contaminant concentrations measured in soil at the site with Generic Assessment Criteria (GAC).

GAC are conservative values adopted to ensure that they are applicable to the majority of possible contaminated site. These values may be published Contaminated Land Exposure Assessment Model (CLEA) derived GAC derived by a third party or the Environment Agency/ DEFRA. It is imperative to the risk assessor to understand the uncertainties and limitations associated with these GAC to ensure that they are used appropriately. Where the adoption of a GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses, then a Detailed Quantitative Risk Assessment (DQRA) may be undertaken to develop site specific values for relevant soil contaminants based on the site specific conditions.

1.2 General Assessment Criteria

The Contaminated Land Regime reflects the UK Government's stated objectives of achieving sustainable development through the 'suitable for use approach'.

1.2.1 Contaminated Land Exposure Assessment Model (CLEA)

Current United Kingdom risk assessment practice is based on the Contaminated Land Exposure Assessment Model (CLEA).

The CLEA Guidance comprises the following documents:

- EA Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil.
 - EA Science Report SC050021/SR3: Updated technical background to the CLEA model.
 - EA CLEA Bulletin (2009).
 - CLEA software version 1.04 (2009)
 - Toxicological reports and SGV technical notes.
-

The CLEA guidance and tools:

1. do not cover other types of risk to humans, such as fire, suffocation or explosion, or short-term and acute exposures.
 2. do not cover risks to the environment, such as groundwater, ecosystems or buildings.
 3. do not provide a definitive test for telling when human health risks are significant.
 4. are not a legal requirement in assessing land contamination risks. They are not part of the legal regime for Part 2A of the Environmental Protection Act 1990.
-

1.3 Soil Guideline Values (2009)

The EA are publishing a series of SGV reports for a selection of common contaminants relevant to the assessment of land contamination.

SGV's are generic assessment criteria based on CLEA standard land-uses and can be used to simplify the assessment of human health risks from long-term exposure to

chemical contamination in soil. They do not cover short-term exposure (i.e. construction and maintenance workers), acute exposure or other risks such as fire, suffocation or explosion, as might arise from an accumulation of gases such as methane and carbon dioxide, or either odour or aesthetic issues.

SGV's represent 'trigger values', indicators that soil concentrations above the SGV level may pose a possibility of *significant harm* to human health. The converse, where soil concentrations are less than the SGV, is that the long-term human health risks are considered to be tolerable or minimal.

The CLEA guidance derives soil concentrations of contaminants above which (in the opinion of the EA) there may be a concern that warrants further investigation. It does not provide a definitive test for establishing that the risk is significant.

1.4 Ongoing development of CLEA based guidance

The EA is involved in a programme of publishing SGV's and related toxicity data (the TOX reports). As at July 2009 ten SGV's and matching TOX reports had been published. Soil Assessment Criteria (SAC's) may be derived using toxicity data from the updated TOX reports, where these are published, or from the original TOX reports. SGV reports also take account of recent updates for plant uptake and other factors.

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- GAC's developed by CLEA guidance and given in this report will need to be assessed against updated TOX reports and SGV's when these are published.
 - SGV reports may give values that differ from the GAC's used in this report.
 - These variations may materially alter the remediation requirement for the site, requiring either an increase or decrease in the extent, type and cost of remediation.
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1.5 Phytotoxicity

CLEA guidance only addresses human health toxicity; assessment of plant toxicity (phytotoxicity) is based on threshold trigger values obtained from the following source:

ICRCL 70/90: *Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing.*

1.6 Other Generic Assessment Criteria

If an SGV is not available for a substance identified in the soil then the range of Generic Assessment Criteria published from a collaborative research by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health (CIEH) are used for example. In the case of Lead, Category 4 screening levels (C4SLs) have replaced the AtRisk Soil SSV.

1.6.1 EIC/AGS/CL: AIRE

The report represents the collaborative effort of risk assessors from 26 EIC and AGS member companies to produce generic assessment criteria (GAC) for soils for human health risk assessment. The project involved the collation and review of physico-chemical data, toxicological data and information on background

exposure for 44 contaminants sometimes encountered on land affected by contamination in the UK and the derivation of GAC for 351 of these using the CLEA model (v1.06). The GAC are intended to complement soil guideline values (SGV) produced by the Environment Agency of England and Wales and the 2nd edition GAC produced by LQM and CIEH (Nathanail *et al*, 2009). All three sets of assessment criteria have been derived in general accordance with the Environment Agency of England and Wales Contaminated Land Exposure Assessment (CLEA) guidance and thus the combined efforts of these three groups have resulted in a useful set of screening criteria for the assessment of risks to human health from soil contamination for more than 120 potentially contaminative substances.

1.6.2 CL: AIRE Category 4 screening levels (C4SLs) (2014)

A new statutory DEFRA guidance recently (i.e. August 2014) published some GACs with a more pragmatic (but still strongly precautionary) approach in their derivation called the Category 4 screening levels (C4SLs). These values provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land. They are intended as generic screening values, (ii) they describe a level of risk that whilst above 'minimal' is still 'low' and (iii) they provide a 'higher simple test' for deciding that land is suitable for use and definitely not contaminated. These values were derived for four generic land uses: residential, commercial, allotments, and public open space.

1.6.3 LQM/CIEH Suitable 4 Use Level (S4UL) (2015)

The new S4UL's ((Nathanail *et al*, 2015), was developed for around 85 substances and are intended to enable a screening assessment of the risks posed by soil quality on development sites. The updated LQM/CIEH GAC publication was developed to accommodate recent developments in the understanding of chemical, toxicological and routine exposure to soil-based contaminants. The S4ULs were:

- based on Health Criteria Values, updated to reflect changes since 2009
- derived for the standard CLEA land uses and the two public open space scenarios developed by Defra SP1010
- developed for ca 85 substances (those previously covered by the LQM/CIEH GAC and the SGV substances);
- Compliant with SR2 and the long standing principle of 'suitable for use' and reflecting changes to exposure parameters produced by Defra SP1010.

For derivation of these Generic Assessment Criteria reference must be made to: Nathanail, P., McCaffrey, C., Ashmore, M., Cheng, Y., Gillet, A., Ogden, R., Scott, D. *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (3rd edition)*. **Land Quality Press**. 2015.

1.7 Standard Land-use Scenarios

The standard land-use scenarios used to develop conceptual exposure models are presented in the following sections:

1.7.1 Residential

Generic scenario assumes a typical two-storey house built on a ground bearing slab with a private garden having a lawn, flowerbeds and a small fruit and vegetable patch.

- | |
|--|
| • Critical receptor is a young female child (zero to six years old) |
| • Exposure duration is six years. |
| • Exposure pathways include direct soil and indoor dust ingestion, consumption of home-grown produce and any adhering soil, skin contact with soils and indoor dust and inhalation of indoor and outdoor dust and vapours. |
| • Building type is a two-storey small terraced house. |

A sub-set of this land-use is residential apartments with communal landscaped gardens where the consumption of home grown vegetables will not occur.

1.7.2 Allotments

Provision of open space (about 250sq.m) commonly made available to tenants by the local authority to grow fruit and vegetable for their own consumption. Typically, there are a number of plots to a site which may have a total area of up to 1 hectare. The tenants are assumed to be adults and that young children make occasional accompanied visits.

Although some allotment holders may choose to keep animals including rabbits, hens, and ducks, potential exposure to contaminated meat and eggs is not considered.

- | |
|--|
| • Critical receptor is a young female child (zero to six years old) |
| • Exposure duration is six years. |
| • Exposure pathways include direct soil ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and inhalation of outdoor dust and vapours. |
| • There is no building. |

1.7.3 Commercial/Industrial

The generic scenario assumes a typical commercial or light industrial property comprising a three-storey building at which employees spend most time indoors and are involved in office-based or relatively light physical work.

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| • Critical receptor is a working female adult (aged 16 to 65 years old). |
| • Exposure duration is a working lifetime of 49 years. |
| • Exposure pathways include direct soil and indoor dust ingestion, skin contact with soils and dusts and inhalation of dust and vapours. |
| • Building type is a three-storey office (pre 1970). |

1.7.4 Public Open Space within Residential Area

The generic scenario refers to any grassed area 0.05 ha and that is close to Housing.

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- Grassed area of up to 0.05 ha and a considerable proportion of this (up to 50%) may be bare soil
-
- Predominantly used by children for playing and may be used for activities such as a football kick about
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- Sufficiently close proximity to home for tracking back of soil to occur, thus indoor exposure pathways apply
-
- older children as the critical receptor on basis that they will use site most frequently (Age class 4-9)
-
- ingestion rate 75 mg.day⁻¹
-

1.7.5 Public Open Space Park

This generic scenario refers to any public park that is more than 0.5ha in area:

-
- Public park (>0.5 ha), predominantly grassed and may also contain children's play equipment and border areas of soil containing flowers or shrubs (75% cover)
-
- Female child age classes 1-6
-
- Soil ingestion rate of 50 mg.day⁻¹
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- Occupancy period outdoors = 2 hours.day⁻¹
-
- Exposure frequency of 170 days.year⁻¹ for age classes 2-18 and 85
-
- days.year⁻¹ for age class 1
-
- Outdoor exposure pathways only (no tracking back).
-

1.8 Detailed Quantitative Risk Assessments (DQRA)

Where the adoption of an SGV/GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses, then a DQRA may be undertaken to develop site specific values for relevant soil contaminants.

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- Establishing the plausibility that generic exposure pathways exist in practice by measurement and observation.
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- Developing more accurate parameters using site data.
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1.9 Current Criteria

Table 1 presents the current Generic Assessment Criteria and reference should be made to the original publications if needed.

1.10 Statistical Tests

DEFRA R&D Publication CLR 7 (DOE 1994) and CL: AIRE Category 4 screening levels (C4SLs) (2014) addressed the statistical treatment of test results and their comparison to Soil Guideline Values.

Consideration must be given to the appropriate area of land to be considered termed the critical averaging area.

For a communal open space or commercial land-use, the critical averaging area will depend on the proposed layout. For a residential use with private gardens the averaging area is the individual plot.

It may be appropriate to compare the upper 95th percentile concentration with the Soil Guideline Value, subject to applying a statistical test to establish that the range of concentrations are reasonably consistent and belonging to the same underlying distribution of data.

The DEFRA discussion paper Assessing risks from land contamination – a proportionate approach ('the way forward') (CLAN06/2006) aimed to increase understanding of the role that statistics can play in quantifying the uncertainty attached to the estimates of the mean concentration of contaminants in soil. In direct response CLAIRE/CIEH published a joint report, *Guidance in comparing soil contamination data with a critical concentration* (CLAIRE/CIEH 2008). A software implementation of the statistical techniques given in the report was published by ESI International (2008).

Treatment of Hot-Spots

- A statistical test is applied to establish whether the data is a part of a single set, or whether data outliers are present.
 - Provided that the data is based on random sampling and no distinct contamination source was present at the sampling location, the hot-spot(s) may be excluded and the mean of the remaining data assessed.
-

Land Use			Residential With or Without Plant Uptake									Public Open Space (POS)									Name	Authority	Date		
			With			Without			Allotments			Commercial			Residential			Park							
			home-grown produce	1.0	2.5	6	home-grown produce	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1				2.5	6
Type	Contaminants	Species	Year	SGM	1.0	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6			
Metals	Antimony		2010							550				7500									EIC/AGS/CLAIRE	EIC/AGS/CLAIRE	2010
	Arsenic		2014				37			40			49		640		79		168			C4SL	DEFRA	2014	
			2015			37			40		40		640		79		170		S4UL	LQM/CIEH	2015				
	Beryllium		2015			1.7			1.7		35		12		2.2		63		S4UL	LQM/CIEH	2015				
	Boron		2015			290			11000		45		240000		21000		46000		S4UL	LQM/CIEH	2015				
	Cadmium		2015			11			85		1.9		190		120		532		S4UL	LQM/CIEH	2015				
	Chromium	III	2014			28			149		4.9		410		220		800		C4SL	DEFRA	2014				
			2015			910			910		18000		8600		1500		33000		S4UL	LQM/CIEH	2015				
			2014			21			21		170		49		22		250		C4SL	DEFRA	2014				
			2015			6			6		1.8		33		7.7		220		S4UL	LQM/CIEH	2015				
			Copper	2015			2400			7100		520		68000		12000		44000		S4UL	LQM/CIEH	2015			
			Lead					200			310		80		2330		630		1300		C4SL	DEFRA	2014		
	Mercury	Elemental	2012				1.0			1.0		26		26							SGV	DEFRA	2012		
			2015				1.2			1.2		21		58		16		30		S4UL	LQM/CIEH	2015			
			2012				170			170		80		36000						SGV	DEFRA	2012			
			2015				40			56		19		1100		120		240		S4UL	LQM/CIEH	2015			
			2012				11			11		8		410						SGV	DEFRA	2012			
			2015				11			15		6		320		40		68		S4UL	LQM/CIEH	2015			
	Nickel		2012				130			130		230		1800							SGV	DEFRA	2012		
			2015				130			180		53		980		230		800		S4UL	LQM/CIEH	2015			
	Selenium		2012				350			350		120		13000							SGV	DEFRA	2012		
			2015				250			430		88		12000		1100		1800		S4UL	LQM/CIEH	2015			
	Vanadium		2015				410			1200		91		9000		2000		5000		S4UL	LQM/CIEH	2015			
	Zinc		2015				3700			40000		620		730000		81000		170000		S4UL	LQM/CIEH	2015			
BTEX & MTBE	Benzene		2012				0.33			0.33		0.07		95							SGV	DEFRA	2012		
			2014				0.87			3.3		0.18		98		140		230		C4SL	DEFRA	2014			
			2015	0.087	0.17	0.37	0.38	0.7	1.4	0.017	0.034	0.075	27	47	90	72	72	73	90	100	110	S4UL	LQM/CIEH	2015	
	Toluene		2012				610			610		120		4400							SGV	DEFRA	2012		
			2015	130	290	660	880	1900	3900	22	51	120	65000	110000	180000	56000	56000	56000	87000	95000	100000	S4UL	LQM/CIEH	2015	
	Ethylbenzene		2012				350			350		90		2800							SGV	DEFRA	2012		
			2015	47	110	260	83	190	440	16	39	91	4700	13000	27000	24000	24000	25000	17000	22000	27000	S4UL	LQM/CIEH	2015	
	Xylenes	o-xylene	2012				250			250		160		2600								SGV	DEFRA	2012	
			2015	60	140	330	88	210	480	28	67	160	6600	15000	33000	41000	42000	43000	17000	24000	33000	S4UL	LQM/CIEH	2015	
			2012				240			240		180		3500								SGV	DEFRA	2012	
			2015	59	140	320	82	190	450	31	74	170	6200	14000	31000	41000	42000	43000	17000	24000	32000	S4UL	LQM/CIEH	2015	
			2012				230			230		160		3200									SGV	DEFRA	2012
			2015	56	130	310	79	180	310	29	69	160	5900	14000	30000	41000	42000	43000	17000	23000	31000	S4UL	LQM/CIEH	2015	
Petroleum Hydrocarbons Fractions	Aliphatic >C3 - C6		2015	42	78	160	42	78	160	730	1700	3900	3200	5900	12000	570000	590000	600000	95000	130000	180000	S4UL	LQM/CIEH	2015	
	Aliphatic >C6 - C8		2015	100	230	530	100	230	530	2300	5600	13000	7800	17000	40000	600000	610000	620000	150000	220000	320000	S4UL	LQM/CIEH	2015	
	Aliphatic >C8 - C10		2015	27	65	150	27	65	150	320	770	1700	2000	4800	11000	13000	13000	13000	14000	18000	21000	S4UL	LQM/CIEH	2015	
	Aliphatic >C10 - C12		2015	130	330	760	130	330	770	2200	4400	7300	9700	23000	47000	13000	13000	13000	21000	23000	24000	S4UL	LQM/CIEH	2015	
	Aliphatic >C12 - C16		2015	1100	2400	4300	1100	2400	4400	11000	13000	13000	59000	82000	90000	13000	13000	13000	25000	25000	26000	S4UL	LQM/CIEH	2015	
	Aliphatic >C16 - C35		2015	65000	92000	110000	65000	92000	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000	S4UL	LQM/CIEH	2015	
	Aliphatic >C35 - C44		2015	65000	92000	140000	65000	92000	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000	S4UL	LQM/CIEH	2015	
	Aromatic >C3 - C7		2015	70	140	300	370	690	1400	13	27	57	26000	46000	86000	56000	56000	56000	76000	84000	92000	S4UL	LQM/CIEH	2015	
	Aromatic >C7 - C8		2015	130	290	660	860	1800	3900	22	51	120	56000	110000	180000	56000	56000	56000	87000	95000	100000	S4UL	LQM/CIEH	2015	
	Aromatic >C8 - C10		2015	34	83	190	47	110	270	8.6	21	51	3500	8100	17000	5000	5000	5000	7200	8500	9300	S4UL	LQM/CIEH	2015	
	Aromatic >C10 - C12		2015	74	180	380	250	590	1200	13	31	74	16000	28000	34000	5000	5000	5000	9200	9700	10000	S4UL	LQM/CIEH	2015	
	Aromatic >C12 - C16		2015	140	330	660	1800	2300	2500	23	57	130	36000	37000	38000	5100	5100	5000	10000	10000	10000	S4UL	LQM/CIEH	2015	
Aromatic >C16 - C21		2015	260	540	930	1900	1900	1900	46	110	260	28000	28000	28000	3800	3800	3800	7600	7700	7800	S4UL	LQM/CIEH	2015		

Land Use			Residential With or Without Plant Uptake									Allotments			Commercial			Public Open Space (POS)						Media	Authority	Date
			With			Without			Residential									Park								
			SOM	1.0	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6					
Type	Contaminants	Species	Year																							
	Aromatic >C21 - C35		2015	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015		
	Aromatic >C34 - C44		2015	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015		
	Aliphatic + Aromatic >C44 - C70			1600	1800	1900	1900	1900	1900	1200	2100	3000	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015		
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)	Acenaphthene		2015	210	510	1100	3000	4700	6000	34	85	200	84000	97000	100000	15000	15000	15000	29000	30000	30000	S4UL	LQM/CIEH	2015		
	Acenaphthylene		2015	170	420	920	2900	4600	6000	28	69	160	83000	97000	100000	15000	15000	15000	29000	30000	30000	S4UL	LQM/CIEH	2015		
	Anthracene		2015	2400	5400	11000	31000	35000	37000	380	950	2200	520000	54000	540000	74000	74000	74000	150000	150000	150000	S4UL	LQM/CIEH	2015		
	Benzo(a)anthracene		2015	7.2	11	13	11	14	15	2.9	6.5	13	170	170	180	29	29	29	49	56	62	S4UL	LQM/CIEH	2015		
	Benzo(a)pyrene		2014		5			5.3				5.7			76			10		21	CASL	DEFRA	2014			
			2015	2.2	2.7	3	3.2	3.2	3.2	0.97	2	3.5	35	35	36	5.7	5.7	5.7	11	12	13	S4UL	LQM/CIEH	2015		
	Benzo(b)fluoranthene		2015	2.6	3.3	3.7	3.9	4.0	4.0	0.99	2.1	3.9	44	44	45	7.1	7.2	7.2	13	15	16	S4UL	LQM/CIEH	2015		
	Benzo(g,h)perylene		2015	320	340	250	360	360	360	290	470	640	3900	4000	4000	640	640	640	1400	1500	1600	S4UL	LQM/CIEH	2015		
	Benzo(k)fluoranthene		2015	77	93	100	110	110	110	37	75	130	1200	1200	1200	190	190	190	370	410	440	S4UL	LQM/CIEH	2015		
	Chrysene		2015	15	22	27	30	31	32	4.1	9.4	19	350	350	350	57	57	57	93	110	120	S4UL	LQM/CIEH	2015		
	Dibenz(a,h)anthracene		2015	0.24	0.28	0.3	0.31	0.32	0.32	0.14	0.27	0.43	3.5	3.6	3.6	0.57	0.57	0.58	1.1	1.3	1.4	S4UL	LQM/CIEH	2015		
	Fluoranthene		2015	280	560	890	1500	1600	1600	52	130	290	23000	23000	23000	3100	3100	3100	6300	6300	6400	S4UL	LQM/CIEH	2015		
	Fluorene		2015	170	400	860	2800	3800	4500	27	67	160	63000	68000	71000	9900	9900	9900	20000	20000	20000	S4UL	LQM/CIEH	2015		
	Indeno(1,2,3-cd)pyrene		2015	27	36	41	45	46	46	9.5	21	39	500	510	510	82	82	82	150	170	180	S4UL	LQM/CIEH	2015		
	Naphthalene		2015	2.3	5.6	13	2.3	5.6	13	4.1	10	24	190	460	1100	4900	4900	4900	1200	1900	3000	S4UL	LQM/CIEH	2015		
	Phenanthrene		2015	95	220	440	1300	1500	1500	15	38	90	22000	22000	23000	3100	3100	3100	6200	6200	6300	S4UL	LQM/CIEH	2015		
	Pyrene		2015	620	1200	2000	3700	3800	3800	110	270	620	54000	54000	54000	7400	7400	4700	15000	15000	15000	S4UL	LQM/CIEH	2015		
	Coal Tar(Bap as surrogate matter)		2015	0.79	0.98	1.1	1.2	1.2	1.2	0.32	0.67	1.2	15	15	15	2.2	2.2	2.2	4.4	4.7	4.8	S4UL	LQM/CIEH	2015		
Chloroalkanes & alkenes	1,2 Dichloroethane		2015	0.0071	0.011	0.019	0.0092	0.013	0.023	0.0046	0.0083	0.016	0.67	0.97	1.7	29	29	29	21	24	28	S4UL	LQM/CIEH	2015		
	1,1,1 Trichloroethane		2015	8.8	18	39	9	18	40	48	110	240	660	1300	3000	140000	140000	140000	57000	76000	100000	S4UL	LQM/CIEH	2015		
	1,1,2,2 Tetrachloroethane		2015	1.6	3.4	7.5	3.9	8	17	0.41	0.89	2	270	550	1100	1400	1400	1400	1800	2100	2300	S4UL	LQM/CIEH	2015		
	1,1,1,2 Tetrachloroethane		2015	1.2	2.8	6.4	1.5	3.5	8.2	0.79	1.9	4.4	110	250	560	1400	1400	1400	1500	1800	2100	S4UL	LQM/CIEH	2015		
	Tetrachloroethene		2015	0.18	0.39	0.9	0.18	0.4	0.92	0.65	1.5	3.6	19	42	95	1400	1400	1400	810	1100	1500	S4UL	LQM/CIEH	2015		
	Tetrachloromethane (Carbon Tetrachloride)		2015	0.026	0.056	0.13	0.026	0.056	0.13	0.45	1	2.4	2.9	6.3	14	890	920	950	190	270	400	S4UL	LQM/CIEH	2015		
	Trichloroethene		2015	0.016	0.034	0.075	0.017	0.036	0.08	0.041	0.091	0.21	1.2	2.6	5.7	120	120	120	70	91	120	S4UL	LQM/CIEH	2015		
	Trichloromethane		2015	0.91	1.7	3.4	1.2	2.1	4.2	0.42	0.83	1.7	99	170	350	2500	2500	2500	2600	2800	3100	S4UL	LQM/CIEH	2015		
	Vinyl Chloride (chloroethene)		2015	0.00064	0.00087	0.0014	0.00077	0.001	0.0015	0.00055	0.001	0.0018	0.059	0.077	0.12	3.5	3.5	3.5	4.8	5	5.4	S4UL	LQM/CIEH	2015		
Explosives	2,4,6 Trinitrotoluene		2015	1.6	3.7	8.1	65	66	66	0.24	0.58	1.4	1000	1000	1000	130	130	130	260	270	270	S4UL	LQM/CIEH	2015		
	RDX (Hexogen/Cyclonite/1,3,5-trinitro-1,3,5-triazacyclohexane)		2015	120	250	540	13000	13000	13000	17	38	85	210000	210000	210000	26000	26000	27000	49000	51000	53000	S4UL	LQM/CIEH	2015		
	HMX (Octogen/1,3,5,7-tetranitro-1,3,5,7-tetrazacyclo-octane)		2015	5.7	13	26	6700	6700	6700	0.86	1.9	3.9	110000	110000	110000	13000	13000	13000	23000	23000	24000	S4UL	LQM/CIEH	2015		
Pesticides	Aldrin		2015	5.7	6.6	7.1	7.3	7.4	7.5	3.2	6.1	9.6	170	170	170	18	18	18	30	31	31	S4UL	LQM/CIEH	2015		
	Dieldrin		2015	0.97	2	3.5	7	7.3	7.4	0.17	0.41	0.96	170	170	170	18	18	18	30	30	31	S4UL	LQM/CIEH	2015		
	Atrazine		2015	3.3	7.6	17.4	610	620	620	0.5	1.2	2.7	9300	9400	9400	1200	1200	1200	2300	2400	2400	S4UL	LQM/CIEH	2015		
	Dichlorvos		2015	0.032	0.066	0.14	6.4	6.5	6.6	0.0049	0.01	0.022	140	140	140	16	16	16	26	26	27	S4UL	LQM/CIEH	2015		
	Alpha - Endosulfan		2015	7.4	18	41	160	280	410	1.2	2.9	6.8	5600	7400	8400	1200	1200	1200	2400	2400	2500	S4UL	LQM/CIEH	2015		
	Beta - Endosulfan		2015	7	17	39	190	320	440	1.1	2.7	6.4	6300	7800	8700	1200	1200	1200	2400	2400	2500	S4UL	LQM/CIEH	2015		
	Alpha -Hexachlorocyclohexanes		2015	0.23	0.55	1.2	6.9	9.2	11	0.035	0															

Land Use			Residential With or Without Plant Uptake									Public Open Space (POS)									Media	Authority	Date			
			With						Allotments			Commercial			Residential									Park		
			home-grown produce			Without home-grown produce																				
Type	Contaminants	Species	Year	SOM	1.0	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6				
Phenols & Chlorophenols	1,2,3,4,-Tetrachlorobenzene		2015	15	36	78	24	56	120	4.4	11	26	1700	3080	4400	830	830	830	1500	1600	1600	S4UL	LQM/CIEH	2015		
	1,2,3,5,- Tetrachlorobenzene		2015	0.66	1.6	3.7	0.75	1.9	4.3	0.38	0.9	2.2	49	120	240	78	79	79	110	120	130	S4UL	LQM/CIEH	2015		
	1,2,4, 5,- Tetrachlorobenzene		2015	0.33	0.77	1.6	0.73	1.7	3.5	0.06	0.16	0.37	42	72	96	13	13	13	25	26	26	S4UL	LQM/CIEH	2015		
	Pentachlorobenzene		2015	5.8	12	22	19	30	38	1.2	3.1	7	640	770	830	100	100	100	190	190	190	S4UL	LQM/CIEH	2015		
	Hexachlorobenzene		2015	1.8	3.3	4.9	4.1	5.7	6.7	0.47	1.1	2.5	110	120	120	16	16	16	30	30	30	S4UL	LQM/CIEH	2015		
	Phenols		2012				420			420			280			3200						SGV	DEFRA	2012		
			2015	120	200	380	440	690	1200	23	42	83	440	690	1300	440	690	1300	440	690	1300	S4UL	LQM/CIEH	2015		
	Chlorophenols (4 Congeners)		2015	0.87	2	4.5	94	150	210	0.13	0.3	0.7	3500	4000	4300	620	620	620	1100	1100	1100	S4UL	LQM/CIEH	2015		
	Pentachlorophenols		2015	0.22	0.52	1.2	27	29	31	0.03	0.08	0.19	400	400	400	60	60	60	110	120	120	S4UL	LQM/CIEH	2015		
Others																										
	Carbon Disulphide		2015	0.14	0.29	0.62	0.14	0.29	0.62	4.8	10	23	11	22	47	11000	11000	12000	1300	1900	2700	S4UL	LQM/CIEH	2015		
	Hexachloro-1,3-Butadiene		2015	0.29	0.7	1.6	0.32	0.78	1.8	0.25	0.61	1.4	31	66	120	25	25	25	48	50	51	S4UL	LQM/CIEH	2015		
	Sum of PCDDs, PCDFs and dioxin-like PCB's.		2012				8		8			8			240							SGV	DEFRA	2012		

NOTE		
Priority	Guideline (mg kg ⁻¹)	
1	Site Specific Assessment Criteria (SSAC) (Soils Limited)	
2	2014: Category 4 Screening Level (C4SL) (Contaminated Land: Application in Real Environment (CLARE), 2014)	
3	2012: Soil Guideline Value (SGV) (Environment Agency, 2009)	
4	2015: Suitable 4 Use Level (S4UL) (Nathanail <i>et al</i> , 2015)	
For Generic Risk Assessment, the values in Bold have priority		

Appendix D.4 Determination of Hazardous Waste Classification

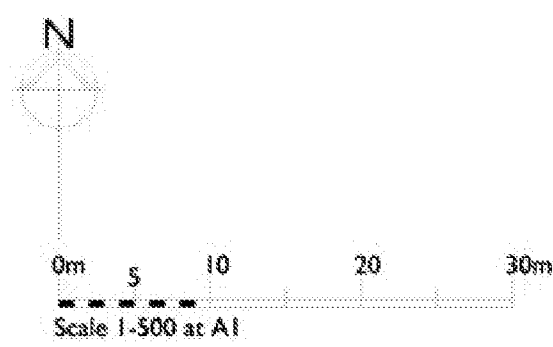
Software such as the HazWasteOnline produced Hazardous Waste Classification Tool, enables soils 'total' chemical testing data to be used to identify the classification of waste soils in accordance with Environment Agency guidance. The HazWasteOnline Hazardous Waste Classification Tool was designed primarily for the classification of soil wastes as identified by the European Waste Catalogue (EWC) Chapter 17 - Construction and demolition wastes (including contaminated soils).

The classification of waste as either hazardous or non-hazardous must be conducted in accordance with the 2003 Environment Agency publication Interpretation of the Definition and Classification of Hazardous Waste (Technical Guidance WM2). This establishes the regulatory framework and allows classification of wastes based on their various risk phrases. Additional guidance provided by the 2007 Environment Agency publication 'How to Find Out if Waste Oil and Wastes that Contain Oil Are Hazardous' (HWR08) provides further clarification on the classification methodology for hydrocarbon contamination.

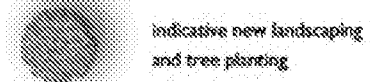
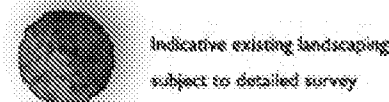
As part of the Hazardous Waste Classification process, contaminant compounds are selected based on historical and contemporary land-use. The inclusion of such data on the input form enables the correct waste classification to be determined. For example, in cases of land associated with former gasworks, the classification of coal-tar contaminated soils can be partially determined using total PAH concentrations as opposed to TPH concentrations as coal-tar may be deemed a "substance". Hazardous (HWR08) provides further clarification on the classification methodology for hydrocarbon contamination.

Appendix E Information Provided by the Client

REVISIONS				
REV.	DESCRIPTION	DRAWN	CHECKED	DATE
A	New Site Layout	HR	SS	09/11/17
B	Plots 16-17 & 34-35 ref. revised	HR	SS	01/12/17



Final boundary positions to be agreed.
All subject to detailed site survey.



fence plot division

affordable housing

Brick wall with gas

1000mm high feature railings

Refuse:recycle

 B.C.P.
 Bin Collection Point

Precautionary land areas requiring special surface treatment.
See Barrell Tree Care Information and drawings.



urban pulse design

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Land Of Burndell Road
Yapton

Mildred Holmes

Project type	Design classification	Work stage
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Housing		Site Layout
DRAWING TITLE		

Site Plan, Coloured

MILDBEN

MILDRDEN HOMES

SCALE	SWIFT SIZE	SWIFT No.	DRAGON	CHSD	DATE	CAD FILE
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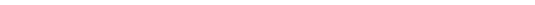
1.500	A1	41	99	01/12/2017
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Detail Planning

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16-1016-002-B



Appendix E Information Provided by the Client