



Phase II Ground Investigation Report

at

**Orchard Business Park, North End Road, Yapton,
West Sussex BN18 0GA**

for

Crayfern Homes

Reference: 16671/GIR

February 2018

Control Document

Project

Orchard Business Park, North End Road, Yapton, West Sussex BN18 0GA

Document Type

Phase II Ground Investigation Report (GIR)

Document Reference

16671/Phase II GIR

Document Status

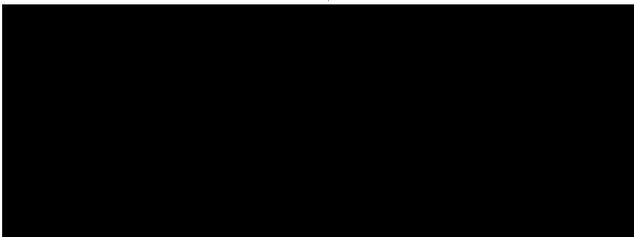
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Date

February 2018

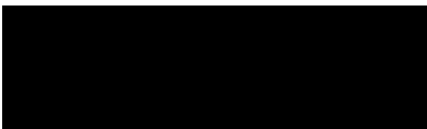
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This is not a valid document for use in the design of the project unless it is titled Final in the document status box.

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 to undertake a Phase II Ground Investigation on land at Orchard Business Park, North End Road, Yapton, West Sussex BN18 0GA. The scope of the investigation was outlined in the Soils Limited quotation reference Q19478, dated 1st December 2017.

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: 16671/DS, dated December 2017.

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 -
- 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.

Contents

Section 1	Introduction.....	1
1.1	Objective of Investigation.....	1
1.2	Location	1
1.3	Site Description.....	1
1.4	Proposed Development	2
1.5	Anticipated Geology.....	2
1.5.1	River Terrace Deposits	2
1.5.2	Lewes Nodular Chalk Formation.....	2
1.6	Limitations and Disclaimers	3
Section 2	Site Works	5
2.1	Proposed Project Works	5
2.1.1	Actual Project Works.....	5
2.2	Ground Conditions	6
2.3	Ground Conditions Encountered in Trial Holes	8
2.3.1	Made Ground and Topsoil	8
2.3.2	River Terrace Deposits	9
2.3.3	Lewes Nodular Chalk Formation.....	9
2.4	Roots	10
2.5	Groundwater	11
Section 3	Discussion of Geotechnical In-Situ and Laboratory Testing	12
3.1	Dynamic Probe Tests.....	12
3.2	Dynamic Cone Penetrometer Tests	12
3.3	Infiltration Tests	13
3.4	Atterberg Limit Tests.....	13
3.5	Particle Size Distribution Tests	14
3.6	Saturation Moisture Content Tests.....	14
3.7	Sulphate and pH Tests	14
Section 4	Foundation Design	15
4.1	General.....	15
4.1.1	Made Ground and Topsoil	15
4.1.2	River Terrace Deposits	16
4.1.3	Lewes Nodular Chalk Formation.....	16

4.1.4	Roots	17
4.1.5	Groundwater	18
4.2	Foundation Scheme General	18
4.2.1	Guidance on Shrinkable Soils	18
4.3	Foundation Scheme	19
4.3.1	Shallow Foundations into the River Terrace Deposits (Southern Site Area)	20
4.3.2	Shallow Foundations into the Lewes Nodular Chalk Formation (Southern Site Area)	21
4.3.3	Possible Solution Feature	22
4.4	Subsurface Concrete	23
4.5	Excavations	23
4.6	Pavements	24
4.7	Surface Water Disposal	24
Section 5	Determination of Chemical Analysis	27
5.1	Site Characterisation and Revised Conceptual Site Model	27
5.2	Soil Sampling	27
5.3	Determination of Chemical Analysis	27
Section 6	Qualitative Risk Assessment	29
6.1	Assessment Criteria	29
6.2	Representative Contamination Criteria - Soil	29
6.2.1	Asbestos	30
6.3	Groundwater	30
6.4	Tier 1 Quantitative Risk Assessment	30
6.4.1	Soils	30
6.4.2	Groundwater	31
6.4.3	Soil Gas	31
6.5	Remedial Objective	31
6.6	Development of Soil Remediation Strategy	31
6.6.1	Asbestos	32
6.7	Duty of Care	32
6.8	Excavated Material	32
6.8.1	Risk Based Hazard Assessment of Waste	33
6.9	Re-use of Excavated Material On-site	33

6.10	Imported Material	34
6.11	Discovery Strategy	34

List of Figures

Figure 1 – Site Location Map	37
Figure 2 – Aerial Photograph	38
Figure 3 – Trial Hole Plan	39

List of Tables

Table 2.1 Final Depth of Trial Holes	7
Table 2.2 Ground Conditions	8
Table 2.3 Final Depth of Made Ground/Topsoil	9
Table 2.4 Final Depth of River Terrace Deposits	9
Table 2.5 Final Depth of Lewes Nodular Chalk Formation	10
Table 2.6 Depth of Root Penetration	10
Table 2.7 Groundwater Monitoring	11
Table 3.1 Infiltration Rates	13
Table 4.1 Allowable Bearing Capacities within the River Terrace Deposits (Southern Site Area)	21
Table 5.1 Sampling Strategy	27
Table 5.2 Chemical Analysis Specification	28
Table 6.1 Summary of Chemical Analysis of Soils Sample Exceedance	29
Table 6.3 Risk Based Hazard Assessment of Waste	33
Table B.1.1 SPT "N" Blow Count Cohesive Classification	
Table B.1.2 SPT "N" Blow Count Granular Classification	
Table B.1.3 Interpretation of SPT "N" Blow Counts in Chalk	
Table B.2.1 Interpretation of DPSH Blow Counts	
Table B.2.2 Interpretation of Atterberg Limit Tests	
Table B.2.3 Interpretation of PSD Tests	
Table C.1.1 CSM Revised Pre Testing	

Table C.1.2 CSM Revised Post Testing

List of Appendices

Appendix A Field Work

Appendix A.1 Engineers Logs

Appendix B Geotechnical In-Situ and Laboratory Testing

Appendix B.1 Classification

Appendix B.2 Interpretation

Appendix B.3 Geotechnical In-Situ and Laboratory Results

Appendix C Chemical Laboratory Testing

Appendix C.1 Conceptual Site Model

Appendix C.2 Chemical Laboratory Results

Appendix C.3 General Assessment Criteria

Appendix C.4 Determination of Hazardous Waste Classification

Appendix D Information Provided by the Client

Section I Introduction

I.1 Objective of Investigation

Soils Limited was commissioned by Crayfern Homes 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: 16671/DS, December 2017) and/or the Revised Conceptual Site Model presented in Appendix C.1.

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: 16671/DS, dated December 2017.

I.2 Location

The site was located at Orchard Business Park, North End Road, Yapton, West Sussex BN18 0GA and had an approximate O.S Land Ranger Grid Reference of SU 979 037.

The site location plan is given in Figure 1.

I.3 Site Description

At the time of the investigation (December 2017), the site for the proposed development comprised a field predominantly covered with grass adjacent to an industrial estate to the east.

Two double-height warehouses and six storage shipping container units with no apparent associated sources of contamination, were located adjacent to the eastern site boundary.

Vegetation was mainly observed on the perimeter of the property with mature and immature trees along the north-east and the north site boundary. Hedgerows were located along the western and eastern site boundary.

The area surrounding the site was residential to the north, commercial to the north-east and mixed commercial/residential to the south. Open fields were noted to the west and to the north-east of the site.

The main access to the site was provided via North End Road bounding the site to the west.

The site area was gently sloping down to the south-east.

An aerial photograph has been included in Figure 2.

1.4 Proposed Development

At the time of reporting, February 2018, the proposed development of the site was to comprise 2No. two-bed, 7No. three-bed and 1No. 4-bed terraced two-storey houses with garages and car parking spaces. The development included hard landscaping such as access roads driveways and pavements and soft landscaping such as private gardens and amenity areas.

In compiling this report reliance was placed on drawing number 2.10 rev.P2 prepared by Crossley Design Architecture, dated May 2017. 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 D.

1.5 Anticipated Geology

The 1:50,000 BGS Geology map showed the site to be underlain by the Lewes Nodular Chalk Formation bedrock, with overlying superficial deposits of River Terrace Deposits.

1.5.1 River Terrace Deposits

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 Gravel 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.

1.5.2 Lewes Nodular Chalk Formation

The Lewes Nodular Chalk Formation is composed of hard to very hard nodular chalks and hardgrounds with interbedded soft to medium hard chalks (some grainy) and marls; some griotte chalks. The softer chalks become more abundant towards the top. Nodular chalks are typically lumpy and iron-stained. Brash is rough and flaggy or rubbly, and tends to be dirty. First regular seams of nodular flint, some large, commence near the base and continue throughout. Chalk formations are

susceptible to ground dissolution, typically caused by water passing through soluble rocks producing underground cavities and cave systems. These cavities reduce support to the ground above and can cause localised collapse of the overlying rocks and deposits.

Occasional erosional features, such as pipes, swallow holes and solution cavities, usually in-filled with drift deposits, are found in the chalk. The features sometimes manifest themselves at the surface as shallow circular depressions. Solution features may be reactivated by the concentrated ingress of water from leaking drains or soakaways. Reactivation may lead to surface collapse.

1.6 Limitations and Disclaimers

This Phase II Ground Investigation Report relates to the site located at Orchard Business Park, North End Road, Yapton, West Sussex BN18 0GA and was prepared for the sole benefit of Crayfern Homes (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 (Q19478, dated 1st December 2017), was therefore to comprise the following items:

- 4No 5.00m deep windowless sampler boreholes;
- 4No 6.00m deep super heavy dynamic probes;
- TRL probes for CBR values;
- Well installation for long term groundwater level monitoring;
- Infiltration testing to BRE365;
- Geotechnical laboratory testing;
- Contamination laboratory testing.

2.1.1 Actual Project Works

The actual project works were undertaken on 14th December 2017 and comprised:

- 1No. machine excavated trial pit to 2.00m bgl (TP2A), 1No. trial pit to 3.00m bgl (TP3), 1No. trial pit to 4.50m bgl (TP2), 1No. trial pit to 5.20m bgl (TP1);
- Infiltration testing (BRE365) within the trial pits;
- 1No. windowless sampler borehole to 3.00m bgl, 3No. windowless sampler boreholes to 5.00m bgl;
- 4No. dynamic probes DPSH – SPT equivalent to 6.00m bgl;
- Installation of 1No. groundwater monitoring well to 2.90m within WS1, Installation of 1No. groundwater monitoring well to 4.75m within WS2, Installation of 1No. groundwater monitoring well to 4.80m within WS3;
- 5 No. CBR tests using the TRL-DCP probe (DCP1-DCP5);
- Geotechnical laboratory testing;
- Contamination laboratory testing.

Dual purpose groundwater/gas monitoring wells were installed within three of the windowless sampler boreholes (WS1, WS2 and WS3), reaching to depths of up to 2.90m bgl within WS1, 4.75m bgl within WS2 and 4.80m bgl within WS3, and fitted with a gas tap on top. The response zone of the wells was constructed using slotted plastic pipe from approximately 1.00m bgl depth. Plastic plain pipe was used from the end of the response zone to the ground level. The response zone was backfilled with gravel while bentonite was used for the rest of the hole to the surface. In the

absence of a well installation, windowless sampler borehole WS4 was backfilled with pea shingle upon completion.

The windowless sampler borehole WS1 stopped at a shallower depth than proposed due to the hard ground encountered which the equipment could not safely penetrate.

Four super heavy dynamic probes, (DP1, DP2, DP3 and DP4) were driven prior and adjacent to their corresponding windowless sampler borehole to depths reaching up to 6.00m bgl.

Trial pit TP2A was excavated next to TP2, following the suggestion of the client, in order to examine the infiltration rates within the grounds encountered at shallower depth.

All the machine excavated trial pits (TP1, TP2, TP2A, TP3 and TP4) were backfilled with arisings upon the completion of infiltration testing and mounded over to allow for future settlement.

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.

2.2 Ground Conditions

On 14th December 2017 four windowless sampler boreholes (WS1 – WS4) were drilled, using an Archway Competitor, to depths ranging between 3.00m (WS3) and 5.00m below ground level (bgl) (WS2 and WS4) at locations selected by Soils Limited and approved by the client using a development plan provided by the client.

Three standpipes were installed within window sample borehole locations WS1, WS2 and WS3 to allow for continued monitoring of groundwater, where present.

Four super heavy dynamic probes, super heavy, (DP1 – DP4) were driven prior and adjacent to their corresponding windowless sampler borehole to depth reaching up to 6.00m bgl.

In situ CBR tests (DCP1 – DCP5) were carried out at locations selected by Soils Limited and agreed with the Client, on the areas of the proposed car parks and driveways, using the TRL Dynamic Cone Penetrometer (DCP). Information on the DCPs is provided in Section 3.2.

Four trial pits were machine excavated, using a JCB 3CX, to depths ranging between 2.00m (TP2A) and 5.20m bgl (TP1) at locations selected by Soils Limited and approved by the client. Following the construction of the trial holes, infiltration tests were carried in

accordance with the principles of BRE DG365:2016 within three of the four trial holes (TP1, TP2A and TP3). Description and results on the infiltration testing is outlined in Section 3.3.

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 signal generator (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)	Trial Hole	Depth (m bgl)
WS1	3.00 ^w	DPI	6.00	TP1	5.20
WS2	5.00 ^w	DP2	6.00	TP2	4.50
WS3	5.00 ^w	DP3	6.00	TP2A	2.00
WS4	5.00	DP4	6.00	TP3	3.00

Note: w - well installation

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:

Made Ground/Topsoil (MG/TS)
River Terrace Deposits (RTD)
Lewes Nodular Chalk Formation (LPCK)

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

Table 2.2 Ground Conditions

Strata	Period	Depth Encountered (m bgl)		Typical Thickness (m)	Typical Description
		Top	Bottom		
MG/TS	Anthropocene	G.L.	0.20-1.70	0.85	MG: Turf over soft dark brown very silty CLAY to clayey gravelly SILT becoming gravelly fine to coarse SAND becoming silty sandy fine to boulder sized GRAVEL with depth. TS: Turf over dark brown gravelly sandy clayey SILT to soft dark brown silty CLAY.
RTD	Quaternary	0.20-1.70	2.00 ¹ -3.80	2.00	Firm dark orangish brown CLAY to clayey SILT to grey and red very gravelly fine to coarse SAND becoming clayey gravelly SAND to firm sandy gravelly CLAY to clayey sandy gravelly SILT with depth.
LPCK	Campanian	2.20-3.80	5.00-6.00 ¹	Not proven ²	Moderately weak, light brown weathered structureless CHALK composed of silty sub-angular to sub-rounded mainly fine and medium GRAVEL. Gravel was weak to hard low to high density, light brown. Bedding fractures medium-spaced; Matrix was light brown silty. Occasional soft spots were noted. Occasional angular flint gravel (Grade Dm to Grade Dc with depth).

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 Made Ground and Topsoil

Soils described as Made Ground were encountered in three trial holes (WS4, DP4 and TP1) out of the twelve trial holes, from ground level to depths ranging between 1.50m (WS4) to 1.70m bgl (DP4).

The Made Ground typically comprised turf over soft dark brown very silty CLAY to clayey gravelly SILT becoming gravelly fine to coarse SAND becoming silty sandy fine to boulder sized GRAVEL with depth. Gravel was fine to coarse flint brick concrete glass and roof tiling. Frequent fine roots and rootlets were encountered.

The depths of Made Ground have been included in Table 2.3.

Soils described as Topsoil were encountered in nine trial holes (WS1, WS2, WS3,

DP1, DP2, DP3, TP2, TP2A and TP3) from ground level to depths ranging between 0.20m (TP3) to 1.30m bgl (DP3).

The Topsoil comprised turf over dark brown gravelly sandy clayey SILT to soft dark brown silty CLAY. Gravel was fine sub-angular flint. Frequent fine roots and rootlets were encountered.

The depth of Topsoil has been included in Table 2.3.

Table 2.3 Final Depth of Made Ground/Topsoil

Trial Hole	Depth (m bgl)	Strata	Probe Hole	Depth (m bgl)	Strata	Test Hole	Depth (m bgl)	Strata
WS1	0.85	TS	DPI	0.85 ¹	TS	TPI	1.60	MG
WS2	0.80	TS	DP2	0.80 ¹	TS	TP2	0.35	TS
WS3	1.20	TS	DP3	1.30 ¹	TS	TP2A	0.30	TS
WS4	1.50	MG	DP4	1.70 ¹	MG	TP3	0.20	TS

Note: ¹ Conditions inferred from dynamic probes

2.3.2 River Terrace Deposits

Soils described as River Terrace Deposits were encountered within all the trial holes from directly below the Made Ground/Topsoil to depths ranging between 2.00m (TP2A) and 4.50m bgl (TP2).

The River Terrace Deposits typically comprised firm dark orangish brown CLAY to clayey SILT to grey and red very gravelly fine to coarse SAND becoming clayey gravelly SAND to firm sandy gravelly CLAY to clayey sandy gravelly SILT with depth. Gravel was fine to coarse angular flint and chalk.

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

Table 2.4 Final Depth of River Terrace Deposits

Trial Hole	Depth (m bgl)	Probe Hole	Depth (m bgl)	Test Hole	Depth (m bgl)
WS1	2.80	DPI	3.00 ¹	TPI	2.40
WS2	2.20	DP2	2.20 ¹	TP2	4.50 ²
WS3	3.00	DP3	3.00 ¹	TP2A	2.00 ²
WS4	3.80	DP4	3.80 ¹	TP3	2.40

Note: ¹ Conditions inferred from dynamic probes ² Final depth of the trial hole

2.3.3 Lewes Nodular Chalk Formation

Soils described as the Lewes Nodular Chalk Formation were encountered in ten out of the twelve trial holes from directly below the River Terrace Deposits to the final investigatory depth.

The soils of the Lewes Nodular Chalk Formation, as described from the trial pits, comprised moderately weak, light brown weathered structureless CHALK composed of silty sub-angular to sub-rounded mainly fine and medium GRAVEL. Gravel was weak to hard low to high density, light brown. Bedding fractures medium-spaced; Matrix was light brown silty. Occasional soft spots were noted. Occasional angular flint gravel (Grade Dm to Grade Dc with depth).

The depth of Lewes Nodular Chalk Formation has been included in Table 2.5.

Table 2.5 Final Depth of Lewes Nodular Chalk Formation

Trial Hole	Depth (m bgl)	Probe Hole	Depth (m bgl)	Test Hole	Depth (m bgl)
WS1	3.00 ²	DPI	6.00 ¹	TP1	5.20 ²
WS2	5.00 ²	DP2	6.00 ¹	TP2	N/E
WS3	5.00 ²	DP3	6.00 ¹	TP2A	N/E
WS4	5.00 ²	DP4	6.00 ¹	TP3	3.00 ²

Note: ¹ Conditions inferred from dynamic probes ² Final depth of the trial hole
N/E = not encountered

2.4 Roots

Roots were encountered in all the windowless sampler holes and trial pits at depths ranging between 0.50m (TP2A) and 1.60m bgl (TP1 and TP2).

The depths of root penetration have been included in Table 2.6.

Table 2.6 Depth of Root Penetration

Trial Hole	Depth (m bgl)	Trial Hole	Depth (m bgl)
WS1	0.85	TP1	1.60
WS2	1.30	TP2	1.60
WS3	1.20	TP2A	0.50
WS4	0.55	TP3	1.20

Note:

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.

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.

Vegetation was mainly observed on the perimeter of the property with mature and immature trees along the north-east and the north site boundary. Hedgerows were in were located along the western and eastern site boundary.

2.5 Groundwater

Groundwater was not encountered in any of the trial holes during the initial visit on site for the investigation.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in December (2017), when groundwater levels should be rising from their annual maximum (highest) elevation, which typically occurs around March.

Further groundwater monitoring was conducted within the standpipes installed on site following completion of site works and has been presented in Table 2.7.

Table 2.7 Groundwater Monitoring

Trial Hole	Depth to Water (m bgl)			
	14/12/2017	05/01/2018	30/01/2018	07/02/2017
WS1	Not encountered	Not encountered	2.61	2.83
WS2	Not encountered	3.26	3.92	4.78
WS3	No encountered	4.14	4.45	4.74

Note:

Groundwater monitoring was ongoing at the time of reporting and an update will be provided when complete.

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 four locations (DP1 to DP4) adjacent and prior to the drilling of WS1 to WS4 to depth reaching up to 6.00m bgl. 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 recorded equivalent SPT “N60” values between **3 and 32** within cohesive beds and **4 to 25** in granular beds. Classifying the cohesive soils as **very low to very high** strength and inferred undrained cohesive strength of **15kPa to 160kPa**. The granular beds were classified as **loose to medium dense**.

The Lewes Nodular Chalk Formation recorded equivalent SPT “N60” values between **14 and >35** and was classified as **Structureless (Grade Dc) to Structured Chalk (C5-A1)** based on the dynamic probe results.

The SPT “N60” values presented within this report 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. The rig efficiency used on site was 1.25.

It should be noted that the values given on the logs within Appendix A.1 are uncorrected.

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 382%** for the soils encountered in the top 0.74m bgl within CPT1. The high value is likely to have been some form of obstruction encountered by the probe tip and could be discounted as unrepresentative. Within the remaining DCP locations (DCP2, DCP3, DCP4 and DCP5) the CBR values recorded ranged between **2% and 18%** in the top 0.824m bgl.

The high CBR values encountered within CPT1 were anticipated due to the variable soils of Made Ground encountered at depths from ground level to 1.60m bgl in TP1 (located close to the area of DCP1).

The DCP results are presented in Appendix B.3.

3.3 Infiltration Tests

Infiltration testing was undertaken in TP1 and TP3 within the Lewes Nodular Chalk Formation bedrock and in TP2A within the superficial River Terrace Deposits following the principles of BRE Digest 365 Soakaway design: 2016. The tests comprised piping clean water via a water tanker into the open trial hole, the drop-in water level over time was then recorded to give an indication of soakage potential.

BRE 365 states that for an accurate infiltration rate to be obtained a soakage pit needs to be filled three times in quick succession. Each test can only be ended once 75% of the water present has drained away.

Only a single test was carried out within each of the trial holes due to the very slow infiltration rates recorded.

BRE software BRESOAK was used to calculate the infiltration rates in TPB and TPC and the results outlined in Table 3.1.

Table 3.1 Infiltration Rates

Trial Hole (Test No.)	Test Stratum	Test Depth (m bgl)	Infiltration Rate (m/sec)	Notes
TP1(SI)	LCK	5.20	-	No infiltration rate was calculated in any location due to the high fines content of the soils encountered and the negligible infiltration recorded
TP2A(SI)	RTD	2.00	-	
TP3 (SI)	LCK	3.00	-	

Notes: RTD = River Terrace Deposits, LCK = Lewes Nodular Chalk Formation

Considering that the noted reduction in the head of water was 11% over 5 hours (TP1), 2% over 4 hours (TP2A) and 9% over 3.5 hours (TP3), infiltration testing was only conducted once within the trial holes.

Tests within all locations were abandoned due to the minimal infiltration recorded over the course of the day.

3.4 Atterberg Limit Tests

Atterberg Limit tests were performed on five samples, one obtained from the granular beds of the River Terrace Deposits (WS1:1.70m bgl) and the remaining four from the cohesive beds of the River Terrace Deposits (WS1:1.20m, WS2:0.90m, WS3:1.20m and WS4:1.80m bgl). The results were classified in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

The cohesive beds as well as the granular beds of the River Terrace Deposits were classified as having a **low 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 Particle Size Distribution Tests

A Particle Size Distribution (PSD) test was performed on one sample from the granular soils of the River Terrace Deposits.

PSD classified the granular beds of the River Terrace Deposits as having a volume change potential in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2. Note that a cohesive soil is only classified as having a volume change potential if it is also plastic and an Atterberg Limit test can be conducted on the strata.

A full interpretation of the PSD test is outlined in Table B.2.3, Appendix B.2 and the laboratory report in Appendix B.3.

3.6 Saturation Moisture Content Tests

One sample (TP3 :3.00m bgl) was sent to the laboratory for a Saturation Moisture Content (SMC) test. The sample was not suitable for testing as no intact chalk fragments were present, mainly chalk putty (Grade Dm) was identified.

It was not possible to perform tests on alternative samples due to the absence of suitable intact chalk as retrieved from the trial holes.

3.7 Sulphate and pH Tests

Six samples (TP1:0.25m, TP1:0.50m, TP2:0.20m, WS2:0.10m, WS3:0.10m and WSA:0.50m bgl) were taken from the Made Ground/Topsoil and two samples (TP2:1.10m and WS2:1.50m bgl) were taken from the River Terrace Deposits 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** and **35mg/l** with pH values of **6.5 to 8.1**.

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 in the following section. Soil descriptions are based on analysis of disturbed samples taken from the trial holes.

4.1.1 Made Ground and Topsoil

The terms *Fill* and *Made Ground* are used to describe material, which has been placed by man either for a particular purpose e.g. to form an embankment, or to dispose of unwanted material. For the former use, the Fill and/or Made Ground may well have been selected for the purpose and placed and compacted in a controlled manner. With the latter, great variations in material type, thickness and degree of compaction invariably occur and there can be deleterious or harmful matter, as well as potentially methanogenic organic material.

The BSI Code of Practice for Foundations, BS 8004:1986, Clause 2.2.2.3.5 Made Ground and Fill, includes the caveat that *'all Topsoil should be treated as suspect, because of the likelihood of extreme variability'*.

Soils described as Made Ground were encountered in three (WS4, DP4 and TP1) out of the twelve trial holes from ground level to depths ranging between 1.50m (WS4) to 1.70m bgl (DP4). The Made Ground typically comprised turf over soft dark brown very silty CLAY to clayey gravelly SILT becoming gravelly fine to coarse SAND becoming silty sandy fine to boulder sized GRAVEL with depth. Gravel was fine to coarse flint brick concrete glass and roof tilling. Frequent fine roots and rootlets were encountered. The depths of Made Ground have been included in Table 2.3.

Soils described as Topsoil were encountered in nine trial holes (WS1, WS2, WS3, DP1, DP2, DP3, TP2, TP2A and TP3) from ground level to depths ranging between 0.20m (TP3) to 1.30m bgl (DP3). The Topsoil comprised turf over dark brown gravelly sandy clayey SILT to soft dark brown silty CLAY. Gravel was fine sub-angular flint. Frequent fine roots and rootlets were encountered. The depth of Topsoil has been included in Table 2.3.

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

4.1.2 River Terrace Deposits

Soils described as River Terrace Deposits were encountered within all the trial holes from directly below the Made Ground/Topsoil to depths ranging between 2.00m (TP2A) and 4.50m bgl (TP2). The River Terrace Deposits typically comprised firm dark orangish brown CLAY to clayey SILT to grey and red very gravelly fine to coarse SAND becoming clayey gravelly SAND to firm sandy gravelly CLAY to clayey sandy gravelly SILT with depth. Gravel was fine to coarse angular flint and chalk. The depth of River Terrace Deposits has been included in Table 2.4.

The results from DPSH testing inferred that the cohesive soils of the River Terrace Deposits were of a **very low to high strength**, with undrained cohesions of between **15kPa and 160kPa**. The granular beds were classified as having a **loose to medium dense** relative density.

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

Soils of the River Terrace Deposits are normally consolidated and are expected to display low to moderate bearing capacities with high to moderate settlement characteristics, depending on their fines content. In the absence of roots / rootlets the soils of the River Terrace Deposits could be considered suitable for the proposed development only within the southern part of the site (areas of DP2 and DP3), due to the low blow counts encountered within the dynamic probes to the northern part of the site. Foundations within the River Terrace Deposits are possible from a depth of 1.50m bgl, however, not enough information is available regarding the thickness of the superficial layer across the southern part of the site. As a consequence, there is a risk for the potential development of differential settlements if founding within the River Terrace Deposits.

4.1.3 Lewes Nodular Chalk Formation

Soils described as the Lewes Nodular Chalk Formation were encountered in ten out of the twelve trial holes from directly below the River Terrace Deposits to the final investigatory depth. The soils of the Lewes Nodular Chalk Formation as described from the trial pits, comprised moderately weak, light brown weathered structureless CHALK composed of silty sub-angular to sub-rounded mainly fine and medium GRAVEL. Gravel was weak to hard low to high density, light brown. Bedding fractures medium-spaced; Matrix was light brown silty. Occasional soft spots were noted. Occasional angular flint gravel (Grade Dm to Grade Dc with depth). The results from the dynamic probing inferred that the Lewes Nodular Chalk Formation was typically **structureless Dc to Structured Chalk (C5-A1)**.

DP1, DP2 and DP4 encountered structured chalk from directly below the River Terrace Deposits to the final investigatory depth (6.00m bgl). DP2 inferred the Lewes Nodular Chalk Formation as structured chalk down to 6.00m bgl with a band of structureless chalk Grade Dc at 4.70m to 5.00m bgl.

TP1 and TP3 encountered structureless chalk grade Dm from directly below the River Terrace Deposits gradually becoming structureless grade Dc at approximately 3.50m bgl to the final depth (5.20m and 3.00m bgl respectively). The bedrock of Lewes Nodular Chalk formation was not encountered within TP2 and TP2A.

Saturation moisture content testing was not performed on the chalk due to the absence of suitable samples as retrieved from the trial holes.

Chalk descriptions from windowless sampler boreholes are not in accordance with CIRIA C574 and are not representative of in-situ chalk. Chalk descriptions from trial holes are in accordance with CIRIA C574 and are expected to be representative of in-situ chalk. Generally, soils of the Lewes Nodular Chalk Formation are structureless to weak rock and would possess low to moderate bearing and settlement characteristics. The Lewes Nodular Chalk Formation would be suitable as a bearing stratum however the depth that the stratum was encountered may be prohibitive for the adoption of strip footings.

The Lewes Nodular Chalk Formation was found to increase in thickness to the south-west of the site. In the area of DP2 where the chalk was encountered in shallower depths (2.20m bgl), the foundations could locally be constructed within the chalk. However, the Lewes Nodular Chalk Formation was encountered at greater depths in most locations across the site, so it is more likely that the shallow foundations if adopted, will be constructed within the overlying superficial stratum of the River Terrace Deposits. Generally, the bearing capacities within the superficial River Terrace Deposits can be considered as low. The bearing capacities within the chalk if confirmed to be at suitable depths for strip foundations can be of at least Grade Dc and shall be preferred.

It must be noted that the depth to chalk was not constant across the site. In some areas of the site the foundations could potentially bear partially within the chalk and partially within the River Terrace Deposits. This would induce large differential settlements therefore; the **foundations must bear within the same soil stratum**.

Unweathered chalk is a weak rock and it must be noted that the drilling process can disturb the structure and fabric.

4.1.4 Roots

Roots were encountered in all the windowless sampler holes and trial pits at depths ranging between 0.50m (TP2A) and 1.60m bgl (TP1 and TP2). The depths of root penetration have been included in Table 2.6.

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.

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. Vegetation was mainly observed on the perimeter of the property with mature and immature trees along the north-east and the north site boundary. Hedgerows were located along the western and eastern site boundary.

4.1.5 Groundwater

Groundwater was not encountered in any of the trial holes during the siteworks.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in December (2017), when groundwater levels should be rising from their annual minimum (lowest) elevation, which typically occurs around September.

Further groundwater monitoring was conducted within the standpipes installed on site following completion of site works and has been presented in Table 2.7.

Groundwater monitoring was ongoing at the time of reporting and an update will be provided when complete.

4.2 Foundation Scheme General

At the time of reporting, February 2018, the proposed development of the site was to comprise 2No. two-bed, 7No. three-bed and 1No. 4-bed terraced two-storey houses with garages and car parking spaces. The development included hard landscaping such as access roads driveways and pavements and soft landscaping such as private gardens and amenity areas.

In compiling this report reliance was placed on drawing number 2.10 rev.P2 prepared by Crossley Design Architecture, dated May 2017. 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 D.

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 had **low volume change potential** in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

Low volume change potential must therefore be adopted where foundations pass through or bear within the River Terrace Deposits.

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 Made Ground/Topsoil due to the likely variability and potential for large load induced settlements both total and differential.

Roots were encountered in all the windowless sampler holes and trial pits at depths ranging between 0.50m (TP2A) and 1.60m bgl (TP1 and TP2), generally to a depth of up to 1.20m bgl across the site. 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.

According to the information we have from the site investigation, the chalk encountered within the trial pits was mainly of Grade Dm (putty chalk). However, the bearing capacities

in the chalk can be of at least Grade Dc due to the high dynamic probe values encountered within the soils of Lewes Nodular Chalk Formation. Therefore, high bearing capacities are anticipated within the chalk across the site. The top to the chalk layer was however observed at variable depths across the site, not always compatible with the construction of shallow foundations. Also, the thickness of the superficial River Terrace Deposits stratum, where observed to be suitable as a foundation layer, was not constant across the site and therefore potentially subjected to differential settlements. Considering as well that roots were encountered generally at a depth of up to 1.20m bgl within the site area, **piled foundations should be preferred across the site.**

The present Ground Investigation does not allow for the design of piled foundations. To permit design values for a piled foundation an additional investigation to a greater depth with cable percussive boreholes (CPBH) should be carried on site.

Alternatively, it is recommended to carry out additional investigation in the form of window sampling and dynamic probing to delineate the thickness of the layer of the River Terrace Deposits and the depth to the chalk across the site, in order to define the possibility to adopt **shallow foundations on a local basis.**

Based on the information we already have, and the type of proposed development, strip or deep strip foundations could be utilised to the southern site area within the River Terrace Deposits, only if additional investigation is carried on site as aforementioned. Strip or deep strip foundations could be considered within the soils of Lewes Nodular Chalk Formation where encountered within founding depths to the southern part of the site, only if additional investigation is carried on site as aforementioned. Due to the soft soils encountered during the investigation and the dynamic probe results, low bearing capacity values must be expected to a depth of up to 2.50m bgl in the areas of DP1 and DP4 (northern site area). **A piled foundation option should be considered for the northern part of the site (areas of DP1 and DP4) due to the soft soils encountered to depths of up to 2.50m bgl.**

Where foundations pass from the Lewes Nodular Chalk Formation to the River Terrace Deposits differential settlements would be anticipated and, as a result, footings should only bear onto one stratum along its length.

The proposed development is likely to be both light and brittle. It is therefore considered that foundation design is undertaken using NHBC Standards Chapter 4.2.

4.3.1 Shallow Foundations into the River Terrace Deposits (Southern Site Area)

Based on a 5.00 by 0.75m strip foundation, using commercial software Table 4.1 shows the calculated bearing values and anticipated settlement characteristics. Due to the maximum encountered depths of Made Ground/Topsoil and the low dynamic probe values encountered to the northern part of the site (DP1 and DP4), bearing capacities were calculated just for the southern site area:

Table 4.1 Allowable Bearing Capacities within the River Terrace Deposits (Southern Site Area)

Depth (m bgl)	Size (m)	Bearing Capacity (kPa)	Anticipated Settlement (mm)
1.30	5.00 x 0.75	70	<25
1.60		75	<25
2.00		90	<25

Note: Bearing capacity values within the areas of DP2 and DP3 (southern part of the site only)

The use of reinforced trench fill foundations would simplify construction and reduce the possibility of differential settlement affecting the foundations.

For the allowable bearing value given above, settlements should not exceed the presented values, provided that excavation bases are carefully bottomed out and blinded, or concreted as soon after excavation as possible and kept dry.

Foundations must not be constructed over former structures and other hard spots. The foundations design must be suitable for the conditions present at the site.

The anticipated settlement includes both elastic settlement and long-term drained settlement (in the case of cohesive soils).

Anticipated settlements may be taken as proportional to the bearing capacity adopted (for the same configuration of foundation), therefore if the bearing value is halved the anticipated settlement will halve.

All loose material, loose blocks of chalk and soft spots must be removed from the base of the excavations, these excavations then being either concreted or blinded as soon after excavation as possible. Failure to do so could result in increased settlements. Foundations must not be cast over foundations of former structures and/or other hard spots.

4.3.2 Shallow Foundations into the Lewes Nodular Chalk Formation (Southern Site Area)

Using the relationship reported in CIRIA C574 Report, the calculated bearing values and anticipated settlement characteristics for isolated strip foundations have been calculated, **where the bedrock of Lewes Nodular Chalk Formation is encountered at shallower depths during the foundation construction phase.** Generally, the bearing capacities within the superficial River Terrace Deposits can be considered as low. The bearing capacities within the chalk if confirmed to be at suitable depths for strip foundations can be of at least Grade Dc and shall be preferred.

Considering the size of the site, a single founding depth has not been provided as

this will need to be verified on a side-by-side basis along the length of foundation excavations in order for foundations to pass through unsuitable soils and bear well into the Lewes Nodular Chalk Formation. The founding level must also ensure that a minimum chalk grade of Dc is established to limit the potential for unacceptable settlements. Soils of a minimum grade Dc were inferred across the site. It is anticipated that founding depths will vary depending on the depth to the Lewes Nodular Chalk Formation encountered across the development footprint.

Based on the results of the investigation a **bearing value of 220kPa** may be adopted for foundations taken into the Lewes Nodular Chalk Formation (Grade Dc). Anticipated settlements using the foundation loads given will be less than 10mm when the foundations will be constructed within soils of the Lewes Nodular Chalk Formation of at least Dc (structureless) grade. This bearing value is likely to be considerably higher than required and if a lower bearing pressure is adopted then settlements may be taken as proportional to the pressure, for the same foundation configuration. Foundations must not be constructed in soft pockets of chalk. Should such pockets be found the foundation excavation must be extended through them.

An experienced person must inspect the excavations in order to verify the suitability of the soils and provide the designer with reasonable values for the bearing capacity and expected settlements in the event structureless (Dm) grade chalk was encountered at the time of excavations.

Where foundations are located in or pass through the clayey soils of River Terrace Deposits or other plastic soils overlying the chalk, they must be designed in accordance with BRE and/or NHBC statements for foundations subjected to potential swelling.

The presence of weak layers could potentially induce the development of larger settlements, resulting in an increased potential for differential settlements. The construction, therefore, should be designed to resist potential differential settlements especially if pads foundations will be adopted. The use of reinforced trench fill foundations would simplify construction and reduce the possibility of differential settlement affecting the foundations or, in the case of pad foundations, the superstructure.

4.3.3 Possible Solution Feature

The available information presented within Phase I Desk study (Report ref: 16671/DS dated January 2018) indicated a very low risk regarding Ground Dissolution features on site.

The investigation identified the presence of a possible solution feature in the area of TP2 where a marked increase in the thickness of the River Terrace Deposits was noted.

Erosional features, such as pipes, swallow holes and solution cavities, usually in-

filled with drift deposits, are occasionally found in the chalk, sometimes manifesting themselves at the surface as shallow circular depressions, however given the development undertaken in the area it would not be possible to visually identify any such features. Subsequent collapse of erosional features is usually as a result of localised intense inflow of water into the feature.

Considering the information presented above it was concluded that such geo-hazards are caused by localised erosion of the upper surface of the chalk. This could potentially lead to unacceptable settlements if conventional foundations are adopted. The possible feature was encountered within one location (TP2), where no proposed development was to take place, as the trial pit location was outside the proposed development footprint the risk was therefore considered low. Similar features may be present in other areas on site. **If the configuration of the proposed development changes, Soils Limited must be informed as this may invalidate the foundation recommendations given within this report.**

Solution features may be reactivated by the concentrated ingress of water from leaking drains or soakaways. Reactivation may lead to surface collapse. Therefore, attention must be drawn in order to ensure that no soakaways are constructed near the area of TP2.

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 **6.5 and 8.1**. 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 Made Ground/Topsoil and River Terrace Deposits are likely to be marginally stable in the short term at best.

Deeper excavations taken into the Lewes Nodular Chalk Formation are likely to be stable in the short term, depending on the thickness of overlying River Terrace Deposits and the depth of groundwater. 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 (DCP1 – DCP5) on site.

The results from DCP testing indicated CBR values of between **2% and 382%** for the soils encountered in the top 0.74m bgl within CPT1. The high value is likely to have been some form of obstruction encountered by the probe tip and could be discounted as unrepresentative. Within the remaining DCP locations (DCP2, DCP3, DCP4 and DCP5) the CBR values recorded ranged between **2% and 18%** in the top 0.824m bgl.

The high CBR values encountered within CPT1 were anticipated due to the variable soils of Made Ground encountered at depths from ground level to 1.60m bgl in TP1 (located close to the area of DCP1).

When removing 400mm of either Made Ground or Topsoil the worst case CBR value was **4%** within DCP1.

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. Any soft spots at formation level should be dug out and replaced with a suitably compacted granular fill. Prior to construction the formation level should be proof rolled.

No plasticity indices were available regarding the soils of the Made Ground, since these may be highly variable. However, the soils of Made Ground encountered can be considered likely to be frost susceptible.

The soils of the Lewes Nodular Chalk Formation would be frost susceptible however given the depth that they were encountered the action of frost on the soils of the Lewes Nodular Chalk Formation has not been considered further.

4.7 Surface Water Disposal

Infiltration testing was undertaken in TP1 and TP3 within the Lewes Nodular Chalk Formation bedrock and within TP2A within the superficial River Terrace Deposits following the principles of BRE Digest 365 Soakaway design: 2016. The tests comprised piping clean water via a water tanker into the open trial hole, the drop-in water level over time was then recorded to give an indication of soakage potential.

For a soakaway to be viable it is required to empty by 50% in a 24-hour period in saturated ground conditions. Tests within all locations were abandoned due to minimal infiltration recorded over the course of the day.

Considering that the noted reduction in the head of water was 11% over 5 hours (TP1), 2% over 4 hours (TP2A) and 9% over 3.5 hours (TP3), infiltration testing was only conducted once within the trial holes.

Given the very slow infiltration observed during the tests it is considered that surface water drainage via conventional soakaway is not suitable for this site and that alternative methods of surface water disposal (e.g. existing storm water drainage system, rainwater harvesting or a combination of both) must be considered for the site. Alternatively, with further testing, consideration could be given to a shallow system such as permeable pavement with associated attenuation.

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. The available information presented within Phase I Desk study (Report ref: 16671/DS dated January 2018) indicated a very low risk regarding Ground Dissolution features on site. The investigation identified the presence of a possible solution feature in the area of TP2 where a marked increase in the thickness of the River Terrace Deposits was noted.

Dissolution features can form due to manmade 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, pavements 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.

Due to the lack of any suitable intact chalk as retrieved from the trial holes, SMC tests were not performed to identify the chalk density. Considering also the presence of a possible solution feature in the area of TP2, soakaways should be avoided if at all possible but, if unavoidable, should be sited at least 20m away from any foundations.

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: 16671/DS dated January 2018) identified a **very low to moderate risk** of ground contamination from previous usage of the site and offsite sources.

The Phase II Ground Investigation identified Made Ground in three (WS4, DP4 and TP1) out of the twelve trial holes from ground level to inferred depths ranging between 1.50m (WS4) to 1.70m bgl (DP4). The Made Ground typically comprised turf over soft dark brown very silty CLAY to clayey gravelly SILT becoming gravelly fine to coarse SAND becoming silty sandy fine to boulder sized GRAVEL with depth. Gravel was fine to coarse flint brick concrete glass and roof tiling. Frequent fine roots and rootlets were encountered.

Superficial River Terrace Deposits were encountered underlying the Made Ground. Shallow groundwater was not encountered within the Made Ground, River Terrace Deposits.

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
TPI:0.25	Made Ground	Rear garden area of properties 1&2
TPI:0.50		
TP2:0.20	Possible heavy metals, pesticides, hydrocarbon contamination – silty soils	Rear garden area of property 5
WS2:0.10		Rear garden area of property 4
WS3:0.10		Rear garden area of property 6
WS4:0.50	Made Ground	Rear garden area of property 10

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)					
	WS2:0.10 ^s	WS3:0.10 ^s	WS4:0.50 ^s	TP1:0.25 ^w	TP1:0.50 ^s	TP2:0.20 ^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 C.3.

6.2 Representative Contamination Criteria - Soil

At the time of reporting, February 2018, the proposed development of the site was to comprise 2 No. two-bed, 7 No. three-bed and 1 No. 4-bed terraced two-storey houses with garages and car parking spaces. The development included hard landscaping such as access roads driveways and pavements and soft landscaping such as private gardens and amenity areas.

In compiling this report reliance was placed on drawing number 2.10 rev.P2 prepared by Crossley Design Architecture, dated May 2017. 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) for the proposed "Residential with plant uptake" use scenario.

Table 6.1 outlines the samples that have exceeded their relevant assessment criteria. The full laboratory report is presented in Appendix C.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 plant uptake' land-use scenario
Asbestos	TP1:0.50 - Bundles in soil / Type: Chrysotile

The guideline values are assessed against the "Residential with plant uptake" 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 **1.2%** and **3.6%**. For each soil sample tested, the Soil Organic Matter recorded was used to derive the appropriate guideline value for organic determinants.

In summary, asbestos was found in one of the samples tested (TP1:0.50m bgl).

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

6.2.1 Asbestos

Asbestos Containing Material (ACM) was detected within the sample from TP1 at 0.50m bgl. The ACM was determined to comprise Asbestos Cement (chrysotile).

As asbestos containing material was identified in one of the samples tested 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 Groundwater

Groundwater was not recovered from the standpipes installed within WS1, WS2 and WS3 since groundwater sampling and testing was not within the client's brief.

Groundwater was not encountered within any of the trial holes during the initial site investigation visit.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in December (2017), when groundwater levels should be rising from their annual minimum (lowest) elevation, which typically occurs around September.

Further groundwater monitoring was conducted within the standpipes installed on site following completion of site works and has been presented in Table 2.7. Groundwater monitoring was ongoing at the time of reporting and an update will be provided when complete.

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 C.1. The full laboratory chemical report is presented in Appendix D.2.

6.4.1 Soils

Asbestos Containing Material (ACM) was detected within the sample from TP1 at 0.50m bgl. The ACM was determined to comprise Asbestos Cement (chrysotile).

TP1 is situated in soft landscaping of proposed residential gardens. The asbestos recorded represent a risk to future site occupants and site workers via dermal, ingestion and inhalation pathways. The detection of Asbestos Cement within TP1 could suggest that Asbestos Containing Material (ACM) might be present in other areas of the site.

6.4.2 Groundwater

As identified by the Phase I Desk study (report ref: 16671/DS dated January 2018), the overall groundwater vulnerability was Major Aquifer soils (I1), soils which can possibly transmit a wide range of pollutants.

Groundwater sampling and testing has not been commissioned as part of the site investigation, however as no substances were detected in excess of the relevant soil screening values for the proposed “Residential with plant uptake” use and the most onerous land use scenario, ‘Residential with plant uptake’ it is considered that **there is no risk to groundwater**.

6.4.3 Soil Gas

The Phase I Desk Study identified a very low to low risk of soil gas associated with pit full of Made Ground/waste material to the north-west of the site, a farm located at 105m and a nursery located at 57m to the north-west of the site.

Soil gas monitoring was ongoing at the time of reporting and a soil gas risk assessment letter report will be issued when complete.

6.5 Remedial Objective

In summary, asbestos was found in one of the samples tested (TP1:0.50m bgl).

Therefore, there is a risk to the Human Health, 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.

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 Development of Soil Remediation Strategy

TP1 is situated in soft landscaping of proposed residential gardens. The asbestos recorded represent a risk to future site occupants and site workers via dermal, ingestion and inhalation pathways. To remove the risks, the potential pathways need to be severed. This could be undertaken following the method outlined below.

6.6.1 Asbestos

Asbestos-containing soils (ACSs) were identified at the site, with one out of six soil samples tested detecting asbestos material. The asbestos matrix identified was described as 'bundles in soil.' The asbestos type was chrysotile. In collaboration with a licensed asbestos removal contractor consultation must be made with the local authority to determine a remediation strategy. Asbestos-containing soils (ACSs) do not necessarily require removal or treatment, but would require a suitable capping layer to remain in-situ. All future works should have suitable health and safety procedures in place to protect workers from airborne asbestos fibres. If ACSs remain in-situ measures should be put in place to ensure the risk of exposures is not increased, such as exposing buried asbestos at the surface. Where ACSs have to be removed from site quantification of the asbestos would be required. Waste containing asbestos will be hazardous waste if it contains more than 0.1% by weight of asbestos, (CIRIA C733, Asbestos in soil and made ground: a guide to understanding and managing risks).

Asbestos quantification would be recommended on the soil samples where asbestos was identified, so an assessment can be carried out.

6.7 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.

6.8 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 undertaken on one sample (TP1:0.50m bgl), in case material is required to be taken off-site.

6.8.1 Risk Based Hazard Assessment of Waste

The analysis results of the chemical laboratory testing undertaken as part of report, prepared by QTS Environmental Ltd were used for the **Hazardous Waste Classification** process. The determination of the hazardous waste classification process is outlined in Appendix C.4.

Full results of the laboratory analysis and hazardous waste classification tool are given in Appendix C.2 with the samples classified as hazardous outlined in Table 6.2.

Table 6.2 Risk Based Hazard Assessment of Waste

Trial Hole	Depth (m bgl)	Certificate	Description (general)	Type/Waste Code	HazWasteOnline Classification Hazardous Waste
TP1	0.50	17-68595	Brown sandy clay with stones	17 05 03*	Inert Waste Landfill

Note: 17 05 03* (Soil and stones containing hazardous substances)

Asbestos **was** encountered during the Phase II intrusive investigation. Waste containing asbestos would either need to be pre-treated on-site, removing the asbestos, before removing to landfill or sent to a specialist landfill which can deal with waste containing asbestos.

6.9 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.

6.10 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.

6.11 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.

List of Figures

Figure 1 – Site Location Map	37
Figure 2 – Aerial Photograph	38
Figure 3 – Trial Hole Plan.....	39

List of Appendices

Appendix A Field Work

Appendix A.1 Engineers Logs

Appendix B Geotechnical In-Situ and Laboratory Testing

Appendix B.1 Classification

Appendix B.2 Interpretation

Appendix B.3 Geotechnical In-Situ and Laboratory Results

Appendix C Chemical Laboratory Testing

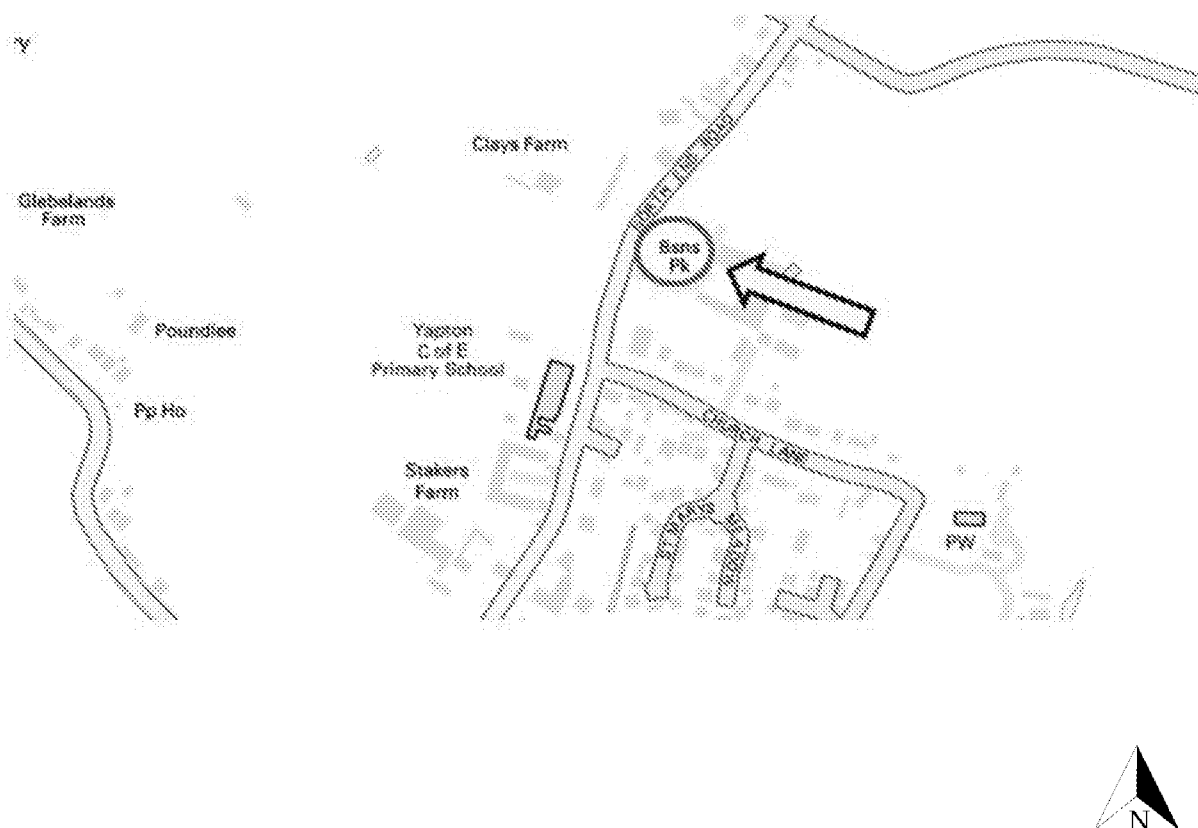
Appendix C.1 Conceptual Site Model

Appendix C.2 Chemical Laboratory Results

Appendix C.3 General Assessment Criteria

Appendix C.4 Determination of Hazardous Waste Classification

Appendix D Information Provided by the Client

**Figure 1 – Site Location Map**

Job Number 16671	Project Orchard Business Park, North End Road, Yaptan, BN18 0GA
Client Crayfern Homes	Date February 2018



Figure 2 – Aerial Photograph

Project

Orchard Business Park, North End
Road, Yaptan, BN18 0GA

Client

Crayfern Homes

Date

February 2018

Job Number

16671





Figure 3 – Trial Hole Plan

Project

Orchard Business Park, North End
Road, Yapton, BN18 0GA

Client

Crayfern Homes

Date

February 2018

Job Number

16671



Appendix A Field Work

Appendix A.1 Engineers Logs

Project Name: Orchard [REDACTED]

Hole Type
WS

Location: Orchard Business Park, North End Road, Yapton, BN18 0GA

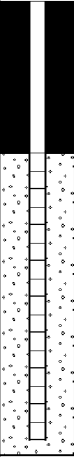
Level:

Scale
1:50

Client: Crayfern Homes

Dates: 21/12/2017

Logged By

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (mAOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	J+D					Grass over soft dark brown very silty CLAY. Frequent fine roots and rootlets. Rare fine sub-angular flints. A pocket of plant material at 0.55m bgl. TOPSOIL.	
		0.50	J+D						
		0.80	J+D		0.85				
		1.20	D		1.30			Firm dark organish brown gravelly sandy CLAY. Sand is fine. Gravel is fine to coarse angular flint. RIVER TERRACE DEPOSITS	1
		1.70	D					Brownish orange clayey fine SAND. RIVER TERRACE DEPOSITS	2
		2.60	D		2.50			Firm dark organish brown sandy CLAY. Sand is fine. Gravel is fine to coarse angular flint. RIVER TERRACE DEPOSITS	
					2.80			Yellowish white weathered structureless CHALK recovered as fine to coarse intact blocks in a clayey silty matrix. Rare pockets of fine angular flint fragments. Grade C5-A1. LEWES NODULAR CHALK FORMATION	3
					3.00			End of Borehole at 3.00m	
									4
									5
									6
									7
									8
									9
									10

General Remarks:

Roots encountered to 0.85m bgl. No groundwater has been encountered.

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

**Soils Limited**

Newton House, Cross Road, Tadworth KT20 5SR

Borehole Log

Borehole No.

WS2

Sheet 1 of 1

Project Name: Orchard Business Park

Project No.: 16671

Co-ords:

Hole Type
WS

Location: Orchard Business Park, North End Road, Yapton, BN18 0GA

Level:

Scale
1:50

Client: Crayfern Homes

Dates: 21/12/2017

Logged By

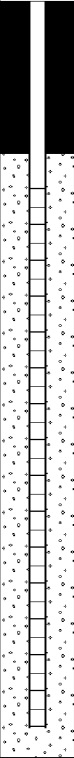
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (mAOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	J+D		0.80			Grass over soft dark brown very silty CLAY. Frequent fine roots and rootlets. TOPSOIL.	
		0.50	J+D						
		0.90	J+D						
		1.50	D		2.20			Soft dark organish brown sandy CLAY. Sand is fine. Occasional rootlets to 1.30m bgl. RIVER TERRACE DEPOSITS	1
		2.30	D						2
		2.80	D						3
		3.50	D						4
		4.30	D						5
		4.80	D						6
					5.00			End of Borehole at 5.00m	7
									8
									9
									10

General Remarks:

Roots encountered to 1.30m bgl. No groundwater has been encountered.

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: Orchard Business Park	Project No.: 16671	Co-ords:	Hole Type WS
Location: Orchard Business Park, North End Road, Yapton, BN18 0GA	Level:		Scale 1:50
Client: Crayfern Homes	Dates: 21/12/2017		Logged By

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (mAOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	J+D					Grass over soft dark brown very silty CLAY. Frequent fine roots and rootlets. Rare fine angular flints. TOPSOIL.	
		0.50	J+D						
		0.90	J+D						
		1.20	J+D		1.20				1
		1.80	D					Soft dark organish brown sandy CLAY. Sand is fine. Frequent black organic patches. RIVER TERRACE DEPOSITS	
		2.30	D		2.10			Brownish orange clayey gravelly fine SAND. Gravel is fine to medium angular flint. RIVER TERRACE DEPOSITS	2
		2.80	D						
		3.20	D		3.00			Yellowish white weathered structureless CHALK recovered as fine to coarse intact blocks in a clayey silty matrix. Rare pockets of fine angular flint fragments. Grade Dc to C5-A1. LEWES NODULAR CHALK FORMATION	3
		3.80	D						4
		4.30	D						
		4.80	D		5.00				
								End of Borehole at 5.00m	5
									6
									7
									8
									9
									10

General Remarks:

Roots encountered to 1.20m bgl. No groundwater has been encountered.

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



Soils Limited

Newton House, Cross Road, Tadworth KT20 5SR

Borehole Log

Borehole No.

WS4

Sheet 1 of 1

Project Name: Orchard

Hole Type
WS

Location: Orchard Business Park, North End Road, Yapton, BN18 0GA

Level:

Scale
1:50

Client: Crayfern Homes

Dates: 21/12/2017

Logged By

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (mAOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	J+D					Grass over soft dark brown very silty CLAY. Frequent fine roots and rootlets. Rare fine to medium angular flints. MADE GROUND	
		0.50	J+D		0.55				
		0.80	J+D					Grey and red very gravelly fine to coarse SAND. Gravel is fine to coarse brick flint concrete and roof tiling. MADE GROUND.	1
					1.50				
		1.80	D					Soft to firm creamish brown to light brown gravelly sandy CLAY. Sand is fine. Gravel is fine to medium sub-angular to angular flint and chalk. RIVER TERRACE DEPOSITS	2
		2.50	D						3
		3.50	D						
					3.80				
		4.50	D					Yellowish white weathered structureless CHALK recovered as fine to coarse intact blocks in a clayey silty matrix. Rare pockets of fine angular flint fragments. Grade C5-A1. LEWES NODULAR CHALK FORMATION	4
					5.00			End of Borehole at 5.00m	5
									6
									7
									8
									9
									10

General Remarks:

Roots encountered to 0.55m bgl. No groundwater has been encountered.

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: Orchard Business Park

Project No.: 16671

Method:

Hole Type

Location: Orchard Business Park, North End Road, Yapton, BN18 0GA

Plant:

TP

Support:

Scale

Client: Crayfern Homes

Trial Pit Length: m

Trial Pit Width: m

1:25

Dates: 14/12/2017

Level:

Co-ords:

Logged By

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.25	J+D					Turf over firm dark brown friable clayey gravelly SILT becoming dark brown at 0.40m bgl. Gravel is fine to cobble sized sub-angular brick concrete and glass. Frequent fine roots. MADE GROUND	
	0.50	J+B						
	0.80	J+D		0.75			Loose to medium dense slightly silty very sandy fine to boulder sized concrete brick ceramic and breeze block GRAVEL. Frequent fine roots. MADE GROUND	1
	1.40	D			1.60			
	1.80	D					Soft to firm dark orangish brown friable clayey SILT with occasional large pockets of orangish brown sandy silty clay. RIVER TERRACE DEPOSITS	2
	2.30	D			2.40			
	2.60	B					Moderately weak, light brown weathered structureless CHALK composed of silty sub-angular to sub-rounded mainly fine and medium GRAVEL. Gravel was weak to hard low to high density, light brown. Bedding fractures medium-spaced; Matrix was light brown silty. Occasional soft spots were noted. Occasional angular flint gravel (Grade Dm to Grade Dc). LEWES NODULAR CHALK FORMATION	3
	3.00	D						
	3.50	D						
	4.00	D						4
	4.50	B						
							Continued on Next Sheet	5

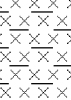
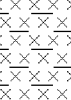
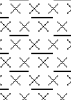
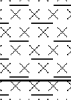
General Remarks:

No groundwater has been encountered. Roots encountered to 1.60m bgl.

Sample Type

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

Groundwater Remarks:

		Soils Limited Newton House, Cross Road, Tadworth KT20 5SR 			Trial Pit Log		Trial Pit No. TP2 Sheet 1 of 1	
Project Name: Orchard				Method:		Hole Type TP		
Location: Orchard Business Park, North End Road, Yapton, BN18 0GA				Plant:		Scale 1:25		
Client: Crayfern Homes				Trial Pit Length: m		Trial Pit Width: m		
Dates: 14/12/2017		Level:		Co-ords:		Logged By		
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20	J+D		0.35			Turf over soft to firm friable dark brown slightly sandy slightly gravelly SILT. Gravel is fine sub-angular flint. A darker brown/black layer from 0.20 to 0.35m bgl. Abundant fine roots and rootlets. TOPSOIL	
							Firm orangish brown friable clayey SILT becoming mottled light grey and orange at 3.00m bgl. Occasional fine roots and rootlets. Occasional medium to coarse sub-angular flint gravel at 2.40m bgl. RIVER TERRACE DEPOSITS	
	1.10	D						
	2.10	D						
	2.40	D						
	2.70	D						
	3.00	D						
	3.50	D		3.40			Firm dark orange slightly sandy clayey SILT becoming light grey and orange mottled at 3.50m bgl becoming slightly gravelly at 3.80m bgl. Gravel is fine to coarse sub-angular flint. Occasional fine to medium chalk gravel at 4.40m bgl. RIVER TERRACE DEPOSITS	
	4.00	D						
	4.40	D		4.50				
							End of Pit at 4.50m	
General Remarks: No groundwater has been encountered. Roots encountered to 2.70m bgl.							Sample Type D: Disturbed B: Bulk J: Jar W: Water	
Groundwater Remarks:								

**Soils Limited**

Newton House, Cross Road, Tadworth KT20 5SR

Trial Pit Log

Trial Pit No.

TP2A

Sheet 1 of 1

Project Name: Orchard Business Park

Project No.: 16671

Method:

Plant:

Support:

Hole Type

TP

Scale

1:25

Logged By

Location: Orchard Business Park, North End Road, Yapton, BN18 0GA

Client: Crayfern Homes

Trial Pit Length: m

Trial Pit Width: m

Dates: 14/12/2017

Level:

Co-ords:

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	J+D					Turf over soft dark brown silty CLAY with frequent fine roots. TOPSOIL	
	0.40	J+D		0.30			Soft to firm friable light brown clayey SILT becoming orangish brown slightly sandy at 1.90m bgl. RIVER TERRACE DEPOSITS	1
	1.90	D		2.00			End of Pit at 2.00m	2
								3
								4
								5

General Remarks:

No groundwater has been encountered. Roots encountered to 0.50m bgl.

Sample Type

D: Disturbed

B: Bulk

J: Jar

W: Water

Groundwater Remarks:

Project Name: Orchard Business Park		Project No.: 16671		Method:		Hole Type TP
Location: Orchard Business Park, North End Road, Yapton, BN18 0GA				Plant:		
Client: Crayfern Homes		Trial Pit Length: m		Trial Pit Width: m		
Dates: 14/12/2017		Level:		Co-ords:		Scale 1:25
						Logged By

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20	J+D		0.20			Turf over brown slightly gravelly clayey SILT. Gravel is fine to coarse angular flint. Abundant fine to medium roots and rootlets. TOPSOIL	
	0.60	J+D					Soft to firm friable clayey SILT becoming dark orangish brown at 1.20m bgl. Occasional fine roots. RIVER TERRACE DEPOSITS	
	1.20	D						1
	1.80	D						
	2.20	D						
	2.40			2.40				
	2.55	D						
	3.00	D		3.00				
							End of Pit at 3.00m	3
								4
								5

General Remarks: No groundwater has been encountered. Roots encountered to 1.20m bgl.		Sample Type D: Disturbed B: Bulk J: Jar W: Water
Groundwater Remarks:		

Project Name:	Orchard Business Park	Project No:	16671	Co-ords:		Hole Type	DP
Location:	Orchard Business Park, North End Road, Yapton, BN18 0GA			Level:	m AOD	Scale	1:50
Client:	Crayfern Homes			Dates:	14/12/2017	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					55
1.1					
1.2					
1.3					
1.4					
1.5					
1.6					
1.7					
1.8					
1.9					
2					45
2.1					
2.2					
2.3					
2.4					
2.5					
2.6					
2.7					
2.8					
2.9					
3					40
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					50
5.1					
5.2					
5.3					
5.4					
5.5					
5.6					
5.7					
5.8					
5.9					
6					
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 760mm		Cone Base Diameter mm		
	Hammer Weight 63.5kg		Final Depth 6m		
	Probe Type DPSH- A		Energy Ratio (Er) 75%		

Project Name:	Orchard Business Park	16671	Co-ords:		Hole Type DP
Location:	Orchard Business Park, North End Road, Yapton, BN18 0GA		Level:	m AOD	Scale 1:50
Client:	Crayfern Homes		Dates:	14/12/2017	Logged By

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0	0				
0.1	1				
0.2	2				
0.3	1				
0.4	2				
0.5	1				0
0.6	1				
0.7	2				
0.8	3				
0.9	3				
1	4				
1.1	7				
1.2	7				
1.3	7				
1.4	16				
1.5	7				
1.6	16				
1.7	10				
1.8	9				
1.9	10				
2	8				100
2.1	10				
2.2	10				
2.3	10				
2.4	19				
2.5	13				
2.6	12				
2.7	10				
2.8	8				
2.9	9				
3	9				50
3.1	10				
3.2	10				
3.3	10				
3.4	10				
3.5	11				
3.6	16				
3.7	14				
3.8	14				
3.9	14				
4	15				50
4.1	11				
4.2	12				
4.3	12				
4.4	11				
4.5	12				
4.6	11				
4.7	11				
4.8	12				
4.9	12				
5	11				
5.1					
5.2					
5.3					
5.4					
5.5					
5.6					
5.7					
5.8					
5.9					
6					
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					
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7.5					
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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 760mm		Cone Base Diameter mm		
	Hammer Weight 63.5kg		Final Depth 6m		
	Probe Type DPSH- A		Energy Ratio (Er) 75%		

Project Name:	Orchard Business Park	Project No:	16671	Co-ords:		Hole Type	DP
Location:	Orchard Business Park, North End Road, Yapton, BN18 0GA			Level:	m AOD	Scale	1:50
Client:	Crayfern Homes			Dates:	14/12/2017	Logged By	

Depth (m)	Blows/100mm					Torque (Nm)
	0	10	20	30	40	
0	0					40
0.2	2					
0.4	2					
0.6	3					
0.8	7					
1.0	6					35
1.2	5					
1.4	3					
1.6	2					
1.8	2					
2.0	3					40
2.2	3					
2.4	3					
2.6	4					
2.8	5					
3.0	6					45
3.2	7					
3.4	6					
3.6	6					
3.8	5					
4.0	6					45
4.2	7					
4.4	9					
4.6	12					
4.8	13					
5.0	17					55
5.2	16					
5.4	15					
5.6	8					
5.8	8					
6.0	8					
6.2	9					
6.4	8					
6.6	7					
6.8	7					
7.0	5					
7.2	4					
7.4	4					
7.6	5					
7.8	6					
8.0	6					
8.2	6					
8.4	6					
8.6	7					
8.8	7					
9.0	5					
9.2	6					
9.4	6					
9.6	6					
9.8	6					
10.0	6					

Remarks	Fall Height	760mm	Cone Base Diameter	mm
	Hammer Weight	63.5kg	Final Depth	6m
	Probe Type	DPSH- A	Energy Ratio (Er)	75%



Project Name:	Orchard Business Park	16671	Coordinates:		Hole Type
Location:	Orchard Business Park, North End Road, Yapton, BN18 0GA		Level:	m AOD	DP
Client:	Crayfern Homes		Dates:	14/12/2017	Scale
					1:50
					Logged By

Depth (m)	Blows/100mm				Torque (Nm)
	0	10	20	30	40
0	0				
0.1	1				
0.2	2				
0.3	4				
0.4	7				
0.5	6				
0.6	2				
0.7	2				
0.8	1				
0.9	1				
1	2				55
1.1	0				
1.2	1				
1.3	2				
1.4	0				
1.5	1				
1.6	2				
1.7	0				
1.8	1				
1.9	2				
2	1				20
2.1	2				
2.2	3				
2.3	2				
2.4	3				
2.5	3				
2.6	7				
2.7	9				
2.8	9				
2.9	9				
3	10				40
3.1	7				
3.2	6				
3.3	8				
3.4	8				
3.5	5				
3.6	6				
3.7	7				
3.8	7				
3.9	7				
4	9				50
4.1	7				
4.2	6				
4.3	6				
4.4	5				
4.5	6				
4.6	6				
4.7	7				
4.8	6				
4.9	5				
5	6				55
5.1	8				
5.2	8				
5.3	7				
5.4	7				
5.5	8				
5.6	6				
5.7	7				
5.8	7				
5.9	7				
6	6				55
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 760mm		Cone Base Diameter mm		
	Hammer Weight 63.5kg		Final Depth 6m		
	Probe Type DPSH- A		Energy Ratio (Er) 75%		

Soakaway Calculations

Soakaway Test No.	TP1-SK1
Contract:	Orchard Business Park, North End Road, Yapton, BN18 0GA
Contract No.	16671

Field Test

Trial Pit Log (include details of groundwater):
See trial Pit record

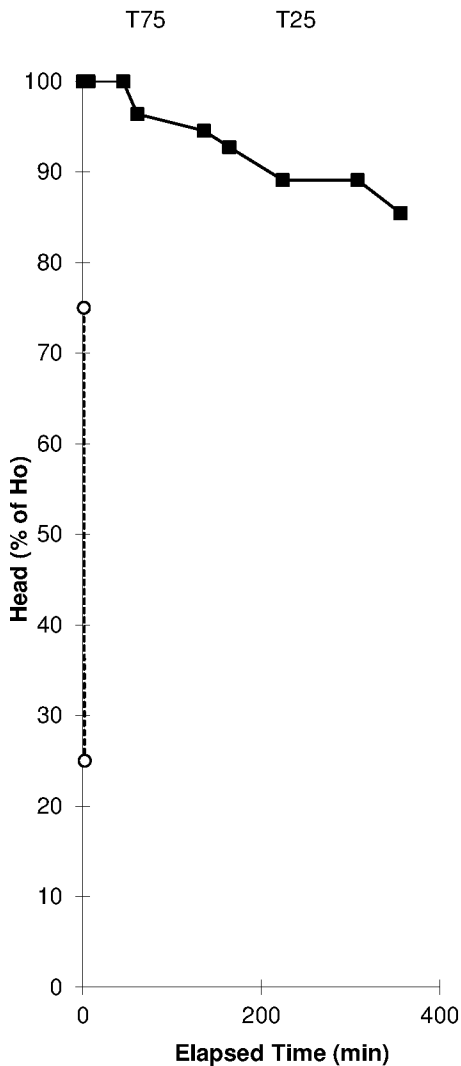
Depth of Pit	5.20 m
Width of Pit	1.30 m
Length of Pit	3.00 m
Depth of Pit Soaked	0.55 m

ap50	6.265	m2
ap75-25	1.0725	m3
ap75-25	N/A	min
water used	2.1450	m3
$\dot{e}$	N/A	m/sec.

Field Data

[illegible]

T75	N/A	75
T25	N/A	25
T75-25	N/A	Derived from Best Fit



Comments

Infiltration stopped - unable to calculate infiltration rate

SOILS LIMITED

**Newton House, Cross Road, Tadworth
Surrey, KT20 5SR**

Telephone: 01737 814 221
Facsimile: 01737 812 557

Soakaway Calculations

Soakaway Test No.	TP2A-SK1
Contract:	Orchard Business Park, North End Road, Yapton, BN18 0GA
Contract No.	16671

Field Test

Trial Pit Log (include details of groundwater):
See trial Pit record

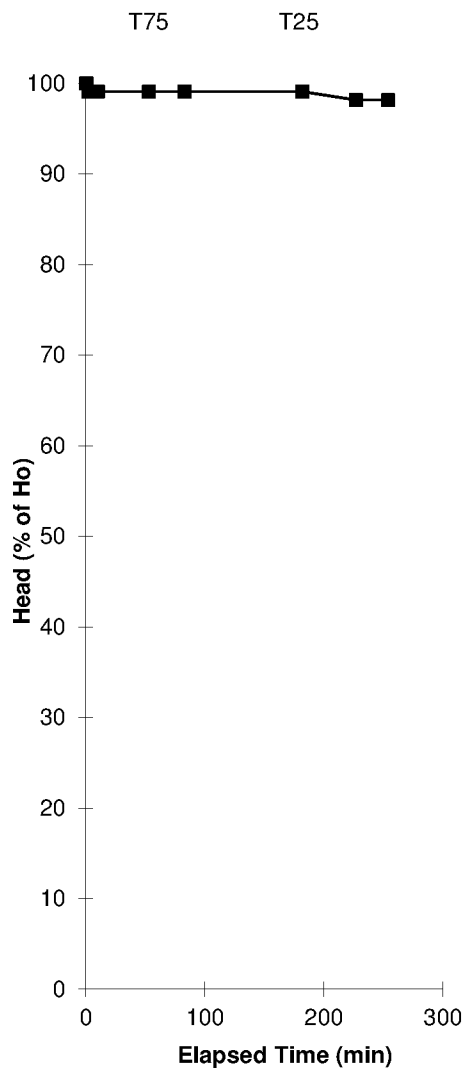
Depth of Pit	2.00 m
Width of Pit	0.70 m
Length of Pit	2.00 m
Depth of Pit Soaked	1.09 m

ap50	4.343	m2
ap75-25	0.763	m3
ap75-25	N/A	min
water used	1.5260	m3
f	N/A	m/sec.

Field Data

[illegible]

T75	N/A	75
T25	N/A	25
T75-25	N/A	Derived from Best Fit



Comments

Infiltration stopped - unable to calculate infiltration rate

SOILS LIMITED

**Newton House, Cross Road, Tadworth
Surrey, KT20 5SR**

Telephone: 01737 814 221
Facsimile: 01737 812 557

Soakaway Calculations

Soakaway Test No.	TP3-SK1
Contract:	Orchard Business Park, North End Road, Yapton, BN18 0GA
Contract No.	16671

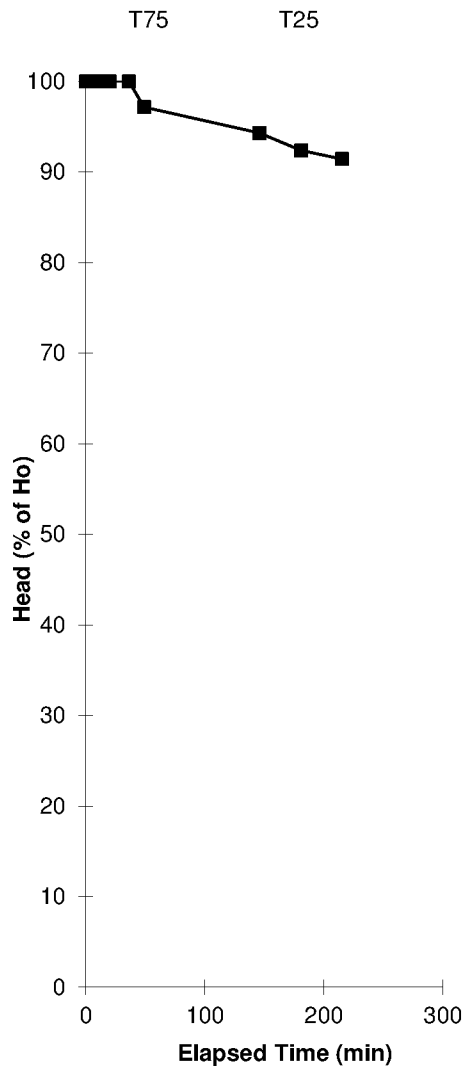
Field Test

Trial Pit Log (include details of groundwater):
See trial Pit record

Depth of Pit	3.00 m
Width of Pit	0.70 m
Length of Pit	1.80 m
Depth of Pit Soaked	1.05 m
ap50	3.885 m ²
q _{p75-25}	0.6615 m ³
c75-25	N/A min
water used	1.3230 m ³
f	N/A m/sec.

Field Data

<i>Depth to</i>	<i>Elapsed</i>	<i>Head of</i>	<i>Head of</i>
<i>Water</i>	<i>Time</i>	<i>Water</i>	<i>Water</i>
(m)	(min)	(% of Ho)	(m)
1.95	0.1	100	1.05
1.95	1.00	100	1.05
1.95	3.00	100	1.05
1.95	7.00	100	1.05
1.95	11.00	100	1.05
1.95	20.00	100	1.05
1.95	36.00	100	1.05
1.98	49.00	97	1.02
2.01	146.00	94	0.99
2.03	181.00	92	0.97
2.04	215.00	91	0.96
T75	N/A	75	
T25	N/A	25	
T75-25	N/A	Derived from Best Fit	



Comments

Infiltration stopped - unable to calculate infiltration rate

SOILS LIMITED

**Newton House, Cross Road, Tadworth
Surrey, KT20 5SR**

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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 "N" 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 "N" Value Range	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
DPI	RTD (cohesive) 0.85 – 1.30 Gravelly CLAY	3 – 7	Very low to low ($C_u = 15 - 35\text{kPa}$)
	RTD (granular) 1.30 – 3.00 Clayey SAND	4 - 14	Loose to medium dense
	LPCK ¹ 3.00 – 6.00 CHALK	17 - >35	Structured chalk (C5 – A1)
DP2	RTD(cohesive) 0.80 – 2.20 Gravelly CLAY	4 - 25	Very low to high ($C_u = 20 - 100\text{kPa}$)
	LPCK ¹ 2.20 – 6.00 CHALK	21 - >35	Structured chalk (C5 – A1)
DP3	RTD (cohesive) 1.30 – 2.00 Gravelly CLAY	7 - 11	Low to Medium ($C_u = 35 - 55\text{kPa}$)
	RTD (granular) 2.00 – 3.00 Clayey SAND	18 - 25	Medium dense
	LPCK ¹ 3.00 – 6.00 CHALK	14 - >35	Structureless (Dc) to structured chalk (C5 – A1)
DP4	RTD (cohesive) 1.70 – 3.80 Gravelly CLAY	4 - 32	Very low to very high ($C_u = 20 - 160\text{kPa}$)
	LPCK ¹ 3.80 – 6.00 CHALK	21 - 32	Structured chalk (C5 – A1)

Note: ¹ Ground conditions inferred past the base of windowless sampler boreholes.

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 (cohesive)	18 - 23	13 - 20	78 - 89	10 - 18	CL - CI	Low	Low
RTD (granular)	13	11	100	11	CL	Low	Low

Stratum	Moisture	Plasticity	Passing	Modified	Soil	Volume	
	Content	Index	425µm	Plasticity		Change Potential	
	(%)	(%)	Sieve	Index	Classification	BRE	NHBC
			(%)	(%)			

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 15%. 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)

Table B.2.3 Interpretation of PSD Tests

Location	Depth (m bgl)	Soil Description	Volume Change		Passing 63µm Sieve (%)
			BRE	NHBC	
WSI	1.70	Brown fine to medium sandy silty CLAY	Yes	Yes	69

Note: BRE 240 states that a soil has a volume change potential when the clay fraction **exceeds 15%**. Only the silt and clay combined fraction are determined by sieving therefore the volume change potential is estimated from the percentage passing the 63µm sieve. NHBC Standards Chapter 4.2 states that a soil is shrinkable if the percentage of silt and clay passing the 63µm sieve is greater than 35% and the Plasticity Index is greater than 10%.

(The Particle Size Distribution Tests were undertaken in accordance with BS 1377: Part 2: 1990 Clause 9)

Appendix B.3 Geotechnical In-Situ and Laboratory Results



Contract Number: 37732

Client Ref: **16671**

Report Date: **12-01-2018**

Client PO: **16671**

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

Contract Title: **Orchard Business Park, North End Road, Yapton, BN18 0GA**
For the attention of: **Olia Kontogianni**

Date Received: **05-01-2018**
Date Commenced: **05-01-2018**
Date Completed: **12-01-2018**

Test Description	Qty
Moisture Content BS 1377 : Part 2 : 3.2 - * UKAS	5
4 Point Liquid & Plastic Limit (LL/PL) BS 1377 Part 2 : 4.3 & 5.3 - * UKAS	5
PSD Wet Sieve method 1377 : 1990 Part 2 : 9.2 - * UKAS	1
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 14/01/18 PL Tel: 01554 784040 Fax: 01554 784041 info@gstl.co.uk gstl.co.uk

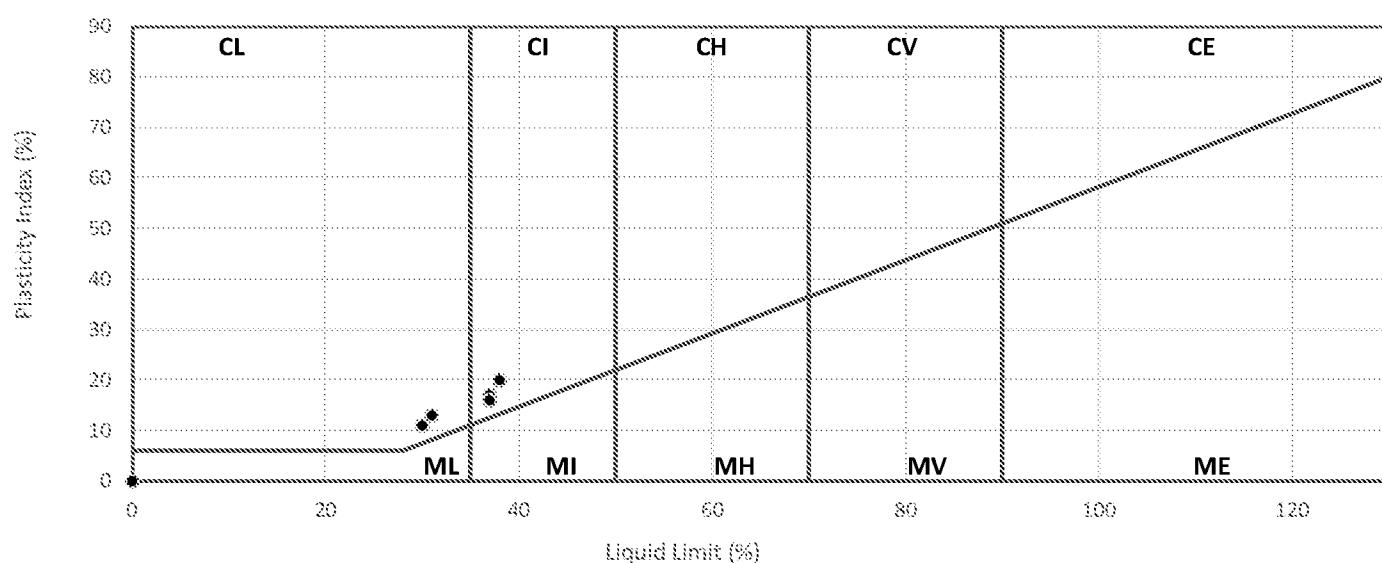
LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5)

Contract Number	37732	
Site Name	Orchard Business Park, North End Road, Yapton, BN18 0GA	

[illegible]

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

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION



Operators	Checked	11/01/2018	Sean Penn
DB	Approved	12/01/2018	Ben Sharp



PARTICLE SIZE DISTRIBUTION
BS 1377 Part 2:1990
Wet Sieve, Clause 9.2

Contract Number

37732

Borehole/Pit No.

WS1

Site Name

Orchard Business Park, North End Road, Yapton, BN18 0GA

Sample No.

Soil Description

Brown fine to medium sandy silty CLAY

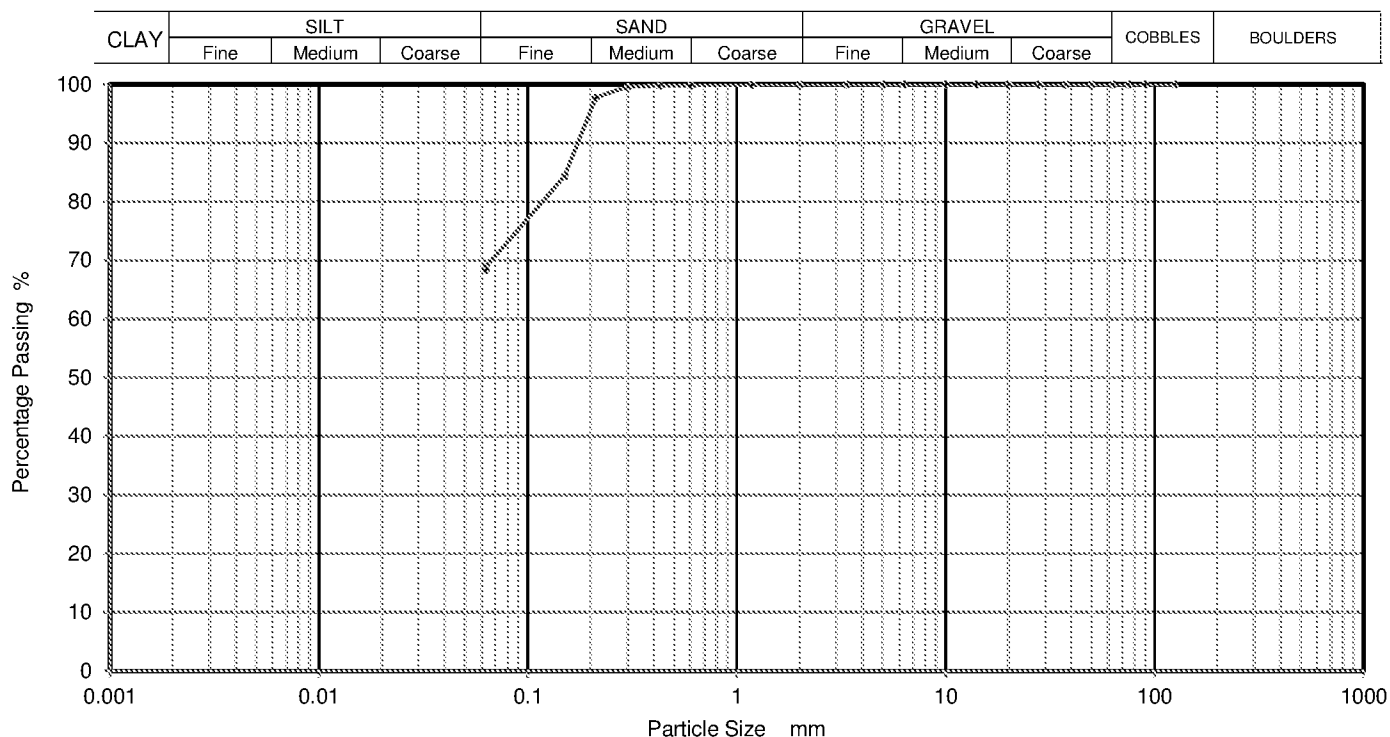
Depth Top

1.70

Depth Base

Sample Type

D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	
90	100	0.0060	
75	100	0.0019	
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	100		
0.3	100		
0.212	98		
0.15	84		
0.063	69		

Sample Proportions	% dry mass
Cobbles	0
Gravel	0
Sand	31
Silt and Clay	69

Grading Analysis	
Uniformity Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	11/01/2018	Sean Penn
RO/MH	Approved	12/01/2018	Ben Sharp



Appendix C Chemical Laboratory Testing

Appendix C.1 Conceptual Site Model

Table C.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		
Nursery Off-site sources from which potential contamination would have migrated onto the site.	Ammonia, Pesticides, Metals, Semi-metals and non-metals, PAHs	Inhalation of dust	Site Workers/Site Maintenance	Medium	Unlikely	Low	Phase II ground investigation to confirm the ground conditions present and chemical testing prior to undertaking a generic quantitative risk assessment.	
			End Users	Medium	Low	Moderate/Low		
			Off-site Users	Medium	Unlikely	Low		
	PAHs, TPHs	Inhalation of Vapour/gases	Site Workers/Site Maintenance	Minor	Unlikely	Very Low		
			End Users	Medium	Unlikely	Low		
			Off-site Users	Minor	Unlikely	Very low		
	Ammonia, Pesticides, Metals, Semi-metals and non-metals, PAHs, TPHs, Asbestos	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	Medium	Unlikely	Low		
			End Users	Medium	Low	Moderate/Low		
	Ammonia, Pesticides, Metals, Semi-metals and non-metals, PAHs, TPHs	Migration via surface runoff	Surface Water	-	-	-		
			Surface Water	-	-	-		
		Migration in solution via groundwater	Shallow Aquifer	-	-	-		
			Deep Aquifer	Medium	Low	Moderate/Low		
		Direct contact with construction material	Buried structures	Mild	Low	Low		
			Buried Services					
	PAHs, TPHs	Migration of gases via permeable soils	Site Workers/Site Maintenance	Minor	Unlikely	Very Low		
			End Users					
			Off-site Users	Minor	Unlikely	Very low		
			Building and confined spaces					
Clays Farm On-site sources of potential contamination	Pesticides, PAHs, TPHs	Inhalation of dust	Site Workers/Site Maintenance	Medium	Unlikely	Low	Phase II ground investigation to confirm the ground conditions present and chemical testing prior to undertaking a generic quantitative risk assessment.	
			End Users	Medium	Unlikely	Low		
			Off-site Users	Medium	Unlikely	Low		
	PAHs, TPHs	Inhalation of Vapour/gases	Site Workers/Site Maintenance	Minor	Unlikely	Very Low		
			End Users	Medium	Unlikely	Low		
			Off-site Users	Minor	Unlikely	Very Low		
	Pesticides, PAHs, TPHs	Migration via surface runoff	Surface Water	-	-	-		
			Surface Water	-	-	-		
		Migration in solution via groundwater	Shallow Aquifer	-	-	-		
			Deep Aquifer	Medium	Low	Moderate/Low		
	Pesticides, PAHs, TPHs	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	Medium	Unlikely	Low		
			End Users	Medium	Low	Moderate/Low		
		Direct contact with construction material	Buried structures	Mild	Unlikely	Very Low		
	PAHs, TPHs	Migration of gases via permeable soils	Site Workers					
			Site Workers/Site Maintenance	Minor	Unlikely	Very Low		
			End Users	Medium	Unlikely	Low		
			Off-site Users	Minor	Unlikely	Very low		
			Building and confined spaces	Minor	Unlikely	Very low		
Electric boxes On-site sources of potential contamination	PCB's	Inhalation of dust	Site Workers/Site Maintenance	Medium	Unlikely	-	Phase II ground investigation to confirm the ground conditions present and chemical testing prior to undertaking a generic quantitative risk assessment.	
			End Users	Medium	Unlikely	-		
			Off-site Users	Medium	Unlikely	-		
		Inhalation of Vapour/gases	Site Workers/Site Maintenance	Minor	Unlikely	-		
			End Users	Medium	Unlikely	-		
			Off-site Users	Minor	Unlikely	-		
		Migration via surface runoff	Surface Water	-	-	-		
			Surface Water	-	-	-		
		Migration in solution via groundwater	Shallow Aquifer	-	-	-		
			Deep Aquifer	Minor	Low	Very Low		
		Ingestion and absorption via direct contact	Site Workers/Site Maintenance	Minor	Unlikely	Very Low		
			End Users	Minor	Low	Very Low		
		Direct contact with construction material	Buried structures	Mild	Unlikely	Very Low		
		Migration of gases via permeable soils	Site Workers					
			Site Workers/Site Maintenance	Minor	Unlikely	-		
			End Users	Medium	Unlikely	-		

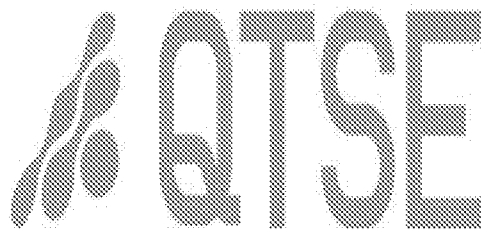
Source (See Error! Reference source not found. and Error! Reference source not found.)	Potential Contaminant (See Error! Reference source not found.)	Exposure Pathway (See Error! Reference source not found.)	Receptor (See Error! Reference source not found.)	Initial Assessment from Desk Study Information			Comments	Proposed Investigation
				Severity	Probability	Risk		
Pit full of waste material (Made Ground) On-site sources of potential contamination	PAHs, TPHs, Metals, Semi-metals and non-metals, Sulphate, Asbestos	Inhalation of dust	Off-site Users	Minor	Unlikely	-		Phase II ground investigation to confirm the ground conditions present and chemical testing prior to undertaking a generic quantitative risk assessment.
			Building and confined spaces	Minor	Unlikely	-		
			Site Workers/Site Maintenance	Medium	Low	Moderate/Low		
			End Users	Medium	Unlikely	Low		
	PAHs, TPHs, Metals, Semi-metals and non-metals, Sulphate	Inhalation of Vapour/gases	Off-site Users	Medium	Unlikely	Low		
			Site Workers/Site Maintenance	Mild	Unlikely	Low		
			End Users	Medium	Unlikely	Low		
			Off-site Users	Mild	Unlikely	Low		
	PAHs, TPHs, Metals, Semi-metals and non-metals, Sulphate	Migration via surface runoff	Surface Water	-	-	-		
		Migration in solution via groundwater	Surface Water	-	-	-		
			Shallow Aquifer	-	-	-		
			Deep Aquifer	Medium	Low	Moderate/Low		
	PAHs, TPHs, Metals, Semi-metals and non-metals, Sulphate, Asbestos	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	Medium	Unlikely	Low		
			End Users	Medium	Low	Moderate/Low		
		Direct contact with construction material	Buried structures	Mild	Low	Low		
			Site Workers					
	PAHs, TPHs, Metals, Semi-metals and non-metals, Sulphate	Migration of gases via permeable soils	Site Workers/Site Maintenance	Mild	Unlikely	Very Low		
			End Users	Medium	Unlikely	Low		
			Off-site Users	Mild	Unlikely	Very Low		
			Building and confined spaces	Minor	Unlikely	Very low		

Table C.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		
Nursery Off-site sources from which potential contamination would have migrated onto the site.	None	Inhalation of dust	Site Workers/Site Maintenance	Medium	Unlikely	-	Soil gas monitoring was ongoing at the time of reporting and a letter report will be provided when complete.	
			End Users	Medium	Low	-		
			Off-site Users	Medium	Unlikely	-		
	PAHs, TPHs	Inhalation of Vapour/gases	Site Workers/Site Maintenance	Minor	Unlikely	Very Low		
			End Users	Medium	Unlikely	Low		
			Off-site Users	Minor	Unlikely	Very low		
	None	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	Medium	Unlikely	-		
			End Users	Medium	Low	-		
	None	Migration via surface runoff	Surface Water	-	-	-		
		Migration in solution via groundwater	Surface Water	-	-	-		
			Shallow Aquifer	-	-	-		
			Deep Aquifer	Medium	Low	-		
		Direct contact with construction material	Buried structures	Mild	Low	-		
			Buried Services					
	PAHs, TPHs	Migration of gases via permeable soils	Site Workers/Site Maintenance	Minor	Unlikely	Very Low		
			End Users					
			Off-site Users	Minor	Unlikely	Very low		
			Building and confined spaces					
Clays Farm On-site sources of potential contamination	None	Inhalation of dust	Site Workers/Site Maintenance	Medium	Unlikely	-	Soil gas monitoring was ongoing at the time of reporting and a letter report will be provided when complete.	
			End Users	Medium	Unlikely	-		
			Off-site Users	Medium	Unlikely	-		
	PAHs, TPHs	Inhalation of Vapour/gases	Site Workers/Site Maintenance	Minor	Unlikely	Very Low		
			End Users	Medium	Unlikely	Low		
			Off-site Users	Minor	Unlikely	Very Low		
	None	Migration via surface runoff	Surface Water	-	-	-		
		Migration in solution via groundwater	Surface Water	-	-	-		
			Shallow Aquifer	-	-	-		
			Deep Aquifer	Medium	Low	-		
	None	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	Medium	Unlikely	-		
			End Users	Medium	Low	-		
		Direct contact with construction material	Buried structures	Mild	Unlikely	-		
	PAHs, TPHs	Migration of gases via permeable soils	Site Workers					
			Site Workers/Site Maintenance	Minor	Unlikely	Very Low		
			End Users	Medium	Unlikely	Low		
			Off-site Users	Minor	Unlikely	Very low		
			Building and confined spaces	Minor	Unlikely	Very low		
Pit full of waste material (Made Ground) On-site sources of potential contamination	Asbestos	Inhalation of dust	Site Workers/Site Maintenance	Medium	Low	Moderate/Low	Remediation Strategy as proposed in Section 6	
			End Users	Medium	Low	Moderate/Low		
			Off-site Users	Medium	Unlikely	Low		
	None	Inhalation of Vapour/gases	Site Workers/Site Maintenance	Mild	Unlikely	-		
			End Users	Medium	Unlikely	-		
			Off-site Users	Mild	Unlikely	-		
	None	Migration via surface runoff	Surface Water	-	-	-		
		Migration in solution via groundwater	Surface Water	-	-	-		
			Shallow Aquifer	-	-	-		
			Deep Aquifer	Medium	Low	-		
	Asbestos	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	Medium	Low	Moderate/Low		
			End Users	Medium	Low	Moderate/Low		
		Direct contact with construction material	Buried structures	-	-	-		
	None	Migration of gases via permeable soils	Site Workers					
			Site Workers/Site Maintenance	Mild	Unlikely	-		
			End Users	Medium	Unlikely	-		
			Off-site Users	Mild	Unlikely	-		

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		
			Building and confined spaces	Minor	Unlikely	-		

Appendix C.2 Chemical Laboratory Results



Olia Kontogianni
Soils Ltd
Newton House
Cross Road
Tadworth
Surrey
KT20 5SR

QTS Environmental Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN



QTS Environmental Report No: 17-68595

Site Reference: Orchard Business Park, Yapton, BN18 0GA

Project / Job Ref: 16671

Order No: None Supplied

Sample Receipt Date: 20/12/2017

Sample Scheduled Date: 20/12/2017

Report Issue Number: 1

Reporting Date: 03/01/2018

Authorised by:

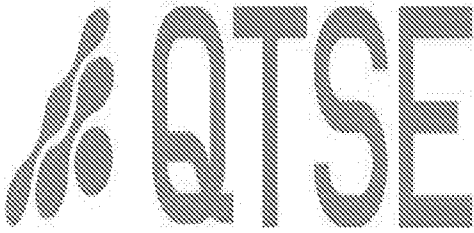
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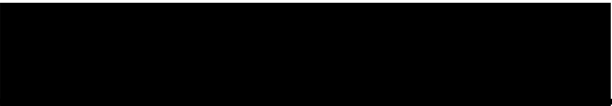
Associate Director of Client Services

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



Soil Analysis Certificate						
QTS Environmental Report No: 17-68595	Date Sampled	14/12/17	14/12/17	14/12/17		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Orchard Business Park, Yapton, BN18 0GA	TP / BH No	TP1	TP1	TP2		
Project / Job Ref: 16671	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	Depth (m)	0.25	0.50	0.20		
Reporting Date: 03/01/2018	QTSE Sample No	307834	307835	307836		

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Detected	Not Detected		
Sample Matrix ^(S)	Material Type	N/a	NONE		Bundles in soil			
Asbestos Type ^(S)	PLM Result	N/a	ISO17025		Chrysotile			
pH	pH Units	N/a	MCERTS	7.5	8.2	6.9		
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2		
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	35	33	15		
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.03	0.03	0.01		
Sulphide	mg/kg	< 5	NONE	< 5	< 5	< 5		
Organic Matter	%	< 0.1	MCERTS	3.1	3.1	3.6		
Total Organic Carbon (TOC)	%	< 0.1	MCERTS	1.8	1.8	2.1		
Antimony (Sb)	mg/kg	< 1	NONE	1.4	2.3	< 1		
Arsenic (As)	mg/kg	< 2	MCERTS	8	11	6		
Beryllium (Be)	mg/kg	< 0.5	NONE	0.6	0.7	0.5		
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	20	25	17		
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2		
Copper (Cu)	mg/kg	< 4	MCERTS	26	20	11		
Lead (Pb)	mg/kg	< 3	MCERTS	82	182	44		
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1		
Nickel (Ni)	mg/kg	< 3	MCERTS	12	21	10		
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3		
Vanadium (V)	mg/kg	< 2	NONE	29	37	25		
Zinc (Zn)	mg/kg	< 3	MCERTS	82	116	56		
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)



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



Soil Analysis Certificate - Speciated PAHs

QTS Environmental Report No: 17-68595	Date Sampled	14/12/17	14/12/17	14/12/17		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Orchard Business Park, Yapton, BN18 0GA	TP / BH No	TP1	TP1	TP2		
Project / Job Ref: 16671	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	Depth (m)	0.25	0.50	0.20		
Reporting Date: 03/01/2018	QTSE Sample No	307834	307835	307836		

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	0.42	< 0.1		
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Fluoranthene	mg/kg	< 0.1	MCERTS	0.17	1.39	< 0.1		
Pyrene	mg/kg	< 0.1	MCERTS	0.14	1.25	< 0.1		
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	0.75	< 0.1		
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	0.78	< 0.1		
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.15	1.14	< 0.1		
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	0.38	< 0.1		
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	0.86	< 0.1		
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	0.58	< 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	0.52	< 0.1		
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	8.1	< 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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Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN



Soil Analysis Certificate - TPH LQM Banded						
QTS Environmental Report No: 17-68595	Date Sampled	14/12/17				
Soils Ltd	Time Sampled	None Supplied				
Site Reference: Orchard Business Park, Yapton, BN18 0GA	TP / BH No	TP1				
Project / Job Ref: 16671	Additional Refs	None Supplied				
Order No: None Supplied	Depth (m)	0.25				
Reporting Date: 03/01/2018	QTSE Sample No	307834				

Determinand	Unit	RL	Accreditation				
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01			
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05			
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2			
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2			
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3			
Aliphatic >C16 - C35	mg/kg	< 10	MCERTS	< 10			
Aliphatic >C35 - C44	mg/kg	< 10	NONE	< 10			
Aliphatic (C5 - C44)	mg/kg	< 30	NONE	< 30			
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01			
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05			
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2			
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2			
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	< 2			
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	< 3			
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	< 10			
Aromatic >C35 - C44	mg/kg	< 10	NONE	< 10			
Aromatic (>C5 - C44)	mg/kg	< 30	NONE	< 30			
Total >C5 - C44	mg/kg	< 60	NONE	< 60			

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



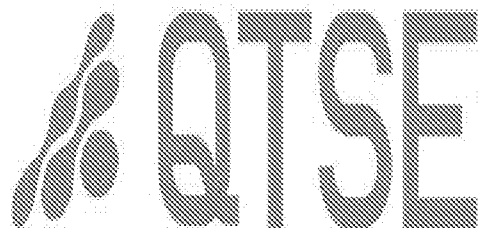
QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN



Soil Analysis Certificate - BTEX / MTBE						
QTS Environmental Report No: 17-68595	Date Sampled	14/12/17				
Soils Ltd	Time Sampled	None Supplied				
Site Reference: Orchard Business Park, Yapton, BN18 0GA	TP / BH No	TP1				
Project / Job Ref: 16671	Additional Refs	None Supplied				
Order No: None Supplied	Depth (m)	0.25				
Reporting Date: 03/01/2018	QTSE Sample No	307834				

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2				
Toluene	ug/kg	< 5	MCERTS	< 5				
Ethylbenzene	ug/kg	< 2	MCERTS	< 2				
p & m-xylene	ug/kg	< 2	MCERTS	< 2				
o-xylene	ug/kg	< 2	MCERTS	< 2				
MTBE	ug/kg	< 5	MCERTS	< 5				

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



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Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN



Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3									
QTS Environmental Report No: 17-68595		Date Sampled	14/12/17			Landfill Waste Acceptance Criteria Limits			
Soils Ltd		Time Sampled	None Supplied						
Site Reference: Orchard Business Park, Yapton, BN18 0GA		TP / BH No	TP1						
Project / Job Ref: 16671		Additional Refs	None Supplied						
Order No: None Supplied		Depth (m)	0.50						
Reporting Date: 03/01/2018		QTSE Sample No	307835						
Determinand	Unit	MDL							
TOC ^{MU}	%	< 0.1	1.8			Inert Waste Landfill			
Loss on Ignition	%	< 0.01	4.70			Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill			
BTEX ^{MU}	mg/kg	< 0.05	< 0.05			Hazardous Waste Landfill			
Sum of PCBs	mg/kg	< 0.1	< 0.1			3%			
Mineral Oil ^{MU}	mg/kg	< 10	< 10			5%			
Total PAH ^{MU}	mg/kg	< 1.7	8.1			6%			
pH ^{MU}	pH Units	N/a	8.2			10%			
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	< 1			6			
						1			
						500			
						100			
						--			
						>6			
						To be evaluated			
						To be evaluated			
Eluate Analysis			2:1 mg/l	8:1 mg/l		Cumulative 10:1 mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)		
Arsenic ^U		< 0.01	0.01		< 0.2	0.5	2	25	
Barium ^U		0.03	0.02		0.2	20	100	300	
Cadmium ^U		< 0.0005	< 0.0005		< 0.02	0.04	1	5	
Chromium ^U		0.019	0.020		< 0.20	0.5	10	70	
Copper ^U		< 0.01	< 0.01		< 0.5	2	50	100	
Mercury ^U		< 0.005	< 0.005		< 0.01	0.01	0.2	2	
Molybdenum ^U		0.005	0.002		< 0.1	0.5	10	30	
Nickel ^U		< 0.007	< 0.007		< 0.2	0.4	10	40	
Lead ^U		0.008	0.020		< 0.2	0.5	10	50	
Antimony ^U		0.008	0.006		< 0.06	0.06	0.7	5	
Selenium ^U		< 0.005	< 0.005		< 0.1	0.1	0.5	7	
Zinc ^U		0.006	0.007		< 0.2	4	50	200	
Chloride ^U		14	5		58	800	15000	25000	
Fluoride ^U		0.5	< 0.5		< 1	10	150	500	
Sulphate ^U		40	8		123	1000	20000	50000	
TDS		177	84		959	4000	60000	100000	
Phenol Index		< 0.01	< 0.01		< 0.5	1	-	-	
DOC		7.1	8.7		84.5	500	800	1000	
Leach Test Information									
Sample Mass (kg)			0.22						
Dry Matter (%)			81.1						
Moisture (%)			23.4						
Stage 1									
Volume Eluate L2 (litres)			0.31						
Filtered Eluate VE1 (litres)			0.22						
Results are expressed on a dry weight basis, after correction for moisture content where applicable									
Stated limits are for guidance only and QTS Environmental cannot be held responsible for any discrepancies with current legislation									
M Denotes MCERTS accredited test									
U Denotes ISO17025 accredited test									



QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
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Maidstone
Kent ME17 2JN



Soil Analysis Certificate - Sample Descriptions

QTS Environmental Report No: 17-68595
Soils Ltd
Site Reference: Orchard Business Park, Yapton, BN18 0GA
Project / Job Ref: 16671
Order No: None Supplied
Reporting Date: 03/01/2018

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
307834	TP1	None Supplied	0.25	22.1	Brown sandy clay with vegetation
307835	TP1	None Supplied	0.50	19	Brown sandy clay with stones
307836	TP2	None Supplied	0.20	18.3	Brown sandy clay

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

Insufficient Sample ^{1/5}

Unsuitable Sample ^{U/5}



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Soil Analysis Certificate - Methodology & Miscellaneous	
QTS Environmental Report No: 17-68595	
Soils Ltd	
Site Reference: Orchard Business Park, Yapton, BN18 0GA	
Project / Job Ref: 16671	
Order No: None Supplied	
Reporting Date: 03/01/2018	

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 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received



Olia Kontogianni
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KT20 5SR

QTS Environmental Ltd
Unit 1
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Lenham Heath
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ME17 2JN

QTS Environmental Report No: 17-68815

Site Reference: Orchard Business Park, Yapton, BN18 0GA

Project / Job Ref: 16671

Order No: None Supplied

Sample Receipt Date: 25/12/2017

Sample Scheduled Date: 25/12/2017

Report Issue Number: 1

Reporting Date: 05/01/2018

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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Rose Lane
Lenham Heath
Maidstone



Soil Analysis Certificate						
QTS Environmental Report No: 17-68815	Date Sampled	21/12/17	21/12/17	21/12/17		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Orchard Business Park, Yapton, BN18 0GA	TP / BH No	WS2	WS3	WS4		
Project / Job Ref: 16671	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	Depth (m)	0.10	0.10	0.50		
Reporting Date: 05/01/2018	QTS Sample No	308732	308733	308734		

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	6.9	7.2	8.1	
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	16	15	15	
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.02	0.02	0.02	
Sulphide	mg/kg	< 5	NONE	< 5	< 5	< 5	
Organic Matter	%	< 0.1	MCERTS	2.4	1.2	2.6	
Total Organic Carbon (TOC)	%	< 0.1	MCERTS	1.4	0.7	1.5	
Antimony (Sb)	mg/kg	< 1	NONE	1.6	2	2.4	
Arsenic (As)	mg/kg	< 2	MCERTS	7	10	8	
Beryllium (Be)	mg/kg	< 0.5	NONE	0.6	0.8	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	20	27	24	
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	
Copper (Cu)	mg/kg	< 4	MCERTS	13	14	18	
Lead (Pb)	mg/kg	< 3	MCERTS	47	26	152	
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1	
Nickel (Ni)	mg/kg	< 3	MCERTS	12	19	15	
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3	
Vanadium (V)	mg/kg	< 2	NONE	29	39	36	
Zinc (Zn)	mg/kg	< 3	MCERTS	69	64	127	
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: 17-68815	Date Sampled	[REDACTED] 7/17			
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	
Site Reference: Orchard Business Park, Yapton, BN18 0GA	TP / BH No	WS2	WS3	WS4	
Project / Job Ref: 16671	Additional Refs	None Supplied	None Supplied	None Supplied	
Order No: None Supplied	Depth (m)	0.10	0.10	0.50	
Reporting Date: 05/01/2018	QTSE Sample No	308732	308733	308734	

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	0.16	
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.94	
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.58	
Fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	5.69	
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	4.68	
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	2.23	
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.89	
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.97	
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.77	
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.54	
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.86	
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.12	
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.85	
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	23.3	

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



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Soil Analysis Certificate - TPH LQM Banded

QTS Environmental Report No: 17-68815	Date Sampled	21/12/17				
Soils Ltd	Time Sampled	None Supplied				
Site Reference: Orchard Business Park, Yapton, BN18 0GA	TP / BH No	WS4				
Project / Job Ref: 16671	Additional Refs	None Supplied				
Order No: None Supplied	Depth (m)	0.50				
Reporting Date: 05/01/2018	QTSE Sample No	308734				

Determinand	Unit	RL	Accreditation				
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01			
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05			
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2			
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2			
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3			
Aliphatic >C16 - C35	mg/kg	< 10	MCERTS	< 10			
Aliphatic >C35 - C44	mg/kg	< 10	NONE	< 10			
Aliphatic (C5 - C44)	mg/kg	< 30	NONE	< 30			
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01			
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05			
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2			
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2			
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	2			
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	21			
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	60			
Aromatic >C35 - C44	mg/kg	< 10	NONE	< 10			
Aromatic (>C5 - C44)	mg/kg	< 30	NONE	83			
Total >C5 - C44	mg/kg	< 60	NONE	83			

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



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Soil Analysis Certificate - BTEX / MTBE

QTS Environmental Report No: 17-68815	Date Sampled	21/12/17				
Soils Ltd	Time Sampled	None Supplied				
Site Reference: Orchard Business Park, Yapton, BN18 0GA	TP / BH No	WS4				
Project / Job Ref: 16671	Additional Refs	None Supplied				
Order No: None Supplied	Depth (m)	0.50				
Reporting Date: 05/01/2018	QTSE Sample No	308734				

Determinand	Unit	RL	Accreditation				
Benzene	ug/kg	< 2	MCERTS	< 2			
Toluene	ug/kg	< 5	MCERTS	< 5			
Ethylbenzene	ug/kg	< 2	MCERTS	< 2			
p & m-xylene	ug/kg	< 2	MCERTS	< 2			
o-xylene	ug/kg	< 2	MCERTS	< 2			
MTBE	ug/kg	< 5	MCERTS	< 5			

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



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Soil Analysis Certificate - Sample Descriptions

QTS Environmental Report No: 17-68815

Soils Ltd

Site Reference: Orchard Business Park, Yapton, BN18 0GA

Project / Job Ref: 16671

Order No: None Supplied

Reporting Date: 05/01/2018

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
308732	WS2	None Supplied	0.10	17.1	Brown sandy clay
308733	WS3	None Supplied	0.10	17.1	Brown sandy clay
308734	WS4	None Supplied	0.50	17.4	Brown sandy clay with stones

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

Insufficient Sample ^{U/S}

Unsuitable Sample ^{U/S}



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Soil Analysis Certificate - Methodology & Miscellaneous

QTS Environmental Report No: 17-68815

Soils Ltd

Site Reference: Orchard Business Park, Yapton, BN18 0GA

Project / Job Ref: 16671

Order No: None Supplied

Reporting Date: 05/01/2018

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

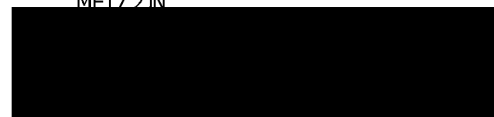
AR As Received



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Lenham Heath
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ME17 2JN



QTS Environmental Report No: 18-69036

Site Reference: Orchard Business Park, Yapton, BN18 0GA

Project / Job Ref: 16671

Order No: None Supplied

Sample Receipt Date: 10/01/2018

Sample Scheduled Date: 10/01/2018

Report Issue Number: 1

Reporting Date: 15/01/2018

Authorised by:



Associate Director of Laboratory

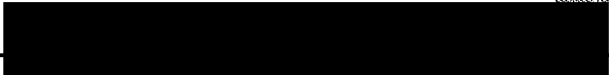
Authorised by:

Associate Director of Client Services

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



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Lenham Heath
Maidstone
Kent ME17 2JN



Soil Analysis Certificate						
QTS Environmental Report No: 18-69036	Date Sampled	21/12/17	21/12/17			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Orchard Business Park, Yapton, BN18 0GA	TP / BH No	TP2	WS2			
Project / Job Ref: 16671	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	1.10	1.50			
Reporting Date: 15/01/2018	QTSE Sample No	309641	309642			

Determinand	Unit	RL	Accreditation				
pH	pH Units	N/a	MCERTS	6.5	6.9		
Total Sulphate as SO ₄	mg/kg	< 200	NONE	< 200	< 200		
Total Sulphate as SO ₄	%	< 0.02	NONE	< 0.02	< 0.02		
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	14	< 10		
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.01	< 0.01		
Total Sulphur	%	< 0.02	NONE	< 0.02	< 0.02		
Ammonium as NH ₄	mg/kg	< 0.5	NONE	2.1	< 0.5		
Ammonium as NH ₄	mg/l	< 0.05	NONE	0.21	< 0.05		
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	38	19		
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	19	9.3		
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	< 3	MCERTS	36	< 3		
Water Soluble Nitrate (2:1) as NO ₃	mg/l	< 1.5	MCERTS	18	< 1.5		
W/S Magnesium	mg/l	< 0.1	NONE	0.8	0.6		

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 - Sample Descriptions

QTS Environmental Report No: 18-69036

Soils Ltd

Site Reference: Orchard Business Park, Yapton, BN18 0GA

Project / Job Ref: 16671

Order No: None Supplied

Reporting Date: 15/01/2018

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
\$ 309641	TP2	None Supplied	1.10	15.8	Brown sandy clay
\$ 309642	WS2	None Supplied	1.50	13.7	Brown sandy clay

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

Insufficient Sample ^{1/5}

Unsuitable Sample ^{1/5}

\$ samples exceeded recommended holding times



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Soil Analysis Certificate - Methodology & Miscellaneous Information

QTS Environmental Report No: 18-69036

Soils Ltd

Site Reference: Orchard Business Park, Yapton, BN18 0GA

Project / Job Ref: 16671

Order No: None Supplied

Reporting Date: 15/01/2018

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 dphenylcarbazine 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 C.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.

-
- 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.
-

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.

-
- 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.

-
- 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
-
- 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
-
- 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.

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

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	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce						
Type	Contaminants	Species	Year	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	
			2014			28			149			4.9			410			220			880		C4SL	DEFRA	2014	
	Chromium	III	2015			910			910			18000			8600			1500			33000		S4UL	LQM/CIEH	2015	
			IV	2014			21			21			170			49			22			256		C4SL	DEFRA	2014
			IV	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	
		Inorganic	2012			170			170			80			36000									SGV	DEFRA	2012
			2015			40			56			19			1100			120			240		S4UL	LQM/CIEH	2015	
			Methyl	2012			11			11			8			410									SGV	DEFRA
			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	
		m-xylene	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	
		p-xylene	2012			230			230			160			3200										SGV	DEFRA
			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(Sap 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	0.087	0.21	170	180	180	24	24									

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			1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6				1	2.5	6
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 C.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 D Information Provided by the Client

- SCHEDULE OF UNITS - 10 TOTAL
- PLOT 1 - 3 bedroom semi-detached unit @ 1000 sq.ft.
PLOT 2 - 2 bedroom semi-detached units @ 850 sq.ft.
PLOT 3 - 3 bedroom detached unit @ 1000 sq.ft.
PLOT 4 - 4 bedroom detached unit @ 1291 sq.ft.
PLOT 5 - 3 bedroom detached unit @ 1000 sq.ft.
PLOT 6 - 3 bedroom semi-detached unit @ 1000 sq.ft.
PLOT 7 - 2 bedroom semi-detached units @ 850 sq.ft.
PLOTS 8 & 9 - 3 bedroom linked-detached units @ 1000 sq.ft.
PLOT 10 - 3 bedroom detached unit @ 1000 sq.ft.



EXISTING ACCESS UPGRADED &
RE-USED FOR HOUSING

2.4m x 45m vision splays approx.

EXISTING ACCESS FOR
BUSINESS PARK

NORTH END ROAD

Telephone
Exchange

Christmas
Lodge

The
Bund

CHURCH LANE

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0m 50m 10m 15m 20m
1:500 scale @ A2

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client
CRAFTERN HOMES

project
RESIDENTIAL DEVELOPMENT
ORCHARD BUSINESS PARK
NORTH END ROAD
YAPTON, BN18 0GA

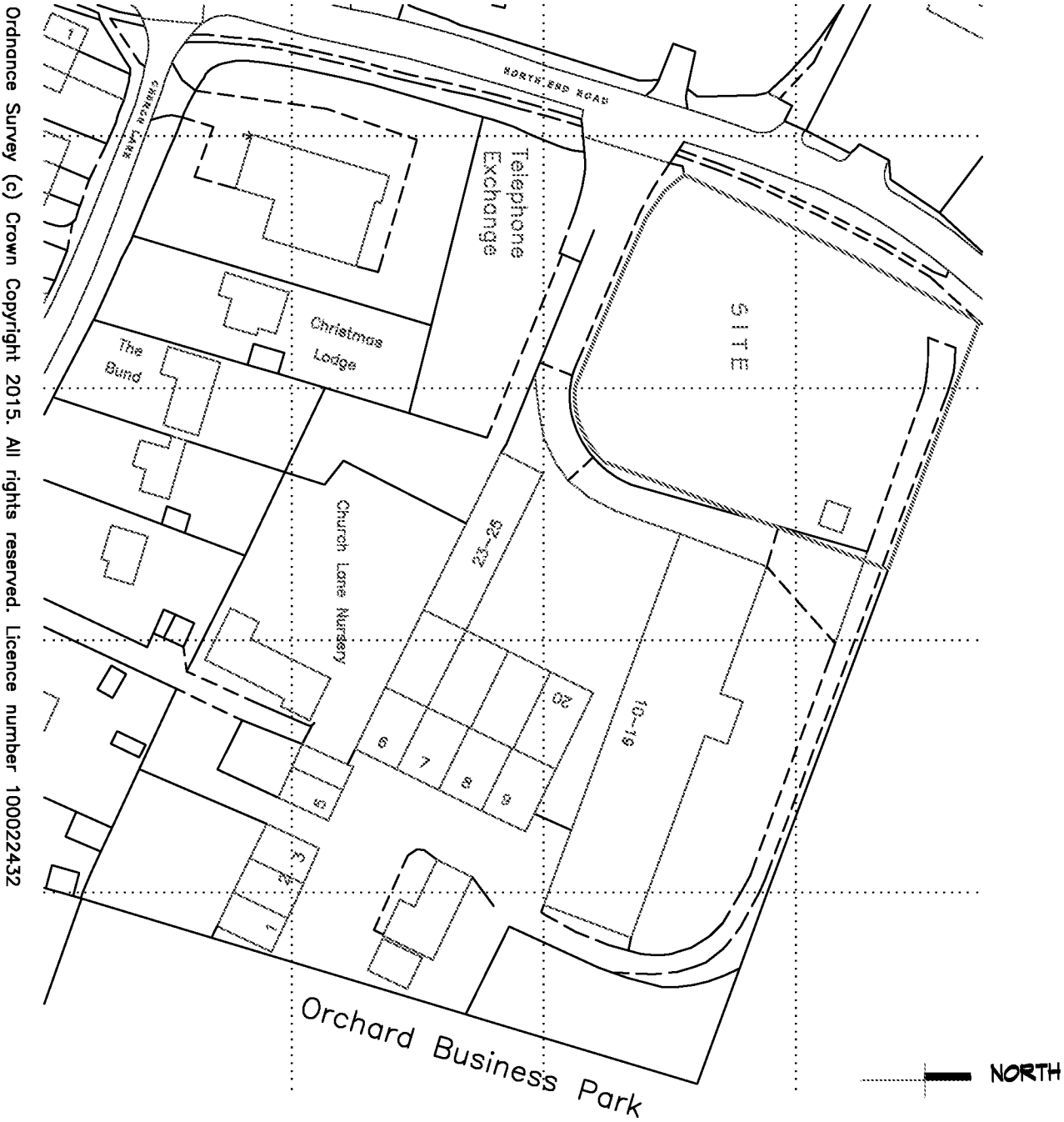
drawing

SITE PLAN

scale	date	job no.	ding no.	rev.
1:500 @A2	MAY 17	1706	2.10	P2

77% drawing to the standards of Ordnance Survey publications

Preliminary 2



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0 10 20 m
1:1250 SCALE @ A3

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CRAFTERN HOMES

project

RESIDENTIAL DEVELOPMENT
ORCHARD BUSINESS PARK
NORTH END ROAD
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drawing

LOCATION PLAN

scale	date	job no.	dwg no.	rev.
1:1250 @A3	MAY 17	1106	1.01	-

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