

Part 2: DESIGN BASIS REPORT

This section of the report provides an interpretation of the findings detailed in Part 1, in the form of a ground model, and then provides advice and recommendations with respect to the proposed development.

5.0 INTRODUCTION

It is understood that it is proposed to construct new two to three-storey residential units. Loads are anticipated to be light.

A limited programme of earthworks will be required as part of the development.

6.0 GROUND MODEL

The desk study has revealed that the site has not had a potentially contaminative historical use as it has not been developed since prior to 1878, and on the basis of the fieldwork, the ground conditions at this site can be characterised as follows:

- below a relatively consistent thickness of made ground, the New Pit Chalk Formation is present which extends to the maximum depth of the investigation, of 20.00 m (68.00 m OD);
- the made ground comprises brown silty sand with variable amounts of chalk and flint gravel and fragments of shell, brick, concrete, metal, ash, coal and tile to a maximum depth of 0.70 m;
- the New Pit Chalk initially consists of a structureless chalk, assessed as Grade Dm, becoming Dc, over very weak, low density structured white chalk (Grade C5) with partings of structureless chalk (Grades Dm / Dc), fissures are initially very closely spaced and infilled with a brown clay and comminuted chalk, becoming closely spaced and clean (Grade B3) at a depth of about 3 m. Scattered flint gravel and cobbles are present throughout the chalk; and
- groundwater was not encountered and is expected to be at depth within the chalk.

7.0 ADVICE AND RECOMMENDATIONS

The chalk encountered at shallow depth should provide a suitable bearing stratum for spread foundations supporting the anticipated light loads.

A cut and fill exercise is proposed, to create level building areas across this sloping site. It is understood that new levels have not been finalised, but levels may alter by around 1.5 m to 2.0 m.

7.1 Earthworks

The excavation and handling of chalk can be problematic and the selected contractor should be experienced in working with the material, as the structure of the chalk can rapidly

deteriorate upon exposure to the elements. The earthworks should be carried out during dry conditions, in order to minimise the disruption to the chalk fabric as light rainfall may cause instability within the chalk.

Excavation of the New Pit Chalk at this site can be undertaken using a face shovel, although excavation is anticipated to be feasible with smaller plant at shallow depths.

Following the site strip of the made ground and superficial deposits, much of the material that will be removed by the proposed earthworks will comprise New Pit Chalk. It should be possible to excavate temporary cut faces at angles of approximately 75° . This cut angle may not protect against minor spalling of the chalk and the cut slopes should be left open for as short a period as possible. It would be prudent to conduct daily inspection of all cut faces by a qualified engineer. Vehicle movements at the top of unsupported cut faces should be minimised. Alternatively, the structured chalk could be cut back at a flatter angle of about 33° to ensure stability and avoid spalling and the unstructured chalk cut back at 26° .

Temporary weather protection layers above the sub-formation on the top of the chalk fill and above chalk or sub-formations in cut should either be constructed or left with a minimum thickness of 600 mm if they are to be in place throughout the winter.

Detailed specification of the requirements for excavating, transporting and compacting the chalk is outside the scope of this report and will need be considered in more detail once the proposals have been finalised. On the basis of the intact dry density (IDD) and natural moisture content (NMC) results, and with reference to CIRIA C574, and specifically Table 5.5, the chalk can be classified as Classes CD to CCs. This material can be compacted using Compaction Method 4 in accordance with Table 6/4 of the Manual of Contract Documents for Highway Works Vol 1 Specification for Highway Works (MCHW1), although the use of material classified as Class CD may not be economical in general embankment fill.

CIRIA C574 recommends that a face shovel be used in order to excavate the chalk and that temporary instability should be expected, or at best is probable; it further concludes that working the chalk in rainy conditions should be avoided. However, there are various other criteria that need to be taken into account in the selection of method of excavation, transporting and compacting of chalk. Further consideration should be given to these aspects once the proposals have been finalised.

On completion of a portion of the compaction, it would be prudent to excavate a number of trial pits through the excavated material to check the quality of the compaction.

7.2 Spread Foundations

Spread foundations bearing on the initial low density Grade Dm chalk at a minimum depth of 0.75 m may be designed to apply a net allowable bearing pressure of 200 kN/m^2 . A slightly higher bearing pressure of 225 kN/m^2 may be applied on the low density Grade Dc chalk. These values incorporate an adequate factor of safety against bearing capacity failure and should ensure that settlement remains within normal tolerable limits.

If Head Deposits are encountered in the north of the site, as indicated by the geology map of the area, additional investigation should be carried out to determine the bearing characteristics of the material.

7.3 Shallow Excavations

On the basis of the trial pit findings it is considered likely that it will be feasible to form relatively shallow excavations through the made ground terminating within the New Pit Chalk Formation without the requirement for lateral support in the short term.

However, if deeper excavations are considered or if excavations are to remain open for prolonged periods it is recommended that provision be made for battered side slopes or lateral support. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides should be considered, in order to comply with normal safety requirements.

The investigation has indicated that groundwater will not be encountered within shallow excavations.

7.4 Piled Foundations

For the ground conditions at this site, driven or bored piles could be adopted. Driven piles would have the advantage of minimising the spoil that is generated, but consideration would need to be given to the effects of noise and vibrations on neighbouring sites. Some form of bored pile may therefore be more appropriate. Conventional rotary augered piles may be suitable, although temporary casing would need to be installed through the chalk fill. Alternatively, bored piles installed using continuous flight auger (cfa) techniques would be an appropriate type.

The following parameters, based upon the guidance provided by CIRIA^{5,6} for piles in chalk, are considered suitable for the preliminary design of straight-shafted bored piles installed using cfa techniques. The design has principally been based on the ground conditions encountered within Borehole Nos 6, 7 and 8.

The following table of ultimate coefficients may be used for the preliminary design of bored piles, which have been based on the SPT / depth and level graph in the appendix.

Stratum	Depths m	kN / m ²
Ultimate Skin Friction		
Made Ground	Ground level to 0.7	Ignore
Chalk	0.7 to 15.0	Increasing linearly from 5 to 135
Ultimate End Bearing		
Chalk	10.0 to 15.0	Increasing linearly from 4400 to 6200

In the absence of pile tests, a factor of safety of 3.0 should be applied to the above coefficients or 1.5 to Ultimate Shaft Friction and 3.5 to Ultimate End Bearing, whichever gives the lower bound safe theoretical working loads.

5 *Engineering in Chalk* CIRIAC574 (2002)
 6 *Shaft Friction of cfa piles in chalk*. CIRIA Project Report 86 (2003)

Pile diameter mm	Depth Below Ground Level m	Safe Working Load* kN
300	10	250
	15	500
450	10	470
	15	900

* care should be taken not to exceed the values given for base resistance of low density and medium / high density chalk in accordance with CIRIA C574

The above examples are not intended to constitute any form of recommendation with regard to pile size or type, but merely serve to illustrate the use of the above coefficients. Specialist piling contractors should be consulted with regard to the design of an appropriate piling scheme and the need for additional deeper investigation. Their attention should be drawn to the presence of potential flint layers within the Chalk. These pile designs are based on in-situ ground conditions and as a result do not account for the placement of fill. Once the depths of fill on site have been confirmed a more comprehensive design should be completed.

Care should be taken in the construction of cfa piles in these types of soils. Careful control of concrete pressures and drilling rate will be required to maintain the pile shaft integrity in the made ground. In addition, as with any situation where bored piles are constructed in chalk, consideration will need to be given to the possibility of variations in the level and quality of the chalk and the possibility of undetected significant variations between borehole positions.

Prospective contractors should be consulted to determine how they intend to control and monitor the pile installation and with regard to their experience in similar ground conditions. The contractors should be provided with all of the exploratory data. Consideration may need to be given on the depths of fill and their influence on negative skin friction.

7.5 Ground Floor Slabs

Following the site strip, it should generally be possible to adopt ground bearing floor slabs, bearing on the chalk. Where chalk is exposed at formation level, ground floor slabs of unheated or poorly insulated buildings should be constructed over a layer of well compacted, free draining material of at least 300 mm thickness. In heated, well insulated buildings, ground floor slabs can be constructed directly on chalk although should not be exposed during construction for more than five consecutive days if the mean daily air temperature is below freezing.

Chalk is frost susceptible, and to avoid damage from frost action, the depth of the underside of the foundation should be at least 600 mm below finished ground level. This depth should also be used when construction is undertaken during cold weather. Alternatively, precautions should be taken to avoid freezing of the ground.

If ground bearing floor slabs are to be placed on areas of compacted material it should be ensured that a suitable degree of compaction is specified.

7.6 Retaining Walls

The following parameters are suggested for the design of permanent retaining walls.

Stratum	Bulk Density (kg/m ³)	Effective Cohesion (c' – kN/m ²)	Effective Friction Angle (ϕ' – degrees)
Made ground	1800	Zero	22
Unstructured Chalk	1800	Zero	30
Structured Chalk	1800	Zero	35

Groundwater is unlikely to be encountered within the excavations.

7.7 Disposal of Surface Water

In order to provide an indication of the suitability of shallow soakaways for the disposal of surface water, soakage tests were carried out in the cable percussion boreholes and in a number of the trial pits. The results of the soakage tests are summarised below.

Borehole or Trial Pit No	Excavation Depth (m)	Infiltration rate (m/s)
BH6	5	9.81×10^{-6}
	10	3.51×10^{-5}
	15	3.34×10^{-6}
	20	5.15×10^{-4}
BH7	6.5	1.81×10^{-5}
	10	1.13×10^{-4}
	15	5.21×10^{-5}
BH8	5	3.07×10^{-5}
	10	3.20×10^{-5}
	15	9.39×10^{-5}
	20	3.87×10^{-5}
TP1	1	5.1×10^{-6}
TP2	0.9	3.5×10^{-5}
TP3	1.2	2.0×10^{-5}
TP5	2.4	4.4×10^{-5}
TP6	2.5	3.0×10^{-5}
TP7	2.9	2.9×10^{-4}

The tests yielded soakage rates of 3.34×10^{-6} m/s to 5.15×10^{-4} m/s; these assessments are based on the linear portion of the graph, unless otherwise stated.

7.7.1 Shallow Soakaways

The use of shallow soakaways is a viable option, but as the chalk has been identified as having a low density, soakaways would need to be located at a minimum distance of 10 m away from new and existing foundations. This is not a practical requirement on a development of this type and consideration has therefore been given to the use of deep bored soakaways.

7.7.2 Deep Bored Soakaways

In order to allow soakaways to be located closer to foundations, consideration is being given to the use of deep bored soakaways. It is understood that currently two options of deep bored soakaway design are being considered; each design adopts an impermeable chamber within the upper 5 m of chalk nearest to proposed foundations. The two proposed options are:

- a 2.4 m diameter chamber at 2.5 m effective depth, with a 15 m deep borehole; and
- a 3.0 m diameter chamber at 3.0 m effective depth, with a 20 m deep borehole.

The laboratory results have identified the chalk as having a low density to the full depth of the investigation, of 20.00 m. CIRIA guidance suggests that in low density chalk, soakaways should be located at least 10 m away from foundations but it is understood that meeting this criterion will be very difficult on a housing development of this type. On the basis that the density of the chalk is in part medium density and elsewhere generally at the upper end of the low density classification, it is considered that soakaways located with a 5 m lateral offset and an impermeable plain well screen over the upper 5 m measured from below nearest foundation levels, will provide sufficient assurance.

Following discussions with the drainage engineer it is understood that a design value of 3.2×10^{-5} m/s has been adopted as the design soakage rate for the site, with a factor of safety of 3. Based on the evidence provided by the drainage engineer it is understood that both soakaway designs are sufficient to accommodate a 1 in 100 year storm event with a 40 % climate change allowance.

Although it is considered that the design of the soakaways is adequate, it is likely that the effectiveness of some soakaways will be better than others, due to lateral and vertical variations of the fissures in the New Pit Chalk. Consideration could therefore be given to the linking of any proposed soakaways such that, should a low rate of soakage be occurring in one bore, the overflow from that chamber could pass to another chamber with a better soakage rate, so that advantage can be taken of those with the greatest outflow performance. It would be prudent to perform soakage testing within each soakaway to confirm its drainage potential.

The chalk stratum is considered to be an important aquifer and as such consultation should be carried out with the Environment Agency when planning soakaway installations. It is a usual requirement that at least a 1.0 m thick attenuation zone be maintained between the base of any soakaway and the groundwater surface.

7.7.3 Permeable Paving

The use of unlined permeable paving should not pose an issue to shallow foundations, assuming that it replicates current surface drainage conditions, although it would be prudent to maximise the distance, where possible, from foundations and ensure that the system avoids a concentrated ingress of water into the chalk. A sub-base thickness of 450 mm should be adopted in order to protect against frost action.

7.8 Pavement Design

Formation level for the proposed roads and hardstanding is currently unknown, however the results of the geotechnical testing indicate however that the shallow chalk should be regarded as frost susceptible, such that a minimum construction thickness of 450 mm may be required in accordance with CIRIA C574. A CBR value of 2% is appropriate for highly weathered in-

situ chalk and 8% on recompacted chalk, although if compacted well, achieving a maximum air voids ratio of 10%, a higher CBR value of 15% may be achieved. It would however be prudent to consult the Local Authority in this regard to determine local practice.

Prior to construction it would be prudent to proof roll formation level and infill any soft spots with suitably compacted granular material.

7.9 Topsoil Testing

Topsoil testing, to determine the suitability to re-use the in-situ topsoil within areas of soft landscaping, is currently in hand and will be reported separately.

7.10 Effect of Sulphates

Chemical analyses have revealed relatively low concentrations of soluble sulphate and mildly alkaline pH in accordance with Class DS-1 conditions of Table C1 of BRE Special Digest 1:SD Third Edition (2005). The measured pH values of the samples show that an ACEC class of AC-1 would be appropriate for the site. This assumes a mobile water condition at the site. The guidelines contained in the digest should be followed in the design of foundation concrete.

7.11 Contamination Risk Assessment

The desk study findings indicate that the site has not had a potentially contaminative history as it has apparently not been developed. The chemical analyses have revealed no elevated concentrations of contaminants within the samples tested.

The made ground across the site was noted to contain fragments of extraneous material, including ash and coal, which can potentially contain high concentrations of metals. This could potentially be the source of the lead contamination. However it is not likely to be in a soluble form and as such should not pose a risk to groundwater or adjacent sites.

It is recommended that any topsoil being imported onto site and used in soft landscaping that will be utilised for plant growth be tested and validated in accordance with NHBC guidelines prior to being installed.

Site workers should follow standard good practice when handling any soil. The method of site working should be in accordance with guidelines set out by HSE and CIRIA⁷ and the requirements of the Local Authority Environmental Health Officer.

7.12 Waste Disposal

Under the European Waste Directive, waste is classified as being either Hazardous or Non-Hazardous and landfills receiving waste are classified as accepting hazardous or non-hazardous wastes or the non-hazardous sub-category of inert waste in accordance with the Waste Directive. Waste classification is a staged process and this investigation represents the preliminary sampling exercise of that process. Once the extent and location of the waste that is to be removed has been defined, further sampling and testing may be necessary. The results from this ground investigation should be used to help define the sampling plan for such further testing, which could include WAC leaching tests where the totals analysis

7 CIRIA (1996) *A guide for safe working on contaminated sites* - Report 132, Construction Industry Research and Information Association

indicates the soil to be a hazardous waste or inert waste from a contaminated site. It should however be noted that the Environment Agency guidance WM3⁸ states that landfill WAC analysis, specifically leaching test results, must not be used for waste classification purposes.

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE⁹ guidance, will need to be disposed of to a licensed tip. Waste going to landfill is subject to landfill tax at either the standard rate of £84.40 per tonne (about £150 per m³) or at the lower rate of £2.65 per tonne (roughly £5 per m³). However, the classifications for tax purposes and disposal purposes differ and currently all made ground and topsoil is taxable at the 'standard' rate and only naturally occurring soil and stones, which are accurately described as such in terms of the 2011 Order, would qualify for the 'lower rate' of landfill tax.

Based upon on the technical guidance provided by the Environment Agency it is considered likely that the soils encountered during this ground investigation, as represented by the five chemical analyses carried out, would be generally classified as follows;

Soil Type	Waste Classification (Waste Code)	WAC Testing Required Prior to Landfill Disposal?	Comments
Made Ground	Non-hazardous (17 05 04)	No	
New Pit Chalk Formation	Inert	Should not be required but confirm with receiving landfill	

Under the requirements of the European Waste Directive all waste needs to be pre-treated prior to disposal. The pre-treatment process must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper¹⁰ which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be segregated onsite prior to excavation by sufficiently characterising the soils insitu prior to excavation.

The above opinion with regard to the classification of the excavated soils is provided for guidance only and should be confirmed by the receiving landfill once the soils to be discarded have been identified.

The local waste regulation department of the Environment Agency (EA) should be contacted to obtain details of tips that are licensed to accept the soil represented by the test results. The tips will be able to provide costs for disposing of this material but may require further testing.

8 Environment Agency 2015. *Guidance on the classification and assessment of waste*. Technical Guidance WM3 First Edition
 9 CL:AIRE March 2011. *The Definition of Waste: Development Industry Code of Practice* Version 2
 10 Environment Agency 23 Oct 2007 *Regulatory Position Statement Treating non-hazardous waste for landfill - Enforcing the new requirement*

8.0 OUTSTANDING RISKS AND ISSUES

This section of the report aims to highlight areas where further work is required as a result of limitations on the scope of this investigation, or where issues have been identified by this investigation that warrant further consideration. The scope of risks and issues discussed in this section is by no means exhaustive, but covers the main areas where additional work may be required.

The ground is a heterogeneous natural material and variations will inevitably arise between the locations at which it is investigated. This report provides an assessment of the ground conditions based on the discrete points at which the ground was sampled, but the ground conditions should be subject to review as the work proceeds to ensure that any variations from the Ground Model are properly assessed by a suitably qualified person.

If during ground works any visual or olfactory evidence of contamination is identified it is recommended that further investigation be carried out and that the risk assessment is reviewed.

The geology map of the area indicates the presence of Head Deposits in the northern part of the site, although these have not been encountered by this investigation. If encountered, these soils are likely to predominantly comprise clay and may require foundations to be deepened. Further inspection by a geotechnical engineer is recommended if these soils are found to be present.

These areas of doubt should be drawn to the attention of prospective contractors and further investigation will be required or sufficient contingency should be provided to cover the outstanding risk.

APPENDIX

Borehole Records

Trial Pit Records

Soakage Test Results

Geotechnical Test Results

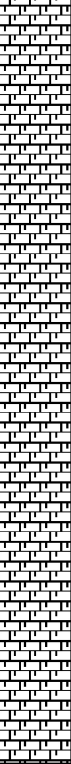
SPT / Depth Graph

Chemical Analyses (Soil)

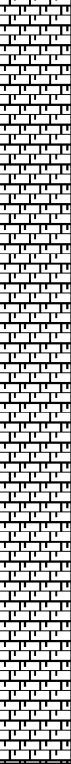
Envirocheck Extracts

Historical Maps

Site Plan

				Widbury Barn Widbury Hill Ware, Herts SG12 7QE		Site Newmarket Road, Royston SG8 7NJ		Number BH1
Excavation Method Opendrive Sampler		Dimensions		Ground Level (mOD) 82.00		Client Countryside Properties PLC		Job Number J16202
		Location 536705 E 240745 N		Dates 07/09/2016		Engineer		Sheet 1/1
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30	E			81.60	(0.40) 0.40	MADE GROUND (brown silty sand with occasional rootlets, fragments of brick, chalk, flint, coal and shells and ash)		
1.00-1.45 1.00	SPT N=28 D		4,7/5,6,7,10			CHALK: recovered as structureless white with specks of orange staining with scattered flint and occasional partings of brown silty clay. Black specks between 1.00 - 1.20 m Damp from 1.10 - 3.00 m Flint cobble		
2.00-2.45 2.00	SPT N=32 D		7,10/10,9,6,7					
3.00-3.35 3.00	SPT 50/200 D		5,10/10,11,15,14		(5.05)			
4.00-4.45 4.00	SPT N=30 D		7,9/9,8,7,6					
5.00-5.45 5.00	SPT N=33 D		8,9/7,7,9,10	76.55	5.45	Complete at 5.45m		
Remarks Groundwater was not encountered							Scale (approx) 1:50	Logged By LB
							Figure No. J16202.BH1	

 Geotechnical & Environmental Associates				Widbury Barn Widbury Hill Ware, Herts SG12 7QE		Site Newmarket Road, Royston SG8 7NJ		Number BH2
Excavation Method Opendrive Window Sampler		Dimensions		Ground Level (mOD) 112.00		Client Countryside Properties PLC		Job Number J16202
		Location 536748 E 240466 N		Dates 07/09/2016		Engineer		Sheet 1/1
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30	E			111.45	(0.55) 0.55	MADE GROUND (brown silty gravelly sand with rootlets, rare shell fragments, and coal fragments, gravel of chalk and flint is fine to medium, angular to rounded)		
1.00-1.45 1.00	SPT N=12 D		3,3/3,3,3,3			CHALK: recovered as structureless white with specks of orange staining with scattered flint and occasional partings of brown silty clay.		
2.00-2.45 2.00	SPT N=19 D		3,5/4,5,5,5					
3.00-3.45 3.00	SPT N=17 D		1,2/4,4,4,5		(4.90)	Flint cobble		
4.00-4.45 4.00	SPT N=27 D		3,4/6,7,7,7					
5.00-5.45 5.00	SPT N=23 D		2,3/5,5,5,8	106.55	5.45	Complete at 5.45m		
Remarks Groundwater was not encountered							Scale (approx) 1:50	Logged By LB
							Figure No. J16202.BH2	

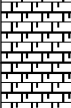
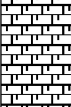
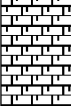
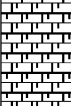
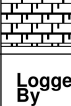
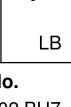
 Geotechnical & Environmental Associates				Widbury Barn Widbury Hill Ware, Herts SG12 7QE		Site Newmarket Road, Royston SG8 7NJ		Number BH3
Excavation Method Opendrive Window Sampler		Dimensions		Ground Level (mOD) 89.00		Client Countryside Properties PLC		Job Number J16202
		Location 536988 E 240638 N		Dates 07/09/2016		Engineer		Sheet 1/1
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30	E			88.60	(0.40) 0.40	MADE GROUND (brown silty clayey sand with fragments of flint, chalk, ash and coal)		
1.00-1.45 1.00	SPT N=15 D		2,2/3,4,4,4			CHALK: recovered as structureless white with specks of orange staining with scattered flint and occasional partings of brown silty clay. Becoming damp, low density from 1.10 m		
2.00-2.45 2.00	SPT N=15 D		2,3/4,3,3,5					
3.00-3.45 3.00	SPT N=11 D		2,3/1,3,3,4		(5.05)			
4.00-4.45 4.00	SPT N=18 D		2,2/3,3,5,7					
5.00-5.45 5.00	SPT N=40 D		5,6/7,9,12,12	83.55	5.45	Complete at 5.45m		
Remarks							Scale (approx) 1:50	Logged By JD
							Figure No. J16202.BH3	

				Widbury Barn Widbury Hill Ware, Herts SG12 7QE		Site Newmarket Road, Royston SG8 7NJ		Number BH4
Excavation Method Opendrive Window Sampler		Dimensions		Ground Level (mOD) 88.00		Client Countryside Properties PLC		Job Number J16202
		Location 537076 E 240823 N		Dates 07/09/2016		Engineer		Sheet 1/1
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.40	E			87.30	(0.70)	MADE GROUND (brown sandy silt with gravel of chalk and flint, fine to medium, rootlets and wood fragments)		
1.00-1.45 1.00	SPT N=18 D		5,5/5,4,5,4		0.70	CHALK: recovered as structureless white with specks of orange staining with scattered flint and occasional partings of brown silty clay.		
2.00-2.45 2.00	SPT N=12 D		2,2/2,3,3,4					
3.00-3.45 3.00	SPT N=10 D		2,2/3,3,2,2		(4.75)			
4.00-4.45 4.00	SPT N=16 D		3,3/3,5,4,4					
5.00-5.45 5.00	SPT N=18 D		4,5/4,4,5,5	82.55	5.45	Complete at 5.45m		
Remarks Groundwater was not encountered							Scale (approx) 1:50	Logged By LB
							Figure No. J16202.BH4	

				Widbury Barn Widbury Hill Ware, Herts SG12 7QE		Site Newmarket Road, Royston SG8 7NJ		Number BH5
Excavation Method Opendrive Sampler		Dimensions		Ground Level (mOD) 106.00		Client Countryside Properties PLC		Job Number J16202
		Location 537076 E 240823 N		Dates 07/09/2016		Engineer		Sheet 1/1
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.40	E			105.30	(0.70)	MADE GROUND (brown sandy silt with gravel of chalk and flint, fine to medium, rootlets and wood fragments)		
1.00-1.45 1.00	SPT N=23 D		4,4/5,5,7,6		0.70	CHALK: recovered as structureless white with specks of orange staining with scattered flint and occasional partings of brown silty clay.		
2.00-2.45 2.00	SPT N=21 D		4,5/5,5,5,6					
3.00-3.45 3.00	SPT N=16 D		2,2/3,4,4,5		(4.75)			
4.00-4.45 4.00	SPT N=17 D		3,2/3,4,5,5					
5.00-5.45 5.00	SPT N=23 D		3,4/4,5,6,8	100.55	5.45	Complete at 5.45m		
Remarks Groundwater was not encountered							Scale (approx) 1:50	Logged By LB
							Figure No. J16202.BH4	

GEA Geotechnical & Environmental Associates					Widbury Barn Widbury Hill Ware, Herts SG12 7QE		Site Newmarket Road, Royston SG8 7NJ		Borehole Number BH6	
Boring Method Cable Percussion		Casing Diameter 150mm cased to 1.50m			Ground Level (mOD) 104.00		Client Countryside Properties PLC		Job Number J16202	
		Location 537100 E 240571 N			Dates 17/11/2016-22/11/2016		Engineer		Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
1.00-1.45 1.00-1.45	SPT N=6 D1			1,2/1,2,1,2	103.70 103.50	(0.30) 0.30 (0.20) 0.50	MADE GROUND (light brownish grey sandy gravelly silt with rootlets, metal, ash, coal, and flint cobbles, gravel of chalk and flint is fine-medium, angular-rounded, sand is very fine to fine) CHALK: recovered as chalk fragments CHALK: recovered as structureless CHALK composed of offwhite and greyish white, with orange staining, sandy gravelly silt. Gravel is very weak to weak, low density, offwhite with frequent orange staining and occasional black specks, subangular to subrounded, with scattered flint gravel	 		
2.00-2.45 2.00-2.45	SPT N=10 D2			2,1/2,3,2,3						
3.00-3.45 3.00-3.45	SPT N=8 D3			1,1/2,1,2,3						
4.00-4.45 4.00-4.45	SPT N=8 D4			1,1/1,2,2,3						
5.00-5.45 5.00-5.45	SPT N=9 D5			3,3/2,2,2,3						
6.00	D6									
6.50-6.95 6.50-6.95	SPT N=17 D7			3,3/4,4,4,5						
7.50	D8									
8.00-8.45 8.00-8.45	SPT N=18 D9			4,3/4,4,5,5						
9.00	D10									
9.50-9.95 9.50-9.95	SPT N=9 D11			2,2/2,2,2,3						
Remarks Groundwater was not encountered. Falling head test performed at 5 m, 10 m, 15 m and 20 m.								Scale (approx)	Logged By	
								1:50	LB	
								Figure No. J16202.BH6		

GEA Geotechnical & Environmental Associates				Widbury Barn Widbury Hill Ware, Herts SG12 7QE		Site Newmarket Road, Royston SG8 7NJ		Borehole Number BH6	
Boring Method Cable Percussion		Casing Diameter 150mm cased to 1.50m		Ground Level (mOD) 104.00		Client Countryside Properties PLC		Job Number J16202	
		Location 537100 E 240571 N		Dates 17/11/2016-22/11/2016		Engineer		Sheet 2/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.50	D12								
11.00-11.45 11.00-11.45	SPT N=22 D13			4,5/6,5,5,6					
12.00	D14								
12.50-12.95 12.50-12.95	SPT N=48 D15			3,10/14,8,12,14					
13.50	D16								
14.00-14.45	U1			56 blows					
14.45-14.50	D17								
15.00	D18					(19.50)			
15.50-15.95 15.50-15.95	SPT N=50 D19			4,6/14,10,16,10					
16.50	D20								
17.00-17.45 17.00-17.45	SPT N=36 D21			5,6/6,7,12,11					
18.00	D22								
18.50-18.95 18.50-18.95	SPT N=38 D23			5,5/5,8,10,15					
19.50	D24								
84.00							20.00		
Remarks								Scale (approx)	Logged By
								1:50	LB
								Figure No. J16202.BH6	

GEA Geotechnical & Environmental Associates					Widbury Barn Widbury Hill Ware, Herts SG12 7QE		Site Newmarket Road, Royston SG8 7NJ		Borehole Number BH7	
Boring Method Cable Percussion		Casing Diameter 150mm cased to m			Ground Level (mOD) 83.00		Client Countryside Properties PLC		Job Number J16202	
		Location 536905 E 240704 N			Dates 20/12/2016- 21/12/2016		Engineer		Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
0.50	B1					(0.70)	MADE GROUND (light brownish grey sandy gravelly silt with rootlets, metal, concrete and brick fragments, and flint cobbles, gravel of chalk and flint is fine-medium, angular-rounded, sand is very fine to fine)			
1.00-1.45 1.00-1.45	CPT N=17 B2			3,4/4,5,4,4	82.30	0.70 (1.05)	CHALK: recovered as structureless CHALK composed of offwhite, creamish white and brown with orange staining gravelly silt of communited chalk. Gravel is low to medium density, weak offwhite and creamish white chalk, subangular to subrounded			
1.75 2.00-2.45	D1 U1			60 blows	81.25	1.75	CHALK: recovered as structureless CHALK composed of slightly silty, subangular to subrounded gravel and cobbles. Clasts are low density, very weak to weak, offwhite and creamish white with frequent orange staining, rare black specks and scattered flint gravel			
2.50 2.75	B3 D2									
3.00-3.45 3.00-3.45	SPT N=30 D3			6,7/8,7,7,8						
3.50 3.75	B4 D4									
4.00-4.45	U2			70 blows						
4.50 4.75	B5 D5									
5.00-5.45 5.00-5.45	SPT N=31 D6			5,7/8,7,8,8						
5.75 6.00	D7 B6									
6.50-6.95	U3			80 blows						
7.00	B7									
7.75 8.00-8.45 8.00-8.45	D8 SPT N=36 D9			6,8/9,8,9,10		(13.25)				
8.50	B8									
9.00	D10									
9.50-9.95	U4			80 blows 20/12/2016: 21/12/2016:						
Remarks Groundwater was not encountered Falling head tests conducted at 6.5 m, 10 m and 15 m								Scale (approx) 1:50	Logged By LB	
								Figure No. J16202.BH7		

GEA Geotechnical & Environmental Associates				Widbury Barn Widbury Hill Ware, Herts SG12 7QE		Site Newmarket Road, Royston SG8 7NJ		Borehole Number BH7	
Boring Method Cable Percussion		Casing Diameter 150mm cased to m		Ground Level (mOD) 83.00		Client Countryside Properties PLC		Job Number J16202	
		Location 536905 E 240704 N		Dates 20/12/2016- 21/12/2016		Engineer		Sheet 2/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.50	B9								
11.00-11.45 11.00-11.50	SPT N=28 D11			3,5/6,7,7,8					
12.00	D12								
12.50-12.95	U5			80 blows		(13.25)			
13.50	B10								
14.55-15.00 14.55-15.00 14.55-15.00	SPT N=35 B11 D13			5,7/8,7,8,12					
				21/12/2016:	68.00	15.00			
							Complete at 15.00m		
Remarks								Scale (approx) 1:50	Logged By LB
								Figure No. J16202.BH7	

GEA Geotechnical & Environmental Associates					Widbury Barn Widbury Hill Ware, Herts SG12 7QE		Site Newmarket Road, Royston SG8 7NJ		Borehole Number BH8	
Boring Method Cable Percussion		Casing Diameter 150mm cased to 6.20m			Ground Level (mOD) 91.00		Client Countryside Properties PLC		Job Number J16202	
		Location 536750 E 240643 N			Dates 19/12/2016- 20/12/2016		Engineer		Sheet 1/3	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
1.00-1.45	U1			50 blows	90.50	(0.50) 0.50	MADE GROUND (light brownish grey sandy gravelly silt with rootlets, metal and flint cobbles, gravel of chalk and flint is fine-medium, angular-rounded, sand is very fine to fine) CHALK: recovered as structureless CHALK composed of slightly silty, subangular to subrounded gravel and cobbles. Clasts are low density, very weak to weak, offwhite and creamish white with frequent orange staining, rare black specks and scattered flint gravel and cobbles			
1.50	B1									
1.75	D1									
2.00-2.45	SPT N=8			2,2/2,2,2,2						
2.00-2.45	D2									
2.75	D3									
3.00-3.45	U2			65 blows						
3.50	B2									
3.75	D4									
4.00-4.45	SPT N=31			2,4/6,9,8,8						
4.00-4.45	D5									
4.75	D6									
5.00-5.45	U3			65 blows						
5.50	B3									
6.00	D7									
6.50-6.95	SPT N=25			2,4/5,6,7,7						
6.50-6.95	D8									
7.50	B4									
8.00-8.45	U4			60 blows						
9.00	D9									
9.50-9.95	SPT N=30			6,5/6,7,7,10						
9.50-9.95	D10									
Remarks Groundwater was not encountered Falling head tests conducted at 5 m, 10 m, 15 m and 20 m								Scale (approx) 1:50	Logged By LB	
								Figure No. J16202.BH8		