Weston Homes Plc

Mill Pond Site, Dartford

Geotechnical Investigation Report

Project no 27265-01(00)

OCTOBER 2014

RSK GENERAL NOTES

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Title: Geotechnical Investigation Report: Mill Pond Site, Dartford

Client: Weston Homes Plc

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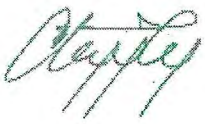
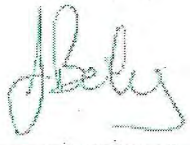
Signature		Signature	
Date:	10th October 2014	Date:	10th October 2014
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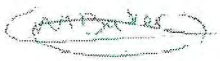
Signature		Signature	
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1 INTRODUCTION

RSK Environment Limited (RSK) was commissioned by Weston Homes Plc (the 'Client') to carry out a geotechnical assessment of the former GlaxoSmithKline (GSK) site, now known as Mill Pond Site. It is understood the site is being considered for redevelopment with up to 7-storeys high mixed residential and commercial properties.

This report is subject to the RSK service constraints given in **Appendix A**.

1.1 Objective

The objective of the work is to obtain sufficient information on the ground conditions beneath the site and give recommendations on the geotechnical issues arising from the proposed development including the design of new foundations and infrastructure.

1.2 Scope

The project was carried out to an agreed brief as set out in RSK's proposal (ref. 27265-T01(00), dated 24th June 2014), and subsequent correspondence. The scope of works for the assessment included:

- a review of published geological data including review of the available investigation reports for the site;
- an intrusive investigation consisting of four boreholes with subsequent groundwater monitoring;
- geotechnical laboratory analysis on selected soil samples;
- interpretation of ground conditions and geotechnical data to provide recommendations with respect to foundation basement design; and
- a factual and interpretative report.

1.3 Existing reports

Two intrusive investigations have been previously carried out on the site. The works have included cable percussive drilling, trial pitting and window sampling and the findings have been referenced in completion of the current study.

1.4 Limitations

The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels flows may vary from those reported due to seasonal, or other, effects.

2 THE SITE

2.1 Site location and description

The former GSK facility (hereafter referred as 'the site') is located approximately 1km to the north of Dartford Town Centre, at National Grid reference 554537^{E} 174640^{N}, as shown on **Figure 1**. The site extends across two separate areas namely, the Northern Gateway East (NGE) and the Mill Pond sites.

The Mill Pond site is located immediately to the north of Mill Pond Road, and to the west of Central Road and the NGE site. The site currently comprises an open area some 3 hectares in plan, covered by a capping layer associated with former commercial and industrial buildings, now demolished to floor slab level.

The Mill Pond, a surface water feature, and the River Darent, occupy approximately 0.5 hectare in the south-western and central portion of the site, surrounded by associated vegetation.

A current site layout plan is presented as **Figure 2**.

2.2 Proposed development

The site in question is being considered for redevelopment with six residential apartment blocks up to 7-storey high, with associated infrastructure. The details of proposed structures, as well as the maximum loading imposed on the ground, were not available at the time of writing this report.

3 GEOLOGY, HYDROGEOLOGY AND HYDROLOGY

3.1 Geology

The published 1:50,000 - scale geological map (Sheet No. 271 'Dartford') indicates that the superficial geology of the site is characterised by a variable thickness of made ground, overlying Alluvium and Boyn Hill Gravel Member of the River Terrace Deposits, with the White Chalk Sub Group at depth.

Information available from previous investigations confirms that the site is underlain by a variable thickness of made ground, extending to a maximum depth of 4m within the footprint of the infilled wharf in the northern portion of the site, underlain by organic material associated with the infilled pond and / or alluvial deposits. The superficial deposits were encountered as alluvial sands and gravels, and River Terrace Deposits with thickness up to 12m, with the White Chalk Sub Group at depth.

However, it is likely that the thicknesses of the superficial deposits (made ground and Alluvium) have been altered as a result from remediation operations, undertaken on the site between the initial and current investigation works.

Based on the Edmund's risk assessment model for natural dissolution features referred to in CIRIA Report C574 (2002), the site indicates a low risk of natural dissolution features.

With reference to Edmund's database of known natural and man-made chalk solution features there are five such features within 500m of the site. The nearest feature, a solution pipe, is located some 266m to the southeast of the site at the feathering margin of the Thanet Sand Formation. It should be noted that due to the large area covered by the site, the identified features could be closer to the site boundaries.

3.2 Hydrogeology

Based on the published geological map referred to above, the hydrogeology of the site is likely to be characterised by the presence of a shallow unconfined aquifer comprising the Alluvium / River Terrace Deposits, and the underlying White Chalk Sub Group. These units are expected to be in hydraulic continuity.

The anticipated depth to the water table, i.e. the thickness of the unsaturated zone is anticipated to be a few metres. In addition, groundwater levels beneath the site may be affected by tidal variations, as the tidal Dartford Creek is situated immediately downstream of a tide lock located on-site.

The drift deposits and the White Chalk are classified by the Environment Agency (EA) as a Principal Aquifer as indicated on the Environment Agency Groundwater Vulnerability Map of the area, Sheet No. 40 'Thames Estuary'.

3.3 Hydrology

The River Darent flows through the centre of the Mill Pond site in a northerly direction and is tidally influenced downstream of a weir located on the northern boundary of the site. South of the weir, i.e. on the study site, the river is considered to be predominantly fresh-water. The Mill Pond is situated centrally in the southern area of the site and is in hydraulic continuity with the River Darent. A culverted stream passes beneath the central northern area of the site and land to the north, carrying the discharge from the outflow of the Mill Pond to the River Darent.

4 SITE INVESTIGATION METHODOLOGY

4.1 Site works and investigation locations

RSK carried out intrusive investigation work and subsequent groundwater monitoring in July and August 2014, to confirm the ground conditions identified in the previous sections, and to inform the design of foundations for the proposed development.

The techniques adopted for the investigation have been chosen considering the anticipated ground conditions, existing land use, and the proposed development.

The following site work was carried out:

- sinking of 4No. cable percussive boreholes to maximum 22m depth below existing ground level, with associated sampling and in-situ testing; and
- two return visits to site to undertake groundwater monitoring after the fieldwork.

The investigation and the soil descriptions were carried out in general accordance with 'BS 5930:1999, Code of Practice for Site Investigations' (BSI, 1999) and CIRIA C574 Engineering in (2002). The exploratory hole records are presented in **Appendix B**.

The locations of the intrusive investigation are shown on **Figure 2**, and the rationale for these locations is given in Table 1.

Table 1: Exploratory hole location rationale

Exploratory hole number	Investigation Type	Rationale
BH1 to BH4	Light cable percussive method	To prove the geological succession beneath the site and obtain geotechnical data for the purpose of foundation design. To enable installation of groundwater monitoring wells
BH1 to BH4	Monitoring well installations	Groundwater monitoring
BH1 to BH4	Groundwater level monitoring in monitoring well installations	Measurement of depth to groundwater

The investigation points were located approximately by reference to physical features present on the site at the time of investigation. The ground levels at the exploratory locations have not been determined.

Due to the presence demolition rubble forming the capping layer and within the fill material, boreholes BH1 and BH2 reached premature refusal at relatively shallow depths, and had to be slightly re-located in order to advance to their specified depths.

4.2 Soil sampling, in-situ testing and laboratory analysis

The sampling strategy was designed to characterise the made ground and natural strata beneath the site, and to provide information on the mechanical characteristics of the underlying soils for the purpose of geotechnical design. Disturbed samples were taken from each strata encountered to facilitate subsequent geotechnical analysis.

Standard penetration tests (SPTs) and cone penetration tests (CPTs) were carried out within the made ground and the natural strata, at regular intervals of approximately 1m in the initial 5m depths, and then at 1.5m intervals to the terminal depth of the cable percussion boring. Tests were undertaken in accordance with part 9 of BS 1377:1990 (BSI, 1990) and the results are given on the borehole logs presented in **Appendix B**, and **Figure 3**.

The programme of geotechnical tests undertaken on samples obtained from the intrusive investigation is presented in Table 2, the main purpose of which was to determine the physical properties of the underlying soils. Where appropriate, testing was undertaken in accordance with BS 1377:1990 Method of Tests for Soils for Civil Engineering Purposes within RSK's UKAS accredited laboratory.

Table 2: Scheduled geotechnical analysis – soil

Strata	Tests Undertaken	Number of tests
Made Ground	Natural Moisture Content	2
	Plasticity Classification	2
	Particle Size Distribution incl. Sedimentation by pipette	2
	pH & Water Soluble Sulphate	2
Boyn Hill Gravel	Particle Size Distribution	12
	pH & Water Soluble Sulphate	3
White Chalk	Saturation Moisture Content	2
	pH & Water Soluble Sulphate	2

4.3 Groundwater monitoring

Depths to groundwater were recorded using an electronic dip meter on 11th and 22nd August 2014, and the results are given in **Appendix C**, and discussed in Section 5.3.

5 GROUND CONDITIONS

The results of the intrusive investigation and subsequent laboratory analysis undertaken are detailed below. The descriptions of the strata encountered, list of samples taken, field observations of soil and groundwater, in-situ testing and details of monitoring well installations are included on the exploratory hole records presented in **Appendix B.**

5.1 Soil

The exploratory holes revealed that the site is underlain by an initial capping layer, over significant thickness of made ground/fill, over the Boyn Hill Gravel Member of the River Terrace Deposits, with White Chalk Sub-group at depth. This confirms the stratigraphical succession encountered during previous phases of investigation, locally with the addition of fill material as a result of the previous earthworks operations. For the purpose of discussion, the ground conditions are summarised in Table 3, and the strata discussed in subsequent subsections

Table 3: General succession of strata encountered

Strata	Exploratory holes encountered	Depth to top of stratum m bgl	Thickness (m)
Made ground (Capping Layer)	All	G.L.	0.5
Made Ground	All	0.5	1.7 to 4.4 (not proven in BH1 and BH2)
Boyn Hill Gravel	All	2.5 to 4.4	3.2 to 17.0 (not proven in BH3)
White Chalk Subgroup	All (except BH3)	6.5 to 20.2	proven to 22.0mbgl

5.1.1 Made ground

The made ground was variable in nature and thickness across the site, but generally can be divided into two sub-groups: capping layer and general made ground material.

5.1.1.1 Capping Layer

The capping layer was encountered across the entire site with a thickness up to 0.5m. It typically comprises brown, grey, slightly silty, sandy gravel of brick, flint with occasional cobble sized concrete and brick fragments.

Based on the field observations, this layer is clearly distinct in the western and southern parts of the site, while it appears to be absent or mixed with the general fill material in central and eastern sections of the site.

5.1.1.2 *General Made Ground Material*

Beneath the capping layer, a variable general fill was encountered across the entire site. This material generally comprises brown, grey, silty, sandy, gravelly clay, with variable portion of brick and concrete fragments and flint gravel. Locally towards its base, there is an inclusion of black, organic rich sand and clay, likely to be a remnant of the alluvial deposits associated with the River Darent.

The in-situ and laboratory test results for this stratum can be found in **Appendices B** and **D**. A summary of the results is presented in Table 4.

Table 4: Summary of in-situ and laboratory test results for the made ground

Soil parameters	Range		Reference
Grading (%)	Cobbles	0 to 36	Appendix D
	Gravel	23 to 36	
	Sand	24 to 38	
	Silt	10 to 14	
	Clay	7 to 12	
Liquid Limit (%)	50 to 51		Figure 5; Appendix D
Plastic Limit (%)	23 to 32		Appendix D
Plasticity Index (%)	18 to 28		Figure 5; Appendix D
Natural Moisture Content (%)	31 to 32		Figure 4; Appendix D
SPT 'N' Values	7 to >50 (refusal)		Figure 3 ; Appendix B

5.1.2 Boyn Hill Gravel

This stratum was encountered beneath the made ground with significant variation in thickness across the site. The maximum thickness of the stratum was proven in borehole BH1A in the western portion of the site (17.0m), while in borehole BH4 in the eastern part the thickness was proven to be only 3.2m.

The Boyn Hill Gravel was recovered as predominantly dense, locally very dense, brown sandy to very sandy gravel of angular to sub-rounded fine to coarse flint, with occasional flint cobbles. Traces of organic material were present at the surface of the stratum indicating the presence of alluvial deposits, likely removed as a part of the previous earthworks operations.

A summary of the measured soil parameters for this stratum are presented in Table 5.

Table 5: Summary of in-situ and laboratory test results for the Head Deposits

Soil parameters	Range		Reference
Grading (%)	Cobbles	2 to 25	Appendix D
	Gravel	63 to 90	

Soil parameters	Range		Reference
	Sand	6 to 35	
	Silt/Clay	0 to 2	
SPT 'N' Values	17 to >50		Figure 3 ; Appendix B
Density Term	Dense to very dense (locally medium dense)		

5.1.3 White Chalk Subgroup

The White Chalk was encountered beneath the Boyn Hill Gravel at depths ranging from 6.5mbgl in the east, to 20.0mbgl in the central and western parts of the site. The highly variable depths to the surface of the chalk are likely due to the regional geological history, in particular, former erosion, dissolution and peri-glacial disturbance (e.g. cryoturbation and solifluction) features.

The stratum was recovered as structureless chalk, composed of white silty, slightly sandy, weak, low to medium density fine to coarse chalk gravel clasts, with occasional flints.

The results of the in-situ and laboratory test results for this stratum is presented in **Appendices B** and **D**. A summary is provided in Table 6.

Table 6: Summary of in-situ and laboratory test results for the White Chalk

Soil parameters	Range	Reference
Natural Moisture Content (%)	26 to 29	Appendix D
Saturation Moisture Content (%)	26 to 30	Appendix D
Bulk Density (Mg/m^3)	1.93 to 2.00	Appendix D
Dry Density (Mg/m^3)	1.50 to 1.59	Appendix D
SPT 'N' values	11 to 23	Figure 3 ; Appendix B
BS 5390 Strength Term	Weak	
Density Term	Low to Medium	

5.2 Groundwater

Groundwater was encountered during the investigation, in all boreholes at depths detailed in Table 7, which also shows groundwater levels monitoring period.

Table 7: Groundwater results during investigation

BH/TP	Strata	Strike (m bgl)	Rise (m.bgl)	Monitoring Results (m.bgl)	
				11/08/14	22/08/14
BH1A	BHG[1)]	4.5	4.0	1.95	2.05

BH/TP	Strata	Strike (m bgl)	Rise (m.bgl)	Monitoring Results (m.bgl)	
				11/08/14	22/08/14
	WC[1)]	21.5	NR[2)]	not installed	
BH2A	BHG[1)]	NR[2)]	NR[2)]	1.95	2.01
	WC[1)]	22.0	NR[2)]	not installed	
BH3	BHG[1)]	4.4	4.0	2.05	2.12
BH4	BHG[1)]	3.9	3.2	2.12	2.12

[1)] Key: BHG – Boyn Hill Gravel; WC – White Chalk
[2)] NR – no record

The findings reflect the general groundwater table in the Boyn Hill Gravel, resting at depths of around 2.0m below existing ground levels.

It should be noted that groundwater levels might fluctuate for a number of reasons including seasonal and tidal variations. Ongoing monitoring would be required to establish both the full range of conditions and any trends in groundwater levels.

6 GEOTECHNICAL SITE ASSESSMENT

6.1 Engineering considerations

It is understood that the proposed development is to involve the construction of six residential apartment blocks up to 7-storey high, with associated infrastructure.

The details of proposed structures, as well as the maximum loading imposed on the ground, were not available at the time of writing this report.

6.2 Geotechnical hazards

A summary of commonly occurring geotechnical hazards is given in Table 8, together with an assessment of whether the site may be affected by each of the stated hazards.

Table 8: Summary of main potential geotechnical hazards that may affect site

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
Sudden lateral changes in ground conditions	✓	Significant variability in the thickness of made ground and Boyn Hill Gravel across the site		Likely to affect ground engineering and foundation design and construction
Shrinkable clay soils			✓	Design to NHBC Standards Chapter 4 or similar
Highly compressible and low bearing capacity soils, (including peat and soft clay)		✓	Local presence of soft organic clays at the base of the made ground/surface of Boyn Hill Gravel	Likely to affect ground engineering and foundation design and construction
Silt-rich soils susceptible to rapid loss of strength in wet conditions		✓		Likely to affect ground engineering and foundation design and construction
Running sand at and below water table		✓	Could be present for excavations beneath groundwater levels	Likely to affect ground engineering and foundation design and construction

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
Karstic dissolution features (including 'swallow holes' in Chalk terrain)	✓	Low risk		May affect ground engineering and foundation design and construction – refer to Section 4.1.2
Evaporite dissolution features and/or subsidence			✓	May affect ground engineering and foundation design and construction
Ground subject to or at risk from landslides			✓	Likely to require special stabilisation measures
Ground subject to peri-glacial valley cambering with gulls possibly present			✓	Likely to affect ground engineering and foundation design and construction
Ground subject to or at risk from coastal or river erosion			✓	Likely to require special protection/stabilisation measures
High groundwater table (including waterlogged ground)	✓	Standing groundwater levels at around 2.0mbgl		May affect temporary and permanent works
Rising groundwater table due to diminishing abstraction in urban area			✓	May affect deep foundations, basements and tunnels
Underground mining		✓		Likely to require special stabilisation measures
Existing sub-structures (e.g. tunnels, foundations, basements, and adjacent sub-structures)	✓	See Geophysical Investigation Report, Ref: 294523 01(00)		Likely to affect ground engineering and foundation design and construction
Filled and made ground (including embankments, infilled ponds and quarries)	✓	Variable and significant (up to 4.4m) thickness of made ground across the site		Likely to affect ground engineering and foundation design and construction
Adverse ground chemistry (including expansive slags and weathering of sulphides to sulphates)			✓ See Section 6.6	May affect ground engineering and foundation design and construction
Note: Seismicity is not included in the above table as this is not normally a design consideration in the UK.				

6.3 Foundations

6.3.1 General suitability

The ground conditions encountered beneath the site comprise a significant thickness of made ground of up to 4.4m below existing ground level, over dense to very dense, sandy to very sandy gravel (Boyn Hill Gravel), with significantly variable thickness, extending to depths of 6.5mbgl in the eastern part of the site (BH4) to 20.2mbgl towards the central and western portion. This is underlain by the White Chalk subgroup to beyond the terminal depth of the investigation.

Groundwater levels have been recorded to be at the highest resting depth of 1.95mbgl.

On the basis of the presence of significant thickness of made ground, and in view of the likely relatively high column loads expected from the proposed structures, it is considered that piles will provide the most suitable foundation option for the proposed development.

Given variable depths to the surface of the White Chalk encountered across the site, the proposed piles in the western part of the site are likely to be constructed as end bearing fully within the Boyn Hill Gravel, considering only the friction resistance of the stratum. Piles in the eastern part, however, may rely upon the added contribution of the end bearing resistance of the White Chalk.

Alternatively, consideration may be given to ground improvement techniques, such as vibro-stone columns, extending below any made ground strata, to provide support to the more lightly loaded low-rise structures. However, advice should be sought from a specialist ground improvement contractor with respect to the pattern of treatment points and design loads available after treatment. The layout of treatment points should be tailored to the structural layout and floor loading capacity requirements.

6.3.2 Piled foundations

Recommendations for the design and construction of pile foundations in relation to the ground conditions are set out in Table 9.

Table 9: Design and construction of piled foundations

Design/construction considerations	Design/construction recommendations
Pile type and possible constraints	The construction of bored and driven piles is considered technically feasible at this site Driven piles may not be suitable from an environmental viewpoint where there is a risk of driving contaminated made ground soils below the groundwater table. Furthermore, very dense ground conditions were noted in the cable-percussive boreholes, which could potentially result in the premature set of driven piles.
Temporary casing	Bored piles will require temporary casing throughout their depth due to the presence of groundwater within the Boyn Hill Gravel and the White Chalk. In order to overcome these issues the use of continuous flight auger (CFA) injected bored piles can be adopted. Additionally, CFA piling is often the preferred technique on contaminated sites where

Design/construction considerations	Design/construction recommendations	
	controlled waters may be at risk	
Man-made obstructions	The presence of buried sub-structures or other obstructions within made ground may lead to some difficulty during piling. Although, it is likely that all buried obstructions were removed during the previous earthworks, it would be prudent that once the proposed pile layout has been determined, pre-pile probing be carried out at each of the pile positions. Reference should also be made to RSK Geophysical Investigation Report, ref: 294523 01(00), for the likely obstruction locations. Where buried obstructions are encountered, it will be necessary to either relocate the pile(s) or make allowance for removing the obstruction	
Hard strata	An allowance should be made for the presence of hard flint bands within the White Chalk	
Contribution of made ground and drift deposits	Due to the variability and possible presence of the organic rich remnants of the alluvial deposits, the contribution of the overlying made ground/Boyn Hill Gravels up to 5m depth have been ignored in the analysis	
Soil and pile design parameters for Boyn Hill Gravel	Shaft friction factor ($k_s \times \tan \delta$)	0.44
	Base Resistance	Q_{all} = 800 kN/m^2
Soil and pile design parameters for White Chalk	Shaft Resistance (τ_{sf})	$0.8\sigma_v$' for SPT 'N' > 10
	Base Resistance	Q = 200 N, limited to: Q_{all} = 600 – 800 kN/m^2 for SPT 'N' < 25
General parameters	Factor of safety on the shaft resistance	2.5 1.1[1)]
	Global factor of safety	2.5
	Limiting concrete stress	7.5N/mm^2
	Limiting shaft friction stress	110kN/m^2
Special precautions relating to bored pile shafts and bases	Bored pile concrete should be cast as soon after completion of boring as possible and in any event the same day as boring. Prior to casting the base of the pile bore should be clean, otherwise a reduced safe working load will be required. Similarly, if the pile bore is left open the shaft walls may relax/soften, leading to a reduced safe working load.	

[1)] nominal factor of safety assumed on shaft with no end bearing capacity

The design procedure for piles varies considerably, depending on the proposed type of pile and to a large extent on the method and care taken during their installation. It is therefore recommended that further detailed advice of a specialist-piling contractor be sought as to the most suitable type of pile for the prevailing ground conditions and also as to their lengths and diameters to support the required working loads.

However, for illustrative purposes only, Table 10 and Table 11 give likely working pile loads for traditional bored, cast-in-situ concrete piles of various diameters and lengths, end bearing into the Boyn Hill Gravel and the White Chalk, respectively, based on the design parameters in Table 9.

As stated above, due to the potential for granular soils to be loosened at the base of bored piles, the working loads provided within Table 10 have been calculated adopting a nominal factory of safety on the shaft resistance and excluding any end bearing capacity.

Table 10: Illustration of typical pile working loads for bored cast-in-situ piles constructed wholly in the Boyn Hill Gravel

Typical pile working loads (kN)				
Depth of pile below existing ground level (m)	Pile diameter			
	300mm	450mm	600mm	750mm
10	96	166	237	324
15	215	339	475	622
20	380	586	804	1034

Table 11: Illustration of typical pile working loads for bored cast-in-situ piles end bearing into the White Chalk

Typical pile working loads (kN)				
Depth of pile below existing ground level (m)	Pile diameter			
	300mm	450mm	600mm	750mm
10	144	234	334	446
15	345	534	735	947
20	530[1)]	845	1150	1466

[1)] limited by the maximum concrete stress

It should be stressed that the above capacities do not take into consideration pile group effects which is more pronounced for a large number of closely spaced piles.

6.4 Floor slabs

The site is generally underlain by more than 600mm of existing made ground. National House-Building Council (NHBC) standards require that ground floor slabs should be suspended in areas where made ground is greater than 600mm in thickness.

6.5 Roads, hardstanding and drainage

In the 1m to 1.5m below the proposed finished ground level the exploratory holes have revealed a soil profile comprising a heterogenous made ground.

In pavement design terms, the groundwater conditions are anticipated to comprise a low water table, i.e. at least 1m below the pavement formation level.

In the absence of any in-situ testing, the estimated minimum, equilibrium soil-suction, California bearing ratio (CBR) value for the soils and groundwater conditions described above under a completed pavement is 2%, based upon Table C1 in TRRL (1984) Report LR1132.

The sub-grade soils can be regarded as non-frost-susceptible, based upon the criteria given in Appendix 1 of TRRL (1970) Report Road Note 29. When the sub-grade is frost-susceptible the thickness of sub-base must be sufficient to give a total thickness of non-frost-susceptible pavement construction over the soil of not less than 450mm.

6.6 Chemical attack on buried concrete

The results of chemical tests carried out on soil samples indicate 2:1 water soil extract sulfate contents of up to 131mg/l with generally slightly alkaline pH values.

These results indicate that, in accordance with BRE Special Digest 1: 2005 *Concrete in aggressive ground*, the Aggressive Chemical Environment for Concrete (ACEC) Classification is ***AC-1*** with a Design Sulphate Class for the site of ***DS-1***. This assumes nominally mobile groundwater conditions.

6.7 Soakaways

The significant depths of made ground do not appear suitable from a geotechnical viewpoint for the use of pit soakaways to discharge surface run-off water. However, it is stressed that to-date no infiltration tests have been performed to confirm this preliminary assessment and the actual infiltration characteristics of the sub-soils. For environmental reasons, careful consideration will have to be given to selecting their locations and design details.

The EA should be contacted at the design stage in order to obtain a 'consent to discharge'. This may not be forthcoming where soakage will be into or just above the water table, particularly in the Agency's sensitive aquifer protection zones. In addition, planning approval will have to be sought for their use.

FIGURES

RSK
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Client: WESTON HOMES PLC

Project Title: MILL POND SITE, DARTFORD

Drawing Title: SITE LOCATION MAP

Rev	Drawn	Date	Checked	Date	Approved	Date
00	SAY	29.08.14	ST	29.08.14	ST	29.08.14

Dimensions	Scale	Original Size	Project Number	Drawing File	Drawing Number
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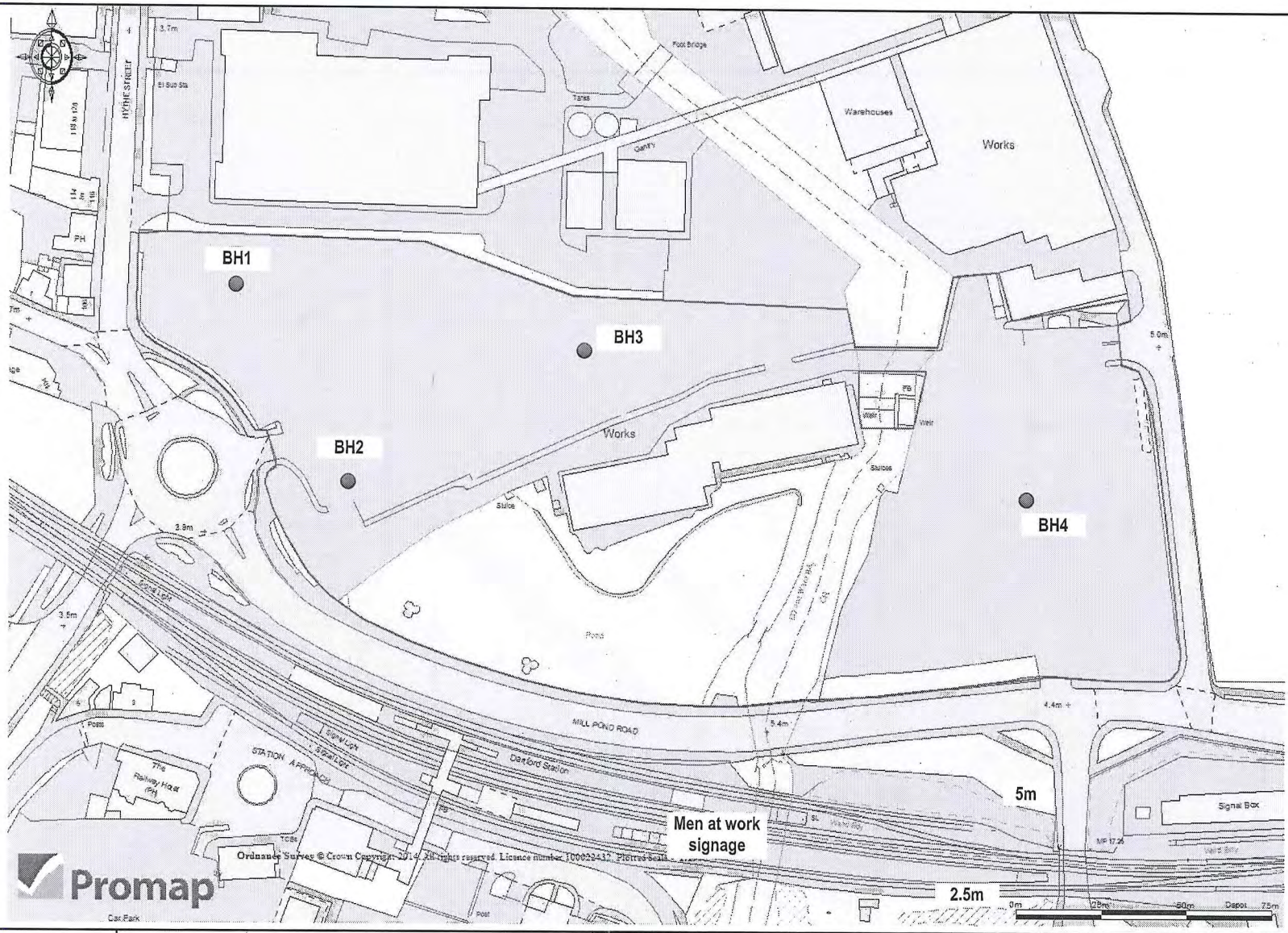
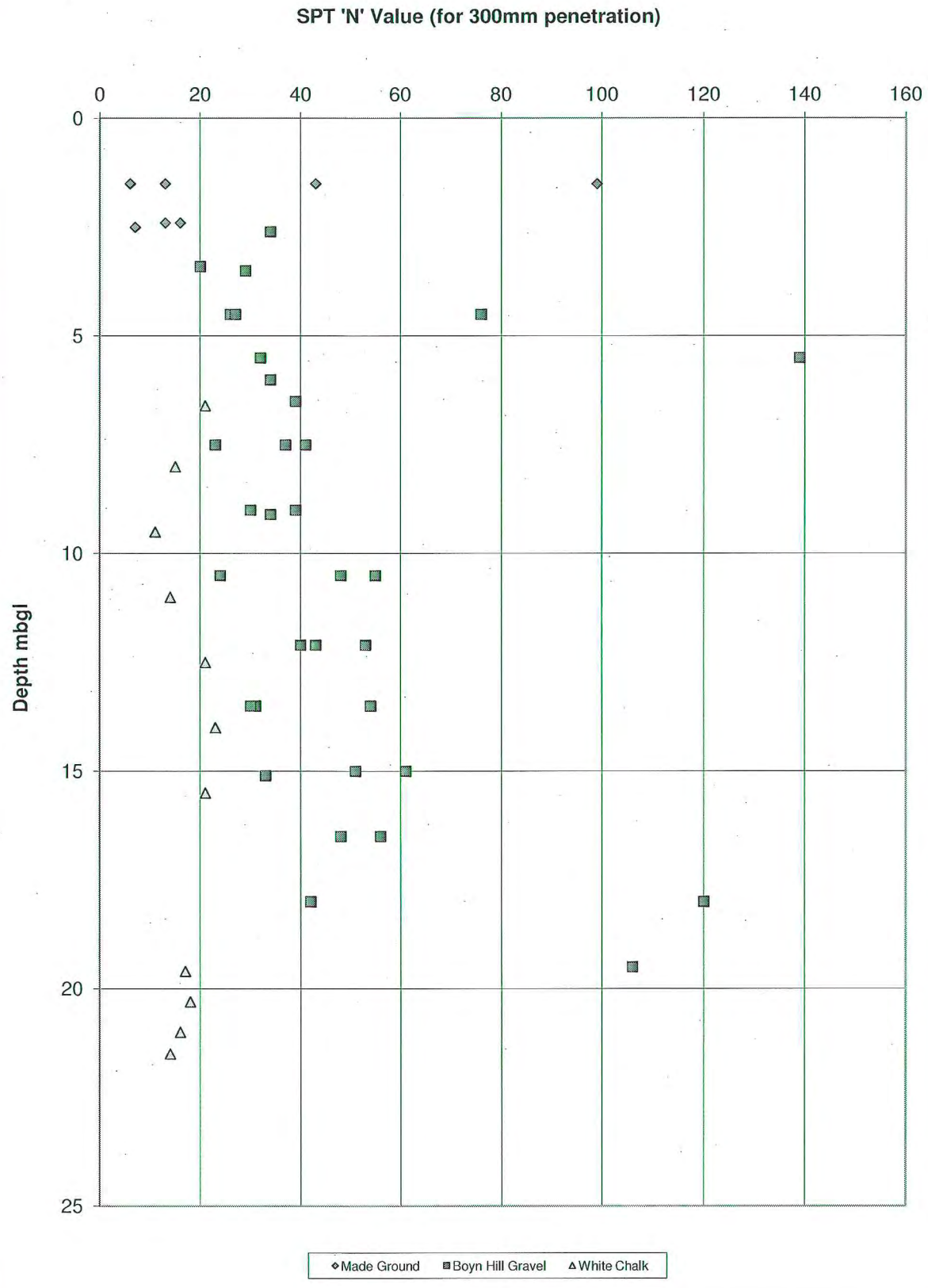


RSK	**Site Layout and Borehole Locations Plan**	**Client:**	Weston Homes Plc	**Figure No:**	2
		Site:	Mill Pond Site, Dartford	**Tender No:**	27265-01(00)
		Scale:	NTS	**Source:**	Weston Homes Plc

RSK

SPT 'N' VALUES vs DEPTH

Site:	Client:	Job Number:	27265
Mill Pond Site, Dartford	Weston Homes	Figure:	3



APPENDIX A
SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Weston Homes Plc (the "client") in accordance with the terms of a contract between RSK and the "client", dated 28th July 2014.. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.

2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.

3. Unless otherwise agreed in writing the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**

4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.

5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.

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

7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.

8. The intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (boreholes, trial pits etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.