

Berewood, Town Park Phase B

Ground Investigation Report



Report for:

WYG

CS-J-0161

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03	31/10/19	Issue 3 – Inclusion of full set of geotechnical results	Craig Pennell	James Dodd	Mike Nicolas

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EXECUTIVE SUMMARY

Project Information	
Project details	This Ground Investigation report has been prepared by T&P Regeneration Ltd (T&P) on behalf of WYG for Berewood, Town Park Phase B PO7 3DG / NGR: 467459, 108954.
Site description and current land use	The site irregular in shape comprising 4N° irregularly shaped open grass fields currently used as public open space. An additional area situated centrally within the site which was previously used as a farming compound and comprises two small open grass areas bounded by hedge rows and trees. The site is approximately 13 hectares (ha).
Proposed development	The proposed development comprises the construction of the construction of a model boating lake/pond with sport field areas and public open space.
Ground Investigation	
Scope of work	An intrusive ground investigation was undertaken on the 6th and 20th August 2019, comprising the following: - Excavation of 4N° trial pits to a maximum depth of 3.20 metres below ground level (mbgl). - Infiltration testing within 1N° trial pits. - Drilling of 7N° windowless soil sampling boreholes. - Drilling of 1N° cable percussive borehole. Access across the central field of the site was hindered due to rutted ground and the presence of tall foliage. Furthermore, it was not possible to access the eastern portion of the site on the first day of the ground investigation due to the presence of a large recreation park located on the southern boundary and the prohibition of construction vehicles within the newly constructed residential estate located to the north of the site. A subsequent site visit allowed entry to the eastern portion of the site.
Ground conditions	Made ground was encountered within exploratory locations TP03 and TP04 with a reported thickness of between 0.45 and 1.10m. Made ground was generally found to comprise sandy, silty gravel with a medium to high cobble content, which included brick, glass and bitumen fragments. Topsoil was encountered in the majority exploratory locations. In general, the topsoil was found to comprise soft to firm light brown slightly gravelly clay which, given the agricultural setting of the site, is likely to have been reworked through ploughing and crop cultivation. The generally soft to firm clay of the weathered portion of the London Clay Formation was encountered within the majority of exploratory hole location during the ground investigation with top depths ranging between 0.20mbgl (below topsoil) and 1.0mbgl. Below depths of between 2.80 and 4.60mbgl the clay of the London Clay Formation becomes stiff to very stiff. No significant visible or olfactory evidence of contamination was encountered during the ground investigation.
Groundwater	Groundwater was encountered within BH01, WS02 and WS06 during the ground investigation with depths to groundwater ranging between 3.30mbgl and 7.30mbgl. Groundwater was not encountered in any of the other exploratory hole locations during the ground investigation.
Considerations and Recommendations for Further Work	
Considerations	- A Desk Study has not been carried-out for the site area. As such, there may be problematic areas undiscovered. - Many areas within the former farming compound have not been investigated and maybe concealing a thickness of made ground. - Infiltration testing was not undertaken in full accordance with BRE Digest DG-365 (2016) as it was not possible to complete three infiltration tests within the soakaway location in the time available.

Recommendations	<u>Engineering</u> • Infiltration testing highlighted that soakaways may offer a viable mechanism for surface water management on site. Supplementary testing should therefore be undertaken to provide results in full accordance with BRE365 prior to detailed soakaway design. • Should any exceptionally soft spots or oversized material be noted during construction, they should be removed and replaced with compacted granular fill for road construction. <u>General</u> • Discussions should be held with local landfill/soil waste treatment facilities to agree material classification/pre-treatment required for any soils to be disposed off-site as a result of proposed construction works. • Ground workers should remain vigilant for visible and olfactory signs of contamination following demolition of on-site buildings. • Ground workers should be vigilant for potential UXO and seek immediate professional advice if anything suspicious is encountered during groundworks. • A site-specific health and safety plan should be prepared to inform on risks posed from the previous site use and mitigations for ground workers developing the site e.g. requirements for appropriate PPE, hygiene practices, environmental monitoring and requirements for mitigation measures during construction works. • A copy of this report should be provided to the relevant regulatory authorities to confirm that they are in agreement with the report findings.
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1 INTRODUCTION

1.1 Contract Details

Following instruction from WYG ('the client'), an intrusive ground investigation was undertaken for a proposed area of public open space and sports fields on the land south of Parker Drive, Waterloooville (the 'site').

1.2 Proposed Development

Information presented to T&P Regeneration Ltd (T&P) indicates that the proposed development is intended to comprise the construction of 1N° model boating lake/pond, sports fields and areas of public open space (planning application number: APP/18/01317). A development layout plan is included in Appendix A although it is understood this may be subject to change following completion of master planning.

1.3 Objectives

The purpose of the assessment is to establish geotechnical conditions of the site to aid design for the future development while presenting contamination data in a factual format.

1.4 Scope of Works

The scope of work was defined by the client, as set out in the T&P proposal and client correspondence. Broadly, this includes:

- Intrusive ground investigation comprising trial pitting, windowless dynamic sampling and cable percussive drilling;
- Completion of in situ TRL DCP tests;
- Completion of infiltration testing;
- Collection of soil samples for chemical and geotechnical laboratory testing; and,
- Presentation of geotechnical information to assist with foundation design.

1.5 Report Limitations

The recommendations, interpretations and conclusions of this report are based on the historical and current site conditions reported by database and mapping sources as supplemented with information gathered during on-site visits. No responsibility can be accepted for the accuracy of third-party information including reference data contained within site specific database reports. Due to the inherent variability of the ground conditions between exploratory hole positions interpretations are accurate only for the date of the investigation works.

2 SITE INFORMATION AND SETTING

2.1 Site Location

Site location information is summarised in Table 2.1. A Site Location Plan is presented within Appendix A.

Table 2.1 Site Location Information

Information	Description
Full postal address	Land south of Park Drive Berewood Waterlooville PO7 3DG
National Grid Reference (NGR)	467459, 108954

2.2 Site Description

A summary of pertinent site information is provided in Table 2.2 with reference to information in previous reports.

Table 2.2 Summary of Site Information

Information	Description
Site description including current site use and area (ha)	The site and its boundary is irregular in shape comprising 4N° irregularly shaped open grass fields currently used as public open space. An additional area situated centrally within the site which was previously used as a farming compound and comprises two small open grass areas bounded by hedge rows and trees. The site is approximately 13 hectares (ha).
Surrounding land uses	North A new residential development is located off the northern boundary.
	South The site is bounded by a recreation park and open grass land that leads onto London Road.
	East To the east of the site is an open grass area that opens onto the site and an area used for allotments.
	West To the west of the site is open farmland.
Site access	The site was accessed off Plant Farm Avenue located in the north-western corner of the site. Access across the site was hindered by tall foliage found across the entirety of the central field of the site. Furthermore, deep ruts in the topsoil and sub-soil were noted across the central field creating movement issues for on-site plant.
Ground cover (%)	The site ground cover comprises: - Soft landscaping (grass/planting) (82%) - Gravel (2%) - Hard landscaping – tarmac/concrete (<1%) - Dense vegetation (15%)
Site elevation and topography	The site elevation ranges between 46 and 55 metres Above Ordnance Datum (mAOD). The site is generally level with a gentle slope down towards the north. A depression in the form of a pond or a tributary is located centrally within the historic farming compound.
Site boundaries	North The northern boundary is comprised of Plant Farm Avenue In the western area and Laxton Leaze in the eastern area.
	South A large recreation park is located along the southern boundary, bounded by a newly constructed 1m tall fence.
	East Public open space is located along the whole length of the eastern boundary with an area sectioned off for allotments. With the exception of the shoring

Information	Description	
		around the allotments no shoring or fencing is found along POS section of the boundary.
	West	Open farmland is present along the western boundary.
Significant on-site features	A depression in the form of a pond or tributary was observed within the farming compound located centrally within the site boundary.	

3 SCOPE OF WORK

3.1 Summary of Fieldwork

An intrusive ground investigation was undertaken on the 6th and 20th August 2019, comprising the following:

- Excavation of 4N° trial pits;
- Infiltration testing within 1N° trial pits;
- Drilling of 7N° dynamic windowless soil sampling boreholes;
- *In situ* TRL DCP tests in 9N° locations;

The work was completed in general accordance with BS5930¹.

An exploratory location plan is presented in Appendix A. A selection of photographs is provided within Appendix B. Exploratory logs are presented in Appendix C.

3.2 Exploratory Locations and Access Restrictions

A summary of exploratory locations with supporting rationale is provided in Table 3.1.

Table 3.1 Rationale for Exploratory Locations

Exploratory location(s)	Rationale/justification
TP01	As per client's specification
TP02	Soakaway test (client's specification)
TP03 – TP04	Investigating the former farm track/path (client's specification)
BH01 and WS03	Location of model boating lake/pond (client's specification)
WS01 – WS02 & WS04 – WS07	As per client's specification

Access across the central field of the site was hindered due to rutted ground and the presence of tall foliage. Furthermore, it was not possible to access the eastern portion of the site on the first day of the ground investigation due to the presence of a large recreation park located on the southern boundary and the prohibition of construction vehicles within the newly constructed residential estate located to the north of the site. A subsequent site visit allowed entry to the eastern portion of the site.

3.3 Trial Pits

T&P supervised the excavation of 4N° trial pits (TP01 – TP04) using a tracked 8 Tonne excavator. The trial pits were terminated at depths ranging between 0.85 and 3.20 metres below ground level (mbgl) either as directed by the client's specification or due to maximum trial pit depth reached. Trial pits were backfilled with arisings compacted in suitable layers with the surface layers and topsoil replaced last.

¹ BS5930. Code of Practice for Ground Investigations. 2015.

3.4 Dynamic Windowless Soil Sampling Boreholes

T&P supervised the drilling of 7N° windowless sample boreholes (WS01 – WS07) which were terminated at a depth of 5.0mbgl in accordance with the client's specification. *In situ* standard penetration testing (SPT) was undertaken at 1.0m intervals or with noted changes in geology.

3.5 Cable Percussion Boreholes

T&P supervised the drilling of 1N° cable percussive borehole (BH01) which was terminated at a depth of 15mbgl.

3.6 TRL Dynamic Cone Penetrometer Tests

T&P supervised the completion of 9N° dynamic probes using an *in situ* TRL Dynamic Cone Penetrometer (TRL DCP) probe at the locations of the majority of exploratory hole positions (WS01-WS07, BH01 and TP01-TP02). Test results are included in Appendix D.

3.7 Infiltration Testing

T&P supervised infiltration testing within 1N° of the trial pits (TP02) which was undertaken in accordance with the client's specification. Test results are included within Appendix F.

4 SUMMARY OF GROUND CONDITIONS

4.1 Recorded Ground Conditions

The geological sequence encountered during the ground investigation is summarised in Table 4.1 and described further in the following sub-sections. Ground conditions were found to broadly correspond with published geological information. Exploratory logs are included in Appendix C.

Table 4.1 Summary of Ground Conditions

Top depth range (mbgl)	Base depth range (mbgl)	Exploratory holes	Area of site	General description/comments
Ground level	0.20-0.50	TP01-TP02 & WS01-WS07	General	Soft to firm light brown gravelly occasionally sandy CLAY. Gravel is subangular to subrounded fine to coarse of flint, chert and rare glass, bitumen and brick. (TOPSOIL & REWORKED TOPSOIL)
Ground level	0.45-1.10	TP03-TP04	Central	Light brown, black and grey silty sandy GRAVEL with medium to high cobble content. Gravel is angular to subrounded fine to coarse of flint, brick, glass, bitumen and chalk. (MADE GROUND)
0.20-1.10	0.55-4.60	TP03-TP04, WS01-WS02 & WS07	Central and central southern areas of the site	Very soft to firm bluish grey and orange to orange mottled grey CLAY with fibrous peat traces, root traces and occasional angular to subrounded fine to coarse gravel of flint and chalk. Rare glass, coal and brick fragments were found at depths no greater than 1.0mbgl. (REWORKED LONDON CLAY FORMATION)
0.20-1.0	0.85-5.0	BH01, TP01-TP03 & WS01-WS07	General	Soft to firm orangish brown occasionally mottled grey slightly sandy CLAY. (WEATHERED LONDON CLAY FORMATION)
2.80-4.60	3.20-15.0	BH01, TP01, WS02-WS03, WS05 & WS07	General	Stiff to very stiff grey CLAY. (LONDON CLAY FORMATION)

4.1.1 Made ground

Made ground was encountered within exploratory locations TP03 and TP04 located in the central area of the site along the old farm track with a reported thickness of between 0.45 and 1.10m. Made ground was generally found to comprise sandy, silty gravel with a medium to high cobble content, which included brick, glass and bitumen fragments.

4.1.2 *Topsoil*

Topsoil was encountered in the majority exploratory locations with a typical thickness ranging between 0.20 and 0.50m and locally up to 0.50m in the vicinity of WS05 on the eastern boundary. In general, the topsoil was found to comprise soft to firm light brown slightly gravelly clay which, given the agricultural setting of the site, is likely to have been reworked through ploughing and crop cultivation.

4.1.3 *Reworked London Clay Formation*

The reworked London Clay Formation was encountered in a number of trial pit and windowless sample positions with depths ranging between 0.20 and 1.0mbgl and locally up to 2.60mbgl in the vicinity of WS07. The reworked deposits generally comprised soft to firm slightly gravelly to gravelly clay with the gravel component generally comprising flint, chalk and rare glass, bitumen and brick fragments.

4.1.4 *Bedrock Geology – London Clay Formation*

The generally soft to firm clay of the weathered portion of the London Clay Formation was encountered within the majority of exploratory hole location during the ground investigation with top depths ranging between 0.20mbgl (below topsoil) and 1.0mbgl. Below depths of between 2.80 and 4.60mbgl the clay of the London Clay Formation becomes stiff to very stiff.

4.1.5 *Evidence of Contamination*

With the exception of made ground within TP03 and TP04 and the rare red brick, glass and bitumen fragments within the topsoil across the site, no significant visible or olfactory evidence of any contamination was noted during the ground investigation.

4.1.6 *Below Ground Structures and Obstructions*

No below ground structures or obstructions were encountered during the ground investigation.

4.2 **Groundwater**

Groundwater was encountered within BH01, WS02 and WS06 during the ground investigation with depths to groundwater ranging between 3.30mbgl and 7.30mbgl. Groundwater was not encountered in any of the other exploratory hole locations during the ground investigation.

5 SUMMARY OF LABORATORY ANALYSES

5.1 Geotechnical Testing

The geotechnical testing deemed necessary to adequately characterise the site from a geotechnical perspective in the context of the proposed development is summarised in Table 5.1.

Samples from the investigation were forwarded to a UKAS accredited laboratory. Complete results are provided in Appendix D.

Table 5.1 Summary of Geotechnical Testing

Test	Notes	Quantity
Moisture content	-	6 soils
Atterberg limits	-	6 soils
Remoulded CBR (including soaking)	-	4 soils
Geochemical analysis BRE SD1 Suite	pH, Sulphur, Chloride, Nitrate, 2:1 water soluble Sulphate, Magnesium, Total Sulphate	6 soils

5.2 Chemical Testing – Soil

The soil testing deemed necessary to adequately characterise the site from a contamination perspective in the context of the conceptual site model and proposed development is summarised in Table 5.2.

Additional asbestos testing have been added to the suite as a result of the discovery of an area of significant made ground around TP03 and TP04.

Samples from the investigation were forwarded to a UKAS and MCERTS accredited laboratory. Complete chemical results are provided in Appendix E.

Table 5.2 Summary of Chemical Testing

Test type	Quantity
<i>Soils</i>	
Arsenic, Boron, Cadmium, Chromium, Lead, Mercury, Nickel, Copper, Zinc, Selenium, Phenols and US EPA 16 Polycyclic Aromatic Hydrocarbons.	5 soils
Asbestos screening/ID	2 soils
TPH CWG including benzene, toluene, ethylbenzene and xylenes (BTEX)	2 soil

6 INFILTRATION TESTING

6.1 Summary of Field Testing

Infiltration testing was undertaken within 1N° trial pits (TP02) at approximate assumed deep soakaway formation level (i.e. 2m below existing level) to assess the viability of using traditional soakaway drainage within the proposed development. Graphical representations of the data are contained within Appendix F.

The trial pit was positioned as per the client's specification as show on the exploratory hole location plan contained within Appendix A. Infiltration tests were not completed in areas of the site where made ground was encountered.

The infiltration testing and subsequent calculation of soil infiltration rates were carried out in general accordance with the methodologies detailed within BRE 365².

Ideally, to fully comply with the BRE methodology, infiltration tests should be undertaken a minimum of three times. However, due to the limited time available and the slow infiltration rates encountered, it was not possible to complete the repeat testing. Therefore, the results for these tests should be considered as preliminary only and may not be a suitable basis for final drainage design.

6.2 Soil Infiltration Rate Calculations

The infiltration rates (F) have been calculated in accordance with BRE Digest DG-365 (2016). A summary of the results of the infiltration tests and calculated infiltration rates is provided in Table 6.1.

Table 6.1 Summary of Calculated Infiltration Rates

Exploratory Location	Date	Total Measured water level change (m)	Time Period (mins)	Calculated infiltration rate (m/s)
TP02 (T1)	02/07/19	0.11	116	3.01E-06

6.3 Discussion

The calculated infiltration rates indicate the soils beneath the site have relatively poor infiltration characteristics which is reflective of the clay encountered within the shallow weathered London Clay Formation.

Based upon the test results and site observations it is considered that traditional soakaways are unlikely to offer a viable solution for surface water discharge. However, further testing comprising three repeat tests is required to confirm this.

² Soakaway Design BRE Digest DG-365 (2016).

7 COMMENTS ON ENGINEERING DESIGN

7.1 General

Eurocode 7 (Section 2)³ advocates the use of geotechnical categorisation of the proposed structures to establish the design requirements. Information presented to T&P indicates that the proposed development is to comprise the construction of a model boating lake/pond with a number of small ancillary structures. At this stage it is unknown what the magnitude of the desired loadings will be.

In consideration of the available information on the development proposals, for the purposes of this investigation the proposed structures have been classified as follows:

- Geotechnical category 1: Strip or piled foundations, roads, pavements, car parks, retaining walls below 2m, small excavations for drainage works, with the proposed housing development considered to be within this category.

7.2 Summary of Geotechnical Parameters

Stratum thicknesses and geotechnical parameters for the strata encountered in the investigation are summarised in the following sections. The level of confidence in the derived parameters is provided in Table 7.1.

Table 7.1 Confidence Levels

Key	Description
value	High level of confidence - based on information from investigation.
value	Medium level of confidence - based on published data.
value	Low level of confidence – more data required if parameter to be used in design.

7.2.1 London Clay Formation

The design thicknesses and geotechnical parameters for use in the London Clay Formation are described in Table 7.2.

Table 7.2 Summary of Geotechnical Parameters – London Clay Formation

Parameter	Units	Min	Max	Design	Comments
Top Depth	mbgl	0.20	1.10	0.30	Generally, the top depth was recorded at 0.30mbgl.
Base Depth	mbgl	0.85	>15.0	>15.0	Base not proven
Thickness	m	>0.65	>13.9	>13.90	Thickness not proven
Moisture Content	%	17	29	23	-
Liquid Limit	%	35	55	45	-
Plastic Limit	%	18	25	22	-
Plasticity Index	-	Not plastic	33	33	-
% passing 425µm sieve	%	0	2	N/A	-

³ BS EN 1997 – Part 2. Geotechnical Design.

Parameter	Units	Min	Max	Design	Comments
Modified Plasticity Index	-	Not plastic	33	33	Based on current NHBC guidance, results are indicative of soils of a medium volume change potential
Undrained shear Strength	kPa	25	110	50	Determined from hand shear vanes. Indicative of clay of medium to high strength
Standard Penetration Resistance	N Value	4	41	19	High value likely due to an obstruction during testing, therefore excluded from the dataset.
Modulus of volume compressibility	m ² /MN	0.1	0.3	0.3	Derived from published data.
Skempton Consolidation Factor μ	-	1	1	1	Worst case value so should provide a conservative design.
pH	-	7.2	7.9	-	
Water soluble sulphate (SO ₄ ²⁻)	mg/l	400	100	350	Design value should be worst case if less than 5 samples. If between 5 and 9 samples – the mean of the highest 2 should be used for design. If 10 or more results – mean of the highest 20% of the results should be used (rounded to nearest 100mg/l). (Ref = BRE Special Digest 1).
Acid soluble sulphate (SO ₄ ²⁻)	%	0.05	<0.01	0.05	-
Total Sulphur	%	0.02	<0.01	0.02	-
Total Potential Sulphate	%	0.06	0.03	0.06	-
Oxidisable Sulphide	%	0.01	<0.01	0.01	-

7.3 Construction Considerations

7.3.1 Subsurface Concrete

Based on the pH values, water soluble sulphate and SD1 suite concentrations recorded by the chemical and geotechnical laboratory analysis, together with the calculated oxidisable sulphide⁴, a DS2-AC1s design mix concrete should be suitable for buried structures placed within the shallow soils when compared against the BRE⁵ assessment levels.

7.3.2 Floor Slabs

The results of the investigation indicate that the cohesive soils on site are of medium volume change potential. As such, proprietary suspended ground floor slabs should be designed with a minimum 250mm void based upon NHBC guidance.

⁵ BRE Special Digest 1:2005 – Third edition – Concrete in aggressive ground.

7.3.3 *Building Near Trees*

Soils of the London Clay Formation are likely to be of medium-volume change potential. Based upon the volume change potential and in accordance with NHBC guidelines the minimum founding depth of traditional foundations would be 0.90mbgl. At this stage due to the medium volume change potential provision should be made for the use of void formers where shallow strip foundations are to be placed at a depth greater than 1.50mbgl due to the influence of existing trees. However, the impact of any new planting associated with future potential development of the site should take into account the volume change potential of the soils.

Due to the medium-volume change potential of the soils, foundations will be susceptible to the influence of trees. It is recommended the findings of this report are considered in conjunction with an arboricultural survey and the recommendations given by the NHBC regarding the over deepening of foundations in the vicinity of trees.

7.3.4 *Deep Excavations*

Made and natural ground were generally found to be stable during the intrusive ground investigation. Man entry into any excavations should be avoided where possible. However, if entry into excavations is required, the excavation sides should be adequately shored and supported or battered back to a safe angle in accordance with appropriate temporary works design.

7.3.5 *Groundwater*

Groundwater was encountered within BH01, WS02 and WS06 during the ground investigation with depths to groundwater ranging between 3.30mbgl and 7.30mbgl. Recorded groundwater observations were generally noted as seepages. Groundwater was not encountered in any of the other exploratory hole locations during the ground investigation.

7.3.6 *Buried Utilities*

It is recommended that existing live services are accurately located by careful hand digging and liaison undertaken with the utility companies with regard any required works in these areas. The services should be clearly marked and taken into account in the construction design process.

Excavation in close proximity to live services will need to ensure that the excavation walls are stable or appropriately battered to a safe angle. Temporary slope stability works and pumping of groundwater may be required in any deep excavations.

7.3.7 *Earthworks and Material Handling*

Currently it is anticipated that site levels will be raised and lowered in different areas of the development based on development information supplied by the client. A plan showing areas of ground development across the site can be viewed in Appendix A. To minimise the requirement for material to be moved off-site, it is likely that re-use of existing soils will be required as part of redevelopment proposals. Should earthworks be required, an earthworks specification will be necessary to ensure the appropriate management and reuse of the existing soils.

7.3.8 *Road Construction*

The *in situ* TRL DCP test results recorded CBR results across the site ranging from 2.3% - 55.1% at assumed formation level.

Based on the test results a design CBR value of 2.5% is recommended subject to firm cohesive soils being encountered at formation level. It should be noted however that where revealed the clay soils are moisture sensitive and will be prone to deterioration to give lower CBR values if

left exposed during periods of wet weather. In such circumstances the use of geotextile at the base of construction may be prudent to reduce the potential loss of granular sub-base if placed during periods of inclement weather.

Furthermore, made ground was revealed along the redundant farm track located in the central area of the site, which would be unlikely to be suitable to remain beneath adoptable roads, with very low and variable related CBR values. Where it is observed at formation level it should be excavated and replaced with compacted granular fill.

Typical adoptable road construction thicknesses for a CBR of 2.5% are given below based on current guidance⁶:

- Foundation Class 1 – 550mm capping.
- Foundation Class 2 – 450mm sub-base.
- Foundation Class 3 – 340mm sub-base.
- 350mm Foundation Class 2 sub-base with 250mm Foundation Class 1 capping.
- 290mm Foundation Class 3 sub-base with 250mm Foundation Class 1 capping.

The thicknesses given above may be reduced subject to surface modulus performance testing following placement of the materials.

In total 4N° laboratory remoulded CBR tests were undertaken on samples either at assumed approximate formation level or within natural soils. A copy of the test report can be found in Appendix E. CBR values between 0.47% and 3.7% were recorded by the remoulded testing.

Based on the soils description and considering the CBR testing it is advised that CBR values of 1-2.5% are assumed for design purposes subject to London Clay Formation being encountered at formation level. Greater design CBR values may be achieved following *in situ* testing prior to or during construction phase that may reduce the required thickness of roadway construction.

Where revealed, clay soils will be prone to deterioration if left exposed during periods of wet weather to give lower CBR values of <1%. Therefore, due to the potential for such circumstances, adopting a lower CBR design value of 2% may be more realistic and the use of geotextile at the base of construction may be prudent to reduce the potential loss of granular sub-base, if placed during periods of inclement weather.

Made ground was locally revealed along the redundant farm track located in the central area of the site and was up to 1.10mbgl thick, which would not be suitable to remain beneath adoptable roads. Where it is observed at formation it should be excavated and replaced with compacted granular fill.

7.4 Preliminary Foundation Recommendations

The proposed development is to comprise 1No model boating lake/pond, sports fields and areas of public open space with ancillary buildings. Loadings are unknown at this stage however it has been assumed that maximum line loads will be approximately 50kN/m.

The ground conditions across site were found to be generally consistent with topsoil and reworked topsoil underlain by soft to firm becoming stiff clay of the London Clay Formation. Made ground was identified beneath a redundant farm track and it appears to be limited to that area.

⁶ Interim Advice Note 73/06 Revision 1 (2009)

Engineer's observations and *in situ* testing within the London Clay Formation indicate an undrained shear strength of between 25 and 110kPa. Therefore, a typical value of 50kPa has been used for preliminary design purposes.

Based on the above and taking into account the NHBC guidance it is considered that traditional shallow strip foundations placed at the minimum depth of 0.90mbgl within the firm clay be designed for an allowable bearing capacity of 100kPa for acceptable settlement. Higher bearing capacities may be achieved by taking foundations into stiff material encountered at greater depth.

8 CONSIDERATIONS AND RECOMMENDATIONS

8.1 Considerations

The following uncertainties/data gaps have been identified which may require further consideration:

- Exploratory holes were positioned in accordance with the Client's instructions.
- Infiltration testing was not undertaken in full accordance with BRE Digest DG-365 (2016) as it was not possible to complete three infiltration tests within the soakaway location in the time available.

8.2 Recommendations

8.2.1 Engineering

- Infiltration testing highlighted that soakaways may offer a viable mechanism for surface water management on site. Supplementary testing should therefore be undertaken to provide results in full accordance with BRE365 prior to detailed soakaway design.
- Should any exceptionally soft spots or oversized material be noted during construction, they should be removed and replaced with compacted granular fill for road construction.

8.2.2 General

- Discussions should be held with local landfill/soil waste treatment facilities to agree material classification/pre-treatment required for any soils to be disposed off-site as a result of proposed construction works.
- Ground workers should remain vigilant for visible and olfactory signs of contamination following demolition of on-site buildings.
- A site-specific health and safety plan should be prepared to inform on risks posed from the previous site use and mitigations for ground workers developing the site e.g. requirements for appropriate PPE, hygiene practices, environmental monitoring and requirements for mitigation measures during construction works.
- A copy of this report should be provided to the relevant regulatory authorities to confirm that they are in agreement with the report findings.

Appendix A – Drawings

— Site Boundary



Base Map
Company: -
DWG Title: -
DWG Number: -
Date: -

Drawn	Checked	Amendment	Date	Rev.
-	-	-	-	-
WYG				
Project				
Berewood - Town Park Phase B				
Title				
Site Location Plan				
Scale	Date	Drawn by	Check by	Rev.
1:10000@A4	30/07/19	AW	CP	-



Unit 4 Brunel Lock Development, Smeaton
Road, Bristol, BS1 6SE
Tel: 0117 927 7756
Email: info@TP-regen.co.uk



Rev.	Drawing No.
-	CS-J-0161-01-001

- Rotary Borehole Locations (BH1)
- Windowless Sampling Locations (WS01 - WS07)
- Trial Pit Locations (TP01 - TP04)
- ◆ TRL Locations (TRL01 - TRL10)
- Site Boundary



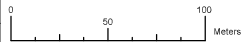
Base Map
 Company - Mayer Brown Limited
 DWG Title - Proposed Oil Test Locations
 DWG Number - 011WVRLLE_17259K06
 Date - July 2019

Drawn	Checked	Amendment	Date	Rev.
WYG				1

T&P
 Regen
 Unit 4 Brunel Lock Development, Smeaton Road, Bristol, BS1 6SE
 Tel: 0117 927 7756
 Email: info@TP-regen.co.uk

Exploratory Hole Location Plan

Scale	Date	Drawn by	Check by	Rev.	Drawing No.
1:2000@A3	12/08/19	AW	CP	-	CS-J-0161-01-002



- Rotary Borehole Locations (BH1)
- Windowless Sampling Locations (WS01 - WS07)
- Trial Pit Locations (TP01 - TP04)
- ◆ TRL Locations (TRL01 - TRL10)
- Site Boundary



Base Map
 Company:
 DWG Title:
 DWG Number:
 Date:

Drawn	Checked	Amendment	Date	Rev.

WYG

Project
 Berewood - Town Park Phase B

T&P
 Exploratory Hole Location Plan

Unit 4 Brunel Lock Development, Smeaton Road, Bristol, BS1 6SE
 Tel: 0117 927 7756
 Email: info@TP-regen.co.uk

Scale	Date	Drawn by	Check by	Rev.	Drawing No.
1:2000@A3	12/08/19	AW	CP	-	CS-J-0161-01-002