GROUND INVESTIGATION REPORT

PROPOSED REDEVELOPMENT:

277A, GRAY'S INN ROAD, LONDON WC1X 8QF

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227A, GRAY'S INN ROAD, LONDON WC1X 8QF

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1.0 INTRODUCTION

Consideration is being given to the demolition of the existing warehouse and construction of new residential/multi-purpose units with basements. In connection with the proposed works, Soil Consultants Ltd [SCL] were commissioned by Pringuer-James Consulting Engineers Ltd to carry out a ground investigation to include the following elements:

- Identification of ground sequence
- Provision of recommendations for foundation, retaining wall, floor slab and pavement design

This report describes the investigation undertaken, gives a summary of the ground conditions encountered, and then provides foundation design recommendations.

The site has been the subject of investigations by Herts & Essex Site Investigations [HESI], which include the following:

- Site Investigation Report, ref. MRS/12138, dated June 2014
- Additional Site Investigation, ref. 12138, dated August 2014
- Phase 1 Desk Study Report, ref. 12138, dated September 2014

This report makes use of the borehole records and laboratory test results from the HESI site investigation reports.

The site is also the subject of a Phase 2a site investigation and generic quantitative risk assessment report by Terragen Environmental Ltd [ref. TJ2824AR1v1.0, dated February 2015] and subsequent Risk Management Strategy report [ref. TJ2824AR2v1.0, dated February 2015], based on the same site works as contained within this report.

2.0 SITE DESCRIPTION

The site is located on the western side of Gray's Inn Road, in the King's Cross district of the London Borough of Camden, with its approximate centre at NGR 530460E, 182840N, as shown on the Location Maps in Appendix A.

The site, which is approximately rectangular on plan, has overall dimensions of approximately 110m x 30m and is occupied, almost entirely, by a single storey warehouse building of steel-framed and brick wall construction, with partial [approximately 10m wide], single level basement. The site was reportedly most recently in use as a car park. The remainder of the site, at the north-western and eastern access points, comprises access roads.

The surrounding area is in mixed residential and commercial use and is bounded by residential-style properties on St Chad's Street to the north. To the east of the site are residential and commercial properties on Gray's Inn Road. These mostly comprise four-storey terraced brickwork buildings, many of which have rear annex buildings that extend as far as the site boundary. On the west side is the Birkenhead Street residential estate [four multi-storey residential blocks with single level basements] and to the south is a four-storey building, No 55 Argyle Street.

The site is within the broad flat valley of the River Fleet [now culverted], which formerly ran along the eastern side of Gray's Inn Road and, in general, the surrounding topography slopes gently down north-westwards.

The site lies at approximately +19.1mOD [as shown on the engineer's drawing L1706_03_01, dated 12/11/2014] and has been raised above the surrounding road levels by around 1.6m at the northern end and by 1.0m on the Gray's Inn Road side, with access via ramps.

The site is devoid of significant vegetation, although there are several trees within the Birkenhead Street residential estate to the west, including some close to the site boundary.

The current site features are shown on the Site Plan which is included in Appendix A.

3.0 PREVIOUS INVESTIGATIONS

The 2014 HESI investigations comprised map and environmental database searches [Phase I - desk study]; formation of five boreholes [BHA to BHE], and subsequent geotechnical laboratory testing.

The desk study, in brief, revealed that the site history, since the likely initial development of the site from agricultural fields in the late nineteenth century, was mostly as warehouses, including a beer bottling warehouse, but included a short period as a depot.

The first three HESI boreholes, BHA to BHC, were located within the existing basement and terminated at shallow depth [0.30m to 1.20m] on concrete obstructions. The two later boreholes, BHD and BHE, were constructed outside of the existing basement footprint using cable percussion techniques to a depth of 15.00m below ground level. Samples were recovered and laboratory testing performed, including natural moisture contents, Atterberg Limits, undrained triaxial compression tests, one dimensional consolidation tests, pH and water-soluble sulphate.

The HESI borehole and laboratory records are presented in Appendix B to this report.

4.0 EXPLORATORY WORK

Our ground investigation was carried out in March 2015 and comprised the following elements.

Cable percussive boreholes

Three boreholes [BH101 to BH103] were completed to a depth of 25.00m below ground level. Representative samples were taken for environmental and geotechnical testing and in-situ testing [Standard Penetration Tests] was carried out at appropriate intervals. Boreholes BH101 and BH103 were located close to the HESI boreholes BHD and BHE, respectively, and comprised only disturbed sampling above the final depth of those former boreholes [15.00m]. A monitoring pipe was installed in borehole BH102 on completion.

Gas and ground-water monitoring

Gas and ground-water monitoring was carried out on one occasion following completion of the site works - on 25 March 2015. Monitoring of HESI BHD and BHE was conducted and SCL BH102 could not be found [assumed destroyed]. The gas monitoring results will be addressed by Terragen.

Geotechnical laboratory testing

The following geotechnical laboratory testing was completed for this report:

- Natural moisture content and index properties tests [Atterberg Limits]
- Unconsolidated, undrained triaxial compression tests
- Soluble sulphate/pH analyses [tested externally by QTS Environmental Ltd]

The engineering borehole logs and the laboratory testing results are included in Appendix A. The co-ordinates at the borehole positions were extrapolated from public domain data and approximate ground levels were interpolated from a Pringuer-James drawing [ref. L1706-03_01, dated May 2014].

5.0 GROUND CONDITIONS

The 1:50,000 scale British Geological Survey map of the area indicates that the site is underlain by the London Clay Formation, which overlies, in turn, the Lambeth Group, the Thanet Formation and the White Chalk Sub-group. Nearby deep BGS and SCL boreholes indicate that, beneath the site, the London Clay is likely to extend to a depth of around 21m, the Lambeth Group to around 40m [18m thick]; and the Thanet to 42m [2m thick]. Beneath these the White Chalk extends to substantial depth.

HESI boreholes BHD and BHE revealed made ground to depths of 1.30m and 3.20m, comprising 'sandy brick rubble', that overlaid the London Clay Formation, which was described, in general, as brown, slightly silty to silty clay, which becomes grey with depth. Ground-water was not recorded, either during boring or on subsequent monitoring of installed standpipes one week from completion [on 14 September 2014].

Our investigation confirmed the natural sequence [as far as the Lambeth Group] and revealed made ground at surface. The disposition of these strata is described more fully below and further illustrated by the cross-section in Appendix A.

Correction to the field N-values [to N_{60}-values] for the effects of energy delivery have been applied to the SPT [Standard Penetration Test] results from this investigation, in line with the recommendations given in BS EN ISO 22476-3, 2005, National Annex A. The value for the energy ratio of the specific test equipment, Er, of 76% has been taken from the equipment annual calibration certificate. A copy of the certificate is presented following the SPT Summary in Appendix A.

5.1 Made ground

The surfacing was mostly of reinforced concrete, with granite setts at surface near to the southern entrance. The concrete varied in thickness between 200mm and 250mm at the exploratory positions.

The underlying made ground extended to depths of between 1.30m [HESI BHD] and 3.60m [SCL BH103] and largely comprised brown, slightly gravelly, slightly sandy, silty clay. The gravel was of flint, brick and concrete. The HESI boreholes BHD and BHE recorded 'sandy brick rubble', which is unclear as to the predominant grain-size but suggests that there may be localised thicknesses of sandy brick gravel.

Elsewhere across the site, the made ground contains numerous obstructions which prevented borehole progress, with three of the HESI boreholes abandoned within 1.2m of the surface.

This fine-grained made ground was noted to be of soft, locally firm, consistency.

5.2 London Clay Formation

The London Clay was met at depths of between 1.30m and 3.60m in the five boreholes which penetrated to depth. This formation initially comprises typical fissured, brown and orange-brown [weathered] clay. With depth this passes into the grey [unweathered] London Clay, becoming slightly sandy and with occasional small pockets of silt. Borehole BH101 encountered a claystone obstruction at 7.60m depth, requiring 30 minutes of chiselling to by-pass.

Atterberg limits tests on the London Clay classify it as Intermediate to [typically] Very High plasticity clay [in the BS 5930 scheme] and of medium to [typically] high volume-change potential in the NHBC scheme.

The London Clay was generally of firm, becoming stiff to very stiff consistency but there was an anomalous zone, reported to be of soft consistency, in HESI BHE to 4.40m. Laboratory triaxial compression testing and conversion of the SPT 'N_{60}' values, to undrained shear strength [using $c_u = 5.0N_{60}$] indicate the London Clay to be of initially very low shear strength, generally increasing with depth and typically of high to very high strength between 3.0m and 10.5m depth bgl and very high strength below 10.5m depth.

5.3 Lambeth Group

The Lambeth Group comprised fissured, variegated red-brown, orange-brown, brown and blue-grey clay and its upper surface was present at depths of between 20.90m to 21.50m bgl in the three deeper boreholes of this investigation – that is levels of between approximately -2.30mOD and -3.00mOD.

Atterberg limits tests on the Lambeth Group classify it as High plasticity clay [in the BS 5930 scheme].

The Lambeth Group was of very stiff consistency. Laboratory triaxial compression testing and conversion of the SPT 'N_{60}' values, to undrained shear strength [using $c_u = 5.0N_{60}$] indicate the Lambeth Group to be of very high to extremely high shear strength.

5.4 Ground-water

The only ground-water encountered in any of the boreholes was as a seepage at 14.3m bGL in BH103, which is probably associated with silt partings [or claystones] within the clay strata.

Monitoring of the standpipe in HESI borehole BHE [reported elsewhere, by Terragen, on 9 December 2014] revealed a standing depth of 11.1m bGL. It is thought that this probably represents of an accumulation from water perched within the made ground rather than a body of ground-water in the London Clay and our more recent monitoring of HESI boreholes BHD and BHE revealed them both to be dry.

6.0 GEOTECHNICAL ASSESSMENT

Detailed design proposals have not been finalised for this site but it is understood that the proposed works are likely to include the following elements:

- demolition of the existing building
- construction below existing ground level across most of the site, with a basement occupying [approximately] the southern and mid-sections of the site and a lower ground floor outside of this
- basement FFL around 5.6m bGL [+13.455mOD] and lower ground floor FFL around 3.4m bGL [+15.690mOD]
- construction of mixed-use blocks of between two and eight storeys

Our investigation has revealed a significant thickness of made ground [between 1.30m and 3.60m where fully penetrated] overlying the London Clay, which in turn overlay the Lambeth Group at depths of between 20.90m and 21.50m bGL - between -2.30mOD and -3.00mOD.

It is understood that a piled foundation solution is envisaged, with approximate unfactored pile loads of between 400kN and 900kN. It may be possible to adopt a spread/raft foundation solution as an alternative.

The foundation type[s] of the existing building is not known and it would be important to determine this prior to furthering the design. If there are existing strip/spread foundations then these would require removal prior to forming new foundations. If, alternatively, the existing building is supported on piled foundations then consideration will also have to be given to avoiding undue interference with new foundations.

6.1 Basement excavation and retaining wall

It is understood that some sections of the basement excavation are planned to be supported by piled retaining walls. Specifically these would be the sections adjoining the Birkenhead Estate, the southern end, adjoining Argyle Street, and the southern end of the eastern side, adjoining Gray's Inn Road. The remainder of the excavation is planned to be within an open cut, which would normally require temporary battered slopes or benching to maintain stability.

Preliminary engineer design drawings indicate that the lower ground floor FFL is to be around 3.4m deep [+15.690mOD] and the basement FFL is to be around 5.6m deep [+13.455mOD], with expected depths of excavation to around 4.4m [+14.69mOD] and 6.6m [+12.45mOD], respectively. The proposed excavation is expected to involve the near total removal of the made ground and therefore, across most of the site, to expose the London Clay.

Ground-water was generally not met other than as minor seepages at depth. There is, of course, the possibility of some water to be trapped, or perched, locally within the made ground [especially during wetter periods] and, if so, it should be possible to deal with it using sumps and pumps.

For the design of embedded walls in the temporary, short-term condition it is usually more economical to carry out an undrained [total stress] analysis in the fine-grained soils. Careful selection of the appropriate design parameters is needed and CIRIA Report C580 provides more detail.

It should be noted that the potential for induced movements of the supported structures will be significantly increased if the method adopted is not well designed and specified. A very high quality of workmanship will be required if the scheme is to be successful and a well-established specialist who has extensive experience with this type of construction must be used to undertake this work. The key to limiting ground movements during construction will be to adopt a robust arrangement of temporary internal bracings/props.

In the permanent case the lateral earth pressures will be supported directly by the piled retaining wall or by a reinforced concrete lining wall cast within the piles. Permanent horizontal support to the wall will be provided by the new ground, lower-ground and basement floor slabs.

Based on the results of this investigation and previous experience in comparable ground the following table of coefficients may be used for the design of the basement retaining wall:

Stratum	Bulk density [Mg/m^3]	Effective cohesion, c' [kN/m^2]	Effective friction angle, ϕ' [degrees]
Made ground	1.80	0	23
London Clay:			
<5m embedment below basement level	2.00	0	22
>5m embedment below basement level	2.00	5	22

The wall designer should use these parameters to derive the active and passive earth pressure coefficients, Ka and Kp. The determination of appropriate earth pressure coefficients, together with factors such as the pattern of earth pressure distribution, will depend upon the type/geometry of the wall and the overall design approach.

The piled walls may, of course, also be used to provide vertical load capacity subject to the necessary allowance being made for interaction effects. In areas within the zone of root influence from existing trees, the depth of basement may be beyond the depth of influence, but, nevertheless, some swelling pressures may occur in the future [when desiccated clays re-hydrate], which may affect the retaining wall. It would thus be necessary to ensure that the retaining wall is sufficiently robust to withstand potential future soil swell pressures in any affected area[s].

We recommend that a specialist contractor is consulted to confirm the most appropriate type of wall and to provide the final wall design.

It would be prudent to conduct condition surveys of adjacent structures prior to construction to contest any spurious damage claims arising from construction activities.

In respect to areas that will be constructed in open cut, the sides will need to be battered to a safe temporary angle and then the permanent wall constructed in short panels.

6.2 Piled foundations

For the ground conditions encountered we consider that CFA piles will present the optimum choice. Consideration could also be given to conventional bored piles, although the possibility of inflows from sandy zones within the London Clay/Lambeth Group will need to be taken into account. The plant used will need to be sufficiently powerful to penetrate the occasional claystones that may be encountered within the London Clay. Provisions should also be made for probing and obstruction removal within the made ground prior to piling operations.

Subject to an arboricultural survey, piles may have to be designed to withstand the effects of clay desiccation caused by the trees, either by the use of suitable reinforcement, or by the provision of sleeving through the shrinkage/swelling zone of any affected clays. This will only be at limited locations where buildings are within the zone of influence of the trees - such as along the western side close to the Birkenhead Estate. Any pile caps and ground beams within the zone of influence of trees should be separated from the soil by a suitable void former on both sides and, in the case of ground beams, underneath: assuming a High volume-change potential. The NHBC Standards are the industry standard in this respect and may be used to provide a preliminary assessment of the likely lateral extent and depth of tree root influence.

The following table of coefficients may be used for the design of bored/CFA piles, based upon the measured strength/depth profile included in Appendix A.

Shaft friction

Stratum	Depth	Undrained shear strength [from strength profile]	Ultimate unit shaft friction 'q_s' [incorporates α = 0.50]
Made ground and basement excavation	GL to 6.0m	Ignore	Ignore
London Clay	Below 6.0m depth to 21.5m	Increases linearly from 103kPa at a rate of 7.6kPa/m	Increases linearly from 51.5kPa at a rate of 3.8kPa/m

Notes:

a] Unit shaft friction 'q_s' = α x c_u [where α = 0.50 and c_u is the undrained shear strength from the design line]

b] The α value of 0.5 is based upon 102mm diameter triaxial compression tests and this should not be varied

c] The average shaft friction over the pile length should be limited to 110kPa

d] The maximum value for unit shaft friction should be limited to 140kPa

End bearing

Stratum	Depth	Undrained shear strength [from strength profile]	Ultimate unit base resistance 'q_b' [incorporates N_c = 9]
London Clay	Below 12.0m depth	Increases linearly from 148kPa at a rate of 7.6kPa/m	Increases linearly from 1,332kPa at a rate of 68kPa/m

Notes:

a] Unit base resistance 'q_b' = N_c x c_u [where N_c = 9 and c_u is the equivalent undrained shear strength from the design line]

An overall Factor of Safety of 2.6 should be appropriate when applied to these ultimate parameters, in line with the current guidelines by the London District Surveyors Association [LDSA]. As a guide to the use of the above coefficients, we have calculated the following capacities for various single piles of various lengths and diameters:

Pile diameter [mm]	Pile length [m]	Pile toe level [mOD]	Ultimate load [kN]	Working load [kN]
450	12	+1.10	745	285
	14	-0.90	985	380
	16	-2.90	1250	480
	18	-4.90	1535	590
600	12	+1.10	1085	420
	14	-0.90	1420	545
	16	-2.90	1780	685
	18	-4.90	2170	835
750	12	+1.10	1475	570
	14	-0.90	1905	730
	16	-2.90	2365	910
	18	-4.90	2865	1100

Notes:

a] Working load is calculated using F_{shaft} and F_{base} = 2.6

b] Concrete stress should be considered in the final design

c] Pile length measured from top of pile at 6.0m bGL

These examples are for illustration purposes only and are not intended to constitute recommendations as to the final diameter or length of pile to be adopted. The working load settlement of the piles will vary depending on the pile diameter and loads. This should be checked by analysis for final design by the piling contractor.

Eurocode 7 adopts a slightly different approach, applying partial factors to the ultimate pile capacity in accordance with EC7 [BS EN 1997-1:2004 and UK National Annex] for the ultimate limit state GEO Design Approach 1, Combinations 1 and 2. The following partial factors, as recommended in the UK National Annex, are applied:

a] Model Factor, γ_{Rd} = 1.4 [Combinations 1 and 2]

b] Factor on shaft resistance, γ_s = 1.6 [Combination 2]

c] Factor on base resistance, γ_b = 2.0 [Combination 2]

When designing to EC7, the engineer must ensure that the correct comparisons are made between the Design Actions and Design Resistances. Whilst the partial factors address ULS design, serviceability limit checks should also be carried out.

If a comprehensive pile test programme, which includes preliminary tests, is initiated it will be possible to use lower factors and increase the pile working capacities. We recommend that a specialist contractor is consulted at an early stage to assist in the development of an appropriate test strategy and to provide the final pile design.

6.3 Spread/raft foundations

The new excavation is likely to be between about 4.4m to 6.5m deep, with excavation for the LGF around +14.69mOD and for the basement around +12.45mOD. It may be possible to adopt spread foundations at basement/lower ground-floor level and any such foundations would probably comprise either discrete pads/strips or, more probably, reinforced thickenings within the basement slab. Moderate sized strip or pad foundations [say up to 2.5m width], founded in the medium strength London Clay Formation may be designed at an allowable bearing pressure of up to 150kPa, at which pressure the Factor of Safety against bearing capacity failure should be >3 and settlements should remain within tolerable limits. We note that low strength clays were, however, identified by HESI, locally [not recorded in the SCL boreholes], and if these are encountered at formation level then reduced bearing pressures would apply, or the low strength material will require removal and replacement with compacted coarse-grained fill.

If the layout and configuration of the new loads permit, a reinforced concrete basement raft could be considered as an alternative, subject to assessment of settlements once the load distribution is known.

Whilst no special precautions are likely to be required with respect to tree root growth and desiccation at basement floor level [as this is highly likely to be below the depth of root influence], in accordance with good construction practice careful inspection of the formation should be carried out and, if any root-infested clay soils are encountered at formation level, these should be removed and replaced with compacted coarse-grained fill.

Potential heave should, of course, be considered in the design, as discussed below.

6.4 Basement Slab [non-raft], Ground Movements and Heave/Uplift Pressures

Basement excavation will cause an unloading of the strata at basement level [about 120kPa for a 6.0m deep excavation]. This stress reduction will, theoretically, result in an element of heave in the London Clay that underlies the site, with factors such as the length of the construction programme and the basement slab stiffness determining the amount of heave that will occur. The potential long term effect of this heave in the clay soils as they recover should be considered during slab design.

The slab could be designed as a fully suspended structure, supported on the main foundations, and incorporating an effective void beneath to accommodate future heave movement.

We have carried out a preliminary analysis and this indicates that a total unrestrained heave of approximately 80mm could occur as a result of the unloading. Approximately 50% of this heave movement is likely to occur during a typical construction programme, leaving a maximum possible post-construction heave of about 40mm to be accommodated. In reality ground movements may be somewhat lower than indicated due to sand beds/hard strata, and so on, within the Lambeth Group, however, the indicated ground response is useful as an upper-bound estimate.

Alternatively, the slab could be ground-bearing and designed to withstand potential heave forces/ movements. If it is [reasonably] assumed that the relationship between heave movement and pressure is linear, the maximum heave pressure for an infinitely stiff slab could, therefore, be about 60kPa for the fully constrained condition. However, this may not occur in reality and the heave pressure beneath a more flexible slab will clearly be less [due stress dissipation as the slab deflects]; we anticipate that an 'average' stiffness slab would experience heave pressures of about 30kPa, with 20mm upward heave movement.

It will also be necessary to consider uplift of the slab due to potential hydrostatic pressures and in this respect the guidelines incorporated in BS8102:2009 [and any relevant Eurocode] should be followed, as appropriate. Whilst ground-water was not encountered in the boreholes, the slab design will need to take account of long term levels, potential seasonal fluctuations and/or accidental and flood conditions. Some engineering judgement will be required in deciding the design water level as this will be influenced by the geology, construction techniques and perceived risk. The safe, default position will be to assume a water level at, say, 1m below ground level, reflecting a relatively conservative condition. It MAY be possible to justify a lower permanent design ground-water level if the design reduces or eliminates the likelihood of ground-water flowing to the underside of the slab. Construction techniques that leave permeable zones and potential flow paths could, clearly, result in a relatively high risk of hydrostatic pressures developing underneath the slab. If the designer is confident that the risk of water flowing beneath the slab is low, then it MAY be possible to adopt a lower design water level; such an approach should be agreed with the local regulatory authority and should ensure the risk to the property [and surrounding structures] is suitably low.

It is important to note that the water pressures will not be additional to any soil heave pressures, but will be the minimum uplift pressure for design purposes. This is due to the fact that our model assumes hydrostatic conditions, uses total stresses throughout and includes the water pressure in the uplift pressures/stresses.

The design of the new basement floor slabs must ensure that potential uplift forces caused by any ground-water and/or soil heave are adequately addressed. Detailed analysis of the potential basement heave, pile tension and effects on adjacent structures is outside the scope of this interpretative report. These issues should be addressed when the final pile layout and configuration is known and the loading calculations for the existing building have been completed.

For a ground-bearing slab, the formation must be inspected, with any desiccated or root-infested clay removed and replaced with well-compacted coarse-grained fill.

6.5 Soakaways

The London Clay deposits that underlie the site are an unsuitable medium for accepting soakaways and a piped system of surface water disposal will have to be considered.

6.6 Foundation concrete

For the proposed development two situations are likely as regards aggression to buried concrete: concrete in contact with the existing made ground, and buried concrete entirely within natural soils.

For the first case [in contact with made ground], moderately high levels of soluble sulphates and neutral to alkaline pH values were measured in selected soil and ground-water samples. The sulphate results fall into Site Design Classes DS-2 to DS-3 of Table C2 given in BRE Special Digest 1 [2005]. We assess the made ground as having 'mobile' ground water and recommend that buried concrete is designed in accordance with ACEC Site Class AC-3.

For the natural soils, low to moderate levels of soluble sulphates and near-neutral to alkaline pH values were measured in selected soil samples. The sulphate results fall into Site Design Class DS-1 to DS-2 of Table C2 given in BRE Special Digest 1 [2005]. We assess the natural soils beneath the site as having 'static' ground-water and recommend that buried concrete placed entirely within the London Clay and/or Lambeth Group is designed in accordance with ACEC Site Class AC-1s.

GENERAL INFORMATION, LIMITATIONS AND EXCEPTIONS

Unless otherwise stated, our Report should be construed as being a Ground Investigation Report [GIR] as defined in BS EN1997-2. Our Report is not intended to be and should not be viewed or treated as a Geotechnical Design Report [GDR] as defined in EN1997-2. Any 'design' recommendations which are provided are for guidance only and are intended to allow the designer to assess the results and implications of our investigation/testing and to permit preliminary design of relevant elements of the proposed scheme.

The methods of investigation used have been chosen taking into account the constraints of the site including but not limited to access and space limitations. Where it has not been possible to reasonably use an EC7 compliant investigation technique we have adopted a practical technique to obtain indicative soil parameters and any interpretation is based upon our engineering experience and relevant published information.

The Report is issued on the condition that Soil Consultants Ltd will under no circumstances be liable for any loss arising directly or indirectly from ground conditions between the exploratory points which differ from those identified during our investigation. In addition Soil Consultants Ltd will not be liable for any loss arising directly or indirectly from any opinion given on the possible configuration of strata both between the exploratory points and/or below the maximum depth of the investigation; such opinions, where given, are for guidance only and no liability can be accepted as to their accuracy. The results of any measurements taken may vary spatially or with time and further confirmatory measurements should be made after any significant delay in using this Report.

Comments made relating to ground-water or ground-gas are based upon observations made during our investigation unless otherwise stated. Ground-water and ground-gas conditions may vary with time from those reported due to factors such as seasonal effects, atmospheric effects and and/or tidal conditions. We recommend that if monitoring installations have been included as part of our investigation, continued monitoring should be carried out to maximise the information gained.

Specific geotechnical features/hazards such as [but not limited to] areas of root-related desiccation and dissolution features in chalk/soluble rock can exist in discrete localised areas - there can be no certainty that any or all of such features/hazards have been located, sampled or identified. Where a risk is identified the designer should provide appropriate contingencies to mitigate the risk through additional exploratory work and/or an engineered solution.

Where a specific risk of ground dissolution features has been identified in our Report [anything above a 'low' risk rating], reference should be made to the local building control to establish whether there are any specific local requirements for foundation design and appropriate allowances should be incorporated into the design. If such a risk assessment was not within the scope of our investigation and where it is deemed that the ground sequence may give rise to such a risk [for example near-surface chalk strata] it is recommended that an appropriate assessment should be undertaken prior to design of foundations.

Where spread foundations are used, we recommend that all excavations are inspected and approved by suitably experienced personnel; appropriate inspection records should be kept. This should also apply to any structures which are in direct contact with the soil where the soil could have a detrimental effect on performance or integrity of the structure.

Ground contamination often exists in small discrete areas - there can be no certainty that any or all such areas have been located, sampled or identified.

The findings and opinions conveyed in this Report may be based on information from a variety of sources such as previous desk studies, investigations or chemical analyses. Soil Consultants Limited cannot and does not provide any guarantee as to the authenticity, accuracy or reliability of such information from third parties; such information has not been independently verified unless stated in our Report.

Our Report is written in the context of an agreed scope of work between Soil Consultants Ltd and the Client and should not be used in any different context. In light of additional information becoming available, improved practices and changes in legislation, amendment or re-interpretation of the assessment or the Report in part or in whole may be necessary after its original publication.

Unless otherwise stated our investigation does not include an arboricultural survey, asbestos survey, ecological survey or flood risk assessment and these should be deemed to be outside the scope of our investigation.

[Rev_1_08_03_2013]

APPENDIX A

Fieldwork, in-situ testing and monitoring

- Borehole records
- Standard Penetration Test results
- Standard Penetration Test equipment calibration certificate
- Gas and ground-water monitoring record

Laboratory testing

- Index property testing
- Plasticity charts
- Unconsolidated undrained triaxial compression test results
- Soil soluble Sulphate/pH results [QTS Environmental]

Ground profiles

- Plot of SPT 'N_{60}' value and undrained shear strength against depth
- Cross sections through boreholes

Plans & drawings

- Proposed development plans
- Site Plan
- Location Maps

Site & Location:	**277A Gray's Inn Road, London WC1X 8QF**	Borehole No:	**BH101**
Client:	**Regal Homes Ltd**	Coordinates: 530425E, 182890N	Sheet 1 of 3
Engineer:	**Pringuer-James Consulting Engineers Ltd**	Ground Level: +17.90mOD	Report No: 9708/MC

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH commenced: 04/03/2015				0.10	17.80		MADE GROUND: Granite paving setts. [Description from driller's log]	
BH casing diameter: 150mm				0.25	17.65		MADE GROUND: Reinforced concrete slab. [Description from driller's log]	
Inspection pit to 1.20m	D	1.00					MADE GROUND: Soft, dark green-grey and dark grey, slightly gravelly, slightly sandy, clay, with occasional small pockets of sand. Gravel is of flint and fragments of concrete.	1
				1.20	16.70		MADE GROUND: Firm, brown, slightly gravelly clay. Gravel is fragments of brick.	
				1.70	16.20		Firm, becoming stiff below 2.5m, and very stiff below 4.5m, fissured, thinly laminated, brown and orange-brown, thinly veined blue-grey CLAY, with occasional selenite. Some orange-brown gleying on fissure planes.	
	D	2.00						2
Casing depth: 2.50m								
	D	3.00						3
	D	4.00						4
	D	5.00						5
	D	6.00						6
				6.60	11.30		Very stiff, thinly laminated, fissured, dark grey-brown CLAY, with rare small pockets of light grey-brown silt.	
	D	7.00						7
Chiselling of claystone from 7.60m to 7.90m [0.5 hours]							*...light brown claystone between 7.60m and 7.90m*	
				7.90	10.00		Very stiff, sparsely fissured, dark grey-brown, slightly sandy CLAY, with occasional small pockets of silt, rare pyrite nodules and rare carbonaceous matter.	
	D	8.00						8
	D	9.00						9
	D	10.00		10.00	7.90			10
							Continued on next sheet	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone HV = Hand Vane [kPa]
PP = Pocket Penetrometer [kg/cm²] PID = Photo Ionisation Detector [ppmv] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: Approximate coordinates interpolated from public domain data.
Approximate Ground Level interpolated from Pringuer-James drawing (ref. L1706-03_01, dated May 2014).

Borehole No: **BH101**

Site & Location:	**277A Gray's Inn Road, London WC1X 8QF**	Borehole No:	**BH101**
Client:	**Regal Homes Ltd**	Coordinates: 530425E, 182890N	Sheet 2 of 3
Engineer:	**Pringuer-James Consulting Engineers Ltd**	Ground Level: +17.90mOD	Report No: 9708/MC

Progress & Observations	Samples & Tests Type	Samples & Tests Depth (m)	Field Test Results	Strata Depth (m)	Strata Level (m)	Legend	Strata Descriptions	Backfill / Installation
							Very stiff, sparsely fissured, dark grey-brown, slightly sandy CLAY, with occasional small pockets of silt, rare pyrite nodules and rare carbonaceous matter.	
	D	11.00						11
	D	12.00						12
	D	13.00						13
	D	14.00						14
	U	15.00						15
	D	15.45						16
	D SPT/S	16.50 16.50	N=30 N_{60}=38					17
	D	17.25						
	U	18.00						18
	D	18.45						19
	D SPT/S	19.50 19.50	N=33 N_{60}=42					
				20.00	-2.10			20
							Continued on next sheet	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone HV = Hand Vane [kPa]
PP = Pocket Penetrometer [kg/cm²] PID = Photo Ionisation Detector [ppmv] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: Approximate coordinates interpolated from public domain data.
Approximate Ground Level interpolated from Pringuer-James drawing (ref. L1706-03_01, dated May 2014).

Borehole No: **BH101**

Site & Location:	**277A Gray's Inn Road, London WC1X 8QF**	Borehole No:	**BH101**
Client:	**Regal Homes Ltd**	Coordinates: 530425E, 182890N	Sheet 3 of 3
Engineer:	**Pringuer-James Consulting Engineers Ltd**	Ground Level: +17.90mOD	Report No: 9708/MC

Progress & Observations	Samples & Tests Type	Samples & Tests Depth (m)	Field Test Results	Strata Depth (m)	Strata Level (m)	Legend	Strata Descriptions	Backfill / Installation
	D	20.25					Very stiff, sparsely fissured, dark grey-brown, slightly sandy CLAY, with occasional small pockets of silt, rare pyrite nodules and rare carbonaceous matter.	
				20.90	-3.00			
	U	21.00					Very stiff, very closely fissured, locally slickensided, variegated red-brown, orange-brown, brown and blue-grey, CLAY. Locally thinly laminated, locally bioturbated.	
	D	21.40						
	D	22.50						
	SPT/S	22.50	N=50 N_{60}=63					
	D	23.00						
	U	23.50						
	D	23.90						
	D	24.50						
	SPT/S	24.50	N>50*					
BH complete: 04/03/2015 BH depth: 25.00m Casing depth: 2.50m Water depth: Dry				25.00	-7.10		End of borehole at 25.00m	

21 22 23 24 25 26 27 28 29 30

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone HV = Hand Vane [kPa]
PP = Pocket Penetrometer [kg/cm²] PID = Photo Ionisation Detector [ppmv] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: Approximate coordinates interpolated from public domain data.
Approximate Ground Level interpolated from Pringuer-James drawing (ref. L1706-03_01, dated May 2014).

Borehole No: **BH101**

Site & Location:	**277A Gray's Inn Road, London WC1X 8QF**	Borehole No:	**BH102**
Client:	**Regal Homes Ltd**	Coordinates: 530448E, 182853N	Sheet 1 of 3
Engineer:	**Pringuer-James Consulting Engineers Ltd**	Ground Level: +19.10mOD	Report No: 9708/MC

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH commenced: 02/03/2015				0.25	18.85		MADE GROUND: Concrete slab. [Description from driller's log]	
BH casing diameter: 150mm							MADE GROUND: Soft, brown and orange-brown, slightly gravelly, slightly sandy, silty clay. Gravel is of flint, brick and concrete.	
Inspection pit to 1.20m	D	1.00						
				1.70	17.40		MADE GROUND: Firm, brown, slightly gravelly clay. Gravel is fragments of brick.	
Casing depth: 2.00m	D	2.00						
				2.70	16.40		Stiff, becoming very stiff below 5.0m, fissured, thinly laminated, brown and orange-brown, thinly veined blue-grey CLAY, with occasional selenite. Some orange-brown gleying on fissure planes.	
	U	3.00						
	D	3.50						
	D	4.00						
	SPT/S	4.00	N=17 N_{60}=22					
	D	4.50						
	U	5.00						
	D	5.50						
				6.30	12.80		Very stiff, thinly laminated, fissured, dark grey-brown CLAY, with rare small pockets of light grey-brown silt.	
	D	6.50						
	SPT/S	6.50	N=17 N_{60}=22					
	D	7.25						
	U	8.00						
	D	8.50						
	D	9.50						
	SPT/S	9.50	N=23 N_{60}=29					
				10.00	9.10		Continued on next sheet	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone HV = Hand Vane [kPa]
PP = Pocket Penetrometer [kg/cm²] PID = Photo Ionisation Detector [ppmv] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: 50mm diameter standpipe with gas tap installed on completion.
Approximate coordinates interpolated from public domain data.
Approximate Ground Level interpolated from Pringuer-James drawing (ref. L1706-03_01, dated May 2014).

Borehole No: **BH102**

Soil Consultants

Site & Location:	**277A Gray's Inn Road, London WC1X 8QF**	Borehole No:	**BH102**
Client:	**Regal Homes Ltd**	Coordinates: 530448E, 182853N	Sheet 2 of 3
Engineer:	**Pringuer-James Consulting Engineers Ltd**	Ground Level: +19.10mOD	Report No: 9708/MC

Progress & Observations	Samples & Tests Type	Samples & Tests Depth (m)	Field Test Results	Strata Depth (m)	Strata Level (m)	Legend	Strata Descriptions	Backfill / Installation
	D	10.25					Very stiff, sparsely fissured, dark grey-brown, slightly sandy CLAY, with occasional small pockets of silt, rare pyrite nodules and rare carbonaceous matter.	
	U	11.00						11
	D	11.50						
								12
	D	12.50						
	SPT/S	12.50	N=26 N_{60}=33					
								13
	D	13.25						
	U	14.00						14
	D	14.50						
								15
	D	15.50						
	SPT/S	15.50	N=27 N_{60}=34					
								16
	D	16.25						
	U	17.00						17
	D	17.50						
								18
	D	18.50						
	SPT/S	18.50	N=35 N_{60}=44					
								19
	D	19.25						
	U	20.00		20.00	-0.90			20
							Continued on next sheet	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone HV = Hand Vane [kPa]
PP = Pocket Penetrometer [kg/cm²] PID = Photo Ionisation Detector [ppmv] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: 50mm diameter standpipe with gas tap installed on completion.
Approximate coordinates interpolated from public domain data.
Approximate Ground Level interpolated from Pringuer-James drawing (ref. L1706-03_01, dated May 2014).

Borehole No: **BH102**

Site & Location:	**277A Gray's Inn Road, London WC1X 8QF**	Borehole No:	**BH102**
Client:	**Regal Homes Ltd**	Coordinates: 530448E, 182853N	Sheet 3 of 3
Engineer:	**Pringuer-James Consulting Engineers Ltd**	Ground Level: +19.10mOD	Report No: 9708/MC

Progress & Observations	Samples & Tests Type	Samples & Tests Depth (m)	Field Test Results	Strata Depth (m)	Strata Level (m)	Legend	Strata Descriptions	Backfill / Installation
	D	20.50					Very stiff, sparsely fissured, dark grey-brown, slightly sandy CLAY, with occasional small pockets of silt, rare pyrite nodules and rare carbonaceous matter.	
	D	21.50		21.40	-2.30			
	SPT/S	21.50	N=44 N_{60}=56				Very stiff, very closely fissured, locally slickensided, variegated red-brown, orange-brown, brown and blue-grey, CLAY. Locally thinly laminated, locally bioturbated.	
	D	22.25						
	U	23.00						
	D	23.50						
	D	24.50						
	SPT/S	24.50	N>50*					
BH complete: 03/03/2015 BH depth: 25.00m Casing depth: 2.00m Water depth: Dry				25.00	-5.90		End of borehole at 25.00m	

21 22 23 24 25 26 27 28 29 30

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone HV = Hand Vane [kPa]
PP = Pocket Penetrometer [kg/cm²] PID = Photo Ionisation Detector [ppmv] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: 50mm diameter standpipe with gas tap installed on completion.
Approximate coordinates interpolated from public domain data.
Approximate Ground Level interpolated from Pringuer-James drawing (ref. L1706-03_01, dated May 2014).

Borehole No: **BH102**

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Site & Location:	**277A Gray's Inn Road, London WC1X 8QF**	Borehole No:	**BH103**
Client:	**Regal Homes Ltd**	Coordinates: 530478E, 182807N	Sheet 1 of 3
Engineer:	**Pringuer-James Consulting Engineers Ltd**	Ground Level: +19.10mOD	Report No: 9708/MC

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH commenced: 27/02/2015				0.20	18.90		MADE GROUND: Reinforced concrete slab. [Description from driller's log]	
BH casing diameter: 150mm							MADE GROUND: Soft, brown and orange-brown, slightly gravelly, slightly sandy, silty clay. Gravel is of flint, brick and concrete.	
Inspection pit to 1.20m	D	1.00						
Casing depth: 2.00m	D	2.00						
	D	3.00						
	D	3.50		3.40	15.70		MADE GROUND: Firm, brown, slightly gravelly clay. Gravel is fragments of brick. [Description from driller's log]	
				3.60	15.50		Stiff, becoming very stiff below 5.0m, fissured, thinly laminated, brown and orange-brown, thinly veined blue-grey CLAY, with occasional selenite. Some orange-brown gleying on fissure planes.	
	D	4.50						
	D	5.50						
				5.70	13.40		Very stiff, thinly laminated, fissured, dark grey-brown CLAY, with rare small pockets of light grey-brown silt.	
	D	6.50						
	D	7.50						
				7.70	11.40		Very stiff, sparsely fissured, dark grey-brown, slightly sandy CLAY, with occasional small pockets of silt, rare pyrite nodules and rare carbonaceous matter.	
	D	8.50						
	D	9.50						
				10.00	9.10		Continued on next sheet	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone HV = Hand Vane [kPa]
PP = Pocket Penetrometer [kg/cm²] PID = Photo Ionisation Detector [ppmv] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: Approximate coordinates interpolated from public domain data.
Approximate Ground Level interpolated from Pringuer-James drawing (ref. L1706-03_01, dated May 2014).

Borehole No: **BH103**

Site & Location:	**277A Gray's Inn Road, London WC1X 8QF**	Borehole No:	**BH103**
Client:	**Regal Homes Ltd**	Coordinates: 530478E, 182807N	Sheet 2 of 3
Engineer:	**Pringuer-James Consulting Engineers Ltd**	Ground Level: +19.10mOD	Report No: 9708/MC

Progress & Observations	Samples & Tests Type	Samples & Tests Depth (m)	Field Test Results	Strata Depth (m)	Strata Level (m)	Legend	Strata Descriptions	Backfill / Installation
							Very stiff, sparsely fissured, dark grey-brown, slightly sandy CLAY, with occasional small pockets of silt, rare pyrite nodules and rare carbonaceous matter.	
	D	10.50						
	D	11.50						
	D	12.50						
	D	13.50						
Ground-water strike at 14.50m depth - seepage, no rise	D	14.50						
	U	15.00						
	D	15.50						
	D	16.50						
	SPT/S	16.50	N=27 N_{60}=34					
	D	17.25						
	U	18.00						
	D	18.50						
	D	19.50						
	SPT/S	19.50	N=29 N_{60}=37					
				20.00	-0.90			
							Continued on next sheet	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone HV = Hand Vane [kPa]
PP = Pocket Penetrometer [kg/cm²] PID = Photo Ionisation Detector [ppmv] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: Approximate coordinates interpolated from public domain data.
Approximate Ground Level interpolated from Pringuer-James drawing (ref. L1706-03_01, dated May 2014).

Borehole No: **BH103**

Site & Location:	**277A Gray's Inn Road, London WC1X 8QF**	Borehole No:	**BH103**
Client:	**Regal Homes Ltd**	Coordinates: 530478E, 182807N	Sheet 3 of 3
Engineer:	**Pringuer-James Consulting Engineers Ltd**	Ground Level: +19.10mOD	Report No: 9708/MC

Progress & Observations	Samples & Tests Type	Samples & Tests Depth (m)	Field Test Results	Strata Depth (m)	Strata Level (m)	Legend	Strata Descriptions	Backfill / Installation
	D	20.25					Very stiff, sparsely fissured, dark grey-brown, slightly sandy CLAY, with occasional small pockets of silt, rare pyrite nodules and rare carbonaceous matter.	
	U	21.00						
	D	21.50		21.50	-2.40		Very stiff, very closely fissured, locally slickensided, variegated red-brown, orange-brown, brown and blue-grey, CLAY. Locally thinly laminated, locally bioturbated.	
	D	22.50						
	SPT/S	22.50	N=48 N_{60}=61					
	D	23.25						
	U	23.50						
	D	24.00						
	D	24.50						
	SPT/S	24.50	N=54 N_{60}=68					
BH complete: 28/02/2015 BH depth: 25.00m Casing depth: 2.00m Water depth: Dry				25.00	-5.90		End of borehole at 25.00m	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone HV = Hand Vane [kPa]
PP = Pocket Penetrometer [kg/cm²] PID = Photo Ionisation Detector [ppmv] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: Approximate coordinates interpolated from public domain data.
Approximate Ground Level interpolated from Pringuer-James drawing (ref. L1706-03_01, dated May 2014).

Borehole No: **BH103**

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Site & Location	**227A Grays Inn Road, London WC1X 8QF**	Report No:	**9708/MC**

STANDARD PENETRATION TEST SUMMARY

BH ID	Depth [m]	Test type	'N' value and blow-counts [Seating blows/Test blows]	N_{60}	N_{60} - ext	Casing depth [m]	Water depth [m]	Remarks
BH101	16.50	S	N = 30 :5 6/ 7 7 8 8	38		2.50	Dry	
	19.50	S	N = 33 :5 5/ 7 8 9 9	42		2.50	Dry	
	22.50	S	N = 50 :6 8/ 11 12 14 13	63		2.50	Dry	
	24.50	S	50 :7 9/ 10 13 16 11 for 30mm	>63*	75**	2.50	Dry	
BH102	4.00	S	N = 17 :2 2/ 3 4 5 5	22		2.00	Dry	
	6.50	S	N = 17 :2 3/ 3 4 5 5	22		2.00	Dry	
	9.50	S	N = 23 :3 3/ 5 5 6 7	29		2.00	Dry	
	12.50	S	N = 26 :3 4/ 5 6 7 8	33		2.00	Dry	
	15.50	S	N = 27 :4 5/ 5 6 7 9	34		2.00	Dry	
	18.50	S	N = 35 :5 6/ 7 9 9 10	44		2.00	Dry	
	21.50	S	N = 44 :6 8/ 9 11 12 12	56		2.00	Dry	
	24.50	S	50 :8 10/ 12 13 15 10 for 60mm	>63*	70**	2.00	Dry	
BH103	16.50	S	N = 27 :3 5/ 6 6 7 8	34		2.00	Dry	
	19.50	S	N = 29 :4 6/ 6 8 7 8	37		2.00	Dry	
	22.50	S	N = 48 :6 7/ 9 10 12 17	61		2.00	Dry	
	24.50	S	N = 54 :7 8/ 10 12 15 17	68		2.00	Dry	

Standard Penetration Test : BS EN ISO 22476:2005 Part 3 Hammer Energy Ratio, Er = 76%

* where full penetration not achieved, the reported N_{60} is based on maximum uncorrected blow-counts of 50

** extrapolated N_{60} value where full penetration not achieved - this is indicative only and should be used with caution

Soil Consultants

Southern Testing
Environmental & Geotechnical

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Southern Testing
Keeble House
Stuart Way
East Grinstead
West Sussex
RH19 4QA

SPT Hammer Ref:	DW1
Test Date:	25/09/2014
Report Date:	25/09/2014
File Name:	DW1.spt
Test Operator:	NPB

Instrumented Rod Data

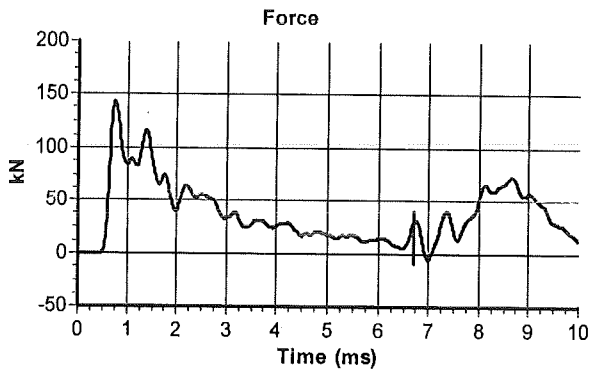
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.6
Assumed Modulus E_a (GPa):	208
Accelerometer No.1:	6458
Accelerometer No.2:	6459

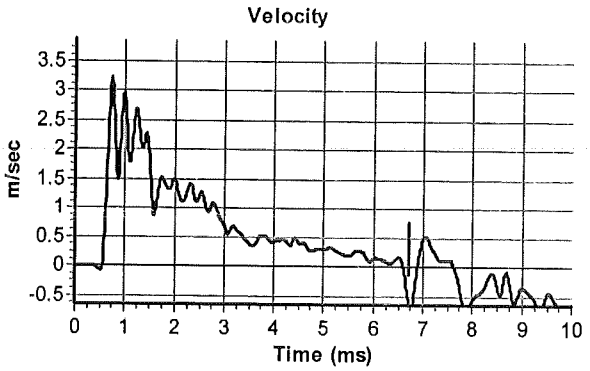
SPT Hammer Information

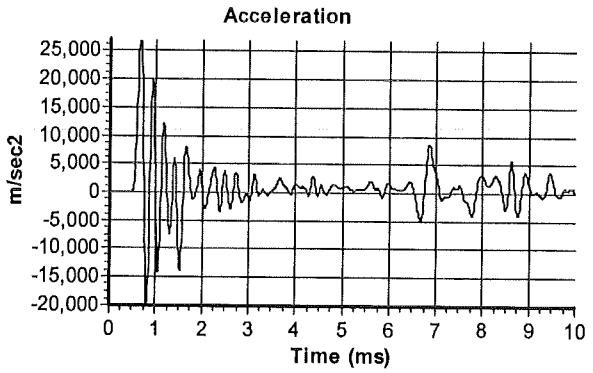
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	14.5

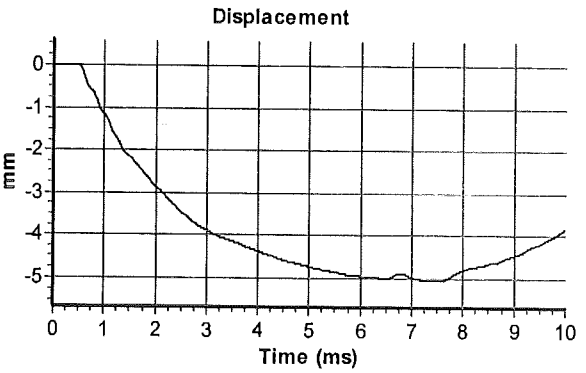
Comments / Location

Charlwoods Road









Calculations

Area of Rod A (mm2):	983
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	360

Energy Ratio E_r (%): **76**

N P Burrows

Signed: N P Burrows

Title: Field Operations Manager

The recommended calibration interval is 12 months

Site	277A Gray's Inn Road	Report No:	9708/MC
Location	London WC1X 8QF		

SUMMARY OF GROUND-WATER/GAS MONITORING RESULTS

Date:	25/03/15	Ambient air temperature [0C]:	8
Time:	AM	Barometric pressure [mB]:	1016
Equipment:	GA2000 Plus MC08/0126/00	Barometric trend:	Rising
Recorded by:	MR	Weather conditions:	Damp and overcast

Ground-water monitoring

Hole ID	Ground level [mOD/SD]	Water depth [m]	Water level [mOD/SD]	Depth of pipe base [m]	Remarks
BHD		dry		11.00	
BHE		dry		11.00	

Gas monitoring

Hole ID	CH4 [%]		CO2 [%]		O2 [%]		Peak [ppmv]		Flow [l/min]	Emission rate [l/hr]	Remarks
	Max	Steady	Max	Steady	Min	Steady	CO	H_2S			
BHD	0.1	0.1	0.1	0.1	20.6	20.6	0.0	0.0	0.0	0.0	
BHE	0.1	0.1	0.9	0.9	19.6	19.6	0.0	0.0	0.0	0.0	

Soil Consultants

Site & Location: **277A Grays Inn Road, London WC1X 8QF**

Report No: **9708/MC**

SUMMARY OF CLASSIFICATION TEST RESULTS

BH ID	Depth (m)	Type	w (%)	wL (%)	wP (%)	Pass 425 (%)	IP (%)	Mod IP (%)	IL (%)	LOI (%)	Description
BH101	15.00	U	21								Dark grey-brown, slightly sandy, slightly micaceous, CLAY.
	18.00	U	23	75	29	>95	46		-0.14		Dark grey-brown, slightly sandy, slightly micaceous, CLAY.
	21.00	U	19								Variegated red-brown, orange-brown, brown and blue-grey, CLAY.
	23.50	U	20	59	27	>95	32		-0.23		Variegated red-brown, orange-brown, brown and blue-grey, CLAY.
BH102	3.00	U	28	71	25	>95	46		0.07		Brown and orange-brown, thinly veined blue-grey, slightly micaceous CLAY, with occasional selenite.
	5.00	U	28								Brown and orange-brown, thinly veined blue-grey, slightly micaceous CLAY, with occasional selenite.
	8.00	U	27								Dark grey-brown CLAY.
	11.00	U	23	81	30	>95	51		-0.14		Dark grey-brown, slightly sandy, slightly micaceous, CLAY.
	14.00	U	26								Dark grey-brown, slightly sandy, slightly micaceous, CLAY.
	17.00	U	27	76	30	>95	46		-0.07		Dark grey-brown, slightly sandy, slightly micaceous, CLAY.
	20.00	U	20	46	18	>95	28		0.09		Dark grey-brown, slightly sandy, slightly micaceous, CLAY.
	23.00	U	19								Variegated red-brown, orange-brown, brown and blue-grey, CLAY.
BH103	15.00	U	25	74	26	>95	48		-0.02		Dark grey-brown, slightly sandy, slightly micaceous, CLAY.
	18.00	U	18	66	28	>95	38		-0.26		Dark grey-brown, slightly sandy, slightly micaceous, CLAY.
	21.00	U	21								Dark grey-brown, slightly sandy, slightly micaceous, CLAY.
	23.50	U	18	57	24	>95	33		-0.18		Variegated red-brown, orange-brown, brown and blue-grey, CLAY.

Testing in accordance with BS EN ISO 17892 unless specified otherwise

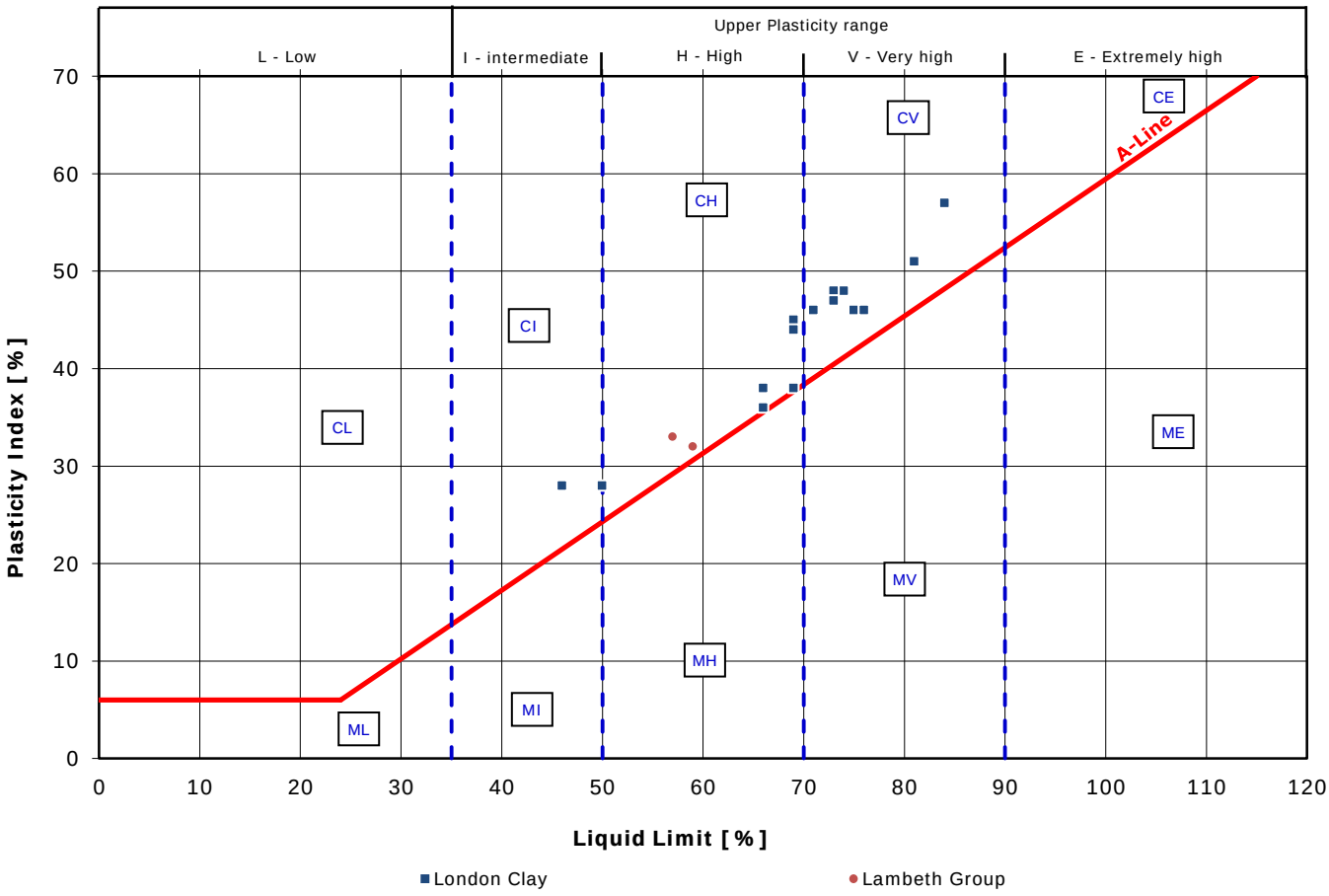
Date: 24 Mar 15

Modified Plasticity Index calculated in accordance with NHBC Standards Chapter 4.2 (reported if %passing 425mm <95%)

Percent passing 425μm: by estimation, by hand* or by sieving**

Site & Location	227A Grays Inn Road, London WC1X 8QF	Report No:	9708/MC

Plasticity Chart



M - SILT [plots below the A-Line]

C - CLAY [plots above the A-Line]

Classification in accordance with BS5930:1999+A2:2010 "Code of practice for site investigations"

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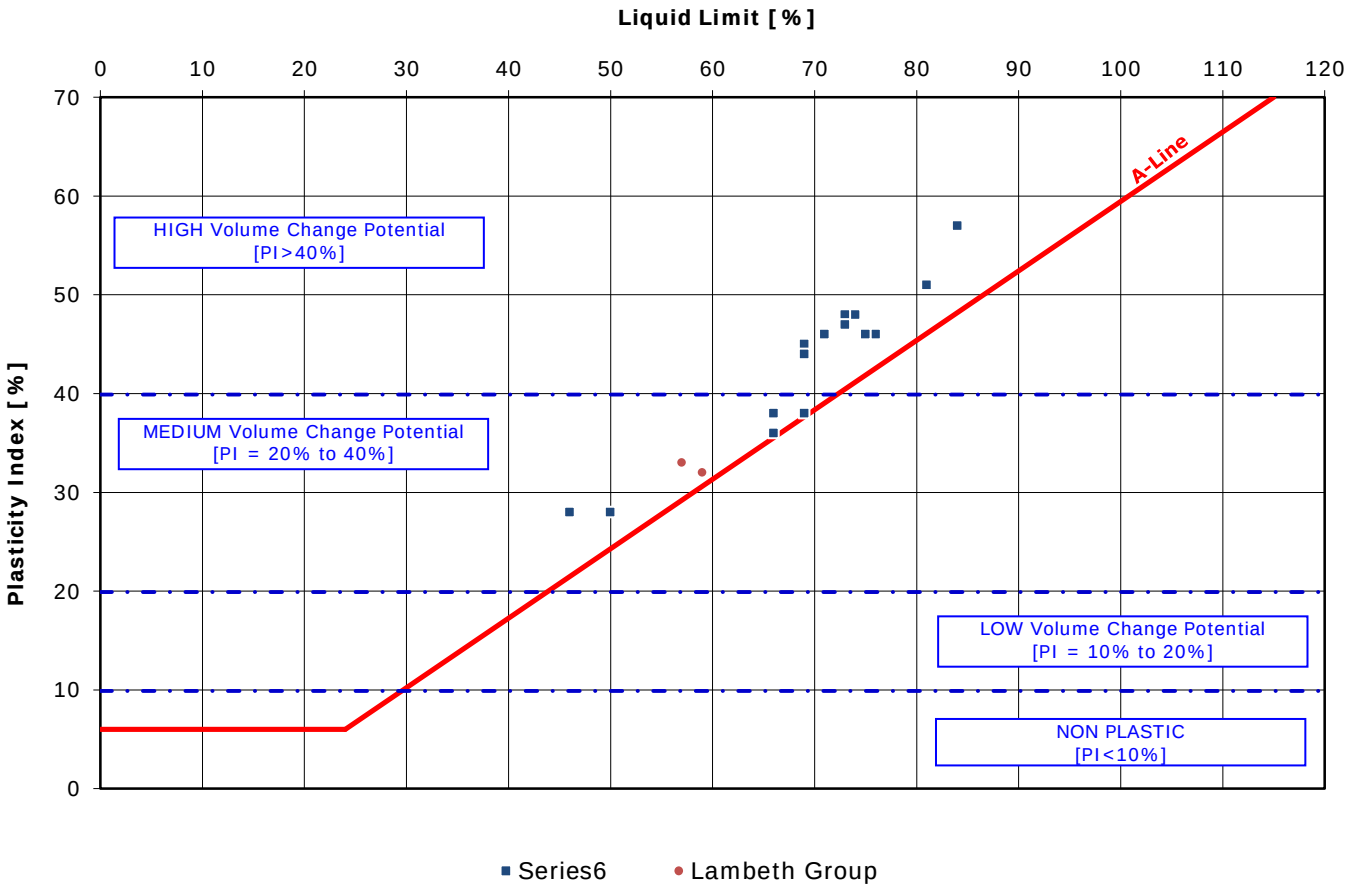
Site & Location	227A Grays Inn Road, London WC1X 8QF	Report No:	9708/MC

Plasticity Chart



Modified Plasticity Index, I'p:

$$I'p = \frac{Ip \times (\%\ \text{passing 425mm})}{100\%}$$

[where Ip = Plasticity Index]

Classification in accordance with NHBC Standards, Part 4 'Foundations', Chapter 4.2 'Building near trees'

Soil Consultants

Site / Location	227A Grays Inn Road, London WC1X 8QF	Report No:	9708/MC

SUMMARY OF UNDRAINED SHEAR STRENGTH TEST RESULTS

BH ID	Depth [m]	Moisture content [%]	Bulk density [Mg/m^3]	Dry density [Mg/m^3]	Cell pressure [kPa]	$(\sigma_1-\sigma_3)_f$ [kPa]	Failure strain [%]	Failure mode	Undrained cohesion [kPa]	Remarks
BH101	15.00	21	2.03	1.68	300	483	4.50	I	242	
	18.00	23	2.04	1.66	360	640	4.50	B	320	
	21.00	19	2.08	1.74	420	804	3.00	B	402	
	23.50	20	2.07	1.73	470	475	3.00	B	238	
BH102	3.00	28	1.88	1.47	100	130	4.00	I	65	
	5.00	28	1.95	1.52	100	218	2.00	B	109	
	8.00	27	1.95	1.54	160	273	3.00	B	137	
	11.00	23	1.99	1.61	220	385	3.00	B	193	
	14.00	26	1.99	1.57	280	301	3.00	B	151	
	17.00	27	1.99	1.57	340	364	3.00	B	182	
	20.00	20	2.04	1.69	400	510	5.50	I	255	
	23.00	19	2.10	1.77	460	733	2.50	B	367	
BH103	15.00	25	2.00	1.60	300	432	4.00	B	216	
	18.00	18	2.06	1.74	360	620	5.00	I	310	
	21.00	21	2.05	1.70	420	784	5.00	B	392	
	23.50	18	2.04	1.73	470	545	5.50	B	273	

Testing in accordance with BS EN ISO 17892 UU = unconsolidated, undrained; MUU = multistage, unconsolidated, ur Date: 24 March 15

Unless stated otherwise: Rate of strain = 2mm/min, Standard latex membrame used with thickness = 0.5mm

Failure modes: B = brittle, I = intermediate, P = plastic

Site & Location: **227A Grays Inn Road, London WC1X 8QF**

Report No: **9708/JRCB**

SUMMARY OF pH & SULPHATE TEST RESULTS

BH ID	Depth (m)	pH	Sulphate 2:1 water-soluble	Sulphate (mg/l)	Total Sulphur (%)	Remarks
TP1	0.90-1.00	7.6	570			QTS Report 14-27306
TP2	0.50-1.80	7.8	1290			
	1.80-2.60	7.9	550			
TP3	0.50-2.00	8.0	760			
TP4	0.30-1.00	7.8	1290			
TP5	0.40-1.10	7.8	1460			
	1.40-2.20	7.9	710			
TP6	0.30-1.10	8.0	1150			
	1.50-2.10	7.7	1260			
TP7	0.60-1.00	9.9	1360			
	1.00-1.70	8.8	840			
TP8	-	8.3	1920			
TP9	-	8.3	1720			
TP10	0.20-2.10	9.0	1430			
	2.40-3.00	8.6	790			
TP13	1.00-1.50	9.0	1210			
BHE	11.10	7.0		1050		QTS Report 14-27324

Date: 07 Apr 15

Soil Consultants

Site & Location: **227A Grays Inn Road, London WC1X 8QF**

Report No: **9708/JRCB**

SUMMARY OF pH & SULPHATE TEST RESULTS

BH ID	Depth (m)	pH	Sulphate 2:1 water-soluble	Sulphate (mg/l)	Total Sulphur (%)	Remarks
BH101	1.00	10.5	390			QTS Report 15-29904
	15.00	7.6	620			QTS Report 15-30147
	23.50	8.8	210			
BH102	1.00	10.9	200			QTS Report 15-29904
	2.00	10.7	430			
	3.50	7.8	100			QTS Report 15-30147
	11.00	7.8	650			
	13.00	8.6	600			
	23.00	8.9	90			
BH103	1.00	10.0	460			QTS Report 15-29904
	2.00	10.9	830			
	3.00	11.0	1260			
	3.50	9.4	1590			
	18.00	7.7	450			QTS Report 15-30147
	23.50	9.1	290			

Date: 07 Apr 15

Soil Consultants

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Soil Consultants Ltd
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Buckinghamshire
HP15 6QT

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

QTS Environmental Report No: 15-30147

Site Reference:	277A Gray's Inn Road, London
Project / Job Ref:	9708/JRCB
Order No:	None Supplied
Sample Receipt Date:	17/03/2015
Sample Scheduled Date:	30/03/2015
Report Issue Number:	1
Reporting Date:	01/04/2015

Authorised by:

Russell Jarvis
Director
On behalf of QTS Environmental Ltd

Authorised by:

Kevin Old
Director
On behalf of QTS Environmental Ltd

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

Soil Analysis Certificate						
QTS Environmental Report No: 15-30147	**Date Sampled**	04/03/15	04/03/15	02/03/15	02/03/15	02/03/15
Soil Consultants Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: 277A Gray's Inn Road, London	**TP / BH No**	BH101	BH101	BH102	BH102	BH102
Project / Job Ref: 9708/JRCB	**Additional Refs**	U	U	U	U	U
Order No: None Supplied	**Depth (m)**	15.00	23.50	3.50	11.00	13.00
Reporting Date: 01/04/2015	**QTSE Sample No**	142605	142606	142607	142608	142609

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	7.6	8.8	7.8	7.8	8.6
W/S Sulphate as SO4 (2:1)	g/l	< 0.01	MCERTS	0.62	0.21	0.10	0.65	0.60

Analytical results are expressed on a dry weight basis where samples are dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis $^{(S)}$

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Lenham Heath
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Soil Analysis Certificate						
QTS Environmental Report No: 15-30147	**Date Sampled**	02/03/15	27/02/15	27/02/15		
Soil Consultants Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied		
Site Reference: 277A Gray's Inn Road, London	**TP / BH No**	BH102	BH103	BH103		
Project / Job Ref: 9708/JRCB	**Additional Refs**	U	U	U		
Order No: None Supplied	**Depth (m)**	23.00	18.00	23.50		
Reporting Date: 01/04/2015	**QTSE Sample No**	142610	142611	142612		

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	8.9	7.7	9.1		
W/S Sulphate as SO4 (2:1)	g/l	< 0.01	MCERTS	0.09	0.45	0.29		

Analytical results are expressed on a dry weight basis where samples are dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis $^{(S)}$

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Rose Lane
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Maidstone
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4480

Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 15-30147	
Soil Consultants Ltd	
Site Reference: 277A Gray's Inn Road, London	
Project / Job Ref: 9708/JRCB	
Order No: None Supplied	
Reporting Date: 01/04/2015	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
$ 142605	BH101	U	15.00	14.7	Grey gravelly clay
$ 142606	BH101	U	23.50	17.2	Grey gravelly clay
$ 142607	BH102	U	3.50	18.9	Light grey clay
$ 142608	BH102	U	11.00	17.5	Grey clay
$ 142609	BH102	U	13.00	19.5	Grey clay
$ 142610	BH102	U	23.00	15.2	Brown clay
$ 142611	BH103	U	18.00	15.4	Grey clay
$ 142612	BH103	U	23.50	14.2	Light grey clay

Moisture content is part of procedure E003 & is not an accredited test
Insufficient Sample I/S
Unsuitable Sample U/S

$ samples exceeded recommended holding times

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Maidstone
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Tel : 01622 850410

4480

Soil Analysis Certificate - Methodology & Miscellaneous Information

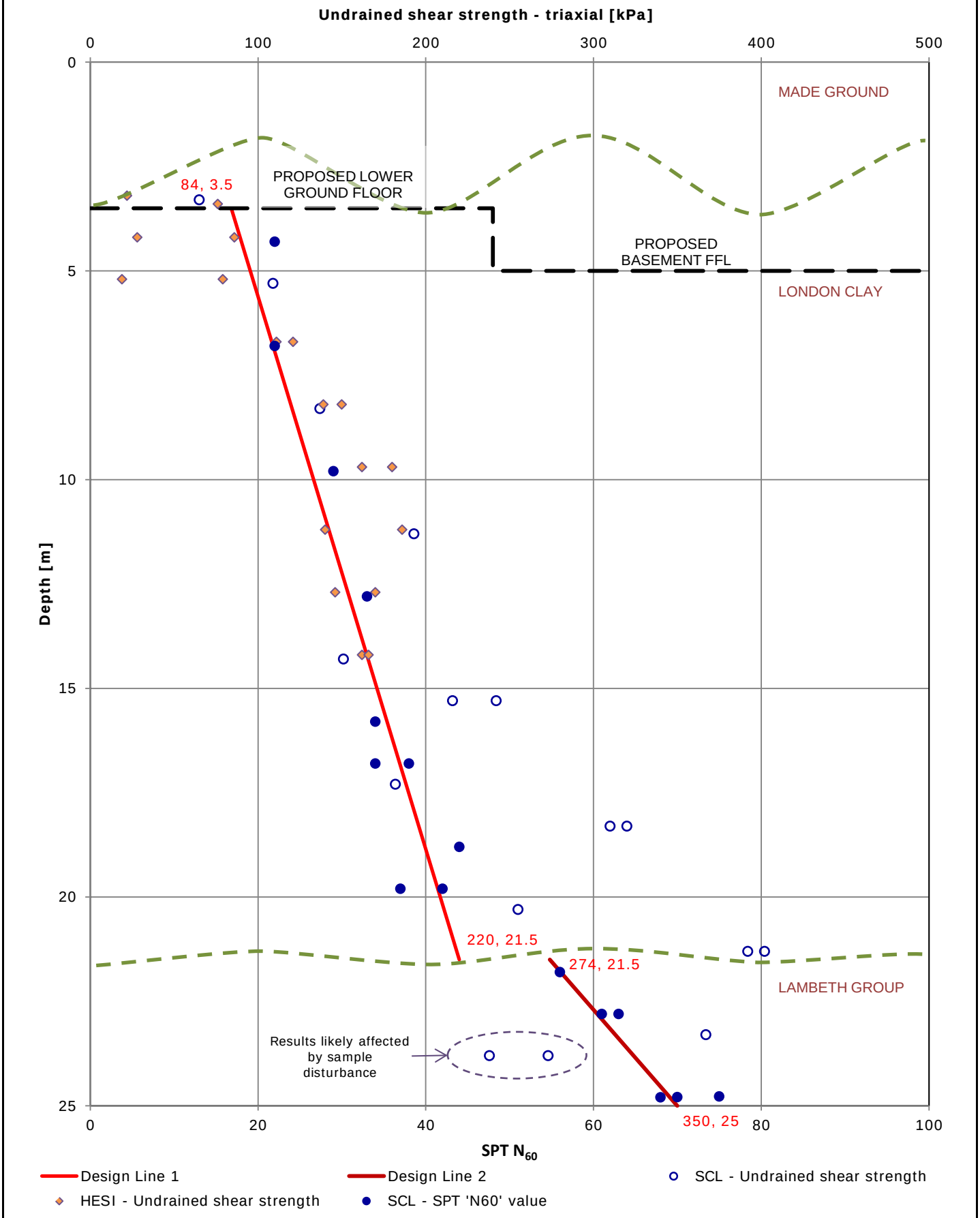
QTS Environmental Report No: 15-30147
Soil Consultants Ltd
Site Reference: 277A Gray's Inn Road, London
Project / Job Ref: 9708/JRCB
Order No: None Supplied
Reporting Date: 01/04/2015

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10 C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

Site & Location	277A Grays Inn Road, London WC1X 8QF	Report No:	9708/MC

Undrained shear strength and SPT [N60] vs depth



Design Line 1 Δcu = 7.6kPa/m

Design Line 2 Δcu = 21.7kPa/m

Note: plot may contain extrapolated SPT results. Generally, where 'N' >50, they are indicative only and should be used with caution.

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Project Id: 9708/JRCB
Project Title: 227A Gray's Inn Road,
Location: London WC1X 8QF
Client: Regal Homes Ltd

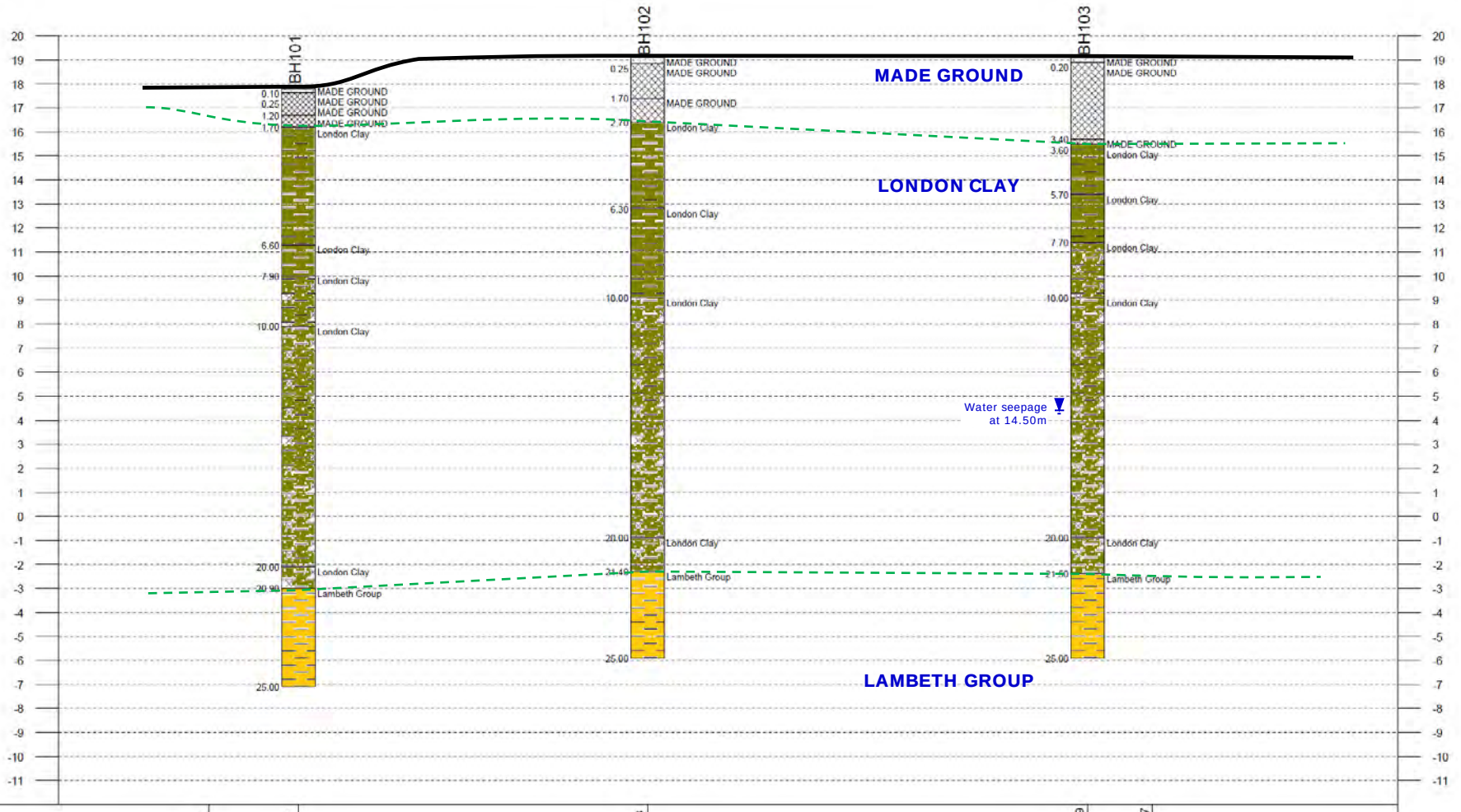
Title: Section line 1
Vertical Scale: 1:250
Horizontal Scale: 1:750
Engineer: Pringuer-James Consulting Engineers Ltd

Soil Consultants

SECTION A-A'

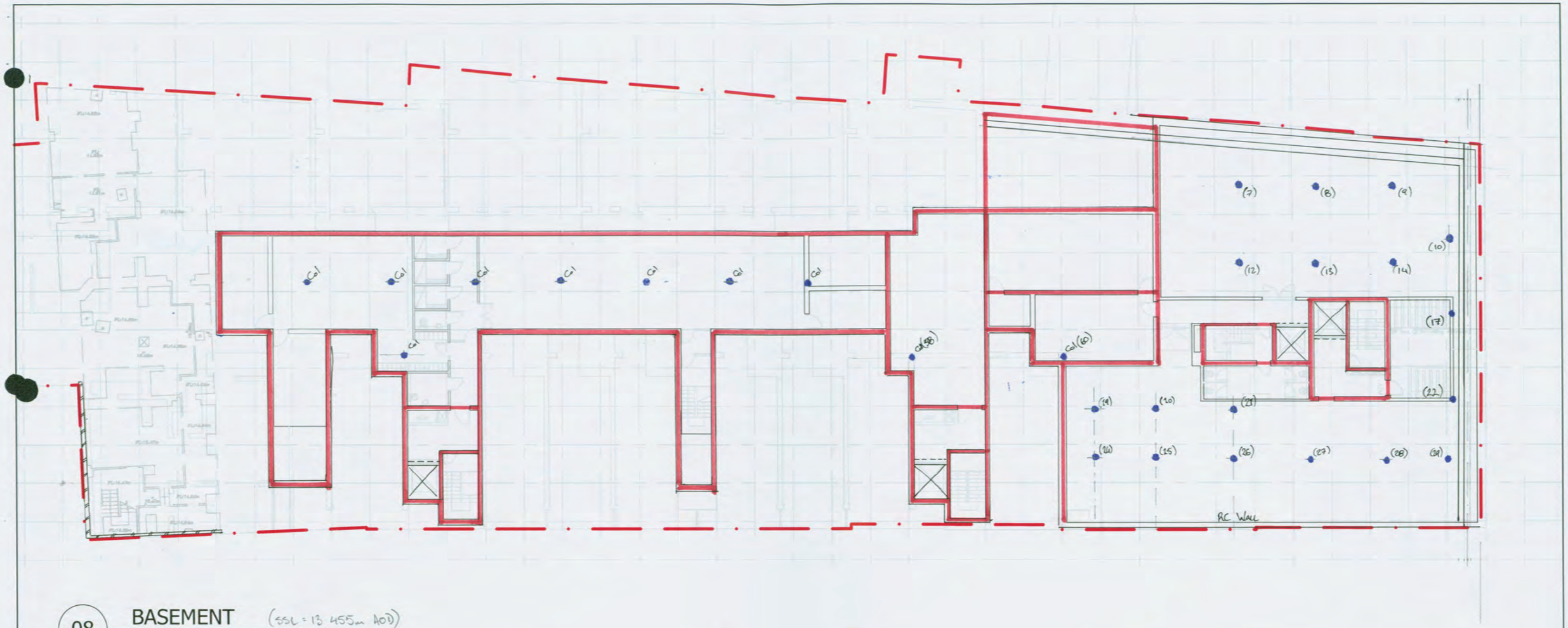
North

South



Chainage (m)	0.00	11.11	54.68	109.59	117.67
Offset (m)	0.29	0.54	0.35		
Elevation (mAOD)	17.90	19.10	19.10		

STRATA BOUNDARIES INDICATIVE ONLY



08 BASEMENT (SSL = 13.455m AOD)

Scale: 1:250

1:250 0 5000 10000 15000 20000 25000

1:1 0 10 20 30 40 50 60 70 80 90 100

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Job No.	Page 3 SK 08	Rev
Date	Eng.	Chd.
Job		

09 LOWER GROUND FLOOR (ESL = 15.705m AOD)

Scale: 1:250

1:250 0 5000 10000 15000 20000 25000

1:1 0 10 20 30 40 50 60 70 80 90 100

PRINGUER-JAMES

CONSULTING ENGINEERS

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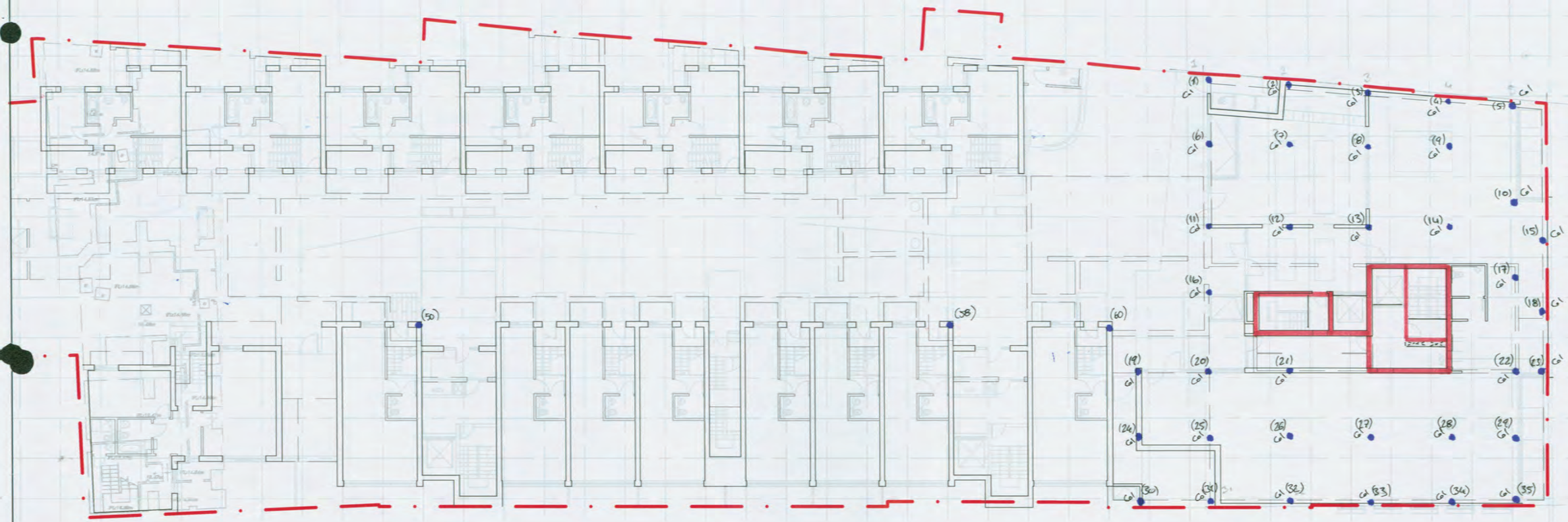
Job No.	Page S.SK 009	Rev
Date	Eng.	Chd.
Job		



10A GROUND FLOOR (ESL = 17.400m AOD)

Scale: 1:250

1:250 0 5000 10000 15000 20000 25000

1:1 0 10 20 30 40 50 60 70 80 90 100

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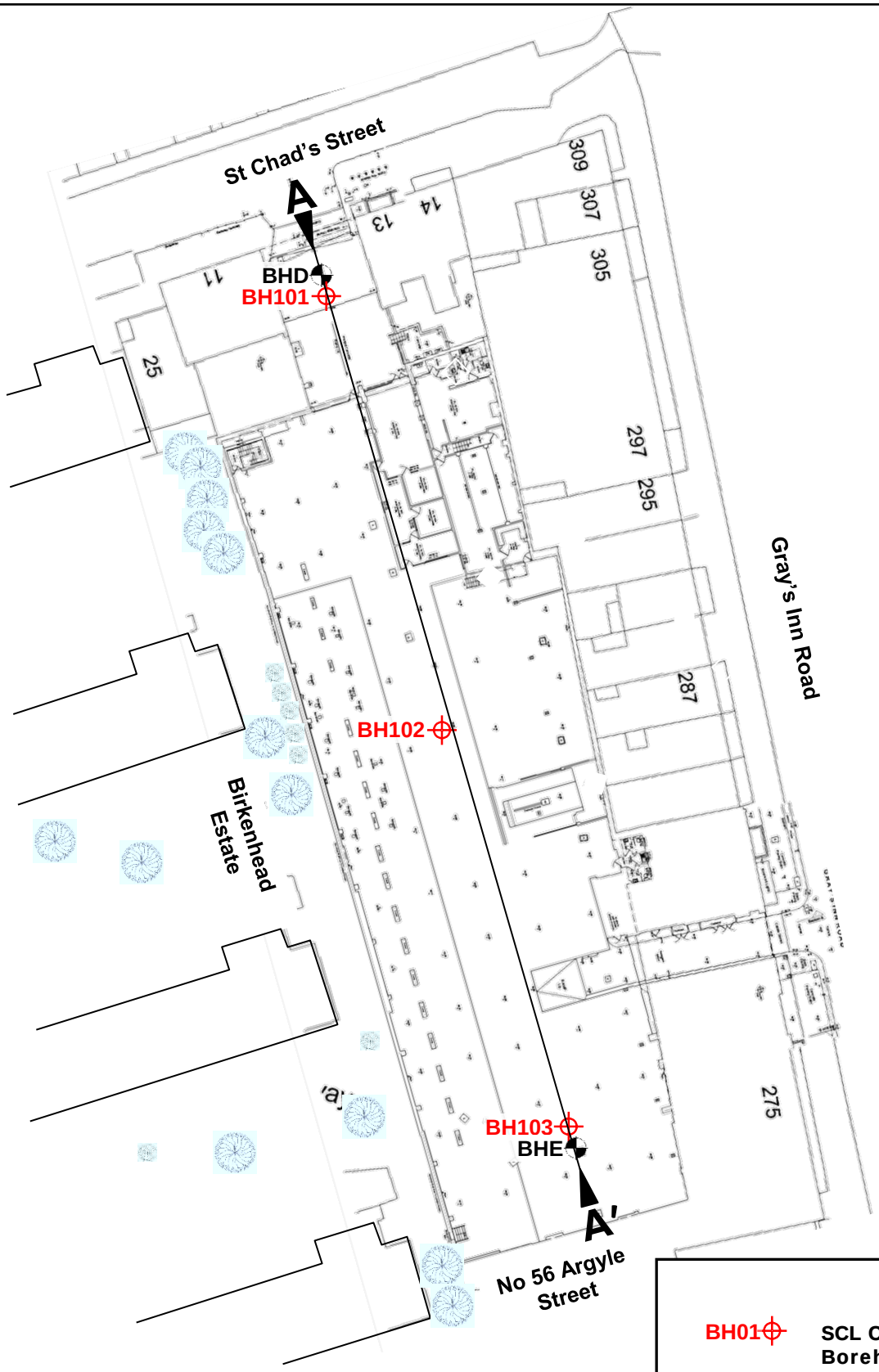
Job No.	Page 5.SK.010(1)	Rev
Date	Eng.	Chd.
Job		

Site & Location	227A Gray's Inn Road London WC1X 8QF	Report No: 9708/JRCB

Site Plan



0 Not to Scale Approx. 50m

Based on extract from supplied drawing

KEY

BH01 — SCL Cable Percussion Borehole

BHD — HESI Cable Percussion Borehole

Line of cross-section

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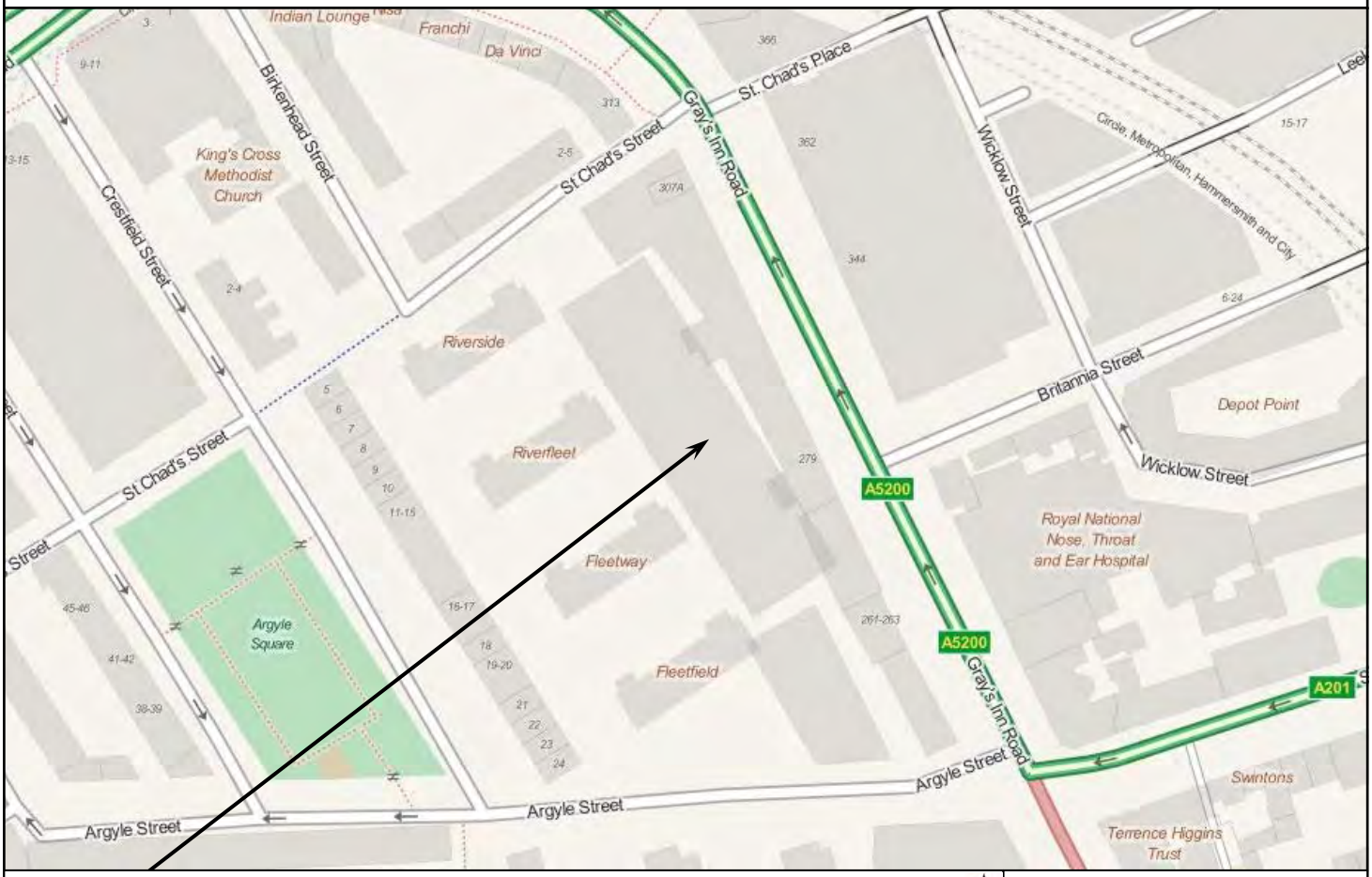
Harwich, Essex CO12 3HL
t: 01255 241639
e: harwich@soilconsultants.co.uk

Site & Location	**227A Gray's Inn Road London WC1X 8QF**	Report No: **9708/JRCB**

Location Maps



SITE LOCATION: approximate NGR 530460E, 182840N

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Soil Consultants

APPENDIX B

Herts & Essex Site Investigations Ltd report extracts

- Borehole records
- Laboratory test results

HERTS & ESSEX SITE INVESTIGATIONS

The Old Post Office, Wellpond Green, Standon, Ware, Herts, SG11 1NJ
Telephone: Ware (01920) 822233
Fax: Ware (01920) 822200

Appendix No. 2
Sheet No. 1
Job No. 12138
Date Aug 2014

277a Grays Inn Road, London WC1X 8QF

Borehole A

Description of Strata	Depth	Thickness (m)	Legend	Installation installed	Water Level	Samples No.	Samples Type	Samples Depth (m)	S.P.T N-Value or Vane Strength	Casing Depth (m)
Concrete	0.20	0.20								
Brown sandy gravel FILL with rare concrete fragments	0.80	0.60								
Concrete	0.90	0.10								
Borehole closed at 0.90m No further progress										

Remarks:

Scale 1:50

Key : U–Undisturbed Sample (100mm diameter) B –Bulk Sample ▼–Water Struck D –Disturbed Sample ▽–Water Standing W–Water Sample P–Piston Sample N–S.P.T. N–Value V–Vane Strength (kN/m²)

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Borehole B

Description of Strata	Depth	Thickness (m)	Legend	Installation installed	Water Level	Samples No.	Samples Type	Samples Depth (m)	S.P.T N-Value or Vane Strength	Casing Depth (m)
Concrete	0.20	0.20								
Brown sandy gravel FILL with rare concrete fragments	0.80	0.60								
Concrete reinforced	1.10	0.30								
Brick rubble FILL	1.20	0.10								
Concrete Borehole closed at 1.20m No further progress										

Remarks:

Scale 1:50

Key : U–Undisturbed Sample (100mm diameter) B –Bulk Sample ▼–Water Struck D –Disturbed Sample ▽–Water Standing W–Water Sample P–Piston Sample N–S.P.T. N–Value V–Vane Strength (kN/m²)

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277a Grays Inn Road, London WC1X 8QF

Borehole 3

Description of Strata	Depth	Thickness (m)	Legend	Installation installed	Water Level	Samples No.	Samples Type	Samples Depth (m)	S.P.T N-Value or Vane Strength	Casing Depth (m)
Concrete	0.20	0.20								
Brick FILL	0.30	0.10								
Concrete Borehole closed at 0.30m No further progress										

Remarks:

Scale 1:50

Key : U–Undisturbed Sample (100mm diameter) B –Bulk Sample ▼–Water Struck D –Disturbed Sample ▽–Water Standing W–Water Sample P–Piston Sample N–S.P.T. N–Value V–Vane Strength (kN/m²)

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277a Grays Inn Road, London WC1X 8QF

Borehole D

Description of Strata	Depth	Thickness (m)	Legend	Installation installed	Water Level	Samples No.	Samples Type	Samples Depth (m)	S.P.T N-Value or Vane Strength	Casing Depth (m)
Cobbles over concrete reinforced	0.20	0.20								
Sandy brick rubble FILL	1.30	1.10		Bentonite Seal; Solid Pipework						
Soft brown silty slightly CLAY	4.40	3.10		Slotted Pipework 50 mmø Response Zone	DRY	1	D	1.50		
						2	D	2.40		
						1	U	3.00		
						2	U	4.00		
Firm becomming stiff brown slightly silty CLAY	6.95	2.55				3	U	5.00		
						4	U	6.50		
Stiff grey slightly silty CLAY		8.05				5	U	8.00		
						6	U	9.50		

Remarks:

Scale 1:50

Key : U–Undisturbed Sample (100mm diameter) B –Bulk Sample ▼–Water Struck D –Disturbed Sample ▽–Water Standing W–Water Sample P–Piston Sample N–S.P.T. N–Value V–Vane Strength (kN/m²)

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277a Grays Inn Road, London WC1X 8QF

Borehole D ..... continued

Description of Strata	Depth	Thickness (m)	Legend	Installation installed	Water Level	Samples No.	Samples Type	Samples Depth (m)	S.P.T N-Value or Vane Strength	Casing Depth (m)
As above		0.05		150 mmø Slotted Pipework / Pea Shingle Gravel		7	U	11.00		
		8.05				8	U	12.50		
	15.00					9	U	14.00		
Borehole closed at 15.00m										

Remarks:

Scale 1:50

Key : U–Undisturbed Sample (100mm diameter) B –Bulk Sample ▼ –Water Struck D –Disturbed Sample ▽ –Water Standing W–Water Sample P–Piston Sample N–S.P.T. N–Value V–Vane Strength (kN/m²)

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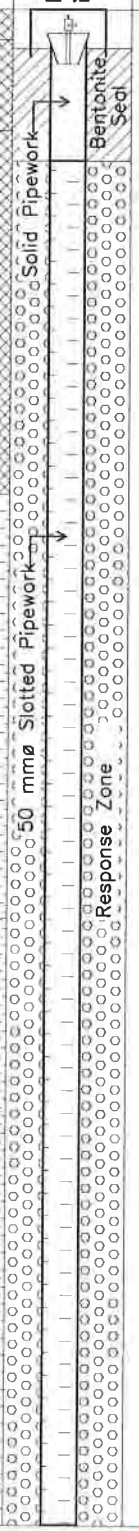
277a Grays Inn Road, London WC1X 8QF

Borehole E

Description of Strata	Depth	Thickness (m)	Legend	Installation installed	Water Level	Samples No.	Samples Type	Samples Depth (m)	S.P.T N-Value or Vane Strength	Casing Depth (m)
Concrete reinforced	0.20	0.20								
Brown sandy topsoil FILL much brick and flint gravel FILL	0.80	0.60								
Sandy brick rubble FILL	3.20	2.40								
Firm becoming stiff brown slightly silty CLAY	6.00	2.80			DRY	1	U	3.20		
						2	U	4.00		
						3	U	5.00		
Stiff grey slightly silty CLAY		9.00				4	U	6.50		
						5	U	8.00		
						6	U	9.50		



Remarks:

Scale 1:50

Key : U–Undisturbed Sample (100mm diameter) B –Bulk Sample ▼ –Water Struck D –Disturbed Sample ▽ –Water Standing W–Water Sample P–Piston Sample N–S.P.T. N–Value V–Vane Strength (kN/m²)

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277a Grays Inn Road, London WC1X 8QF

Borehole E ..... continued

Description of Strata	Depth	Thickness (m)	Legend	Installation installed	Water Level	Samples No.	Samples Type	Samples Depth (m)	S.P.T N-Value or Vane Strength	Casing Depth (m)
As above		9.00		50 mmø Slotted Pipework / Pea Shingle Gravel		7	U	11.00		
						8	U	12.50		
						9	U	14.00		
	15.00									
Borehole closed at 15.00m										

Remarks:

Scale 1:50

Key : U–Undisturbed Sample (100mm diameter) B –Bulk Sample ▼–Water Struck D –Disturbed Sample ▽–Water Standing W–Water Sample P–Piston Sample N–S.P.T. N–Value V–Vane Strength (kN/m²)

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Appendix No. 3
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LOCATION 277a Grays Inn Road, London WC1X 8QF

UNDRAINED COMPRESSION TEST RESULTS

Borehole	Depth (m)	Sample	Natural Moisture Content (%)	Bulk Density (Mg/m^3)	Lateral Pressure (kN/m^2)	Deviator Stress (kN/m^2)	Apparent Cohesion (kN/m^2)	Angle of Shearing Resistance	Remarks
D	3.00	U	40	1.99	60	44	22		
D	4.00	U	44	1.99	80	56	28		
D	5.00	U	30	2.00	100	158	79		
D	6.50	U	34	2.04	130	142	121		
D	8.00	U	22	2.05	160	300	150		
D	9.50	U	28	2.05	190	360	180		
D	11.00	U	28	2.08	220	372	186		
D	12.50	U	32	2.10	250	292	146		
D	14.00	U	25	2.10	280	324	162		
E	3.20	U	33	2.02	64	152	76		
E	4.00	U	29	2.03	80	172	86		
E	5.00	U	31	2.04	100	238	119		
E	6.50	U	30	2.04	130	222	111		
E	8.00	U	31	2.06	160	278	139		
E	9.50	U	26	2.06	190	324	162		
E	11.00	U	29	2.08	220	280	140		
E	12.50	U	27	2.10	250	340	170		
E	14.00	U	23	2.11	280	332	166		

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LOCATION 277a Grays Inn Road, London WC1X 8QF

LIQUID AND PLASTIC LIMIT TEST RESULTS

Borehole	Depth (m)	Sample	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Group Symbol	Desiccation Profile	Percentage Retained 425 Micron Sieve (%)
D	3.00	U	40	73	25	48	CV		0
D	5.00	U	30	69	24	45	CH		0
D	8.00	U	22	50	22	28	CI/CH		0
D	12.50	U	32	84	27	57	CV		0
E	4.00	U	29	69	25	44	CH		0
E	6.50	U	30	73	26	47	CV		0
E	9.50	U	26	69	31	38	CH		0
E	14.00	U	23	66	30	36	CH		0

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LOCATION 277a Grays Inn Road, London WC1X 8QF

SULPHATE ANALYSIS TEST RESULTS

Borehole	Depth (m)	Sample	Concentrations of Soluble Sulphate			Classification	pH
			Soil		Groundwater		
			Total SO_4 (%)	SO_4 in 2:1 water:soil (g/l)			
D	3.00	U		0.49			7.84
D	8.00	U		0.21			7.72
E	6.50	U		0.18			7.84
E	14.00	U		0.09			7.78

CALCULATION OF VOID RATIO

Project Address : **Grays Inn Road**
Job No. 12138

Borehole No. : 1
Sample No. : U1
Depth, (m) : 3.20m

Specific Gravity (measured)	Dry Weight of Sample (g)	Diameter of Ring (mm)	Initial Thickness of sample (mm)	Dry Density (Mg/m³)	eo
2.75	105.9	75.00	19.00	1.262	1.179

Voids Ratio Change Factor 0.1147058613

Pressure P (kPa)	Height H (mm)	Change in Voids ratio de	Voids Ratio e1
0	19.000	-	1.17941
60	17.888	0.127553	1.05186
120	17.210	0.205323	0.97409
240	16.360	0.302823	0.87659
480	15.447	0.407550	0.77186
60	16.075	0.335515	0.84390

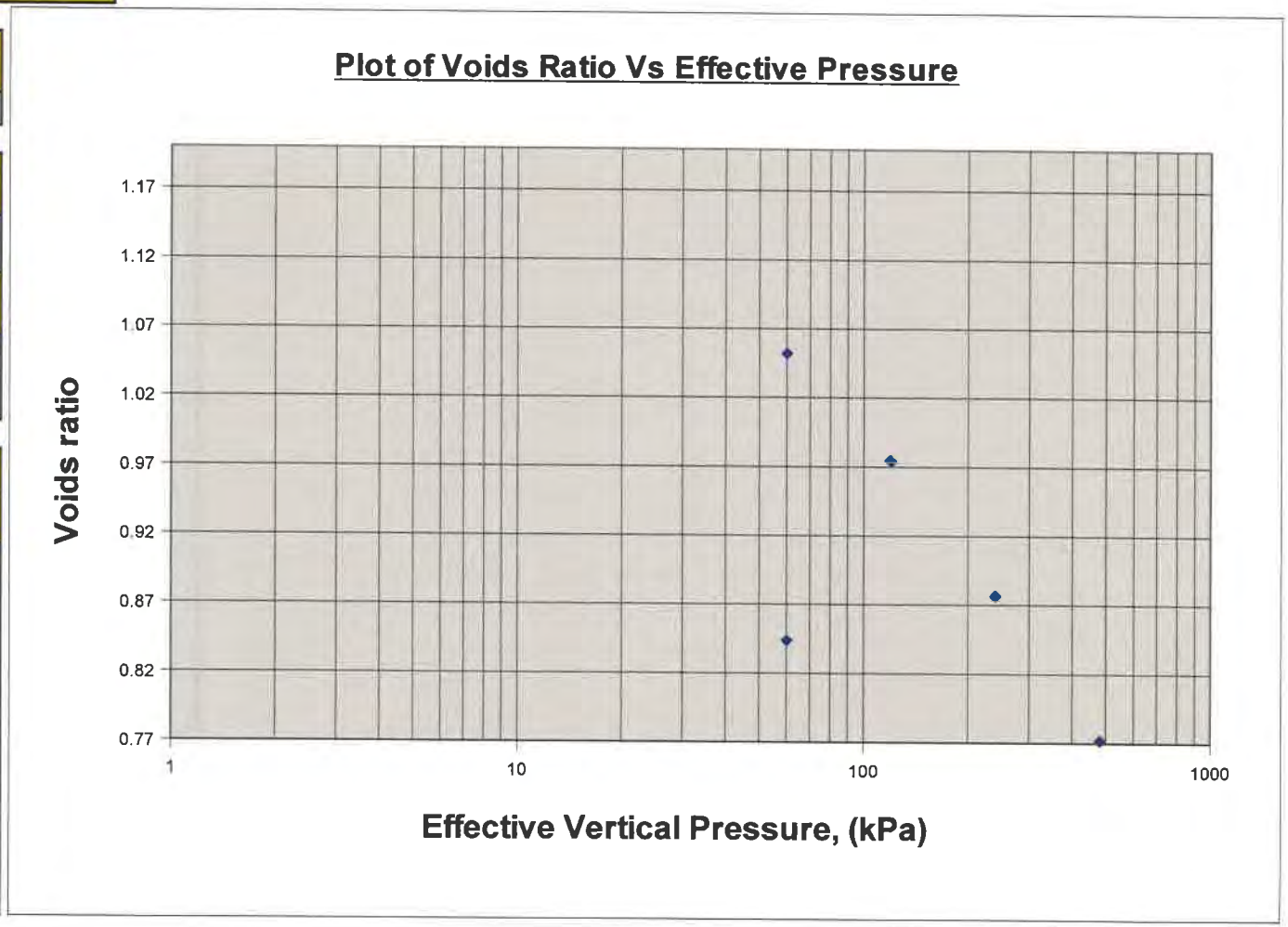
ONE DIMENSIONAL CONSOLIDATION TESTING

Project Address :	Grays Inn Road
Job No.	12138

BH	Sample No.	Depth, (m)
1	U1	3.20m

Description			
Soft dark brown slightly silty CLAY			
Specific Gravity	Moisture Content, (%)		Dry Density (Mg/m³)
2.75 Measured	Start End	42 36	1.262

Pressure kPa	Coefficient of Consolidation m²/year	Coefficient of Compresability m²/
0		
60	0.258	0.9950
120	0.185	0.6317
240	0.221	0.4116
480	0.205	0.2325
60	0.453	0.0968



CALCULATION OF VOID RATIO

Project Address : **Grays Inn Road**
Job No. 12350

Borehole No. : 1
Sample No. : U3
Depth, (m) : 5.00

Specific Gravity (measured)	Dry Weight of Sample (g)	Diameter of Ring (mm)	Initial Thickness of sample (mm)	Dry Density (Mg/m^3)	eo
2.73	115.8	75.00	19.00	1.379	0.979

Voids Ratio Change Factor 0.1041576053

Pressure P (kPa)	Height H (mm)	Change in Voids ratio de	Voids Ratio e1
0	19.000	-	0.97899
140	18.251	0.078014	0.90098
280	17.866	0.118115	0.86088
560	17.300	0.177068	0.80193
1120	16.514	0.258936	0.72006
140	17.544	0.151653	0.82734

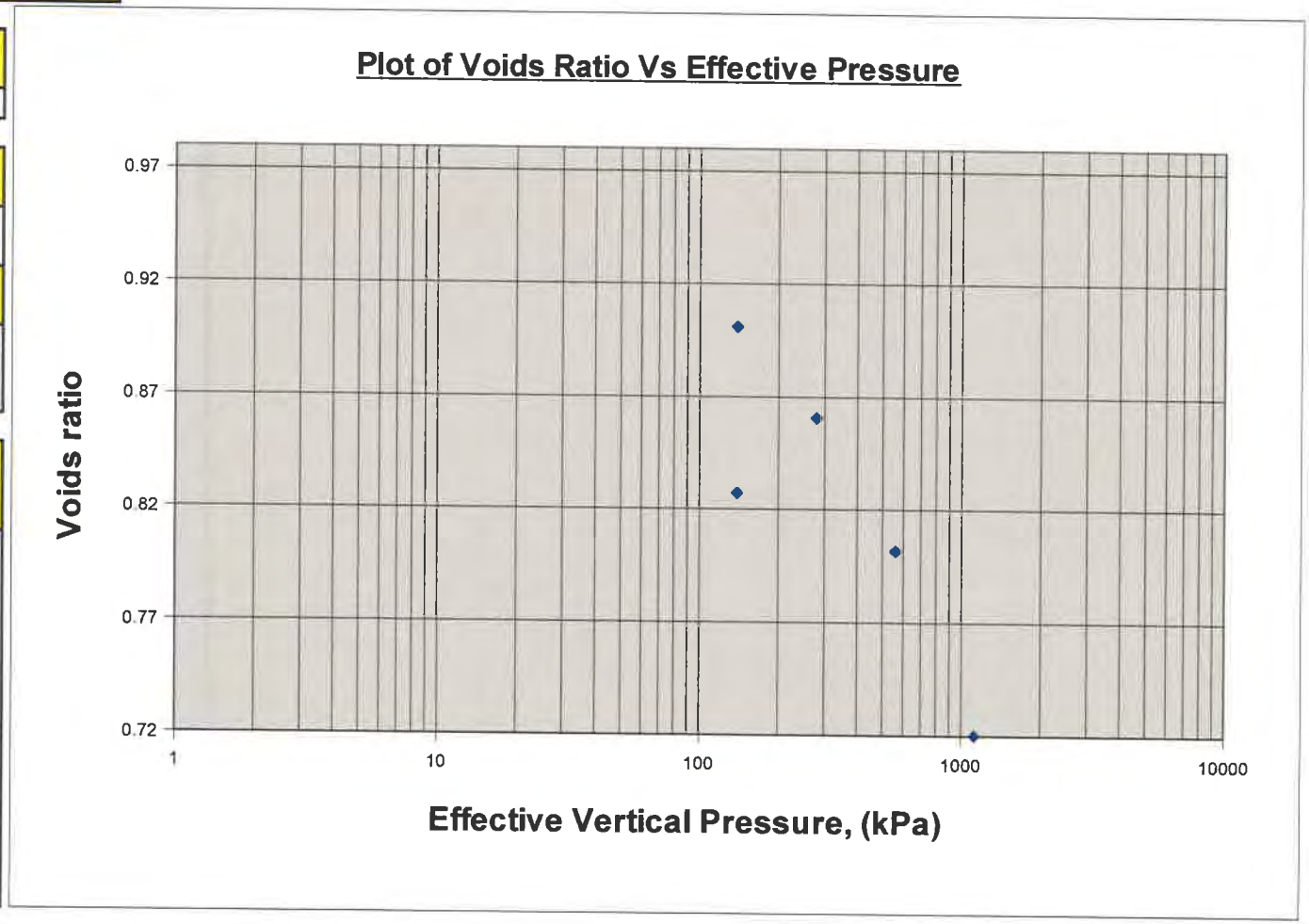
ONE DIMENSIONAL CONSOLIDATION TESTING

Project Address :	Grays Inn Road
Job No.	12350

BH	Sample No.	Depth, (m)
1	U3	5.00

Description			
Very stiff dark brown CLAY			
Specific Gravity	Moisture Content, (%)		Dry Density (Mg/m^3)
2.73 Measured	Start End	31.7 29	1.379

Pressure kPa	Coefficient of Consolidation m^2/year	Coefficient of Compresability m^2/
0		
140	1.540	0.2836
280	1.788	0.1507
560	0.644	0.1131
1120	0.367	0.0811
140	0.286	0.0636



CALCULATION OF VOID RATIO

Project Address : **Grays Inn Road**
Job No. 12350

Borehole No. : E
Sample No. : U2
Depth, (m) : 4.00

Specific Gravity (measured)	Dry Weight of Sample (g)	Diameter of Ring (mm)	Initial Thickness of sample (mm)	Dry Density (Mg/m^3)	eo
2.73	124.7	75.00	19.00	1.486	0.837

Voids Ratio Change Factor 0.0966805723

Pressure P (kPa)	Height H (mm)	Change in Voids ratio de	Voids Ratio e1
0	19.000	-	0.83693
140	18.518	0.046600	0.79033
280	18.122	0.084886	0.75205
560	17.587	0.136610	0.70032
1120	16.879	0.205059	0.63187
140	17.746	0.121237	0.71569

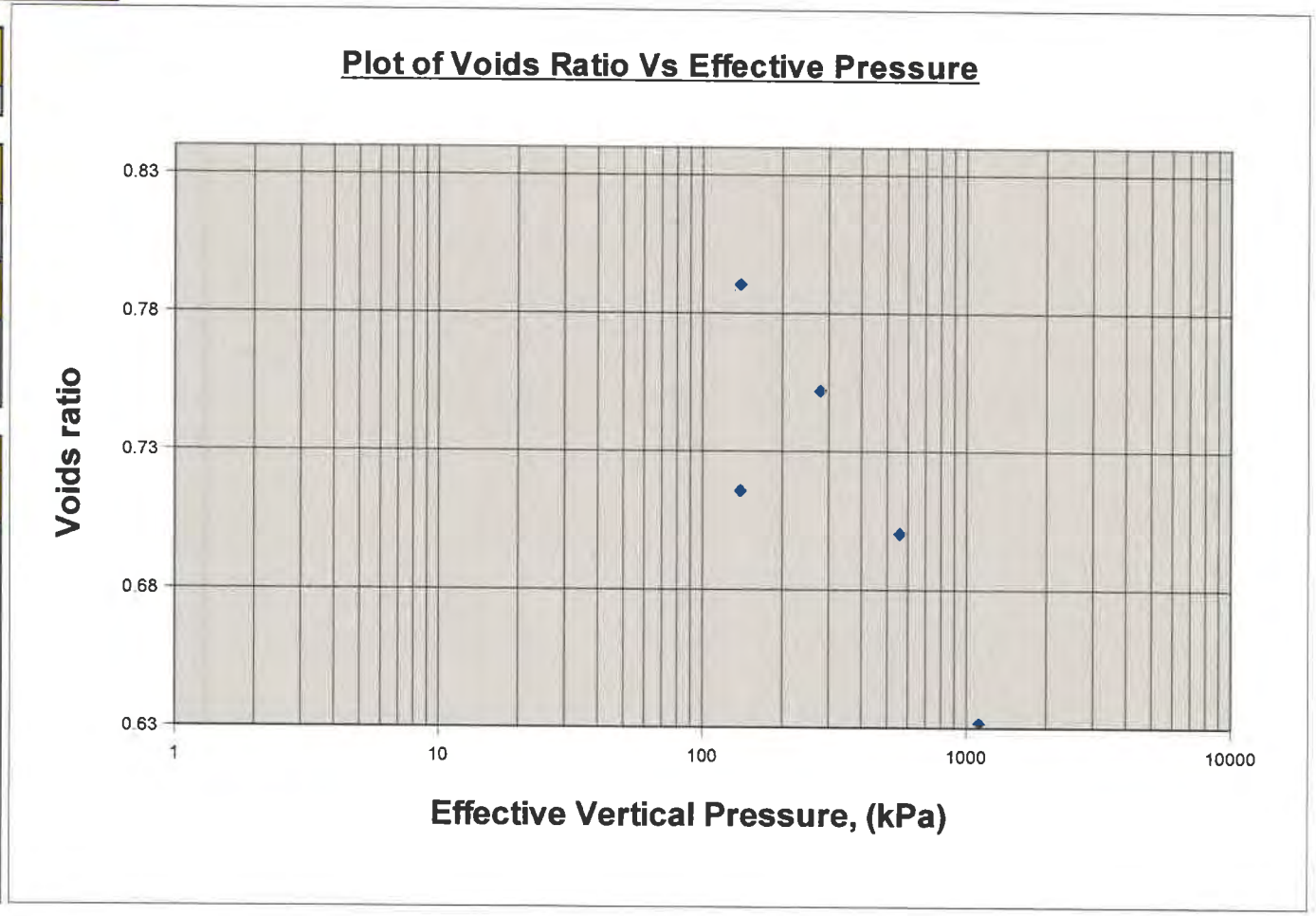
ONE DIMENSIONAL CONSOLIDATION TESTING

Project Address :	**Grays Inn Road**
Job No.	**12350**

BH	Sample No.	Depth, (m)
E	U2	4.00

Description		
Very stiff dark brown CLAY		
Specific Gravity	**Moisture Content, (%)**	**Dry Density (Mg/m³)**
2.73 Measured	Start 29.3 End 27	1.486

Pressure kPa	Coefficient of Consolidation m²/year	Coefficient of Compresability m²/
0		
140	2.324	0.1823
280	0.662	0.1527
560	0.812	0.1054
1120	0.619	0.0719
140	0.411	0.0524



CALCULATION OF VOID RATIO

Project Address : **Grays Inn Road**
Job No. 12138

Borehole No. : E
Sample No. : U4
Depth, (m) : 6.50m

Specific Gravity (measured)	Dry Weight of Sample (g)	Diameter of Ring (mm)	Initial Thickness of sample (mm)	Dry Density (Mg/m³)	eo
2.75	129.2	76.00	19.00	1.498	0.835

Voids Ratio Change Factor 0.0965899216

Pressure P (kPa)	Height H (mm)	Change in Voids ratio de	Voids Ratio e1
0	19.000	-	0.83521
160	18.498	0.048488	0.78672
320	18.078	0.089056	0.74615
640	17.556	0.139476	0.69573
1280	16.810	0.211532	0.62368
160	17.996	0.096976	0.73823

ONE DIMENSIONAL CONSOLIDATION TESTING

Project Address :	Grays Inn Road
Job No.	12138

BH	Sample No.	Depth, (m)
E	U4	6.50m

Description		
Very stiff dark grey slightly silty CLAY		
Specific Gravity	**Moisture Content, (%)**	**Dry Density (Mg/m³)**
2.75 Measured	Start 29.3 End 28	1.498

Pressure kPa	Coefficient of Consolidation m²/year	Coefficient of Compresability m²/
0		
160	0.566	0.1660
320	0.479	0.1419
640	0.390	0.0902
1280	0.423	0.0664
160	0.288	0.0630