Basement Impact Assessment

Site	36 Flask Walk London NW3 1HE
Client	Mr Vidhur Mehra
Date	July 2015
Our Ref	BIAREV/5568

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Report Status: **FINAL**		
Role	**By**	**Signature**
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Foreword

This report has been prepared in accordance with the scope and terms agreed with the Client, and the resources available, using all reasonable professional skill and care. The report is for the exclusive use of the Client and shall not be relied upon by any third party without explicit written agreement from Chelmer Site Investigation Laboratories Ltd.

This report is specific to the proposed site use or development, as appropriate, and as described in the report; Chelmer Site Investigation Laboratories Ltd accept no liability for any use of the report or its contents for any purpose other than the development or proposed site use described herein.

This assessment has involved consideration, using normal professional skill and care, of the findings of ground investigation data obtained from the Client and other sources. Ground investigations involve sampling a very small proportion of the ground of interest as a result of which it is inevitable that variations in ground conditions, including groundwater, will remain unrecorded around and between the exploratory hole locations; groundwater levels/pressures will also vary seasonally and with other man-induced influences; no liability can be accepted for any adverse consequences of such variations.

This report must be read in its entirety in order to obtain a full understanding of our recommendations and conclusions.

1.0 INTRODUCTION

1.1 This Basement Impact Assessment has been prepared in support of a planning application to be submitted to the London Borough of Camden (LBC) for the construction of a basement beneath No.36 Flask Walk, NW3 1HE. The proposed works comprise a single storey basement beneath the full footprint of the house, including a lightwell at the front of the property. This report is for planning and scheme development purposes and is not a design document.

1.2 The assessment is in accordance with the requirements of the London Borough of Camden (LBC) Development Policy DP27 in relation to basement construction, and follows the requirements set out in LBC's guidance document CPG4 'Basements and Lightwells' (September 2013).

1.3 This assessment has been prepared by Keith Gabriel, a Chartered Geologist with an MSc degree in Engineering Geology, and Mike Summersgill, a Chartered Civil Engineer and Chartered Water and Environmental Manager with an MSc degree in Soil Mechanics. Both authors have previously undertaken assessments of basements in several London Boroughs.

1.4 A preliminary site inspection (walk-over survey) of the house was undertaken on Tuesday 28th January 2015. Photos from that visit are presented in Appendix A. Desk study data have been collected from various sources including borehole records (Appendix B) and geological data, environmental data and historic maps from GroundSure which are presented in Appendices E, F and G. Relevant information from the desk study and site inspections is presented in Sections 2–6, followed by the basement impact assessment in accordance with CPG4 Stages 1–4 in Sections 7–10 respectively. The factual report on the ground investigation is included in Appendix C and the findings are summarised in Section 9.

1.5 The following site-specific documents in relation to the proposed basement and planning application have been considered:

XUL Architecture:

Existing

- Drg No. 14_18/LP-01 Layout Plan (& Block Plan)
- Drg No. 14_18/EX-01 Rev 01 Ground Floor Plan
- Drg No. 14_18/EX-02 Rev 01 Basement Floor Plan
- Drg No. 14_18/EX-03 Rev 01 Front & Rear Elevation
- Drg No. 14_18/EX-04 Rev 01 Section A-A

Proposed

- Drg No. 14_18/PA-01 Rev 01 Ground Floor Plan
- Drg No. 14_18/PA-02 Rev 01 Basement Floor Plan
- Drg No. 14_18/PA-03 Rev 01 Front & Rear Elevation
- Drg No. 14_18/PA-04 Rev 01 Section A-A
- Drg No. 14_18/PA-05 Rev 01 Section B-B

Trigram Partnership (Consulting Engineers)

- Preliminary ground investigation results – Letter to Vidhur Mehra (03/12/2014)
- Drg No. 4266-SI.01 rev.A Site Investigations – Plan & Trial Pit Sections
- Drg No. 4266-SK.01 Party wall 34/36 – Section
- Drg No. 4266-SK.02 Party wall 36/38 – Section
- Load Takedown – Foundation Loading (9 sheets).

Chelmer Site Investigations (CSI):
Factual Report on Site Investigation, Ref: FACT/4938 (November 2014).

This report should be read in conjunction with all the documents and drawings listed above.

1.6 Instructions to prepare this Basement Impact Assessment (BIA) were covered by Signed order received by email on 30th June 2015.

2.0 THE PROPERTY AND TOPOGRAPHIC SETTING

2.1 No.36 Flask Walk is a three storey terraced house (see cover photo) within the Hampstead Conservation Area, in the London Borough of Camden. Flask Walk can be accessed at both its north-east end, where it adjoins Well Walk and New End Square, or at its south-west end where it adjoins Back Lane, for vehicular access, and Hampstead High Street across a pedestrianized section. No.36 is situated on the south-east side of Flask Walk, adjoining No.34 to the south-west and No.38 to the north-east (as shown in Figure 1 and Photos 1 & 2 in Appendix A), and is bounded to the south-east by the rear garden to No.19 Spencer Walk.

Figure 1: Extract from 1:1,250 OS map (not to scale) with the site outlined in red

2.2 Reference to the earliest available historic Ordnance Survey (OS) map from 1870 (see Appendix F) shows that the road network in the surrounding area had already been constructed and that the site of No.36 Flask Walk had been developed prior to that date, as well as several properties close to the site, including some of those on the north-west side of Flask Walk (No's 37-47). At that time a row of terraced houses occupied the plots of No.36 Flask Walk and the adjoining six houses to the south-west, although some of the plot boundaries did not match the current boundary positions. Those houses remained until the sites of No's 30-36 were redeveloped between the publication of the 1915 and 1953 OS maps. During this time an 'SA Hall' (Salvation Army?) was built on the site of No's 36 & 34, with an additional smaller hall constructed on the site of No's 30 & 32 Flask Walk. These buildings remained in use as halls until publication of the 1966 OS map, by which time the smaller hall was in use as a nursery, and publication of the 1974 OS map by which time the 'SA Hall' had been re-labelled as No.30, so appeared to have reverted to a residential use. The existing terrace which comprises No's 30-36 Flask Walk was then constructed between the publication of the 1974 and 1991 OS maps, as was the large Spencer Walk development immediately to the south of the Flask Walk properties.

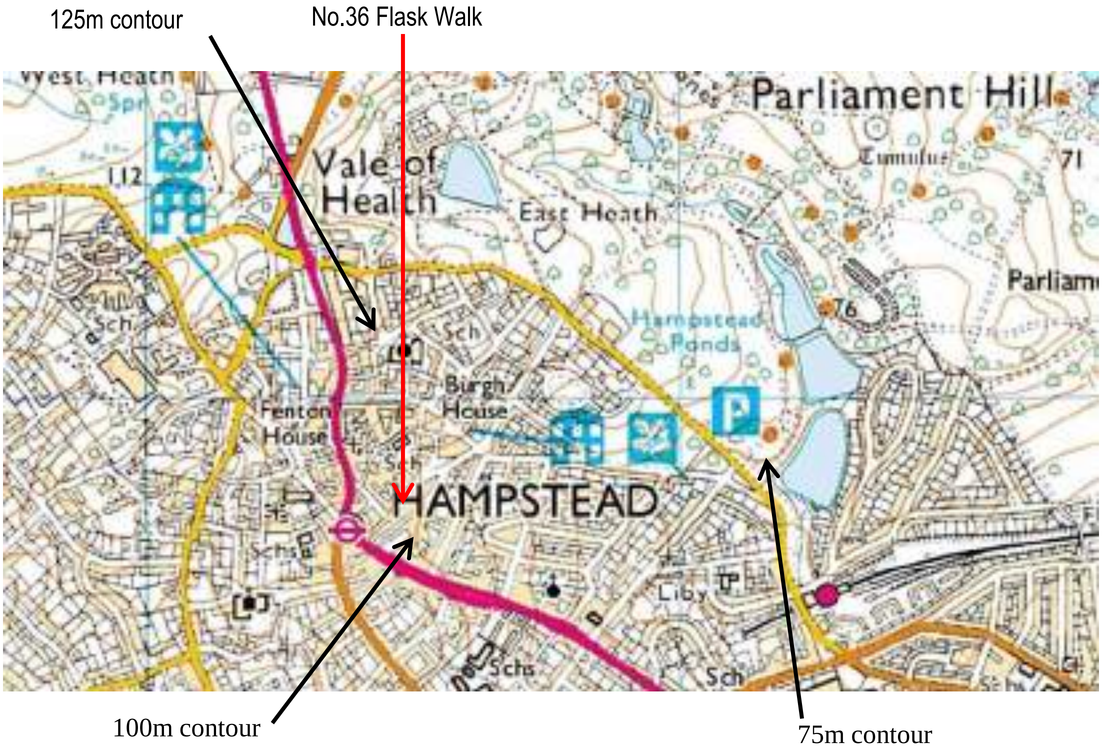

Figure 2: Enlarged extract from 1:25,000 Ordnance Survey map showing site location.

2.3 No.36 Flask Walk is situated on an east-facing slope, on the south-west side of a weakly developed valley which leads down to the former alignment of the river Fleet. Willow Road broadly follows the bottom of this valley to the east of Flask Walk, as illustrated by the contours on Figure 2. The contours on the 1:25,000 scale Ordnance Survey (OS) map indicate an overall slope angle within the immediate vicinity of the site of approximately 4.5° to the east (measured between the 105m and 100m contours). Considerable variation in the slope angle can be found both above and below the site, with measured slope angles ranging from 3.4° (between the 100m and 90m contours downslope) to approximately 8° (between the 110m and 115m contours upslope). However, Figure 16 of the Camden GHHS (Camden Geological, Hydrogeological and Hydrological Study by Arup, November 2010) shows that there are no slopes >7° in the vicinity of the site – see extract presented in Figure 4.

Level of properties on Flask Walk illustrated by shaded area.

Figure 3: Extracts from Spencer Walk cross sections A-A (top) and V-V (bottom), showing the difference in level between the Spencer Walk development and rear of No's 30-36 Flask Walk (shaded area)

2.4 To the south of Flask Walk is the Spencer Walk development (Figure 1), which was constructed after No's 30-36 Flask Walk, during the 1980's (Application E6/15/A/33430, see paragraph 2.7 below). A level difference of 4.0m was recorded between the rear patio of No.36 Flask Walk and the adjoining rear garden to No.19 Spencer Walk (Figure 3), although the topographic survey by On Centre Surveys shows a difference of approximately 3.3m. Figure 3 also shows that a single storey basement carpark exists beneath No's 1-17 Spencer Walk, adjacent to the communal garage beneath No.30 and part of No.32.

2.5 The bomb map for Hampstead shows that the closest recorded hit to the property was a high explosive or incendiary bomb, which landed near Streatly Place, approximately 120m to the north of No.36. The OS maps do not show any major changes to the pattern of housing after WWII in the area concerned.

2.6 Externally there are two small raised planting areas at the front of the property, either side of the front entrance which sits above a small flight of steps that lead up from the footway (Cover photo & Photo 4). To the rear of the house is a fully walled, paved courtyard/patio area (Photo 5). Beneath the rear patio areas to No's 30-36 is a covered communal garage which can be accessed via a ramp which leads down from street level beneath the adjoining No.34 (Photos 1 & 6). This covered communal garage serves all four properties in the terrace (Nos. 30, 32, 34, 36).

2.7 Minor cracking was noted around the east end of the beam which carried the rear wall above the patio. This beam appeared to be supported off reinforced concrete (RC) sections of the party walls; the 34/36 party wall projected out from the RC column seen in the communal garage below (see Photo 7) so this part of the building appeared to have a concrete frame.

2.8 The topographic survey by On Centre Surveys recorded ground levels which varied from 103.3m above Ordnance Datum (AOD) on the public footway at the front of No.36 to 101.9m in the communal garage, immediately alongside the rear wall to No.36. The floor level in the communal garage for No's 30-36 was also shown to be about 0.99m above the level of the Spencer Walk gardens. The internal ground floor level was surveyed at 103.96-103.99m AOD (mainly 103.97m AOD).

2.9 A search of planning applications on LBC's planning website found only a very small number of applications for the construction of basements beneath houses or the construction of new houses with basements in the vicinity of No.36, including:

- **No.7 Lakis Close:** Application (PWX0103303) involving the "*Erection of 2 storey front extension and single storey side extension, plus excavation to create new basement rooms for dwelling house.*" was granted planning permission on 23rd July 2001. No documents relating to a ground investigation were found on the website.
- **Spencer Walk:** Application (E6/15/A/33430) involving "*the erection of a scheme comprising 15 3 storey houses, 20 flats and maisonettes in 3 storey blocks, together with the landscaping details for scheme and a basement car park for 64 cars at the Blue Star Site 32/38 Hampstead High Street, ….*" was granted conditional planning permission on 2nd July 1982, then full planning permission on 20th June 1984 following the approval of conditions. No documents relating to a ground investigation were found on the website, however the application did include drawings of the proposed development, revealing the scale of the basement car park adjacent to No.36.

2.10 The front wall of No.38 appeared to have had an injected damp proof course installed (visible in the bottom left corner of Photo 4, third brick row above the pavement), which suggested that there has been an issue in the adjacent property with rising damp from shallow groundwater.

3.0 PROPOSED BASEMENT

3.1 Drawings by XUL Architecture show that the proposed basement for which planning permission will be sought comprises a single storey beneath the full footprint of the house. This basement will extend out to the front boundary to enable a cloakroom to be included beneath the access steps, together with a lightwell immediately adjacent to the front entrance. The Finished Floor Level (FFL) of this basement will be approximately 3.0m below the ground floor level, giving around 2.7m of headroom, as shown on XUL Architecture's proposed section A-A (Drg No. PA-04 revision 01).

3.2 The drawings by Trigram Partnership, consulting structural engineers (Drg No's 4266-SK.01 & SK.02) show that the structural form of the basement will comprise mass concrete underpins to the party walls, with a reinforced concrete (RC) 'box' within the underpins. The underpins shown on Trigram's drawings include 1100-1400mm wide bases positioned centrally beneath the party walls; these are discussed in Section 10.4.

3.3 Trigram's sketch sections show that the base of the RC basement box will be 250mm thick, and underlain by 50mm of blinding, and 150mm of "well compacted hardcore" - giving an overall thickness of approximately 0.45m, plus any 'finishes' (such as drainage membrane, insulation and screed/floor structure). The founding level for the basement slab including sub-base is therefore expected to be approximately 3.6m below the internal ground floor level, which represents a depth of excavation of 2.4-2.6m measured from the existing oversite screed (1.0-1.2m below the existing finished floor level of the ground floor, see borehole and trial pit logs in Appendix C). The founding level of the mass concrete underpins is indicated as approximately 300mm and 250mm below excavation for the basement slab's formation level, at 3.90m and 3.85m below the existing internal floor level, as shown on Trigram Partnership's drawings for the 34/36 and 36/38 party walls respectively (Drg Nos. SK.01 and SK.02).

4.0 GEOLOGICAL SETTING

4.1 Mapping by the British Geological Survey (BGS) indicates that the site is located just east of the boundary between the Bagshot Formation (to the west), and the Claygate Member which underlies the site. Figure 4 shows an extract from Figure 16 of the Camden GHHS (Camden Geological, Hydrogeological and Hydrological Study by Arup, November 2010) which illustrates the site geology of the Hampstead area.

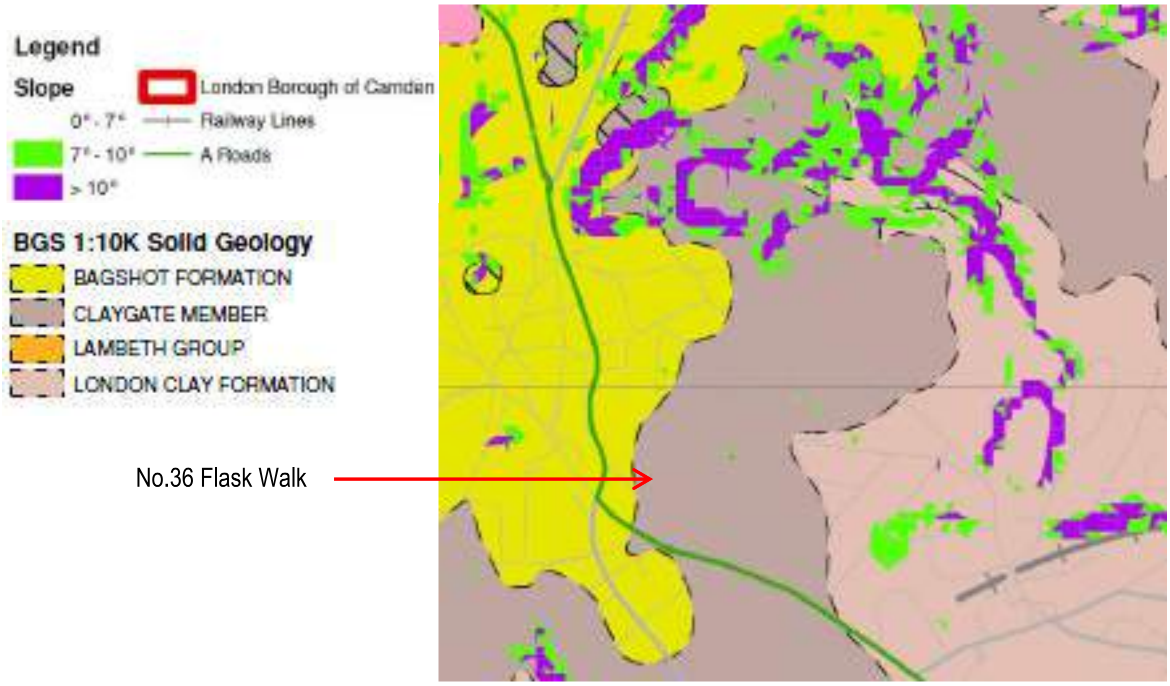

Figure 4: Extract from Figure 16 of the Camden GHHS (Arup, 2010) showing geology and slope angles >7° and >10°.

4.2 In urban parts of London, these natural strata are typically overlain by Made Ground. A thin superficial layer of natural, locally-derived re-worked soils called 'Head' deposits may also be present (because these are not mapped by the British Geological Survey where they are expected to be less than 1.0m thick). In the areas which have been excavated, some or all of these deposits may have been removed.

4.3 The Claygate Member forms the uppermost unit of the London Clay Formation and is described in the relevant BGS memoir (Ellison et al, 2004) as "*alternating beds of clayey silt, very silty clay, sandy silt and glauconitic silty fine sand. Beds are generally 1 to 5m thick, although the boundaries are generally diffuse as a result of bioturbation*". The Claygate Member was 16.0m thick in the Hampstead Heath borehole (located to the north of the site of present interest, near the top of the Heath) where the Claygate Member occurred between the levels of 93.71m and 109.71m AOD).

4.4 The London Clay beneath the Claygate Member is well documented as being a firm to very stiff over-consolidated clay which is typically of high or very high plasticity and high volume change potential. As a result it undergoes considerable volume changes in response to variations in its natural moisture content (the clay shrinks on drying and swells on subsequent rehydration). These changes can occur seasonally, in response to normal climatic variations, to depths of up to 1.50m and to much greater depths in the presence of the trees whose roots abstract moisture from the clay. The clay will also swell when unloaded by excavations such as those required for the construction of basements. The more silty and sandy clays of the Claygate Member generally have somewhat lower plasticities.

4.5 The Bagshot Formation which crops out to the west of the site is described by the BGS as "*pale yellow-brown to pale grey or white, locally orange or crimson, fine- to coarse-grained sand that is frequently micaceous and locally clayey, with sparse glauconite and sparse seams of gravel*". The base of the Bagshot Formation is marked by an erosional surface, with a basal fine gravelly sand developed in places.

4.6 The results of the BGS classifications of six natural ground subsidence/stability hazards are presented in the GroundSure GeoInsight report (see Appendix D, Section 4); all indicated "Negligible" or "Very low" hazard ratings with the exception of 'Shrink – Swell Clay' for which a 'Moderate' hazard rating was given, which reflects the outcrop of the Claygate Member at surface. Although the hazard rating for 'Running Sand' was indicated as "Very low" on site, it was given a "Low" hazard rating 37m to the west of the site, reflecting the outcrop of the Bagshot Formation at surface.

4.7 A search of the BGS borehole database was undertaken for information on previous ground investigations and any wells in the vicinity of the site. Four relevant boreholes were identified, the locations of which are shown on the plan in Appendix B. BH TQ28NE/93 (originally known as OF6) was on Heath Street by the Heath Street Baptist church, north-west of the site. BH TQ28NE/94 (originally OF7) was at a slightly lower level on Heath Street, by the junction between Heath Street and Back Lane, while BH TQ28NE/95 (originally OF8) was further downslope, by the junction between Heath Street and Holly Bush Lane, west of the site. BH TQ28NE/98 (originally known as OF11) was on Well Road by the former Old White Bear pub, north-east of the site. These boreholes are summarised in Table 1, with a tentative correlation between them. Reference should be made to the logs in Appendix B for full strata descriptions.

Table 1: Summary of BGS and other Boreholes - Depths/levels to base of strata								
Strata (abbreviated descriptions)	**BH TQ28NE/93 OF6**		**BH TQ28NE/94 OF7**		**BH TQ28NE/95 OF8**		**BH TQ28NE/98 OF11**	
Approx GL (ft AOD)	Depth (m)	**Level 117.76**	Depth (m)	**Level 112.58**	Depth (m)	**Level 108.77**	Depth (m)	**Level 107.93**
Made Ground	1.83	**115.93**	0.30	**112.28**	0.61	**108.16**	0.30	**107.63**
CLAY with sand and gravel (Head?)	3.35	**114.41**	-	-	-	-	-	-
Brown sandy to slightly sandy CLAY	3.65	**114.11**	-	-	1.83	**106.94**	-	-
CLAY with fine sand and/or clayey sand	4.56	**113.20**	-	-	-	-	-	-
Fine SAND & clayey SAND	6.71	**111.05**	3.05	**109.53**	3.35	**105.42**	-	-
Silty sandy CLAY and fine SAND	8.53	**109.23**	-	-	-	-	-	-
Wet running fine silty SAND	12.19	**105.57**	-	-	-	-	-	-
Soft/firm brown silty sandy CLAY	12.50	**105.26**		-	-	-	-	-
Firm to stiff CLAY & fine sand 'mixture' (Claygate Mbr)	-	-	8.69	**103.89**	5.49	**103.28**	3.66	**104.27**
Silty clayey SAND	13.72	**104.04**	>12.19		-	-	-	-
Silty, fine SAND	-	-			-	-	5.18	**102.75**
Firm, grey/red, silty CLAY and fine sand	-	-			-	-	6.71	**101.22**
Dark grey, silty, sandy CLAY	>15.70				-	-	7.62	**100.31**
Silty SAND & CLAY					-	-	10.67	**97.26**
Firm/stiff, dark grey silty CLAY (London Clay Fm?)					>12.65		>12.19	

5.0 HYDROLOGICAL SETTING (SURFACE WATER)

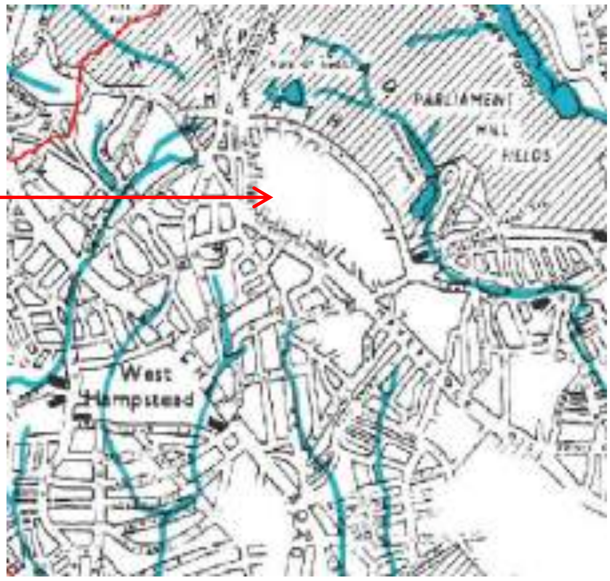

Figure 5: Extract from Figure 11 of the Camden GHHS (Arup, 2010) showing former watercourses, based on Barton (1992).

5.1 As shown in Figure 5, none of the 'lost' rivers of London, most of which now run in dedicated culverts or the sewer system, are illustrated as flowing close to the property. The nearest former watercourses to the property were two tributaries of the river Westbourne, which were located to the west and south-west of the site, but they are in a separate catchment to the one in which the property is situated. No.36 is in the catchment off the 'lost' river Fleet, because, as previously mentioned, the topographic map of the area (Figure 2) shows that the property is in a weakly developed valley which leads down to a former tributary to the Fleet, although no former watercourse is shown in that valley in the historical Figure 11 from the GHHS.

5.2 Figure 14 of the Camden GHHS (Arup, 2010) shows that the site is not within the catchment of any of the Hampstead Heath Pond Chains, of which the Hampstead Chain is the nearest.

5.3 Surface water on the public footway and Flask Walk carriageway will run-off downhill to the north-east because:

- The steps which lead up from the footway to the front entrance will drain towards the footway,
- the footway falls gently towards the carriageway,
- there was a slightly steeper fall towards the carriageway on the cross-over to the communal garage,
- there are brick walls surrounding the raised planting areas (see paragraph 2.6)..

5.4 The surface water catchment for the raised planting areas at the front of No.36 must be restricted exclusively to direct rainfall, and any drains which discharge into it, by the relatively high enclosing brickwork walls. Some infiltration is likely to occur in these areas as they consist of soft landscaping, although it is inferred that these may be constructed on original paved surface (see Paragraph 9.8), and hence whether recharge to the aquifer is possible. However, even if they have no bases, recharge is likely to be minimal given that the underlying Made Ground and natural soils were all clays.

5.5 The rear patio area to No.36 is bounded by high rendered boundary walls, therefore the surface water catchment for this area is also restricted to direct rainfall, and any drains which discharge into it. There will be no run-off from or to the neighbouring patio areas because the patio is fully walled. The rear patio area to No.36 is a suspended deck (surfaced with tiles), so infiltration will be nil.

5.6 Figure 6 shows that Flask Walk did not flood during either the 1975 or the 2002 flood events. The closest roads to the property which flooded during either of these events is Heath Street to the west of the site and Willow Road to the east, which flooded in 1975 and 2002 respectively.

Figure 6: Extract from Figure 15 of the Camden GHHS (Arup, 2010) showing roads which flooded in 1975 (light blue), in 2002 (dark blue), and 'Areas with potential to be at risk of surface water flooding' (wide light blue bands).

5.7 Maps on the website of the Environment Agency (EA) show that the site lies within Flood Zone 1, which is defined as areas where flooding from rivers and the sea is very unlikely, with less than a 0.1 per cent (1 in 1000) chance of such flooding occurring each year. The EA's website also shows that this area does not fall within an area at risk of flooding from reservoirs.

5.8 The following hydrological data for the site has been obtained from the GroundSure EnviroInsight report (see Appendix E), including:

- There are no rivers (or more specifically "Detailed River Network entries") within 500m of the site (App.E, Section 5.10).
- There are no surface water features within 250m of the site (see App.E, Section 5.11).
- There are no surface water abstraction licences within 2000m of the site (App.E, Section 5.4).
- There are no flood defences, no areas benefitting from flood defences and no flood storage areas within 250m of the site (App.E, Sections 6.3, 6.4 & 6.5).

5.9 Further modelling of surface water flooding has been undertaken by the Environment Agency and was published on its website in January 2014; an extract from their model is presented in Figure 7. While this map identifies four levels of risk (high, medium, low and very low) it is understood that it is based at least in part on depths of flooding. This modelling shows a 'Very Low' risk of flooding (the lowest category for the national background level of risk) for No.36 and the surrounding area, however it should be noted that the area immediately to the south of the property is obscured by the Hampstead tube station label in Figure 7.

Figure 7: Extract from the Environment Agency's 'Risk of Flooding from Surface Water'.

5.10 The implications from these flood models are discussed in Section 10.7.

5.11 A 'Sewer Flooding History Enquiry' report has been obtained from Thames Water Utilities Ltd (TWU). In response to the question 'Is the requested address or area at risk of flooding due to overloaded public sewers?' (TWU's wording) the response given was: "*The flooding records held by Thames Water indicate that there have been no incidents of flooding in the requested area as a result of surcharging public sewers*". A copy of the report is available on request.

6.0 HYDROGEOLOGICAL SETTING (GROUNDWATER)

6.1 The Claygate Member and the overlying Bagshot Formation are both classified by the Environment Agency as a superficial ‘Secondary A Aquifer’, whereas the underlying London Clay is an ‘Unproductive Stratum’ as indicated by Figure 8.

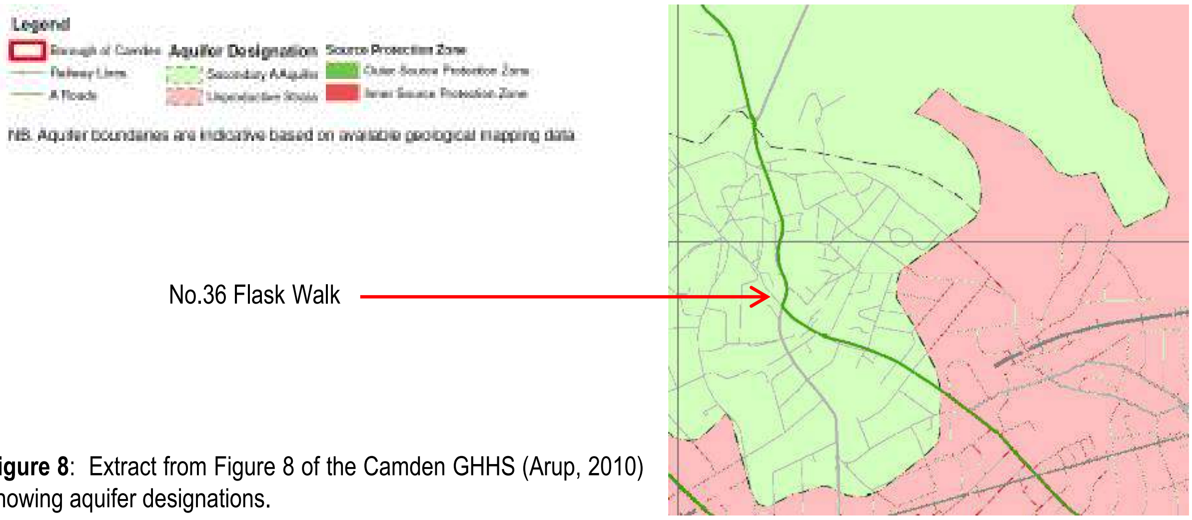

Figure 8: Extract from Figure 8 of the Camden GHHS (Arup, 2010) showing aquifer designations.

6.2 The Chalk Principal Aquifer which occurs at depth beneath the London Clay is not considered relevant to the proposed basement so is not considered further.

6.3 Under the old groundwater vulnerability classification scheme, which now applies only to superficial soils, the site is classed as ‘Minor Aquifer’ - High groundwater vulnerability, as shown in Figure 9.

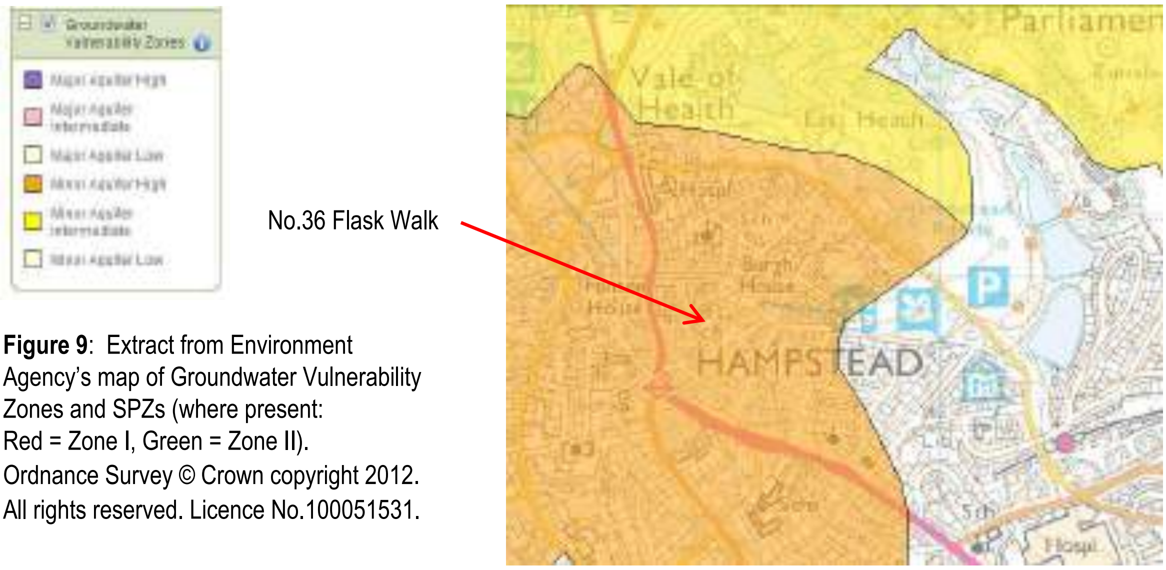

Figure 9: Extract from Environment Agency’s map of Groundwater Vulnerability Zones and SPZs (where present: Red = Zone I, Green = Zone II).
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6.4 The beds of silty sand and sandy silt within the Claygate Member would generally be expected to be water-bearing and where these are laterally continuous they can give rise to moderate water entries into excavations. The clay and silty clay beds would also be expected to be saturated, with water pressures controlled by the water levels/ pressures in adjacent silt/sand beds, by tree root activity or by the influence of man-made changes such as utility trenches (which can act either land drains or as sources of water and high groundwater pressures). Boreholes drilled through low permeability layers can also homogenise groundwater pressures between permeable layers if they are not adequately sealed. Natural groundwater flow rates, if any, in the silt/sand horizons within the Claygate Member are typically low. Variations in groundwater levels and pressures will occur seasonally and with other man-induced influences.

6.5 Local perched groundwater may occur near surface in Made Ground, and possibly also in any Head deposits which overlie the Claygate Member, in at least the winter and early spring seasons.

6.6 While the London Clay Formation is classified as an 'Unproductive Stratum' it can still be water-bearing. In this case however, the London Clay is likely to be sufficiently deep to be of limited relevance.

6.7 The presence of interbedded sands, silts and clays of the Claygate Member give rise to various springs in the headwater valleys of the river Fleet. Of note is the Chalybeate spring on Well Walk, approximately 330m to the north-east of the site (see historic OS maps in Appendix F). Chalybeate springs are particularly iron-rich, as well as having high levels of some other minerals, and were claimed to have a variety of health-giving properties. From the 1915 map onwards it is referred to as a well, rather than a spring. The lack of springs recorded within Hampstead village on the historic Ordnance Survey maps in Appendix F probably reflects their having been collected and channelled into drains/culverts long before the first OS map was published. A spring line is also often found at the interface between the Bagshot Formation, which is predominantly composed of sands, and the top of the Claygate Member, though is less likely to occur in this area where the upper part of the Claygate Member may also consist of sands, and because the numerous trenches dug for services in this built-up area will intercept and provide a drainage route for such water before it reaches the ground surface.

6.8 The historic OS maps show several wells in this part of Hampstead. These exploited either the Bagshot Formation or the sand layers within the Claygate Member.

6.9 The log for the BGS boreholes (see Table 1) recorded:

BH OF6: 'Water first met at 29.0' (108.92) and then again at 47.0' (103.43mAOD) in the sand dominant horizon of soft CLAY and clayey SAND, and in the silty sandy CLAY at the base of the Borehole respectively.

BH OF7: 'Water first met at 18.0' (107.09mAOD), in the firm CLAY + wet very fine SAND, below the near-surface sands.

BH OF8: 'Water first met at 32.0' (99.02mAOD), in the London Clay Formation.

BH OF11: Water was 'first met' at 17'.0" (102.75mAOD) which is the base level of the 'extremely wet' silty fine SAND in that borehole.

These records were taken during drilling, so all are likely to be below the true equilibrium levels at that time. Piezometers were installed in most of these boreholes, but no readings from them were included in the records on the BGS website.

6.10 The groundwater catchment areas upslope of No.36 are likely to differ for each of the main stratigraphic units:

- Made Ground: The catchment for any perched groundwater in the Made Ground is probably limited to No.36's own front planting areas, except where the trenches for drains and other services provide greater interconnection.
- Claygate Member and London Clay Formation: The catchment for the underlying in-situ strata will comprise recharge from the overlying soils in the vicinity of the site plus a much wider area determined by the lateral degree of interconnection between the sand horizons in the Claygate Member and the overlying Bagshot Formation.

6.11 Other hydrogeological data obtained from the GroundSure EnviroInsight report (Appendix E) include:

- The nearest groundwater abstraction licence is 1544m to the south of the site at the Swiss Cottage Open Space Borehole (TQ28SE1769) (see App.E, Section 5.3), so is irrelevant to the proposed basement.
- There are no abstraction licences for potable water within 2000m of the site (App.E, Section 5.5).
- There are no Source Protection Zones (SPZ) within 500m of the site (App.E, Section 5.6). The nearest is over 1.2km to the south of the site, so is irrelevant to the current issue.
- For an area within 50m of No.36 the BGS has classified the susceptibility to groundwater flooding as '**Limited Potential**', at a 'Low' confidence level (App.E, Sections 6.6 and 6.7). Such groundwater flooding is defined as "*the emergence of groundwater at the ground surface or the rising of groundwater into man-made ground under conditions where the normal range of groundwater levels is exceeded*".

6.12 Details of what was found by the site-specific ground investigation in February 2015 are presented in Section 9.

7.0 STAGE 1 - SCREENING

7.1 The screening has been undertaken in accordance with the three screening flowcharts presented in LBC's CPG4 guidance document. Information to assist with answering these screening questions has been obtained from various sources including the site-specific ground investigation, the Camden geological, hydrogeological and hydrological study (Camden GHHS, Arup, 2010), historic maps and data obtained from GroundSure (see Appendices D, E & F) and other sources as referenced.

7.2 Subterranean (groundwater) flow screening flowchart:

Question		Response, with justification of 'No' answers	Clauses where considered further
1a	Is the site located directly above an aquifer?	Yes	Carried forward to Scoping: 8.2, Section 10.2
1b	Will the proposed basement extend beneath the water table surface?	Yes (probably)	Carried forward to Scoping: 8.2, Sections 10.2 & 10.3
2	Is the site within 100m of a watercourse?	No – The nearest surface water feature is Hampstead Pond No.1 on the river Fleet, around 700m to the east of the site.	5.1 & 5.8
3	Is the site within the catchment of the pond chains on Hampstead Heath?	No – As shown on Figure 14 of the Camden GHHS.	
4	Will the proposed basement development result in a change in the proportion of hard surfaced/ paved areas?	Yes (possibly) - A lightwell with a small patio area and flower bed is proposed at the front of the property, in place of the existing small raised planting areas.	Carried forward to Scoping: 8.2, Section 10.2
5	As part of the site drainage, will more surface water (eg: rainfall and run-off) than at present be discharged to the ground (eg: via soakaways and/or SUDS)?	No – There will either be no change or a slight reduction, depending on whether the existing raised planters have solid bases.	2.6, 5.4
6	Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line?	No – There are no surface water features within 500m of the site. The main (Chalybeate) spring in the vicinity is 330m to the NE of the site at a similar level. It has been described as a 'well' on OS maps since 1915, which suggests a long-term decline in groundwater levels.	5.8, 6.7

7.3 Slope/ground stability screening flowchart:

Question		Response, with justification of 'No' answers	Clauses where considered further
1	Does the existing site include slopes, natural or man-made, greater than 7°? (approximately 1 in 8)	No – Gradients within the site are gentle (Level changes are supported by retaining walls). See Camden GHHS Figure 16 (Fig 4 above).	2.3
2	Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7°?	No – There will be no Re-profiling of slopes as part of the proposed works	
3	Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No – There are no slopes >7° in the vicinity of the site. See Figure 4.	2.3
4	Is the site in a wider hillside setting in which the general slope is greater than 7°?	No – As Q3 above	2.3
5	Is the London Clay the shallowest strata at the site?	No – Site is underlain by Claygate Member.	4.1
6	Will any tree/s be felled as part of the proposed development and/or are any works proposed within any tree root protection zones where trees are to be retained?	No and No. There are no trees on site. The closest trees are those on the north-west side of Flask Walk, however the proposed works are assumed to be outside of any tree root protection zones.	
7	Is there a history of seasonal shrink/swell subsidence in the local area, and/or evidence of such effects at the site?	No – no evidence seen.	
8	Is the site within 100m of a watercourse or potential spring line?	No – The Chalybeate spring is approx 330m to the NE.	6.7
9	Is the site within an area of previously worked ground?	Yes – Reworked Ground was recorded in on-site borehole logs, however BGS map extract (Figure 4) and maps on pages 8 & 15 of the GeoInsight report (in Appendix D).do not show any areas of previously worked ground within the vicinity of the site.	Carried forward to Scoping: 8.3, Section 10.4
10	Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	Yes and Yes	Carried forward to Scoping: 8.3, Section 10.4
11	Is the site within 50m of the Hampstead Heath ponds?	No – Site is approx 700m from nearest Hampstead Pond Chain (No.1).	5.8
12	Is the site within 5m of a highway or a pedestrian right of way?	Yes – Proposed lightwell adjoins the footway at the	Carried forward to Scoping:

		front of the property.	8.3, Section 10.4
13	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	Yes	Carried forward to Scoping: 8.3, Section 10.4
14	Is the site over or within the exclusion zone of any tunnels, eg railway lines.	No – Re railway tunnels, though LUL must be asked to confirm (Northern line tunnels pass close to SW but are deep). Unknown re other tunnels.	Carried forward to Scoping: 8.3, 10.1.3

7.4 Surface flow and flooding screening flowchart:

Question		**Response, with justification of 'No' answers**	**Clauses where considered further**
1	Is the site within the catchment of the pond chains on Hampstead Heath?	No – As shown on Figure 14 of the Camden GHHS.	
2	As part of the proposed site drainage, will surface water flows (eg volume of rainfall and peak run-off) be materially changed from the existing route?	Unknown	Carried forward to Scoping: 8.4 & Section 10.7
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes (possibly) - A lightwell with a small patio and flower bed is proposed at the front of the property, in place of the existing raised planters.	3.1 Carried forward to Scoping: 8.4 & Section 10.7
4	Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by the adjacent properties or downstream watercourses?	No – There is no run-off to adjacent properties or surface watercourses.	5.3, 5.4, 5.5
5	Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No – as above.	5.3, 5.4, 5.5
6	Is the site in an area known to be at risk from surface water flooding, such as South Hampstead, West Hampstead, Gospel Oak and King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature?	No – Flask Walk did not flood during either the 1975 or 2002 flood events, and surface water flood modelling by the Environment Agency indicated a 'Very Low' flood risk (the lowest) for this property and the surrounding area.	5.9, Figure 6 & Figure 7.

7.5 <u>Non-technical Summary – Stage 1:</u>

The screening exercise in accordance with CPG4 has identified ten issues which need to be taken forward to Scoping (Stage 2); three related to groundwater, five are related to ground stability and two are related to flooding potential.

8.0 STAGE 2 - SCOPING

8.1 The scoping stage is required to identify the potential impacts from the aspects of the proposed basement which have been shown by the screening process to need further investigation. A conceptual ground model is usually compiled at the scoping stage however, because the ground investigation has already been undertaken for this project, the conceptual ground model including the findings of the ground investigation is described under Stage 4 (see Section 10.1).

8.2 Subterranean (groundwater) flow scoping:

Issue (= Screening Question)		Potential impact and actions
1a	Is the site located directly above an aquifer?	**Potential impact**: Infiltration could be reduced. **Action:** Ground investigation required, then review.
1b	Will the proposed basement extend beneath the water table surface?	The anticipated groundwater regime is described in Section 6, Hydrogeological Setting. **Potential impact**: Local restriction of groundwater flows (perched groundwater or below groundwater table). **Action:** Ground investigation required, then review.
4	Will the proposed basement development result in a change in the proportion of hard surfaced/ paved areas?	**Potential impact:** Increased hard surfacing would decrease infiltration of surface water into the ground. Reduced hard surfacing above an aquifer, while generally beneficial in promoting recharge, might lead to local groundwater flooding elsewhere. **Action:** Review potential impacts of proposed changes, including appropriate types of SuDS for use as site-specific mitigation when/if relevant.

8.3 Slope/ground stability scoping:

Issue (= Screening Question)		Potential impact and actions
9	Is the site within an area of previously worked ground?	**Potential impact:** Potentially variable ground conditions, locally with weaker/more compressible ground than would otherwise be expected **Action:** Review ground investigation and consider the need for special design measures (eg: pile foundations).
10	Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	**Potential impact:** Inadequate provision of dewatering can lead to collapse of excavations. Inappropriate dewatering can cause removal of fines and/or unacceptable increases ineffective stress, both of which can cause ground structures to settle. Reduced bearing capacity in granular strata. **Action:** Ground investigation required in order to enable a proper assessment of the appropriate

		forms of groundwater control, and appropriate foundation design.
12	Is the site within 5m of a highway or a pedestrian right of way?	**Potential impact:** Excavation of basement causes loss of support to footway/highway and damage to the services beneath them. **Action:** Ensure adequate temporary and permanent support by use of best practice working methods.

13	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	**Potential impact:** Loss of support to the ground beneath the foundations to No's 34 & 38 if basement excavations are inadequately supported. **Action:** Ensure adequate temporary and permanent support by use of best practice underpinning methods. Consider the need for transition underpinning.
14	Is the site over or within the exclusion zone of any tunnels, eg railway lines.	**Potential impact:** Stress changes on any tunnel lining. **Action:** Undertake services search to check that there are no tunnels/services in the vicinity.

8.4 Surface flow and flooding scoping:

Issue (= Screening Question)		**Potential impact and actions**
2	As part of the proposed site drainage, will surface water flows (eg volume of rainfall and peak run-off) be materially changed from the existing route?	**Potential impact:** Changes to drainage route can alter the discharge hydrograph and potentially result in increased flooding elsewhere. **Action:** Investigate existing drainage system, and provide appropriate flood resistance and mitigation measures as appropriate.
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	**Potential impact:** May increase flow rates to sewer, and thus increase the risk of flooding (locally or elsewhere). **Action:** Assess net change in hard surfaced/paved areas and, if required, recommend appropriate types of SuDS for use as site-specific mitigation.

8.5 Non-technical Summary – Stage 2:

The scoping exercise has reviewed the potential impacts for each of the items carried forward from Stage 1 screening, and has identified the following actions to be undertaken:

- A ground investigation is required (which has already been undertaken).
- Review of site's hydrogeology and groundwater control requirements.
- Assess the net change in area of hard surfacing and the potential for change in discharge to the ground (if any).
- Investigate existing drainage system.
- Review need to implement appropriate types of Sustainable Drainage System (SuDS) in order to offset (mitigate) any potential increase in discharge to mains sewer.
- Consider the need for special foundation design measures in relation to the apparent presence of worked/disturbed ground.
- Ensure adequate temporary and permanent support by use of best practice working methods.
- Consider the need for transition underpinning to mitigate differential foundation depths.
- Undertake a services search to ensure there are no deep tunnels/services.
- Review flood risk and include appropriate flood resistance and mitigation measures in the scheme's design.

All these actions are covered in Stage 4, or Stage 3 for the ground investigation.

9.0 STAGE 3 – GROUND INVESTIGATION

9.1 A site-specific ground investigation was undertaken by Chelmer Site Investigations (CSI) on 9th February 2015, and included two continuous flight auger boreholes (BH1 & BH2) drilled to depths of 10m below the internal ground floor level. Three additional hand augered boreholes were undertaken on 26th June 2015 in order to assess whether the planters to the front of the house have solid bases. The factual findings from the investigation are presented in Appendix C, including site plans, borehole logs, groundwater monitoring and laboratory test results.

9.2 In addition to the above ground investigation undertaken by Chelmer Site Investigations, two trial pits were excavated by Trigram Partnership in November 2014 in order to investigate the foundations to the party walls at their respective locations.

- TP1 was dug alongside the No.36/38 party wall, which forms the north-eastern flank wall of the house. This pit was dug to a depth of around 2.8m and revealed brickwork with three 75mm high corbels at its base, resting on a 450mm thick mass concrete strip footing, founded at 2.57m below the existing ground floor level. The footing was found to protrude 300mm from the face of the wall.
- TP2 was dug alongside the No.36/34 party wall, which forms the south-western flank wall of the house. This pit was dug to a depth of around 3.0m and revealed brickwork resting on a 500mm thick concrete strip or pad footing founded at 2.81m below the existing ground floor level. The footing was found to protrude 800mm from the face of the wall, which suggests that it might be reinforced though no evidence of reinforcement was found by Trigram when they cut a 100mm deep slot in the edge of the footing.

Both pits recorded the footings as bearing onto "SANDY CLAY" of the Claygate Beds.

9.3 As shown on the site plan, BH1 and BH2 were drilled inside No.36. Both boreholes recorded a void (crawl space) beneath the suspended floor, to a depth of 1.2m below the level of the existing ground floor, whereas Trigram recorded the crawl space immediately alongside the party walls as 1.005m. The site's geology as found by the boreholes is summarized below, with all depths measured relative to ground level, which is taken as the level of the existing ground floor.

- Made Ground: Intercepted beneath 0.1m of oversite concrete, Made Ground was recorded to a depth of 2.0m below ground level (bgl) in both BH1 and BH2. In BH1, this Made Ground was described as "medium compact, dark brown, slightly gravelly, slightly sandy silty **clay**, with brick and concrete fragments". In BH2, 0.1m of the same Made Ground as was described in BH1, was recorded overlying Made Ground consisting of "medium compact, light grey silty sandy fine **gravel** with concrete and brick fragments".
- Reworked Ground: Described from the base of the overlying Made Ground to depths of 5.5m and 4.5m bgl in BH1 and BH2 respectively, this Reworked Ground was recorded as "mid brown, silty sandy CLAY with occasional fine gravel and brick fragments".
- Claygate Member: Immediately beneath the Reworked Ground, BH1 and BH2 recorded "Stiff, orange/brown, silty very sandy CLAY with fine gravel" to depths of 6.9m and 6.0m bgl respectively. "Very stiff, mid grey, fissured silty CLAY with partings of grey silt and fine sand" was then recorded to a depth of 9.0m bgl in BH1, and to the base of BH2 at 10m bgl. In BH1 only, "Very stiff, dark grey, fissured silty CLAY with partings of fine silt" was then recorded from 9.0m bgl to the base of the borehole at 10m bgl.

9.4 Hand vane measurements of shear strength were taken in-situ in the borehole. In the upper part of the Reworked Ground these tests gave averaged values of 83kPa at 2.0m, rising to 116kPa at 4.0m. At 5.0m, averaged values of 124kPa and 121kPa were recorded in BH1 and BH2 respectively, and below 6.0m, all readings were >130kPa. These values show a typical profile with depth for weathered London Clay, which would suggest that this material was placed formally as an engineered fill, but vane tests do not allow for the clay's fabric such as fissures, so typically over-estimate the soil's strength and should NOT be used for design.

9.5 No roots were observed in either of the boreholes.

9.6 Groundwater strikes were recorded at 6.6 and 6.0m bgl in BH1 and BH2 respectively, with a standing level of 7.0m recorded in BH1, and both boreholes were described as wet and open on completion

9.7 In order to monitor the ground water levels, plastic standpipes were installed to 10m within both boreholes. Subsequent monitoring visits were made on 13th and 25th February 2015, during which time the groundwater levels (phreatic surface) remained consistent at 5.03m and 3.84m bgl in BH1 and BH2 respectively. This significant difference suggests that there is only very limited groundwater flow between these locations.

9.8 The three hand augered boreholes in the planters at the front of the house recorded obstructions, believed to be concrete (possibly the original paving) at depths of 1.05-1.32m bgl.

9.9 Laboratory Testing:
Laboratory tests were carried out by Chelmer Geotechnical Laboratories and others on samples recovered from the two boreholes. The tests undertaken included classification tests (moisture content and plasticity) and chemical testing in accordance with BRE Special Digest 1 (2005) to assess the potential for acid or sulphate attack on buried concrete (by QTS Environmental Ltd). The results are presented in CGL's Geotechnical Testing report (see Appendix C).

9.10 Plasticity tests were performed on samples of the clayey strata (Reworked Ground and underlying Claygate Member), including four samples recovered from BH1 at 3.0m, 4.0m, 5.0m and 10.0m bgl, and two samples recovered from BH2 at 3.0m and 4.0m bgl. All six of the samples were found to be of Intermediate Plasticity, as classified by BS5930 (1999, 2010), and Medium volume change potential, as defined by the NHBC (NHBC Standards, 2013, Chapter 4.2, Building near Trees), with very little variation between the samples.

9.11 The moisture contents of the six samples tested were found to vary between 28% and 40%, with the overall trend from both boreholes showing an increase in moisture content with increasing depth (see plotted profiles against depth in CGL's report).

9.12 The chemical tests were undertaken on a total of eleven samples, recovered at various depths from both boreholes, in order to assess the potential for acid or sulphate attack on buried concrete (three were on samples submitted for contaminant testing, as reported elsewhere). Four tests were undertaken in full accordance with BRE Special Digest 1 (2005). The following ranges of results were recorded:

pH value:	6.9 – 7.8
Water-soluble sulphate:	100 – 1020 mg/l
Total Sulphur:	247 – 4740 mg/kg
Total Sulphate	714 – 2771 mg/kg

Calculations following BRE Digest SD1 gave:

Total Potential Sulphate:	0.07 – 1.42%
Oxidisable sulphides:	0.0 – 1.2 %.

These results indicated that the samples fell within the following Design Sulphate Classes, as defined by BRE Special Digest 1 (2005):

DS-1 to DS-2: Samples from the Made Ground and 'Reworked Ground', although high Total Sulphate values from the samples tested for contaminants suggested that higher classifications could be relevant to the Made Ground and Reworked Ground (but cannot be evaluated without Total Sulphur values).

DS-4: One sample from the 'unweathered' Claygate Member at 10.0m bgl.

9.13 <u>Non-technical Summary – Stage 3:</u>

9.13.1 The ground investigation found an unexpected thickness of 'Reworked Ground', recorded to a maximum depth of 5.5m below the level of the internal ground floor. This Reworked Ground was recorded as "mid-brown, silty sandy CLAY, with occasional fine gravel and brick fragments", therefore appearing to consist of reworked sands and clays from the underlying Claygate Member. In-situ, silty very sandy, to silty clays attributed to the Claygate Member were found underlying the Reworked Ground to the maximum depths investigated (10m below floor level).

9.13.2 Groundwater strikes were recorded in the boreholes during drilling, and water levels in the standpipes remained consistent at 3.84m/5.03m below the internal floor level during the short period of monitoring.

9.13.3 The laboratory testing has shown that all of the clay specimens from the Reworked Ground and underlying Claygate Member were of Intermediate plasticity and medium volume change potential, with very little variation between the samples.

9.13.4 The chemical tests recorded aggressive ground conditions in the 'unweathered' clays (DS-4, with probably similar levels in the Made Ground and Reworked Ground); appropriate measures will be required to protect the concrete from chemical attack.

10.0 STAGE 4 – BASEMENT IMPACT ASSESSMENT

10.1 Conceptual Ground Model

10.1.1 The desk study evidence together with the ground investigation findings suggest a conceptual ground model for the site characterised by:

- Made Ground: Proved to a maximum depth of 2.0m below internal ground level (bgl), though only 0.8m thick (including 0.1m of concrete and) owing to the presence of the suspended floor and crawl space. This Made Ground was discovered within all of the exploratory holes, and was described as "silty **clay**" to "silty sandy fine **gravel**". Brick and concrete fragments were found throughout the Made Ground; however other materials, as well as other soil types and greater thicknesses/depths are also likely to be present on site, owing to the inherent variability of Made Ground.
  Perched groundwater may occur locally within this Made Ground, supported on horizons of lower permeability; such perched groundwater may only be present during the wetter winter and spring seasons.
- Reworked Ground: The site specific ground investigation at No.36 recorded Reworked Ground to a maximum depth of 5.5m bgl. This Reworked Ground consisted of "silty sandy CLAY, with occasional fine gravel and brick fragments". Several phases of redevelopment were identified from the historic OS maps, and it is possible that one of the previous on-site developments had a basement, resulting in a reasonable thickness of fill when the basement was later demolished and the site redeveloped. However, the Reworked Ground was described to a greater depth than the likely founding level of a previous basement, and was notably uniform and had similar geotechnical properties to undisturbed clays in the Claygate Member, so the origin of the Reworked Ground remains unknown.
- Weathered Claygate Member (part of the London Clay Formation): CLAY with a broadly similar description to the overlying Reworked Ground (except without brick fragments) was recorded to a maximum depth of 6.9m bgl. This clay most likely consists of in-situ weathered Claygate Member.
- Claygate Member ?: CLAYS with a similar description to un-weathered London Clay were described directly beneath the weathered Claygate Member to the maximum depths excavated. The Claygate Member was 16.0m thick in the Hampstead Heath borehole (see paragraph 4.3), and a relatively similar thickness would therefore be expected on-site, due to its close proximity to the overlying Bagshot Formation (see paragraph 4.1). As a result, it is uncertain whether these clays belong to the lower part of the Claygate Member, or unit D (the uppermost unit) of the London Clay Formation.
- The groundwater pressures may be close to fully hydrostatic (which means that the water pressure increases linearly with depth) or may be hydrostatic modified locally by seepage/flow pressures and/or under-drainage (via permeable layers which are drained further downslope). Groundwater flow will generally be limited to seepage through any of the silt/sand partings which are sufficiently interconnected.
- The change of the Chalybeate spring to the east of No.36 to a well suggests that there has been a long-term decline in groundwater levels (or pressures and the phreatic surface) in some parts of Hampstead.
- The hydrogeology may be complicated further by the backfill in service trenches and granular pipe bedding (where present) forming preferential groundwater flow pathways within the strata they pass through.

10.1.2 The hydrogeological regime outlined above will be affected by long-term climatic variations as well as seasonal fluctuations, all of which must be taken into account when selecting a design water level for the permanent works. No multi-seasonal monitoring data are available, so a conservative approach will be needed, in accordance with current geotechnical design standards which require use of 'worst credible' groundwater levels/pressures. See paragraph 10.2.7 for the recommended provisional design groundwater level.

10.1.3 Tunnels for London Underground's Northern Line are known to pass close to the west of the site, though at considerable depth (57m bgl according to GroundSure). London Underground should be asked to confirm that the proposed basement is outside any of their exclusion zones. Other infrastructure (including tunnels), for sewers, cables or communications might be present within the zone of influence of the proposed basement, so an appropriate services search should be undertaken. If any such infrastructure is identified, then its potential influence on the proposed basement must be assessed. These searches will not identify any private services.

10.2 Subterranean (Groundwater) Flow – Permanent Works

10.2.1 Groundwater flow in this naturally stratified and much altered ground will be complex. The Made Ground consisted predominantly of clays, which are relatively low permeability materials so are likely to permit little or no flow of any perched groundwater (unless the clays are voided). Silty sandy fine gravel was also present in the Made Ground in BH2 which could facilitate flow of groundwater, however no groundwater entries were recorded from that horizon or from the upper part of BH1 or into the trial pits. This indicates that there was no mobile groundwater in the Made Ground at the locations investigated, although perched groundwater may still be present elsewhere or may be held in the clays.

10.2.2 The limited thickness of the Made Ground (0.8m) in the boreholes, together with the depth of the footings recorded in the trial pits and the presence of the retaining wall along the boundary with Spencer Walk, means that the existing foundations are likely to block most/all flow through the Made Ground below No.36, except where services penetrate through the footings. Service trenches beneath Flask Walk, especially any with pipes laid in granular bedding, are also likely to facilitate channelled flow downslope to the north-east and may intercept natural groundwater flows from upslope to the north-west.

10.2.3 The injected damp proof course visible in the front wall of No.38 (downslope of No.36), above the original dpc, indicates that they have had a problem with damp, perhaps from perched groundwater above foundation level.

10.2.4 The founding depths for the proposed basement are approximately 100.1m AOD for the underpins and 100.5m AOD for the blinding below the basement slab. At these levels the basement will be constructed within the Reworked Ground which is known to be water-bearing. The groundwater strikes in both boreholes were at 97.37m/97.97m AOD (6.6m/6.0m bgl), below the base of the Reworked Ground. The recorded standing level in BH2 at 100.13m AOD (3.84m bgl) in February 2015 places it just above the maximum anticipated depth of excavation for the underpins, though the groundwater level is likely to be higher at the up-slope (front) end of the basement and is expected to rise to higher levels at times. However, based on current information, both the volume and rate of any flow through the Made Ground and Reworked Ground are likely to be very limited, so minimal adverse impact on groundwater flow is anticipated from the construction of this basement, subject to inspection of at least the initial underpin excavations by an appropriately experienced engineering geologist/hydrogeologist.

10.2.5 Use of a granular sub-base as currently shown on the scheme drawings, is not recommended as that might facilitate greater softening of the clays following excavation (by providing enhanced access for groundwater to the clays immediately below the basement slab). See 10.3.3 below for further guidance.

10.2.6 In the unlikely event that the basement excavations encounter a local deposit of more permeable soils of sufficient thickness and extent to permit significant flow, then it is possible that an engineered groundwater bypass might be required. This bypass would have to be detailed once the geometry of the permeable soil unit is known.

10.2.7 Current geotechnical design standards require use of a 'worst credible' approach to selection of groundwater pressures. As perched groundwater at shallow depth is suspected to be present (from the injected damp proof course which has been installed at No.38), and long-term discharge of land drainage to the mains drainage system is generally not acceptable to Thames Water, use is recommended of provisional design groundwater levels equal to ground level for short-term (total stress) design situations, and equal to 0.5m below ground level for long-term (effective stress) design situations. If the design is undertaken in accordance with Eurocode 7 (BS EN 1997-1), then groundwater should be taken at ground level in both short-term and long-term situations. Ground levels should be taken as:

- Front wall, rear wall and 34/36 party wall: The public footway and the ramp/floor in the communal garage.
- 36/38 party wall: At the floor levels beneath No.38, which is believed to have a ground bearing floor at the front of the building, and to step down to a much lower level to the rear; these levels must be confirmed as part of the Party Wall Act processes.

10.2.8 The basement structure must be designed to resist the buoyant uplift pressures which would be generated by groundwater at the design levels. The variable depth of the proposed basement means that the uplift pressures will also vary along its length from approximately 39kPa at the upslope front wall to 18kPa beneath the communal garage at the rear of the basement (both un-factored), and possibly less along the rear part of the 36/38 party wall.

10.2.9 The proposed basement will need to be fully waterproofed in order to provide adequate long-term control of moisture ingress from the groundwater. Detailed recommendations for the waterproofing system are beyond the scope of this report although it is noted that, as a minimum, it would be prudent for the system to be designed in compliance with the requirements of BS8102:2009.

10.2.10 The National House Building Council published new guidance on waterproofing of basements in November 2014 (NHBC Standards, Chapter 5.4). Compliance would be compulsory if an NHBC warranty is required, otherwise it may provide a useful guide to best practice.

10.3 Subterranean (Groundwater) Flow – Temporary Works

10.3.1 Groundwater may be present at multiple levels within the depth of excavations required for this basement, despite the lack of any groundwater entries into the trial pits and the upper parts of the boreholes, so it is likely that groundwater control will be required during the basement construction works. Water entries may be manageable by sump pumping, although use of well pointing techniques might be required, depending on the permeability of the strata encountered in the excavations. Suitably screened sumps or well points should be used in order to minimise the removal of fines, subject to advice from a dewatering specialist. An appropriate discharge location must be identified for the water removed from the excavations.

10.3.2 A careful watch should be maintained to check that fine soils are not removed with the groundwater; if any such erosion/removal of fines is noticed, then pumping should cease and the advice of a suitably experienced and competent ground engineer should be sought.

10.3.3 Where the formation level for the underpins and the basement slab consists of clays, the formation must be protected from water ingress. The clay will soften rapidly when exposed to water. Thus, the formation should be blinded with concrete immediately following excavation and inspection.

10.3.4 A leaking water supply pipe to the property could increase significantly the volume of water entries, so it would be prudent to ensure the isolation stopcock is both accessible and operational before the start of the works.

10.4 Slope and Ground Stability

Slope Stability

10.4.1 With overall slope angles of approximately 4.5° in the immediate vicinity of this property the proposed basement excavation would raise no concerns in relation to the overall stability of the slope, subject to normal precautions in supporting the ground around the basement, if excavated in natural strata.

10.4.2 The reason for the presence of Reworked Ground to depths of 98.47m/99.47m AOD, 0.6-1.6m below the proposed founding level for the underpins, remains unclear. The laboratory test results suggest that the Reworked Ground has plasticities similar to the Claygate Member, and a strength profile similar to in-situ London Clay, although the high locked-in horizontal stresses (which exist because of the over-consolidated state of the London Clay, caused by its past geological history) would not apply. This consistent strength profile suggests that the clays were placed as an engineered fill material. Such reworking and re-compacting is a well-established method for improving the stability of slope failures, in which case there may be a sharp change to in-situ soils somewhere upslope of BH2. The initial underpin excavation beneath each of the walls should be inspected by a suitably experienced and competent ground engineering professional in order to assess further the condition and extent of the Reworked Ground.

Underpinning Methods and Ground Movements alongside the Basement

10.4.3 The structural design sketches prepared by Trigram show that the basement will be constructed using mass concrete underpins beneath the perimeter walls of the building, together with reinforced concrete (RC) lining walls. Cast in-situ RC retaining walls will also be required for the front lightwell; these should be cast on the same 'hit and miss' basis as used for the underpins. For the 1100-1400mm wide mass concrete underpins, Trigram's scheme requires mining by up to 535m horizontally beyond the far face of the party walls. Special provision will be required in order to maintain the stability of the roof of these excavations, possibly with full roof support given that this state of compaction of the Reworked Ground is likely to be variable.

10.4.4 Underpinning methods involve excavation of the ground in short lengths in order to enable the stresses in the ground to 'arch' onto the ground or completed underpinning on both sides of the excavation. Loads from the structure above will similarly arch across the excavation, provided that the structure is in good condition.

10.4.5 Some ground movement is inevitable when basements are constructed. When underpinning methods are used, the magnitude of the movements in the ground being supported by the new basement walls is dependent primarily on:

- the geology,
- the adequacy of temporary support to both the underpinning excavations and the partially complete underpins prior to installation of full permanent support;
- the quality of workmanship when constructing the permanent structure.

A high quality of workmanship and the use of high stiffness temporary support systems, installed in a timely manner in accordance with best practice methods, are therefore crucial to the satisfactory control of ground movements alongside basement excavations (see 10.4.5 to 10.4.7 below). Any cracks in load-bearing walls which have weakened their structural integrity should be fully repaired in accordance with recommendations from the appointed structural engineers before any underpinning is carried out.

10.4.6 The minimum temporary support requirements recommended for the excavations for the proposed underpins and RC retaining walls at No.55, subject to inspection and review as described in 10.4.8 below, are:

- Full face support must be installed as the excavations progress for all the excavations for the proposed basement, owing to the reworked nature of the ground. It is recommended that the first underpin excavation of each of the four sides of the basement should be inspected by an appropriately experienced ground engineering professional in order to review the condition of the Reworked Ground and the extent of support required.
- Temporary support will be required to all the new underpins and RC retaining wall panels, and must be maintained until the full permanent support has been completed, including allowing time for the concrete to gain adequate strength.

10.4.7 Compliant with current UK accepted good practice, the contractor is responsible for designing and implementing the temporary works, so it is considered essential that the contractor employed for these works should have completed similar schemes successfully. For this reason, careful pre-selection of the contractors who will be invited to tender for these works is recommended. Full details of the temporary works should be provided in the contractor's method statements.

10.4.8 In accordance with normal health and safety good practice, the requirements for temporary support of any excavation must be assessed by a competent person at the start of every shift and at each significant change in the geometry of the excavations as the work progresses. Fissures in clays can cause seemingly strong, stable excavations to collapse with little or no warning. Thus, in addition to normal monitoring of the stability of the excavations, a suitably competent person should check whether such fissuring is present and, if encountered, should assess what support is appropriate.

10.4.9 The construction sequence will be covered in the structural engineer's Construction Method Statement.

Geotechnical Design

10.4.10 Design of the basement retaining walls must include all normal design scenarios (sliding, over-turning and bearing failure) and must take into consideration:

- Earth pressures from the surrounding ground, the level of which below No.38 must be determined (see also paragraph 10.4.11 below);
- Dead and live loads from the superstructure, including loads from the adjoining houses which are carried on the party walls;
- Loads from vehicles on the footway and in the garage;
- Normal surcharge allowances elsewhere;
- Swelling displacements/pressures from the underlying clays;
- A provisional design groundwater level at GL/0.5m bgl (see paragraph 10.2.7);
- Precautions to protect the concrete from sulphate attack.

The adequacy of the available bearing capacity should be checked when the initial underpin excavations are inspected (see 10.4.2 above) and the underpin design should be revised if necessary.

10.4.11 The following geotechnical parameters should be used when calculating earth pressures:

Made Ground:	Unit weight, γ_b:	18.0 kN/m^3
(siltyclays)	Effective cohesion, c':	0 kPa
	Angle of internal friction, φ':	24°
Reworked Ground:	Unit weight, γ_b:	20.0 kN/m^3
(sandy clays)	Effective cohesion, c':	0 kPa
	Angle of internal friction, φ':	25°

These parameters should be used in conjunction with appropriate partial factors dependent upon the design method selected.

10.4.12 The formation level clays onto which the underpins and the basement slab will bear must be protected from water to prevent softening and loss of strength, as described in 10.3.3 above.

10.4.13 Normal good practice in foundation construction requires progressive stepping up between foundations of different depths beneath a single structure. Subject to agreement under the Party Wall Act negotiations, transitional underpins should therefore be considered for the load-bearing walls which adjoin No.36 in the following locations:

- around No.34's entrance and stairs;
- which form the storage cupboards alongside the ramp into the communal garage;
- in No.38;
- the 36/38 party wall to the rear of the basement (which forms the flank wall to the communal garage; the rear wall of the garage, which is party with the Spencer Walk development, is 4.8+m from the basement, so is beyond the zone of influence of the basement excavations).

10.5 Heave/Settlement Assessment

Basement Geometry and Stresses:

10.5.1 Analyses of vertical ground movements (heave or settlement) have been undertaken using PDISP software in order to assess the potential magnitudes of movements which may result from the changes of vertical stresses caused by excavation of the basement. These preliminary analyses have not modelled the horizontal forces on the retaining walls, so have simplified the stress regime significantly.

10.5.2 Figure D1 in Appendix D illustrates the layout of the 'proposed basement foundation plan' based on XUL Architecture Drg No.14_18/PA-02 and Trigram Partnership's sketch sections. The maximum overall dimensions of the proposed basement are 5.57m wide by 12.37m long. The depths of excavation are as given in paragraph 3.3 above.

10.5.3 It is understood that the loads from the front wall of the house and the rear wall at 1st and 2nd floor levels will be carried entirely on the party walls.

10.5.4 Table 2 presents the co-ordinates of the zones used to input the main elements of the basement's geometry into PDISP based on the illustration in Figure D2, together with the net changes in vertical pressure for the four major stages in the stress history of the basement's construction, as detailed in paragraph 10.5.6 below.

Table 2: Coordinates and pressures for PDISP							
ZONE	Centroid		Dimensions		Net change in vertical pressure (kPa)		
#	Xc(m)	Yc(m)	X(m)	Y(m)	Stage 1	Stage 2	Stages 3 and 4
1	0.300	0.550	0.600	1.100	85.89	85.89	96.89
2	2.800	0.550	4.400	1.100	85.89	85.89	96.89
3	8.100	0.550	6.200	1.100	77.34	77.34	88.34
4	0.300	2.635	0.600	3.070	-15.73	-15.73	-4.73
5	5.900	2.635	10.600	3.070	0.00	-45.41	-34.41
6	11.335	2.635	0.270	3.070	0.00	-45.41	-34.41
7	0.300	4.870	0.600	1.400	67.98	67.98	78.98
8	2.800	4.870	4.400	1.400	67.98	67.98	78.98
9	8.100	4.870	6.200	1.400	56.63	56.63	67.63
10	11.785	0.550	1.170	1.100	77.34	77.34	88.34
11	11.920	2.635	0.900	3.070	-14.06	-14.06	-3.06
12	11.785	4.870	1.170	1.400	56.63	56.63	67.63

Ground Conditions:

10.5.4 The ground profile was based on the site-specific ground investigation by Chelmer Site Investigations, as presented in Sections 9 and 10.1 above, and the desk study information.

10.5.5 The short-term and long-term geotechnical properties of the soil strata used for the PDISP analyses are presented in Table 3, based on this investigation and data from other projects.

Table 3: Soil parameters for PDISP analyses				
Strata	**Level** (m bgl)	**Undrained Shear Strength,** Cu (kPa)	**Short-term, undrained Young's Modulus,** Eu (MPa)	**Long-term, drained Young's Modulus,** E' (MPa)
Reworked Ground, over Claygate Fm, London Clay	3.85 15	100 184	50 92	30 55
Where: Undrained shear strength, Cu estimated as Cu = 100 + 7.5z kPa where z = depth below the founding level (3.85m bgl) Undrained Young's Modulus, Eu = 500 * Cu Drained Young's Modulus, E' = 0.6 * Eu				

PDISP Analyses:

10.5.6 Three dimensional analyses of vertical displacements have been undertaken using PDISP software and the basement geometry, loads/stresses and ground conditions outlined above in order to assess the potential magnitudes of ground movements (heave or settlement) which may result from the vertical stress changes caused by excavation of the basement. PDISP analyses have been carried out as follows:

- Stage 1 – Construction of underpins/retaining walls – Short-term condition
- Stage 2 – Bulk excavation of central area to formation level – Short-term condition
- Stage 3 – Construction of basement slab – Short-term (undrained) condition
- Stage 4 – As Stage 3, except – Long-term (drained) condition.

10.5.7 The results of the analyses for the Stages 2, 3 and 4 are presented as contour plots on the appended Figures D2 to D4 respectively.

Heave/Settlement Assessment:

10.5.8 Excavation of the basement will cause immediate elastic heave in response to the stress reduction, followed by long-term plastic swelling as the underlying clays take up groundwater. The amount of swelling in the Reworked clays will depend on several factors, including their condition when placed, the amount of compactive effort applied, and their subsequent access to water, so cannot be quantified without testing on good quality samples. However as a worst case scenario a typical profile of deformation moduli for London Clay has been used, based on the similarity of the measured shear vane strengths to a normal London Clay profile. The rate of plastic swelling in the in-situ clays will be determined largely by the availability of water and as a result, given the low permeability of the clays in the Claygate Member/London Clay Formation, can take decades to reach full equilibrium. The basement slab will need to be designed so as to enable it to accommodate the swelling displacements/pressures developed underneath it.

10.5.9 The PDISP analyses indicated only modest heave movements less than 10mm are likely to develop beneath the basement walls. The ranges of predicted short-term and long-term movements for each of the main walls are presented in Table 4 below.

Table 4: Summary of predicted displacements

Location	Stage 2 (Figure D2)	Stage 3 (Figure D3)	Stage 4 (Figure D4)
Front wall	1mm Settlement – 0.5mm Heave	0 – 1.5mm Settlement	0 – 3.5mm Settlement
36/38 party wall	0.5mm – 1.5mm Settlement	1mm – 2mm Settlement	1.5mm – 4mm Settlement
Rear wall	1mm Settlement – 0.5mm Heave	0mm – 1.5mm Settlement	0mm – 3.5mm Settlement
34/36 party wall	0.5mm – 1.5mm Settlement	1mm – 2mm Settlement	1.5mm – 4mm Settlement
Basement slab	1.5mm Heave – 0.5mm Settlement	0.5mm Heave – 1mm Settlement	1mm Heave – 2mm Settlement

10.5.10 All the short-term elastic displacements would have occurred before the basement slab is cast, so only the post-construction incremental heave/settlements are relevant to the slab design. The analyses indicated that the maximum predicted post-construction displacements beneath the slab are likely to be about 0.5-1mm heave and 1mm settlement, which represent an incremental differential settlement of about 2mm across the slab in a hogging type deformation.

10.6 Damage Category Assessment

10.6.1 When underpinning, it is inevitable that the ground will be un-supported or only partially supported for a short period during excavation of each pin, even when support is installed sequentially as the excavation progresses. This means that the behaviour of the ground will depend on the quality of workmanship and suitability of the methods used, so rigorous calculations of predicted ground movements are not practical. However, provided that the temporary support follows accepted good practice as outlined in Section 10.4 above, then extensive past experience has shown that the bulk movements of the ground alongside the basement caused by underpinning for a single storey basement (typical depth 3.5m) should not exceed 5mm in either horizontal or vertical directions.

10.6.2 The depth of excavation required for the underpins, measured from the oversite screed beneath No.36's crawl space, will range from 2.65m to 2.90m. However, for the damage category assessment it is the depth below the underside of the footings of the adjoining or adjacent properties which is relevant. Thus, separate damage category assessments are required to consider the worst-credible situation for each adjoining property.

No.32 including 32/34 party wall on far side of access ramp to garage: Assume founded at same level as 34/36 party wall at 101.16m AOD (as per TP2), which is 1.1m above proposed underpin level (100.07m AOD). Distance between party wall centrelines is approximately 4.35m, so minimum distance between underpins and 32/34 footings is about 3.3m.

Storage cupboards and No.34's entrance/stairs: Extend 1.6m beyond centreline of party wall, and hence 0.9m from rear edge of the proposed underpin. Also assumed to be founded at same level as 34/36 party wall. Transition underpins as recommended in paragraph 10.4.13 would fully support the transverse walls, so no damage category assessment is required.

No.38: Assume founded at same level as 36/38 party wall: 101.4m AOD (as per TP1), which is 1.28m above proposed underpin level (100.12m AOD).

10.6.3 In order to relate the typical ground movements to possible damage which adjoining properties might suffer, it is necessary to consider the strains and the angular distortion (as a deflection ratio) which they might generate using the method proposed by Burland (2001, in CIRIA Special Publication 200, which developed earlier work by himself and others).

10.6.4 Ground movements associated with the construction of retaining walls in clay soils have been shown to extend to a distance up to 4 times the depth of the excavation. For No.32, the geometries listed above give:

Zone of influence from basement = 1.1 x 4 = 4.4m = Width (L)

The minimum separation of 3.3m between underpins and No.32's footings means that only the north-easternmost 1.1m of No.32 will be within the zone of influence, which is probably about equal to the width of the footing to the 32/34 party wall, so no damage category assessment is relevant.

10.6.5 The damage category calculations for No.38, using the geometries listed above, are as follows.

Zone of influence from basement = 1.28 x 4 = 5.12m = Width (L)

Height (H) = approx. 5.8m (front), 8.6m (rear)

Hence L/H = 0.88 (front), 0.60 (rear)

Thus, for the anticipated 2mm maximum horizontal displacement (reduced pro-rata from 5mm for the reduced depth of excavation) the strain beneath the No.38 would, theoretically, be in the order of ε_h = 3.91 x 10^{-4} (0.039%).

10.6.6 The settlement of the 36/38 party wall predicted by the PDISP analysis must be added to the settlement resulting from relaxation of the ground alongside the excavation. The predicted settlements directly beneath this party wall were 3.5-4.0mm with allowance for monolithic behaviour at the ends (see Figure D5). The 4.0mm value at the rear end of the party wall, combined with the greater width of that part of No.38, represents the least favourable state, which gives 6mm total predicted settlement of the ground below the rear part of No.38. The settlement profile is expected to be convex, so the combined ground movement profile gave a maximum deflection, with a worst case ratio of 17%, Δ = 1.02mm, which represents a deflection ratio, Δ/L = 1.99 x 10^{-4} (0.020%).

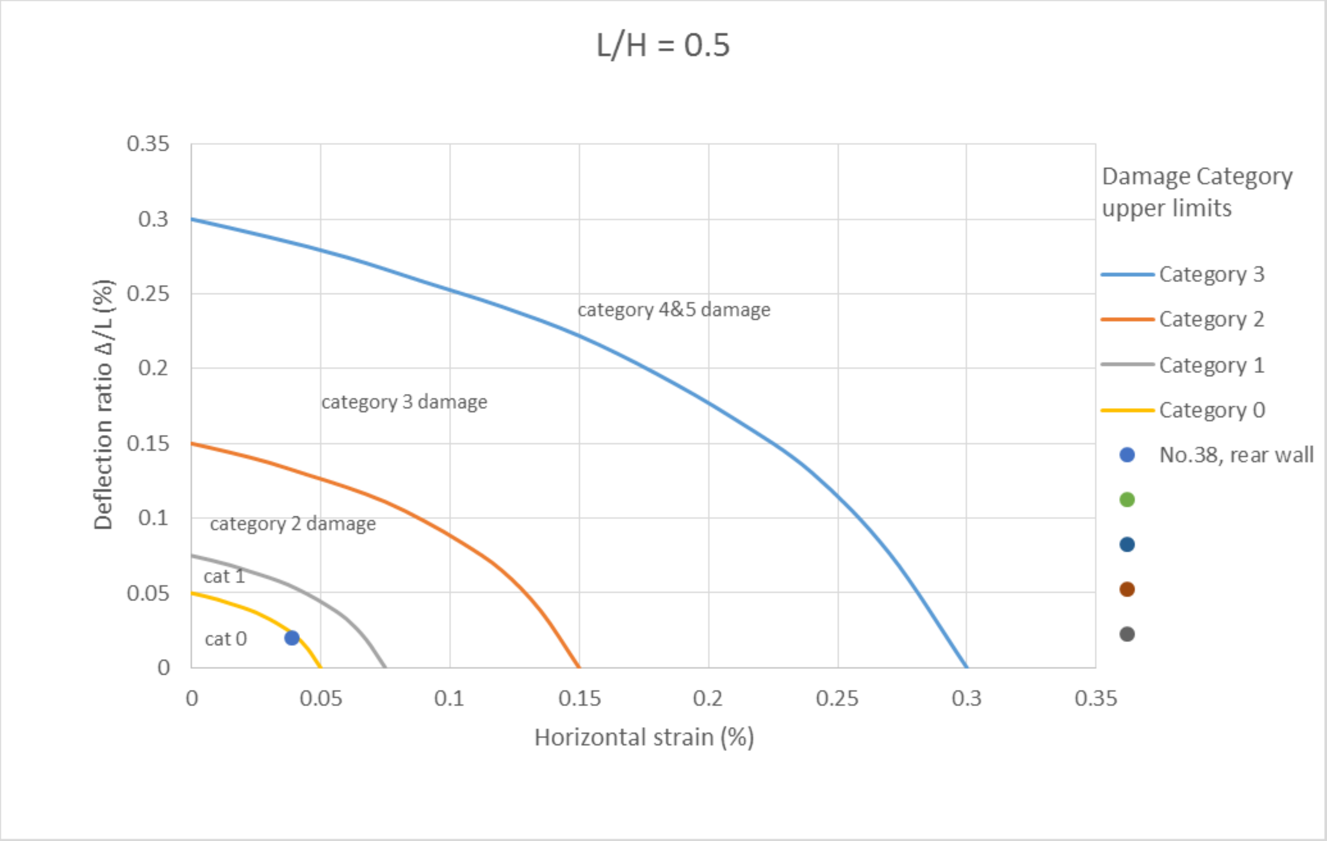

Figure 10: Damage category assessment for rear wall of No.38, the critical location.

10.6.7 Using the graphs for L/H = 0.5, these deformations represent a damage category of 'negligible' (Burland Category 0, ε_{lim} = <0.05%), close to the boundary with Category 1 'slight', as given in CIRIA SP200, Table 3.1, and illustrated in Figure 10 above.

10.6.8 Use of best practice construction methods, as outlined in paragraphs 10.4.5 to 10.4.8, will be essential to ensure that the ground movements are kept in line with the above predictions.

10.7 Monitoring

10.7.1 Condition surveys should be undertaken of the neighbouring properties before the works commence, in order to provide a factual record of any pre-existing damage. Such surveys are usually carried out while negotiating the Party Wall Award and are beneficial to all parties concerned.

10.7.2 Precise movement monitoring should be undertaken weekly throughout the period during which the basement walls and slab are constructed with initial readings taken before excavation of the basement starts. Readings may revert to fortnightly once all the perimeter walls and the basement slab have been completed. This monitoring should be undertaken with a total station instrument and targets attached at two levels at the following locations (as a minimum):

- Internally, at four equally spaced intervals along the party walls with both No's 34 & 38;
- Externally/within the communal garage, at three equally spaced intervals along the flank wall to No.34's entrance/stairs and the storage cupboards;
- Externally/within the communal garage, at three equally spaced intervals along the 32/34 party wall;
- Externally and within the communal garage, on the 36/38 party wall where it extends to the rear of the proposed basement (1 target at each level);
- Externally, on both the front and rear walls of No's 34/36/38, aligned with the 32/34, 34/36 and 36/38 party walls and No.38's flank wall (8 sets in total).

10.7.3 The accuracy of this system of monitoring is usually quoted as ± 2mm. Thus, if recorded movements in either direction reach 5mm, then the frequency of readings should be increased as appropriate to the severity of the movement, and consideration should be given to installing additional targets. If the recorded movements in either direction reach 7mm, then work should stop until new method statements have been prepared and approved by the appointed structural engineer.

10.7.4 If any structural cracks appear in the main loadbearing walls, then those cracks should be monitored using the Demec system (or similar) on the same frequency as the target monitoring.

10.8 Surface Flow and Flooding

10.8.1 The evidence presented in Section 5 has shown that:

- the site lies within the Environment Agency's Flood Zone 1 which means that it is considered to be at negligible risk of fluvial flooding;
- the site is not at risk of flooding from reservoirs, as mapped by Environment Agency;
- Flask Walk was not affected by the surface water flooding events in either 1975 or 2002;
- there are no surface water features within 250m of the site;
- the nearest 'river' is the Hampstead No.1 Pond which forms part of the Tertiary grade upper waters of the river Fleet at approximately 700m east of the property;
- the latest flood modelling by the Environment Agency gives a 'Very Low' risk of surface water flooding (the lowest category, which represents the national background level of risk) for No.36 and the surrounding area (see Figure 7).

10.8.2 While the nearest river to the site is one of the Hampstead Ponds on the river Fleet, the site is not in the catchment of the pond chain. It is, however, in the catchment of the Fleet being close to the head of the weakly developed valley which leads down to the main Fleet valley below Hampstead No.1 Pond. A minor tributary to the Fleet probably created this valley and was culverted or diverted into a sewer when the area was developed. Whether the culvert remains connected hydraulically to the perennial surrounding groundwater is unknown.

Change in Paved Surfacing & Surface Water Run-off:

10.8.3 The proposed front lightwell will replace the raised planter which occupies most of the space to the left of the steps up to the front door to No.36. A gap remains around this free standing, 'C' shaped planter, and the space behind is drained by a surface water gulley in the embayment. Both this raised planter and the one to the right of the steps up to the front door have been found to have solid bases (see paragraph 9.8). A flower bed is proposed within the lightwell, so provided that its area matches the (internal) area of the existing 'C' shaped planter then there would be no net change in soft landscaping and no change to the discharge of surface water to the mains drainage system. The raised planter to the right of the entrance will be replaced as part of the proposed scheme.

Surface Water (Pluvial) Flooding:

10.8.4 No.36 already has a good level of flood resistance, owing to the ground floor level being raised almost 1m above the adjacent footway and the total enclosure of the rear courtyard patio within perimeter walls. The proposed basement includes a wall at the front of the lightwell, which will provide full separation from the footway and will maintain a substantial level of flood resistance at the front of the property/ basement relative to the 'Very Low' risk of flooding predicted by the Environment Agency. Thus, only basic flood resistance measures will be required to protect the basement from flooding by surface water from the lightwell. As use of decking is already proposed within the lightwell this will provide a beneficial raised threshold to the doorway into the basement, and the floor of the lightwell should be set low enough to provide appropriate temporary interception storage for surface water (see 10.8.8 below).

Sewer Flooding:

10.8.5 Thames Water has no records of flooding from public sewers affecting No.36 (see 5.11). However, no drainage system can be guaranteed to have adequate capacity for all storm eventualities and all drainage systems only work at full capacity when they are properly maintained, including emptying gullies and regular checks of the sewers themselves for condition and blockages. Maintenance of the adopted sewers is the responsibility of Thames Water, so is outside both the Applicant's and the Council's control. The probability of future sewer flooding affecting No.36 is considered to be very low, provided that the sewer system is well maintained and appropriate flood resistance measures are implemented, as set out below.

10.8.6 Drainage systems are designed to operate under 'surcharge' at times of peak rainfall, which means that the level of effluent in the sewers may rise to ground level. When this happens the effluent can back-up into un-protected properties with basements or lower ground floors. During major rainfall events it is possible for some sewers to overflow at ground level, though this is rare.

10.8.7 Non-return valves and/or pumped above ground loop systems must therefore be fitted on the drains serving the basement and the lightwell, in order to ensure that water from the mains sewer system cannot enter the basement when the adjacent sewer is operating under surcharge. All drains which discharge via the same outfall as the basement must be protected, including those carrying roof water and foul water. A battery powered reserve pump should be fitted to ensure that the system remains functional during power cuts.

10.8.8 If non-return valves are used without an above-ground loop, then no effluent would at times be able to enter the mains sewer system when the flow in that sewer is sufficient to close the valves. The basement could then be vulnerable to flooding via the gullies in the lightwells and/or other low entry points on the drainage system within the basement. Sufficient temporary interception storage would therefore be required to hold temporarily the predicted maximum volume of water from all relevant sources which discharge via the valve-protected outfall (surface water from roof, rear patio and lightwell, and foul water) for the duration of the predicted surcharged flows in the sewer. If area below the decking in the lightwell is used for interception storage, then it must be protected from backup of foul sewage. This temporary interception storage would require formal design to ensure satisfactory performance.

10.8.9 If a non-return valve is fitted with an above-ground loop, then the loop must rise high enough above ground level to create sufficient pressure head to open the valve when the sewer flow is surcharged to ground level, otherwise the basement would once again be vulnerable to flooding while the surcharged flow continues. If it is not possible to achieve a sufficient rise of the loop above ground level, then temporary interception storage should be provided as recommended above.

10.9 Mitigation

10.9.1 The following mitigation measures have been recommended in Sections 10.2-10.8:

- In the unlikely event that the basement excavations encounter a local deposit of more permeable soils, of sufficient thickness to permit significant flow, then an engineered groundwater bypass should be provided (10.2.6).
- Cracks in load-bearing walls which have weakened their structural integrity should be fully repaired, in accordance with recommendations from the appointed structural engineers, before any underpinning is carried out (10.4.5).
- Subject to Party Wall Act negotiations, transitional underpinning blocks should be included beneath all load-bearing walls which adjoining the basement (10.4.13).
- Provision of a raised threshold at the doorway into the basement from the lightwell (10.8.5).
- Non-return valves and/or above ground loop systems should be fitted to the drains serving the basement and lightwell, in order to ensure that water from the sewer system cannot enter the basement when the mains sewer is operating under surcharge (see paragraphs 10.8.8 to 10.8.10).

11.0 NON-TECHNICAL SUMMARY – STAGE 4

11.1 This summary considers only the primary findings of this assessment; the whole report should be read to obtain a full understanding of the matters considered.

11.2 A services search should be undertaken for any tunnelled/deep utilities and London Underground should be asked to confirm that the basement is outside the exclusion zones for the Northern Line tunnels (10.1.3).

11.3 The proposed basement is expected to have minimal adverse impact on the likely limited groundwater flow at basement level in the Reworked Ground, while flow in the Made Ground is probably blocked by the footings so will only occur where service trenches or granular pipe bedding permits any perched groundwater to flow (10.2.1 to 10.2.3).

11.4 In the unlikely event that the basement excavations encounter a local deposit of more permeable soils of sufficient thickness to permit significant flow, then an engineered groundwater bypass would be required (10.2.6).

11.5 The basement will need to be fully waterproofed. Provisional design groundwater levels equal to ground level (short-term) and 0.5m below ground level (long-term) are proposed, which means that the basement must be able to resist buoyant uplift pressures (un-factored) of up to 18-39kN/m^2 (10.2.7 to 10.2.9).

11.6 Water entries into the basement excavations may be manageable by sump pumping although use of well points might be required (10.3.1). The clays onto which the underpins and the basement slab will bear must be blinded with concrete immediately following excavation and inspection (10.2.5, 10.3.3 and 10.4.11).

11.7 There are no concerns regarding slope stability subject to normal precaution, although the presence of Reworked Ground might have arisen from reinstatement of some past slope failure (10.4.1, 10.4.2).

11.8 The basement will be constructed using underpinning techniques. A high quality of workmanship and best practice methods of construction and temporary support will be crucial to the satisfactory control of ground movements. Requirements for temporary support are summarised (10.4.3 to 10.4.8).

11.9 Various other guidance is provided in relation to the geotechnical design of the basement's perimeter walls. The adequacy of the available bearing capacity in the Reworked Ground must be checked when the first underpins are inspected (10.4.10, 10.4.11).

11.10 Transitional underpins should be considered, subject to agreement under the Party Wall Act negotiations, for all load-bearing walls which adjoin the basement (10.4.13).

11.11 Analyses have been undertaken using PDISP software of the likely heave/settlement in response to the net changes in vertical stress resulting from the construction of these basements. The perimeter walls were predicted to undergo 0-4mm of settlement (see Table 4). The soils beneath the basement floor were predicted to experience between 2mm settlement and 1mm of heave, although the RC floor slabs will only experience the post-construction incremental heave of up to about 1mm with 2mm differential across the slab (Section 10.5).

11.12 A preliminary damage category assessment indicated that, under the worst case scenario, damage to No.57 is likely to fall within Burland Category 0, 'negligible', almost on the boundary with Category 1 'slight' (Section 10.6).

11.13 Condition surveys of the neighbouring properties should be commissioned, and a programme of monitoring the adjoining structures should be established before the works start (Section 10.7).

11.14 The Environment Agency's maps show that the site is at negligible risk of flooding from rivers or the sea, and at no risk of flooding from reservoirs (10.8.1).

11.15 Provided that the area of the flower bed within the lightwell matches the internal area of the 'C' shaped planter to the left of the steps up to the front door, then the proposed basement scheme would not result in any increase in paved surface area or in any increase in surface water discharge to the mains drainage system (10.8.3).

11.16 The property already has a good level of flood resistance, and Flask Walk is not recorded as having flooded during either the 1975 or 2002 surface water flooding events (10.8.4). The latest flood modelling by the Environment Agency gave a 'Very Low' risk of flooding by surface water to No.36's site; this is the lowest, national background level of risk. Appropriate flood mitigation precautions, to provide a raised threshold in the lightwell, are recommended (10.8.5).

11.17 Non-return valves and/or above ground loop systems should be fitted to the drains serving the basement and the lightwell. Temporary interception storage may also be required (10.8.7-10.8.9).

11.18 The mitigation measures recommended in various parts of Sections 10.2 to 10.8 have been summarised in Section 10.9.

References

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URS (2009) Camden Infrastructure Study: Utilities and Physical Infrastructure Needs Assessment.

a) This report has been prepared for the purpose of providing advice to the client pursuant to its appointment of Chelmer Site Investigation Laboratories Limited (CSI) to act as a consultant.
b) Save for the client no duty is undertaken or warranty or representation made to any party in respect of the opinions, advice, recommendations or conclusions herein set out.
c) All work carried out in preparing this report has used, and is based upon, our professional knowledge and understanding of the current relevant English and European Community standards, approved codes of practice, technology and legislation.
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Project:

36 Flask Walk, London, NW3 1HE

15408

Photo 1: Front elevation (street scene) looking east. No.36 Flask Walk is a 3 storey terraced house with a mansard roof. There is a communal covered parking area which is shared by No's 30-36, and can be accessed via the garage door and ramp located beneath the adjoining No.34.

Photo 2: Front elevation (street scene) looking south-west. No.36 is situated on the south-east side of Flask Walk, between No's 34 & 38. Note the north-eastwards fall of the Flask Walk carriageway.

Title:	**Photographs - Sheet 1**					Sheet	**A1**
Date:	28th January 2015	Checked:	AG	Approved:	KRG	Scale :	NTS

Project:

36 Flask Walk, London, NW3 1HE

15408

Photo 3: The footway falls gently towards the carriageway in front of the property, and falls more steeply towards the carriageway at the cross-over to the communal parking area.

Photo 4: At the front of the property there are two raised planting areas, and a short flight of steps which lead up from the footway.

Title:	**Photographs - Sheet 2**					Sheet	**A2**
Date:	28th January 2015	Checked:	AG	Approved:	KRG	Scale :	NTS

Project:

36 Flask Walk, London, NW3 1HE

15408

Photo 5: To the rear of the property there is a courtyard patio area which is bounded by high rendered walls on all sides, and surfaced with tiles.

Photo 6: The communal parking area is located behind No.36, underneath the patio area (photo 5). The depth of the proposed basement will exceed that of the parking area, therefore the rear wall of No.36 will need to be underpinned. Note concrete pillar on left.

Title:	**Photographs - Sheet 3**				Sheet	**A3**
Date:	28th January 2015	Checked: AG	Approved:	KRG	Scale :	NTS

Photo 7: To the rear of the property a concrete beam can be found spanning the width of the house, resting on the No.36/34 and No.36/38 party walls. This beam transfers the load of the rear wall onto the party walls.

Project:

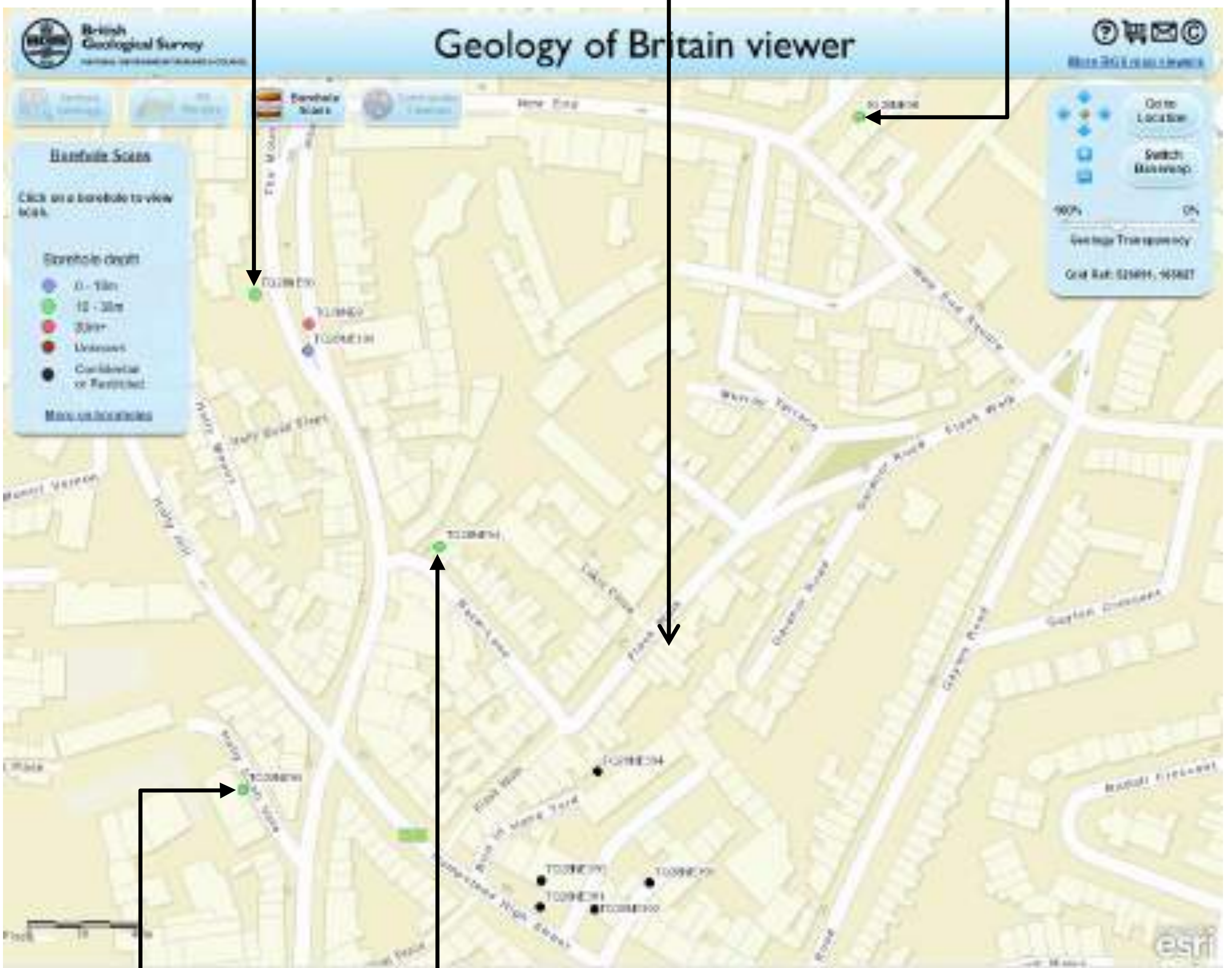
36 Flask Walk, London, NW3 1HE

15408

36 Flask Walk

TQ28NE/93 (OF6)

TQ28NE/98 (OF11)



TQ28NE/95 (OF8)

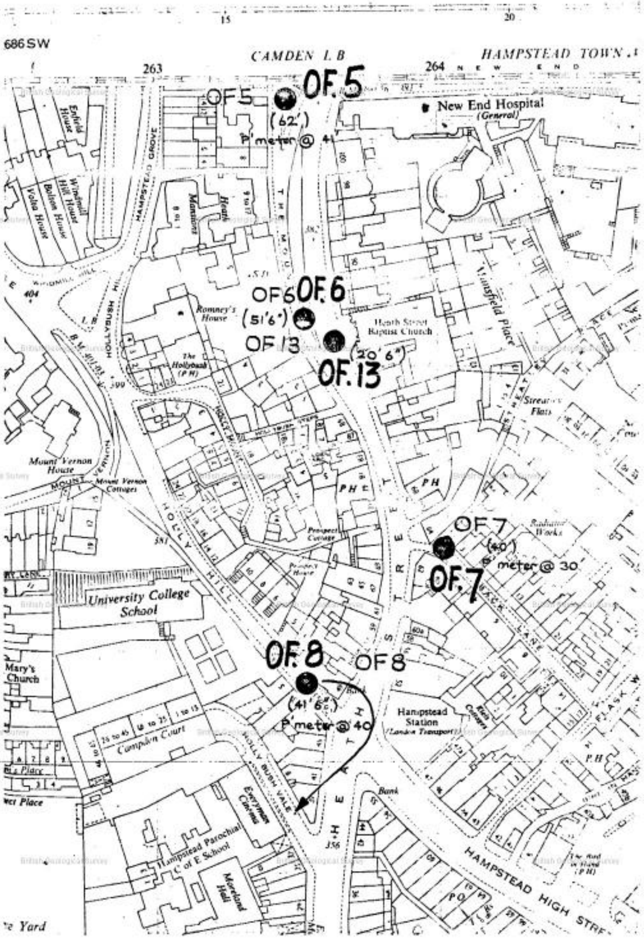
TQ28NE/94 (OF7)

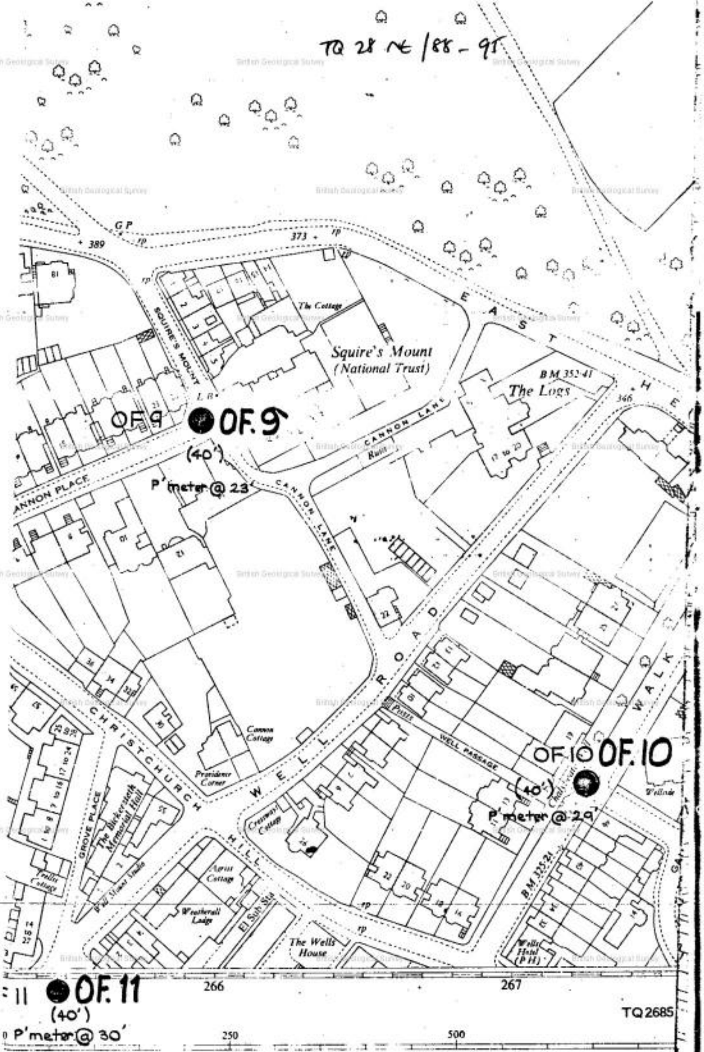
Title:	**Location Plan of BGS Boreholes**					Sheet	**B1**
Date:	24th March 2015	Checked:	AG	Approved:	KRG	Scale :	NTS

E SURVEY TQ 28 NE 88 - 104

Revised May 1965
Levelled 1953

688 inches to 1 mile PLA





...lished by the Director General of the Ordnance Survey, Chessington, Surrey, 1954.

TQ/28NE/93
2634 8593. OF.6

RECORD OF BOREHOLE No. OF6

Location : THE MOUNT/HEATH ST., HAMPSTEAD HEATH
Contract No. : 431
Type of Boring : Shell + Auger
Date (started) : 16. 5. '69

Borehole Dia : 8"
Casing :
Ground Level : 386.34'

Sheet 1 of 2

Depth of Casing	Water Level	Depth	Type	No.	Legend	Depth	Thickness	DESCRIPTION OF STRATA
	DRY							MADE GROUND
		2'6"	D	1			6'0"	(dark brown poorely sorted sand with some clay brick frag. roots + pebbles)
		5'0"	U	2		6'0"		
		7'6"	D	3			5'0"	Firm/stiff brown micaceous CLAY with abundant coarse & med. angular sand fragments.
		10'0"	U	4		11'0"		
						12'0"	1'0"	Compact brown sandy CLAY
		12'6"	D	5			3'0"	Pale fawn/pale grey CLAY, predominates over a fine SAND or clayey sand.
		15'0"	U	6		15'0"		
		17'6"	D	7			7'0"	Orange/brown fine SAND light grey/cream soft CLAY + grey clayey SAND (SAND predominates)
		20'0"	U	8		22'0"		
		22'6"	D	9		23'0"	1'0"	Stiff cream CLAY predom. over fine SAND
						25'0"	2'0"	Fine brown SAND
		25'0" (N=31)	D	10		27'0"	2'0"	Soft/firm brown silty sandy CLAY
		27'6"	D	11		28'0"	1'0"	Soft/firm silty sandy CLAY
		30'0" (N=25)	D	12				
32'0"	4'0"	32'6"	D	13				extremely wet running fine brown silty SAND
32'0"	4'0"						12'0"	
		35'0"	D	14				
		37'6"	D	15				
		40'0" (N=19)	D	16		(40'0")		

REMARKS: Water first met at 29'0" and then again at 47'0"

SCALE 1" = 5'

Foundation Engineering Ltd.

TQ/28NE/93
2634.8593. OF.6

RECORD OF BOREHOLE No: OF6

THE MOUNT/HEATH ST., HAMPSTEAD HEATH

No. : 481

Boring : Shell + Auger

(started) : 16 5/69

Borehole Dia : 8"

Casing :

Ground Level : 386.34'

Sheet 2 of 2

Water Level	SAMPLES Depth	Type	No.	STRATA Legend	Depth	Thickness	DESCRIPTION OF STRATA
					40.0		
					41.0	1.0	Soft/firm brown silty sandy CLAY
	42.6	D	17				
	45.0	U	18		45.0	4.0	Dark brown silty clayey SAND
	47.6	D	19				
					49.0	4.0	Firm dark grey silty sandy CLAY
	50.0	U	20				
2.0					51.6	2.6	Firm grey silty sandy CLAY
				Borehole complete			

Foundation Engineering Ltd.

TQ/28NE/94
2641.8584. OF.7

RECORD OF BOREHOLE No: OF7

BACK LANE,
HAMPSTEAD HEATH

... No : 431
... Boring : Shell + Auger
... (Started) : 19.5.'69

Borehole Dia : 8"
Casing : 6" to 40'0"
Ground Level : 369.350'

Water Level	Samples Depth	Samples Type	Samples No	Strata Legend	Strata Depth	Strata Thickness	Description of Strata
					1'0"	1'0"	MADE GROUND + Top soil
	2'6"	D	1				Light brown fine compact micaceous clayey SAND
	5'0"	U	2			7'0"	(= pale grey CLAY + brown SAND)
	7'6"	D	3		8'0"		
					10'0"	2'0"	Compact golden brown + grey clayey SAND
	10'0"	U	4				Firm cream/grey CLAY, predominates over golden brown fine sand.
	12'6"	D	5		14'0"	4'0"	
	15'0"	U	6				Cream/light grey soft + firm CLAY, + wet very fine brown sand
	17'6"	D	7			9'0"	(= wet mottled micaceous silty sandy clay)
	20'0" (N=16)	D	8				
	22'6"	D	9		23'0"		(as above)
25'0 Dry / 25'0 Dry	25'0" (N=19)	D	10			5'6"	darker in colour
	27'6"	D	11		28'6"		
	30'0"	U	12				Silty SAND predom. over clay bands + lenses.
	32'6"	D	13			6'6"	(= dark grey micaceous silty clayey sand)
	35'0"	U	14		35'0"		(as above)
	37'6"	D	15			5'0"	CLAY content now firm/stiff is very much increased.
40'0 4'0"	40'0"	U	16		40'0"		

Borehole Complete.

Water first met at 18'0"

Piezometer installed at 30'0"

Foundation Engineering Ltd.

TQ/28NE/195
2635.8575. OF.8

RECORD OF BOREHOLE No.: OF8

HOLLY BUSH VALE,
HAMPSTEAD HEATH

No. : 431
Boring : Shell & Auger
(started) : 20.5.65

Borehole Dia : 6"
Casing :
Ground Level : 356.863'

Sheet 1 of 2

Water Level	Samples: Depth	Type	No.	Strata: Legend	Depth	Thickness	Description of Strata
					2:0	2:0	MADE GROUND (Brick Rubble)
	2:6"	D	1				Mottled grey, orange brown & light brown firm slightly sandy CLAY
	5:0	U	2		6:0	4:0	
	7:6	D	3				Loose dry golden brown fine micaceous SAND (very local soft grey clay pockets)
	10:0	U	4		11:0	5:0	
	12:6	D	5		13:0	2:0	Light brown silty soft/firm CLAY & fine orange brown sand.
	15:0	U	6		16:0	3:0	Firm brown sandy CLAY
	17:6	D	7		18:0	2:0	Grey silty firm CLAY & fine brown sand.
	20:0	U	8				
	22:6	D	9				
	25:6	U	10				Dark grey stiff silty micaceous CLAY, (locally greenish tinge)
	27:6	D	11			23:6	
	30:6	U	12				356 / 11 / 345
	32:6	D	13				
	35:0	U	14				
	37:6	D	15				
4:0	40:0	U	16		40:0		

Water first met at 32:0
Piezometer installed at 40:0

Foundation Engineering Ltd.

TQ/28NE/95

2635 . 8978. OF.8

RECORD OF BOREHOLE No: OF8

HOLLY BUSH VALE,
HAMPSTEAD HEATH

... : No. : 431

... of Boring : Shell + Auger

Date (started) : 20 . 5 . 69

Borehole Dia : 6"

Casing :

Ground Level : 356 . 863'

Sheet 2 of 2

Depth of ...	Water Level	SAMPLES			STRATA			DESCRIPTION OF STRATA
		Depth	Type	No.	Legend	Depth	Thickness	
						41·6 Borehole Complete		as on sheet 1.

Foundation Engineering Ltd.

TQ/28NE/98

2656 . 8600.

OF. 11

RECORD OF BOREHOLE No: OF11

WELL ROAD
HAMPSTEAD HEATH

... No. : 431
... Boring : Shell + Auger
... (started) : 22. 5. '69

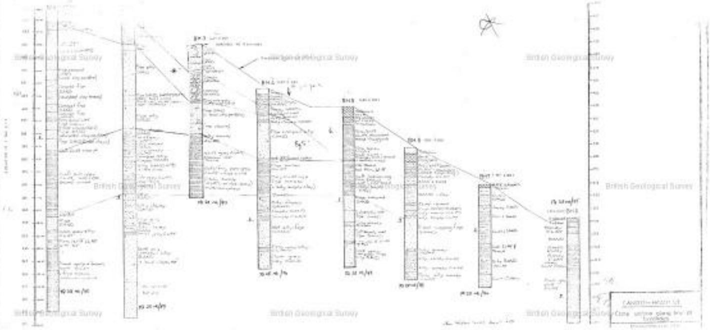
Borehole Dia : 6"
Casing : 6" to 35:0
Ground Level : 354·09'

Water Level	Samples Depth	Type	No.	Legend	Strata Depth	Thickness	Description of Strata
					1'0	1'0	MADE GROUND Asphalt + brick rubble
	2:6	D	1				Dark orange/brown + grey loose micaceous silty sandy CLAY (mixture firm clay + loose sand)
	5:0	U	2		6:0	5:0	
	7:6	D	3				Cream/light grey firm micaceous silty CLAY, predominates over orange/brown fine Sand
	10:0	U	4		12:0	6:0	
	12:6 (N=19)	D	5				extremely wet deep orange/brown fine micaceous silty SAND
	15:0	D	6		17:0	5:0	
	17:6	D	7				Mottled grey + brick red firm micaceous silty CLAY and light brown fine Sand.
	20:0	U	8		22:0	5:0	
	22:6	D	9				Dark grey micaceous silty sandy CLAY
	25:0	U	10		25:0	3:0	
	27:6	D	11				Dark grey + brown mixture of silty SAND + CLAY
	30:0	U	12			10:0	
	32:6	D	13				
	35:0	U	14		35:0		
	37:6	D	15			5:0	Dark grey firm/stiff micaceous silty CLAY
DRY	40:0	U	16		40:0		

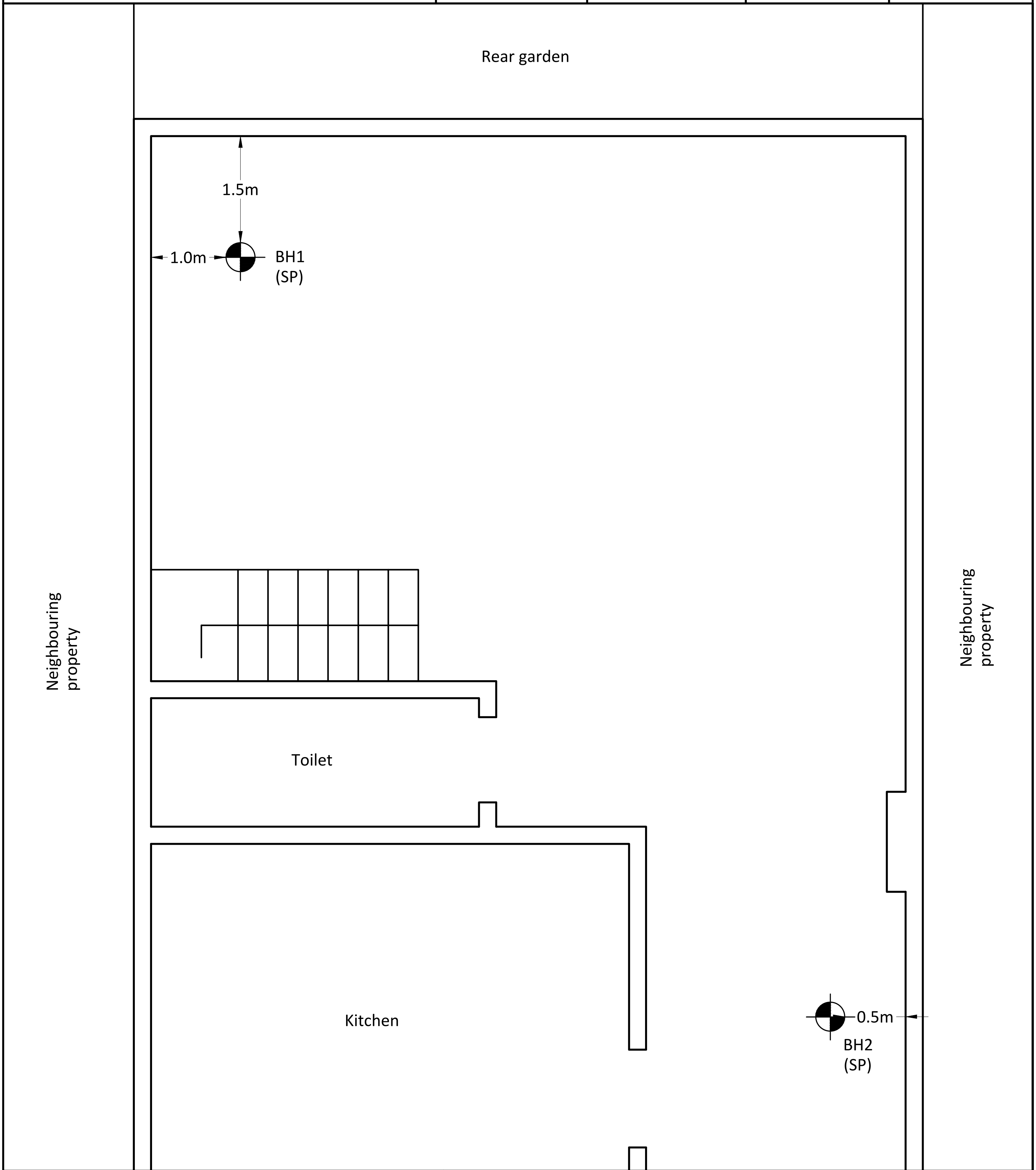
Borehole Complete

Water first met at 17:0
Piezometer installed at 30:0

Foundation Engineering Ltd.


BH 3
BH 2
BH 8
BH 7

Client: Vidhur Mehra	**Scale:** N.T.S.	**Sheet:** 1 of 1	**Date:** 09.02.15	
Location: 36 Flask Walk, London, NW3 1HE	**Job No:** 5058	**Weather:** Internal	**Drawn by:** JP	**Checked by:** JH



Notes: *On site tree identification for guidance only. Not authenticated.*

Standpipes located under floor board.

Key:

Chelmer
Site Investigations
'Groundbreaking Services'

Client: Vidhur Mehra	Scale: N.T.S.	Sheet No: 1 of 1	Weather: Internal	Date: 09.02.15
Site: 36 Flask Walk, London, NW3 1HE	Job No: 5058	Borehole No: 1	Boring method: CFA 100mmØ Secondman	

Depth Mtrs.	Description of Strata	Thickness	Legend	Sample	Test Type	Test Result	Root Information	Depth to Water	Depth Mtrs
F.L. 0.030	FLOOR BOARD	0.030							
1.2	VOID (floor space)	1.17					No roots observed.		
1.3	CONCRETE	0.1		D					1.3
2.0	MADE GROUND: medium compact, dark brown, slightly gravelly slightly sandy silty clay with brick and concrete fragments.	0.7		D					1.5
				D	V	80 86			2.0
				D					2.5
				D	V	96 98			3.0
				D					3.5
	REWORKED GROUND: mid brown, silty sandy clay with occasional fine gravel and brick fragments.	3.5		D	V	116 116			4.0
				D					4.5
				D	V	124 124			5.0
5.5				D					5.5
	Stiff orange/brown silty very sandy CLAY with fine gravel.	1.4		D	V	130+ 130+			6.0
6.9								6.6	
				D	V	130+ 130+		7.0	7.0
	Very stiff, mid grey, fissured silty CLAY with partings of grey silt and fine sand.	2.1		D	V	130+ 130+			8.0
9.0				D	V	130+ 130+			9.0
	Very stiff, dark grey, fissured silty CLAY with partings of grey silt.	1.0							
10.0	Borehole ends at 10.0m			D	V	130+ 130+			10.0

Drawn by: JP **Approved by:** JH

Remarks: *Groundwater strike at 6.6m.*
Groundwater standing at 7.0m on completion.
Borehole wet and open on completion.
Plastic standpipe installed to 10.0m.

Key: T.D.T.D. Too Dense to Drive
D Small Disturbed Sample J Jar Sample
B Bulk Disturbed Sample V Pilcon Vane (kPa)
U Undisturbed Sample (U100) M Mackintosh Probe
W Water Sample N Standard Penetration Test Blow Count

Chelmer Site Investigations 'Groundbreaking Services'

Client: Vidhur Mehra		**Scale:** N.T.S.	**Sheet No:** 1 of 1	**Weather:** Internal	**Date:** 09.02.15
Site: 36 Flask Walk, London, NW3 1HE		**Job No:** 5058	**Borehole No:** 2	**Boring method:** CFA 100mmØ Secondman	

Depth Mtrs.	Description of Strata	Thick-ness	Legend
F.L. 0.030	FLOOR BOARD	0.030	
1.2	VOID(floor space)	1.17	
1.3	CONCRETE	0.1	
1.4	MADE GROUND: medium compact, dark brown, slightly gravelly slightly sandy silty clay with brick fragments.	0.1	
2.0	MADE GROUND: medium compact, light grey silty sandy fine gravel with concrete and brick fragments.	0.6	
4.5	REWORKED GROUND: mid brown, silty sandy clay with occasional fine gravel and brick fragments.	2.5	
6.0	Stiff orange/brown, silty very sandy CLAY with occasional fine gravel.	1.5	
10.0	Very stiff, mid grey, fissured silty CLAY with partings of grey silt and fine sand.	4.0	
	Borehole ends at 10.0m		

Sample	Test Type	Test Result	Root Information	Depth to Water	Depth Mtrs
			No roots observed.		
D					1.3
D					1.5
D	V	80 86			2.0
D					2.5
D	V	96 98			3.0
D					3.5
D	V	116 116			4.0
D					4.5
D	V	121 121			5.0
D					5.5
D	V	130+ 130+		*6.0*	6.0
D	V	130+ 130+			7.0
D	V	130+ 130+			8.0
D	V	130+ 130+			9.0
D	V	130+ 130+			10.0

Drawn by: JP **Approved by:** JH

Remarks: *Groundwater strike at 6.0m.*
Borehole wet and open on completion.
Plastic standpipe installed to 10.0m.

Key: T.D.T.D. Too Dense to Drive
D Small Disturbed Sample J Jar Sample
B Bulk Disturbed Sample V Pilcon Vane (kPa)
U Undisturbed Sample (U100) M Mackintosh Probe
W Water Sample N Standard Penetration Test Blow Count

Laboratory Report

Site	36 Flask Walk, London, NW3 1HE
Client	Vidhur Mehra
Date	20-Feb-15
Our Ref	CSI5058
CGL Ref	CGL04684

Chelmer Site Investigation Laboratories Ltd
Unit 15 East Hanningfield Industrial Estate, Old Church Road, East Hanningfield, Essex CM3 8AB
Essex: 01245 400930 | London: 0203 6409136 |info@siteinvestigations.co.uk | www.siteinvestigations.com

Content Summary

This report contains all test results as indicated on the test instruction/summary (Form Q17).

CGL Reference :	CGL04684	
Client Reference :	CSI5058	
For the attention of :	Vidhur Mehra	
This report comprises of the following :	2	Page(s) of Results
	1	Moisture/Shear Strength Chart
	1	Plasticity Chart
	4	Page(s) BRE SD1 Result(s)

Notes :

General

Please refer to report summary notes for details pertaining to methods undertaken and their subsequent accreditations

Samples were supplied by Chelmer Site Investigations

All tests performed in-house unless otherwise stated

Deviant Samples

Samples were received in suitable containers	Yes
A date and time of sampling was provided	Yes
Arrived damaged and/or denatured	No

Laboratory Testing Results

BS 1377 : 1990

Chelmer Geotechnical Laboratories "Groundbreaking Services"

Job Number : CGL04684
Client : Vidhur Mehra
Client Reference : CSI5058
Site Name : 36 Flask Walk, London, NW3 1HE

Date Received : 13/02/2015
Date Testing Started : 17/02/2015
Date Testing Completed : 20/02/2015
Laboratory Used : Chelmer Geotechnical, CM3 8AB

Sample Ref			Sample Type	*Moisture Content (%) [1]	*Soil Faction > 0.425mm (%) [2]	*Liquid Limit (%) [3]	*Plastic Limit (%) [4]	*Plasticity Index (%) [5]	*Liquidity Index (%) [5]	*Modified Plasticity Index (%) [6]	*Soil Class [7]	Filter Paper Contact Time (h) [8]	*Soil Sample Suction (kPa)	Insitu Shear Vane Strength (kPa) [9]	Organic Content (%) [10]	*pH Value [11]	*Sulphate Content (g/l)		
BH/TP/WS	Depth (m)	UID															SO_3 [12]	SO_4 [13]	Class [14]
BH1	3.0	60491	D	28	<5	49	18	31	0.32	31	CI			97					
BH1	4.0	60492	D	29	<5	48	20	29	0.32	29	CI			116					
BH1	5.0	60493	D	29	<5	48	18	30	0.37	31	CI			124					
BH1	8.0	60494	D											>130		7.1	0.13	0.15	DS-1
BH1	10.0	60495	D	40	<5	47	16	31	0.75	31	CI			>130		7.8	0.10	0.12	DS-1

Notes :- *UKAS Accredited Tests

[1] BS 1377 : Part 2 : 1990, Test No 3.2
[2] Estimated if <5%, otherwise measured
[3] BS 1377 : Part 2 : 1990, Test No 4.4
[4] BS 1377 : Part 2 : 1990, Test No 5.3
[5] BS 1377 : Part 2 : 1990, Test No 5.4
[6] BRE Digest 240 : 1993
[7] BS 5930 : 1981 : Figure 31 - Plasticity Chart for the classification of fine soils
[8] In-house method S9a adapted from BRE IP 4/93
[9] Values of shear strength were determined in situ by Chelmer Site Investigations using a Pilcon hand vane or Geonor vane (GV).
[10] BS 1377 : Part 3 : 1990, Test No 4
[11] BS 1377 : Part 2 : 1990, Test No 9
[12] BS 1377 : Part 3 : 1990, Test No 5.6
[13] $SO_4 = 1.2 \times SO_3$
[14] BRE Special Digest One (Concrete in Aggressive Ground) 2005

Note that if the SO_4 content falls into the DS-4 or DS-5 class, it would be prudent to consider the sample as falling into the DS-4m or DS-5m class respectively unless water soluble magnesium testing is undertaken to prove otherwise

Key

- **D** - Disturbed sample
- **B** - Bulk sample
- **U** - U100 (undisturbed sample)
- **W** - Water sample
- **ENP** - Essentially Non-Plastic
- **U/S** - Underside Foundation

UKAS TESTING 8284

Comments :-

Technician :- HS | Checked By :- MC | Date Checked :- 20-Feb-15

Laboratory Testing Results

BS 1377 : 1990

Job Number : CGL04684
Client : Vidhur Mehra
Client Reference : CSI5058
Site Name : 36 Flask Walk, London, NW3 1HE

Date Received : 13/02/2015
Date Testing Started : 17/02/2015
Date Testing Completed : 20/02/2015
Laboratory Used : Chelmer Geotechnical, CM3 8AB

Sample Ref			Sample Type	*Moisture Content (%) [1]	*Soil Faction > 0.425mm (%) [2]	*Liquid Limit (%) [3]	*Plastic Limit (%) [4]	*Plasticity Index (%) [5]	*Liquidity Index (%) [5]	*Modified Plasticity Index (%) [6]	*Soil Class [7]	Filter Paper Contact Time (h) [8]	*Soil Sample Suction (kPa)	Insitu Shear Vane Strength (kPa) [9]	Organic Content (%) [10]	*pH Value [11]	*Sulphate Content (g/l)		
BH/TP/WS	Depth (m)	UID															SO_3 [12]	SO_4 [13]	Class [14]
BH2	1.5	60496	D													7.3	0.34	0.41	DS-1
BH2	3.0	60497	D	29	<5	48	18	30	0.39	30	CI			97					
BH2	4.0	60498	D	33	<5	48	17	31	0.50	31	CI			116		6.9	0.10	0.12	DS-1

Notes :- *UKAS Accredited Tests

[1] BS 1377 : Part 2 : 1990, Test No 3.2

[2] Estimated if <5%, otherwise measured

[3] BS 1377 : Part 2 : 1990, Test No 4.4

[4] BS 1377 : Part 2 : 1990, Test No 5.3

[5] BS 1377 : Part 2 : 1990, Test No 5.4

[6] BRE Digest 240 : 1993

[7] BS 5930 : 1981 : Figure 31 - Plasticity Chart for the classification of fine soils

[8] In-house method S9a adapted from BRE IP 4/93

[9] Values of shear strength were determined in situ by Chelmer Site Investigations using a Pilcon hand vane or Geonor vane (GV).

[10] BS 1377 : Part 3 : 1990, Test No 4

[11] BS 1377 : Part 2 : 1990, Test No 9

[12] BS 1377 : Part 3 : 1990, Test No 5.6

[13] $SO_4 = 1.2 \times SO_3$

[14] BRE Special Digest One (Concrete in Aggressive Ground) 2005

Note that if the SO_4 content falls into the DS-4 or DS-5 class, it would be prudent to consider the sample as falling into the DS-4m or DS-5m class respectively unless water soluble magnesium testing is undertaken to prove otherwise

Key

D - Disturbed sample
B - Bulk sample
U - U100 (undisturbed sample)
W - Water sample
ENP - Essentially Non-Plastic
U/S - Underside Foundation

UKAS TESTING 8284

Comments :-

Technician :- HS

Checked By :- MC

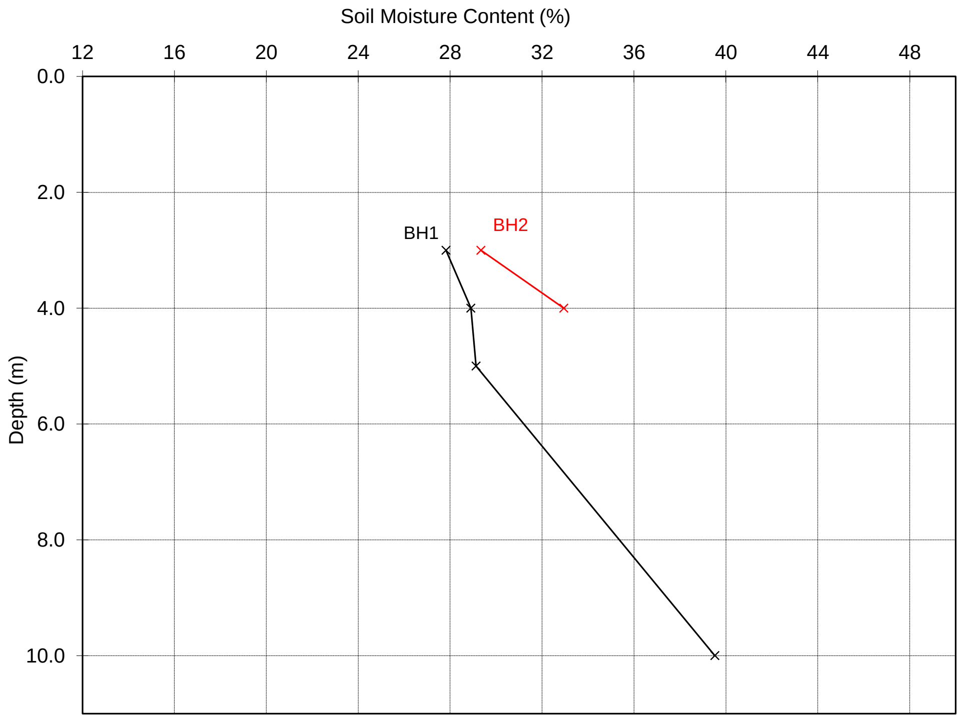
Date Checked :- 20-Feb-15

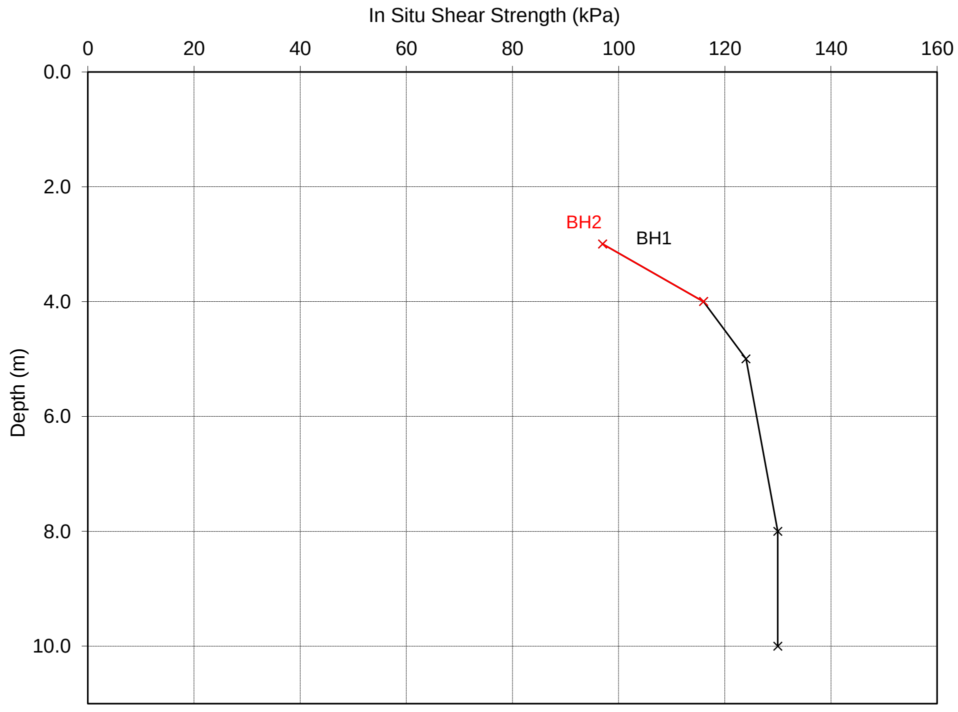
Laboratory Testing Results

Moisture Content/Shear Strength Profile

Job Number : CGL04684
Client : Vidhur Mehra
Client Reference : CSI5058
Site Name : 36 Flask Walk, London, NW3 1HE

Date Received : 13/02/2015
Date Testing Started : 17/02/2015
Date Testing Completed : 20/02/2015
Laboratory : Chelmer Geotechnical Laboratories, CM3 8AB





Notes :-

1. If the Soil Fraction > 0.425mm exceeds 5% the Equivalent Moisture Content of the remainder (calculated in accordance with BS 1377: Part 2 : 1990, cl.3.2.4 note 1) is also plotted and the alternative profile additionally shown as an appropriately coloured broken line.
2. If plotted, 0.4 LL and PL+2 (after Driscoll, 1983) should only be applied to London Clay (and similarly over consolidated clays) at shallow depths.

Unless otherwise stated, values of Shear Strength were determined in situ by Chelmer Site Investigations using a Pilcon Hand Vane the calibration of which is limited to a maximum reading of 140 kPa. (Not UKAS accredited)

UKAS TESTING 8284

Comments :-

Checked By :- MC

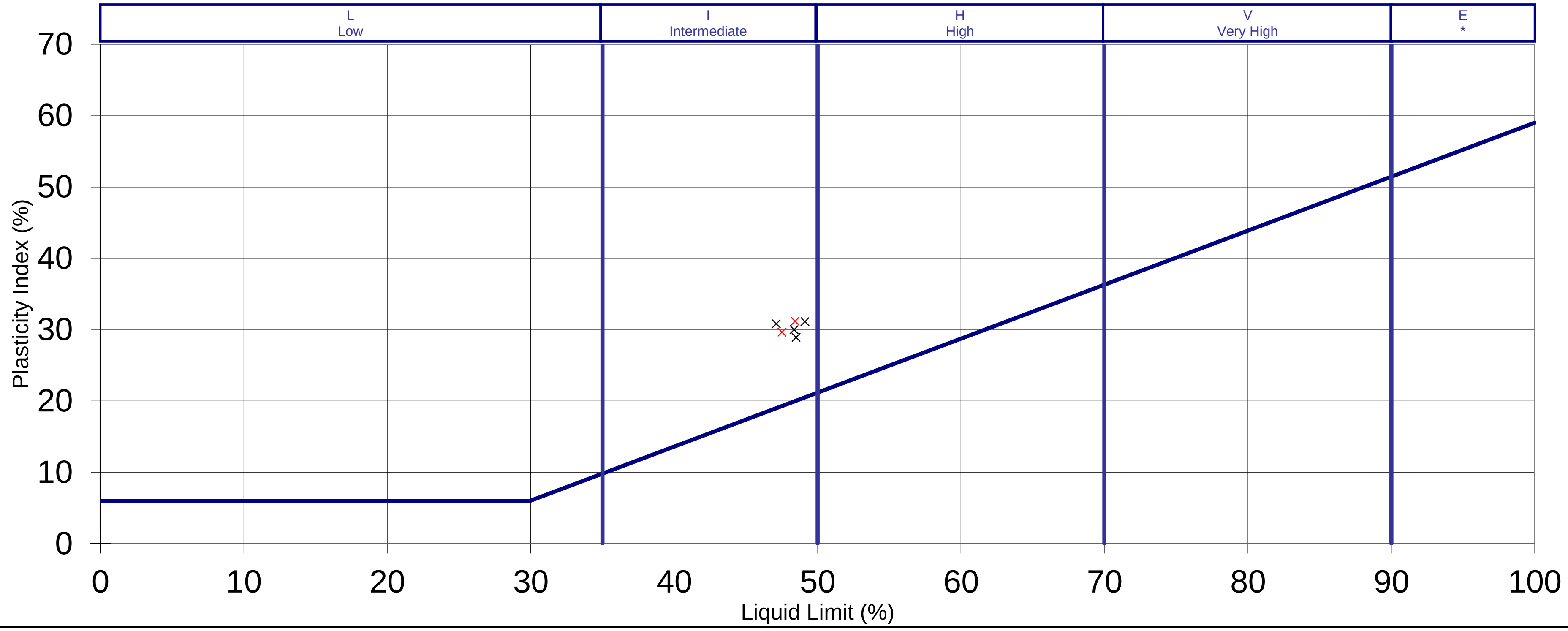
Date Checked :- 20-Feb-15

Laboratory Testing Results

Plasticity Chart for the classification of fine soils and the finer part of coarse soils
In Compliance with BS5930 : 1999

Chelmer Geotechnical Laboratories 'Groundbreaking Services'

Job Number :	CGL04684	Date Received :	13/02/2015
Client :	Vidhur Mehra	Date Testing Started :	17/02/2015
Client Reference :	CSI5058	Date Testing Completed :	20/02/2015
Site Name :	36 Flask Walk, London, NW3 1HE	Laboratory :	Chelmer Geotechnical Laboratories, CM3 8AB



Notes :-

SILT (M-SOIL), M, plots below A-Line
CLAY, C, plots above A-Line }M and C may be combined as FINE SOIL, F.

Key :- BH1
BH2

UKAS TESTING 8284

Comments :-

Checked By :- MC   Date Checked :- 20-Feb-15

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russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 15-28825

Site Reference:	36 Flask Walk, London NW3 1HE
Project / Job Ref:	CSI5058 CGL04684
Order No:	PO/3838/5058/MC
Sample Receipt Date:	17/02/2015
Sample Scheduled Date:	17/02/2015
Report Issue Number:	1
Reporting Date:	23/02/2015

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: 15-28825	**Date Sampled**	09/02/15	09/02/15	09/02/15	09/02/15	
Chelmer Site Investigation Laboratories Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	
Site Reference: 36 Flask Walk, London NW3 1HE	**TP / BH No**	60490	60492	60497	60499	
Project / Job Ref: CSI5058 CGL04684	**Additional Refs**	BH1	BH1	BH2	BH2	
Order No: PO/3838/5058/MC	**Depth (m)**	1.50	4.00	3.00	10.00	
Reporting Date: 23/02/2015	**QTSE Sample No**	136362	136363	136364	136365	

Determinand	**Unit**	**RL**	**Accreditation**					
pH	pH Units	N/a	**MCERTS**	7.2	7.3	7.2	7.2	
Total Sulphate as SO_4	mg/kg	< 200	NONE	2146	714	973	2296	
W/S Sulphate as SO4 (2:1)	g/l	< 0.01	**MCERTS**	0.40	0.24	0.13	0.10	
Total Sulphur	mg/kg	< 200	NONE	720	247	463	4740	
Ammonium as NH_4	mg/kg	< 0.5	NONE	0.6	0.9	1	1.7	
W/S Chloride (2:1)	mg/kg	< 1	**MCERTS**	23	20	18	16	
Water Soluble Nitrate (2:1) as NO_3	mg/kg	< 3	**MCERTS**	21	29	21	8	
W/S Magnesium	g/l	< 0.0001	NONE	0.0258	0.0142	0.0111	0.0139	

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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Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 15-28825	
Chelmer Site Investigation Laboratories Ltd	
Site Reference: 36 Flask Walk, London NW3 1HE	
Project / Job Ref: CSI5058 CGL04684	
Order No: PO/3838/5058/MC	
Reporting Date: 23/02/2015	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
136362	60490	BH1	1.50	18.8	Light brown clay
136363	60492	BH1	4.00	20.2	Light brown clay
136364	60497	BH2	3.00	20.3	Light brown clay
136365	60499	BH2	10.00	24.7	Light brown clay

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

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4480

Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 15-28825
Chelmer Site Investigation Laboratories Ltd
Site Reference: 36 Flask Walk, London NW3 1HE
Project / Job Ref: CSI5058 CGL04684
Order No: PO/3838/5058/MC
Reporting Date: 23/02/2015

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

This report is personal to the client, confidential and non assignable. It is issued with no admission of liability to any third party.

This report shall not be reproduced, except in full, without the written approval of Chelmer Site Investigations Laboratories Ltd.

Where our involvement consists exclusively of testing samples, the results and comments (if provided) relate only to the samples tested.

Any samples that are deemed to be subject to deviation will be recorded as such within the test summary.

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russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 15-28830

Site Reference:	36 Flask Walk, London, NW3 1HE
Project / Job Ref:	CSI5058 CGL04682
Order No:	PO/3836/5058/MC
Sample Receipt Date:	17/02/2015
Sample Scheduled Date:	17/02/2015
Report Issue Number:	2
Reporting Date:	31/03/2015

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
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Tel : 01622 850410

4480

Soil Analysis Certificate						
QTS Environmental Report No: 15-28830	**Date Sampled**	09/02/15	09/02/15	09/02/15		
Chelmer Site Investigation Laboratories Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied		
Site Reference: 36 Flask Walk, London, NW3 1HE	**TP / BH No**	60471	60472	60473		
Project / Job Ref: CSI5058 CGL04682	**Additional Refs**	BH1	BH2	BH2		
Order No: PO/3836/5058/MC	**Depth (m)**	1.50	1.50	2.00		
Reporting Date: 31/03/2015	**QTSE Sample No**	136377	136378	136379		

Determinand	**Unit**	**RL**	**Accreditation**					
Asbestos Screen	N/a	N/a	**ISO17025**	Not Detected	Not Detected			
pH	pH Units	N/a	**MCERTS**	7.1	7.1	7.0		
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2		
Total Sulphate as SO_4	mg/kg	< 200	NONE	2771	2140	1685		
W/S Sulphate as SO4 (2:1)	g/l	< 0.01	**MCERTS**	1.02	0.90	0.40		
Elemental Sulphur	mg/kg	< 10	NONE	< 10	< 10	< 10		
Sulphide	mg/kg	< 5	NONE	< 5	< 5	< 5		
Arsenic (As)	mg/kg	< 2	**MCERTS**	6	4	3		
Cadmium (Cd)	mg/kg	< 0.2	**MCERTS**	< 0.2	< 0.2	< 0.2		
Chromium (Cr)	mg/kg	< 2	**MCERTS**	29	41	34		
Copper (Cu)	mg/kg	< 4	**MCERTS**	15	15	12		
Lead (Pb)	mg/kg	< 3	**MCERTS**	91	29	15		
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1		
Nickel (Ni)	mg/kg	< 3	**MCERTS**	13	20	21		
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3		
Zinc (Zn)	mg/kg	< 3	**MCERTS**	53	41	41		
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2		

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

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

This report refers to samples as received, and QTS Environmental Ltd, takes no responsibility for the accuracy or competence of sampling by others.

The material description shall be regarded as tentative and is not included in our scope of UKAS Accreditation.

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.

Asbestos Analyst: Javeed Malik

RL: Reporting Limit

Pinch Test: Where pinch test is positive it is reported "Loose Fibres - PT" with type(s).

Subcontracted analysis (S)

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

Soil Analysis Certificate - Speciated PAHs						
QTS Environmental Report No: 15-28830	Date Sampled	09/02/15	09/02/15	09/02/15		
Chelmer Site Investigation Laboratories Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: 36 Flask Walk, London, NW3 1HE	TP / BH No	60471	60472	60473		
Project / Job Ref: CSI5058 CGL04682	Additional Refs	BH1	BH2	BH2		
Order No: PO/3836/5058/MC	Depth (m)	1.50	1.50	2.00		
Reporting Date: 31/03/2015	QTSE Sample No	136377	136378	136379		

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Phenanthrene	mg/kg	< 0.1	MCERTS	0.15	< 0.1	< 0.1		
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Fluoranthene	mg/kg	< 0.1	MCERTS	0.20	< 0.1	< 0.1		
Pyrene	mg/kg	< 0.1	MCERTS	0.16	< 0.1	< 0.1		
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	< 1.6		

Analytical results are expressed on a dry weight basis where samples are dried at less than 30^{O}C

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

Soil Analysis Certificate - TPH CWG Banded						
QTS Environmental Report No: 15-28830	**Date Sampled**	09/02/15	09/02/15	09/02/15		
Chelmer Site Investigation Laboratories Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied		
Site Reference: 36 Flask Walk, London, NW3 1HE	**TP / BH No**	60471	60472	60473		
Project / Job Ref: CSI5058 CGL04682	**Additional Refs**	BH1	BH2	BH2		
Order No: PO/3836/5058/MC	**Depth (m)**	1.50	1.50	2.00		
Reporting Date: 31/03/2015	**QTSE Sample No**	136377	136378	136379		

Determinand	**Unit**	**RL**	**Accreditation**					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01		
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05		
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3	< 3	< 3		
Aliphatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3	< 3		
Aliphatic >C21 - C34	mg/kg	< 10	MCERTS	< 10	< 10	< 10		
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	< 21	< 21	< 21		
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01		
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05		
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3	< 3		
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	< 10	< 10	< 10		
Aromatic (C5 - C35)	mg/kg	< 21	NONE	< 21	< 21	< 21		
Total >C5 - C35	mg/kg	< 42	NONE	< 42	< 42	< 42		

Analytical results are expressed on a dry weight basis where samples are dried at less than 30^{O}C

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Rose Lane
Lenham Heath
Maidstone
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Tel : 01622 850410

Soil Analysis Certificate - BTEX / MTBE						
QTS Environmental Report No: 15-28830	Date Sampled	09/02/15	09/02/15	09/02/15		
Chelmer Site Investigation Laboratories Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: 36 Flask Walk, London, NW3 1HE	TP / BH No	60471	60472	60473		
Project / Job Ref: CSI5058 CGL04682	Additional Refs	BH1	BH2	BH2		
Order No: PO/3836/5058/MC	Depth (m)	1.50	1.50	2.00		
Reporting Date: 31/03/2015	QTSE Sample No	136377	136378	136379		

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

Analytical results are expressed on a dry weight basis where samples are dried at less than 30^{O}C

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4480

Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3

QTS Environmental Report No: 15-28830	**Date Sampled**	09/02/15	
Chelmer Site Investigation Laboratories Ltd	**Time Sampled**	None Supplied	
Site Reference: 36 Flask Walk, London, NW3 1HE	**TP / BH No**	60471	
Project / Job Ref: CSI5058 CGL04682	**Additional Refs**	BH1	
Order No: PO/3836/5058/MC	**Depth (m)**	1.50	
Reporting Date: 31/03/2015	**QTSE Sample No**	136377	

Landfill Waste Acceptance Criteria Limits

Determinand	**Unit**	**MDL**		**Inert Waste Landfill**	**Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
TOC[MU]	%	< 0.1	0.3	3%	5%	6%
Loss on Ignition	%	< 0.01	3.32	--	--	10%
BTEX[MU]	mg/kg	< 0.05	< 0.05	6	--	--
Sum of PCBs	mg/kg	< 0.7	< 0.7	1	--	--
Mineral Oil[MU]	mg/kg	< 10	< 10	500	--	--
Total PAH[MU]	mg/kg	< 1.7	< 1.7	100	--	--
pH[MU]	pH Units	N/a	7.1	--	>6	--
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	< 1	--	To be evaluated	To be evaluated

Eluate Analysis	**2:1 mg/l**	**8:1 mg/l**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)**		
Arsenic[U]	< 0.01	< 0.01	< 0.2	0.5	2	25
Barium[U]	0.38	0.10	1.3	20	100	300
Cadmium[U]	< 0.0005	< 0.0005	< 0.02	0.04	1	5
Chromium[U]	0.006	< 0.005	< 0.20	0.5	10	70
Copper[U]	< 0.01	< 0.01	< 0.5	2	50	100
Mercury[U]	< 0.005	< 0.005	< 0.01	0.01	0.2	2
Molybdenum[U]	0.027	0.016	0.2	0.5	10	30
Nickel[U]	< 0.007	< 0.007	< 0.2	0.4	10	40
Lead[U]	< 0.005	< 0.005	< 0.2	0.5	10	50
Antimony[U]	< 0.005	< 0.005	< 0.06	0.06	0.7	5
Selenium[U]	< 0.005	< 0.005	< 0.1	0.1	0.5	7
Zinc[U]	0.006	< 0.005	< 0.2	4	50	200
Chloride[U]	33	4	70	800	15000	25000
Fluoride[U]	< 0.5	< 0.5	< 1	10	150	500
Sulphate[U]	1102	147	2454	**1000**	20000	50000
TDS	1060	250	3328	4000	60000	100000
Phenol Index	< 0.01	< 0.01	< 0.5	1	-	-
DOC	11.7	6.7	72.4	500	800	1000

Leach Test Information	
Sample Mass (kg)	0.21
Dry Matter (%)	83
Moisture (%)	20.6
Stage 1	
Volume Eluate L2 (litres)	0.31
Filtered Eluate VE1 (litres)	0.18

Results are expressed on a dry weight basis, after correction for moisture content where applicable
Stated limits are for guidance only and QTS Environmental cannot be held responsible for any discrepencies with current legislation
M Denotes MCERTS accredited test
U Denotes ISO17025 accredited test

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Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 15-28830	
Chelmer Site Investigation Laboratories Ltd	
Site Reference: 36 Flask Walk, London, NW3 1HE	
Project / Job Ref: CSI5058 CGL04682	
Order No: PO/3836/5058/MC	
Reporting Date: 31/03/2015	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
136377	60471	BH1	1.50	17	Brown gravelly clay with rubble
136378	60472	BH2	1.50	18.4	Light brown clay
136379	60473	BH2	2.00	18.6	Light brown clay

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

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Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 15-28830
Chelmer Site Investigation Laboratories Ltd
Site Reference: 36 Flask Walk, London, NW3 1HE
Project / Job Ref: CSI5058 CGL04682
Order No: PO/3836/5058/MC
Reporting Date: 31/03/2015

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

Landborne Gas Assessment

Site Ref: 5058
Site Name: 36 Flask Walk NW3 1HE

Well	Date	Methane Peak	Methane Steady	Methane GSV	Carbon Dioxide Peak	Carbon Dioxide Steady	Carbon Dioxide GSV	Oxygen	Atmos.	Flow	Response Zone	Depth to Water	CO	H2S
		%v/v	%v/v	l/hr	%v/v	%v/v	l/hr	%v/v	mbar	l/hr	m bgl	m bgl	ppm	ppm
BH1	13.02.15	0.5	0.5	0.0005	**0.7**	**0.7**	0.0007	20.7	988	0.1	1.00-10.00	5.03	4	0
	25.02.15	0.5	0.5	0.0005	**0.7**	**0.7**	0.0007	20.6	1000	0.1		5.03	3	0
BH2	13.02.15	0.5	0.5	0.0005	0.8	0.8	0.0008	20.4	987	0.1	1.00-10.00	3.84	4	0
	25.02.15	0.4	0.4	0.0004	0.8	0.8	0.0008	20.4	1000	0.1		3.84	4	0

Notes

NR = Not recorded
Values in Bold exceed the CO_2 Building Regulations threshold (>1.5%)
Values in Red exceed the Buildings Regulations Action Level (CO_2 >5.0% and CH_4 >1.5%)

REPORT NOTES

Equipment Used

Hand tools, Mechanical Concrete Breaker and Spade, Hand Augers, 100mm/150mm diameter Mechanical Flight Auger Rig, GEO205 Flight Auger Rig, Window Sampling Rig, and Large or Limited Access Shell & Auger Rig upon request and/or access permitting.

On Site Tests

By Pilcon Shear-Vane Tester (Kn/m^2) in clay soils, and/or Mackintosh Probe in granular soils or made ground and/or upon request Continuous Dynamic Probe Testing and Standard Penetration Testing.

Note:

Details reported in trial-pits and boreholes relate to positions investigated only as instructed by the client or engineer on the date shown.

We are therefore unable to accept any responsibility for changes in soil conditions not investigated i.e. variations due to climate, season, vegetation and varying ground water levels.

Full terms and conditions are available upon request.

Chelmer Consultancy Services
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East Hanningfield, Essex CM3 8AB
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Email: info@siteinvestigations.co.uk **Website**: www.siteinvestigations.co.uk

Figure D1. Layout of the proposed basement foundation plan

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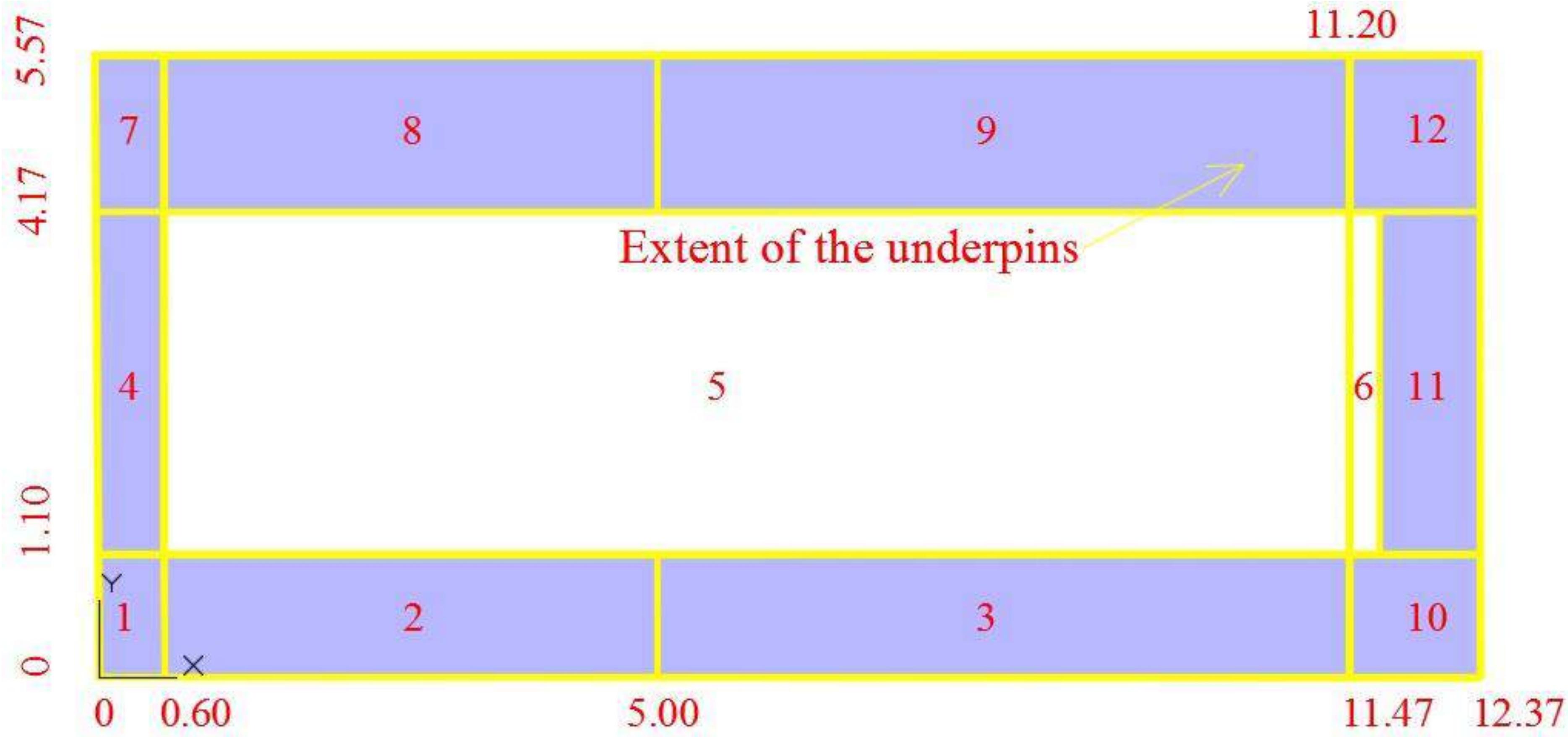

Figure D2. Detail of geometry introduced to PDISP

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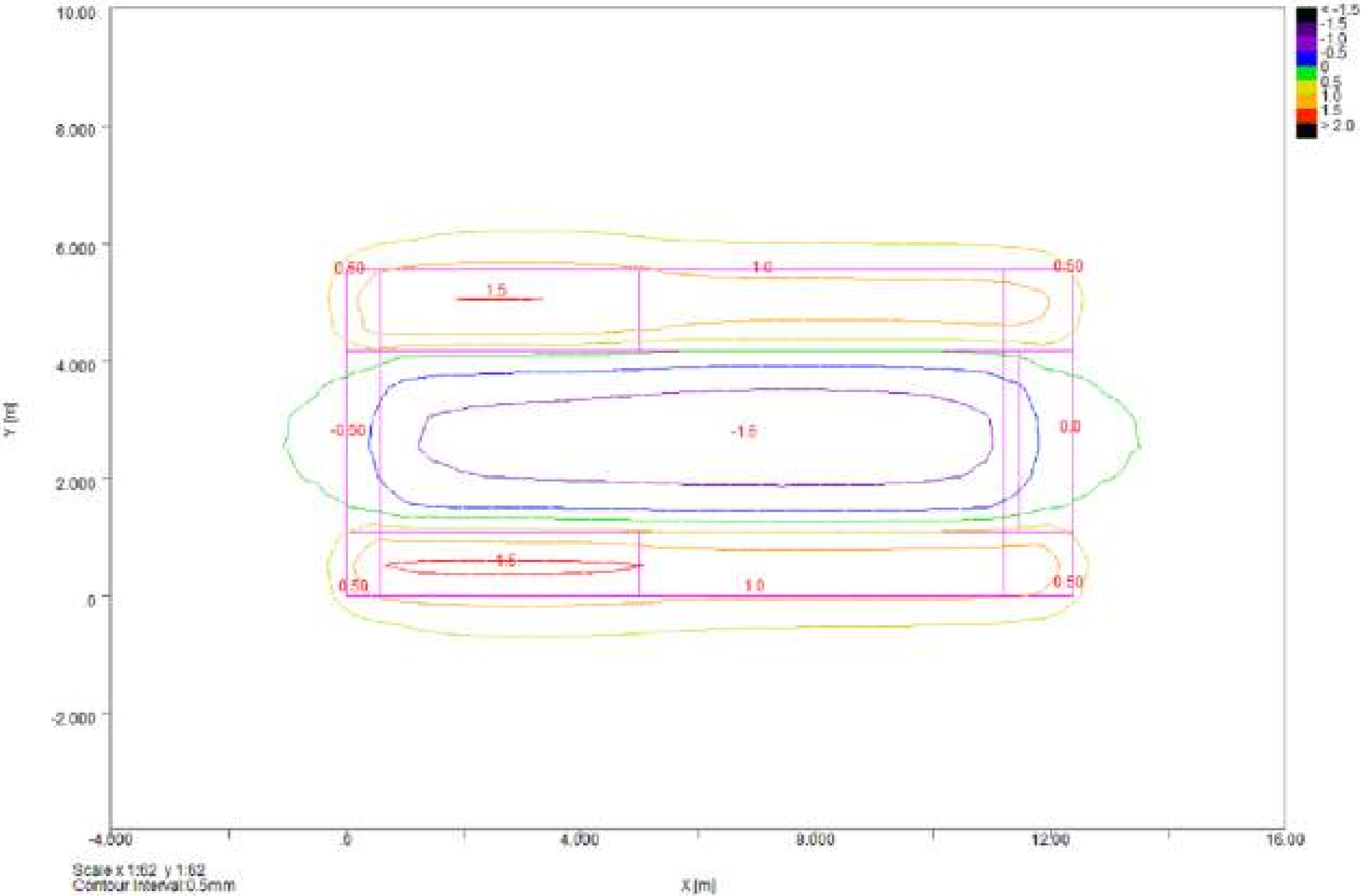

Figure D3. Short term (Stage 2) heave assessment contour

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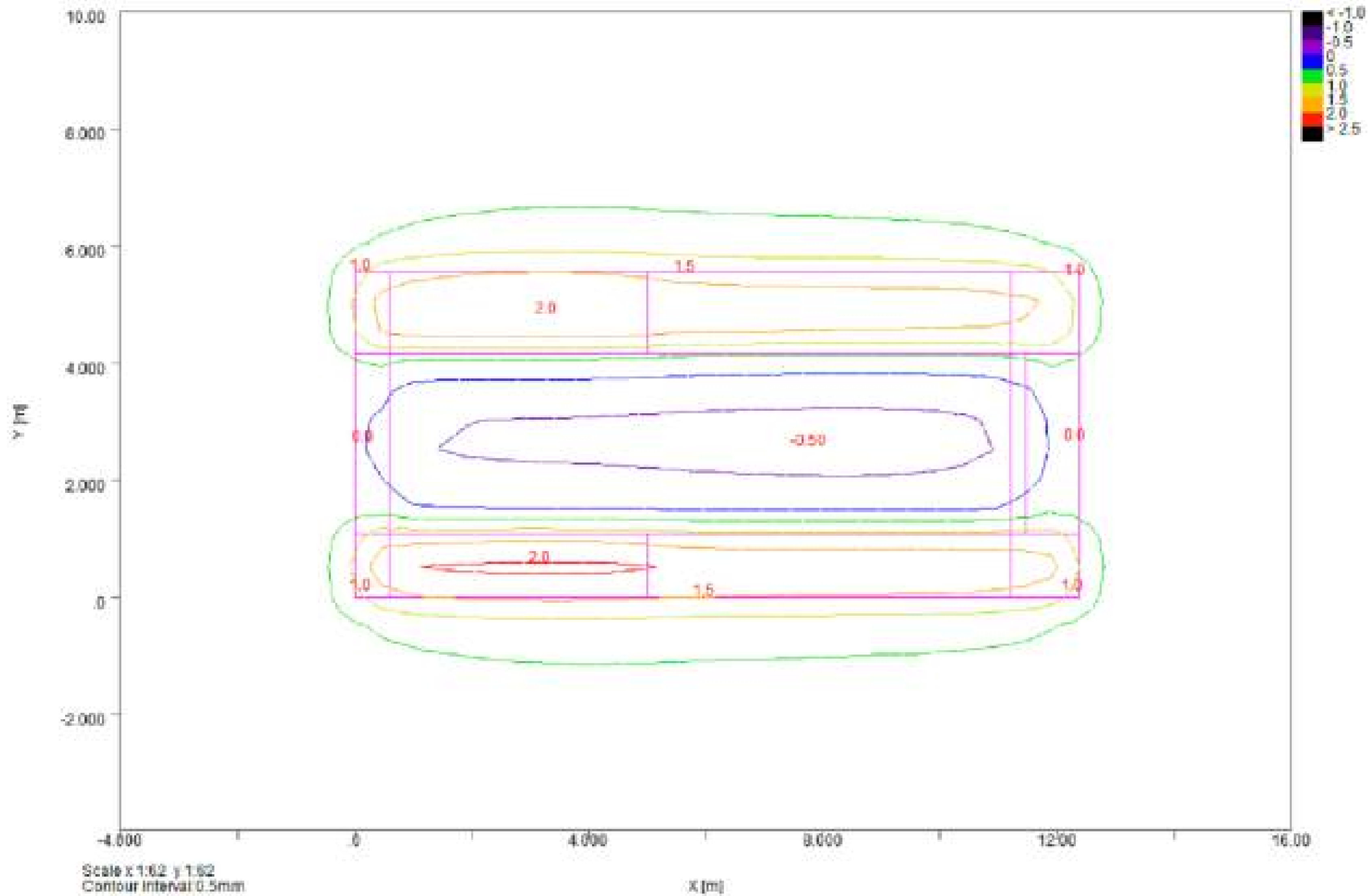

Figure D4. Short term (Stage 3) heave assessment contour

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Telephone: 01245 400 930 **Fax:** 01245 400 933
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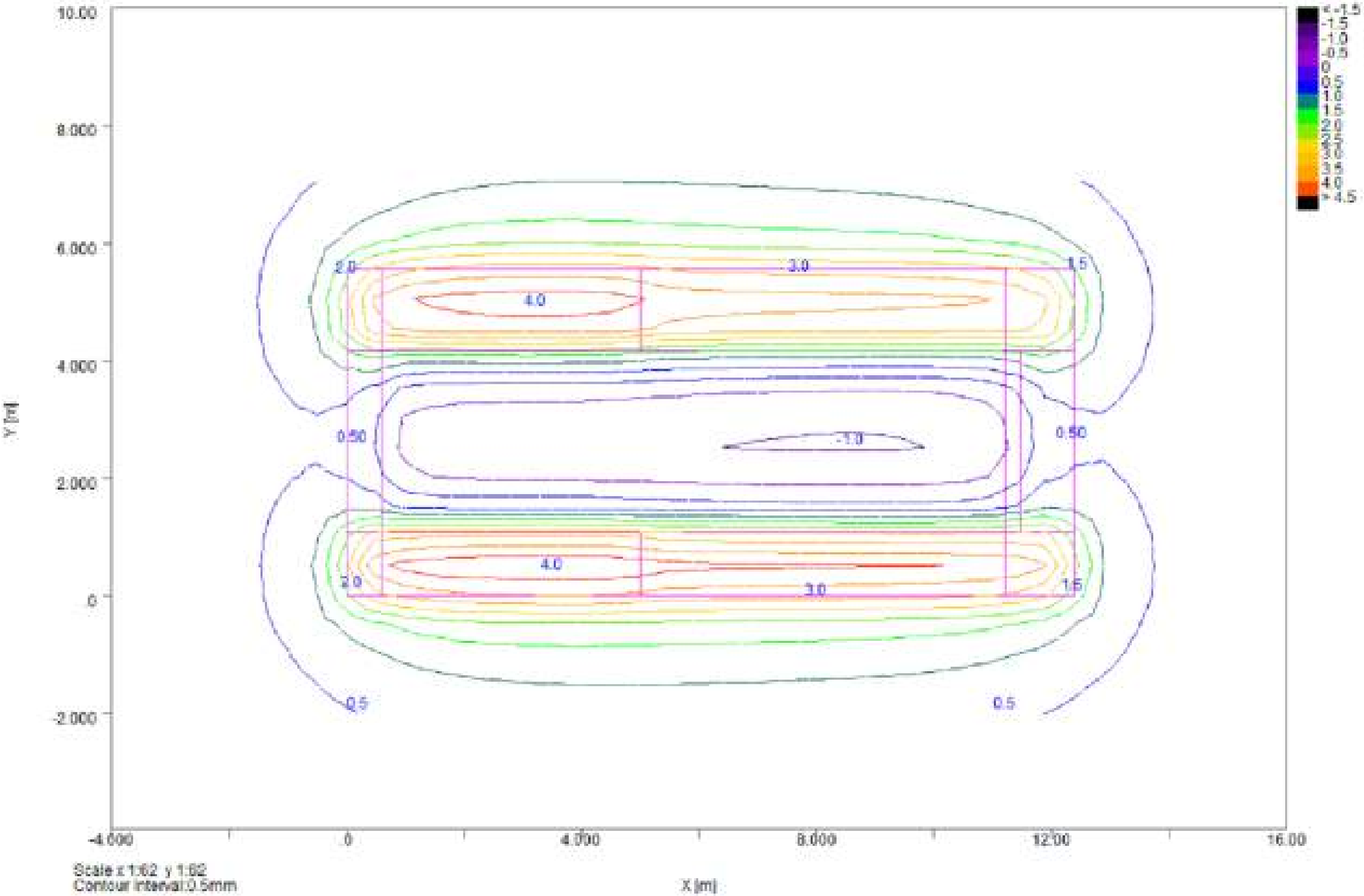


Figure D5. Long term (Stage 4) heave assessment contour

Gabriel GeoConsulting Ltd

HIGHFIELD HOUSE, ROLVENDEN ROAD,
CRANBROOK/BENENDEN, TN17 4EH

GroundSure Reference:	GS-1900230
Your Reference:	15408
Report Date	10 Feb 2015
Report Delivery Method:	Email - pdf

GroundSure Geoinsight

Address: 36, FLASK WALK, LONDON, NW3 1HE

Dear Sir/ Madam,

Thank you for placing your order with GroundSure. Please find enclosed the **GroundSure GeoInsight** as requested.

If you need any further assistance, please do not hesitate to contact our helpline on 08444 159000 quoting the above GroundSure reference number.

Yours faithfully,

Managing Director
Groundsure Limited

Enc.
GroundSure GeoInsight

GroundSure GeoInsight

Address: 36, FLASK WALK, LONDON, NW3 1HE

Date: 10 Feb 2015

Reference: GS-1900230

Client: Gabriel GeoConsulting Ltd

NW N NE

W E

SW S SE

Aerial Photograph Capture date: 20-Apr-2013
Grid Reference: 526497,185802
Site Size: 0.01ha

Contents Page

Overview of Findings

The GroundSure GeoInsight provides high quality geo-environmental information that allows geo-environmental professionals and their clients to make informed decisions and be forewarned of potential ground instability problems that may affect the ground investigation, foundation design and possibly remediation options that could lead to possible additional costs.

The report is based on the BGS 1:50,000 Digital Geological Map of Great Britain, BGS Geosure data; BRITPITS database; Shallow Mining data and Borehole Records, Coal Authority data including brine extraction areas, PBA non-coal mining and natural cavities database, Johnson Poole and Bloomer mining data and GroundSure's unique database including historical surface ground and underground workings.

For further details on each dataset, please refer to each individual section in the report as listed. Where the database has been searched a numerical result will be recorded. Where the database has not been searched '-' will be recorded.

Section 1:Geology		
1.1 Artificial Ground	1.1.1 Is there any Artificial Ground/ Made Ground present beneath the study site?	No
	1.1.2 Are there any records relating to permeability of artificial ground within the study site* boundary?	No
1.2 Superficial Geology and Landslips	1.2.1 Is there any Superficial Ground/Drift Geology present beneath the study site?	No
	1.2.2 Are there any records relating to permeability of superficial geology within the study site boundary?	No
	1.2.3 Are there any records of landslip within 500m of the study site boundary?	No
	1.2.4 Are there any records relating to permeability of landslips within the study site boundary?	No
1.3 Bedrock, Solid Geology & Faults	1.3.1 For records of Bedrock and Solid Geology beneath the study site* see the detailed findings section.	
	1.3.2 Are there any records relating to permeability of bedrock within the study site boundary?	Yes
	1.3.3 Are there any records of faults within 500m of the study site boundary?	No
1.4 Radon data	1.4.1 Is the property in a Radon Affected Area as defined by the Health Protection Agency (HPA) and if so what percentage of homes are above the Action Level?	The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level
	1.4.2 Is the property in an area where Radon Protection Measures are required for new properties or extensions to existing ones as described in publication BR211 by the Building Research Establishment?	No radon protective measures are necessary

Section 2:Ground Workings	On-site	0-50m	51-250	251-500	501-1000
2.1 Historical Surface Ground Working Features from Small Scale Mapping	0	0	1	Not Searched	Not Searched
2.2 Historical Underground Workings from Small Scale Mapping	0	0	0	4	28
2.3 Current Ground Workings	0	0	0	0	0

Section 3:Mining, Extraction & Natural Cavities	On-site	0-50m	51-250	251-500	501-1000
3.1 Historical Mining	0	0	0	0	10

Section 3: Mining, Extraction & Natural Cavities	On-site	0-50m	51-250	251-500	501-1000
3.2 Coal Mining	0	0	0	0	0
3.3 Johnson Poole and Bloomer Mining Area	0	0	0	0	0
3.4 Non-Coal Mining	0	0	0	0	0
3.5 Non-Coal Mining Cavities	0	0	0	0	0
3.6 Natural Cavities	0	0	0	0	0
3.7 Brine Extraction	0	0	0	0	0
3.8 Gypsum Extraction	0	0	0	0	0
3.9 Tin Mining	0	0	0	0	0
3.10 Clay Mining	0	0	0	0	0

Section 4: Natural Ground Subsidence	On-site
4.1 Shrink Swell Clay	Moderate
4.2 Landslides	Very Low
4.3 Ground Dissolution of Soluble Rocks	Negligible
4.4 Compressible Deposits	Negligible
4.5 Collapsible Deposits	Very Low
4.6 Running Sand	Low

Section 5: Borehole Records	On-site	0-50m	51-250
5 BGS Recorded Boreholes	0	1	12

Section 6: Estimated Background Soil Chemistry	On-site	0-50m	51-250
6 Records of Background Soil Chemistry	2	1	5

Section 7: Railways and Tunnels	On-site	0-50m	51-250	251-500
7.1 Tunnels	0	0	1	Not Searched
7.2 Historical Railway and Tunnel Features	0	0	0	Not Searched
7.3 Historical Railways	0	0	0	Not Searched
7.4 Active Railways	0	0	0	Not Searched

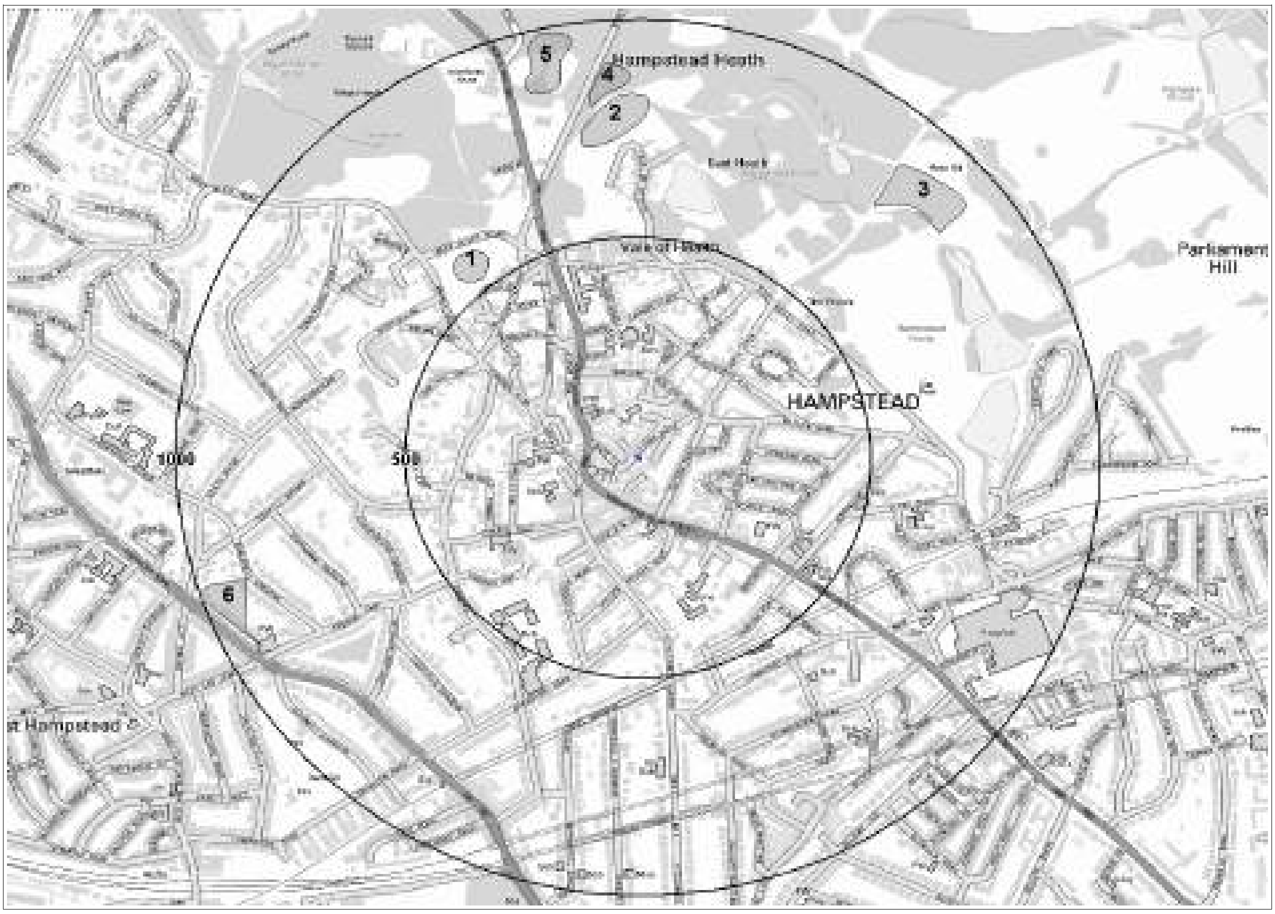
Section 7: Railways and Tunnels	On-site	0-50m	51-250	251-500
7.5 Railway Projects	0	0	0	0

1 Geology

1.1 Artificial Ground Map

NW N NE

W



E

SW S SE

Artificial Ground Legend

Mapping sourced from Ordnance Survey

- Site Outline
- Search Buffers (m): 500, 1000
- Made Ground (undivided)
- Disturbed Ground (undivided)
- Worked Ground (undivided)
- Landscaped Ground (undivided)
- Infilled Ground
- Reclaimed Ground

1 Geology

1.1 Artificial Ground

1.1.1Artificial/ Made Ground

The following geological information represented on the mapping is derived from 1:50,000 scale BGS Geological mapping, Sheet No:256

Are there any records of Artificial/Made Ground within 500m of the study site boundary? No

Database searched and no data found.

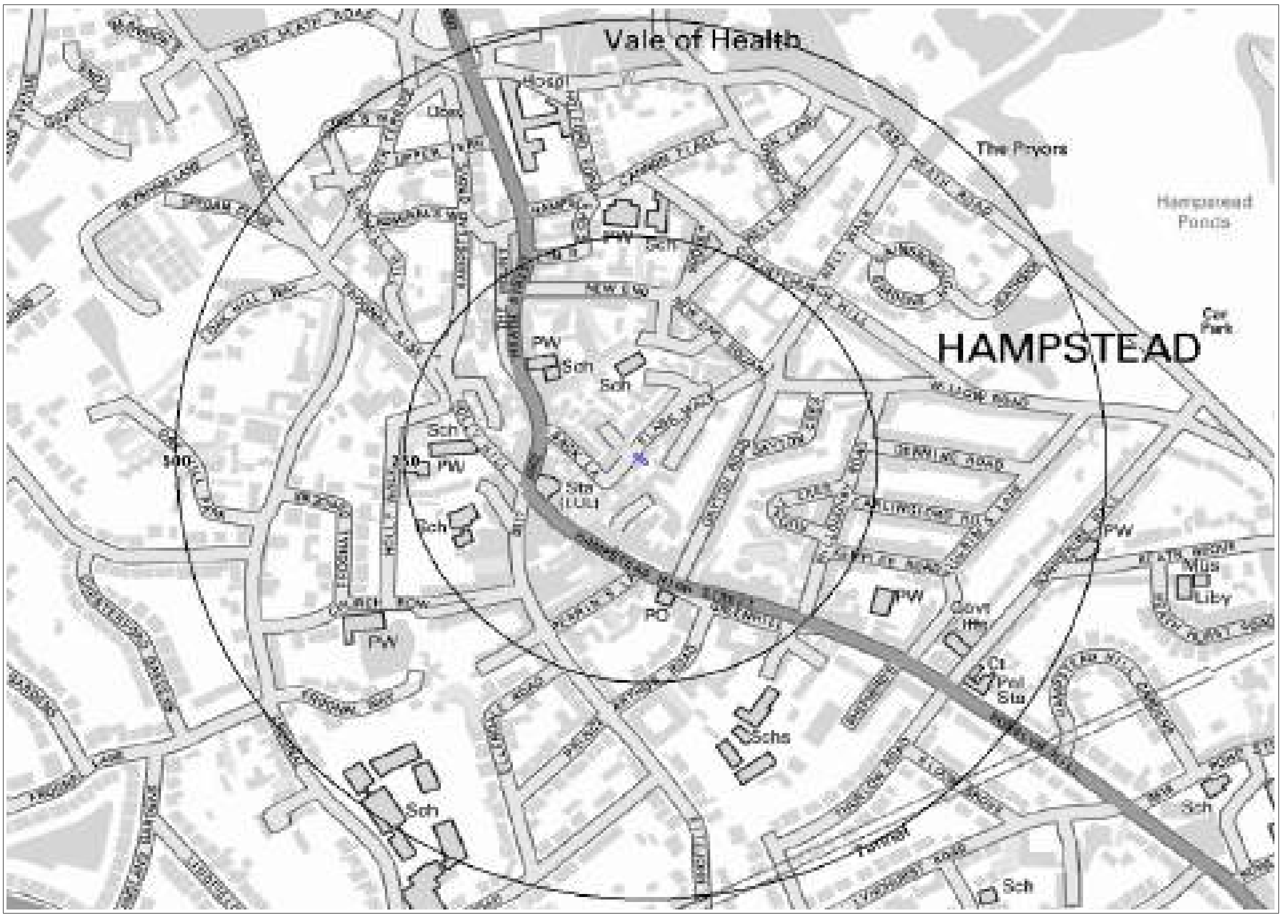
1.1.2 Permeability of Artificial Ground

Are there any records relating to permeability of artificial ground within the study site boundary? No

Database searched and no data found.

1.2 Superficial Deposits and Landslips Map

NW N NE

W  E

SW S SE

Superficial Deposits and Landslips Legend

Mapping sourced from Ordnance Survey

Site Outline

500
1000
Search Buffers (m)

1.2 Superficial Deposits and Landslips

1.2.1 Superficial Deposits/ Drift Geology

Are there any records of Superficial Deposits/ Drift Geology within 500m of the study site boundary? No

Database searched and no data found.

1.2.2 Permeability of Superficial Ground

Are there any records relating to permeability of superficial ground within the study site boundary? No

Database searched and no data found.

1.2.3 Landslip

Are there any records of Landslip within 500m of the study site boundary? No

Database searched and no data found.

This Geology shows the main components as discrete layers, these are: Artificial / Made Ground, Superficial / Drift Geology and Landslips. These are all displayed with the BGS Lexicon code for the rock unit and BGS sheet number. Not all of the main geological components have nationwide coverage.

1.2.4 Landslip Permeability

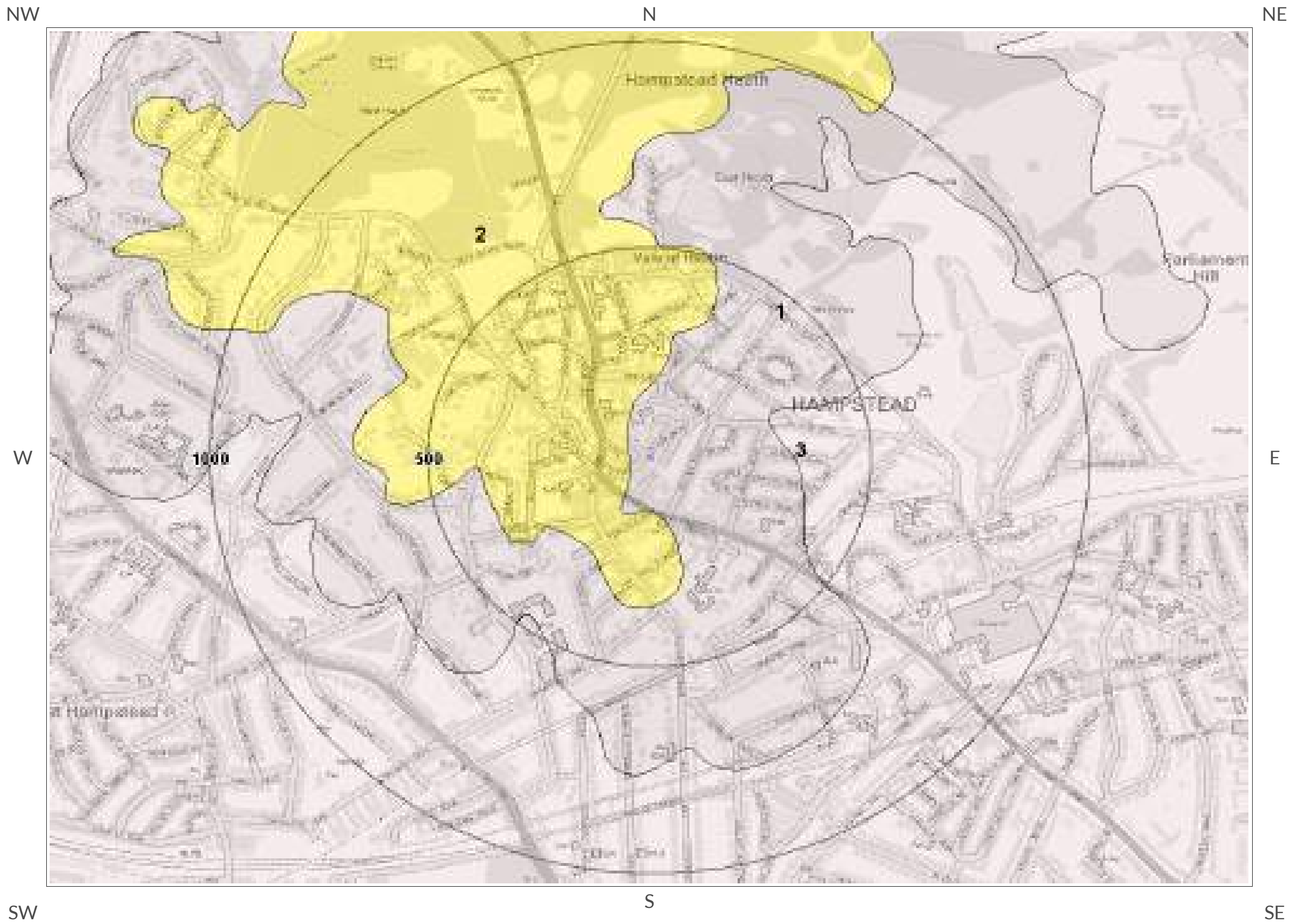
Are there any records relating to permeability of landslips within the study site*[*] boundary? No

Database searched and no data found.

---

* This includes an automatically generated 50m buffer zone around the site

1.3 Bedrock and Faults Map



Bedrock and Faults Legend

Mapping sourced from Ordnance Survey

Site Outline

500
1000
Search Buffers (m)