Ground Investigation and Basement Impact Assessment Report

99A Frognal
Hampstead, London, NW3 6XR

Client	Harrison Varma
Engineer	Fluid Structures

J13053

May 2013




GEA Geotechnical & Environmental Associates

Document Control

Project title	99A Frognal, Hampstead, London, NW3 6XR		**Project ref**	J13053
Report prepared by	Hannah Dashfield BEng FGS			
With input from	Martin Cooper BEng CEng MICE FGS	John Evans MSc FGS CGeol		
Report checked and approved for issue by	Steve Branch BSc MSc CGeol FGS FRGS MIEnvSc			

Issue No	**Status**	**Date**	**Approved for Issue**
1	Final	28 May 2013	

This report has been issued by the GEA office indicated below. Any enquiries regarding the report should be directed to the office indicated or to Steve Branch in our Herts office.

- [x] Hertfordshire tel 01727 824666 mail@gea-ltd.co.uk
- [ ] Nottinghamshire tel 01509 674888 midlands@gea-ltd.co.uk

CONTENTS

EXECUTIVE SUMMARY

Part 1: INVESTIGATION REPORT

1.0	INTRODUCTION		1
	1.1	Proposed Development	1
	1.2	Purpose of Work	1
	1.3	Scope of Work	2
	1.4	Qualifications	3
	1.5	Limitations	3
2.0	THE SITE		3
	2.1	Site Description	3
	2.2	Site History	4
	2.3	Other Information	5
	2.4	Geology	5
	2.5	Hydrology and Hydrogeology	6
3.0	SCREENING		9
	3.1	Screening Assessment	9
4.0	SCOPING AND SITE INVESTIGATION		11
	4.1	Potential Impacts	11
	4.2	Exploratory Work	12
	4.3	Sampling Strategy	12
5.0	GROUND CONDITIONS		13
	5.1	Made Ground / Topsoil	13
	5.2	Bagshot Formation	13
	5.3	Claygate Member	14
	5.4	Groundwater	14
	5.5	Soil Contamination	15
	5.6	Existing Foundations	17

Part 2: DESIGN BASIS REPORT

6.0	INTRODUCTION		18
7.0	GROUND MODEL		18
8.0	ADVICE AND RECOMMENDATIONS		19
	8.1	Basement Construction	19
	8.2	Spread Foundations	21
	8.3	Basement Raft Foundation	22
	8.4	Piled Foundations	22
	8.5	Basement and Ground Floor Slabs	23
	8.6	Slope Stability	23
	8.7	Shallow Excavations	23
	8.8	Effect of Sulphates	23
	8.9	Site Specific Risk Assessment	23
	8.10	Waste Disposal	24
9.0	BASEMENT IMPACT ASSESSMENT		25
10.0	OUTSTANDING RISK AND ISSUES		27
	APPENDIX		

EXECUTIVE SUMMARY

This executive summary contains an overview of the key findings and conclusions. No reliance should be placed on any part of the executive summary until the whole of the report has been read. Other sections of the report may contain information that puts into context the findings that are summarised in the executive summary.

BRIEF

This report describes the findings of a site investigation carried out by Geotechnical and Environmental Associates Limited (GEA), on the instructions of Fluid Structures, on behalf of Harrison Varma, with respect to the demolition of the existing building and construction of a detached three-storey house, with a basement extending to a maximum depth of approximately 10 m. The purpose of the investigation has been to to determine the ground conditions and hydrogeology, to investigate the existing foundations along the northern garden boundary wall, to assess the extent of any contamination and to provide information to assist with the design of suitable foundations and retaining walls. The report also includes information required to comply with the London Borough of Camden (LBC) Planning Guidance CPG4, relating to the requirement for a Basement Impact Assessment (BIA). A desk study has previously been carried out by GEA (report ref J10088 Report Issue 1, dated 10 May 2010) and is referred to in this report as appropriate.

DESK STUDY FINDINGS

The previous desk study research indicated that the site was developed with two small buildings located in the northern part of the site prior to 1871. Further buildings were constructed and subsequently all buildings with the exception of one, located in the northeastern corner of the site, were demolished by 1954. An access road was constructed along the southern boundary of the site between 1958 and 1966 and the site remained unoccupied until some time between 1968 and 1970, when the existing building, labelled as 99a Frognal, was constructed on the central western part of the site. The site has remained essentially unaltered from that time.

GROUND CONDITIONS

The investigation has encountered the expected ground conditions in that, beneath a moderate thickness of made ground, extending to depths of between 1.00 m and 2.50 m (120.34 m OD and 116.57 m OD), the Bagshot Formation was encountered, overlying the Claygate Member of the London Clay Formation, proved to the full depth investigated. The Bagshot Formation extended to depths of between 2.60 m and 6.80 m (116.92 m OD and 113.78 m OD) and generally comprised medium dense brown orange-brown, pale brown and reddish brown gravelly sand with rare pockets of greyish brown silty clay and organic matter. The Claygate Member generally comprised firm orange-brown mottled grey silty sandy clay or clayey silty fine sand, extending to depths of 16.70 m (102.48 m OD) and 15.30 m (104.22 m OD). This layer was in turn underlain by firm to stiff dark grey silty sandy clay or clayey silty fine sand, which was proved to the maximum depth investigated of 20.00 m (99.18 m OD and 99.52 m OD). Groundwater has been measured in the standpipes at depths of between 9.30 m and 10.50 m (110.22 m OD and 108.68 m OD). Two trial pits were excavated against the northern boundary garden wall, which was found to be bearing on made ground at depths of 0.10 m and 0.47 m. Contamination testing has revealed an elevated concentration of lead in a single sample of made ground tested.

RECOMMENDATIONS

Formation level of the approximately 10 m deep basement, extending to roughly 112 m OD will be near the base of the Bagshot Formation or top of the Claygate Member. On the basis of the results of the groundwater monitoring to date, groundwater is not expected to be encountered within the basement excavation, although further groundwater monitoring and trial excavations should be carried out to confirm this view. Excavations for the proposed basement structure will require temporary support to maintain stability and prevent any excessive ground movements. The most suitable method for basement excavation would be to install a bored pile wall. The stability of the northern, southern and western garden boundary walls will need to be ensured at all times and the retaining walls will need to be designed to accommodate the loads from these foundations unless they are underpinned.

The BIA has not indicated any concerns with regard to the effects of the proposed basement on the site and surrounding area.

It is recommended that additional sampling and contamination testing is carried out in the proposed garden areas to determine the precautions required, once the redevelopment proposals are finalised.

Part 1: INVESTIGATION REPORT

This section of the report details the objectives of the investigation, the work that has been carried out to meet these objectives and the results of the investigation. Interpretation of the findings is presented in Part 2.

1.0 INTRODUCTION

Geotechnical and Environmental Associates (GEA) has been commissioned by Fluid Structures, on behalf of Harrison Varma, to carry out a ground investigation at 99A Frognal, Hampstead, London, NW3 6XR. This report also forms part of a Basement Impact Assessment (BIA), which has been carried out in accordance with guidelines from the London Borough of Camden (LBC) in support of a planning application.

A desk study has previously been carried out at the site by GEA (ref J10088 Report Issue 1, dated 10 May 2010) and is referred to in this report as appropriate.

1.1 Proposed Development

Consideration is being given to the demolition of the existing detached two-storey house and for the subsequent construction of a detached three-storey house, with a basement extending to a maximum depth of approximately 10 m (roughly 112 m OD).

This report is specific to the proposed development and the advice herein should be reviewed if the proposals are amended.

1.2 Purpose of Work

The principal technical objectives of the work carried out were as follows:

- to review the previous desk study (report ref; J10088) carried out by GEA in May 2010;
- to determine the ground conditions and their engineering properties;
- to investigate the configuration of existing foundations along the northern boundary garden wall;
- to assess the possible impact of the proposed development on the local hydrogeology;
- to provide advice with respect to the design of suitable foundations and retaining walls;
- to provide an indication of the degree of soil contamination present; and
- to assess the risk that any such contamination may pose to the proposed development, its users or the wider environment.

1.3 Scope of Work

In order to meet the above objectives, an intrusive ground investigation was carried out which comprised, in summary, the following activities:

- three boreholes, advanced to depths of 15.0 m and 20.0 m, by means of a cable percussion drilling rig;
- standard penetration tests (SPTs), carried out at regular intervals in the cable percussion boreholes, to provide quantitative data on the strength of the soils;
- four drive-in window sampler boreholes advanced to depths of 7.0 m;
- two dynamic probes advanced to depths of 10.0 m to obtain information on the strength of the soils in two window sampler boreholes;
- the installation of four groundwater monitoring standpipes and four subsequent monitoring visits over a period of roughly six weeks;
- two trial pits excavated by hand to depths of 0.60 m and 0.88 m to investigate the existing foundations of the northern boundary garden wall;
- laboratory testing of selected soil samples for geotechnical purposes and for the presence of contamination; and
- provision of a report presenting and interpreting the above data, together with our advice and recommendations with respect to the proposed development.

The report includes a contaminated land assessment which has been undertaken in accordance with the methodology presented in Contaminated Land Report (CLR) 11[1] and involves identifying, making decisions on, and taking appropriate action to deal with, land contamination in a way that is consistent with government policies and legislation within the United Kingdom. The risk assessment is thus divided into three stages comprising Preliminary Risk Assessment, Generic Quantitative Risk Assessment, and Site-Specific Risk Assessment.

1.3.1 Basement Impact Assessment (BIA)

The work carried out also includes a Hydrogeological Assessment and Land Stability Assessment (also referred to as Slope Stability Assessment), all of which form part of the BIA procedure specified in the London Borough of Camden (LBC) Planning Guidance CPG4[2] and their Guidance for Subterranean Development[3] prepared by Arup. The aim of the work is to provide information on land stability and in particular to assess whether the development will affect the stability of neighbouring properties and whether any identified impacts can be appropriately mitigated by the design of the development.

1 *Model Procedures for the Management of Land Contamination* issued jointly by the Environment Agency and the Department for Environment, Food and Rural Affairs (DEFRA) Sept 2004

2 London Borough of Camden Planning Guidance CPG4 *Basements and lightwells*

3 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

1.4 Qualifications

The land stability element of the Basement Impact Assessment (BIA) has been carried out by Martin Cooper, a BEng in Civil Engineering, a chartered engineer (CEng), member of the Institution of Civil Engineers (MICE), and Fellow of the Geological Society (FGS) who has over 20 years specialist experience in ground engineering. The subterranean (groundwater) flow assessment has been carried out by John Evans, MSc in Hydrogeology, Chartered Geologist (CGeol) and Fellow of the Geological Society of London (FGS). The assessments have been made in conjunction with Steve Branch, a BSc in Engineering Geology and Geotechnics, MSc in Geotechnical Engineering, a chartered geologist (CGeol) and Fellow of the Geological Society (FGS) with 25 years' experience in geotechnical engineering and engineering geology. All assessors meet the Geotechnical Adviser criteria of the Site Investigation Steering Group and satisfy the qualification requirements of the Council guidance.

The surface water and flooding element of the BIA is provided for guidance only and should be confirmed by a suitably qualified engineer experienced in carrying out surface water assessments.

1.5 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of soil, gas or groundwater samples tested; no liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

2.0 THE SITE

2.1 Site Description

The site is located roughly 350 m to the west of Hampstead London Underground station. It is roughly rectangular in shape, measuring about 30 m north-south by 55 m east-west and is accessed via a private road leading off Frognal. It is bordered on all sides by residential properties.

To the north the site is bordered by the detached houses of Nos 5 and 7 Oak Hill Way, which are set back roughly 20 m from the northern boundary garden wall of the site, although there is a swimming pool located approximately 3.0 m to 5.0 m from this boundary. These properties are at a slighter higher elevation.

To the east, the site is bordered by the property of 99 Frognal; which comprises an irregular shaped building, single storey to three-storeys in height, located in excess of 25 m from the eastern garden boundary of the site and a large garden area to the west. This property is located at a lower elevation.

To the south, the site is bordered by a number of properties, including Nos 4 to 6 Oak Hill Park and Nos 4 and 4A Oak Hill Park. The buildings are located at a lower elevation, roughly 2.0 m from the southern garden boundary wall.

To the west by an apartment block which comprises Nos 1 to 12 Northwood Lodge, which fronts onto Oak Hill Park, located at a lower elevation and is located roughly 15 m to the west of the western garden boundary wall.


Northern boundary


Southern boundary

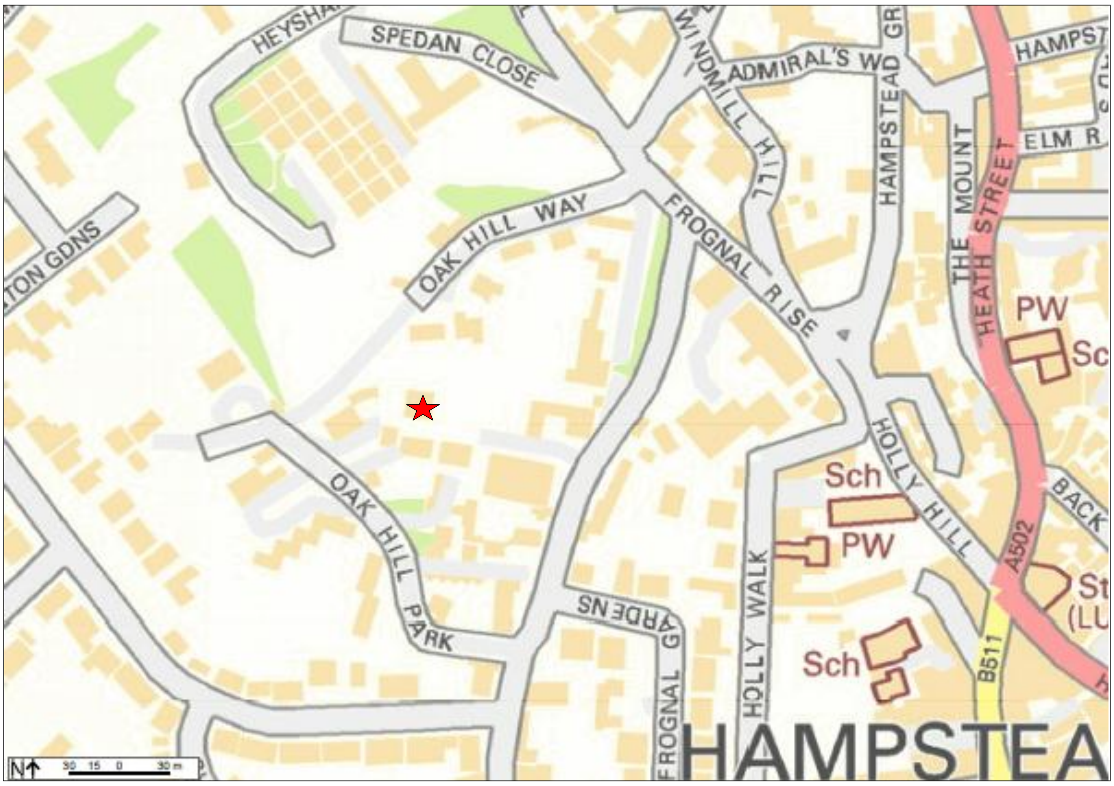

Eastern boundary


Western boundary

The site may additionally be located by National Grid reference 526030, 185880 and is shown on the map opposite.

The site is situated on the eastern side of the crest of a ridge, with the ground generally sloping away from the site towards the east. The site is on a number of different levels to accommodate the change in slope.

The site is currently occupied by a house with an adjoining garage, located along the southern elevation. The building is cut into the slope of the ground, such that it comprises two storeys along the eastern elevation and a single storey along the western elevation, although there is an enclosed basement lightwell present along the eastern elevation.



At the front of the house a driveway is situated between the existing house and the southern garden boundary wall. The driveway slopes down in an easterly direction from 119.18 m OD to 115.29 m OD over a distance of roughly 40 m, to meet the private access road.

Along the eastern elevation of the house is an essentially level patio area at approximately 119.29 m OD, leading onto a central lawn, which slopes gently towards the east from 119.29 m OD to 117.26 m OD over a distance of roughly 30 m. In the northern part of the garden is a number of terraces, leading up to an ornate garden at 121.08 m OD. Further steps lead up to a patio area, located along the rear elevation of the house and garage at 122.31 m OD. A lawn is present at this level at the southern end of the patio area. In the southwestern corner of the site a single storey outbuilding is present. Another set of steps are present to the south of the garage building from the driveway at 119.18 m OD leading up to the rear garden at 122.31 m OD.

Numerous mature and semi-mature trees of mixed deciduous and evergreen species are present on the site, predominantly in the eastern part of the site.


Eastern elevation of house


Driveway looking west


Ornate garden, looking east


Front garden, looking north


Western elevation of house


Rear garden, looking north

2.2 Site History Summary

The previous desk study has indicated that the site was mostly undeveloped at the time of the 1871 map and comprised a lightly wooded area crossed by an intricate pattern of paths, with two small buildings located on the northern part of the site. Frognal House was located less than 50 m to the east of the site and it may be that the site comprised a landscaped area belonging to this estate, or to the row of buildings that adjoined the southeastern part of the site.

The site remained essentially unaltered until some time between 1879 and 1895, when the trees were cleared and two rectangular buildings constructed on the central part of the site. At some time between 1896 and 1915, the northernmost of the two buildings was replaced with a much smaller structure and by 1934, both buildings appear to have been demolished and replaced with an L-shaped building on the central part of the site.

At some time between 1951 and 1954 this building was demolished and the site was essentially unoccupied, except for a small building in the northeastern corner of the site. An access road, running along the southern boundary of the site towards Frognal, was established between 1958 and 1966, although the site remained unoccupied until some time between 1968 and 1970, when the existing building, labelled as 99a Frognal, was constructed on the central western part of the site. Shortly after this time, Frognal House was demolished and by 1974 the existing property at 99 Frognal was constructed. The site has remained essentially unaltered from that time.

2.3 Other Information

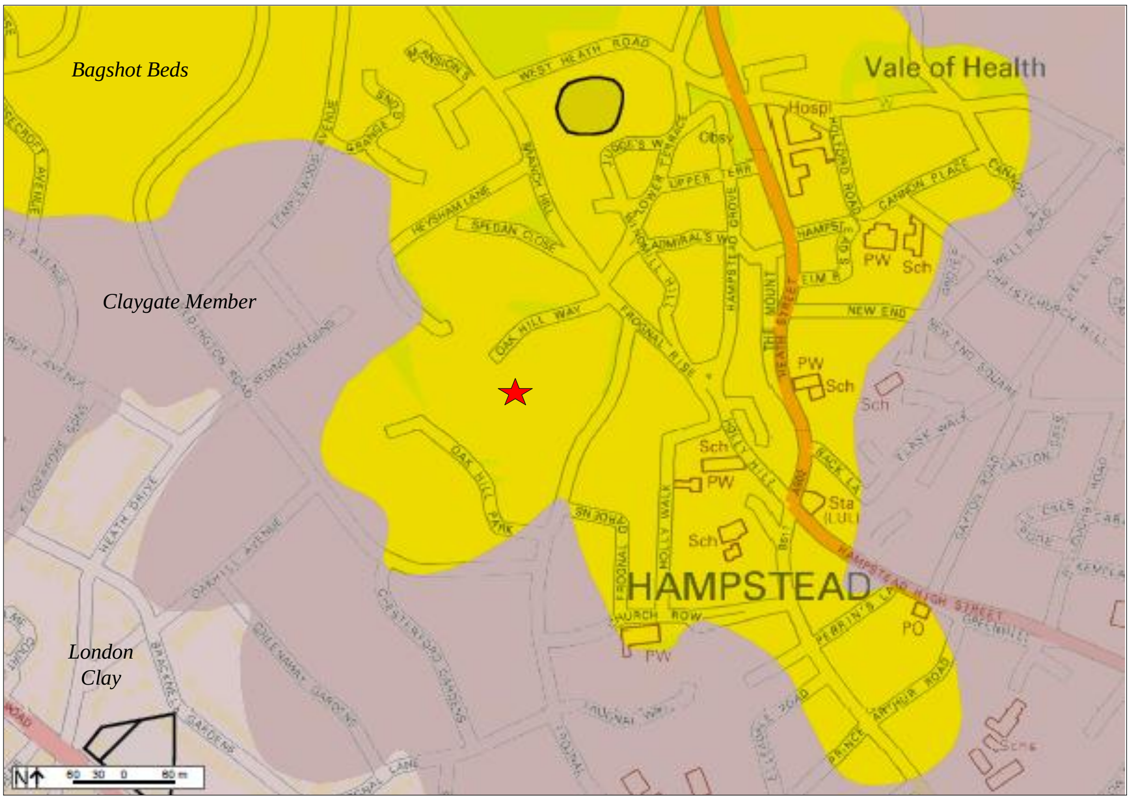
The historical usage of the site that has been established by the desk study indicates that the site does not have a significantly contaminative history by virtue of it having appeared to have had a residential use for its entire known developed history. There is, therefore, assessed to be a VERY LOW risk of contamination at this site.

No recorded landfills or registered waste transfer facilities have been identified within a 500 m radius of the site and a risk from hazardous landfill gas has not been identified.

The search has indicated that the site is located in an area where less than 1% of homes are affected by radon emissions; which is the lowest classification given by the Health Protection Agency (HPA) and therefore no radon protective measures will be necessary.

2.4 Geology

The Geological Survey map of the area (BGS sheet 256) indicates that the site is underlain by the Bagshot Formation, overlying the Claygate Member, which is in turn underlain by the London Clay and is shown on the map below.



The geology in this area is generally horizontally bedded such that the boundary between the lithologies roughly follows the contour lines. The boundary between the Bagshot Formation and the underlying Claygate Member is located approximately 140 m both to the south and west of the site and the boundary between the Claygate Member and London Clay is located roughly 300 m to the south and approximately 210 m to the west of the site.

Our archives of nearby investigations and the published geological map indicate that the Bagshot Beds extends to a level of approximately 115 m OD to 110 m OD and the Claygate Member extends to a level of roughly 90 m OD to 85 m OD in this area.

The Bagshot Formation comprises yellow, brown and orange-brown fine-grained sand which is silty in parts with occasional laminae of pale grey clay. The Claygate Member comprises alternating beds of clay, silt and fine grained sand. The boundary between the two stratum is often difficult to determine.

2.5 Hydrology and Hydrogeology

The Environment Agency classifies the Bagshot Formation as Secondary 'A' Aquifer (formerly Minor Aquifer) capable of supporting local supplies and baseflow to watercourses. The underlying Claygate Member is also classified as a Secondary 'A' Aquifer (however this classification is based on the presence of continuous saturated sand bed horizons) and the London Clay is classified as Unproductive Strata (formerly Non Aquifer), i.e. not capable of providing useable quantities of water.

Existing and historical spring lines are present at the interface of the sandy Bagshot Formation and the underlying less permeable Claygate Member, within the Claygate Member itself and between the Claygate Member and the underlying essentially impermeable London Clay. These springs have been the source of a number of London's "lost" rivers.

According to the Lost Rivers of London [4] a number of tributaries of the River Westbourne rose within the vicinity of the site, approximately 150 m to the northwest, 320 m to the south and 400 m to the southeast of the site respectively. Each of the tributaries flowed separately in a south to southwesterly direction, before coming together and merging to the north of Kilburn High Road. Today the River Westbourne is entirely covered and culverted and forms part of the surface water sewerage system, running beneath South Hampstead to where it discharges into the Thames to the west of Chelsea Bridge.

Any water infiltrating the Bagshot Formation will generally tend to flow vertically downwards at a slow rate towards the Claygate Member and London Clay. The direction of groundwater flow within the Bagshot Beds beneath the site is likely to be controlled by the local topography in an easterly or southerly direction, with the general slope of the ground away from the site, towards the former tributaries of the River Westbourne.

The nearest natural water feature is a spring, which issues on West Heath, approximately 650 m to the north of the site and flows in a westerly direction into Leg of Mutton Pond. The site lies outside the catchment of the Hampstead Heath chain of ponds.

The site is not at risk of flooding from rivers or sea, as defined by the Environment Agency; Frognal has not been identified as a street at risk of surface water flooding, specified in the London Borough of Camden (LBC) Planning Guidance CPG4 and therefore a flood risk assessment will not be required.

The site does not lie within a nitrate vulnerable zone or a source Protection Zone (SPZ).

4 Barton, N (1992) *The Lost Rivers of London,* Historical Publications Limited

3.0 SCREENING

The LBC guidance suggests that any development proposal that includes a subterranean basement should be screened to determine whether or not a full BIA is required.

3.1 Screening Assessment

A number of screening tools are included in the Arup document and for the purposes of this report reference has been made to Appendix E which includes a series of questions within a screening flowchart for three categories; groundwater flow; land stability; and surface water flow. Responses to the questions are tabulated below.

3.1.1 Subterranean (groundwater) Screening Assessment

Question	Response for 99A Frognal
1a. Is the site located directly above an aquifer?	*Yes. The site is underlain by the Bagshot Formation which is designated as a Secondary 'A' Aquifer by the Environment Agency, capable of supplying local water supplies and supporting small watercourses.*
1b. Will the proposed basement extend beneath the water table surface?	*Unlikely. Groundwater has been measured at depths of between 9.30 m and 10.50 m (110.22 m OD and 108.68 m OD) from within the Claygate Member. The proposed basement formation level extends to a maximum depth of approximately 10 m (roughly 112 m OD) below existing ground level.*
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	*No. Historical maps indicate that the site lies c.200m south of a headwater tributary of the River Westbourne. The headwater is not present at surface and is likely to have been culverted to form part of the local surface water sewer.*
3. Is the site within the catchment of the pond chains on Hampstead Heath?	*No. The site is outside the catchment of Hampstead Heath ponds.*
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	*No. The footprint of the proposed new house is already hard surfaced / paved area and no change would be made to the current site drainage arrangements.*
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	*No. No change would be made to the current site drainage arrangements.*
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 or spring line?	*No. There are no local ponds or spring lines present within 100m of the site.*

The screening exercise has identified the following potential issues which should be assessed:

Q1a The site is located on a Secondary 'A' Aquifer.

3.1.2 Stability Screening Assessment

Question	Response for 99A Frognal
1. Does the existing site include slopes, natural or manmade, greater than 7°?	*Yes? The site contains a number of retaining walls.*
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	*Possibly*
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	*No*
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	*No not according to the slope angle map (figure 16) produced by Arup as part of the CPG4 report.*
5. Is the London Clay the shallowest strata at the site?	*No*
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	*No*
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	*No*
8. Is the site within 100 m of a watercourse or potential spring line?	*No*
9. Is the site within an area of previously worked ground?	*No*
10. Is the site within an aquifer?	*Yes. The site is underlain by the Bagshot Formation and Claygate Member which are designated a Secondary 'A' Aquifer by the Environment Agency, capable of supporting baseflow to watercourses.*
11. Is the site within 50 m of Hampstead Heath ponds?	*No*
12. Is the site within 5 m of a highway or pedestrian right of way?	*No*
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	*Yes. The property is detached but the new proposed development will increase foundation depths to a maximum depth of 10.0 m (roughly 112 m OD).*
14. Is the site over (or within the exclusion zone of) any tunnels, eg railway lines?	*No*

The above assessment has identified the following potential issues that need to be assessed:

Q1 The site contains slopes greater than 7º

Q2 The site will be profiled

Q10 The site is underlain by a Secondary 'A' Aquifer.

Q13 The development will increase the foundation depths relative to the neighbouring properties to a relatively significant extent.

3.1.3 Surface Flow and Flooding Screening Assessment

This element of the BIA is provided for guidance only and should be confirmed by a suitably qualified engineer experienced in carrying out surface water assessments.

Question	Response for 99A Frognal
1. Is the site within the catchment of the pond chains on Hampstead Heath?	*No*
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	*No*
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	*No*
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	*No*
5. Will the proposed basement result in changes to the quantity of surface water being received by adjacent properties or downstream watercourses?	*No*
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 Kings Cross, or is it at risk of flooding because the proposed basement is below the static water level of a nearby surface water feature?	*No*

The above assessment has not identified any potential issues that need to be assessed.

4.0 SCOPING AND SITE INVESTIGATION

The purpose of scoping is to assess in more detail the factors to be investigated in the impact assessment. Potential consequences are assessed for each of the identified potential impact factors.

4.1 Potential Impacts

The following potential impacts have been identified.

Potential Impact	Possible Consequence
The site is located above a Secondary ‘A’ Aquifer	*The basement may extend into the underlying aquifer and affect the groundwater flow regime*
The site contains man-made slopes greater than 7º	*Slope instability resulting in structural damage to buildings and damage to services.*
Re-profiling of the existing slopes	*Slope instability resulting in structural damage to buildings and damage to services.*
The development will increase the foundation depths relative to the neighbouring properties to a relatively significant extent.	*Excavation may lead to structural damage to neighbouring properties if there is a significant differential depth between adjacent properties*

These potential impacts have been further assessed through the ground investigation, as detailed below.

4.2 Exploratory Work

In order to meet the objectives described in Section 1.2 and to assess the potential impacts identified in the screening exercise of the BIA, three cable percussion boreholes were advanced, to depths of 15.00 m and 20.00 m. Standard Penetration Tests (SPTs) were carried out at regular intervals in the cable percussion boreholes to provide quantitative data on the strength of soils encountered.

In addition, a further four window sampler boreholes were drilled to depths of 7.00 m to provide additional coverage of the site. Dynamic probing was carried out in positions adjacent to Borehole Nos 1 and 3 to obtain information on the density of the soil, to depths of 10.00 m. In addition to the boreholes and dynamic probes, two hand-dug trial pits were carried out to depths of 0.60 m and 0.88 m to investigate the existing foundations of the northern boundary garden wall.

Groundwater monitoring standpipes were installed in four of the boreholes to depths of between 7.00 m and 14.00 m, and have been monitored on four occasions to date, over a period of roughly six weeks.

All of the above work was carried out under the supervision of a geotechnical engineer from GEA.

A selection of the disturbed and undisturbed samples recovered from the boreholes and trial pits were submitted to a soil mechanics laboratory for a programme of geotechnical testing and an analytical laboratory for a programme of contamination testing.

The borehole, dynamic probe and trial pit records and the results of the laboratory analyses are appended, together with a site plan indicating the exploratory locations. The Ordnance Datum (OD) levels shown on the borehole records have been interpolated from temporary benchmark levels (shown on a topographical survey carried out by STH Surveys Limited, provided by the architects; Simon Bowden) that have been correlated using a digital altimeter with a known OD level from a nearby Thames Water manhole cover, located on the corner of Redington Road, at the junction with Frognal.

4.3 Sampling Strategy

Originally it was understood that the proposal comprised the construction of a basement extending to a maximum depth of 4.0 m and the scope of the works was specified by GEA to meet the requirements of the consulting engineers. Subsequent discussions with the consulting engineers, prior to carrying out the fieldwork, indicated that the proposals had been amended and the basement depth increased to accommodate a swimming pool, extending to a maximum depth of 6.0 m and on this basis the proposed scope of works was amended.

Following a site visit, to check access prior to the fieldwork, it was apparent that it would not be possible to carry out a cable percussion borehole at the higher ground due to the access constraints and a dynamic probe was therefore included to obtain data on the strength of the soils at this level.

The borehole and trial pit positions were specified by the consulting engineers, and positioned on site by GEA in accessible locations, with due regard to the proposed development, whilst avoiding areas of known services.

Since completion of the fieldwork, the proposals have since been amended and the basement footprint increased in size, occupying nearly the entire breadth of the site from north to south and the maximum depth of the proposed basement increased to a depth of roughly 10 m.

Laboratory geotechnical classification and strength tests were undertaken on samples of the natural soil.

Four samples of the made ground were subjected to analysis for a range of common industrial contaminants and contamination indicative parameters. For this investigation the analytical suite for the soil included a range of metals, speciation of total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH), total cyanide and monohydric phenols. The soil samples were selected to provide a general view of the chemical conditions of the soils that are likely to be involved in a human exposure or groundwater pathway and to provide advice in respect of re-use or for waste disposal classification.

At the request of the client, two samples of the made ground were also subjected to waste acceptance criteria (WAC) tests to provide advice in respect of waste disposal classification.

The contamination analyses were carried out at an MCERTs accredited laboratory with the majority of the testing suite accredited to MCERTS standards. Details of the MCERTs accreditation and test methods are included in the Appendix together with the analytical results.

5.0 GROUND CONDITIONS

The Bagshot Formation predominantly comprises sand deposits, whereas the Claygate Member comprises a sequence of clays, silt and fine grained sand. The base of the Bagshot Formation is marked in the Hampstead area by a layer of coarse sand and rounded flint gravel. On the basis of an inspection of the recovered soil, it has been interpreted that the investigation encountered a moderate thickness of topsoil / made ground, overlying the Bagshot Formation, underlain by the Claygate Member of the London Clay, proved to the maximum depth investigated of 20.0 m.

5.1 Made Ground / Topsoil

The made ground was found to extend to depths of between 1.00 m and 2.50 m (120.34 m OD and 116.57 m OD) and generally comprised brown silty clayey gravelly sand with occasional brick fragments, burnt coal and ash. Topsoil was encountered in Borehole Nos 4 and 7 only and generally comprised brown sandy silt with occasional fine flint gravel and fine rootlets, extending to depths of 0.20 m (118.87 m OD and 119.32 m OD).

No visual or olfactory evidence of contamination was noted in the made ground, apart from the presence of extraneous material such as burnt coal and ash fragments. Four samples of the made ground have tested for the presence of contamination as a precautionary measure and the results are presented in Section 5.5.

5.2 Bagshot Formation

Soils interpreted as comprising the Baghsot Formation were encountered at all locations investigated and comprised predominantly orange-brown, pale brown and reddish brown sand with occasional fine to coarse subangular to rounded flint gravel and rare pockets of greyish brown silty clay and organic matter. The Bagshot Formation was found to extend to depths of between 2.60 m and 6.80 m (116.92 m OD and 113.78 m OD). The base of this formation was not proved in Borehole No 1 and extended to the full depth investigated at this location of 7.00 m (115.04 m OD). The results of Dynamic Probe No 1, which was carried out roughly 1.00 m to the south of Borehole No 1, indicates that the Bagshot Formation extends to a depth of roughly 7.70 m (114.34 m OD).

SPTs have indicated the sand to be generally medium dense.

These soils were observed to be free of any visual or olfactory evidence of soil contamination.

5.3 Claygate Member

The Claygate Member generally comprised firm orange-brown mottled grey silty sandy clay or clayey silty fine sand, extending to depths 16.70 m (102.48 m OD) and 15.30 m (104.22 m OD), in Borehole Nos 5 and 7 respectively. This layer was in turn underlain by firm to stiff dark grey silty sandy clay or clayey silty fine sand, which was proved to the maximum depth investigated of 20.00 m (99.18 m OD and 99.52 m OD).

No evidence of desiccation was noted within the clay soils.

Atterberg limit laboratory tests carried out on samples of the clay indicate it to be of moderate volume change potential.

The results from the laboratory undrained triaxial compression tests indicate the Claygate Member to be of medium strength to very high strength. The undrained shear strength generally increases with depth, although slight variations in strength occur, which is considered to be a result of the sandy and very silty zones within the clay leading to disturbance during recovery of the undisturbed samples.

These soils were observed to be free of any visual or olfactory evidence of soil contamination.

5.4 Groundwater

Groundwater was only encountered during drilling of Boreholes Nos 5 to 7, at depths of between 12.20 m (106.98 m OD) and 13.50 m (106.02 m OD) from within the Claygate Member. Water was not encountered at any other exploratory locations.

Standpipes were installed in Borehole Nos 1, 5, 6 and 7 to depths of between 7.00 m and 14.00 m. Subsequent groundwater monitoring has been carried out on four occasions to date over a period of roughly one month.

The table opposite shows the depths at which water was measured on each of the monitoring visits:

Borehole No	Standpipe depth in m (m OD)	Depth to groundwater in m (m OD)			
		19/03/2013	05/04/2013	16/04/2013	22/04/2013
1	7.00 (115.04)	Dry	Dry	Dry	Dry
5	14.00 (105.18)	10.50 (108.68)	10.43 (108.75)		10.46 (108.72)
6	12.20 (107.01)	9.50 (109.71)	10.10 (109.11)	10.05 (109.16)	10.25 (108.96)
7	14.00 (105.52)	9.30 (110.22)	9.35 (110.17)	9.34 (110.18)	9.35 (110.17)

It was not possible to monitor Borehole No 5 on the third groundwater monitoring visit as a car was parked over the position.

5.5 Soil Contamination

The table below sets out the values measured within four samples of made ground analysed. All concentrations are in mg/kg unless otherwise stated.

Determinant	Maximum concentration recorded (mg/kg)	Minimum concentration recorded (mg/kg)	Number of samples below detection limit	Normalised upper bound US_{95}
Arsenic	18	6.6	All	16.6
Cadmium	<0.10	<0.10	All	<0.10
Chromium	29	8.4	All	26.7
Copper	21	5.9	All	21.5
Mercury	0.85	<0.10	All	0.9
Nickel	16	<5	All	15
Lead	**1500**	50	Three	**1283.9**
Selenium	<0.20	<0.20	All	<0.20
Zinc	85	15	All	77.7
Total Cyanide	<0.5	<0.5	All	0.5
Total Phenols	<0.3	<0.3	All	<0.3
Sulphide	1.1	<0.50	All	1.2
TPH	<10	<10	All	<10
Total PAH	<2	<2	All	<2
Benzo(a)pyrene	<0.1	<0.1	All	<0.1
Naphthalene	<0.1	<0.1	All	<0.1
Total organic carbon %	1.60	0.31	All	1.6

**Threshold values marked thus are for compounds with a limited human toxicity hence the threshold values adopted are not derived on a risk based methodology. Justification for all of the values quoted is provided in the appended table of Generic Risk Based Threshold Soil Guideline Values*

5.5.1 Generic Quantitative Risk Assessment

The use of a risk-based approach has been adopted to provide an initial screening of the test results to assess the need for subsequent site-specific risk assessments. To this end contaminants of concern are those that have values in excess of a generic human health risk based guideline values which are either that of the CLEA[5] Soil Guideline Value where available, or is a Generic Guideline Value calculated using the CLEA UK Version 1.06 software assuming a residential end use. The key generic assumptions for this end use are as follows:

- that groundwater will not be a critical risk receptor;
- that the critical receptor for human health will be young female children aged zero to six years old;
- that the exposure duration will be six years;
- that the critical exposure pathways will be direct soil and indoor dust ingestion, consumption of homegrown produce, consumption of soil adhering to homegrown produce, skin contact with soils and indoor dust, and inhalation of indoor and outdoor dust and vapours; and
- that the building type equates to a two-storey small terraced house.

It is considered that these assumptions are acceptable for this generic assessment of this site. The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix.

Where contaminant concentrations are measured at concentrations below the generic screening value it is considered that they pose an acceptable level of risk and thus further consideration of these contaminant concentrations is not required. However where concentrations are measured in excess of these generic screening values there is considered to be a potential that they could pose an unacceptable risk and thus further action will be required which could include;

- additional testing to zone the extent of the contaminated material and thus reduce the uncertainty with regard to its potential risk;
- site specific risk assessment to refine the assessment criteria and allow an assessment to be made as to whether the concentration present would pose an unacceptable risk at this site; or
- soil remediation or risk management to mitigate the risk posed by the contaminant to a degree that it poses an acceptable risk.

This assessment is based upon the potential for risk to human health, which at this site is considered to be the critical risk receptor.

The chemical analyses has revealed an elevated concentration of lead in a single sample of made ground, obtained from Borehole No 4 at a depth of 1.0 m.

5 *Updated Technical Background to the CLEA Model (Science Report SC050021/SR3) Jan 2009* and Soil Guideline Value reports for specific contaminants; all DEFRA and Environment Agency.

No elevated concentrations of any other contaminants were measured in excess of the generic risk based screening values for a residential end-use with plant uptake.

The elevated concentration of lead could thus pose a potentially unacceptable risk to human health through direct contact, accidental ingestion or inhalation of soil or soil derived dust.

The significance of these results are considered further in Part 2 of the report.

5.6 Existing Foundations

Two trial pits were excavated against the northern boundary garden wall, which was found to be bearing on made ground at depths of 0.10 m (120.98 m OD) and 0.47 m (122.17 m OD). Groundwater was not encountered in the trial pits.

The trial pit records and photographs are included in the Appendix.

Part 2: DESIGN BASIS REPORT

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

6.0 INTRODUCTION

Consideration is being given to the demolition of the existing detached two-storey house and for the subsequent construction of a detached three-storey house, with a basement extending to a maximum depth of approximately 10 m (roughly 112 m OD).

7.0 GROUND MODEL

The previous desk study revealed that the site and surrounding area have not had a potentially contaminative history, and on the basis of the fieldwork, the ground conditions at this site can be characterised as follows.

- Beneath a moderate thickness of made ground / topsoil, the Bagshot Formation was encountered overlying the Claygate Member, which was proved to the maximum depth investigated of 20.00 m (99.18 m OD and 99.52 m OD);
- the made ground extends to depths of between 1.00 m and 2.50 m (120.34 m OD and 116.57 m OD) and generally comprises brown silty clayey gravelly sand with occasional brick fragments, burnt coal and ash;
- the Bagshot Formation extends to depths of between 2.60 m and 6.80 m (116.92 m OD and 113.78 m OD) and generally comprises medium dense orange-brown, pale brown and reddish brown gravelly sand with occasional fine to coarse with rare pockets of greyish brown silty clay;
- the Claygate Member initially comprises firm orange-brown mottled grey silty sandy clay or clayey silty fine sand, underlain by firm to stiff dark grey silty sandy clay or clayey silty fine sand, proved to the full depth investigated;
- groundwater is present within the Claygate Member at depths of between 9.30 m and 10.50 m (110.22 m OD and 108.68 m OD); and
- the contamination testing revealed elevated concentrations of lead, within a single sample of made ground.

8.0 ADVICE AND RECOMMENDATIONS

Excavations for the proposed basement structure will require temporary support to maintain stability of the surrounding structures and to prevent any excessive ground movements. The existing foundations along the northern, southern and western boundary garden walls will need to be underpinned prior to construction of the proposed basement or will need to be supported by new retaining walls.

Based on the groundwater observations to date, groundwater is not expected to be encountered within the 10 m deep excavation, although monitoring of the standpipes should be continued in order to confirm this view and to determine the extent of seasonal fluctuations.

Formation level for the proposed development is likely to be within the Bagshot Formation or Claygate Member, which will provide an eminently suitable bearing stratum for the support of the anticipated light to moderate loads by means of spread foundations excavated from basement level. Alternatively, if proposed loads are high or spread foundations become uneconomic piled foundations would also provide a suitable solution.

8.1 Basement Construction

8.1.1 Basement Excavation

It is proposed to construct a three-storey house with a single level basement extending to a depth of a maximum depth of approximately 10 m (roughly 112 m OD).

The investigation has indicated that formation level will be near the base of the Bagshot Formation or top of the Claygate Member.

Groundwater has been measured at depths of between 9.30 m and 10.50 m (110.22 m OD and 108.68 m OD) within the Claygate Member on four occasions to date, over a period of roughly four weeks.

On the basis of the groundwater monitoring carried out to date it is not expected that groundwater will be encountered within the basement excavation. It is possible that seepages will be encountered from within the made ground and groundwater may be present within the Bagshot Formation near the boundary with the Claygate Member and within sand and silt layers within the Claygate Member. It is recommended that continued monitoring is carried out to confirm equilibrium levels and the extent of any seasonal fluctuations. Ideally trial excavations would be carried out to the proposed depth of the basement to assess the likely groundwater conditions.

The design of basement support in the temporary and permanent conditions needs to take account of the need to maintain the stability of the excavation and of the neighbouring structures and the extent to which groundwater inflows need to be prevented.

It may be necessary to underpin the northern, southern and western boundary garden walls prior to the construction of the basement, or to design the new retaining walls to accommodate the load from the existing structures.

The size of the proposed structure relative to the site and the depth of the proposed basement will rule out an open cut excavation.

A bored pile wall is likely to be the most appropriate method of supporting the basement excavation in the temporary and permanent conditions and could have the advantage of being incorporated into the permanent works and will be able to provide support for structural loads.

The monitoring carried out to date suggests that groundwater will not be encountered within the excavation and therefore it should be possible to adopt a contiguous bored pile wall with the use of localised grouting and sump pumping if necessary in order to deal with any groundwater inflows. A contiguous bored piled wall would, however, have the disadvantage of reducing usable space in the basement. A secant wall may have the advantage of maximising usable space in the basement as it would not require a secondary waterproofing inside the wall, which would be the case with a contiguous bored pile wall.

The ground movements associated with the basement excavation will depend on the method of excavation and support and the overall stiffness of the basement structure in the temporary condition. Thus, a suitable amount of propping will be required to provide the necessary rigidity. In this respect the timing of the provision of support to the wall will have an important effect on movements. The stability of surrounding structures will need to be ensured at all times and the northern garden boundary wall will need to be underpinned prior to the construction of the basement or the retaining walls will need to be designed to accommodate the loads from these foundations.

8.1.2 Basement Retaining Walls

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

Stratum	Bulk Density (kg/m^3)	Effective Cohesion (c' – kN/m^2)	Effective Friction Angle (ϕ' – degrees)
Made Ground	1700	Zero	20
Bagshot Formation	1850	Zero	30
Claygate Member	1850	Zero	25

Groundwater has been measured at depths of between 9.30 m and 10.50 m (110.22 m OD and 108.68 m OD) to date and is unlikely to be encountered within the 10 m deep excavation, although monitoring of the standpipes should be continued to confirm this view. At this stage, it is recommended that for the design of the retaining walls, groundwater level can be assumed to be below the depth of the basement. However, it is recommended that this is reviewed following further monitoring and consideration should be given to the risk of groundwater and surface water collecting behind the retaining walls. The use of a fully effective drainage system would be prudent in this respect and if this cannot be ensured it would be prudent to assume that water may collect behind the walls and to adopt a water level at two-thirds of the retained height for design purposes. The advice in BS8102:2009[6] should be followed in the design of the basement retaining walls and with regard to waterproofing requirements.

A check should be made on the risk of slope failure affecting the retaining walls.

6 BS8102 (2009) *Code of practice for protection of below ground structures against water from the ground*

8.1.3 **Basement Heave**

The proposed basement extends to a maximum depth of approximately 10 m (roughly 112 m OD). Formation level will be near the base of the Bagshot Formation or top of Claygate Member.

The excavation of the basement will result in a variable unloading of the Claygate Member at formation level. The excavations will result in an approximate unloading of roughly 180 kN/m^2, which will result in an elastic heave and long term swelling of the Claygate Member. The effects of the longer term swelling movement within the Claygate Member will be mitigated to some extent by the load applied by the new foundations. Consideration will need to be given to the effects of differential movement, where the basement extends to different depths.

It is recommended that the basement slab is suitably reinforced to withstand heave or that a void is incorporated below the slab to allow the movement to take place.

It would be prudent to conduct a more detailed analysis of these movements once the basement design has been finalised.

8.2 Spread Foundations

All foundations should bypass the made ground / topsoil, which was found to extend to depths of between 1.00 m and 2.50 m (120.34 m OD and 116.57 m OD).

Where the new building does not include a basement, moderate width pad or strip foundations bearing in the gravelly sand of the Bagshot Formation may be designed to apply a net allowable bearing pressure of 100 kN/m^2 at a minimum depth of 0.75 m

The excavation of the basement will extend to a maximum depth of roughly 10 m (approximately 112 m OD) and formation level for the basement will be near the base of the Bagshot Beds or top of the Claygate Member.

The information to date indicates that groundwater is unlikely to be encountered during basement excavation, although this should be confirmed through continued groundwater monitoring. However at this stage it is considered that it should be possible to adopt spread foundations excavated from basement level, designed to apply a net allowable bearing pressure of 100 kN/m^2 below the proposed basement floor, bearing within the medium dense Bagshot Formation or firm clay of the Claygate Member.

Foundations that span both the sand and clay soils will need to be suitably reinforced to protect against differential settlement.

A check should be made on the potential effects of foundation loadings on slopes that are below the foundation level. As an initial check it should be ensured that when a line is drawn at an angle of 45^o from the underside of the new foundation, it does not “exit” a slope face, but further analysis should ideally be carried out once proposed development details are finalised.

8.3 Basement Raft Foundation

The suitability of a raft foundation will be governed by the net load of the new development, taking into consideration the unloading due to the removal of soil from the basement excavation.

On this site, in view of the depth of the proposed excavation and the estimated heave it is anticipated that the gross load on the raft will not be sufficient to balance the weight of soil removed and the raft may need to be anchored into the ground by piles to resist movements. The raft could be constructed so that it forms a rigid box with the retaining walls such that differential movements are minimised. Further analyses should be carried out once the proposed uniform distributed load is known.

8.4 Piled Foundations

For the ground conditions at this site some form of bored pile is likely to be the most appropriate type. Piles installed using continuous flight auger (cfa) techniques are likely to be the most suitable in order to avoid potential problems associated with instability within the Bagshot Formation and possible groundwater inflows within the silt and sand partings of the Claygate Member.

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

Ultimate Skin Friction		**kN/m^2**
Made Ground and Bagshot Formation	Ground Level to 10.00 m	Ignore (basement excavation)
Claygate Member ($\alpha = 0.5$)	10.00 m to 20.00 m	Increasing linearly from 50 to 90

Ultimate End Bearing		**kN/m^2**
Claygate Member	10.00 m to 20.00 m	Increasing linearly from 900 to 1600

In the absence of pile tests, guidance from the London District Surveyors Association[7] (LDSA) suggests that a factor of safety of 2.6 should be applied to the above coefficients in the computation of safe theoretical working loads.

On the basis of the above coefficients and a factor of safety of 2.6, it has been estimated that a 450 mm diameter pile, 20 m long, extending to a depth of 10 m below the 10 m deep basement should provide a safe working load of about 460 kN.

The above example is not intended to constitute any form of recommendation with regard to pile size or type, but merely serve to illustrate the use of the above coefficients. Specialist piling contractors should be consulted with regard to the design of a suitable piling scheme for this site. Their attention should be drawn to the presence of sand partings and associated groundwater seepages within the Claygate Member.

7 LDSA (2009) *Foundations No 1 – Guidance notes for the design of straight shafted bored piles in London Clay*. LDSA Publication

Consideration will also need to be given to the effects of heave as a result of the basement excavation.

8.5 Basement and Ground Floor Slabs

Where the new buildings do not include a basement, it should be possible to adopt a ground bearing floor slab on the gravelly sand of the Bagshot Formation. The formation level should be proof rolled in any case and any soft spots should be replaced with compacted granular fill.

Following the excavation of the basement, it is likely that the floor slab for the proposed basement will need to be suspended over a void to accommodate the anticipated heave and any potential uplift forces from groundwater pressures unless the slab can be suitably reinforced to cope with these movements. This should be reviewed once the levels and loads are known.

8.6 Slope Stability

On the basis of a visual assessment, the slopes at this site have not suffered from movement although a more detailed slope stability analysis should be carried out once the proposals have been finalised.

8.7 Shallow Excavations

On the basis of the borehole findings and trial pits, it is considered that shallow excavations for foundations and services that extend through the made ground or Bagshot Formation should remain generally stable in the short term, although some instability may occur.

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

Inflows of groundwater into shallow excavations are not generally anticipated although inflows of perched water may occur from within the made ground, particularly in the vicinity of existing foundations and possibly towards the base of the Bagshot Formation and from silt and sand partings from within the Claygate Member. Any inflows should be suitably controlled by sump pumping, although this should be confirmed by continued groundwater monitoring and ideally trial excavations to the full depth of the proposed basement.

8.8 Effect of Sulphates

Chemical analyses carried out on three samples have revealed concentrations of soluble sulphate and near-neutral pH in accordance with Class DS-1 conditions of Table C2 of BRE Special Digest 1 Part C (2005). The measured pH value of the samples show that a ACEC class of AC-1s of Table C2 would be appropriate for the site. This assumes a static water condition at the site. The guidelines contained in the above digest should be followed in the design of foundation concrete.

8.9 Site Specific Risk Assessment

The desk study has not indicated the site to have had a potentially contaminative history. However, the chemical analysis has revealed an elevated concentration of lead within a single sample of made ground, obtained from Borehole No 4 at a depth of 1.00 m above the generic screening value of 450 mg/kg at 1500 mg/kg.

No other concentrations of contaminants were measured above the generic risk based screening values for a residential end use with plant uptake.

The source of the lead contamination is likely to be from demolition rubble of the previous buildings on site. The lead compounds are considered to be non-volatile or of a low volatility and of a low solubility and they do not thus present a significant vapour risk or a significant risk of leaching and migration within groundwater. These contaminants could, however, pose an unacceptable risk to human health through direct contact, accidental ingestion or inhalation of soil or soil derived dust.

End users will be effectively isolated from direct contact with the identified contaminants by the extent of the building and areas of external hardstanding. Only in proposed garden areas could end users conceivably come into direct contact with the contaminated soils, although this pathway is already in existence. Suitable precautions may need to be taken in these areas to protect end users and to allow successful plant growth.

As only a limited number of samples have been tested, it would be prudent to carry out contamination testing on additional samples of made ground / topsoil recovered from the areas of the site that are to remain as soft landscaped gardens, in order to ensure the absence of any significant contamination.

Site workers will be protected from the contamination through adherence to normal high standards of site safety but there may be a requirement for protection of buried plastic services laid within the made ground.

8.9.1 Site Workers

Site workers should be made aware of the contamination and a programme of working should be identified to protect workers handling any soil. The method of site working should be in accordance with guidelines set out by HSE[8] and CIRIA[9] and the requirements of the Local Authority Environmental Health Officer.

8.10 Waste Disposal

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE guidance[10], will need to be disposed of to a licensed tip. Under the European Waste Directive, waste is classified as being either Hazardous or Non-Hazardous and landfills receiving waste are classified as accepting hazardous or non-hazardous wastes or the non-hazardous sub-category of inert waste in accordance with the Waste Directive. Waste going to landfill is subject to landfill tax at either the standard rate of £64 per tonne (about £120 per m^3) or at the lower rate of £2.50 per tonne (roughly £5 per m^3). However, the classifications for tax purposes and disposal purposes differ and currently all

8 HSE (1992) HS(G)66 *Protection of workers and the general public during the development of contaminated land* HMSO

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

10 CL:AIRE (2011) *The Definition of Waste: Development Industry Code of Practice* Version 2, March 2011

made ground and topsoil is taxable at the 'standard' rate and only naturally occurring rocks and soils, which are accurately described as such in terms of the 2011 Order[11], would qualify for the 'lower rate' of landfill tax.

Based upon on the technical guidance provided by the Environment Agency[12] it is considered likely that the made ground from this site, as represented by the four chemical analyses carried out, would be classified as NON-HAZARDOUS waste under the waste code 17 05 04 (soils and stones not containing dangerous substances) and would be taxable at the standard rate. It is likely that the natural soils, if separated out, could be classified as an INERT waste also under the waste code 17 05 04. This material would be taxable at the lower rate, if accurately described as naturally occurring clay in terms of the 2011 Order on the waste transfer note. As the site has never been used for the storage of potentially hazardous materials, it is likely that WAC leaching tests would not be required for such inert waste going to landfill. This would however need to be confirmed by the receiving landfill site.

Under the requirements of the European Waste Directive all waste needs to be pre-treated prior to disposal. The pre-treatment process must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper[13] which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be "segregated" onsite by sufficiently characterising the soils in-situ prior to excavation.

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

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

If consideration were to be given to the re-use of the soil as a structural fill on this or another site, in accordance with the Code of Practice for the definition of waste, it would be necessary to confirm its suitability for use, its certainty of use and to confirm that only as much material is to be used as is required for the specific purpose for which it was being used. A materials management plan could then be formulated and a tracking system put in place such that once placed the material would no longer be regarded as being a waste and thus waste management licensing and landfill tax would not apply.

11 *Landfill Tax (Qualifying Material) Order 2011*

12 Environment Agency (2008) *Hazardous Waste: Interpretation of the definition and classification of hazardous waste. Technical Guidance* WM2 Second Edition Version 2.2, May 2008

13 Regulatory Position Statement (2007) *Treating non-hazardous waste for landfill - Enforcing the new requirement* Environment Agency 23 Oct 2007

9.0 BASEMENT IMPACT ASSESSMENT

It is understood that it is proposed to demolish the existing detached two-storey house and construct a detached three-storey house, with a basement extending to a maximum depth of approximately 10 m (roughly 112 m OD).

Formation level of the approximately 10 m deep basement is likely to be within the Bagshot Formation or top of the Claygate Member, proved to the full depth investigated of 20.00 m (99.18 m OD and 99.52 m OD).

Groundwater monitoring has measured groundwater at depths of between 9.30 m and 10.50 m (110.22 m OD and 108.68 m OD). The proposed basement is above monitored groundwater levels, and would therefore not act as a barrier to groundwater flow beneath the site.

Groundwater from beneath the site generally drains to the southwest and used to issue to the headwaters of the Westbourne Stream. These springs and headwaters no longer flow at surface and have been incorporated into the local surface water sewerage system. Any slight increase in hard surfaced area associated with the proposal would therefore not impact on flows to surface watercourses down gradient of the site.

Based on the findings of the site investigation, the proposed 10 m deep basement is unlikely to result in any significant changes to the groundwater regime in the vicinity of the site.

The screening identified a number of potential impacts. The desk study and ground investigation information has been used below to review the potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

The table below summarises the previously identified potential impacts and the additional information that is now available from the site investigation in consideration of each impact.

Potential Impact	Site Investigation Conclusions
Site is underlain by Secondary 'A' Aquifer – the basement may extend into the underlying aquifer and affect the groundwater flow regime	*Groundwater has been measured at depths of between 9.30 m and 10.50 m (110.22 m OD and 108.68 m OD) from within the Claygate Member. The proposed basement formation level extends to a depth of approximately 10 m (roughly 112 m OD) below existing ground level and the proposed basement will therefore be above the water table.*
Slope instability	*On the basis of a visual assessment, the slopes at this site have not suffered from movement although a more detailed slope stability analysis should be carried out once the proposals have been finalised.*
Increase in the differential depth of foundations relative to neighbouring properties	*The neighbouring properties are detached. The retention system will ensure the stability of the excavation and neighbouring properties at all times.*

The results of the site investigation have therefore been used below to review the remaining potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

Proposed basement structure is located over Secondary 'A' Aquifer

The site is underlain by a Secondary 'A' Aquifer but the groundwater table is at levels of approximately 110.22 m OD and 108.68 m OD and therefore the proposed 10 m deep basement will be above the water table and will not affect the groundwater flow regime.

Slope instability

On the basis of a visual assessment, the slopes at this site have not suffered from movement although a more detailed slope stability analysis should be carried out once the proposals have been finalised.

A check should be made on the risk of slope failure affecting the retaining walls.

Increase in the differential depth of neighbouring foundations

The stability of neighbouring properties and structures will be ensured at all times, through a suitable retention system. There is nothing unusual or exceptional in the proposed development or the findings of the investigation that give rise to any concerns with regard to stability over and above any development of this nature.

10.0 OUTSTANDING RISKS AND ISSUES

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

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

Further groundwater monitoring should be carried out to establish equilibrium levels and the extent of any seasonal fluctuations and it would be prudent to carry out trial excavations, although given the depth of the proposed basement, this is unlikely to be feasible and the contractor should have a contingency in place to deal with any significant groundwater inflows, unless a watertight temporary support system is adopted.

It is recommended that heave movements are checked by further analysis once the loadings and final levels are known.

A slope stability analysis should be carried out once the proposals have been finalised.

If during ground works any visual or olfactory evidence of contamination is identified it is recommended that further investigation be carried out and that the risk assessment is reviewed. These areas of doubt should be drawn to the attention of prospective contractors and further investigation will be required or sufficient contingency should be provided to cover the outstanding risk.

APPENDIX

Borehole Records

Dynamic Probe Records

SPT Summary Sheet

Trial Pit Records

Geotechnical Laboratory Test Results

SPT & Cohesion / Depth Graph

Chemical Analyses (Soil)

Generic Risk Based Screening Values

WAC Test Results

Site Plan

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans AL4 0PG	**Site** 99a Frognal, Hampstead, London, NW3 6XR	**Number** **BH1**

Excavation Method	**Dimensions**	**Ground Level (mOD)**	**Client**	**Job Number**
Drive-in Window Sampler		122.04	Harrison Varma	J13053
	Location	**Dates** 08/03/2013	**Engineer** Fluid Structures	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.20	D1				(0.50)	MADE GROUND (brown sandy clayey slightly gravelly silt with occasional roots and rare brick fragments)		
0.50	D2			121.54	0.50 (0.50)	MADE GROUND (pale brown silty slightly clayey slightly gravelly sand with brick fragments, charcoal and ash)		
1.00	D3			121.04	1.00 (0.70)	MADE GROUND (brown silty slightly clayey gravelly sand with brick fragments, charcoal and ash)		
1.50	D4							
				120.34	1.70	Medium dense becoming dense orange-brown reddish brown silty fine to coarse SAND with fine to coarse subangular to rounded flint gravel encountered at depths of between 3.0 m to 3.5 m and 4.5 m to 7.0 m		
2.00	D5							
2.50	D6							
3.00	D7							
3.50	D8							
4.00	D9							
					(5.30)			
4.50	D10							
5.00	D11							
5.50	D12							
6.00	D13							
6.50	D14							
7.00	D15			115.04	7.00			
						Complete at 7.00m		

Remarks
Groundwater not encountered during drilling
Standpipe installed to a depth of 7.0 m
Subsequent groundwater monitoring recorded the standpipe to be dry on 19/03/2013, 05/04/2013, 16/04/2013 and 22/04/2013

Scale (approx)	**Logged By**
1:50	DA

Figure No. J13053.BH1

GEA Geotechnical & Environmental Associates	Tyttenhanger House, Coursers Road, St Albans, AL4 0PG	Site	Number
		99a Frognal, Hampstead, London, NW3 6XR	BH2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler		122.31	Harrison Varma	J13053
	Location	**Dates**	**Engineer**	**Sheet**
		08/03/2013	Fluid Structures	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.20	D1					MADE GROUND (brown and pale greenish grey silty clayey gravelly sand with ash, brick fragments and charcoal, occasional roots and a pocket of orange-brown silty very sandy clay at 0.8 m)		
0.50	D2				(1.00)			
1.00	D3			121.31	1.00 (0.50)	MADE GROUND (brown silty clayey gravelly sand with roots and occasional brick fragments, charcoal and ash)		
1.50	D4			120.81	1.50 (0.50)	MADE GROUND (brown silty clayey gravelly sand with occasional roots and rare brick fragments)		
2.00	D5			120.31	2.00	Brown mottled yellowish brown, orange-brown and reddish brown silty fine to coarse SAND with fine to medium angular to rounded flint gravel encountered at depths of between 3.7 m to 3.8 m, 4.5 m to 5.2 m. A layer of firm brown silty clay was encountered at a depth of 3.0 m to 3.2 m		
2.50	D6							
3.00	D7							
3.50	D8							
4.00	D9							
4.50	D10				(4.80)			
5.00	D11							
5.50	D12							
6.00	D13							
6.50	D14							
				115.51	6.80 (0.20)	Firm brown silty CLAY with occasional carbonaceous material		
7.00	D15			115.31	7.00	Complete at 7.00m		

Remarks	Scale (approx)	Logged By
Groundwater not encountered	1:50	DA
	Figure No. J13053.BH2	

Geotechnical & Environmental Associates Tyttenhanger House, Coursers Road, St Albans, AL4 0PG		**Site** 99a Frognal, Hampstead, London, NW3 6XR	**Number** BH3
Excavation Method Drive-in Window Sampler	**Dimensions**	**Ground Level (mOD)** 121.08	**Client** Harrison Varma	**Job Number** J13053
	Location	**Dates** 08/03/2013	**Engineer** Fluid Structures	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20)	MADE GROUND (dark brown clayey silty sand with roots)		
0.20	D1			120.88	0.20	MADE GROUND (brown silty clayey sand with brick fragments, ash and a 15 mm thick layer of charcoal at 0.7 m)		
0.50	D2				(1.10)			
1.00	D3							
				119.78	1.30	Brown mottled orange-brown and reddish brown silty fine to coarse SAND with fine to medium subangular to rounded flint gravel encountered at depths of between 1.3 m to 1.6 m and 2.8 m to 5.0 m with occasional carbonaceous material		
1.50	D4							
2.00	D5							
2.50	D6							
3.00	D7							
3.50	D8				(4.20)			
4.00	D9							
4.50	D10							
5.00	D11							
5.50	D12			115.58	5.50	Firm orange-brown mottled grey silty sandy CLAY		
6.00	D13				(1.50)			
6.50	D14							
7.00	D15			114.08	7.00			
						Complete at 7.00m		

Remarks
Groundwater not encountered.

Scale (approx)	Logged By
1:50	DA

Figure No. J13053.BH3

GEA Geotechnical & Environmental Associates Tyttenhanger House, Coursers Road, St Albans, AL4 0PG	Site 99a Frognal, Hampstead, London, NW3 6XR		Number **BH4**
Excavation Method Drive-in Window Sampler	Dimensions	Ground Level (mOD) 119.07	Client Harrison Varma	Job Number J13053
	Location	Dates 08/03/2013	Engineer Fluid Structures	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				118.87	(0.20) 0.20	Topsoil (brown silty sandy clay with roots)		
0.20	D1					MADE GROUND (brown silty sandy clay with occasional fragments of brick and ash)		
0.50	D2							
					(1.30)			
1.00	D3							
1.50	D4			117.57	1.50	MADE GROUND (orange-brown silty very clayey sand with rare brick fragments)		
2.00	D5				(1.00)			
2.50	D6			116.57	2.50	Orange-brown silty fine to coarse SAND with occasional fine to coarse sub-angular to rounded flint gravel		
3.00	D7							
					(1.80)			
3.50	D8							
4.00	D9							
				114.77	4.30	Firm orange-brown silty sandy CLAY		
4.50	D10							
5.00	D11							
5.50	D12				(2.70)			
6.00	D13							
6.50	D14							
7.00	D15			112.07	7.00			
						Complete at 7.00m		

Remarks Groundwater not encountered	Scale (approx) 1:50	Logged By DA
		Figure No. J13053.BH4

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans AL4 0PG	Site 99a Frognal, Hampstead, London, NW3 6XR	Borehole Number **BH5**

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 9.00m	119.18	Harrison Varma	J13053
	Location	**Dates**	**Engineer**	**Sheet**
		11/03/2013- 12/03/2013	Fluid Structures	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					119.08	(0.10) 0.10	Reinforced Concrete		
0.50	D1					(0.90)	MADE GROUND (brown slightly clayey sand occasional fragments of brick and ash)		
1.00	D2				118.18	1.00	Medium dense orange-brown SAND and GRAVEL. Sand is fine to coarse. Gravel is fine to coarse subangular to rounded flint gravel		
1.20-1.65 1.20	CPT N=18 B3	1.20	DRY	1,2/3,3,5,7					
2.00-2.45 2.00	CPT N=21 B4	2.00	1.80	3,3/4,5,5,7					
3.00-3.45 3.00	CPT N=20 B5	3.00	2.60	2,2/3,4,6,7		(4.40)			
4.00-4.45 4.00	CPT N=23 B6	4.00	3.40	1,2/3,5,7,8					
5.00-5.45 5.00	CPT N=10 B7	5.00	3.80	1,1/2,2,2,4					
					113.78	5.40	Firm becoming stiff high strength orange-brown mottled grey silty sandy CLAY interbedded with brown silty fine sand and occasional carbonaceous material		
6.00-6.45 6.00	SPT N=11 D8	6.00	DRY	1,1/2,3,3,3					
7.50-7.95	U9								
8.00	D10								
9.00-9.45 9.00	SPT N=17 D11	9.00	DRY	2,2/2,4,5,6					

Remarks
Hand-dug service pit to a depth of 1.2 m (90 minutes)
Groundwater monitoring standpipe installed to a depth of 14.0 m
Groundwater measured at depths of 10.50 m on 19/03/2013, 10.43 m on 05/04/2013 and 10.46 m on 22/04/2013
150 minutes spent tidying up and bagging up excess spoil
Water added from 1.20m to 5.40m.

Scale (approx)	Logged By
1:50	DA / HD

Figure No. J13053.BH5

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Site	Borehole Number
99a Frognal, Hampstead, London, NW3 6XR	BH5

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 9.00m	119.18	Harrison Varma	J13053
	Location	**Dates** 11/03/2013-12/03/2013	**Engineer** Fluid Structures	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Water
10.50-10.95	U12							
11.00	D13							
12.00-12.45 12.00	SPT N=20 D14	9.00	DRY	3,3/4,5,5,6				
				Slow(1) at 12.50m, sealed at NOT SEALEDm.				∇1
						(11.30)		
13.50-13.95 13.50	SPT N=13 D15	13.50	12.80	2,3/2,3,4,4				
15.00-15.45 15.00	SPT N=19 D16	15.00	14.20	3,3/4,4,5,6				
16.50-16.95 16.50	SPT N=31 D17	16.50	15.50	5,6/7,7,8,9	102.48	16.70	Stiff dark grey silty sandy CLAY	
18.00	D18							
						(3.30)		
18.50-18.95	SPT N=27	18.50	15.80	5,5/6,6,7,8				
19.50-19.95 19.50	SPT N=29 D19	19.50	16.30	5,6/6,7,8,8				
					99.18	20.00		

Remarks

Scale (approx)	Logged By
1:50	DA / HD

Figure No. J13053.BH5

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans AL4 0PG	Site 99a Frognal, Hampstead, London, NW3 6XR	Borehole Number **BH6**

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 14.50m	119.21	Harrison Varma	J13053
	Location	**Dates**	**Engineer**	**Sheet**
		19/03/2013	Fluid Structures	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
					119.16	(0.05) 0.05	Paving slab
					118.96	(0.20) 0.25	Sand sub-base
0.40	D1						MADE GROUND (brown clayey gravelly sand with fine fragments of ash)
0.80	D2						
						(1.95)	
1.20-1.65 1.20	CPT N=4 B3	1.20	DRY	1,1/1,1,1,1			
2.00-2.45 2.00	CPT N=4 B4	2.00	DRY	1,1/1,1,1,1			
					117.01	2.20	Medium dense brown slightly gravelly SAND
						(1.40)	
3.00-3.45 3.00	CPT N=16 B5	3.00	DRY	1,2/5,4,4,3			
					115.61	3.60	Firm becoming stiff medium strength and high strength orange-brown mottled grey silty sandy CLAY interbedded with pale brown silty fine sand with occasional carbonaceous material
3.80	D6						
4.00-4.45 4.00	SPT N=11 D7	4.00	DRY	1,2/3,2,3,3			
4.70	D8						
5.00-5.45	U9						
5.50	D10						
6.00-6.45 6.00	SPT N=17 D11	4.50	DRY	2,3/4,4,4,5			
7.50-7.95	U12						
8.00	D13						
9.00-9.45 9.00	SPT N=21 D14	4.50	DRY	2,3/4,5,6,6			
						(11.40)	

Remarks
Hand-dug service pit to a depth of 1.20 m (90 minutes)
Standpipe installed to a depth of 12.30 m
Groundwater measured at a depth of 9.50 m on 19/03/2013, 10.10 m on 05/03/2013, 10.05 m on 16/04/2013 and 10.25 m on 22/04/2013
90 minutes spent tidying up and bagging up excess spoil
Chiselling from 0.00m to 1.20m for 1.5 hours.

Scale (approx)	Logged By
1:50	DA / HD

Figure No. J13053.BH6

Geotechnical & Environmental Associates (GEA)	Tyttenhanger House, Coursers Road, St Albans, AL4 0PG	Site: 99a Frognal, Hampstead, London, NW3 6XR	Borehole Number: BH6
Boring Method: Cable Percussion	Casing Diameter: 150mm cased to 14.50m	Ground Level (mOD): 119.21	Client: Harrison Varma	Job Number: J13053
	Location:	Dates: 19/03/2013	Engineer: Fluid Structures	Sheet: 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.50-10.95 10.50	SPT N=22 D15	4.50	DRY	3,3/4,5,6,7					
12.00-12.45 12.00	SPT N=22 D16	4.50	DRY	3,4/5,5,6,6 Slow(1) at 12.20m, sealed at NOT SEALEDm.		(11.40)			∇1
13.50-13.95 13.50	SPT N=22 D17	4.50	DRY	3,3/4,5,6,7					
14.50-14.95 14.50	SPT N=23 D18	4.50	DRY	3,4/5,5,6,7					
					104.21	15.00			
							Complete at 15.00m		

Remarks	Scale (approx)	Logged By
	1:50	DA / HD
	Figure No. J13053.BH6	

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Site 99a Frognal, Hampstead, London, NW3 6XR				**Borehole Number** BH7
Boring Method Cable Percussion	**Casing Diameter** 150mm cased to 18.00m	**Ground Level (mTBM)** 119.52	**Client** Harrison Varma	**Job Number** J13053
	Location	**Dates** 13/03/2013	**Engineer** Fluid Structures	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mTBM)	Depth (m) (Thickness)	Description
					119.32	(0.20) 0.20	Topsoil (brown silty sand)
							MADE GROUND (grey mottled brown silty clayey gravelly sand with abundant fragment of brick, ash and charcoal)
0.60	D1						
0.80	D2					(1.20)	
1.20-1.65	CPT N=5	1.20	DRY	1,1/1,2,1,1			
1.20	B1				118.12	1.40	Loose brown SAND with rare fine to medium subangular flint gravel
2.00-2.45	CPT N=7	2.00	DRY	1,1/1,1,2,3		(1.20)	
2.00	B2						
					116.92	2.60	Firm becoming stiff brown mottled grey silty sandy CLAY interbedded with pale brown silty fine sand
2.80	D3						
3.00-3.45	SPT N=9	3.00	DRY	1,2/2,2,2,3			
3.00	D1						
3.80	D4						
4.00-4.45	U1						
4.40	D5						
4.70	D6						
5.00-5.45	SPT N=11	3.00	DRY	1,2/2,2,3,4			
5.00	D2						
6.00-6.45	SPT N=13	3.00	DRY	3,3/3,3,3,4			
6.00	D3						
7.50-7.95	SPT N=17	3.00	DRY	3,3/3,4,5,5			
7.50	D4						
						(12.70)	
9.00-9.45	SPT N=21	3.00	DRY	2,2/3,5,6,7			
9.00	D5						

Remarks
Hand-dug service pit to a depth of 1.20 m (90 minutes)
Standpipe installed to a depth of 14.00 m
Groundwater measured at a depth of 9.30 m 19/03/2013, 9.35 m on 05/04/2013, 9.34 m on 16/04/2013 and 9.35 m on 22/04/2013
60 minutes spent bagging up excess spoil and tidying site

Scale (approx)	Logged By
1:50	DA / HD

Figure No. J13053.BH6

GEA Geotechnical & Environmental Associates
Tyttenhanger House, Coursers Road, St Albans, AL4 0PG

Site	99a Frognal, Hampstead, London, NW3 6XR		**Borehole Number**	BH7
Boring Method	Cable Percussion	**Casing Diameter**	150mm cased to 18.00m	
Ground Level (mTBM)	119.52	**Client**	Harrison Varma	
Job Number	J13053			
Location		**Dates**	13/03/2013	
Engineer	Fluid Structures	**Sheet**	2/2	

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mTBM)	Depth (m) (Thickness)	Description	Legend	Water
10.50	D6			Damp (1) at 10.50m.					∇1
10.50-10.95	SPT N=15	3.00	DRY	2,2/3,4,3,5					
12.00-12.45	SPT N=24	12.00	DRY	3,3/4,5,7,8					
12.00	D7								
						(12.70)			
13.50	D8			Slow(2) at 13.50m, sealed at 18.00m.					∇2
13.50-13.95	SPT N=25	13.50	13.10	3,4/5,5,7,8					
15.00-15.45	SPT N=20	15.00	13.80	3,4/4,5,5,6					
15.00	D9								
					104.22	15.30	Stiff fissured very high stength dark grey silty sandy CLAY with occasional partings of grey fine sand and silt and selenite crystals. A claystone was encounteted at a depth of 18.90 m		
16.50-16.95	SPT N=17	16.50	16.20	3,3/4,4,4,5					
16.50	D10								
						(4.70)			
18.00-18.45	U2								
18.50	D7								
19.50-19.95	SPT N=26	18.00	DRY	3,4/5,6,7,8					
19.50	D11								
					99.52	20.00			

Remarks

Scale (approx)	Logged By
1:50	DA / HD

Figure No.
J13053.BH6

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Standard Penetration Test Results

Site : 99a Frognal, Hampstead, London, NW3 6XR

Client : Harrison Varma

Engineer : Fluid Structures

Job Number J13053

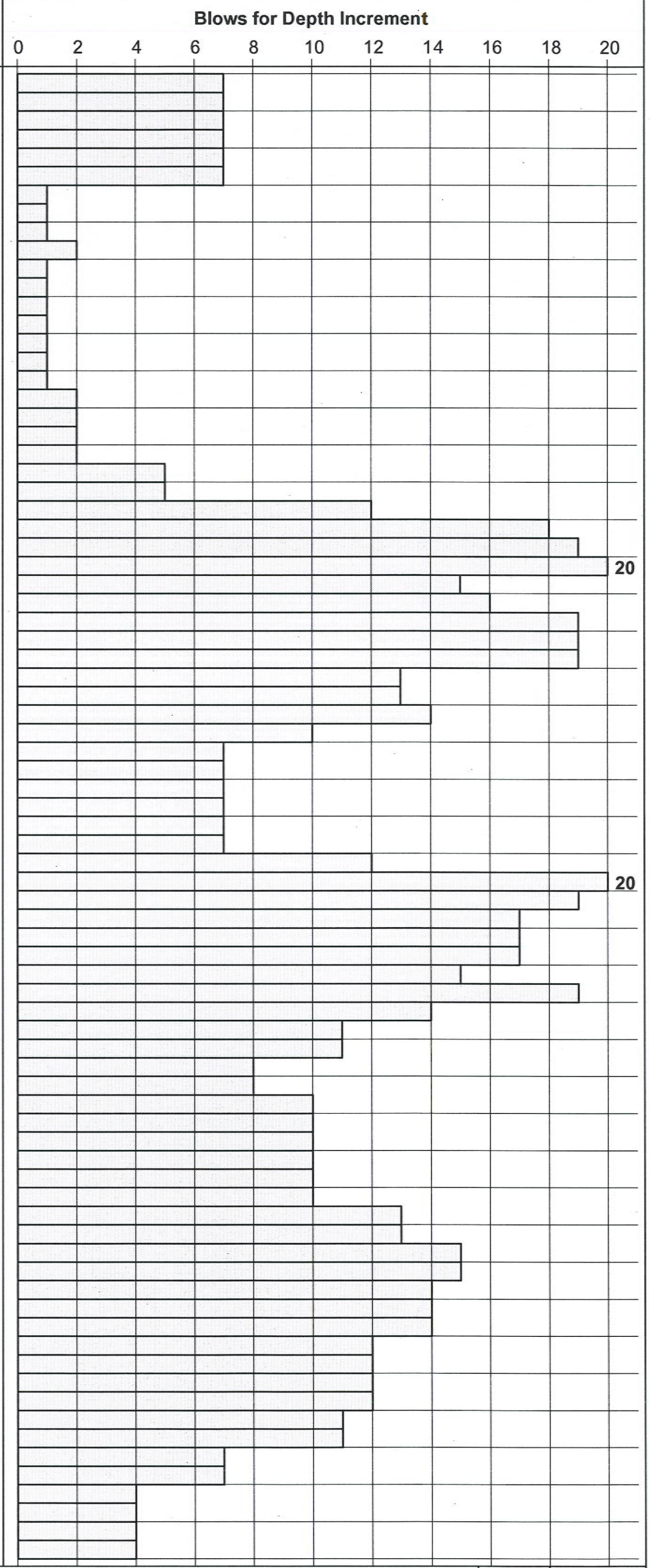
Sheet 1 / 1

Borehole Number	Base of Borehole (m)	End of Seating Drive (m)	End of Test Drive (m)	Test Type	Seating Blows per 75mm		Blows for each 75mm penetration				Result	Comments
					1	2	1	2	3	4		
BH5	1.20	1.35	1.65	CPT	1	2	3	3	5	7	N=18	
BH5	2.00	2.15	2.45	CPT	3	3	4	5	5	7	N=21	
BH5	3.00	3.15	3.45	CPT	2	2	3	4	6	7	N=20	
BH5	4.00	4.15	4.45	CPT	1	2	3	5	7	8	N=23	
BH5	5.00	5.15	5.45	CPT	1	1	2	2	2	4	N=10	
BH5	6.00	6.15	6.45	SPT	1	1	2	3	3	3	N=11	
BH5	9.00	9.15	9.45	SPT	2	2	2	4	5	6	N=17	
BH5	12.00	12.15	12.45	SPT	3	3	4	5	5	6	N=20	
BH5	13.50	13.65	13.95	SPT	2	3	2	3	4	4	N=13	
BH5	15.00	15.15	15.45	SPT	3	3	4	4	5	6	N=19	
BH5	16.50	16.65	16.95	SPT	5	6	7	7	8	9	N=31	
BH5	18.50	18.65	18.95	SPT	5	5	6	6	7	8	N=27	
BH5	19.50	19.65	19.95	SPT	5	6	6	7	8	8	N=29	
BH6	1.20	1.35	1.65	CPT	1	1	1	1	1	1	N=4	
BH6	2.00	2.15	2.45	CPT	1	1	1	1	1	1	N=4	
BH6	3.00	3.15	3.45	CPT	1	2	5	4	4	3	N=16	
BH6	4.00	4.15	4.45	SPT	1	2	3	2	3	3	N=11	
BH6	6.00	6.15	6.45	SPT	2	3	4	4	4	5	N=17	
BH6	9.00	9.15	9.45	SPT	2	3	4	5	6	6	N=21	
BH6	10.50	10.65	10.95	SPT	3	3	4	5	6	7	N=22	
BH6	12.00	12.15	12.45	SPT	3	4	5	5	6	6	N=22	
BH6	13.50	13.65	13.95	SPT	3	3	4	5	6	7	N=22	
BH6	14.50	14.65	14.95	SPT	3	4	5	5	6	7	N=23	
BH7	1.20	1.35	1.65	CPT	1	1	1	2	1	1	N=5	
BH7	2.00	2.15	2.45	CPT	1	1	1	1	2	3	N=7	
BH7	3.00	3.15	3.45	SPT	1	2	2	2	2	3	N=9	
BH7	5.00	5.15	5.45	SPT	1	2	2	2	3	4	N=11	
BH7	6.00	6.15	6.45	SPT	3	3	3	3	3	4	N=13	
BH7	7.50	7.65	7.95	SPT	3	3	3	4	5	5	N=17	
BH7	9.00	9.15	9.45	SPT	2	2	3	5	6	7	N=21	
BH7	10.50	10.65	10.95	SPT	2	2	3	4	3	5	N=15	
BH7	12.00	12.15	12.45	SPT	3	3	4	5	7	8	N=24	
BH7	13.50	13.65	13.95	SPT	3	4	5	5	7	8	N=25	
BH7	15.00	15.15	15.45	SPT	3	4	4	5	5	6	N=20	
BH7	16.50	16.65	16.95	SPT	3	3	4	4	4	5	N=17	
BH7	19.50	19.65	19.95	SPT	3	4	5	6	7	8	N=26	

GEA Geotechnical & Environmental Associates	Tyttenhanger House, Coursers Road, St Albans, AL4 0PG	Site: 99a Frognal, Hampstead, London, NW3 6XR	Probe Number: **DP1**

Method	Cone Dimensions	Ground Level (mOD)	Client	Job Number
Dynamic Probe		122.04	Harrison Varma	J13053
	Location	**Dates**	**Engineer**	**Sheet**
		08/03/2013	Fluid Structures	1/2

Depth (m)	Blows for Depth Increment	Field Records	Level (mOD)	Depth (m)
0.00-0.10	7		122.04	0.00
0.10-0.20	7			
0.20-0.30	7			
0.30-0.40	7			
0.40-0.50	7			
0.50-0.60	7		121.54	0.50
0.60-0.70	1			
0.70-0.80	1			
0.80-0.90	1			
0.90-1.00	2			
1.00-1.10	1		121.04	1.00
1.10-1.20	1			
1.20-1.30	1			
1.30-1.40	1			
1.40-1.50	1			
1.50-1.60	1		120.54	1.50
1.60-1.70	1			
1.70-1.80	2			
1.80-1.90	2			
1.90-2.00	2			
2.00-2.10	2		120.04	2.00
2.10-2.20	5			
2.20-2.30	5			
2.30-2.40	12			
2.40-2.50	18			
2.50-2.60	19		119.54	2.50
2.60-2.70	20			
2.70-2.80	15			
2.80-2.90	16			
2.90-3.00	19			
3.00-3.10	19		119.04	3.00
3.10-3.20	19			
3.20-3.30	13			
3.30-3.40	13			
3.40-3.50	14			
3.50-3.60	10		118.54	3.50
3.60-3.70	7			
3.70-3.80	7			
3.80-3.90	7			
3.90-4.00	7			
4.00-4.10	7		118.04	4.00
4.10-4.20	7			
4.20-4.30	12			
4.30-4.40	20			
4.40-4.50	19			
4.50-4.60	17		117.54	4.50
4.60-4.70	17			
4.70-4.80	17			
4.80-4.90	15			
4.90-5.00	19			
5.00-5.10	14		117.04	5.00
5.10-5.20	11			
5.20-5.30	11			
5.30-5.40	8			
5.40-5.50	8			
5.50-5.60	10		116.54	5.50
5.60-5.70	10			
5.70-5.80	10			
5.80-5.90	10			
5.90-6.00	10			
6.00-6.10	10		116.04	6.00
6.10-6.20	13			
6.20-6.30	13			
6.30-6.40	15			
6.40-6.50	15			
6.50-6.60	14		115.54	6.50
6.60-6.70	14			
6.70-6.80	14			
6.80-6.90	12			
6.90-7.00	12			
7.00-7.10	12		115.04	7.00
7.10-7.20	12			
7.20-7.30	11			
7.30-7.40	11			
7.40-7.50	7			
7.50-7.60	7		114.54	7.50
7.60-7.70	4			
7.70-7.80	4			
7.80-7.90	4			
7.90-8.00	4			
			114.04	8.00



Remarks	Scale (approx)	Logged By
	1:40	DA
	Figure No.	
	J13053.DP1	

GEA Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

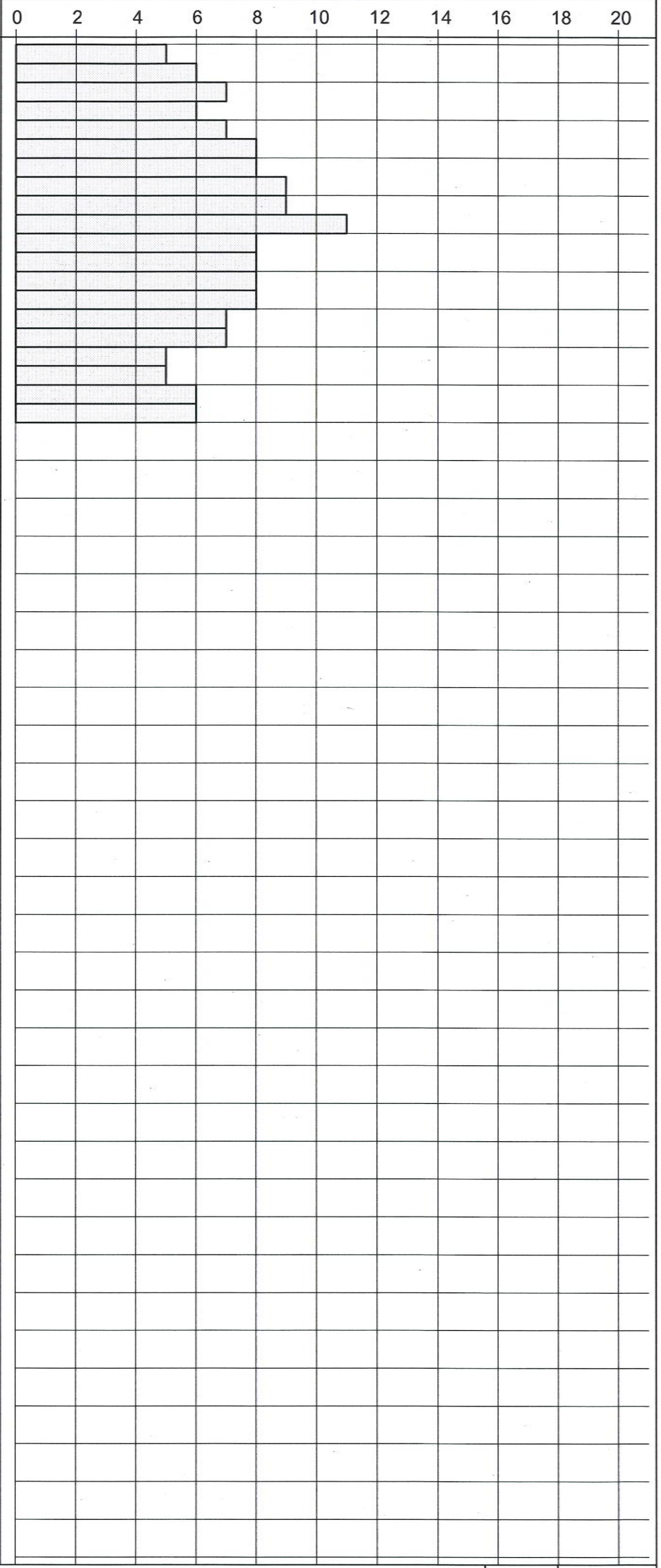
Site	Probe Number
99a Frognal, Hampstead, London, NW3 6XR	DP1

Method	Cone Dimensions	Ground Level (mOD)	Client	Job Number
Dynamic Probe		122.04	Harrison Varma	J13053
	Location	**Dates**	**Engineer**	**Sheet**
		08/03/2013	Fluid Structures	2/2

Depth (m)	Blows for Depth Increment	Field Records
8.00-8.10	5	
8.10-8.20	6	
8.20-8.30	7	
8.30-8.40	6	
8.40-8.50	7	
8.50-8.60	8	
8.60-8.70	8	
8.70-8.80	9	
8.80-8.90	9	
8.90-9.00	11	
9.00-9.10	8	
9.10-9.20	8	
9.20-9.30	8	
9.30-9.40	8	
9.40-9.50	7	
9.50-9.60	7	
9.60-9.70	5	
9.70-9.80	5	
9.80-9.90	6	
9.90-10.00	6	

Level (mOD)	Depth (m)
114.04	8.00
113.54	8.50
113.04	9.00
112.54	9.50
112.04	10.00
111.54	10.50
111.04	11.00
110.54	11.50
110.04	12.00
109.54	12.50
109.04	13.00
108.54	13.50
108.04	14.00
107.54	14.50
107.04	15.00
106.54	15.50
106.04	16.00

Blows for Depth Increment



Remarks	Scale (approx)	Logged By
	1:40	DA
	Figure No.	
	J13053.DP1	

Geotechnical & Environmental Associates (GEA)

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

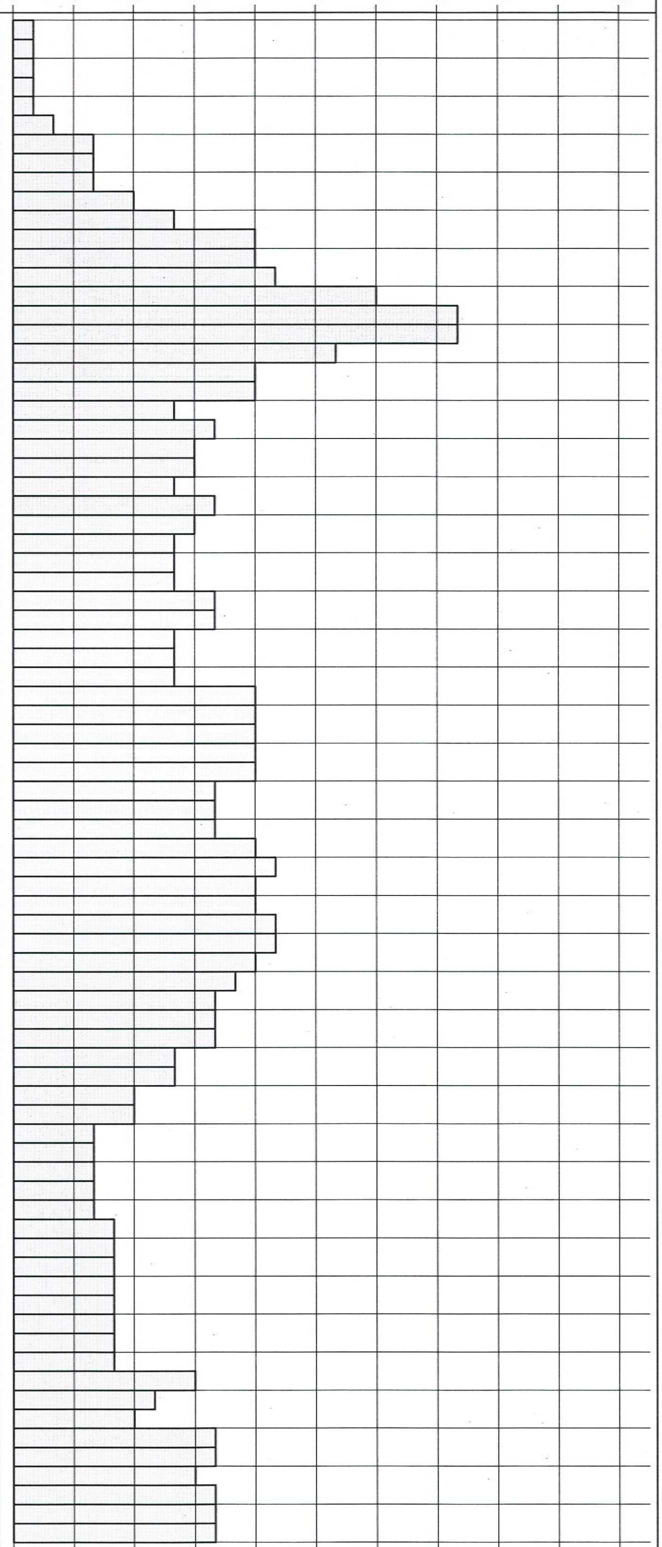
Site	Probe Number
99a Frognal, Hampstead, London, NW3 6XR	DP2

Method	Cone Dimensions	Ground Level (mOD)	Client	Job Number
Dynamic Probe		121.08	Harrison Varma	J13053
	Location	**Dates**	**Engineer**	**Sheet**
		08/03/2013	Fluid Structures	1/2

Depth (m)	Blows for Depth Increment	Field Records
0.00-0.10	1	
0.10-0.20	1	
0.20-0.30	1	
0.30-0.40	1	
0.40-0.50	1	
0.50-0.60	2	
0.60-0.70	4	
0.70-0.80	4	
0.80-0.90	4	
0.90-1.00	6	
1.00-1.10	8	
1.10-1.20	12	
1.20-1.30	12	
1.30-1.40	13	
1.40-1.50	18	
1.50-1.60	22	
1.60-1.70	22	
1.70-1.80	16	
1.80-1.90	12	
1.90-2.00	12	
2.00-2.10	8	
2.10-2.20	10	
2.20-2.30	9	
2.30-2.40	9	
2.40-2.50	8	
2.50-2.60	10	
2.60-2.70	9	
2.70-2.80	8	
2.80-2.90	8	
2.90-3.00	8	
3.00-3.10	10	
3.10-3.20	10	
3.20-3.30	8	
3.30-3.40	8	
3.40-3.50	8	
3.50-3.60	12	
3.60-3.70	12	
3.70-3.80	12	
3.80-3.90	12	
3.90-4.00	12	
4.00-4.10	10	
4.10-4.20	10	
4.20-4.30	10	
4.30-4.40	12	
4.40-4.50	13	
4.50-4.60	12	
4.60-4.70	12	
4.70-4.80	13	
4.80-4.90	13	
4.90-5.00	12	
5.00-5.10	11	
5.10-5.20	10	
5.20-5.30	10	
5.30-5.40	10	
5.40-5.50	8	
5.50-5.60	8	
5.60-5.70	6	
5.70-5.80	6	
5.80-5.90	4	
5.90-6.00	4	
6.00-6.10	4	
6.10-6.20	4	
6.20-6.30	4	
6.30-6.40	5	
6.40-6.50	5	
6.50-6.60	5	
6.60-6.70	5	
6.70-6.80	5	
6.80-6.90	5	
6.90-7.00	5	
7.00-7.10	5	
7.10-7.20	9	
7.20-7.30	7	
7.30-7.40	6	
7.40-7.50	10	
7.50-7.60	10	
7.60-7.70	9	
7.70-7.80	10	
7.80-7.90	10	
7.90-8.00	10	

Level (mOD)	Depth (m)
121.08	0.00
120.58	0.50
120.08	1.00
119.58	1.50
119.08	2.00
118.58	2.50
118.08	3.00
117.58	3.50
117.08	4.00
116.58	4.50
116.08	5.00
115.58	5.50
115.08	6.00
114.58	6.50
114.08	7.00
113.58	7.50
113.08	8.00

Blows for Depth Increment



Remarks	Scale (approx)	Logged By
	1:40	DA
	Figure No.	
	J13053.DP2	

GEA Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Site: 99a Frognal, Hampstead, London, NW3 6XR

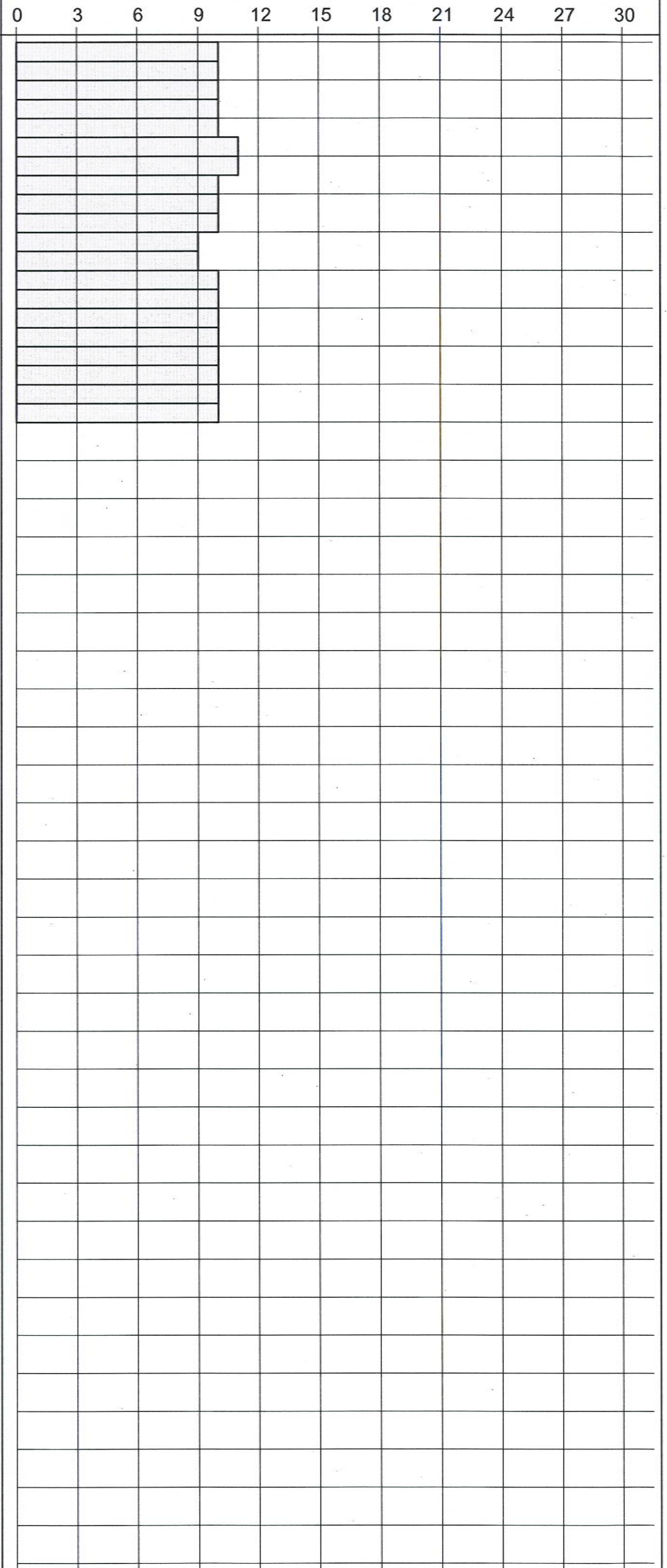
Probe Number: DP2

Method	Cone Dimensions	Ground Level (mOD)	Client	Job Number
Dynamic Probe		121.08	Harrison Varma	J13053
	Location	**Dates**	**Engineer**	**Sheet**
		08/03/2013	Fluid Structures	2/2

Depth (m)	Blows for Depth Increment	Field Records
8.00-8.10	10	
8.10-8.20	10	
8.20-8.30	10	
8.30-8.40	10	
8.40-8.50	10	
8.50-8.60	11	
8.60-8.70	11	
8.70-8.80	10	
8.80-8.90	10	
8.90-9.00	10	
9.00-9.10	9	
9.10-9.20	9	
9.20-9.30	10	
9.30-9.40	10	
9.40-9.50	10	
9.50-9.60	10	
9.60-9.70	10	
9.70-9.80	10	
9.80-9.90	10	
9.90-10.00	10	

Level (mOD)	Depth (m)
113.08	8.00
112.58	8.50
112.08	9.00
111.58	9.50
111.08	10.00
110.58	10.50
110.08	11.00
109.58	11.50
109.08	12.00
108.58	12.50
108.08	13.00
107.58	13.50
107.08	14.00
106.58	14.50
106.08	15.00
105.58	15.50
105.08	16.00

Blows for Depth Increment



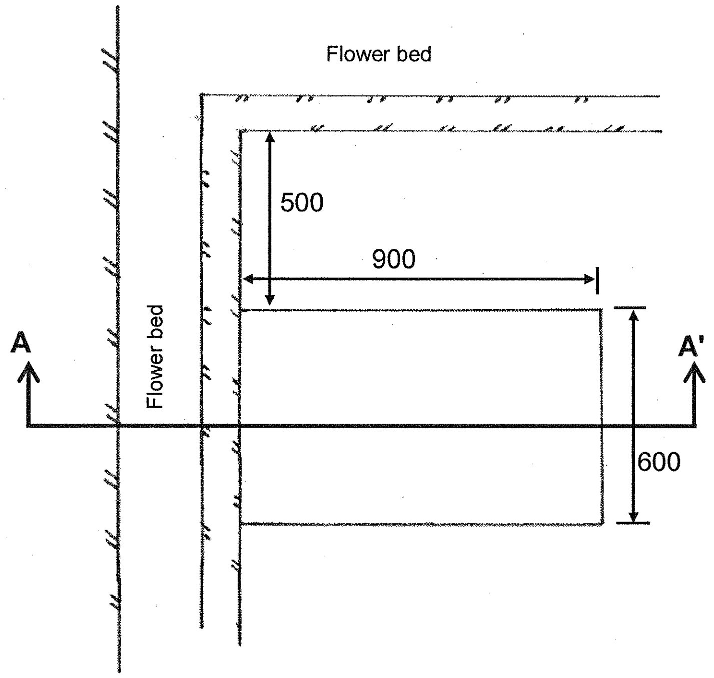
Remarks

Scale (approx)	Logged By
1:40	DA

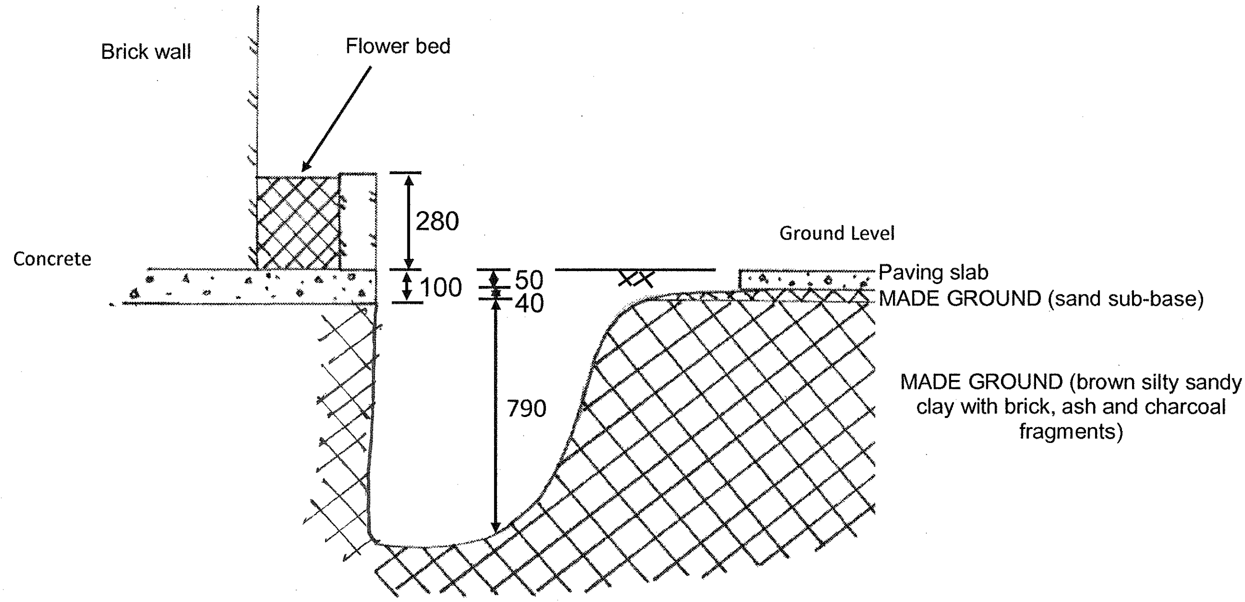
Figure No. J13053.DP2

Geotechnical & Environmental Associates		Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	**Site** 99a Frognal, Hampstead, London, NW3 6XR	**Trial Pit Number** 1
Excavation Method Manual	**Dimensions (mm)** 600 x 900 x 900	**Ground Level (mOD)** 121.08	**Client** Harrison Varma	**Job Number** J13053
	Location	**Dates** 08/03/2013	**Engineer** Fluid Structures	**Sheet** 1 / 4

PLAN



SECTION A - A'



Note: Bar extended 1.0 m beneath footing and no wall was encountered behind

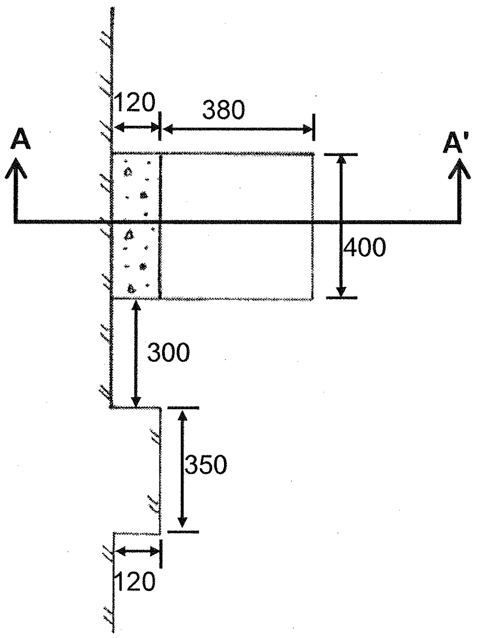
Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: Not encountered	DA

Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Alb	**Trial Pit No 1**

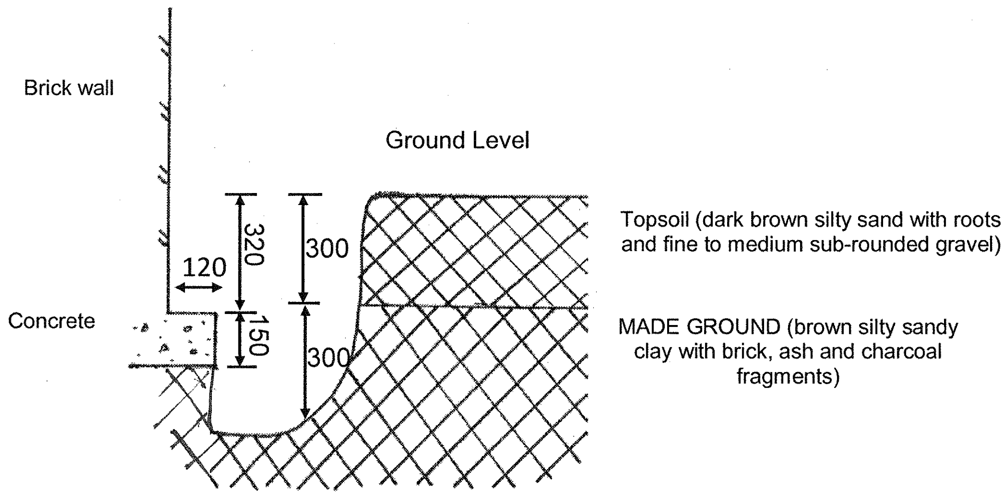
Site	99a Frognal, Hampstead, London, NW3 6XR	**Job Number** J13053
Client	Harrison Varma	**Sheet** 2/4
Engineer	Fluid Structures	

GEA Geotechnical & Environmental Associates	Tyttenhanger House, Coursers Road, St Albans, Herts AL4 0PG		Site: 99a Frognal, Hampstead, London, NW3 6XR	Trial Pit Number: 2
Excavation Method Manual	**Dimensions (mm)** 400 x 500 x 600	**Ground Level (mOD)** 122.64	**Client** Harrison Varma	**Job Number** J13053
	Location	**Dates** 08/03/2013	**Engineer** Fluid Structures	**Sheet** 3 / 4

PLAN



SECTION A - A'



Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: Not encountered	DA

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Trial Pit No 2

Site	99a Frognal. Hampstead, London, NW3 6XR	**Job Number**	J13053
Client	Harrison Varma	**Sheet**	4/4
Engineer	Fluid Structures		

PROJECT NAME	99A FROGNAL, HAMPSTEAD, NW3 6XR	Date	09/04/2013
	Project Number J13053	Approved	J Sturges
PROJECT NO:	GEO / 19426	Page	1 of 2

Sample details					Classification Tests					Density Tests		Undrained Triaxial Compression Tests			Chemical Tests			
Borehole No.	Depth (m)	No.	Type	Description	MC (%)	LL (%)	PL (%)	PI (%)	<425 mic (%)	Bulk (Mg/m³)	Dry (Mg/m³)	Cell Pressure (kPa)	Deviator Stress (kPa)	Shear Stress (kPa)	pH	2:1 W/S SO4 (g/l)	Ground Water SO4 (g/l)	Other tests and comments
BH1	2.50	D6	D	Yellowish brown clayey silty SAND														Particle Size Distribution
BH1	7.00	D15	D	Yellowish brown clayey silty gravelly SAND. Gravel is fine to medium flint and sandstone.														Particle Size Distribution
BH2	7.00	D15	D	Multicoloured fine sandy silty CLAY	27	43	18	25	100									
BH3	5.00	D11	D												5.2	0.07		
BH3	2.50	D6	D	Yellowish brown slightly gravelly clayey silty SAND. Gravel is medium.														Particle Size Distribution
BH3	6.00	D13	D												5.8	0.09		
BH3	6.50	D14	D	Mottled orange and grey brown slightly sandy silty CLAY	27	48	19	29	99									
BH4	6.00	D13	D	Mottled orange, grey and brown slightly sandy silty CLAY	25	47	20	27	100									
BH5	4.00	B4	B	Yellowish brown slightly silty very gravelly SAND. Gravel is fine to coarse.														Particle Size Distribution
BH5	7.50	U1	U	Soft to firm greyish brown clayey SILT	25					1.99	1.59	150	157	78				
BH5	10.50	U2	U	Firm to stiff orange brown silty CLAY	27					2.03	1.60	210	268	134				
BH5	13.50	S4	D	Yellowish brown CLAY, SILT and fine SAND														Particle Size Distribution

SUMMARY OF GEOTECHNICAL TESTING

GEOLABS®

PROJECT NAME	99A FROGNAL, HAMPSTEAD, NW3 6XR
	Project Number J13053
PROJECT NO:	GEO / 19426

Date	09/04/2013
Approved	J Sturges
Page	2 of 2

Sample details					Classification Tests					Density Tests		Undrained Triaxial Compression Tests			Chemical Tests			
Borehole No.	Depth (m)	No.	Type	Description	MC (%)	LL (%)	PL (%)	PI (%)	<425 mic (%)	Bulk (Mg/m³)	Dry (Mg/m³)	Cell Pressure (kPa)	Deviator Stress (kPa)	Shear Stress (kPa)	pH	2:1 W/S SO4 (g/l)	Ground Water SO4 (g/l)	Other tests and comments
BH5	18.00	S7	D	Greyish brown clayey silty fine SAND														Particle Size Distribution
BH6	0.80	D2	D												7.7	0.07		
BH6	3.00	B3	B	Yellowish brown clayey silty very gravelly SAND. Gravel is fine to coarse.														Particle Size Distribution
BH6	5.00	U1	U	Firm mottled grey and orange brown silty CLAY	24					2.01	1.63	100	165	82				
BH6	7.50	U2	U	Soft greyish brown silty CLAY	26					1.98	1.57	150	101	50				
BH7	2.00	B2	B	Greyish brown clayey silty very gravelly SAND. Gravel is fine to coarse.														Particle Size Distribution
BH7	4.00	U1	U	Firm mottled orange, brown and grey silty CLAY	20					2.02	1.68	80	157	79				
BH7	18.00	U2	U	Stiff dark greyish brown silty CLAY	24	61	24	37	100	2.06	1.66	360	370	185				

SUMMARY OF GEOTECHNICAL TESTING

BS1377 : Part 2 : Clause 9 : 1990

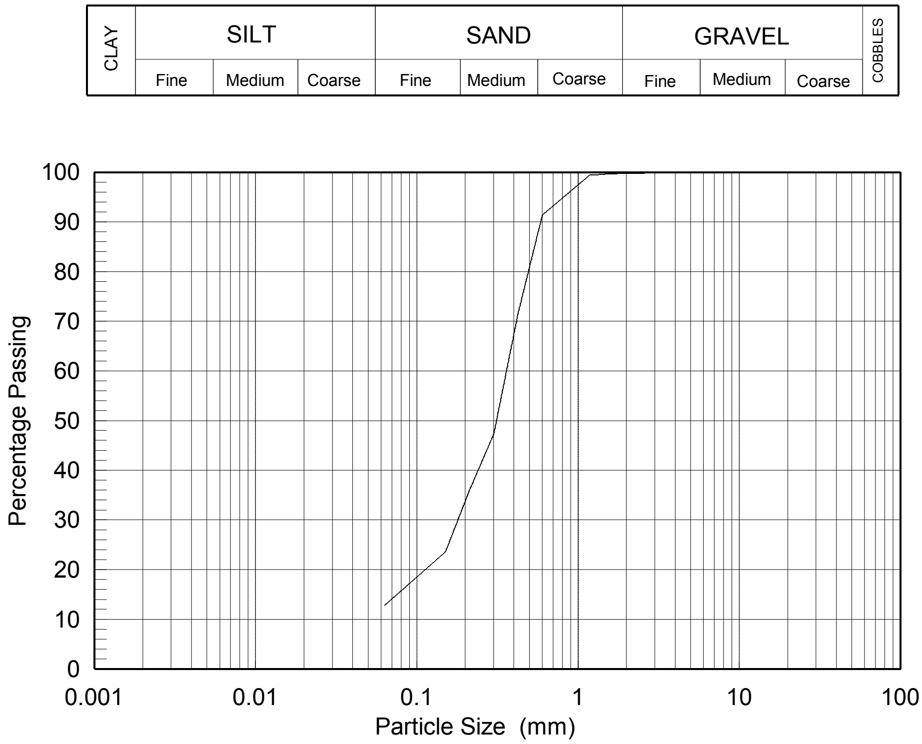
Determination of Particle Size Distribution

Borehole Number: BH1
Sample Number: D6
Depth (m): 2.50

Description:
Yellowish brown clayey silty SAND

BS1377 : Part 2 : Clause 9.2 : 1990 Wet Sieving Method

SIEVE	
Sieve	% pass
200 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	100
20 mm	100
14 mm	100
10 mm	100
6.3 mm	100
5 mm	100
3.35 mm	100
2 mm	100
1.18 mm	99
600 µm	91
425 µm	72
300 µm	47
212 µm	36
150 µm	24
63 µm	13



Particle Proportions		
Cobbles	0.0	%
Gravel	0.2	%
Sand	87.0	%
Silt & Clay	12.8	%

Checked and Approved

Initials: JS

Date: 09/04/2013

Project Number:

GEO / 19426

Project Name:

99A FROGNAL, HAMPSTEAD, NW3 6XR

Project Number J13053

UKAS TESTING 1982

GEOLABS®

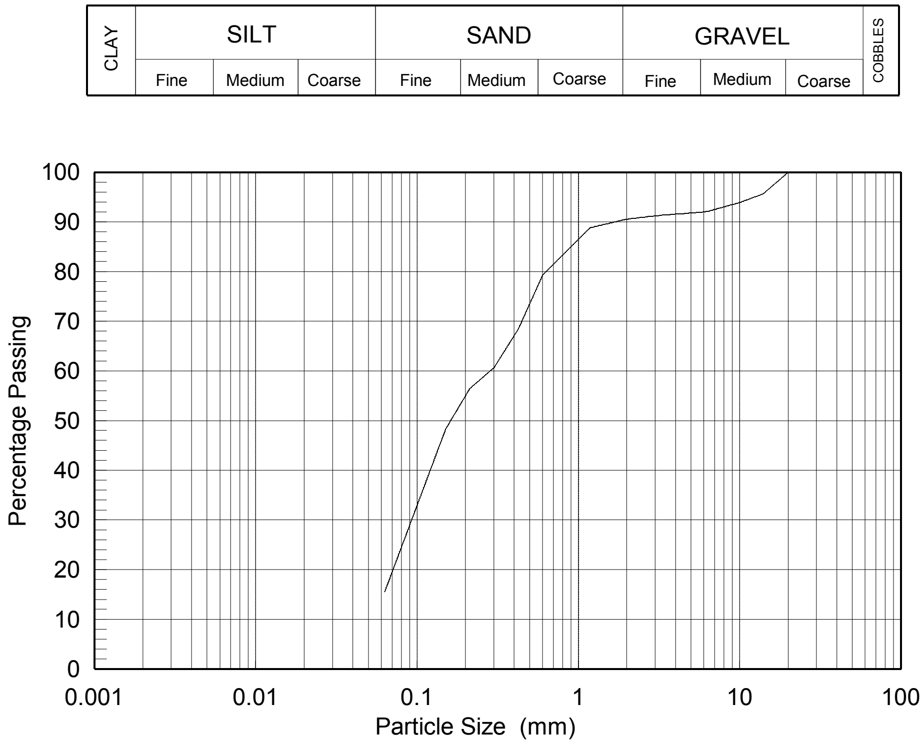
BS1377 : Part 2 : Clause 9 : 1990

Determination of Particle Size Distribution

Borehole Number:	BH1	Description: Yellowish brown clayey silty gravelly SAND. Gravel is fine to medium flint and sandstone.
Sample Number:	D15	
Depth (m):	7.00	

BS1377 : Part 2 : Clause 9.2 : 1990 Wet Sieving Method

SIEVE	
Sieve	% pass
200 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	100
20 mm	100
14 mm	96
10 mm	94
6.3 mm	92
5 mm	92
3.35 mm	91
2 mm	91
1.18 mm	89
600 µm	79
425 µm	68
300 µm	61
212 µm	56
150 µm	48
63 µm	15



Particle Proportions		
Cobbles	0.0	%
Gravel	9.4	%
Sand	75.1	%
Silt & Clay	15.5	%

Checked and Approved	Project Number: GEO / 19426
Initials: JS	Project Name: 99A FROGNAL, HAMPSTEAD, NW3 6XR
Date: 09/04/2013	Project Number J13053

UKAS TESTING 1982

GEOLABS®

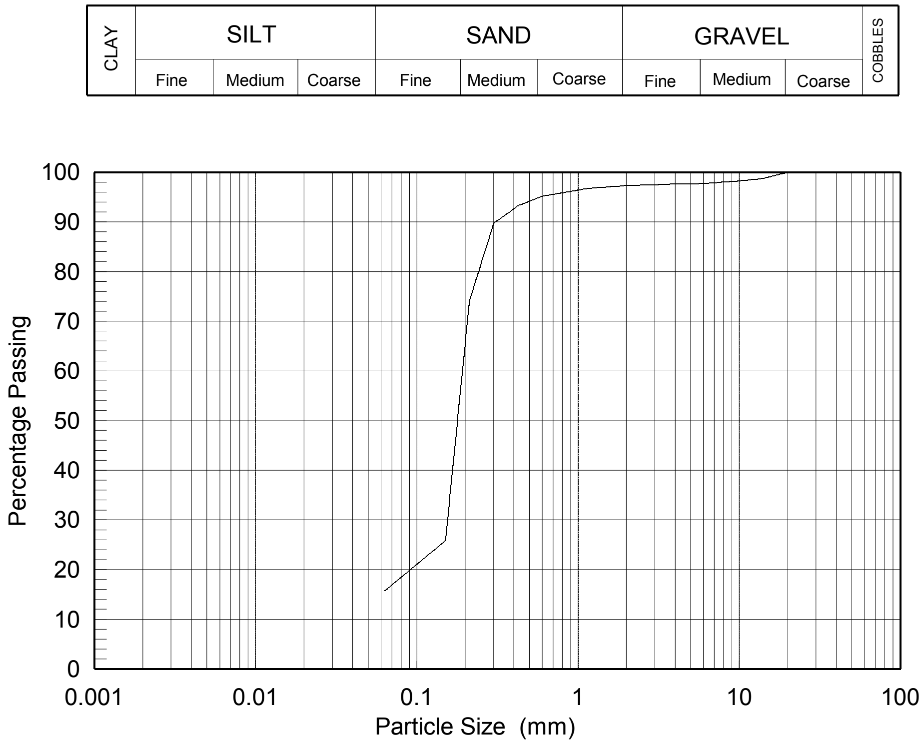
BS1377 : Part 2 : Clause 9 : 1990

Determination of Particle Size Distribution

Borehole Number:	BH3	Description:
Sample Number:	D6	Yellowish brown slightly gravelly clayey silty SAND.
Depth (m):	2.50	Gravel is medium.

BS1377 : Part 2 : Clause 9.2 : 1990 Wet Sieving Method

SIEVE	
Sieve	% pass
200 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	100
20 mm	100
14 mm	99
10 mm	98
6.3 mm	98
5 mm	98
3.35 mm	98
2 mm	97
1.18 mm	97
600 µm	95
425 µm	93
300 µm	90
212 µm	74
150 µm	26
63 µm	16



Particle Proportions		
Cobbles	0.0	%
Gravel	2.6	%
Sand	81.6	%
Silt & Clay	15.7	%

Checked and Approved Initials: JS Date: 09/04/2013	Project Number: **GEO / 19426** Project Name: **99A FROGNAL, HAMPSTEAD, NW3 6XR** **Project Number J13053**	UKAS TESTING 1982 — GEOLABS®

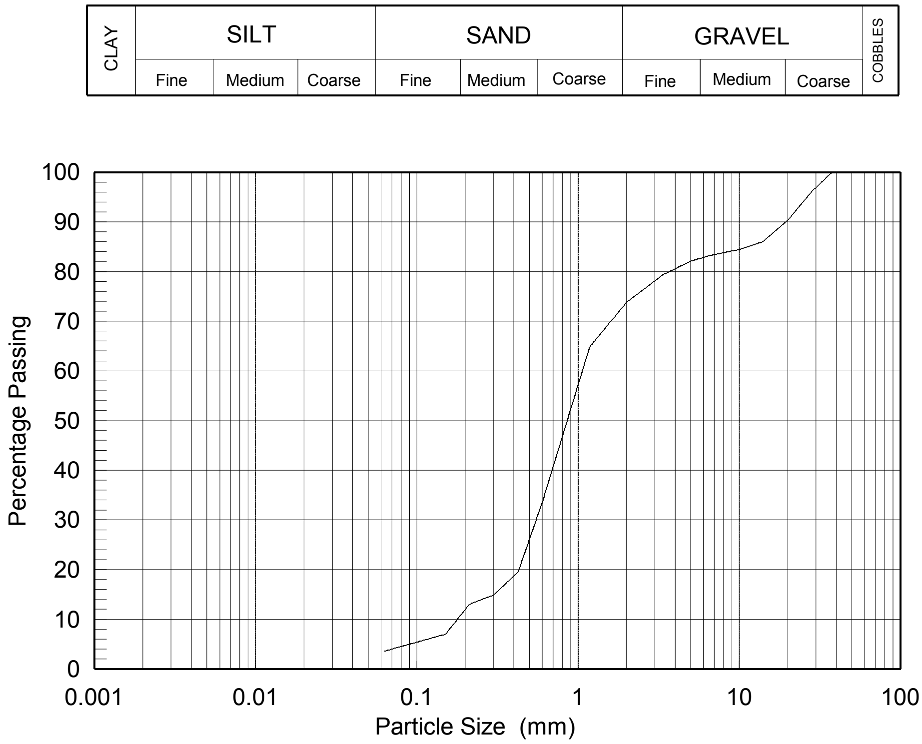
BS1377 : Part 2 : Clause 9 : 1990

Determination of Particle Size Distribution

Borehole Number:	BH5	Description: Yellowish brown slightly silty very gravelly SAND. Gravel is fine to coarse.
Sample Number:	B4	
Depth (m):	4.00	

BS1377 : Part 2 : Clause 9.2 : 1990 Wet Sieving Method

SIEVE	
Sieve	% pass
200 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	96
20 mm	90
14 mm	86
10 mm	84
6.3 mm	83
5 mm	82
3.35 mm	79
2 mm	74
1.18 mm	65
600 µm	34
425 µm	20
300 µm	15
212 µm	13
150 µm	7
63 µm	4



Particle Proportions		
Cobbles	0.0	%
Gravel	26.2	%
Sand	70.2	%
Silt & Clay	3.6	%

Checked and Approved Initials: JS Date: 09/04/2013	Project Number: **GEO / 19426** Project Name: **99A FROGNAL, HAMPSTEAD, NW3 6XR** **Project Number J13053**	UKAS TESTING 1982 / GEOLABS®

BS1377 : Part 2 : Clause 9 : 1990

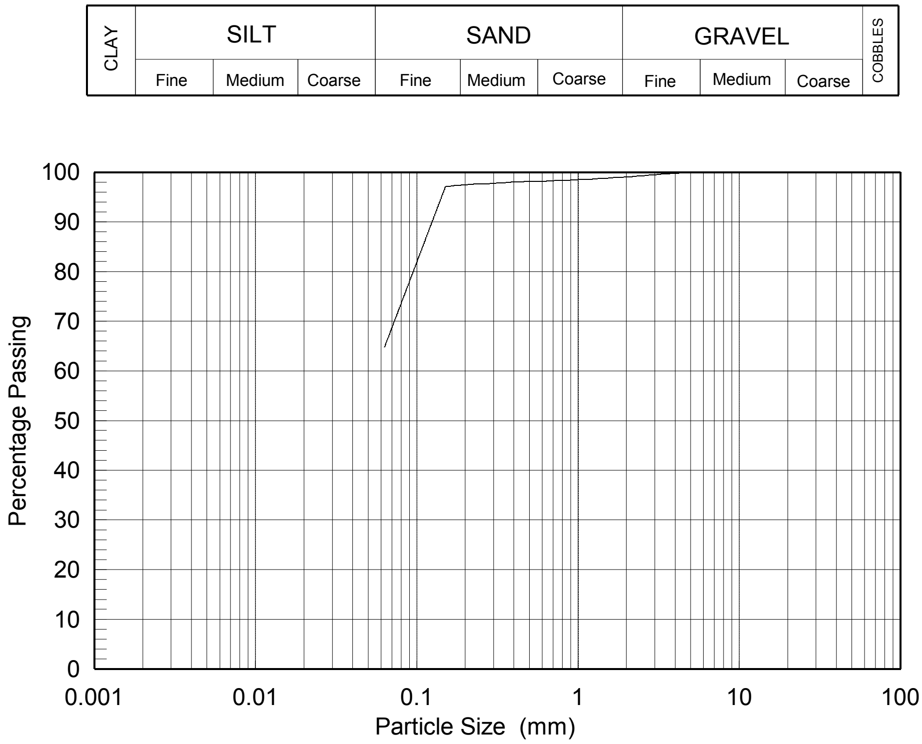
Determination of Particle Size Distribution

Borehole Number:	BH5
Sample Number:	S4
Depth (m):	13.50

Description:
Yellowish brown CLAY, SILT and fine SAND

BS1377 : Part 2 : Clause 9.2 : 1990 Wet Sieving Method

SIEVE	
Sieve	% pass
200 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	100
20 mm	100
14 mm	100
10 mm	100
6.3 mm	100
5 mm	100
3.35 mm	100
2 mm	99
1.18 mm	99
600 µm	98
425 µm	98
300 µm	98
212 µm	98
150 µm	97
63 µm	65



Particle Proportions		
Cobbles	0.0	%
Gravel	0.9	%
Sand	34.3	%
Silt & Clay	64.8	%

Checked and Approved

Initials: JS

Date: 09/04/2013

Project Number:

GEO / 19426

Project Name:

99A FROGNAL, HAMPSTEAD, NW3 6XR

Project Number J13053

UKAS TESTING 1982

GEOLABS®

BS1377 : Part 2 : Clause 9 : 1990

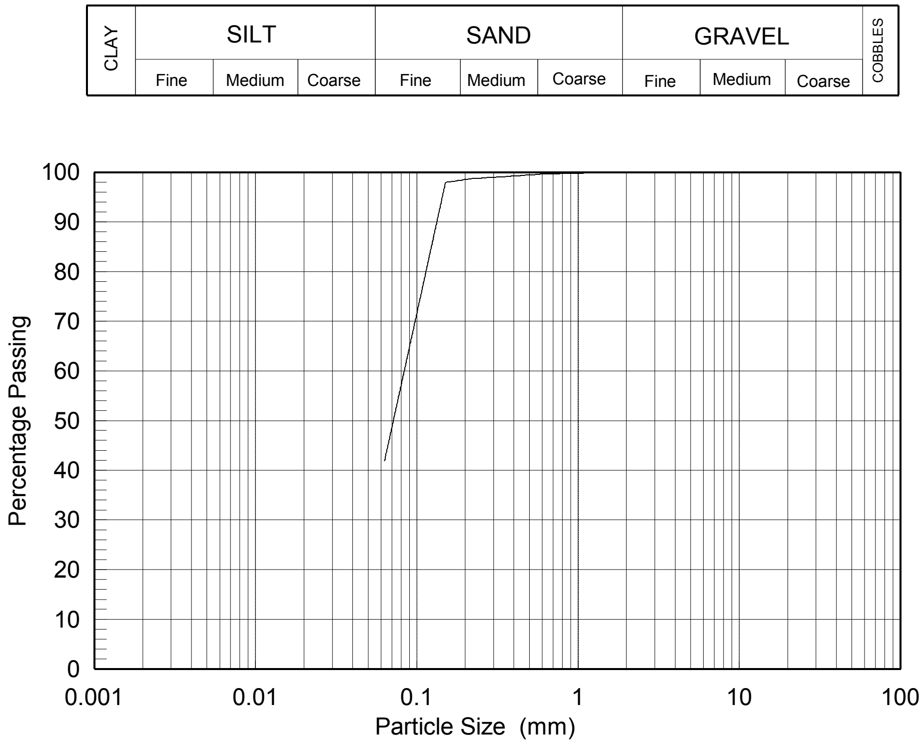
Determination of Particle Size Distribution

Borehole Number:	BH5
Sample Number:	S7
Depth (m):	18.00

Description:
Greyish brown clayey silty fine SAND

BS1377 : Part 2 : Clause 9.2 : 1990 Wet Sieving Method

SIEVE	
Sieve	% pass
200 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	100
20 mm	100
14 mm	100
10 mm	100
6.3 mm	100
5 mm	100
3.35 mm	100
2 mm	100
1.18 mm	100
600 µm	100
425 µm	99
300 µm	99
212 µm	99
150 µm	98
63 µm	42



Particle Proportions		
Cobbles	0.0	%
Gravel	0.0	%
Sand	58.2	%
Silt & Clay	41.8	%

Checked and Approved
Initials: JS
Date: 09/04/2013

Project Number:
GEO / 19426

Project Name:
99A FROGNAL, HAMPSTEAD, NW3 6XR
Project Number J13053

UKAS TESTING 1982

GEOLABS®

BS1377 : Part 2 : Clause 9 : 1990

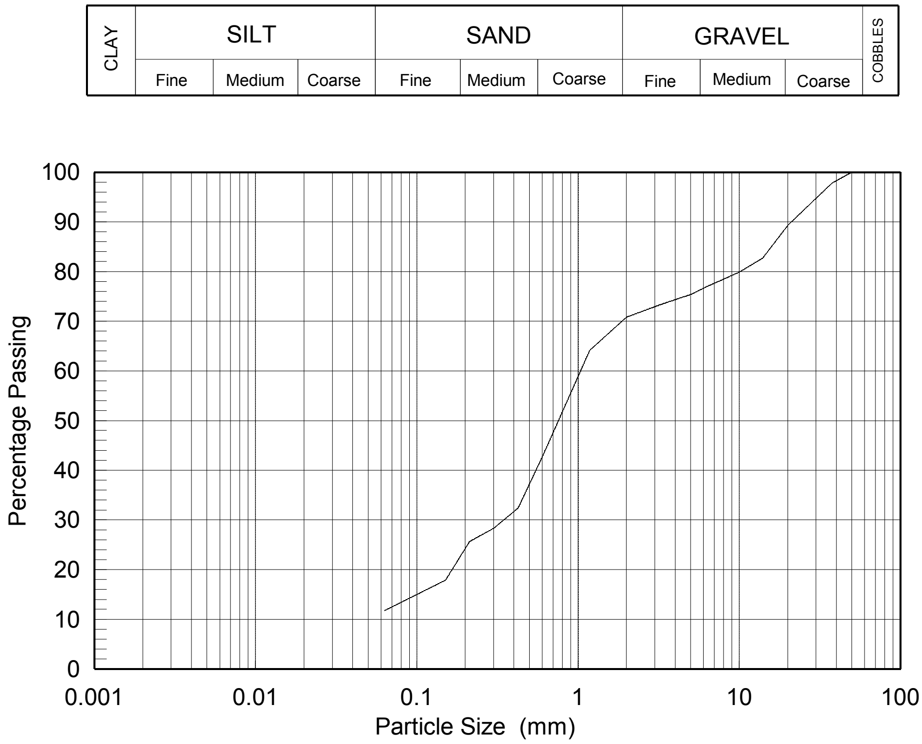
Determination of Particle Size Distribution

Borehole Number:	BH6
Sample Number:	B3
Depth (m):	3.00

Description:
Yellowish brown clayey silty very gravelly SAND.
Gravel is fine to coarse.

BS1377 : Part 2 : Clause 9.2 : 1990 Wet Sieving Method

SIEVE	
Sieve	% pass
200 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	98
28 mm	94
20 mm	89
14 mm	83
10 mm	80
6.3 mm	77
5 mm	75
3.35 mm	74
2 mm	71
1.18 mm	64
600 µm	43
425 µm	32
300 µm	28
212 µm	26
150 µm	18
63 µm	12



Particle Proportions		
Cobbles	0.0	%
Gravel	29.2	%
Sand	59.0	%
Silt & Clay	11.8	%

Checked and Approved

Initials: JS

Date: 09/04/2013

Project Number: **GEO / 19426**

Project Name: **99A FROGNAL, HAMPSTEAD, NW3 6XR**

Project Number J13053

UKAS TESTING 1982

GEOLABS®

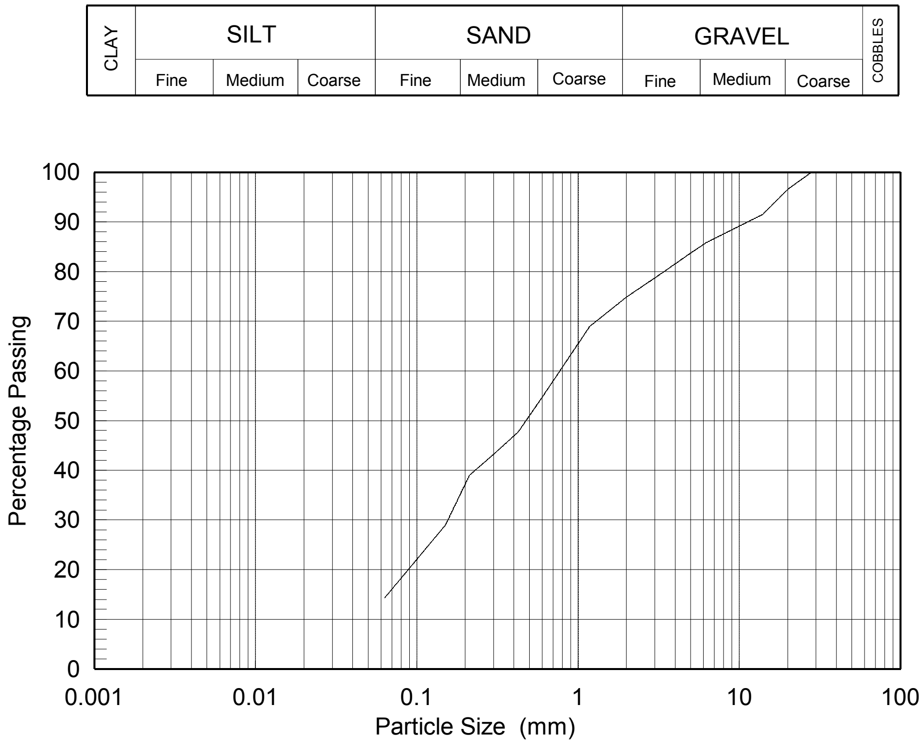
BS1377 : Part 2 : Clause 9 : 1990

Determination of Particle Size Distribution

Borehole Number:	BH7	Description:
Sample Number:	B2	Greyish brown clayey silty very gravelly SAND.
Depth (m):	2.00	Gravel is fine to coarse.

BS1377 : Part 2 : Clause 9.2 : 1990   Wet Sieving Method

SIEVE	
Sieve	% pass
200 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	100
20 mm	97
14 mm	92
10 mm	89
6.3 mm	86
5 mm	84
3.35 mm	80
2 mm	75
1.18 mm	69
600 µm	55
425 µm	48
300 µm	43
212 µm	39
150 µm	29
63 µm	14



Particle Proportions		
Cobbles	0.0	%
Gravel	25.1	%
Sand	60.6	%
Silt & Clay	14.3	%

Checked and Approved Initials: JS Date: 09/04/2013	Project Number: **GEO / 19426** Project Name: **99A FROGNAL, HAMPSTEAD, NW3 6XR** **Project Number J13053**

UKAS TESTING 1982

GEOLABS®

BS1377 : Part 7 : Clause 8 : 1990

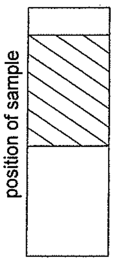
Quick Undrained Triaxial Compression Test

Borehole Number:	BH5	Description:
Sample Number:	U1	Soft to firm greyish brown clayey SILT
Depth (m):	7.50	

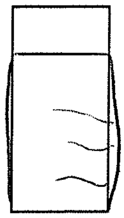
Single Stage Specimen

Specimen details	Single Specimen
Specimen condition:	Undisturbed
Length (mm):	202.0
Diameter (mm):	102.3
Moisture Content (%):	25
Bulk Density (Mg/m³):	1.99
Dry Density (Mg/m³):	1.59
Test details	
Latex membrane thickness (mm):	0.3
Membrane correction (kPa):	1.0
Axial displacement rate (%/min):	2.0
Cell pressure (kPa):	150
Strain at failure (%):	18.3
Maximum Deviator Stress (kPa):	157
Shear Stress Cu (kPa):	78

Orientation and position of sample



Mode of failure:



Checked and Approved

Initials: JS

Date: 09/04/2013

Project Number:

GEO / 19426

Project Name:

99A FROGNAL, HAMPSTEAD, NW3 6XR

Project Number J13053

UKAS TESTING 1982

GEOLABS®

BS1377 : Part 7 : Clause 8 : 1990

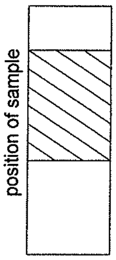
Quick Undrained Triaxial Compression Test

Borehole Number:	BH5	Description:
Sample Number:	U2	Firm to stiff orange brown silty CLAY
Depth (m):	10.50	

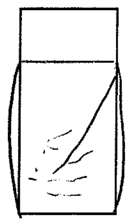
Single Stage Specimen

Specimen details	Single Specimen
Specimen condition:	Undisturbed
Length (mm):	202.7
Diameter (mm):	102.6
Moisture Content (%):	27
Bulk Density (Mg/m³):	2.03
Dry Density (Mg/m³):	1.60
Test details	
Latex membrane thickness (mm):	0.3
Membrane correction (kPa):	1.1
Axial displacement rate (%/min):	2.0
Cell pressure (kPa):	210
Strain at failure (%):	19.7
Maximum Deviator Stress (kPa):	268
Shear Stress Cu (kPa):	134

Orientation and position of sample



Mode of failure:



Checked and Approved Initials: JS Date: 09/04/2013	Project Number: **GEO / 19426** Project Name: **99A FROGNAL, HAMPSTEAD, NW3 6XR** **Project Number J13053**

UKAS TESTING 1982

GEOLABS®

BS1377 : Part 7 : Clause 8 : 1990

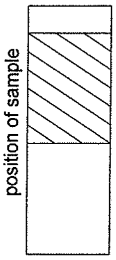
Quick Undrained Triaxial Compression Test

Borehole Number:	BH6	Description: Firm mottled grey and orange brown silty CLAY
Sample Number:	U1	
Depth (m):	5.00	

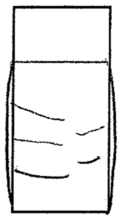
Single Stage Specimen

Specimen details	Single Specimen
Specimen condition:	Undisturbed
Length (mm):	201.8
Diameter (mm):	102.3
Moisture Content (%):	24
Bulk Density (Mg/m^3):	2.01
Dry Density (Mg/m^3):	1.63
Test details	
Latex membrane thickness (mm):	0.3
Membrane correction (kPa):	1.1
Axial displacement rate (%/min):	2.0
Cell pressure (kPa):	100
Strain at failure (%):	19.8
Maximum Deviator Stress (kPa):	165
Shear Stress Cu (kPa):	82

Orientation and position of sample



Mode of failure:



Checked and Approved	Project Number:	
Initials: JS	GEO / 19426	GEOLABS®
Date: 09/04/2013	Project Name: 99A FROGNAL, HAMPSTEAD, NW3 6XR	
	Project Number J13053	

BS1377 : Part 7 : Clause 8 : 1990

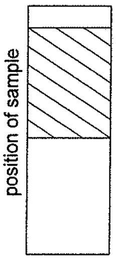
Quick Undrained Triaxial Compression Test

Borehole Number:	BH6	Description:
Sample Number:	U2	Soft greyish brown silty CLAY
Depth (m):	7.50	

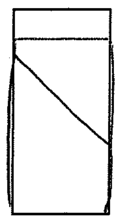
Single Stage Specimen

Specimen details	Single Specimen
Specimen condition:	Undisturbed
Length (mm):	202.0
Diameter (mm):	103.7
Moisture Content (%):	26
Bulk Density (Mg/m^3):	1.98
Dry Density (Mg/m^3):	1.57
Test details	
Latex membrane thickness (mm):	0.3
Membrane correction (kPa):	0.8
Axial displacement rate (%/min):	2.0
Cell pressure (kPa):	150
Strain at failure (%):	12.9
Maximum Deviator Stress (kPa):	101
Shear Stress Cu (kPa):	50

Orientation and position of sample



Mode of failure:



Checked and Approved Initials: JS Date: 09/04/2013	Project Number: **GEO / 19426** Project Name: **99A FROGNAL, HAMPSTEAD, NW3 6XR** **Project Number J13053**	UKAS TESTING 1982 / GEOLABS®

BS1377 : Part 7 : Clause 8 : 1990

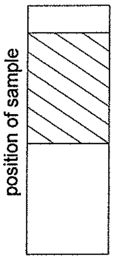
Quick Undrained Triaxial Compression Test

Borehole Number:	BH7	Description: Firm mottled orange, brown and grey silty CLAY
Sample Number:	U1	
Depth (m):	4.00	

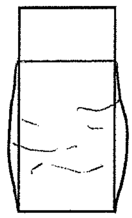
Single Stage Specimen

Specimen details	Single Specimen
Specimen condition:	Undisturbed
Length (mm):	183.6
Diameter (mm):	103.1
Moisture Content (%):	20
Bulk Density (Mg/m³):	2.02
Dry Density (Mg/m³):	1.68
Test details	
Latex membrane thickness (mm):	0.3
Membrane correction (kPa):	1.1
Axial displacement rate (%/min):	2.2
Cell pressure (kPa):	80
Strain at failure (%):	20.2
Maximum Deviator Stress (kPa):	156
Shear Stress Cu (kPa):	78

Orientation and position of sample



Mode of failure:



Checked and Approved Initials: JS Date: 09/04/2013	Project Number: **GEO / 19426** Project Name: **99A FROGNAL, HAMPSTEAD, NW3 6XR** **Project Number J13053**	GEOLABS®

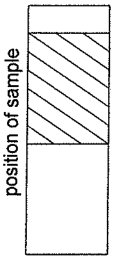
BS1377 : Part 7 : Clause 8 : 1990

Quick Undrained Triaxial Compression Test

Borehole Number:	BH7	Description:	
Sample Number:	U2	Stiff dark greyish brown silty CLAY	
Depth (m):	18.00		

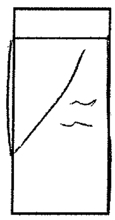
Single Stage Specimen

Specimen details	Single Specimen
Specimen condition:	Undisturbed
Length (mm):	202.0
Diameter (mm):	103.0
Moisture Content (%):	24
Bulk Density (Mg/m³):	2.06
Dry Density (Mg/m³):	1.66
Test details	
Latex membrane thickness (mm):	0.3
Membrane correction (kPa):	0.7
Axial displacement rate (%/min):	2.0
Cell pressure (kPa):	360
Strain at failure (%):	11.4
Maximum Deviator Stress (kPa):	370
Shear Stress Cu (kPa):	185



Orientation and position of sample

Mode of failure:



Checked and Approved Initials: JS Date: 09/04/2013	Project Number: **GEO / 19426** Project Name: **99A FROGNAL, HAMPSTEAD, NW3 6XR** **Project Number J13053**	GEOLABS®

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
Herts AL4 0PG

SPT & Cohesion / Depth Graph

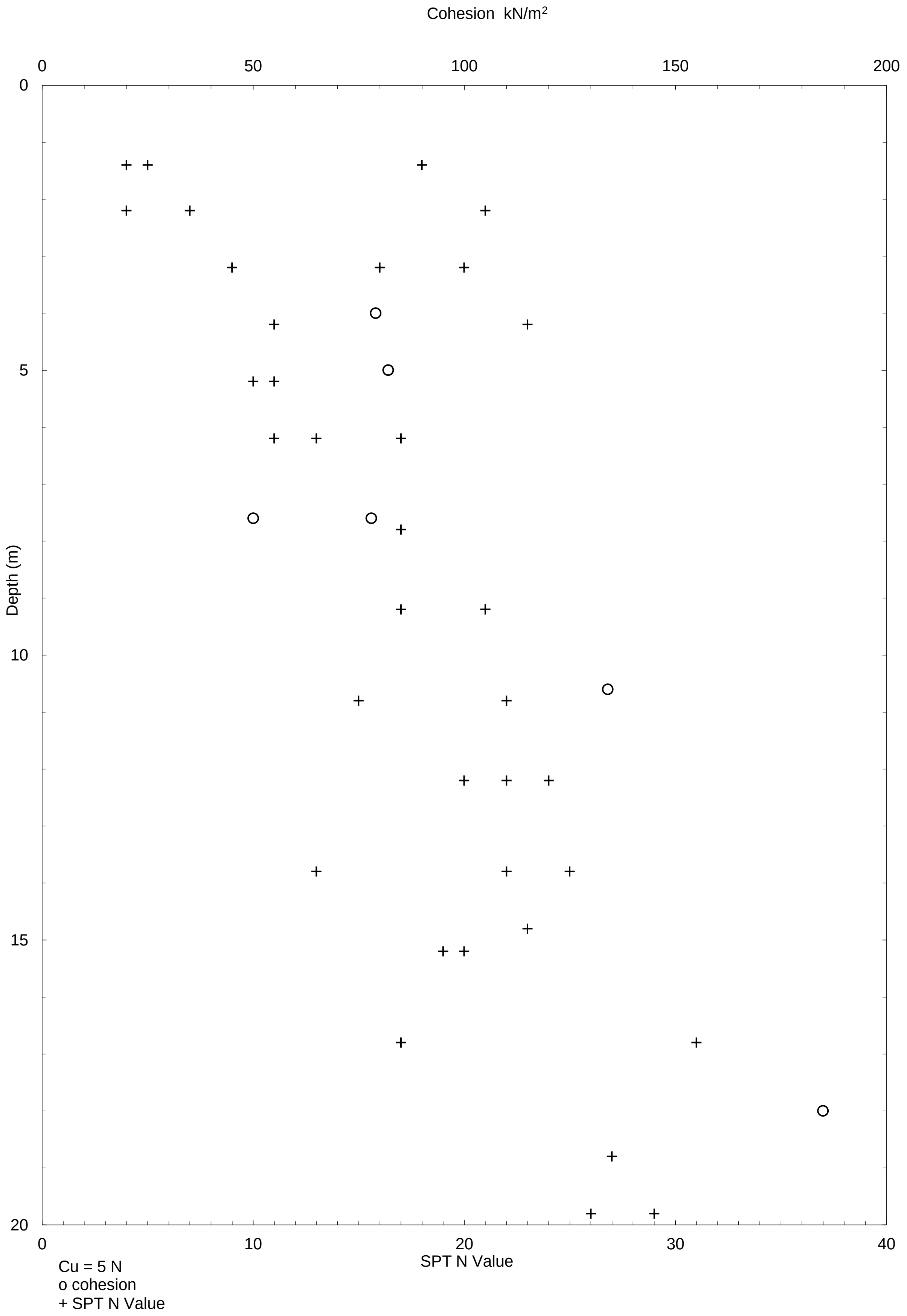
Site 99a Frognal, Hampstead, London, NW3 6XR

Client Harrison Varma

Engineer Fluid Structures

Job Number J13053

Sheet 1 / 1



GEA
Tyttenhanger House
Coursers Road
St Albans Herts
AL4 0PG

FAO Hannah Dashfield

LABORATORY TEST REPORT

Results of analysis of 4 samples
received 25 March 2013

J13053 - 99A Frognal

Chemtest
The right chemistry to deliver results

Report Date
04 April 2013

Login Batch No					**226438**			
Chemtest LIMS ID					AI46568	AI46569	AI46570	AI46571
Sample ID					BH1	BH2	BH3	BH4
Sample No								
Sampling Date					8/3/2013	8/3/2013	8/3/2013	Not Provided
Depth					0.5m	1.5m	1.0m	1.0m
Matrix					*SOIL*	*SOIL*	*SOIL*	*SOIL*
SOP↓	Determinand↓	CAS No↓	Units↓	*				
2030	Moisture		%	n/a	13.9	9.65	11.6	10.7
	Stones content (>50mm)		%	n/a	<0.02	<0.02	<0.02	<0.02
2040	Soil colour			M	brown	brown	brown	brown
	Soil texture			M	clay	sand	clay	clay
	Other material			M	stones	stones	stones	stones
2010	pH			M	8.4	8.2	7.9	8.3
2300	Cyanide (total)	57125	$mg\ kg^{-1}$	M	<0.5	<0.5	<0.5	<0.5
2325	Sulfide (Easily Liberatable)	18496258	$mg\ kg^{-1}$	M	1.1	0.89	<0.50	1.0
2625	Total Organic Carbon		%	M	0.40	0.31	1.1	1.6
2220	Chloride (extractable)	16887006	$g\ l^{-1}$	M	<0.010	<0.010	<0.010	<0.010
2430	Sulfate (total) as SO4		$mg\ kg^{-1}$	M	1200	300	400	1100
2450	Arsenic	7440382	$mg\ kg^{-1}$	M	10	6.6	7.9	18
	Cadmium	7440439	$mg\ kg^{-1}$	M	<0.10	<0.10	<0.10	<0.10
	Chromium	7440473	$mg\ kg^{-1}$	M	29	8.4	12	15
	Copper	7440508	$mg\ kg^{-1}$	M	11	5.9	17	21
	Mercury	7439976	$mg\ kg^{-1}$	M	0.11	<0.10	0.69	0.85
	Nickel	7440020	$mg\ kg^{-1}$	M	16	<5.0	7.4	9.2
	Lead	7439921	$mg\ kg^{-1}$	M	58	50	250	1500
	Selenium	7782492	$mg\ kg^{-1}$	M	<0.20	<0.20	<0.20	<0.20
	Zinc	7440666	$mg\ kg^{-1}$	M	38	15	32	85
2670	TPH >C5-C6		$mg\ kg^{-1}$	U	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,3]
	TPH >C6-C7		$mg\ kg^{-1}$	U	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,3]
	TPH >C7-C8		$mg\ kg^{-1}$	M	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,3]
	TPH >C8-C10		$mg\ kg^{-1}$	M	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,3]

[1]The sample container/fill level was not appropriate for the specified analysis - these results may be compromised. The accreditation for these results remains unaffected.

[2]The stability time for this analyte has been exceeded - these results may be compromised. The accreditation for these results remains unaffected.

[3]No sampling date was specified, stability times for this analyte may have been exceeded and these results may be compromised. The accreditation for these results remains unaffected.

All tests undertaken between 25/03/2013 and 03/04/2013

* Accreditation status

This report should be interpreted in conjuction with the notes on the accompanying cover page.

GEA
Tyttenhanger House
Coursers Road
St Albans Herts
AL4 0PG

FAO Hannah Dashfield

LABORATORY TEST REPORT

Results of analysis of 4 samples
received 25 March 2013

J13053 - 99A Frognal

Chemtest
The right chemistry to deliver results

Report Date
04 April 2013

					226438			
					AI46568	AI46569	AI46570	AI46571
					BH1	BH2	BH3	BH4
					8/3/2013	8/3/2013	8/3/2013	Not Provided
					0.5m	1.5m	1.0m	1.0m
					SOIL	*SOIL*	*SOIL*	*SOIL*
2670	TPH >C10-C12		mg kg^{-1}	M	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,3]
	TPH >C12-C16		mg kg^{-1}	M	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,3]
	TPH >C16-C21		mg kg^{-1}	M	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,3]
	TPH >C21-C35		mg kg^{-1}	M	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,2]	< 0.1 [1,3]
	Total Petroleum Hydrocarbons		mg kg^{-1}	U	< 10 [1,2]	< 10 [1,2]	< 10 [1,2]	< 10 [1,3]
2700	Naphthalene	91203	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Acenaphthylene	208968	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Acenaphthene	83329	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Fluorene	86737	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Phenanthrene	85018	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Anthracene	120127	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Fluoranthene	206440	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Pyrene	129000	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[a]anthracene	56553	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Chrysene	218019	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[b]fluoranthene	205992	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[k]fluoranthene	207089	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[a]pyrene	50328	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Dibenzo[a,h]anthracene	53703	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Indeno[1,2,3-cd]pyrene	193395	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Benzo[g,h,i]perylene	191242	mg kg^{-1}	M	< 0.1	< 0.1	< 0.1	< 0.1
	Total (of 16) PAHs		mg kg^{-1}	M	< 2	< 2	< 2	< 2
2920	Phenols (total)		mg kg^{-1}	N	<0.3	<0.3	<0.3	<0.3

[1] The sample container/fill level was not appropriate for the specified analysis - these results may be compromised. The accreditation for these results remains unaffected.
[2] The stability time for this analyte has been exceeded - these results may be compromised. The accreditation for these results remains unaffected.
[3] No sampling date was specified, stability times for this analyte may have been exceeded and these results may be compromised. The accreditation for these results remains unaffected.

All tests undertaken between 25/03/2013 and 03/04/2013

* Accreditation status

This report should be interpreted in conjuction with the notes on the accompanying cover page.

GEA Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Generic Risk-Based Soil Guideline Values

Site	99a Frognal, Hampstead, NW3 6XR	**Job Number**	J13053
Client	Harrison Varma	**Sheet**	1 / 1
Engineer	Fluid Structures		

Proposed End Use Residential with plant uptake

Soil pH 8

Soil Organic Matter content % 2.5

Contaminant	Guideline Value mg/kg	Data Source
Metals		
Arsenic	32	SGV
Cadmium	10	SGV
Chromium (III)	3000	LQM/CIEH
Chromium (VI)	4.3	LQM/CIEH
Copper	2,330	LQM/CIEH
Lead	450	withdrawn SGV
Elemental Mercury	1	SGV
Inorganic Mercury	170	SGV
Nickel	130	LQM/CIEH
Selenium	350	SGV
Zinc	3,750	LQM/CIEH
Hydrocarbons		
Benzene	0.18	SGV
Toluene	320	SGV
Ethyl Benzene	180	SGV
Xylene	120	SGV
Aliphatic C5-C6	55	LQM/CIEH
Aliphatic C6-C8	160	LQM/CIEH
Aliphatic C8-C10	46	LQM/CIEH
Aliphatic C10-C12	230	LQM/CIEH
Aliphatic C12-C16	1700	LQM/CIEH
Aliphatic C16-C35	64,000	LQM/CIEH
Aromatic C6-C7	See Benzene	LQM/CIEH
Aromatic C7-C8	See Toluene	LQM/CIEH
Aromatic C8-C10	65	LQM/CIEH
Aromatic C10-C12	160	LQM/CIEH
Aromatic C12-C16	310	LQM/CIEH
Aromatic C16-C21	480	LQM/CIEH
Aromatic C21-C35	1100	LQM/CIEH
PRO (C_5 – C_{10})	646	Calc
DRO (C_{12} – C_{28})	66,490	Calc
Lube Oil (C_{28} – C_{44})	65,100	Calc
TPH	**500**	Trigger for speciated testing

Contaminant	Guideline Value mg/kg	Data Source
Anions		
Soluble Sulphate	0.5 g/l	Structures
Sulphide	50	Structures
Chloride	400	Structures
Others		
Organic Carbon (%)	6	Methanogenic potential
Total Cyanide	140	WRAS
Total Mono Phenols	290	SGV
PAH		
Naphthalene	3.70	LQM/CIEH
Acenaphthylene	400	LQM/CIEH
Acenaphthene	480	LQM/CIEH
Fluorene	380	LQM/CIEH
Phenanthrene	200	LQM/CIEH
Anthracene	4,900	LQM/CIEH
Fluoranthene	460	LQM/CIEH
Pyrene	1,000	LQM/CIEH
Benzo(a) Anthracene	4.7	LQM/CIEH
Chrysene	8	LQM/CIEH
Benzo(b) Fluoranthene	6.5	LQM/CIEH
Benzo(k) Fluoranthene	9.6	LQM/CIEH
Benzo(a) pyrene	0.94	LQM/CIEH
Indeno(1 2 3 cd) Pyrene	3.9	LQM/CIEH
Dibenzo(a h) Anthracene	0.86	LQM/CIEH
Benzo (g h i) Perylene	46	LQM/CIEH
Total PAH	**6.3**	B(a)P / 0.15
Chlorinated Solvents		
1,1,1 trichloroethane (TCA)	12.9	LQM/CIEH
tetrachloroethane (PCA)	2.1	LQM/CIEH
tetrachloroethene (PCE)	2.1	LQM/CIEH
trichloroethene (TCE)	0.22	LQM/CIEH
1,2-dichloroethane (DCA)	0.008	LQM/CIEH
vinyl chloride (Chloroethene)	0.00064	LQM/CIEH
tetrachloromethane (Carbon tetra	0.039	LQM/CIEH
trichloromethane (Chloroform)	1.3	LQM/CIEH

Notes

Concentrations measured below the above values may be considered to represent 'uncontaminated conditions' which do not pose a risk to human health. Concentrations measured in excess of these valuesindicate a potential risk, and thus require further, site specific risk assessment.

SGV - Soil Guideline Value, derived from the CLEA model and published by Environment Agency 2009

withdrawn SGV - Former SGV, derived from the CLEA 2000 model and published by DEFRA pending confirmation of new approach to modeling lead

LQM/CIEH - Generic Assessment Criteria for Human Health Risk Assessment 2nd edition (2009)derived using CLEA 1.04 model 2009

Calc - sum of nearest available carbon range specified including BTEX for PRO fraction

B(a)P / 0.15 - GEA experince indicates that Benzo(a) pyrene (one of the most common and most carcenogenic of the PAHs) rarely exceeds 15% of the total PAH concentration, hence this Total PAH threshold is regarded as being conservative

Chemtest
LABORATORY TEST REPORT
CEN 10:1 CUMULATIVE TWO STAGE BATCH TEST

GEA
Tyttenhanger House
Coursers Road
St Albans Herts
AL4 0PG

FAO Hannah Dashfield

Results of analysis of 5 samples received 10 May 2013

J13053 - 99A Frognal

Report Date
20 May 2013

Login Batch No	**229749**
Chemtest LIMS ID	AI66719 Soil: AI66717
Sample ID	BH6
Sample No	
Sampling Date	00:00:00
Depth	1.20m

Solid Waste Analysis

Landfill Waste Acceptance Criteria Limits

Determinand ↓	SOP ↓	*	Units ↓			Inert Waste Landfill	Stable Non-reactive Hazardous Waste in Non-Hazardous Landfill	Hazardous Waste Landfill
Total Organic Carbon	2625	M	%		0.35	3	5	6
Loss on Ignition	2610	N	%		0.82			10
Total BTEX	2761	M	mg kg-¹		<0.005	6		
Total PCBs (7 congeners)	2811	M	mg kg-¹		<1	1		
TPH Total WAC	2670	M	mg kg-¹		< 10	500		
Total (of 17) PAHs	2700	N	mg kg-¹		<2	100		
pH	2010	M			8.4		>6	
Acid Neutralisation Capacity	2015	N	mol kg-¹		<0.002		To evaluate	To evaluate

Eluate Analysis

Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg

Determinand ↓	SOP ↓	*	2:1 Eluate mg l-¹	8:1 Eluate mg l-¹	2:1 Eluate mg kg-¹	Cumulative 10:1 Eluate mg kg-¹	Inert	SNRHW	Hazardous
Arsenic	1450	U	0.002	<0.001	<0.05	<0.05	0.5	2	25
Barium	1450	U	0.082	0.004	<0.5	<0.5	20	100	300
Cadmium	1450	U	<0.0005	<0.0005	<0.01	<0.01	0.04	1	5
Chromium	1450	U	<0.001	<0.001	<0.05	<0.05	0.5	10	70
Copper	1450	U	0.01	0.004	<0.05	0.05	2	50	100
Mercury	1450	U	<0.0005	<0.0005	<0.01	<0.01	0.01	0.2	2
Molybdenum	1450	U	0.005	0.003	<0.05	<0.05	0.5	10	30
Nickel	1450	U	0.004	0.003	<0.05	<0.05	0.4	10	40
Lead	1450	U	0.007	0.001	0.01	0.02	0.5	10	50
Antimony	1450	U	0.008	0.001	0.02	0.02	0.06	0.7	5
Selenium	1450	U	<0.001	<0.001	<0.01	<0.01	0.1	0.5	7
Zinc	1450	U	0.017	<0.001	<0.5	<0.5	4	50	200
Chloride	1220	U	4.9	0.97	9.8	13.2	800	15000	25000
Fluoride	1220	U	0.12	0.16	<1	1.56	10	150	500
Sulfate	1220	U	34	7.5	68	98.5	1000	20000	50000
Total Dissolved Solids	1040	N	130	54	260	607	4000	60000	100000
Phenol Index	1920	N	<0.030	<0.030	<0.5	<0.5	1		
Dissolved Organic Carbon	1610	N	20	12	<50	127	500	800	1000

Solid Information

Dry mass of test portion/kg	0.175
Moisture (%)	7.87

Leach Test Information

Leachant volume 1st extract/l	0.335
Leachant volume 2nd extract/l	1.4
Eluate recovered from 1st extract/l	0.1554

All tests undertaken between 10-May-2013 and 20-May-2013
* Accreditation status
This report should be interpreted in conjunction with the notes on the accompanying cover page.

Chemtest

LABORATORY TEST REPORT

CEN 10:1 CUMULATIVE TWO STAGE BATCH TEST

GEA
Tyttenhanger House
Coursers Road
St Albans Herts
AL4 0PG

FAO Hannah Dashfield

Results of analysis of 5 samples received 10 May 2013

J13053 - 99A Frognal

Report Date
20 May 2013

Login Batch No	**229749**
Chemtest LIMS ID	AI66720 Soil: AI66718
Sample ID	BH7
Sample No	
Sampling Date	00:00:00
Depth	0.60m - 0.80n

Solid Waste Analysis

Determinand ↓	SOP ↓	*	Units ↓			Inert Waste Landfill	Stable Non-reactive Hazardous Waste in Non-Hazardous Landfill	Hazardous Waste Landfill
						Landfill Waste Acceptance Criteria Limits		
Total Organic Carbon	2625	M	%		1.2	3	5	6
Loss on Ignition	2610	N	%		4.67			10
Total BTEX	2761	M	mg kg^{-1}		<0.005	6		
Total PCBs (7 congeners)	2811	M	mg kg^{-1}		<1	1		
TPH Total WAC	2670	M	mg kg^{-1}		< 10	500		
Total (of 17) PAHs	2700	N	mg kg^{-1}		<2	100		
pH	2010	M			8.4		>6	
Acid Neutralisation Capacity	2015	N	mol kg^{-1}		0.063		To evaluate	To evaluate

Eluate Analysis

Determinand ↓	SOP ↓	*	2:1 Eluate mg l^{-1}	8:1 Eluate mg l^{-1}	2:1 Eluate mg kg^{-1}	Cumulative 10:1 Eluate mg kg^{-1}	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg		
Arsenic	1450	U	0.038	0.004	0.08	0.07	0.5	2	25
Barium	1450	U	0.011	0.021	<0.5	<0.5	20	100	300
Cadmium	1450	U	<0.0005	<0.0005	<0.01	<0.01	0.04	1	5
Chromium	1450	U	<0.001	<0.001	<0.05	<0.05	0.5	10	70
Copper	1450	U	0.009	0.006	<0.05	0.06	2	50	100
Mercury	1450	U	<0.0005	<0.0005	<0.01	<0.01	0.01	0.2	2
Molybdenum	1450	U	0.016	0.002	<0.05	<0.05	0.5	10	30
Nickel	1450	U	0.008	0.002	<0.05	<0.05	0.4	10	40
Lead	1450	U	0.003	<0.001	0.01	<0.01	0.5	10	50
Antimony	1450	U	0.004	0.004	0.01	0.04	0.06	0.7	5
Selenium	1450	U	<0.001	<0.001	<0.01	<0.01	0.1	0.5	7
Zinc	1450	U	0.009	0.005	<0.5	<0.5	4	50	200
Chloride	1220	U	7.2	1.5	14.4	20.7	800	15000	25000
Fluoride	1220	U	0.45	0.51	<1	5.04	10	150	500
Sulfate	1220	U	110	19	220	281	1000	20000	50000
Total Dissolved Solids	1040	N	330	120	661	1410	4000	60000	100000
Phenol Index	1920	N	<0.030	<0.030	<0.5	<0.5	1		
Dissolved Organic Carbon	1610	N	22	11	<50	121	500	800	1000

Solid Information

Dry mass of test portion/kg	0.175
Moisture (%)	24.1

Leach Test Information

Leachant volume 1st extract/l	0.295
Leachant volume 2nd extract/l	1.4
Eluate recovered from 1st extract/l	0.1758

All tests undertaken between 10-May-2013 and 20-May-2013
* Accreditation status
This report should be interpreted in conjunction with the notes on the accompanying cover page.

Geotechnical & Environmental Associates

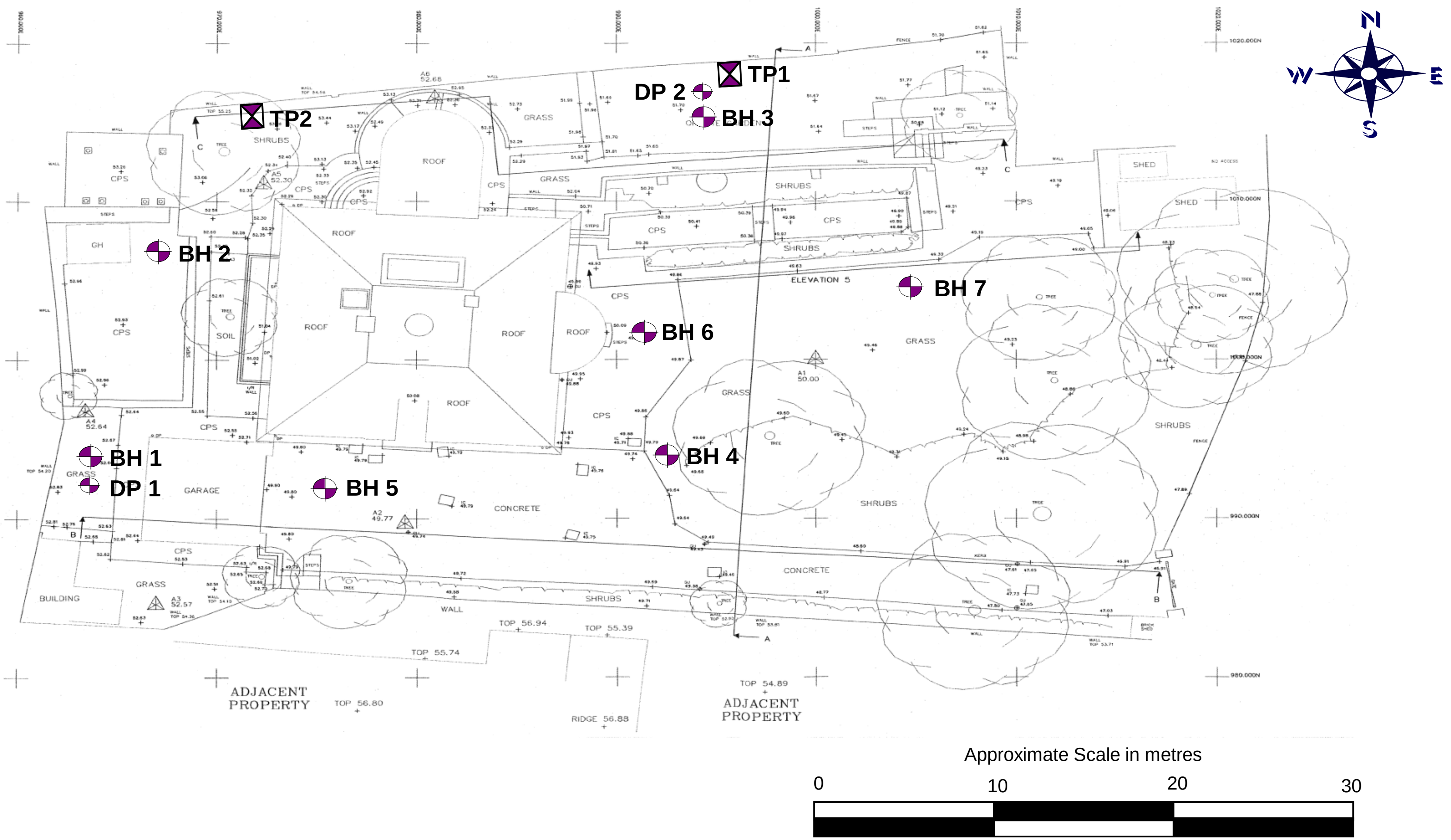
Tyttenhanger House
Coursers Road
St Albans
Herts AL4 0PG

Site Plan

Site	99a Frognal, Hampstead, NW3 6XR
Client	Harrison Varma
Engineer	Fluid Structures

Job Number J13053

Sheet 1 / 1



Geotechnical & Environmental Associates (GEA)
is an engineer-led and client-focused
independent specialist providing a complete
range of geotechnical and contaminated land
investigation, analytical and consultancy services
to the property and construction industries**.**

We have offices at

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG
tel 01727 824666
mail@gea-ltd.co.uk

Church Farm
Gotham Road
Kingston on Soar
Notts
NG11 0DE
tel 01509 674888
midlands@gea-ltd.co.uk

Enquiries can also be made on-line at
www.gea-ltd.co.uk
where information can be found
on all of the services that we offer.

Geotechnical & Environmental Associates