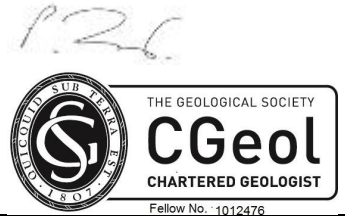
LMB GEOSOLUTIONS LTD

GROUND INVESTIGATION & ASSESSMENT

35 PILGRIMS LANE, LONDON NW3

February 2018

DOCUMENT RECORD

Document Title	Ground Investigation & Assessment
Site	35 Pilgrims Lane, London NW3 1SS
Document Date	27th February 2018
Document Version	Issue 1
Document Authorisation	Philip Lewis BSc (Hons), MSc, CGeol, FGS
	

LMB

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Company No. 8303397
LMB Home

TABLE OF CONTENTS

Contents

EXECUTIVE SUMMARY

Executive Summary

Site Details	35 Pilgrims Lane, London NW3 1SS.
Proposed Development	The development proposals comprise extending the existing lower ground floor to form a single storey basement that will be used to house a home cinema, longue space and a sauna.
Ground & Groundwater Conditions	Made Ground overlying London Clay Formation. Groundwater was recorded during monitoring but is not considered to form a laterally continuous aquifer unit and is present as discrete units within (for example) micro fissures and local mudstone horizons and the recorded groundwater level will most likely be reflective of the pore water pressures within these discrete features.
Preliminary Risk Assessment	Very low to Moderate/Low risk rating.
Assessment of Soil Analytical Results	The results of the GQRA indicate that there are no elevated concentrations of potential contaminants and no plausible pollutant linkages are considered to exist.
Geotechnical Advice	For traditional strip foundations placed on the competent firm clay at a depth of 3.30m bgl a net safe bearing pressure of 100kN/m^2 should be available. The above advice assumes that the proposed basement development and in particular foundations would not be within the influence of any trees or tree routes. Given the size of the excavation and the adjacent and nearby structures, it is considered likely that temporary or permanent support (sheet/secant piles or similar) will be needed for construction. Coefficient of active earth pressure: Made Ground: 0.35. London Clay: 0.42. Coefficient of passive earth resistance: Made Ground: 3.5. London Clay: 2.7. Buried concrete: Made Ground: DS-1, AC-1s. London Clay DS-3, AC-2s.
Ground Movement Assessment	The ground movement assessment undertaken indicates that damage to surrounding properties will generally be Burland Category 0 (Negligible) to 1 (Very Slight).
Recommendations	The full set of recommendations should be reviewed, but in summary the following are provided: • It is recommended that maintenance and construction workers involved in below ground works adopt appropriate management procedures to mitigate potential risks. • It is recommended that movement monitoring is undertaken as part of basement construction. • It is recommended that the potential for heave and uplift due to groundwater pressure are considered within basement design.
This executive summary is not a stand alone document and should be read in conjunction with the full report text, including conclusions and recommendations.	

INTRODUCTION

Introduction

AUTHORISATION

LMB Geosolutions Ltd (LMB) was instructed by Symmetrys Ltd (Consultant Engineers) on behalf of Nori Bali (the Client) in November 2017 to undertake ground investigation and assessment works in relation to the proposed basement development at 35 Pilgrims Lane, London NW3 1SS (the Site).

PROJECT AND SITE DETAILS

Site Address	35 Pilgrims Lane, London NW3 1SS (the Site). A Site Location Plan is provided as **Figure 1**.
Proposed Development	The site currently comprises a three storey (including existing lower ground floor) end of terrace residential property with a converted loft space. It is understood that the client wishes to extend the existing lower ground floor to form a basement. It is understood that the basement will be used to house a home cinema, longue space and a sauna. The basement will extend beneath approximately 30% of the existing building footprint and will also partially extend over a small area of the current front garden outside the existing building footprint.
Background	The scope of works and requirements of this report were based on the information provided by Symmetrys (Consultant Engineers) within the following documents: • Email specification from Camille Corvec (Symmetrys) to Philip Lewis (LMB) 9th November 2017; & • Site Investigation Plan; and • Revised Site Investigation Plan via email from Camille Corvec (Symmetrys) to Philip Lewis (LMB).

AIMS & OBJECTIVES

This report aims to provide information sufficient to meet the requirements of the email specification provided by the Consultant Engineers.

SCOPE OF WORKS

The following scope of works has been completed:

INTRODUCTION

Desk Study (Preliminary Risk Assessment)

- Completion of a site reconnaissance survey to make a preliminary assessment of the site and potential sources of contamination;
- Review of information on the planning portal for records pertaining to basement development in the neighbouring area;
- Review of historical plans for the area to assess historical land uses on and immediately surrounding the site;
- Assessment of the 'sensitivity' of the site location as determined by factors such as hydrogeology, proximity of watercourses, neighbouring land use, ecologically sensitive uses and geology detailed on British Geological Survey (BGS) maps;
- Completion of an interpretive report (to be included within the main ground investigation report) that will include:
    - Details of current site conditions based on the reconnaissance survey;
    - Production of a preliminary conceptual site model;
    - Provision of a Preliminary Risk Assessment outlining potential land contamination issues associated with the proposed development.

Ground Investigation & Assessment

- Site set up including liaison with Consultant Engineers, Client and appointment of sub-contractors;
- Mobilisation to site and transport of the rig to the proposed location;
- Completion of 1No. borehole to a maximum depth of 7.35m bgl (or refusal) with insitu testing and collection of disturbed samples for laboratory testing;
- Completion of 2no. hand excavated trial pits to a maximum depth of 1.20m bgl (or refusal) to expose and inspect existing building foundations. A third trial pit was attempted but had to be abandoned due to the presence of below ground services;
- Supervision and geological logging of the soil arisings in accordance with BS5930 by an appropriately experienced geo-environmental engineer;
- Installation of 1no. monitoring well to maximum depths of 5.0m below ground level and return monitoring of groundwater levels on 2no. occasion;
- Geotechnical laboratory testing of the soil samples for an appropriate suite of determinands (dependent on ground conditions encountered could include pH, sulphate, PSD, triaxial testing, atterberg limits, and moisture content, as appropriate);
- Chemical analysis of 1no. sample of Made Ground, including Waste Acceptance Criteria (WAC);
- Completion of a factual and interpretive report that includes;
    - Details of the ground and groundwater conditions encountered;
    - Schematic sections of exposed foundations;
    - Presentation of chemical analytical results;

INTRODUCTION

- Geotechnical laboratory testing and provision of advice on the material properties of the shallow soil horizon including parameters to aid in retaining wall design and foundation options; &
- Conclusions and recommendations.

Ground Movement Assessment (GMA)

Completion of GMA calculations in accordance with the CIRIA publication C580 Embedded Retaining Walls – Guidance for Economic Design and provision of an interpretive report section (to be incorporated into the main report) that includes:

- Summarises any assumptions and findings;
- Provides estimates of any predicted damage/impact based upon the Burland scale; and
- Provides recommendations for additional works and/or mitigation measures.

CONTRIBUTORS

This report has been reviewed and authorised by Philip Lewis, a hydrogeologist and chartered Geologist with over nineteen years experience as a geoscience professional, including over fifteen years experience as a professional adviser (consultant) in hydrogeology, engineering geology and contaminated land.

The Ground Movement Assessment has been completed by Corrado Candian (CEng, MICE).

LIMITATIONS

LMB has prepared this report solely for the use of the named Client and those parties with whom a warranty agreement and/or assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from LMB and the Client.

LMB accepts no responsibility or liability for:

a) the consequences of this document being used for any purpose or project other than for which it was commissioned, and

b) issue of this document to any third party with whom an agreement has not been executed.

The risk assessment and opinions provided, among other things, take in to consideration currently available guidance and best available techniques relating to acceptable contamination concentrations and interpretation of these values. No liability can be accepted for the retrospective effects of any future changes or amendments to these value.

Preliminary Risk Assessment

A Preliminary Risk Assessment (PRA) has been undertaken and is presented in this section in order to provide further background and context for the ground investigation and assessment presented in the later sections of this report.

SITE RECONNAISANNCE

A representative of LMB completed a site walkover survey on Tuesday 14th November 2017 that included external areas. A photographic record is provided as **Appendix B**.

The site currently comprises a three storey (including existing lower ground floor) end of terrace residential property with a converted loft space (see Plates 1 & 2). The site is located on a residential road that slopes gently to the north west, with a number of mature trees located along the pavements (see Plates 3 & 4).

A number of existing basements / lower ground floors were observed in the neighbouring properties, including the adjacent properties, no. 37 Pilgrims Lane and 49 Denning Road (see Plates 5 to 16).

ENVIRONMENTAL SETTING

Published Geology & Aquifer Designations	Reference to British Geological Survey (BGS) Digital Map (1:50,000) and accessible information contained on the Environment Agency (EA) website indicates that the site is located directly over the London Clay Formation which is designated Unproductive Strata. However, the Claygate Member, which is designated a Secondary (A) Aquifer is shown to outcrop in close proximity to the site.
Local Hydrology	Reference to information on local mapping, the Groundsure Enviro Insight Report (ref. GS-4495494) and *Lost Rivers of London* (Barton, N.J, 1982) indicates that the closest known surface water feature is part of the Hampstead Ponds, located in Hampstead Heath approximately 290m east. The ponds appear to be linked to a culverted tributary of the River Fleet. Information relating to the Thames region within the UK Hydrometric Register indicates that the average annual rainfall in the region is 710mm. Publicly accessible information contained on the EA website, gov.uk website and in the Groundsure Enviro Insight Report (ref. GS-4495494) indicates that the site is not located in an area at risk of flooding from rivers and sea. The referenced information suggests that the property is located in an area with a very low to from surface water flooding, although the area approximately 30m north is shown to be at a low to high risk from surface water flooding.

PRELIMINARY RISK ASSESSMENT

Resource Potential & Ecological Quality	**Surface Water**: The Hampstead Ponds are not included the within the relevant River Basins Management Plan (RBMP, Thames).
	Groundwater: The groundwater within the Claygate Member is not included within the relevant RBMP. The groundwater in the London Clay Formation is designated Unproductive Strata and as such is not characterised as a groundwater body within the relevant RBMP. In addition, the Site is not located within an EA designated Source Protection Zone (SPZ).
Surrounding Land Use	Surrounding land uses are primarily residential.
Local Designations	Reference to information contained on the Groundsure Enviro Insight Report (ref. GS-4495494) indicates that there are no designations (e.g. Sites of Special Scientific Interest) with 500m of the site.

BELOW GROUND ASSETS

As part of the assessment the following organisations were contacted to ascertain if they held any below ground assets below or in close proximity to the site:

- Network Rail;
- Crossrail;
- London Underground Ltd / Transport for London.

Responses have been received from Network Rail and Crossrail confirming they do not hold any below ground assets in the vicinity of the site. A response from London Underground is pending but based on experience of nearby sites below ground assets in the vicinity of the site are not anticipated.

Copies of correspondence are included in **Appendix D**.

SUMMARY OF LIKELY GROUND & GROUNDWATER CONDITIONS

The information presented in the following sections is based on review of available BGS borehole logs for the local area, interpretation of BGS mapping and information presented within the Groundsure Enviro Insight Report (ref. GS-4495494).

The interpretation of this information should be considered preliminary pending completion of site specific ground investigation works.

PRELIMINARY RISK ASSESSMENT

Local Ground Conditions

Available BGS borehole logs for the area surrounding the site are limited to two relatively deep records (>120m) approximately 170m west (ref. TQ28NE6) and 260m east (ref. TQ28NE5) of the site respectively.

The BGS borehole records suggest that approximately 2.10m of Topspoil / Made Ground is present to the west of the site but that it is absent to the east of the site.

The BGS borehole records suggest that the base of the London Clay Formation is present between approximately 89m and 110m bgl. It should be noted that the borehole record to the west of the site is shown on BGS mapping to lie within the outcrop of the Claygate Member, however the corresponding soil descriptions are not consistent with the Claygate Member.

Local Groundwater Conditions

Within the two BGS borehole logs reviewed, groundwater was only recorded within Chalk at depth, although it is likely that groundwater would also be present within the Lambeth Group and Thanet Formation.

Summary

The ground and groundwater conditions on Site based on the data presented above are summarised in the table below:

Stratum	Summary Description	Anticipated Depth to Groundwater (m bgl)	Anticipated Thickness (m)
Made Ground	'Top soil or Made earth.'	None recorded.	0.00 – <2.50
London Clay Formation	'Brown clay, clay with shells and mudstone, sandy clay with shells'		89.00 – <110.00
Lambeth Group	'Clay and pebbles, sand and thin beds of flints'		<15.00 – <26.00
Thanet Formation	'Sand, clay and sand and grey sand.'		<15.00
Chalk	'Hard chalk, soft chalk with water and Hard chalk, no water.'	66.00 – 98.00	20.00 – <50.00(1)

(1) Base not determined

PRELIMINARY RISK ASSESSMENT

Visual and Olfactory Observations

No visual or olfactory evidence of contamination was recorded on the BGS borehole logs reviewed.

SITE HISTORY

A review of historical map data indicates that from c. 1850 the site comprised open land. Historical mapping indicates that by c. 1895 the site was occupied by the existing building and that there was mass residential development of the surrounding area.

POTENTIALLY CONTAMINATIVE HISTORICAL LAND USE

A review of historical data within the Groundsure Enviro Insight Report (GS-4495494) has been completed to identify potentially contaminative previous land uses on site and within 300m of the site.

Date	On Site Features	Off Site Features
1873	-	Militia barracks approximately 176m north-west
1873	-	Pond approximately 207m north-west.
1873	-	Pond, reservoir and unspecified ground works approximately 265m east (1873-1996)
1894	-	Unspecified tank and unspecified ground workings approximately 261m east (1894, 1965)
1953		Garage approximately 275m west. Electricity substation approximately 288m south-west Electricity substation approximately 274m west (1953-1973)
1958	-	Tunnel approximately 299m south west (1958-1996) Police station approximately 243m south (1958-1996)
1991	-	Electricity sub-station approximately 273m south.

REVIEW OF PLANNING HISTORY

A search of planning applications on the London Borough of Camden website has been completed to review any existing and proposed development in the vicinity of the site.

The only planning decisions related to basement construction in the nearby area were as follows:

- 45 Denning Road: Details of elevations and facing materials (condition 2); and privacy screen (condition 3) pursuant to planning permission dated 10/09/2007 (ref.2007/3367/P) for the enlargement of front dormer window, enlargement of basement floor and erection of a rear extension at basement and lower ground floor levels plus sunken courtyard to provide additional accommodation to dwelling house.
- 49 denning Road: Details of landscaping and cycle storage pursuant to conditions 6 and 10 respectively of planning permission (ref:2007/4102/P) granted on 13 November 2007 for the demolition of existing house plus substation in rear garden of 49 Denning Road and garage on site of 35 Pilgrims Lane and erection of a 4 storey plus basements dwelling house including side wing, rear extension with roof terrace above, and forecourt parking space, plus separate parking space for 35 Pilgrims Lane.

These developments have now been completed.

ENVIRONMENTAL & PERMITTING DATA

The table below provides a summary of the environmental and permitting data for the site and surrounding area:

Item	On Site	0 – 250m	Description
Part A (2) and Part B Activities	0	1	Dry cleaning approximately 283m south west.
Current Land Uses	0	0	
Discharge Consents	0	0	
Pollution Incidents	0	2	Firefighter run-off contaminated water approximately 349m south west and an unidentified incident with significant water impact approximately 441m north east.
Local Authority Pollution Prevention Controls	0	0	
Registered Radioactive Substances	0	0	
IPC & IPPC Authorisations	0	0	
Historical & Registered Landfills	0	0	

PRELIMINARY RISK ASSESSMENT

Item	On Site	0 – 250m	Description
Waste Sites	0	0	
Fuel Station Entries	0	0	

ENVIRONMENTAL SENSITIVITY

Overall, the site setting is considered to be of **low** environmental sensitivity, for the following reasons:

- The Site is located in a predominantly residential land use area;
- The Site is underlain by the London Clay Formation, which is designated a Unproductive strata;
- The Site is not located within an SPZ and there are no active licensed groundwater abstractions located within 1km of the site;
- The site is located within an area with very low risk of flooding (surface water, groundwater, rivers and sea). However, the site is close to an area with high surface water flood risk (the end of Pilgrim's Lane).
- The nearest known surface water features are the Hampstead Heath ponds (and culverted tributary of the River Fleet), which are not included in the relevant RBMP; and
- There are no recorded designated sensitive land uses within 1km of the site.

PRELIMINARY CONCEPTUAL SITE MODEL

The information presented in the previous sections of this report and within the former Environment Agency/DEFRA document; Priority Contaminants for the Assessment of Land (CLR8)[1] have been used to complete a Preliminary Conceptual Site Model (PCSM) that details the potential contaminant sources, pathways and receptors.

The PCSM is presented in the table below:

Potential Contaminant Sources	On-site	• None identified, possible Made Ground.
	Off-site	• Militia barracks within 180m. • Possible in-filled reservoir, ponds and unspecified ground works within 265m. • Electricity sub-stations within 290m. • Former garage within 275m.

[1] This document has been withdrawn but is considered to remain useful in proving technical background for identifying potential sources of contamination and designing ground investigation works.

		• Former dry cleaning within 285m • Unspecified tanks within 265m. • Police station within 245m • Tunnel within 300m
Associated Contaminant	On-site	• None identified, possible contaminants associated with Made Ground including heavy metals, asbestos and organic contaminants.
	Off-site	• Heavy metals and inorganic contaminants. • Organic contaminants (including petroleum hydrocarbons and volatile organic compounds). • Bulk ground gases & volatile vapours.
Receptors		• Future Site Users; • Neighbouring residents; • Maintenance and construction workers (acute risk only); and • New built development.
Pathways to Receptors		• Direct contact, inhalation and ingestion of contaminants within any shallow soils (Acute risk during below ground construction and maintenance). • Migration of ground gas & volatile vapours.

POLLUTANT LINKAGE ASSESSMENT

The likelihood of pollutant linkages being present between the potential contaminant sources, pathways and receptors identified in the PCSM are outlined in the table below:

Pathway Linkage	**Likelihood of Pollutant Linkage**	**Consequences**	**Risk Rating**	**Reasoning**
Future Site Users (Direct exposure pathway)				
Ingestion/Dermal Contact/Inhalation (Site Users).	Unlikely	Medium	Low	No potential on site contaminant sources have been identified and basement excavation is likely to remove the majority of Made Ground soils.
Ingestion/Dermal Contact/Inhalation	Unlikely	Mild	Very Low	

Pathway Linkage	Likelihood of Pollutant Linkage	Consequences	Risk Rating	Reasoning
(Maintenance and Construction Workers).				Potential exposure for maintenance and construction workers will be acute and it is assumed they will adopt appropriate management procedures to mitigate potential risks.
Future Site Users (Indirect exposure pathway)				
Enclosed space accumulation of ground gas.	Unlikely	Severe	Moderate/Low	Potential sources of ground gas and volatile vapours are limited to off-site locations separated from the site by buildings and below ground features such as existing basements and utility infrastructure. In addition, the geology comprises low permeability London Clay and as such there is limited potential for ground gas / volatile vapour migration on to site.
Outdoor volatile vapour exposure	Unlikely	Medium	Low	
Ingress into potable water supply pipes	Unlikely	Medium	Low	No on site potential contaminant sources have been identified. Confirmation with the statutory undertaker is recommended.
Risks to Buildings via accumulation of ground gas in	Unlikely	Severe	Moderate/Low	Potential sources of ground gas and volatile vapours are limited to off-site locations separated from the site by

Pathway Linkage	Likelihood of Pollutant Linkage	Consequences	Risk Rating	Reasoning
enclosed spaces and sub-floor voids.				buildings and below ground features such as existing basements and utility infrastructure. In addition, the geology comprises low permeability London Clay and as such there is limited potential for ground gas / volatile vapour migration on to site.
Water Environment				
Contaminant migration on to neighbouring land.	Unlikely	Medium	Low	No on site contaminant sources have been identified and the site is underlain by low permeability London Clay which is designated Unproductive Strata.
Contaminant migration from neighbouring land.	Unlikely	Medium	Low	
Contamination of groundwater	Unlikely	Medium	Low	
Contamination of surface water	Unlikely	Medium	Low	No surface water features have been identified within 200m of the site.
Foundation Piling				
Creation of a pathway between any near surface contaminants	Unlikely	Mild	Very Low	If a piled foundation solution is adopted there is a substantial thickness of low permeability London Clay between potential

PRELIMINARY RISK ASSESSMENT

Pathway Linkage	Likelihood of Pollutant Linkage	Consequences	Risk Rating	Reasoning
and the underlying aquifers.				contaminants and sensitive aquifers (e.g. Principal Chalk Aquifer).
Overall Risk Rating			**Very Low to Moderate/Low**	

Ground Investigation & Findings

INTRODUCTION

The ground investigation works were undertaken on 29th November 2017 and comprised the progression of 1no. heavy duty dynamic (windowless) sampler boreholes to 7.35m bgl and 2no. hand excavated trial pits to expose existing building foundations, with sampling of soil for laboratory testing (see **Figure 2**).

Groundwater monitoring was undertaken following completion of the fieldworks on 4th and 8th December 2017.

Details of the ground investigation completed, along with the findings of the investigation, are provided in the following sections. The exploratory hole logs and laboratory results are presented in **Appendix E, F** and **G** respectively.

Guidance Documents

Details of the best practice guidance documents and reference information used in undertaking the ground investigation and assessment are provided at the end of this report (see Ground Movement & Construction

The predicted building damage during construction is based on a conservative approach and it is recommended that the contractor gives consideration to the Association of Specialist Underpinning Contractors (ASUC) guidelines which should provide some mitigation and reduce the potential movements.

Ground Movements Monitoring

It is recommended that movement monitoring should be undertaken with surveying points set up prior to commencement of the works and it is recommended that monitoring be undertaken at weekly intervals. It is recommended that trigger values for monitoring are based on the predicted ground movements to ensure conservatism and that they are agreed under the Party Wall Act.

REFERENCES & GUIDANCE).

INVESTIGATION STRATEGY

The ground investigation was designed based on the requirements of the Consultant Engineers set out in the email specification from Camille Corvec (Symmetrys) to Philip Lewis (LMB) 9th November 2017 and associated Site Investigation Plan.

GROUND INVESTIGATION & FINDINGS

Soil Chemical Analysis & Laboratory Testing

Soil samples were submitted to the UKAS and MCERTS accredited laboratories of i2 Analytical for chemical analysis and geotechnical testing.

The results of the geotechnical and chemical analysis (including waste acceptance criteria testing) are presented in **Appendix F** and **G** respectively.

GROUND & GROUNDWATER CONDITIONS

Ground Conditions

The table below provides a summary of ground conditions encountered with full descriptions provided in the associated exploratory hole logs provided in **Appendix E**:

Strata	Depth Range to Top (m bgl)	Depth Range to (Base (m bgl)	Summary Description
Made Ground (1)	Ground Level	0.87 – 3.25	The ground surface at trial pit locations was found to comprise wooden decking and/or concrete hardstanding. The Made Ground soils were typically found to comprise gravelly to slightly gravelly clay with bricks.
London Clay Formation (2)	0.87 – 3.25	7.35	The London Clay was typically found to comprise a sequence of firm becoming stiff fissured clays with occasional silty fine sand partings.

(1) Base not determined in all locations.

(2) Base not determined.

Visual and Olfactory Observations

No visual or olfactory evidence of contamination was observed during the ground investigation works. However, Made Ground soils were encountered in all exploratory hole locations and can be indicative of the presence of contaminants.

Groundwater Conditions

No groundwater strikes were recorded during the ground investigation works. During return monitoring, groundwater was recorded at depths ranging between 3.09m and 3.73m bgl.

Groundwater is commonly recorded within the London Clay Formation during monitoring. However, rather than being representative of a permanent and laterally continuous aquifer unit, the groundwater is present

as discrete units within (for example) micro fissures and local mudstone horizons and the recorded groundwater level will most likely be reflective of the pore water pressures within these discrete features.

Characteristic Values of Soil Parameters

A summary of the geotechnical properties of the strata based on the field and laboratory testing is provided in the table below.

Soil Property	**Stratum**	
	Made Ground	London Clay
SPT 'N' Value	5 - 8	10 – >50
Field Undrained Shear Strength (kN/m^2)	-	60 – 80
Undrained Shear Strength (kN/m^2) based on SPT 'N'	-	42 – 60
Bulk Density (mg/m^3)	-	-
Moisture Content (%)	17 – 18	20 – 32
Plasticity Index (%)	-	44 – 52
pH	7.3	7.2
Sulphate (g/l)	0.052	2.4

A plot of SPT 'N' value against depth is provided in **Appendix H.**

The plot indicates that there is a fairly uniform correlation between depth and relative density (SPT N Value). The SPT N value at 7.00m skews the results but is reflective of the mudstone unit encountered at that depth and not the relative density of the London Clay soils.

Geotechnical Advice

INTRODUCTION

The site currently comprises a three storey (including existing lower ground floor) end of terrace residential property with a converted loft space. It is understood that the client wishes to extend the existing lower ground floor to form a basement below approximately 30% of the existing building footprint and will also partially extend over a small area of the current front garden outside the existing building footprint. It is understood that the basement will be used to house a home cinema, longue space and a sauna.

On this basis, it the following assumptions have been made:

- The finished floor level of the basement will be approximately 2.80m bgl.
- The load from the existing structure will be in the region of 30-40KN/m^2.
- For the existing structure (including the roof) the wall load is estimated at approximately 60-80kN/m run.
- There will be no significant changes in elevation over the proposed basement development.
- Foundations will not be eccentrically loaded.

GROUND CONDITIONS SUMMARY AND ENGINEERING PARAMETERS

The ground conditions encountered in the exploratory hole comprise Made Ground overlying a sequence of firm to stiff locally slightly silty and slightly sandy clays.

Groundwater was recorded at depths ranging between 3.09m and 3.73m bgl during the two monitoring visits.

Groundwater is commonly recorded within the London Clay Formation during monitoring. However, rather than being representative of a permanent and laterally continuous aquifer unit, the groundwater is present as discrete units within (for example) micro fissures and local mudstone horizons and the recorded groundwater level will most likely be reflective of the pore water pressures within these discrete features.

FOUNDATION DESIGN

Based on the information supplied, the finished floor level is at approximately 2.80m bgl and it has been estimated that this would equate to a formation level of approximately 3.00m bgl. However, this would place the foundations upon the Made Ground soils which are not considered suitable founding media.

As such it is recommended that the foundations are carried through the Made Ground to a minimum depth of c.3.30m bgl and placed on the firm London soils.

GEOTECHNICAL ADVICE

Spread Foundations

Based on the findings of the ground investigation and the subsequent laboratory testing it has been concluded that for traditional spread foundations (placed on the competent firm London Clay) at the assumed formation level of 3.30m bgl a net safe bearing pressure of 100kN/m^2 should be available.

It is recommended that the undrained shear strength of soils at formation level be confirmed using a hand shear vane and should exceed 50kN/m^2.

Piled Foundations

Based on the proposed development and the ground conditions encountered it is considered unlikely that a piled foundation would be the most feasible solution. However, it is possible that sheet piling (or similar) may be considered as part of the temporary works.

GROUND STABILITY & RETAINING STRUCTURES

Retaining walls constructed in open cut would be the preferred solution, but given the size of the excavation and the adjacent and nearby residential structures it is considered likely that temporary support (sheet piles or similar) will be needed for construction.

Localised groundwater was encountered near the anticipated excavation depth (3.0-3.30m bgl) and the stability of unsupported excavations at the site should not be relied upon. Zones loosened by the removal of existing and relict construction may be particularly unpredictable and liable to collapse.

It may be beneficial to install the retaining wall and floor slab sequentially to provide propping and lateral restraint, which could help to minimise deflections. It is likely that this will need to be given particular consideration beneath the party walls of the adjoining properties.

Safe working conditions should be ensured where persons are required to work in excavations. It is recommended that reference be made to CIRIA Report No. 97,"Trenching Practice" 1992.

The parameters presented in the table below may be considered within the design of retaining walls.

Strata	Depth Range (m bgl)		Effective Angle of Shear Resistance (2)	Coefficient of Active Earth Pressure (Ka) (2)	Coefficient of Passive Earth Resistance (Kp) (2)	Bulk Density
	Top	Base				
Made Ground	Ground Level	0.87 – 3.25	27	0.35	3.5	1.70(1)
London Clay	0.87 – 3.25	7.35	22	0.42	2.7	1.83 – 2.35(3)

(1) Assumed value based on literature information.
(2) Based on soil properties and reference to BS8002 & Tomlinson, M.J. (1986) for a free standing wall.
(3) Literature values taken from Forster (1997)

GEOTECHNICAL ADVICE

BURIED CONCRETE

In accordance with BRE Special Digest 1 (2005), the results indicate that the following design sulphate classes and Aggressive Chemical Environment for Concrete (ACEC) classes would apply:

Strata	Design Sulphate Class	ACEC Class
Made Ground	DS-1	AC-1s
London Clay Formation	DS-3	AC-2s

ADDITIONAL CONSIDERATIONS

Existing Structures

It is recommended that any existing buried construction that will underlie the new development is broken out and removed. However, if buried construction (such as existing foundations) are to remain close to the new structure then care should be taken to avoid interaction i.e. to prevent the slab 'breaking its back' over the existing construction.

Potential for Heave, Settlement & Inward Yielding

The laboratory testing on the London Clay Formation suggests that it is typically a high plasticity clay.

The removal of the overburden during the excavation of the basement is likely to result in some heave and inward yielding of the soils at formation level and possibly a subsequent settlement of the soils outside the excavation. Based on the ground investigation data, the London Clay at formation level is anticipated to comprise firm clay and so the potential effects maybe limited by their relatively low compressibility (as compared to soft clay soils). Inward yielding in firm to stiff clays is typically in the range of 5-40mm (Tomlinson, M.J. (1986).

The total uplift will be a function of the soil heave pressure and water pressure, it is anticipated that almost half of this will be immediate upon excavation, while the remainder would be long term. The estimated depth of excavation is between 3.00m and 3.30m below current ground level, assuming an unsaturated unit weight of 20kN/m^3 and accounting for groundwater within the London Clay, the estimated unload due to the excavation would be in the order of 65kN/m^2.

It is anticipated that following excavation and construction of the basement, the load imposed by the new sub-structure will be less than the overburden pressure at formation prior to excavation.

However, it is anticipated the basement slab would not be loaded if strip footings are adopted. In this case a suspended basement floor slab may be appropriate, constructed with suitable compressible void formers that can accommodate the expected ground heave.

GEOTECHNICAL ADVICE

As outlined, the basement is estimated to extend beneath the entire footprint of the existing building but there will be small limited areas outside the footprint. This could result in differential heave over the long term.

This means there is the potential for longer term heave of the soils at formation level following basement construction.

Based on the information presented above it is recommended that the basement design takes into account the following:

- The potential for short term and long term heave and inward yielding during construction and following construction.
- The potential for differential heave that will occur in the areas of the basement beneath the existing building footprint and those limited areas outside the building footprint.
- The potential for groundwater to cause both lateral and uplift pressure.

Management of Formation Level

Should pockets of inferior material be present during the inspection of the foundation excavation, they should be removed and replaced with well graded, well compacted hardcore or lean mix concrete. The excavated surface should be protected from deterioration and a blinding layer of concrete used where foundations are not completed without delay. Any surface or perched water should not be allowed to collect in the base of excavations since the clay is prone to rapid deterioration in the presence of water, with loss of their favourable bearing properties.

Groundwater & Groundwater Management

Significant dewatering is not anticipated during the construction of these foundations but some groundwater seepages and/or surface water infiltration into the excavation should be anticipated. It is anticipated that any seepages or rates of inflow of groundwater would be slow and it is recommended that seepages be dealt with by pumping from sumps.

Potential Project Risk

It should be noted that the excavation of the basement may undermine the adjacent property and could lead to settlement in gardens and damage to buildings and below ground services. It is recommended that the contractor should allow for suitable mitigation measures that may include:

- A survey of existing ground levels and buildings;
- A survey of existing below ground services;
- Monitoring of adjacent buildings during construction; and
- Monitoring of adjacent ground levels during construction.

Assessment of Soil Analytical Results

INTRODUCTION

As outlined, the basement will extend beneath the footprint of the existing property with the existing front and rear garden areas retained. As such, a large proportion of the Made Ground soils at the site will be removed to facilitate development.

Notwithstanding this a conservative approach has been adopted and a Generic Quantitative Risk Assessment (GQRA) and preliminary waste characterisation have been completed. No statistical analysis has been completed and recorded concentrations have been compared directly to Generic Assessment Criteria (GAC) considering a residential (without plant uptake) end use.

In addition to the GAC, the provisional Category 4 Screening Levels (pC4SL) developed by CL:AIRE for DEFRA in response to the new definitions within the Contaminated Land Statutory Guidance (ref. DEFRA, April 2012) have also been considered within the assessment.

RISK ASSESSMENT

Assessment of Potential Risks to Future Site Users (Soil Contamination)

Two samples of the Made Ground soils were collected during the ground investigation (BH1 at 2.90m and TP2 at 0.60m) and analysed for a range of determinands including, heavy metals, petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAH) and asbestos screening.

The recorded concentrations of determinands were found to either be below the limit of detection for the laboratory method applied or below relevant GAC considering a residential (without plant uptake) end use.

Asbestos in Soils

Both samples of the Made Ground soils were screened for the presence of Asbestos Containing Materials (ACM). No ACM were detected.

WASTE CHARACTERISATION

The Landfill (England and Wales) Regulations (2002, as amended), the Hazardous Waste (England and Wales) Regulations (2005, as amended) and the Waste (England and Wales) Regulations (2011) have changed the way in which waste materials have traditionally been managed (i.e. landfill disposal). If materials are to be discarded from site, appropriate characterisation and classification are required prior to disposal, to determine whether a waste should be described as either non-hazardous or hazardous. The process of classification is based around the List of Wastes (England) Regulations in conjunction with the Environment Agency Guidance Document WM3 (edition 1, 2015). Waste Acceptance Criteria (WAC) are often confused as

a means of classification when, in actuality, they represent criteria that wastes must satisfy for disposal in target landfill types (i.e. non-hazardous waste may be described as inert if it satisfies the appropriate WAC; however, hazardous waste can never be classified as inert even if it satisfies the WAC for an inert landfill).

Certain categories of waste material are termed 'absolute entries' within the List of Wastes Regulations (2005) and are automatically classified as inert or hazardous e.g. glass packaging and acid tars respectively.

Source of Potential Wastes

The waste materials on site are considered to comprise the Made Ground soils that occupy (typically) the upper 1.00m to 3.00m below ground level. In general, the majority of this material could be thought of as 'Construction and Demolition Wastes (including Excavated Soil from Contaminated Sites)' and such soils could be described as inert, non-hazardous or hazardous, dependant on its source and chemical characteristics.

The source of the Made Ground materials is not known but based on the ground conditions encountered it appears to primarily comprise reworked and possible demolition material that is considered to have been derived from historical, local demolition and construction and possibly reworking of the natural soils in the area of the existing property.

BASIC WASTE CHARACTERISATION

Made Ground

On a purely visual basis, the majority of the Made Ground would appear to conform with 'soils and stones' excluding topsoil, peat and excluding soil and stones from contaminated sites (European Waste Catalogue Code 17 05 04), which would be an inert waste material. However, where soil and stones are not automatically classified as inert they will always be treated as so called 'mirror entries' of the List of Waste Regulations (European Waste Catalogue Code 17 05 03 mirror hazardous or 17 05 03 mirror non-hazardous). An assessment of the composition of the soil is required to determine the concentrations of potentially dangerous substances that maybe present in the soils to allow the waste to be classified accordingly.

As such, chemical analysis has been completed on two samples of Made Ground (BH1 & TP2) in general accordance with the Environment Agency document Waste Sampling and Testing for Disposal to Landfill (ref. EBPRI 11507B, March 2013). The results have been used to aid in basic waste characterisation utilising the information presented within the WM3 document for Hazardous wastes.

In addition, the sample of Made Ground was tested for the presence of Asbestos Containing Materials with none detected.

Reference to the WM3 document suggests that the majority of the Made Ground materials will be listed as non-hazardous wastes. Any basic waste characterisation will need to be confirmed by the receiving facility.

ASSESSMENT OF SOIL ANALYTICAL RESULTS

Natural Ground Deposits

The natural soils (London Clay Formation) are likely to be listed as inert (soils and stones, European Waste Catalogue Code 17 05 04), again this will need to be confirmed by the receiving landfill facility.

In addition, given the scarcity of inert landfill cells it may be more appropriate (depending on timescales and feasibility etc) to source an alternative use for the soils (such as fill materials or daily cover) or to dispose to non-hazardous landfill.

Waste Acceptance Criteria (WAC) Testing

WAC testing has been undertaken on the sample of Made Ground collected from BH1 (1.00m), with the results presented in **Appendix G**.

The results indicate that Made Ground soils would meet the inert waste landfill waste acceptance criteria.

UPDATED CONCEPTUAL SITE MODEL & POLLUTANT LINKAGE ASSESSMENT

Updated Conceptual Site Model & Pollutant Linkage Assessment

CONCEPTUAL SITE MODEL

Source-Pathway-Receptor Model

Contaminant Sources

Based on the results of the PRA and ground investigation no potential sources of on site contamination have been identified.

Potential off-site sources of contamination include historical surrounding land uses such as possible in-filled reservoirs, an electricity sub-station, dry cleaners and garage.

Contaminant Migration Pathways & Receptors

The potential exposure pathways and receptors described in the Preliminary Risk Assessment section are largely considered to remain valid.

The ground investigation works confirm the presence of low permeability soils beneath the site which along with the presence of local infrastructure and existing basement/lower ground floors will limit the potential for ground gas / volatile vapour migration on to site.

POLLUTANT LINKAGE ASSESSMENT

Based on the information reviewed and GQRA completed, no plausible pollutant linkages are considered to exist.

There is potential for maintenance and construction workers to come into contact with Made Ground soils during construction works. However, it should be noted that this relates to acute and not chronic risk and as such cannot be assessed using the approach described within the statutory guidance (ref. 2).

It is recommended that maintenance and construction workers involved in below ground works adopt appropriate management procedures to mitigate potential risks.

Ground Movement Assessment

INTRODUCTION

There is the potential for ground movements due to the proposed development from the wall installation and from the excavation process. It has been assumed that the excavation will be undertaken using the traditional method of underpinning formed in a 'hit and miss' sequence up to a depth of approximately 3.30m. An appropriate propping system will be utilised.

To provide some basis of estimating likely movements and damage resulting from excavating the basement in front of the underpinning, and in the absence of underpinning specific guidance, the underpinned sections of the new basement have been treated as piles.

The magnitude and extent of ground movements resulting from installation of a piled wall and excavation in front of such a wall are typically estimated based on the guidance given in the CIRIA publication C760 'Guidance on embedded retaining wall design'. The guidance in the CIRIA publication is based on the behaviour of embedded walls at numerous sites in London, which are predominantly walls embedded in London Clay, though typically with some near surface deposits consisting of River Terrace Deposits and Made Ground.

BUILDING DAMAGE ASSESSMENT

CIRIA C760 provides curves estimating horizontal and vertical ground surface movements due to piled wall installation and to excavation in front of wall. Total ground movements resulting from the excavation will be the combination of the installation movements and the excavation movements.

The method provided within Box 6.3 in CIRIA C760 has been used to inform the assessment. CIRIA C760 curves were used to make a prediction of ground movement assuming a high support stiffness wall. Potential corner stiffening effects have not been applied.

Ground Movements – Wall Installation

The movements resulting from excavation in front of the underpins incorporate the movements resulting from the construction (i.e. installation) of the underpins, since, unlike for the piles, the construction process requires an excavation prior to the pins being formed. However, the analysis has conservatively adopted the values for 'installation of a planar diaphragm wall' to represent the installation of the underpins (Fig. 6.9a and Fig. 6.9b in CIRIA C760).

Ground Movements – Excavation in Front of Wall

In this case consideration has been given to account for the fact that the soil to be excavated comprises a soft to firm clay.

GROUND MOVEMENT ASSESSMENT

A factor of safety against basal heave according to Terzaghi's method (1943) and the system stiffness have been preliminary assessed based on a Cu of 36 kN/m^2 (N=8) for soft clay and a Cu of 65 kN/m^2 for firm clay. These values have been estimated based on Table 8 from CIRIA R143. A Factor of Safety (FoS) of about 8.5 and a system stiffness of about 760 have been assessed.

Fig. 6.12 in CIRIA C760 (from Clough 1989) indicates that the ratio between the maximum lateral wall movement and the excavation depth is in the order of 0.2% for such FoS and system stiffness values.

Furthermore Moormann (2004) carried out extensive empirical studies of retaining wall and ground movements due to excavation in soft soil (cu<75 kN/m^2). He found that the ratio between the maximum vertical settlement at the ground surface behind a retaining wall and the maximum horizontal wall displacement varies between 0.5 and 1.0. A ratio of 1.0 was considered.

As such, the ratio between the maximum lateral wall movement and the excavation depth and the ratio between the maximum ground settlement and the excavation depth have been conservatively taken as 0.2% at the wall location.

In the absence of underpinning specific guidance, Fig. 6.15a and Fig. 6.15b from CIRIA C760 have been used based on the above implications to reflect the soft to firm nature of the soil excavated.

Damage category

Using these predicted movements, estimates of possible damage have been made for the surrounding structures, based on the Damage Classification Scheme proposed by Burland and Wroth (1974), and later supplemented by the work of Boscardin and Cording. This methodology is described within Box 6.3 in CIRIA C760 (and preceding CIRIA publications).

The 'Burland Scale' damage categories are presented in the table below:

Category of damage	Description of typical damage (ease of repair is underlined)	Approximate crack width (mm)	Limiting tensile strain, ε_{lim} (%)
0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible	<0.1	0.0 to 0.05
1 Very slight	**Fine cracks that can easily be treated during normal decoration.** Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection	<1	0.05 to 0.075
2 Slight	**Cracks easily filled. Redecoration probably required.** Several slight fractures showing inside of building. Cracks are visible externally and **some repointing may be required externally** to ensure weathertightness. Doors and windows may stick slightly.	<5	0.075 to 0.15
3 Moderate	**The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable lining. Repointing of external brickwork and possibly a small amount of brickwork to be replaced.** Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5 to 15 or a number of cracks >3	0.15 to 0.3
4 Severe	**Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows.** Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Services pipes disrupted.	15 to 25, but also depends on number of cracks	>0.3
5 Very severe	**This requires a major repair, involving partial or complete rebuilding.** Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	Usually >25, but depends on numbers of cracks	

Damage categories 1 and 2 are generally considered to represent aesthetic damage only.

Summary of Results

Copies of worksheets calculations and graphical representation of the results are presented in **Appendix I** and are summarised in the table below:

Nearby Building / Structure	Estimated Damage Category No.	Category of Damage
49 Denning Road	0	Negligible
56 Pilgrim's Lane	0	
43 Denning Road	0	
37 Pilgrim's Lane	1	Very Slight

The ground movement assessment undertaken indicates that damage to surrounding properties will generally be Burland Category 0 (Negligible) to 1 (Very Slight).

GROUND MOVEMENT ASSESSMENT

Anticipated vertical movements provide a maximum tilt of about 1 in 12,500, which is well within generally tolerable differential movement.

The results achieved in the GMA, adopting the C760 empirical assessment approach, are considered to represent an upper bound of theoretical movements, based on historical data. These movements should be reduced by adopting modern techniques, a suitable sequence of works, and a high stiffness propping system.

In general, ground movements can be minimised by careful design, sequencing and supervision of the works, ensuring that a high quality of workmanship is maintained.

ADDITIONAL CONSIDERATIONS

Heave

As outlined, an excavation of approximately 3.30m thickness of soil will generate a maximum unloading in the order of 65kN/m^2.

This will result in a measure of short term heave and long term swelling of the underlying London Clay, which theoretically takes a number of years to complete. The new basement slab will be designed to withstand the potential heave forces and movements. About 30 to 50% of soil heave pressure would normally be expected to occur prior to construction of the slab (for a normal construction programme). As such 50% to 70% of potential heave will remain after excavation. Groundwater level has been recorded at approximately 3.10m bgl. As such the water pressure would need to be considered in the slab design, in addition to the soil heave pressure.

The excavation depth and modest dimensions of the site are such that heave movement associated with unloading of the clay is unlikely to exceed a few millimetres or to have any significant impact on the surrounding structures. Any movement that does occur will be further mitigated by the necessarily slow rate of the excavation and construction.

Ground Movement & Construction

The predicted building damage during construction is based on a conservative approach and it is recommended that the contractor gives consideration to the Association of Specialist Underpinning Contractors (ASUC) guidelines which should provide some mitigation and reduce the potential movements.

Ground Movements Monitoring

It is recommended that movement monitoring should be undertaken with surveying points set up prior to commencement of the works and it is recommended that monitoring be undertaken at weekly intervals. It is recommended that trigger values for monitoring are based on the predicted ground movements to ensure conservatism and that they are agreed under the Party Wall Act.

REFERENCES & GUIDANCE

1. Environment Agency/Defra (2002). Model procedures for the Management of Land Contamination (CLR 11).
2. Environment Agency/Defra. Contaminated Land Statutory Guidance (April 2012).
3. BS 10175 (2011) Investigation of Potentially Contaminated Sites. Code of Practice.
4. BS5930 (2007) Code of Practice for Site Investigations.
5. BS 5667-11:2009. Water quality sampling. Part 11: Guidance on sampling of groundwaters.
6. BS 8002 (1994) Code of Practice for Earth Retaining Structures.
7. Tomlinson, M.J. (1986) Foundation Design and Construction.
8. Department of the Environment Industry Profiles.
9. Environment Agency/Defra (2002). Sampling strategies for contaminated land (CLR4)2
10. Environment Agency/Defra (2002). Priority Contaminants for the Assessment of Land (CLR8)3
11. CIRIA (2007). Assessing risks posed by hazardous ground gases to buildings.
12. BS 8485:2007. Code of Practice for the Characterisation and Remediation from Ground Gas in affected Development.
13. NHBC (2007). Guidance on the Evaluation of Development proposals on sites where Methane and Carbon dioxide are present.
14. CL:AIRE (December 2013). Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination.
15. CL:AIRE / CIEH (2008), Guidance on Comparing Soil Contamination Data with a Critical Concentration, May 2008;
16. CL:AIRE / EIC (2009), The Soil Generic Assessment Criteria for Human Health, December 2009.
17. Environment Agency (2003), Review of fate & transport of selected contaminants in the Environment, Report P5-079-TR1;
18. Environment Agency (2004), Model Procedures for the Management of Land Contamination, September 2004, ISBN: 1844322955;
19. Environment Agency (2008a), Compilation of Data for Priority Organic Pollutants, Report SC050021/SR7, November 2008;
20. Environment Agency (2009a), Human Health Toxicological Assessment of Contaminants in Soil, Report SC050021/SR2, January 2009;
21. Environment Agency (2009b), CLEA Software (Version 1.04) Handbook (and Software), Report SC050021/SR4, January 2009;
22. Environment Agency (2009c), Updated Technical Background to the CLEA Model, Report SC050021/SR3, January 2009;

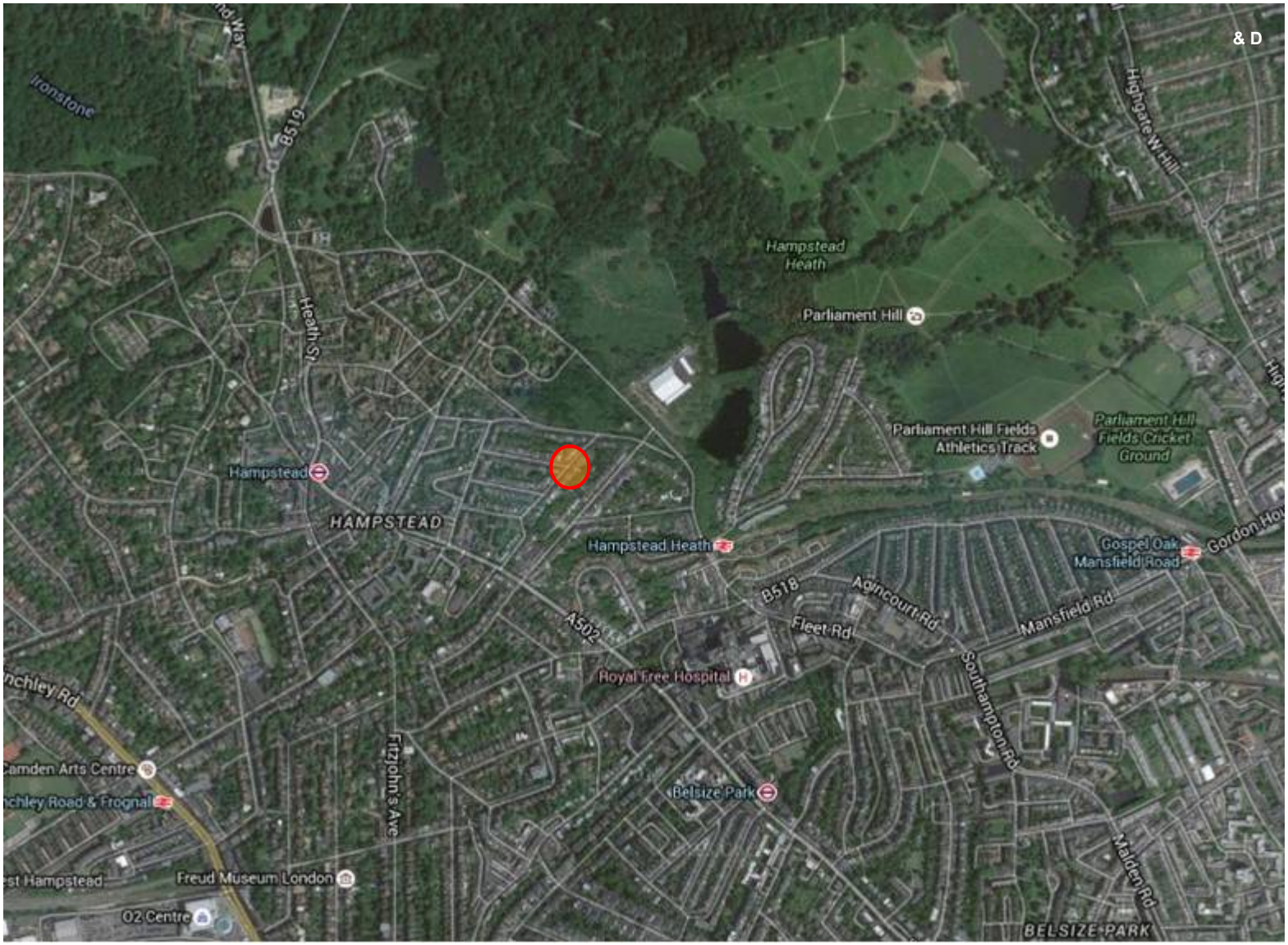
[2] This document has been withdrawn but is considered to remain useful in proving technical background for designing ground investigation works.

[3] This document has been withdrawn but is considered to remain useful in proving technical background for designing ground investigation works.

REFERENCES & GUIDANCE

23. Environment Agency (2009d), A Review of Body Weight and Height Data Used in the CLEA Model, Report SC050021/Final Technical Review 1, January 2009;
24. Nathanial et. al., (2009), The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition), Land Quality Press, Nottingham, ISBN 0-9547474-7-X
25. USEPA (2004), User's Guide for Evaluating Subsurface Vapour Intrusion into Buildings
26. Environment Agency (2013). Groundwater Protection: Principles and Practice (GP3)
27. Water Framework Directive (2000/60/EC)
28. Groundwater Regulations (2009).
29. Drinking Water Quality Standards England & Wales 2000 (Amended 2004, DWS).
30. World Health Organisation (WHO) Petroleum Products in Drinking Water.
31. Environmental Quality Standards (EQS). The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010.
32. Environment Agency (2006). Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination.
33. Environment Agency (2013). Technical Guidance WM2 (v3). Interpretation of the definition and classification of hazardous waste.
34. CIRIA C760 - Guidance on embedded retaining wall design, London 2017.
35. CIRIA R143 - The Standard Penetration Test (SPT): Methods and Use, London 1995.
36. Clough, G.W. and Davidson, R.R. Effects of construction on geotechnical performance. Proceedings of the 9th International Conference on Soil Mechanics. Tokyo, Specialty Session, p. 3, 1977.
37. Clough, G.W. et al. Movement control of excavation support systems by iterative design procedure. ASCE Foundation Engineering: current principles and practices. Vol 1, pp. 869-884, 1989.

FIGURES



Key:

Approximate site location.

IMPORTANT – Please Read

This drawing is for illustrative purposes only and is for use only in conjunction with associated reports relating to the project details below. LMB accepts no liability for the mis-interpretation or use of this illustration by any other parties.

LMB

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

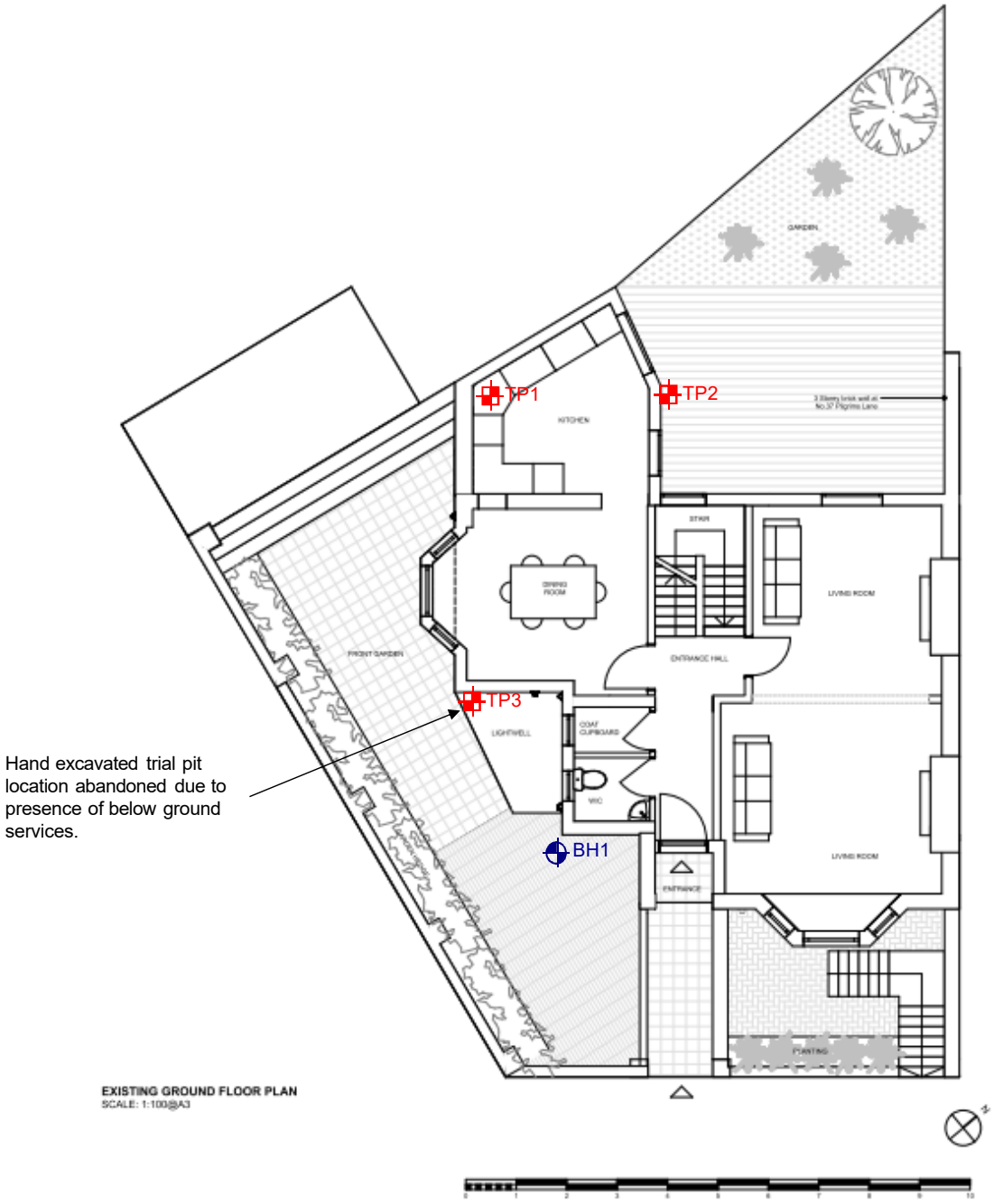
Site: 35 Pilgrims Lane, London NW3

Figure Number: Figure 1

Title: Site Location Plan

Project No:	Created By:	Date:
	PIL	Dec 2017

Client: Nori Bali



Key:

BH — Borehole location.

TP — Hand excavated trial pit location.

IMPORTANT – Please Read

This drawing is for illustrative purposes only and is for use only in conjunction with associated reports relating to the project details below. LMB accepts no liability for the mis-interpretation or use of this illustration by any other parties.

LMB

Ground Investigation
Land Contamination
Hydrogeology
Engineering Geology

Site: 35 Pilgrims Lane, London NW3

Figure Number: Figure 1

Title: Site Location Plan

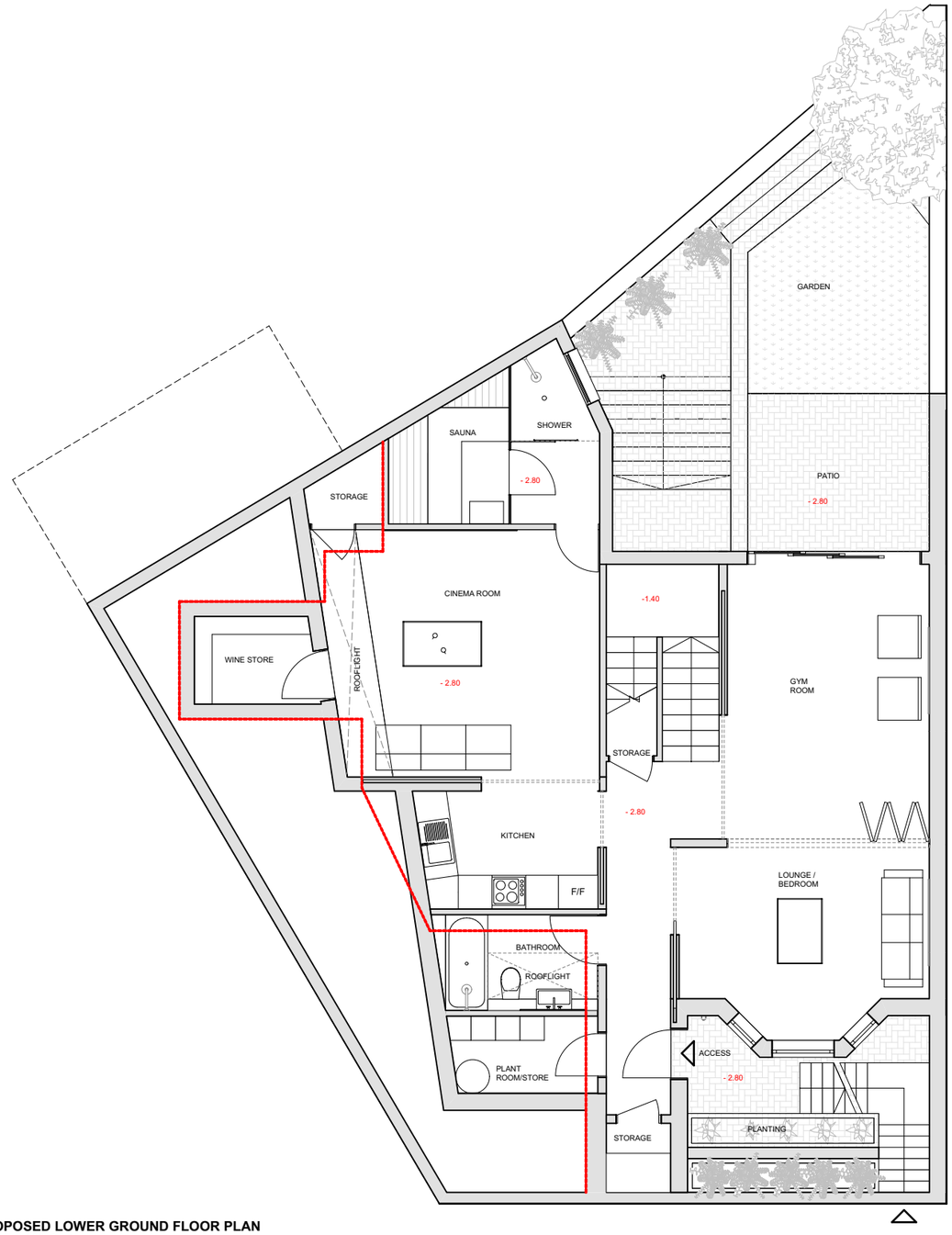
Project No:	Created By:	Date:
	PIL	Dec 2017

Client: Nori Bali

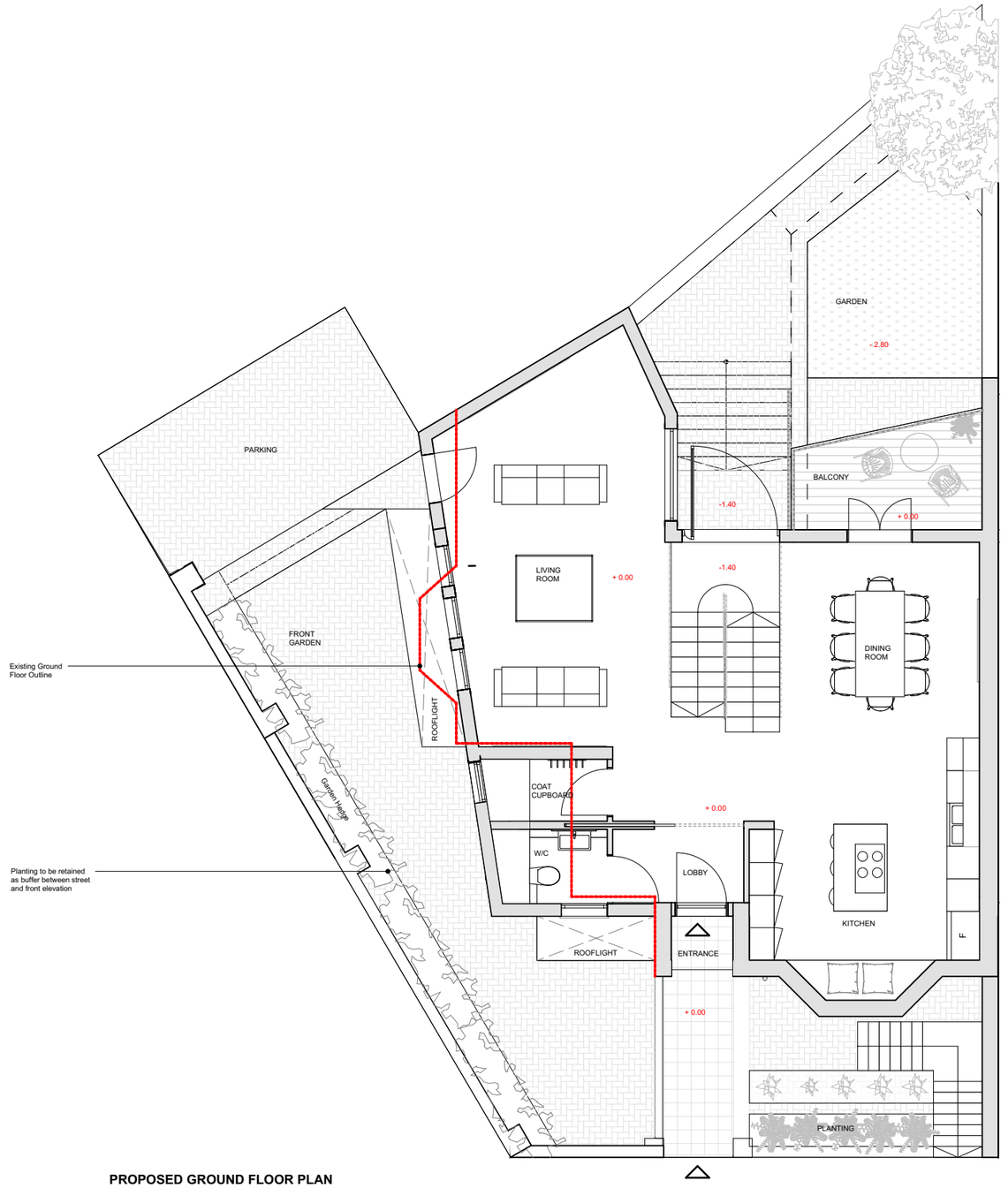
APPENDICES

Appendices

APPENDIX A DEVELOPMENT SCHEMATIC



PROPOSED LOWER GROUND FLOOR PLAN
SCALE 1:100 @A3



PROPOSED GROUND FLOOR PLAN
SCALE 1:100 @A3

N

0 1 2 3 4 5 6 7 8 9 10

Rev:	Date:	Description:	By:	Chkd:

Rev:	Date:	Description:	By:	Chkd:

Project:
Pilgrims Lane, London, NW3 1SS

Project Number:
215

Date:
19/02/2018

Scale:
1:100 @A3

Drawn By:
AS

Checked By:
TW

Drawing Number:
P07

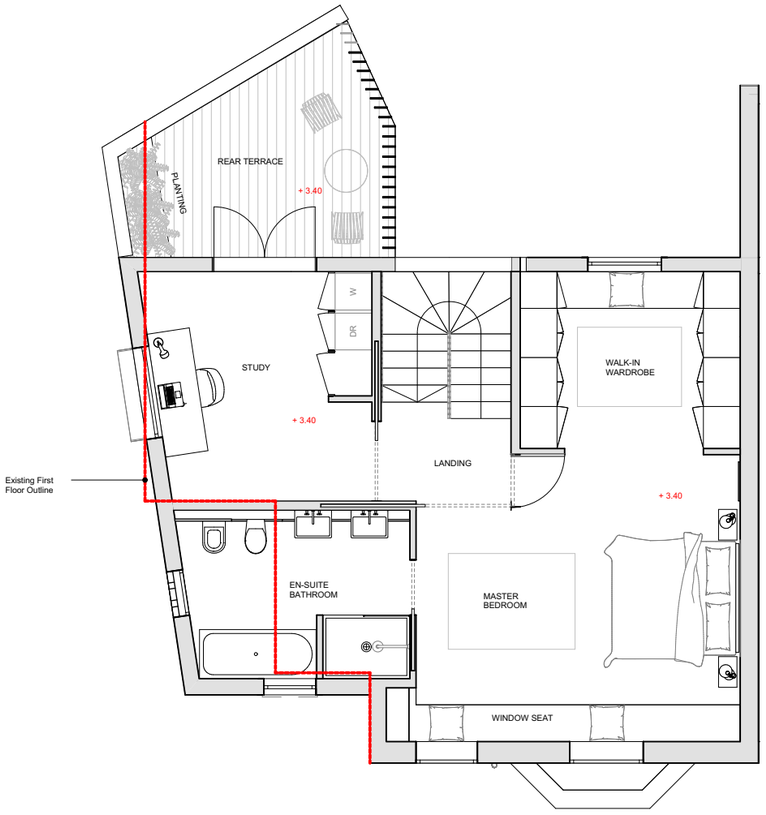
Drawing Status:
Planning

Revision:
0301

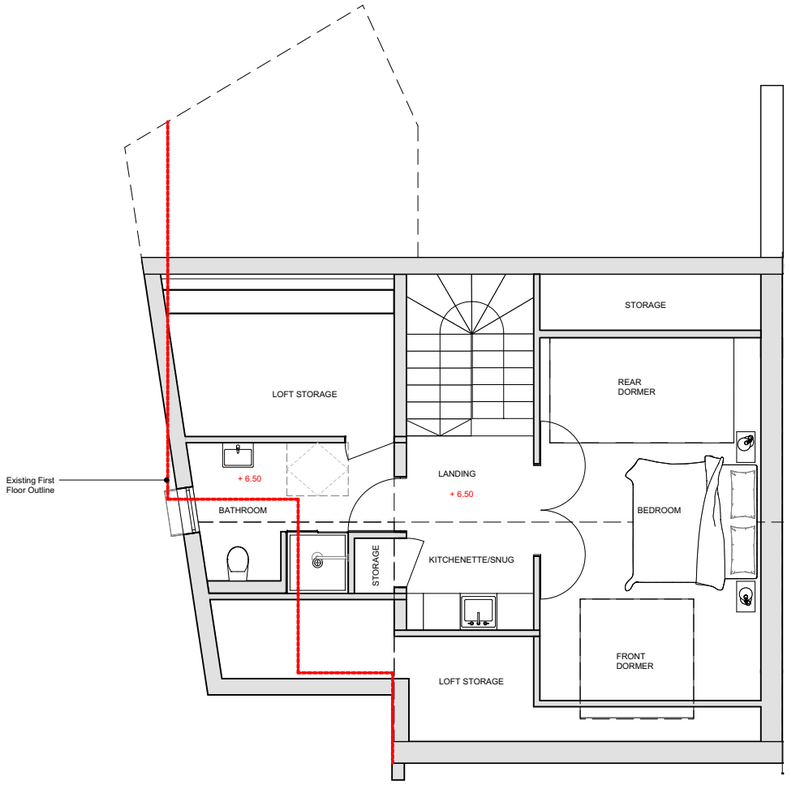
Title:
Proposed Plans

11 Waterloo Court, 10 Theed Street, London SE1 8ST
+44 (0)20 7928 2092 / info@alma-nac.com

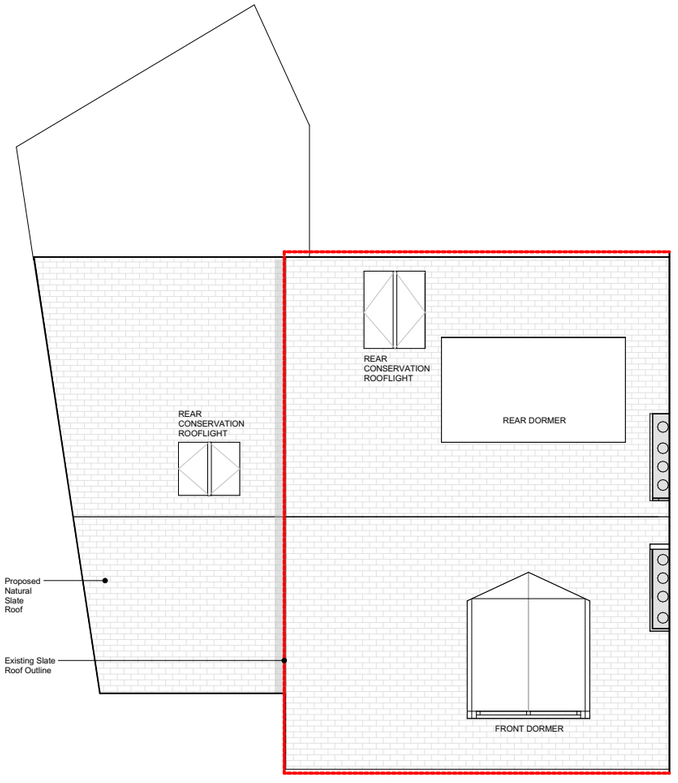
alma-nac



PROPOSED FIRST FLOOR PLAN
SCALE 1:100 @A3



PROPOSED SECOND FLOOR PLAN
SCALE 1:100 @A3



PROPOSED ROOF PLAN
SCALE 1:100 @A3

Rev:	Date:	Description:	By:	Chkd:

Rev:	Date:	Description:	By:	Chkd:

Project:
Pilgrims Lane, London, NW3 1SS

Project Number:
215

Date:
19/02/2018

Scale:
1:100 @A3

Drawn By:
AS

Checked By:
TW

Drawing Number:
P08

Drawing Status:
Planning

Revision:
0301

Title:
Proposed Plans

11 Waterloo Court, 10 Theed Street, London SE1 8ST
+44 (0)20 7928 2092 / info@alma–nac.com

alma–nac