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Knapp Hicks & Partners Ltd
Incorporated in England
No. 2886020

Registered office:
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32655/L/003G/RJM/rjm

2nd October 2015

Seonaid Carr
Principal Planning Officer
Regeneration and Planning
London Borough of Camden
Town Hall
Argyle Street
London WC1H 8ND

BY E-MAIL AND POST

Dear Seonaid,

BASEMENT IMPACT ASSESSMENT – ADDENDUM
13 FERNCROFT AVENUE, NW3 7PG

Introduction

Further to the Audit undertaken by LBH Wembley of our Basement Impact Assessment (BIA), Letter Reference LBH4324, dated March 2015, and subsequent correspondence and telephone conversations, we are pleased to submit this Addendum to the BIA which, along with the attached appendices, addresses the points raised by the audit.

To assist with your review, we have adopted the same numbering system as the LBH letter and have highlighted LBH's comments in bold italics.

Details of the proposed construction methodology and sequence are provided in the following additional documents which are attached with this Addendum:

- Supplementary Site Investigation Records, Knapp Hicks & Partners Ltd
- Preliminary Structural Drawings (32655T/01-04), Knapp Hicks & Partners Ltd
- Hydrogeological Desk Study, 13 Ferncroft Avenue, Hampstead, by Gabriel Geoconsulting Ltd, Ref 16467/R2.1, dated September 2015
- Ground Movement Assessment for Basement, by Gabriel GeoConsulting Ltd, Ref 16457/R1, dated July 2015
- Arboricultural and Planning Integration Report: 13 Ferncroft Avenue, by GHA Trees, Ref GHA/DS/17760:15, dated 11th May 2015

A copy of the LBH Wembley Review document is also attached for reference.

LBH:Item 1 - Introduction & LBH:Item 2 - Policy DP27

No further comment required

LBH:Item 3 - Assessment of Adequacy of Information Provided

3.1 Basement Impact Assessment Stages

This summarises the original BIA findings in relation to CPG4 and DP27. No further comment required.

3.2 LBH: The Audit Process

3.2.1 Qualifications / Credentials of authors

Original BIA met requirements.

In addition, please note that 2 of the attachments provided with this report (Hydrogeology Report and Ground Movement Assessment Report) have been prepared by Keith Gabriel of Gabriel Geo Consulting, who is a Chartered Geologist and UK Registered Ground Engineering Advisor, with experience of preparation of basement assessments for several London Boroughs including Camden.

We can also confirm that the attached structural engineering drawings have been prepared by Sean Fitzpatrick, who is a chartered structural engineer, BSc, CEng, MIStructE. Sean also has several years of experience including design of basements in London Boroughs.

This Addendum has been reviewed by our Managing Director, Geoff Davies who is a past Chairman of the National Subsidence Forum sponsored by the BRE Trust and who has more than 30 years experience including underpinning, basement construction etc.

3.2.2 BIA Scope

The BIA review requested clarification of tree protection zones and what impact the development would have upon them.

To address this query, an arboriculture survey was carried out and the findings are reported in the attached report by GHA Trees. The report includes detailed guidance and recommendations on how all tree protection related matters may be dealt with and has concluded as follows:

"In conclusion, the principal arboriculture features within the site can be retained and adequately protected during development activities."

"Subject to precautionary measures as detailed above (provided in the report), the proposal will not be injurious to trees to be retained."

"There will be no appreciable post development pressure, and certainly none that would oblige the council to give consent to inappropriate tree works."

3.2.3 Description of Works

The BIA review has requested that a specific construction methodology be developed.

We refer you to the attached preliminary structural engineering drawings, Ref 32655T-01 to 04, dated 29/9/2015. In particular Drawing 32655T-01 which includes Basement and Ground Floor Plans showing the proposed foundation arrangements, and detailed notes which cross-reference to the BIA and related specialist reports, and provide a sequence of works. These drawings are preliminary only and are not intended for construction purposes.

The proposed method of construction is underpinning with underpinning blocks to be constructed in a 'hit-and-miss' sequence which is indicated and described in the drawings.

Further detailed structural design will follow upon grant of Planning Permission and will address any specific requirements identified by Planning.

3.2.4 Investigation of Issues

The BIA review identified that a specific ground movement and damage assessment had not been undertaken.

We refer you to the attached 'Ground Movement Assessment for Basement Report' prepared by Gabriel Geo Consulting. This assessment was based upon the methods of construction described on the attached structural drawings and a schedule of loadings at proposed basement level prepared by the Structural Engineer.

Data has been presented as contoured plots of vertical displacements and is also tabulated with accompanying text.

Requirements to minimise ground movements are reviewed.

A Damage category is provided for representative locations using typical displacements alongside underpins and reinforced concrete retaining walls. The report concluded that the worst case damage classification along the boundary would classify as Burland Categories 1 and 2, i.e. very slight to slight, which according to CPG4 Clause 2.30 is acceptable.

The attached structural drawings (Appendix B), Basement Construction Plan (Appendix E) and the Construction Management Plan (Appendix F) describe the proposed construction methods and sequence and we would conclude that the assessment of ground stability is now more robust and we trust this will be acceptable.

3.2.5 Mapping Detail

Original BIA met requirements.

3.2.6 Assessment Methodology

The BIA review identified that a specific ground movement and damage assessment had not been undertaken.

Please refer to 3.2.4 above. In addition, the original BIA is supplemented by further monitoring; a hydrogeology study; structural loadings including a construction sequence. Each of these documents provide advice and guidance for mitigation measures to address the potential impacts identified.

Furthermore, in addition to the above, we have consulted with 2 specialist dewatering contractors, 1 grouting contractor and a basement contractor with in-house dewatering expertise.

3.2.7 Mitigation

The BIA review concluded that the original BIA included recommendations for mitigation measures, but a specific method statement and mitigation has not yet been developed.

Based on this Addendum and the associated attachments, we trust that it is clear that detailed consideration has been given to the Construction Methodology. Mitigation measures are proposed which will ensure that

the construction method is site specific, and appropriate measures will be in place to identify and minimise the effects of all potential impacts on the built environment in the vicinity of the development.

We propose that such mitigating measures may be formally confirmed in a Basement Construction Plan secured by a Section 106 Agreement, which can incorporate any particular requirements of the Party Wall Agreements, and be revised following excavation and observation of the first 3No underpinning blocks.

3.2.8 Monitoring

The BIA review confirmed that the need for structural monitoring has been identified but a detailed scheme has not yet been developed.

Condition surveys should be carried out and agreed with the owners of 11 and 15 Ferncroft Avenue, the public footpath and road prior to any works commencing. The surveys should be in accordance with any Party Wall Awards or agreements and incorporate detailed monitoring regimes of the existing structures, with predetermined allowable movements and written action plans to be implemented in the event that these movements are exceeded.

The excavation methodology will be closely monitored during excavation and filling of the first 3 underpinning blocks in order that the excavation method and most appropriate method of control and dewatering of any water ingress may be refined to suit the site-specific conditions. The excavation and construction of the initial sections of walls will be observed by a geotechnical specialist to assess the stability, soil and groundwater conditions to assess and review the width of the wall sections, with particular attention paid to the wall sections which penetrate the water table. This is clearly identified as a preliminary requirement and is cross-referenced throughout all of the drawings and supporting documents.

The detailed structural monitoring schedule has not been prepared at this stage but it is anticipated this will be also incorporate visual surveys by an appropriately qualified temporary works foreman at the beginning and end of each shift. Visual surveys will include checks that sides of excavations are stable, all shoring and other temporary support is secure, and no structural damage such as cracking is occurring to the Party Wall This will be complemented by structural monitoring across existing cracks with digital callipers. The detail of the monitoring shall be incorporated in the Basement Construction Plan.

Should cracking to the party wall be noted, this is to be reported without delay to the Construction Manager, who should inspect the damage and report to Engineer as appropriate and take appropriate action, including installing temporary works to ensure the party wall is structurally stable.

Digital monitoring or precise levelling, which is triggered if movement gets to a pre-agreed trigger level could be employed, if deemed to be necessary, at key points along the party wall with No15 as this is deemed to be the most critical section of the construction sequence.

3.2.9 Residual Impacts after Mitigation

The BIA Review stated that the scheme had not been developed to a state where any residual impacts can be fully identified.

Knapp Hicks consider that the documents provided with this Addendum have developed the scheme sufficiently that the main technical impacts of the proposed structure have been adequately identified. Appropriate mitigation measures to minimise those impacts have been described and proposed. We propose that these are finalised in a Basement Construction Plan.

We acknowledge that there are other potential impacts associated with the construction such as noise, dust and traffic congestion. We propose that these are addressed by a Construction Management Plan to accompany the Basement Construction Plan.

4. LBH:Assessment of Acceptability of Residual Impacts

4.1 Proposed Construction Methodology

The BIA Review acknowledged that the BIA included recommendations for various mitigation measures but stated that the specific scheme had not been developed.

A preliminary scheme has now been developed on the attached structural drawings and in the specialist Hydrogeology and Ground Movement Assessment Reports. Mitigation measures are proposed to ensure identified groundwater flow and stability impacts are minimised.

4.2 Soundness of evidence

The BIA Review stated the evidence appeared sound.

We trust that the additional information provided with the Addendum enhances this.

4.3 Reasonableness of Assessments

The BIA review identified that a specific ground movement and damage assessment had not been undertaken.

We refer you to the attached 'Ground Movement Assessment for Basement Report' prepared by Gabriel Geo Consulting. Please also refer to 3.2.4 and 3.2.6.

4.4 Robustness of Conclusions and Proposed Mitigation Measures

The BIA Review advised that this could not be judged as the construction methodology had not been sufficiently developed.

We trust that the attached assessments, structural details and supporting information are now sufficiently robust.

5 LBH:Conclusions

The BIA Review states that in the absence of a specific methodology and sequence, that further information is required in respect of the following:

a. Structural stability of the building and neighbouring properties

This is addressed in the attached Ground Movement Assessment and Structural Drawings.

b. Avoiding adverse impact on drainage/run-off or causing other damage to the water environment

The proposed methodology makes no change to the original assessment on Surface Water Flow which identified no causes for concern. Methods of dealing with ground and surface flow during construction will be confirmed in the Basement Construction Plan and approved before construction commences.

c. Avoid cumulative impacts on structural stability or the water environment

We propose that the attached reports, when read in conjunction with the findings of the original site investigations, and taking account of the various mitigation proposals described and stipulated within those reports, will ensure that cumulative impacts will be avoided

5.1 Further Information Required

The BIA Review identified the following further information required to fulfil the requirements of DP27 but advised that these items could be approved either as a condition by planning approval or by a Basement Construction Plan secured by Section 106 agreement.

Knapp Hicks are in agreement with this proposal and a Basement Construction Plan can be prepared when party wall surveyors and a contractor have been appointed.

- ***Condition Surveys of 11 and 15 Ferncroft Avenue***

Refer to Point 3.2.8 above. Condition surveys should be carried out and agreed with the owners to 11 and 15 Ferncroft Avenue, and the public footpath prior to any works commencing. The surveys should be in accordance with any Party Wall Awards or agreements and incorporate detailed monitoring regimes of the existing structures with predetermined allowable movements and written action plans to be implemented in the event that these movements are exceeded.

- ***Trial Pits to confirm details of the foundations to 11 and 15 Ferncroft Avenue***

Further investigations have been undertaken to confirm the detail of the undercroft below No15 and the existing supporting party wall.

The foundations of No15 are expected to be similar to No13 and were confirmed in Trial Pit TP1 at the front of No13 in the original BIA.

Conservative assumptions have been made for the foundations at No11 based upon a site visit and measurements taken by the architect Jim Biek.

The Ground Movement Assessment adopted conservative assumptions in this regard.

- ***Scheme of groundwater investigation and monitoring, including trial excavations to proposed formation level, to inform selection of appropriate groundwater control measures***

Following further monitoring, Rising Head tests were undertaken in the existing boreholes and have informed the proposed methodology.

The first 3No underpinning blocks will be used to confirm an appropriate formation level for underpinning and will inform the selection of appropriate groundwater control measures. Each pit will be infilled with concrete which will become part of the temporary and permanent works.

The excavation and construction of the initial sections of walls will be observed by a geotechnical specialist to assess the stability, soil and groundwater conditions to assess and review the width of the wall sections, with particular attention paid to the wall sections which penetrate the water table. This is clearly identified as a preliminary requirement and is cross-referenced throughout all of the drawings and supporting documents.

- ***Definitive temporary works design and sequence***

This may be based upon the methodology outlined in this report, with site-specific amendments to be agreed and approved following excavation and observation of the first 2-3 underpinning blocks.

- ***Specific ground movement and damage category assessment***

This has been carried out based on a hit-and-miss underpinning methodology and is attached with this report.

- ***Detailed monitoring and contingency plan***

This has been discussed in Section 3.2.8 above and will be included in the Basement Construction Plan and in the Contractors site specific Method Statements and Construction Management Plan.

- ***Appoint a suitably qualified engineer to take responsibility for the design of the temporary works***

A temporary works designer will be appointed by the successful contractor, and their recommendations will be incorporated in the Basement Construction Plan.

32655G/L/003A/RJM
2nd October 2015

SUMMARY:

We have noted the comments made by LBH Wembley in their BIA Audit document, and we confirm that we have undertaken the necessary supplementary investigations and assessments to complete the data set required to assess the impacts of this proposed basement.

Sufficient information has been provided to ensure that following the appointment of a Main Contractor and completion of condition surveys of the neighbouring properties and appropriate Party Wall agreements, a Construction Management Plan and Basement Construction Plan may be completed which describe the proposed construction sequence and method, and address requirements in respect of access and consideration of vehicle movement, safety issues etc.

We are confident that these supplementary measures satisfactorily conclude the Basement Impact Assessment process in accordance with LB Camden Planning Guidance and that the various assessments have demonstrated that the proposed scheme may be constructed, in accordance with the guidelines and recommendations provided, by a competent and experienced contractor with minimal impact to neighbouring property and the environment.

We trust that this addendum will provide the necessary information to conclude the BIA and we look forward to receiving your response in due course.

Yours Sincerely,
For and on behalf of Knapp Hicks & Partners Ltd

Richard Moore

cc Felicia Epstein, 13 Ferncroft Avenue
Jim Biek, BArchitecture
Sean Fitzpatrick, Knapp Hicks & Partners Ltd

APPENDICES

A. Supplementary Site Investigation Records, Knapp Hicks & Partners Ltd and Bchitecture Ltd

B. Preliminary Structural Drawings (32655T/01-04), Knapp Hicks & Partners

C. Hydrogeological Desk Study, 13 Ferncroft Avenue, Hampstead, by Gabriel Geoconsulting Ltd, Ref 16467/R2.1, dated September 2015

D Ground Movement Assessment for Basement, by Gabriel GeoConsulting Ltd, Ref 16457/R1, dated July 2015

E Arboricultural and Planning Integration Report: 13 Ferncroft Avenue, by GHA Trees, Ref GHA/DS/17760:15, dated 11th May 2015

F Independent Review of Basement Impact Assessment for Planning application 2014/7674/P, prepared by LBH Wembley, Reference LBH4324, dated March 2015.

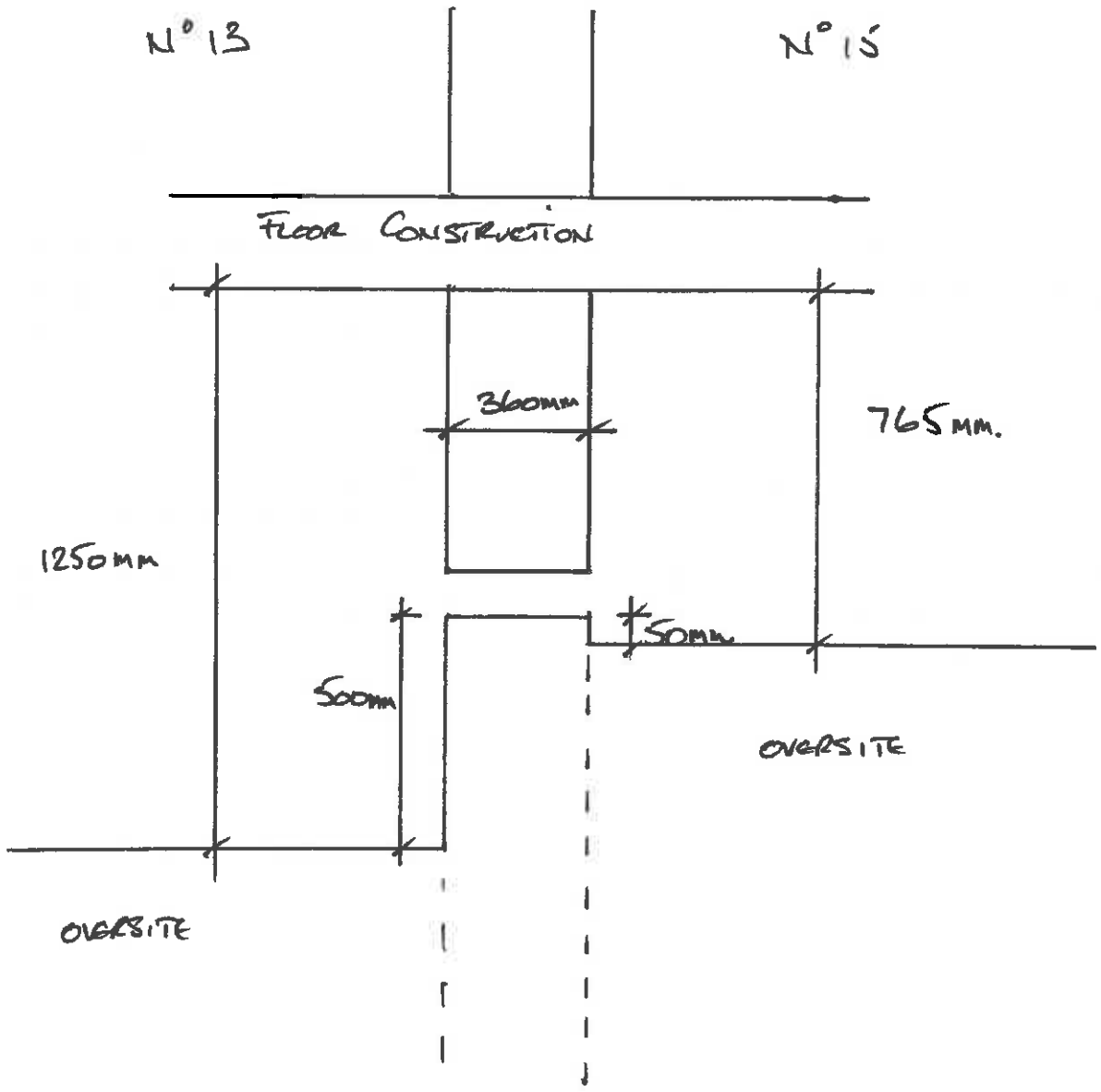
32655G/L/003A/RJM
2nd October 2015

A. Supplementary Site Investigation Records, Knapp Hicks & Partners Ltd and Bchitecture Ltd

COMPLIANCE DRILLING SERVICES

76 Sedgewick Avenue
Hillingdon Middlesex UB10 9DG
Tel / Fax: 01895 904806 Mobile: 07808 295526

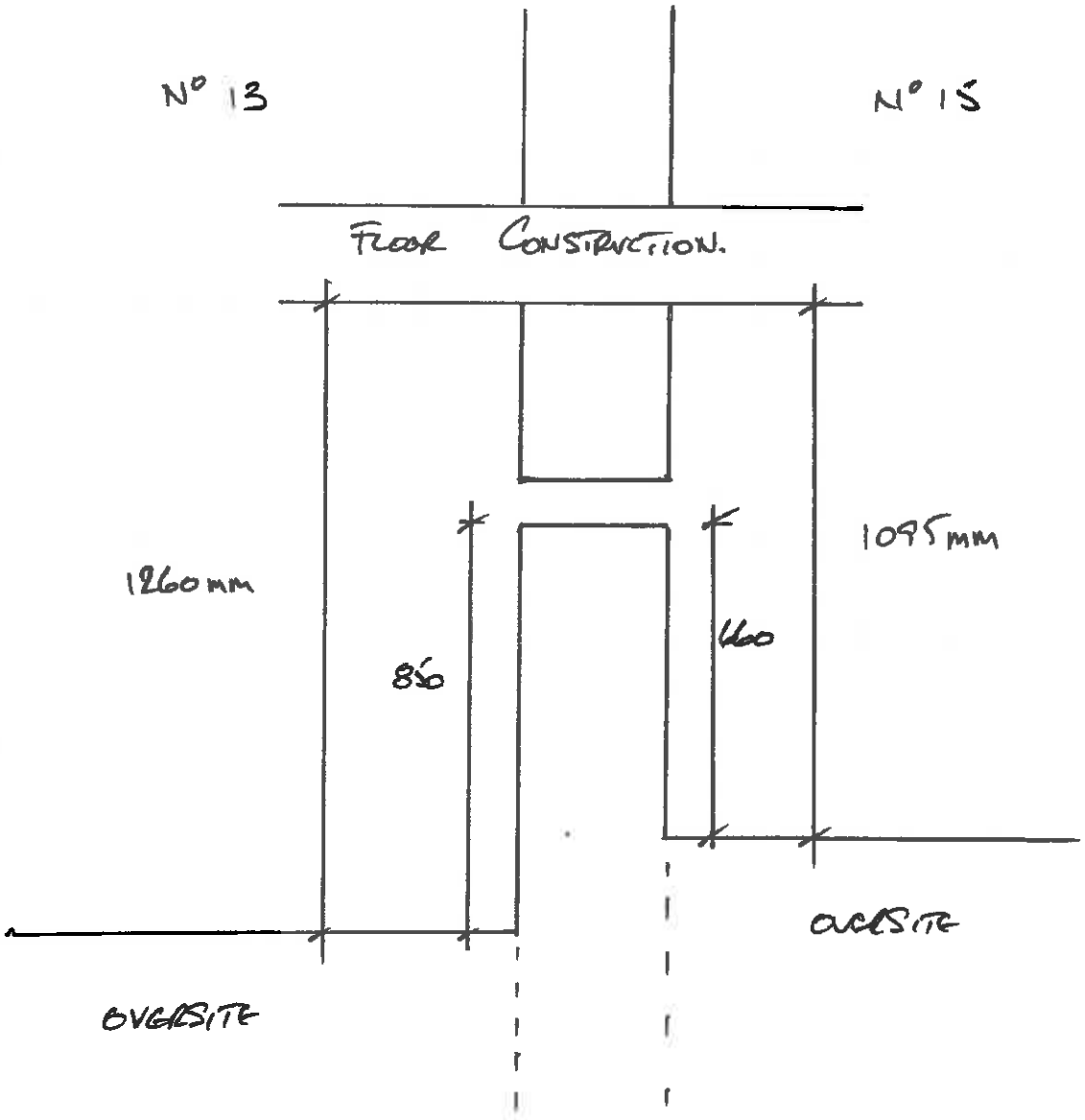
CLIENT KHP	PROJECT 13 FORNCROFT AVENUE NW3		LOCATION CORE A
DATE 08.05.2015	JOB REF TBC	TECHNICIAN LS	SHEET No. 1



COMPLIANCE DRILLING SERVICES

76 Sedgewick Avenue
Hillingdon Middlesex UB10 9DG
Tel / Fax: 01895 904806 Mobile: 07808 295526

CLIENT KHP	PROJECT 13 FERNCROFT AVENUE NW3		LOCATION CORE B
DATE 08.05.2015	JOB REF TBC	TECHNICIAN AS	SHEET No. 2



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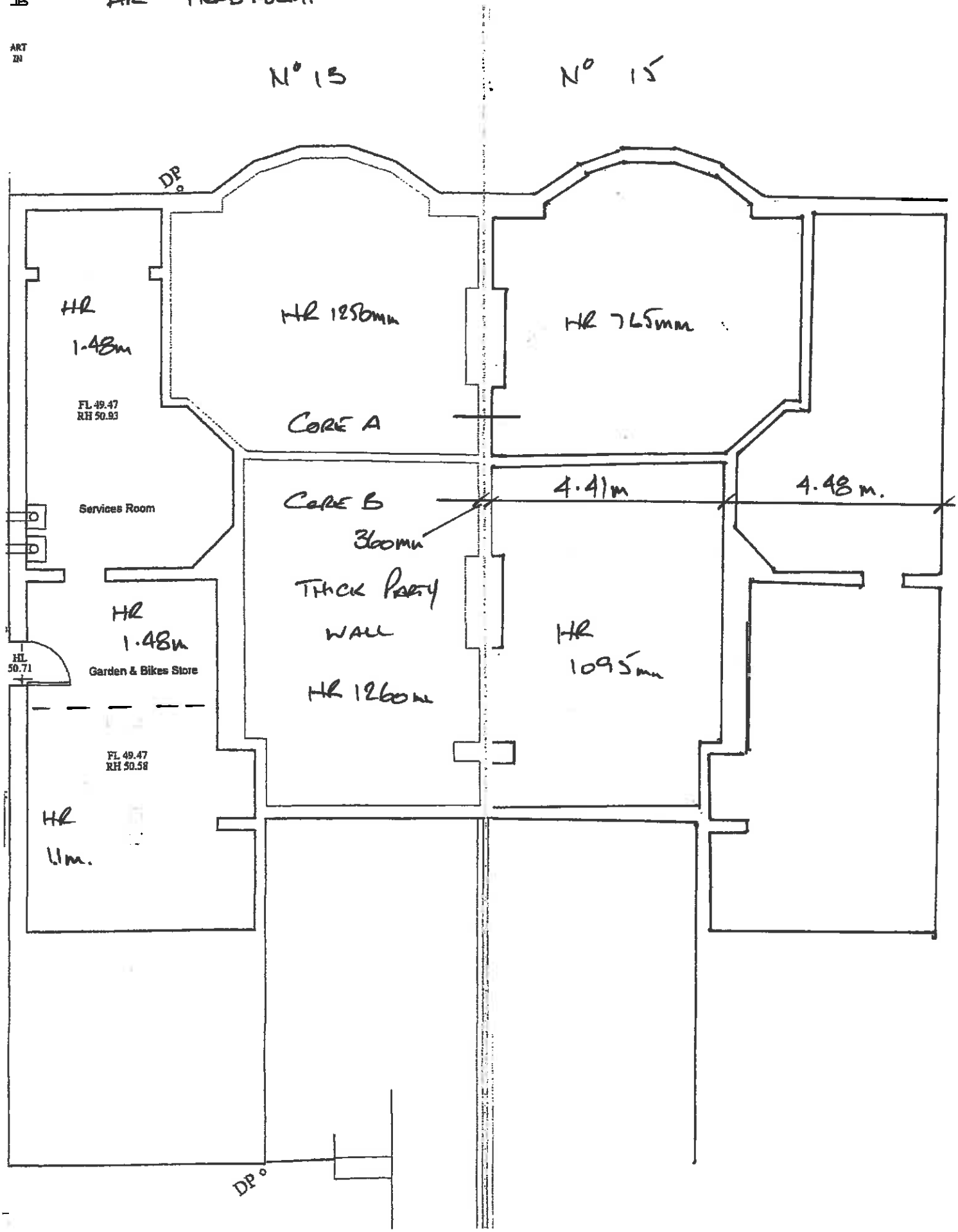
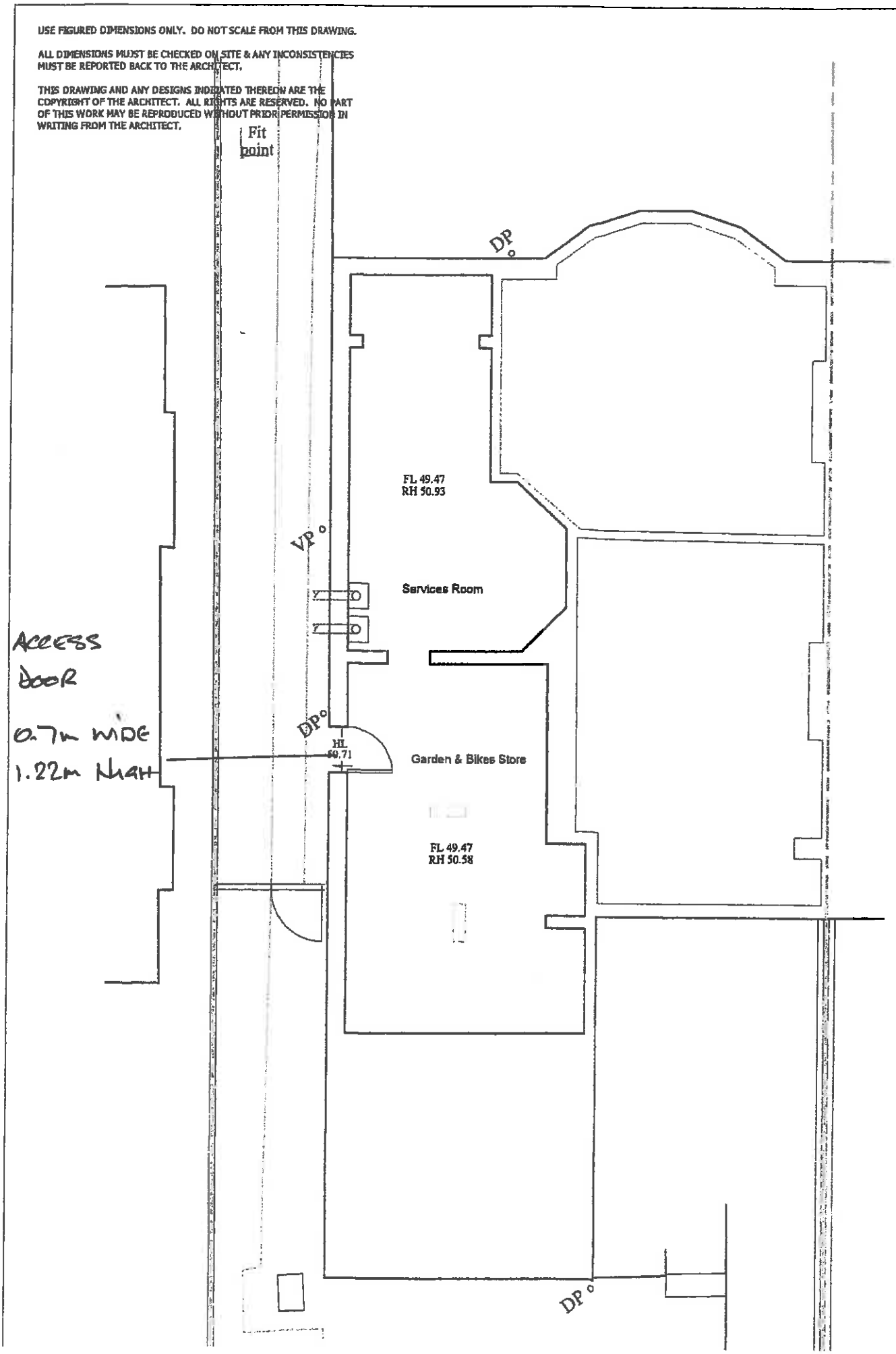
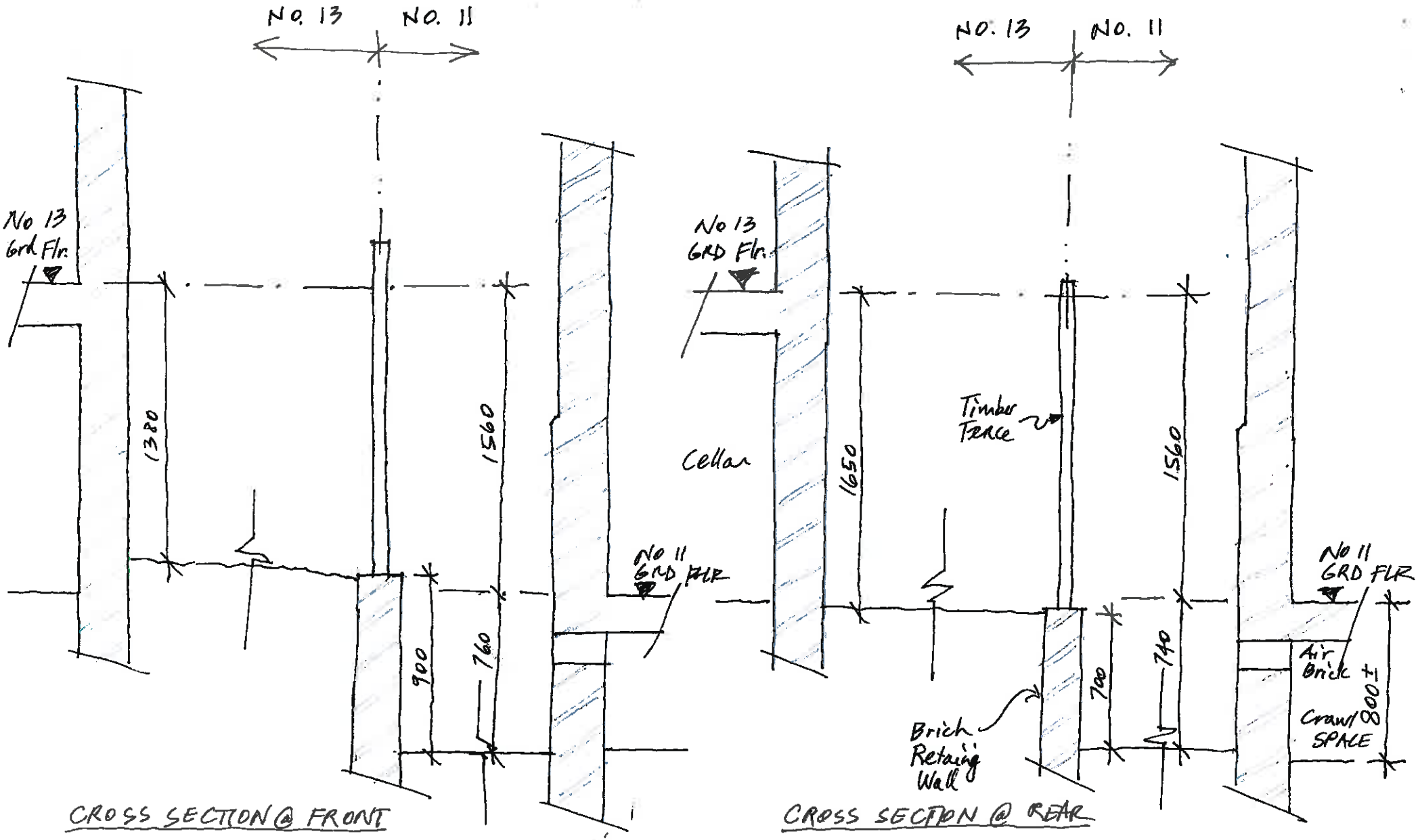
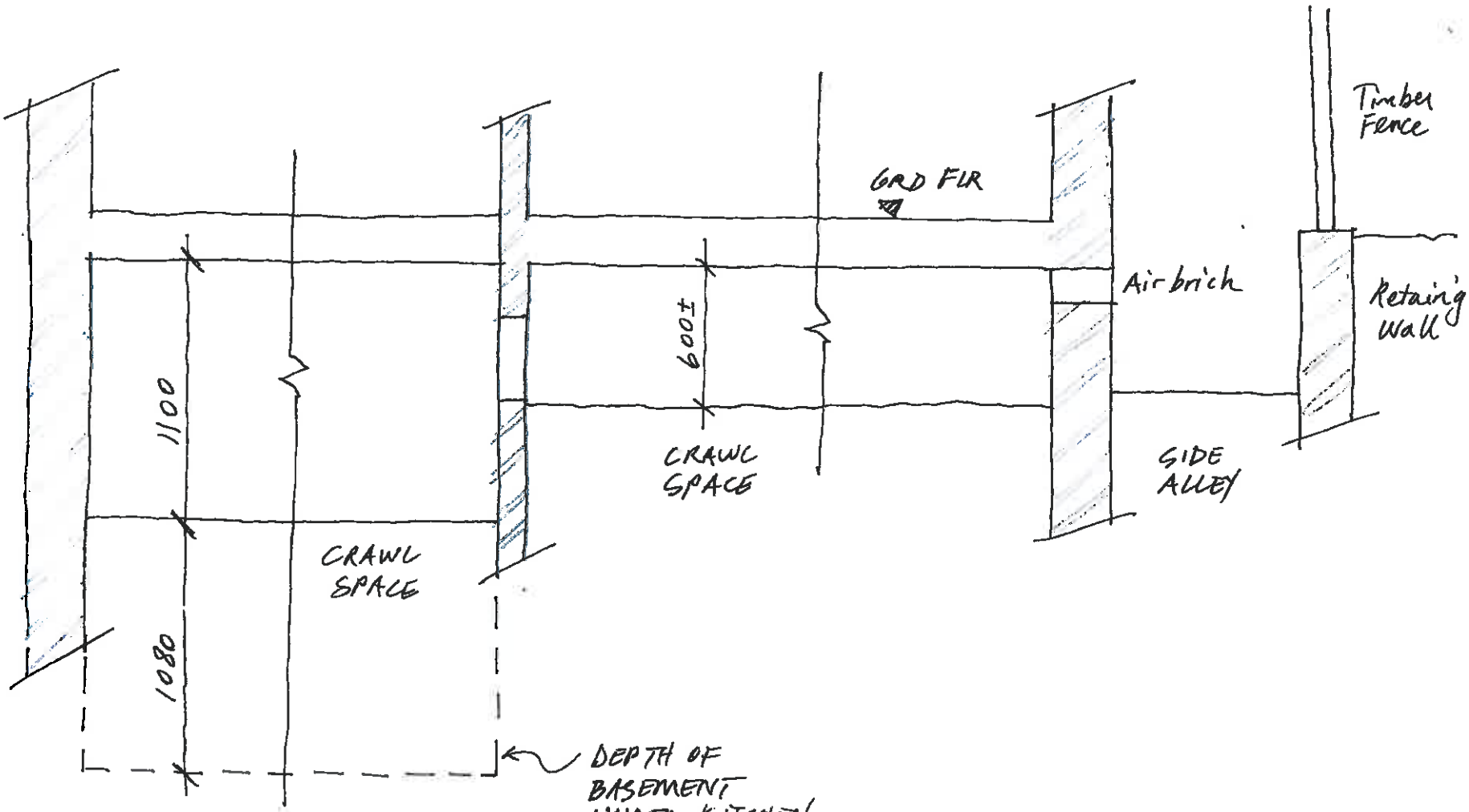






	LOCATION	TITLE	SCALE	DATE	NO
Bob lecture	13 FERNCROFT AVE NW3	BOUNDARY CROSS SECTIONS	1:25 @ A4	8/5/15	SK11

No. 11 FERNCROFT AVE



CROSS SECTION THROUGH HOUSE

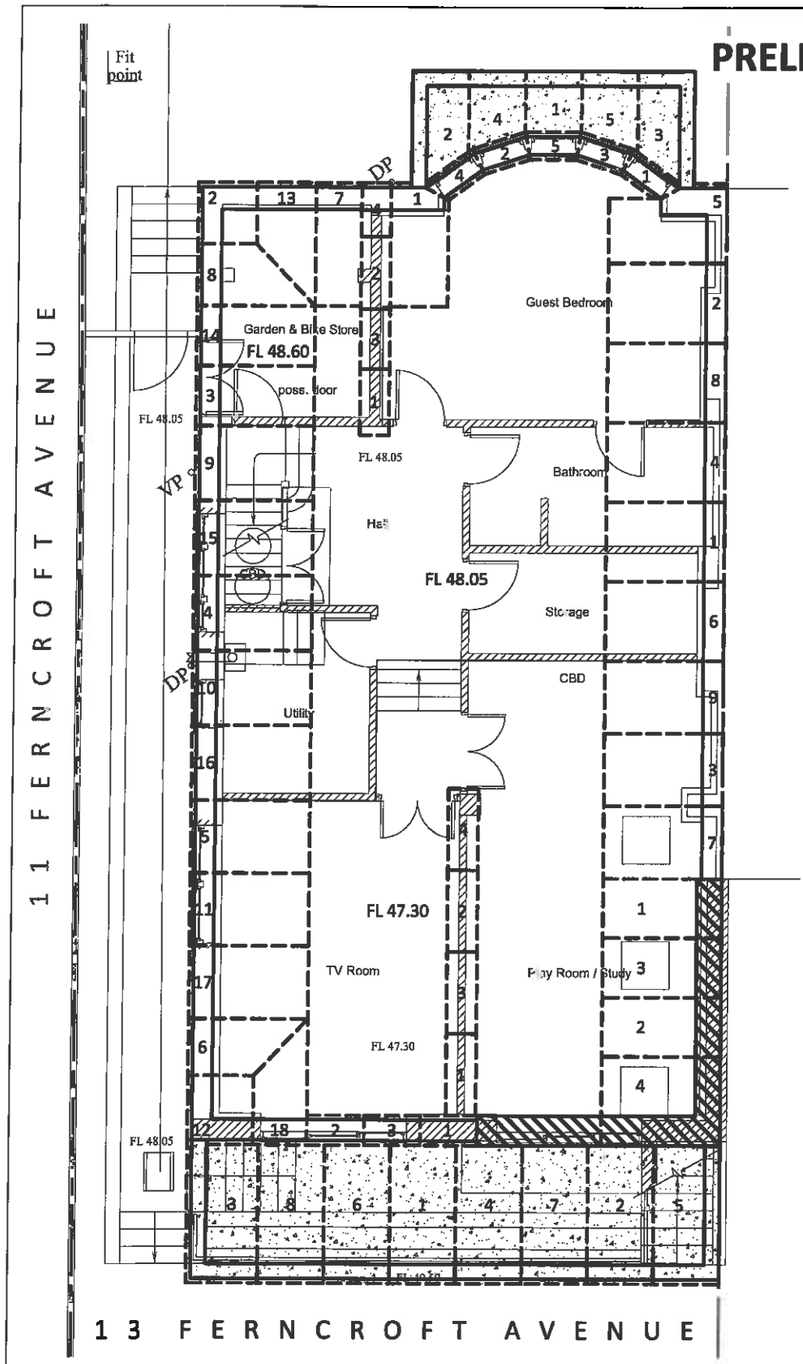
	LOCATION	TITLE	SCALE	DATE	NO
Boh	11 FERNCROFT AVE NW3	CROSS SECTION	1:25 @ A4	8/4/15	SK12

Borehole	Ground Level metres above site datum (mASD)	Depth of standpipe (mbgl)	Groundwater Level mbgl (mASD)			
			29/9/2014	21/11/2014	5/12/2014	29/4/2015
WS1 (Back)	49.34mASD	2.93m	2.40m (46.94mASD)	1.95m (47.39mASD)	2.02m (47.32mASD)	2.24m (47.10mASD)
WS2 (Front)	50.17mASD	3.34m	3.26m (46.57mASD)	2.97m (47.20mASD)	3.005m (47.165mASD)	3.18m (46.99mASD)

Rising Head Test Results Undertaken 29.4.2015 (Refer to above table for pre-test standing water levels)				
WS1 (Back)				WS2 (Front)
t	Dw (mbgl)	t	Dw (mbgl)	No results, unable to reduce water level as only 160mm above base of standpipe.
00:00:18	2.59	00:00:20	2.52	
00:00:56	2.57	00:00:30	2.505	
00:02:40	2.555	00:01:00	2.495	
00:04:15	2.535	00:02:00	2.48	
00:08:30	2.496	00:03:13	2.46	
01:32:00	2.265	00:07:12	2.42	
01:42:00	2.26	00:10:30	2.393	
		00:16:00	2.37	
		00:20:00	2.352	
		00:30:00	2.325	
		00:40:00	2.31	

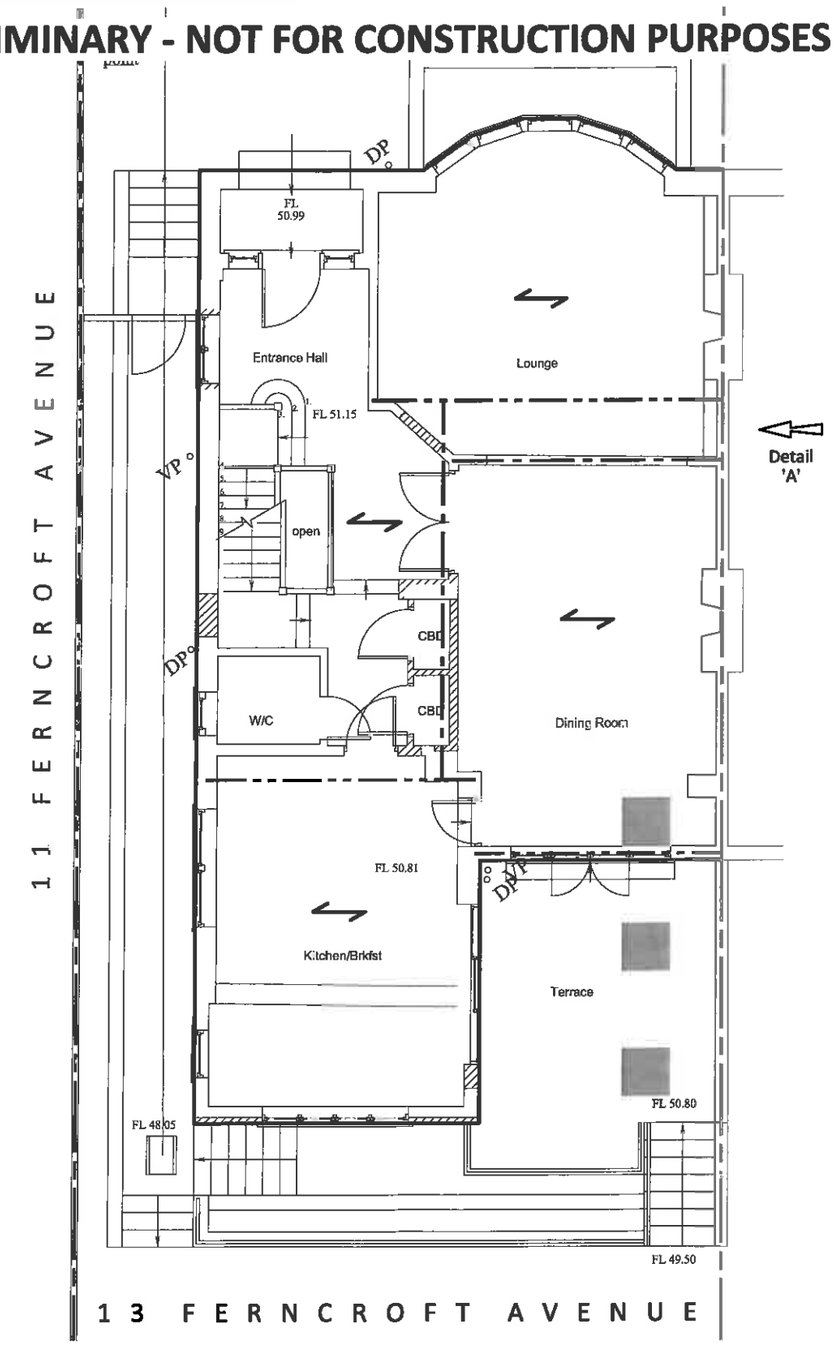
B. Preliminary Structural Drawings (32655T/01-04), **Knapp Hicks & Partners**

PRELIMINARY - NOT FOR CONSTRUCTION PURPOSES



Basement Plan Showing Proposed Foundation Arrangement

Scale 1:100 @ A3



Ground Floor Plan Showing Supporting Steelwork

Scale 1:100 @ A3

1) General

A) Knapp Hicks & Partners drawings are not to be scaled to obtain dimensions.
B) All setting out information and levels are to be confirmed by Architect.
C) Knapp Hicks & Partners Ltd. drawing no.'s 32655T-01 to 04 incl. are to be read in conjunction with the following documents:
BASEMENT IMPACT ASSESSMENT - and all associated documents, with particular reference to the site investigation and monitoring records
HYDROGEOLOGICAL DESK STUDY - Particularly with reference to Items 5.3.2 & 5.3.5 - Groundwater Control - Temporary Works.
GROUND MOVEMENT ASSESSMENT REPORT

2) Works

A) All concrete shall meet requirements of tables 7 and 8 of BS 8500-2:2006
B) Concrete underpinning Foundations to be FND2, C28/35, max water cement ratio of 0.50, 340kg/m^3 min. cement content, max aggregate size 20mm.
C) All foundation concrete is to be vibrated with a mechanical vibrator.
D) The underpinning blocks are to be cast to within 50-75mm of the underside of the existing foundations, then dry pack is to be rammed into the full depth and width of the underpin, no earlier than 72hrs after the concrete underpinning has been poured.
E) Excavation to any section of underpinning shall not be commenced until at least 24hrs after dry packing to previous sections of work. The excavations are to be carried out in such a manner that not more than 25% of the foundation of each wall is left unsupported at any time.
F) The final depths of the proposed underpinning foundations, as indicated on the drawings, are to be determined by the sub-soil conditions encountered, and with the agreement of the Engineer and Local Authority, if applicable.
G) As soon as a base excavation has reached its approved level, the formation is to be blinded with concrete immediately following inspection, in accordance with Item H) below. On no account is the excavation to be left open for any extended period.
H) The first underpin excavations to the front lightwell retaining wall, left party wall underpin legs and rear lightwell retaining wall, all marked '1' on the adjacent plan, are to be assessed in accordance with the following Item 5.3.2 of the Hydrogeological Desk Study: "Groundwater entries into the lower part of the basement excavations must be expected from the sands of the Claygate Member, possibly at multiple levels. Pumping from suitably screened pumps might be adequate to control such entries, subject to ensuring that no fines are removed (see 5.3.4 below). However, it is possible that it will be necessary to use other groundwater control methods such as drawing down the groundwater levels ahead of the excavations using self-jetted, screened, single-stage well points around the perimeter of the basement excavations. These well points should be positioned locally for specific pins as the 'hit and miss' methodology is carried out. Final selection (design) of the groundwater control method(s) to be used should be made by a suitably experienced basement contractor or dewatering specialist following close inspection and monitoring of the first 2-3 underpin excavations (which must include pins beneath both the front and rear walls). The detailed methodologies for dewatering using sump pumps and/or well points should be included in the contractor's Basement Construction Plan, subject to final confirmation following excavation of the initial pins. Well points should be suitably screened in order to minimise the removal of fines, subject to advice from a dewatering specialist."
J) All excavations are to be treated in accordance with the following Item 5.3.5 of the Hydrogeological Desk Study: "The formation onto which the underpins and the basement slab will bear must be protected from water, because they would soften rapidly if water gets onto these surfaces, and disturbance. Thus, the formation should be blinded with concrete immediately following excavation and inspection."
K) Each underpinning leg is to be excavated in bays not exceeding 1.4m in length, concreted & pinned tight to existing footing before commencing next leg. Similarly numbered bays, shown thus: 3, can be carried out simultaneously.
L) The construction of each underpinning block shall be commenced immediately after the bottom of the excavation has been exposed. In all cases where the bottom is likely to be affected by exposure to the atmosphere, the last few millimetres of excavation shall not be taken out unless concreting can proceed forthwith. The bottom shall be sealed with concrete blinding immediately after inspection has shown it to be satisfactory.
M) The underside of existing foundation to be thoroughly cleaned prior to flooding with concrete.
N) The sides of all new foundations are to be thoroughly cleaned and wire brushed prior to casting an adjacent foundation.
O) Underpinning legs to be joined together using suitable dowels/shear keys.
P) For each discrete underpinning foundation area - repeat sequence for other units making sure that excavation is not carried out next to a completed unit until the new foundation has matured for a minimum of 36 hours.
Q) All drainage & services to be suitably protected and any damage made good.

3) Sequence of Works

A) Install & fix ground floor support steelwork.
B) Remove & dispose of existing suspended timber ground floor construction.
C) Excavate down to existing foundation levels - external & internal walls (above ground water level).
D) Excavate 3 no. underpin locations marked '1' on foundation plan - to the front lightwell retaining wall, left party wall underpin legs and rear lightwell retaining wall. Then assess in accordance with Item 5.3.2 of the Hydrogeological Desk Study and confirm dewatering method to be employed.
E) Excavate locally for internal load bearing wall underpinning
F) Cast internal wall underpinning footings, including reinforcement starter bars for underpinning wall.
G) Cast underpinning wall beneath existing internal wall & flood up to underside of existing footing.
H) Cast external wall underpinning footings, including reinforcement starter bars for underpinning wall:- to front bay & part rear walls.
J) Cast underpinning walls beneath front bay & part rear external walls & flood up to underside of existing footing.
K) Cast external wall cantilever underpinning footings to part left party wall and part front/right flank walls.
L) Cast foundations for new part left party wall/part rear wall, to rear left corner of property.
M) Cast lightwells to front & rear elevations.
N) Cast basement floor slabs.
O) Build up blockwork off basement slab to support new concrete ground floor slab.
P) Cast ground floor slabs.
Q) Build remainder of new walls to rear left hand corner of property.

Legend

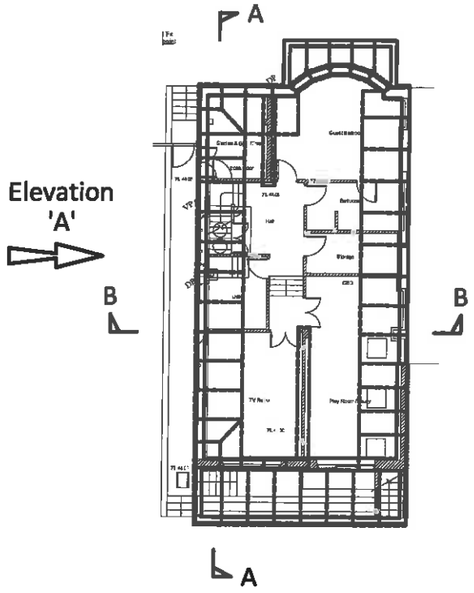
- 8 — Denotes Sequence of Underpinning Legs to Existing Structure
- Denotes Foundations for Proposed New Walls
- Denotes New Ground Retaining Structures
- Denotes Lower Steelwork (see Detail 'A')
- Denotes Higher Steelwork (see Detail 'A')
- Denotes Span of Concrete Ground Floor Slabs

Client	B chitecture, 11A Beresford Road, London, N2 8AT
Project	Proposed Basement Extension at: 13 Ferncroft Avenue, London, NW3 7PG
Title	Site Plans Showing Proposed Foundations & Steelwork

KNAPP HICKS AND PARTNERS LTD.
CONSULTING ENGINEERS
Prospect House, 1 Highpoint Business Village
Henwood, Ashford, Kent TN24 8DH
Tel: +44 (0) 1233 502255

Drn.	CCG
Date	25/09/2015
Scale	1:100 @ A3
Drawing No.	Rev.
32655T-01	A

PRELIMINARY - NOT FOR CONSTRUCTION PURPOSES



Key Plan
Scale 1:250 @ A3

Elevation 'A'
Scale 1:100 @ A3

Client	B chitecture, 11A Beresford Road, London, N2 8AT
Project	Proposed Basement Extension at: 13 Ferncroft Avenue, London, NW3 7PG
Title	Elevation 'A' - Showing Proposed Underpinning to Right Flank

KNAPP HICKS AND PARTNERS LTD.
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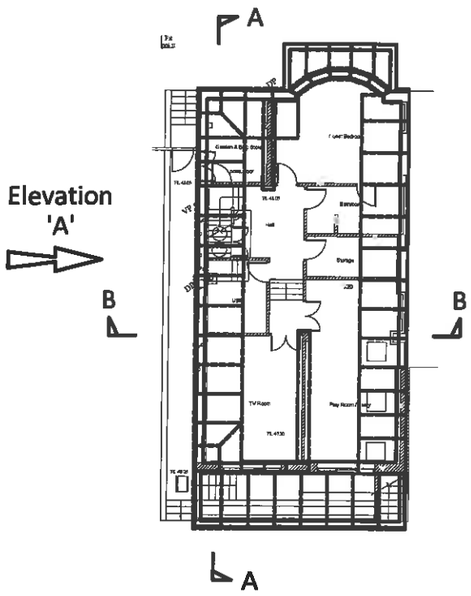
Drn.	CCG
Date	25/09/2015
Scale	1:100 @ A3
Drawing No.	Rev.
32655T-02	A

PRELIMINARY - NOT FOR CONSTRUCTION PURPOSES



Elevation 'A'

Key Plan
Scale 1:250 @ A3

Section 'A-A'
Scale 1:100 @ A3

Client	B chitecture, 11A Beresford Road, London, N2 8AT
Project	Proposed Basement Extension at: 13 Ferncroft Avenue, London, NW3 7PG
Title	Section 'A-A' - Showing Proposed Foundations

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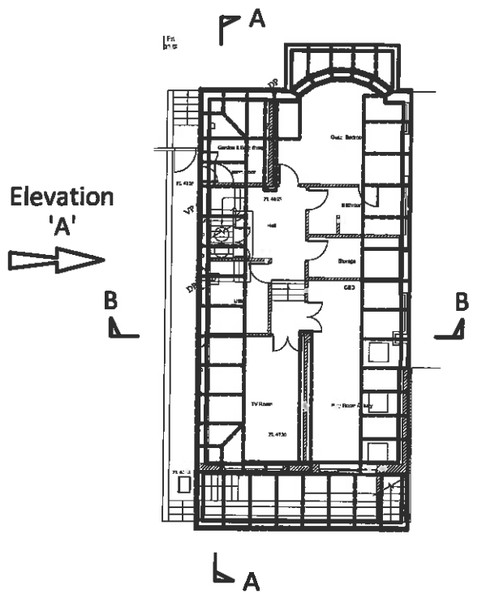
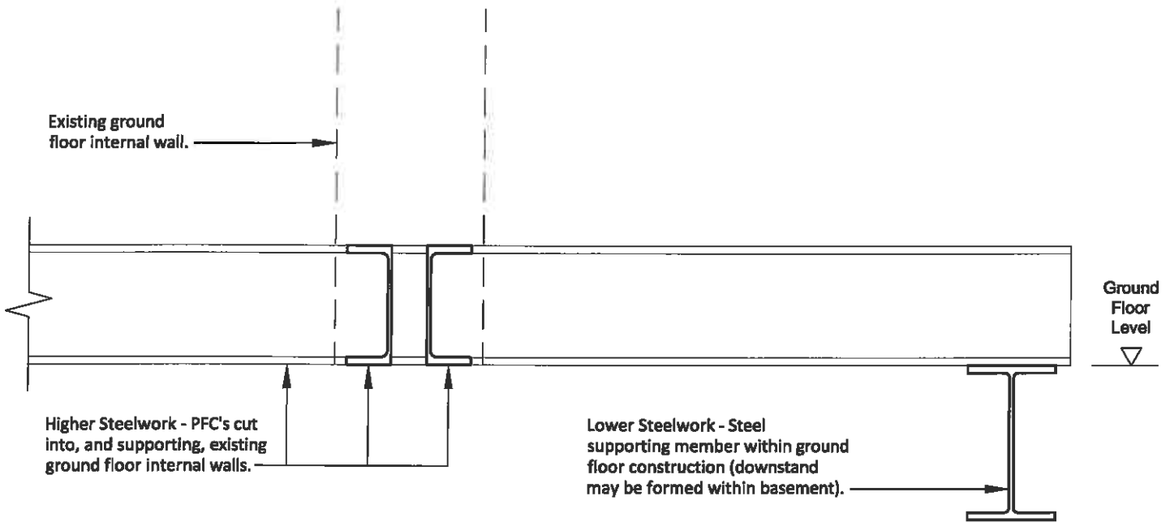
Drn.	CCG
Date	25/09/2015
Scale	1:100 @ A3
Drawing No.	Rev.
32655T-03	A

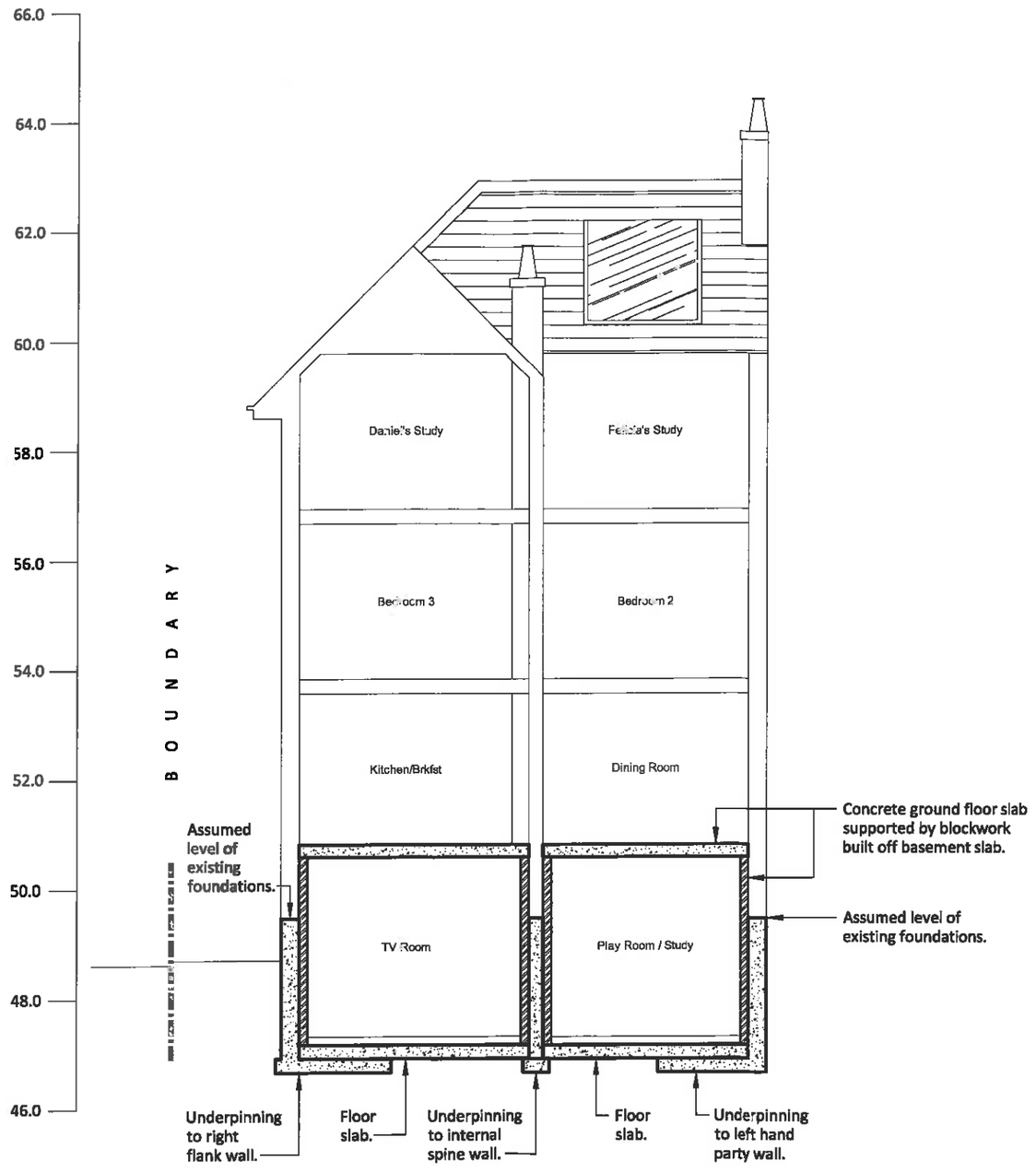
PRELIMINARY - NOT FOR CONSTRUCTION PURPOSES



Key Plan
Scale 1:250 @ A3



Detail 'A' - Indicative Steelwork Levels (Refer to ground floor plan on drg. no. 32655T-01)
Scale 1:10 @ A3



Section 'B-B'
Scale 1:100 @ A3

Client	B chitecture, 11A Beresford Road, London, N2 8AT
Project	Proposed Basement Extension at: 13 Ferncroft Avenue, London, NW3 7PG
Title	Section 'B-B' - Showing Proposed Foundations & Detail 'A'

KNAPP HICKS AND PARTNERS LTD.
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Drn.	CCG
Date	25/09/2015
Scale	1:100 @ A3
Drawing No.	Rev.
32655T-04	A

C. Hydrogeological Desk Study, 13 Ferncroft Avenue, Hampstead, by Gabriel Geoconsulting Ltd, Ref 16467/R2.1, dated September 2015

Report

Hydrogeological Desk Study

13 Ferncroft Avenue, Hampstead
London, NW3 7PG

for

Knapp Hick & Partners

Ref: 16467/R2.1

September 2015

Gabriel GeoConsulting Limited
Highfield House, Rolvenden Road, Benenden, Kent TN17 4EH
Company No. 6455714, registered in England and Wales. Registered office as above.
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Project: **Hydrogeological Desk Study**

Site: **13 Ferncroft Avenue, Hampstead, London, NW3 7PG**

Client: **Knapp Hick & Partners**

Foreword

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

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

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

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

Contents

1. INTRODUCTION

1.1 Construction is proposed of a basement beneath the full footprint of No.13 Ferncroft Avenue, NW3 7PG. The basement works and other alterations to the superstructure, are the subject of current planning application 2014/7674/P. The description of the proposed scheme given on the planning application form, as relevant to this report, is *"Excavation of cellar to form basement accommodation with front, side and rear lightwells, demolition of existing lean-to portion at ground floor level,..."*.

1.2 This hydrogeological desk study has been commissioned in order to review the groundwater regime and to assess possible strategies for dewatering.

1.3 Desk study data have been collected from various sources including borehole/well logs from the vicinity of the site (Appendix A) and geological data, environmental data and historic maps from GroundSure. Relevant information from the desk study is presented in Sections 2–4, including findings from the earlier ground investigation, followed by a discussion of the issues in Section 5.

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

- **Bchitecture (Architects):**

Drg No. 1406/101	Existing Location Plan & Site Plan
Drg No. 1406/102	Existing Basement & Ground Floor Plans
Drg No. 1406/104 & 105	Existing Elevations
Drg No. 1406/106	Existing Section AA
Drg No. 1406/110/C	Proposed Site Plan
Drg No. 1406/111/C	Proposed Basement & Ground Floor Plans
Drg No. 1406/113/B & 114/B	Proposed Elevations
Drg No. 1406/115/ A	Proposed Section AA
Drg No. 1406/116/ A	Proposed Sections BB & CC

This report should be read in conjunction with all the documents and drawings listed above. No structural engineering drawings were available at the time of writing.

1.5 This assessment has been prepared by Keith Gabriel, a Chartered Geologist and UK Registered Ground Engineering Adviser with an MSc degree in Engineering Geology. The author has previously undertaken assessments of basements in several London Boroughs including Barnet, Enfield, Lambeth, Hammersmith & Fulham, Haringey, Kensington & Chelsea, Kingston, Richmond, Southwark, Wandsworth and Westminster, as well as Camden.

1.6 Instructions to prepare this desk study were received by email from Knapp Hicks & Partners Ltd (KH&P) on 8th July 2015 (confirmed by purchase order No.32655G/20/2410).

2. THE PROPERTY

2.1 No.13 is a large 3-storey, semi-detached house with a rear projection which includes a 3-storey section beneath a double-pitched roof, a two-storey section beneath a single-pitched roof and a single-storey lean-to. All three parts of the rear projection are believed to be original features because the footprint of the house has not changed since it first appeared on the 1915 Ordnance Survey (OS) map at 1:2,500 scale; the ratio of lengths between the rear projection and the main part of the house on that map is also the same as on Bchitecture's drawings of the existing house.

2.2 There is an original partial cellar/basement along the full length of the flank wall to the 3-storey part of the house. Beneath the suspended timber floors to the Lounge and Dining Room there is a crawl space with a clear height of about 1.25m below the floor joists. In contrast, the single and 2-storey parts of the rear projection are understood to have ground-bearing floor slabs.

2.3 No.13 is located on the downslope south-west side of Ferncroft Avenue, as shown in Figure 1. Ground levels are higher in the adjoining No.15's site to the south-east of No.13, although both houses have the same internal floor levels, whereas the ground floor in No.11, a detached house to the north-west of No.13, is 1.56m below No.13's.

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

2.4 A low retaining wall is present on the 13/15 boundary to the rear of the houses, and another 0.7-0.9m high retaining wall is present on the boundary between the flank walls to No's 13 and 11. The rear gardens to these properties are bounded to the south-west by tennis courts and Thames Water's Kidderpore Reservoir.

3. PROPOSED BASEMENT

3.1 The proposed basement will underlie the full footprint of the existing house and the courtyard alongside the rear projection. The existing rear lean-to will be removed and replaced by a lightwell. Another lightwell will be added alongside the front bay, and the side access path will be lowered by 0.7-1.1m in order to provide access to the bike store at the front right corner of the house, and to allow windows to be fitted to the basement which match the style of the existing windows.

3.2 The basement's finished floor level (FFL) will step down from front to rear, from 48.05m to 47.30m above Site Datum (ASD) respectively. The bike store's FFL, 48.60mASD, will match that of the adjacent part of the side access path.

3.3 The ground levels beneath and around the existing house also vary significantly, so, for ease of reference, both existing and proposed levels are presented in Table 1 below.

Table 1: Existing & Proposed Ground Levels

	Existing GLs (mASD)	Proposed FFLs (mASD)	
		Front	Rear
Garden by front bay/lightwell:	50.35	48.83	
Crawl space below lounge & dining room:	49.7	48.05	47.30
Cellar/basement store:	49.47	48.05	47.30
Rear end of kitchen:	50.81		47.30
Rear lean-to:	49.59-49.78 (say 49.65)		47.30
Side access path:	49.49-49.72 Falling to S	48.60-48.77 Falling to N	
Rear courtyard (alongside rear projection):	50.26-50.32 (50.27 in centre)		47.30

4. DESK STUDY DATA

4.1 Sources of Information

This desk study is based on information collected from the following sources:

- Current Ordnance Survey mapping
- Borehole logs on the British Geological Survey's database and other planning applications
- GroundSure GeoInsight and EnviroInsight reports
- GroundSure Historic mapping
- The geological memoir for the area (Ellison et al, 2004)

4.2 Topography

4.2.1 No.13 stands at approximately 97m above Ordnance Datum (AOD), on a west-facing slope, on the flank of a ridge which descends towards the south-west from the West Heath. Thames Water's Kidderpore Reservoir is located on the crest of this ridge.

4.2.2 The spacing of the 95m and 100m contours on the 1:25,000 scale Ordnance Survey (OS) map (see Figure 2) indicates overall slope angles in the vicinity of No.13 which vary from 4.4° towards the west (on the north side of Ferncroft Avenue) to a 1.5° fall towards the south-west along the crest of the ridge. The spot heights on the 1:1,250 scale OS map (Figure 1) indicate that Ferncroft Avenue falls towards the north-west at an overall angle of 2.8° adjacent to No.13 (100.1m to 96.2mAOD), increasing to 3.3° in the lower part of the road (96.2m to 91.5mAOD).

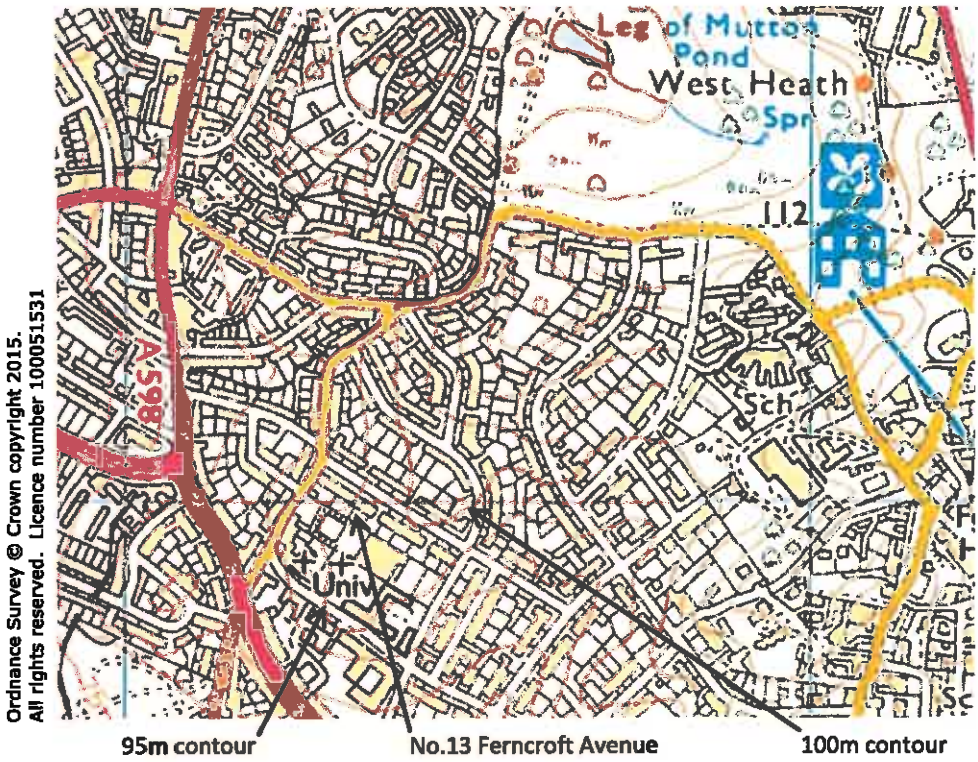


Figure 2: Extract from 1:25,000 OS map (not to scale).

4.2.3 The topographic survey of No.13's plot (see Bchitecture Drg No. 1406/101/-) indicates that the rear garden is broadly level, with a slight cross-fall towards the north-west. The spot heights generally varied between 49.15m and 49.6m, locally rising to 49.97m in the southern corner of the site.

4.3 Historic Maps and other evidence for former Land Uses

4.3.1 Historic Ordnance Survey maps have been reviewed at 'large' scales of 1:1,056, 1:1,250 and 1:2,500, and at 'small' scales of 1:10,560 and 1:10,000.

4.3.2 The earliest available large scale OS map (**1870** County Series) records a "Brick Field" to the west of Platts lane. Ferncroft Avenue did not exist and No.13's plot was in a field, with its southern boundary on the northern boundary of the grounds to Kidderpore Hall. By **1893** Kidderpore Hall had become 'Westfield College (Girls)' and the Kidderpore covered reservoir had been built; the map shows areas of raised and levelled ground on both sides of the visible reservoir which suggests that the reservoir might extend as a buried structure beyond its visible extent.

4.3.3 In **1896** the surrounding area remained largely undeveloped but by **1915** Ferncroft Avenue and all the surrounding roads were in place and fully developed, including No.13. Few changes have occurred in the vicinity of No.13 since then. Tennis courts first appeared on the levelled areas either side of the visible reservoir on the **1953** map and various additions have been made to Westfield College over the years (which is shown on the 1994 map as part of King's College London).

4.3.4 The 1870 County Series OS map shows a stream passing approximately 200m to the east of No.13's site. This stream appeared to rise from a pond closer to the heath and is a former minor tributary of the river Westbourne (see Section 4.4). The stream was not shown on the 1896 map, when the area was still farmland. No springs were recorded, though Kidderpore Hall to the south of No.13's site had a "Pump" which probably drew water from either a well or a near-surface collection chamber. A well was marked near the crest of the heath.

4.3.5 GroundSure's historical land-use database, which was compiled from map data, records various historic workings at surface in the vicinity of No.13. An extract from the associated 'Ground Workings Map' is presented in Figure 3.

- The (minimum) extent of brickfield is shown filling the triangular area between Platt's Lane and Finchley Road, and extending to the north of Briardale Gardens (to the approximate position of the borough boundary). This brickfield is unlikely to have had any impact on the hydrogeology of No.13's site.
- A "Covered Reservoir" is specifically recorded from maps dated 1874, 1974 and 1995 at 6m/19m to the south-west of the site (GeoInsight report, Section 2.1). This is separate from the covered reservoir which is visible at surface, and no equivalent covered reservoir was recorded in the levelled area to the south-east of the visible reservoir, where the tennis club's pavilion is located.

- A small area marked 'Gravel Pit' is shown to the south-west of (and overlapping) Kidderpore Avenue.

4.3.6 No historic underground workings or mining were recorded within 1000m of No.13's site, though underground workings may exist which have not been mapped.

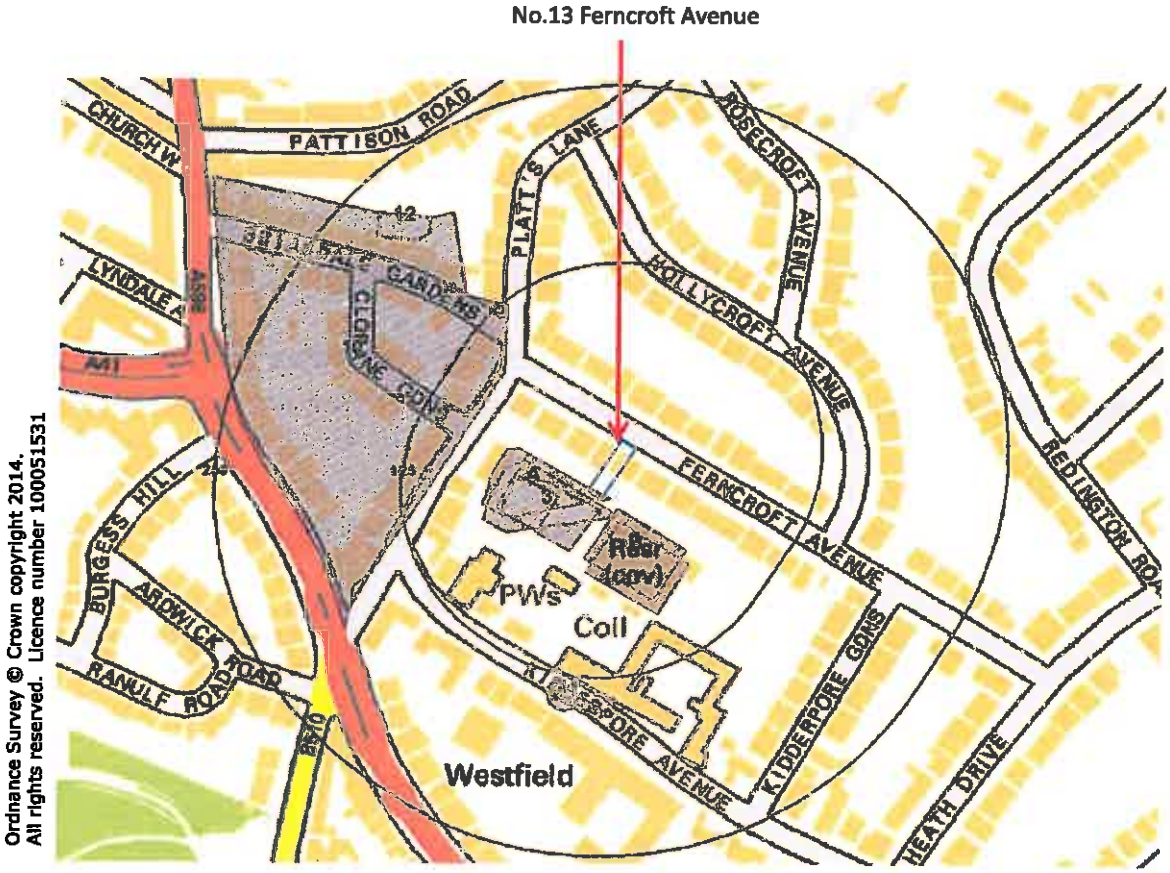


Figure 3: Extract from GroundSure's 'Ground Workings Map' (GeoInsight Report, Section 2).

4.4 Hydrology (Surface Water)

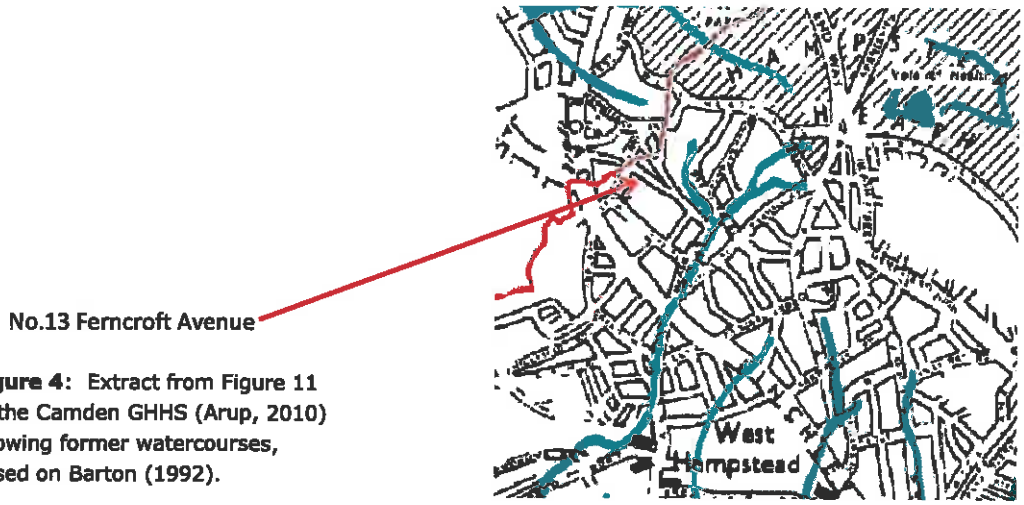


Figure 4: Extract from Figure 11 of the Camden GHHS (Arup, 2010) showing former watercourses, based on Barton (1992).

4.4.1 As already noted, a tributary to the Westbourne, one of the 'lost' rivers of London, formerly flowed approximately 200m to the east of No.13, as illustrated in Figure 4. The contours in Figure 2 show the course of that tributary between Hollycroft Avenue and Redington Road (see Figure 3).

4.4.2 By 1893 the 1:1,056 OS Town Plan shows that the stream had disappeared, having presumably been either culverted or diverted into the sewer system in preparation for development of the houses which had already started on the lower sections of Redington Road. Whether any such culvert was on the original course remains unknown.

4.5 Geology

4.5.1 Mapping by the British Geological Survey (BGS) indicates that the site is underlain by the Claygate Member, with the overlying Bagshot Formation outcropping 139m to the north-east of the site and the London Clay Formation (Unit D) outcropping 210m to the south-east of the site (and to both the south-west and north-west of the site at slightly greater distances). Figure 5 shows an extract from the 1:10,000 scale BGS map which illustrates the geology of the area centred on No.13's site.

4.5.2 The Claygate Member forms the uppermost unit of the London Clay Formation and is described in the relevant BGS memoir (Ellison et al, 2004) as "*alternating beds of clayey silt, very silty clay, sandy silt and glauconitic silty fine sand. Beds are generally 1 to 5m thick, although the boundaries are generally diffuse as a result of bioturbation*". The Claygate Member was 16.0m thick in the Hampstead Heath borehole (located to the ENE of the site of present interest, near the top of the Heath) where the Claygate Member occurred between the levels of 93.71m and 109.71m AOD). The clays can be as plastic as those in the main body of the London Clay, as discussed further in paragraph 4.5.4.

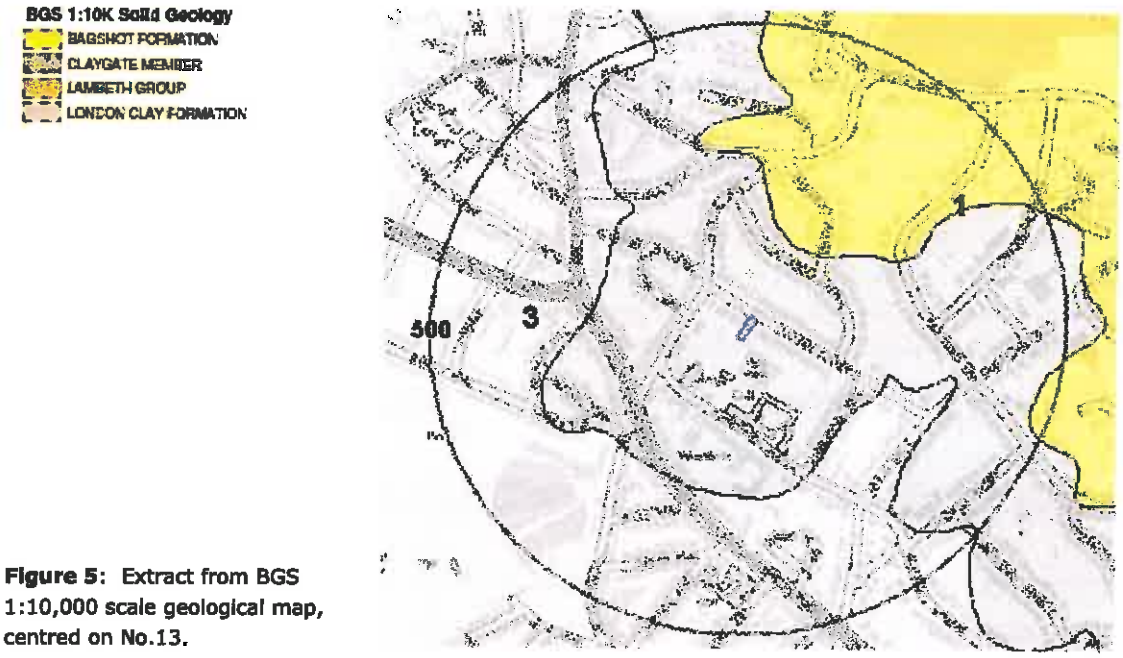


Figure 5: Extract from BGS 1:10,000 scale geological map, centred on No.13.

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

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

4.5.5 We have undertaken a search of the BGS boreholes database for information on previous ground investigations and any wells in the vicinity of No.13. The coverage was sparse, though four particularly relevant boreholes were identified downslope of the site at Westfield College; a location plan and the borehole records are presented in Appendix A, together with two records for other BGS boreholes to the north-west of the site. A borehole drilled by Chelmer Site Investigations at 69 Redington Road, close to the former course of the Westbourne, has also been included (details are available on LB Camden's planning website). The logs for one borehole from each of these sites are summarised in Table 2, with a tentative correlation between them. Reference should be made to the logs in Appendix A for full strata descriptions.

Table 2: Summary of Boreholes - Depths/levels to base of strata						
Strata (abbreviated descriptions) Approx GL (m AOD):	**BGS BH TQ28NE/421 (BH1)**		**BGS BH TQ28NE/119 (BH1)**		**69 Redington Road (BH2)**	
	Depth (m)	**Level 83.34**	Depth (m)	**Level 90.63**	Depth (m)	**Level c. 100.0**
Topsoil	-		-		0.3	**c. 99.7**
Made Ground	1.10	**82.24**	0.53	**90.1**	-	
Firm sandy very silty CLAY & occn'l fine gravel (Head Deposit?)	-	-	-	-	0.9	**c. 99.1**
Sandy clayey SILT ('Firm' bec'g 'stiff' locally 'soft') (Claygate Mbr)	-	-	5.79	**84.84**	-	-
Stiff sandy very silty CLAY (Claygate Mbr)	-	-	-	-	? 1.8	**?c. 98.2**
Variably firm to very stiff, brown silty CLAY (Weathered London Clay Fm)	5.50	**77.84**	-	-	? 3.3	**?c. 96.7**
Stiff to very stiff, dark grey CLAY (v silty at 69RR) (London Clay Fm)	>20.0	-	>15.4	-	>6.0	-
Groundwater level (highest during drilling):	-	-	2.23	**88.40**	None	-
Groundwater level in standpipe:	2.03	**81.31**	-	-	-	-

4.5.6 The level of the interface between the Claygate Member and the London Clay Formation (Unit D) in the other three boreholes which were recorded under reference BH TQ28NE/119 varied between 83.20m and 84.35mAOD. These are slightly lower than suggested by the geological map, which indicates that this interface crops out at about 85mAOD on this part of the College's site. However, these levels are very close to the level of this interface recorded in the Hampstead Heath borehole, which indicates that the strata are approximately horizontal.

4.5.7 Boreholes drilled for another basement application on the opposite side of Briardale Gardens (at No.31) to BGS BH TQ28NE/421 recorded slightly sandy, becoming sandy CLAYS to a depth in excess of 15.0m. In contrast, clays with no silt component or sand were recorded in BH TQ28NE/421 (possibly, in part a difference in application of BS5930), which suggests that a fault might be present between these boreholes.

4.5.8 Borehole BH2 at 69 Redington Road was only a short distance downslope from the mapped outcrop of the Bagshot Formation, yet suggested the Claygate Member to London Clay interface might be as high as 98.2mAOD in that area. This is much higher than expected, so once again could be indicative of faulting (and a more complex geology than has been appreciated in the past).

4.6 Hydrogeology (Groundwater)

4.6.1 The Claygate Member is classified by the Environment Agency as a superficial 'Secondary A Aquifer', whereas the underlying London Clay is an 'Unproductive Stratum' as indicated by Figure 6.

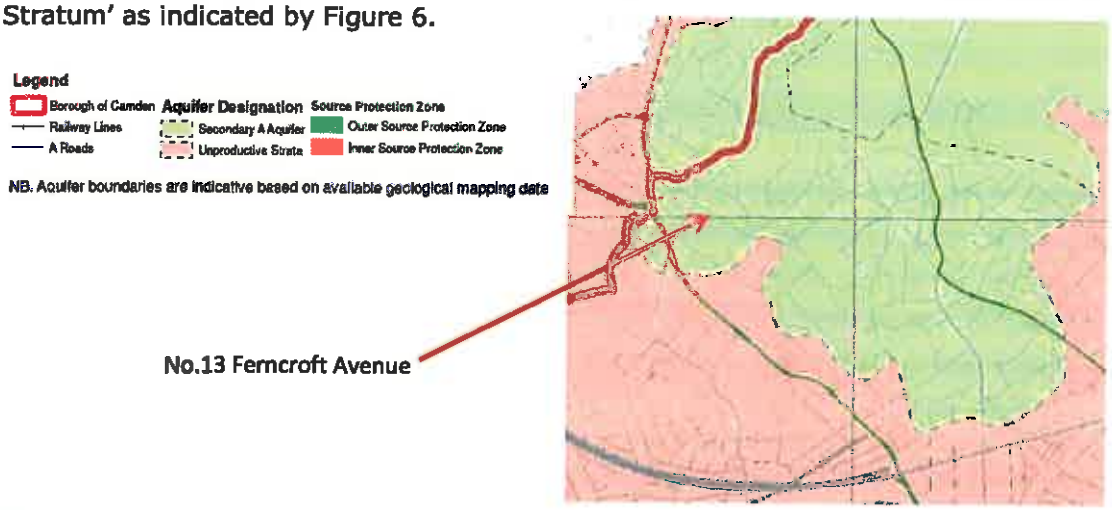


Figure 6: Extract from Figure 8 of the Camden GHHS (Arup, 2010) showing aquifer designations.

4.6.2 The Chalk Principal Aquifer which occurs at depth beneath the London Clay is not considered relevant to the current issues so is not considered further.

4.6.3 Under the old groundwater vulnerability classification scheme, which now applies only to superficial soils, the site is classed as 'Minor Aquifer High' groundwater vulnerability, as shown in Figure 7.

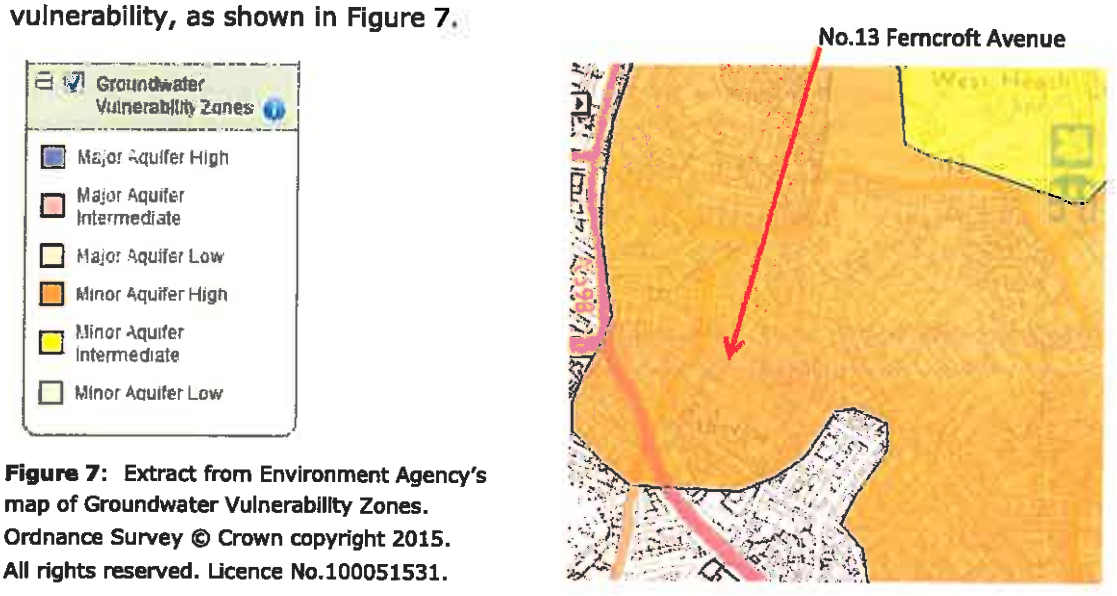


Figure 7: Extract from Environment Agency's map of Groundwater Vulnerability Zones.

4.6.4 There are no Source Protection Zones (SPZs) within 500m of the site. There are no groundwater abstraction licences within 2km of the site, so both are irrelevant to the current issue.

4.6.5 The former tributary to the Westbourne which arises to the north-east of No.13's site (4.3.4 above) is one of many springs which formerly arose from either the Bagshot Formation or the Claygate Member around Hampstead Heath. This part of Hampstead has fewer old wells and 'pumps' recorded on the historic maps than the area further to the east because the area was largely undeveloped till the late 19th century.

4.6.6 The groundwater records from the BGS boreholes (see Table 1) illustrate the presence of groundwater close to surface.

4.6.7 The findings from the two boreholes drilled as part of the site-specific ground investigation for the proposed basement may be summarised as:

- Made Ground: 0.75-0.80m: Included paved surfacing, topsoil and varied soil types (sandy **silt** and firm to stiff **clay**) with assorted inclusions of builders' debris, ash and chalk traces.
- CLAYS of the Claygate Member: Recorded to 1.75m/2.00m below ground level (bgl); stiff or firm-to-stiff, silty CLAYS. Partings/laminations of sand and sandy clays increase with depth. Laboratory tests indicated that these clays were all of High or Very High plasticity, reducing with depth.
- SANDS of the Claygate Member: Recorded to the base of the boreholes at 4.00m below ground level (bgl). These generally silty fine SANDS were inter-laminated with sandy CLAYS, silty CLAYS and clean fine SANDS (although the laboratory described all the samples as slightly to very sandy CLAYS). A 0.1m thick siltstone horizon was recorded in BH2.
  All were noted to be either wet or damp.

4.6.8 Groundwater standing levels were recorded in BHs 1&2 at 2.45m and 3.45m bgl respectively, and gave standing levels after 30/40 minutes at 2.38m and 3.32m bgl. Standpipes were installed in these boreholes, from which standing water levels of 2.40m and 3.26m bgl were obtained in September 2014, and subsequent monitoring recorded levels up to 1.95m bgl and 2.97m bgl respectively in November/December 2014. These represented levels above the site datum of 47.39m and 47.20m ASD beneath the rear and front of the house respectively.

4.7 Mining and Ground Stability

4.7.1 The databases in the GroundSure GeoInsight report contained no records of mining or natural cavities within the 1000m search area.

4.7.2 The results of the BGS classifications for six geological hazards with the potential to cause subsidence were also included in the GroundSure GeoInsight report. The hazard ratings for the site are recorded and, where appropriate, explained in the following paragraphs (4.7.3 to 4.7.8).

4.7.3 Shrink – Swell Clays: "Moderate" hazard. This reflects the presence of Intermediate to Very High plasticity clays in the Claygate Member. The BGS has listed various implications and recommended precautions.

4.7.4 Landslide: "Very Low" hazard. Landslide hazard is unlikely to be a concern on this site, probably because the natural slope angles are less that 7° (Note: this classification assumes that any retaining walls are stable). Areas of 'Low' landslide hazard in Westfield College's site, mainly downslope of Kidderpore Avenue, are associated with slope angle generally exceeding 7° in that area.

4.7.5 Ground dissolution of soluble rocks: "Negligible" hazard, with the comment 'Soluble rocks are not present in the search area'. The Chalk which underlies the London Clay is soluble, though in this setting is unlikely to have been affected by dissolution and hence is very unlikely to present a hazard to the existing buildings.

4.7.6 Compressible ground: "Negligible" hazard, with the comment 'No indicators for compressible deposits identified'.

4.7.7 Collapsible ground: "Very low" hazard, with the comment 'Deposits with potential to collapse when loaded and saturated are unlikely to be present.'

4.7.8 Running sands: "Very low" hazard, with the comment 'Very low potential for running sand problems if water table rises or if sandy strata are exposed to water.'

4.7.9 No special actions or mitigation measures or special ground investigation measures were stated as being required for any of the hazards covered by the BGS with the exception of Shrink-swell clays, for which a series of recommendations were provided.

5. DISCUSSION

5.1 Preliminary Hydrogeological Ground Model

5.1.1 The desk study evidence suggests a preliminary hydrogeological ground model for the site characterised by:

1. Made Ground: Where seen, comprised typically variable soil types and a wide range of artificial included matter. Generally of limited thickness, though could be deeper elsewhere within the site, especially on the north-west side of the site, by the retaining wall on the 11/13 boundary, and in some of the service trenches.
   This Made Ground is likely to contain perched groundwater during at least the winter and spring seasons.
2. Claygate Member: Underlies all of No.13's site and comprised silty clays overlying interbedded sands and clays with variable proportions of minor constituents (silts, clays and sands). Silts may also be present, as recorded in some nearby boreholes.
   The uppermost sand unit, from about 2m bgl in both site-specific boreholes, was described as "wet". Groundwater standing levels were recorded at up to 1.95m bgl (47.39m ASD) beneath the rear of the house and 2.97m bgl (47.20m ASD) below the front garden during the monitoring period from September to December 2014. These standpipes do not appear to have been monitoring a single homogeneous body of groundwater, because they suggest a component of north-eastwards flow, uphill, which is considered improbable. It is also noteworthy that the groundwater level recorded in BH2's standpipe during the monitoring period is well below the level of the uppermost "wet", sands at 48.17-48.42m ASD which implies that there was either perched groundwater in that sand or the groundwater table was higher in that area when BH2 was drilled.
   These groundwater levels should be expected to rise closer to surface in most winters as a result of natural seasonal fluctuations. Slow seepage should be expected through the sand horizons, though this may be modified locally by backfilled service trenches, which may act as either a barrier to or a conduit for flow. Wells and boreholes (unless grouted on completion) often serve to connect and homogenize different groundwater horizons.
   The Claygate Member is classed as a Secondary A Aquifer, which is defined by the Environment Agency as: *'Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers'*. The pump at Kidderpore House confirms that the sand horizons in the Claygate Member have been sufficiently permeable to provide a productive source of groundwater.
3. London Clay Formation: The level of the interface between the Claygate Member and the main part of the London Clay Formation is expected to be below the depth of excavation for the proposed basement. If consistent with the findings from the boreholes at Westfield College, downslope of the site,

then the interface is likely to be at about 83-85m AOD, some 11-14m bgl in No.13's site. Evidence from other boreholes in the area suggests that the geology may be more complicated than indicated on the geological map (which is consistent with other recent findings from the Thames basin), in which case the Claygate Member to London Clay interface could be either deeper or shallower than suggested by the Westfield College boreholes (see Section 4.5). It remains unlikely however that it will be found within the excavations for the proposed basement.

5.1.2 Contact has been made with Thames Water to learn more about the Kidderpore Reservoir. This Victorian reservoir (which has recently been re-roofed and was found when drained to be in generally very good condition) is purely a holding reservoir which is filled from other sources. No groundwater is collected from the Claygate Member by this reservoir. The reservoir will present an obstruction to groundwater flow down the ridge, though, as the slope towards the west/north-west is steeper, most near-surface flow would be expected to occur in that direction.

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

5.2 Groundwater Levels and Flow – Permanent Works

5.2.1 The varied soil types in the Made Ground may be sufficiently permeable to permit some flow of groundwater perched above the underlying clays. The existing foundations, where exposed, were founded at depths of 1.16m and 1.44m below ground level, so are already deep enough to block any flow through the Made Ground. Thus, as the flow would be expected to be predominantly across the site, from east to west, the proposed basement would create no increase in cross-flow width.

5.2.2 The basement's finished floor level (FFL) will step down from front to rear, generally from 48.05m to 47.30m above Site Datum (ASD) respectively. Higher FFLs apply to the bike store (48.60mASD) and the front lightwell (48.83m ASD) so these are less critical with regards to groundwater and are not considered further. With allowance for 0.55m of underpin base, cavity drainage, insulation and floor construction the founding levels for the two main parts of the basement are expected to be 47.50m ASD and 46.75m ASD respectively.

5.2.3 The highest sand strata recorded in the site-specific boreholes were at approximately 48.4m ASD (BH2, front garden) and 47.34m ASD (BH1, close to rear wall). Thus, both the front and rear parts of the proposed basement are expected to be founded in the interlaminated, weathered, silty fine sands and variably silty/sandy clays of the Claygate Member. If the top surface of these sands varies

linearly between the two boreholes then the stepped basement slab would generally be founded in the uppermost 1m of these sands.

5.2.4 The groundwater entries in both boreholes indicated that mobile groundwater was present within the sands of the Claygate Member. Such flow would be expected to be to occur primarily in the 'clean' sands and to a lesser extent in the silty fine sands.

5.2.5 The recorded groundwater levels were below the top of the interlaminated sands, so this aquifer was 'unconfined' at that time. It is likely that groundwater levels will rise sufficiently on occasions during the life of the basement for the aquifer to become 'confined' beneath the clays. In both cases it is expected that flow in the aquifer would be able to find a route around the proposed basement and no adverse impact would caused by the basement. This behaviour is acknowledged in the Camden geological, hydrogeological and hydrological study (Camden GHHS, Arup, November 2010) which noted that even extensive excavations for basements in the City of London have not caused any serious problems in 'damming' groundwater flow, with groundwater simply finding an alternative route (Arup, 2010, paragraph 205).

5.2.6 Current geotechnical design standards require use of a 'worst credible' approach to selection of groundwater pressures. On sites such as this where high plasticity clays are present close to surface the groundwater may rise to ground level, at least in the wettest winters, unless mitigation measures such as land drainage can be installed. No acceptable disposal location exists for such water (because there is no accessible watercourse nearby and Thames Water will not allow long-term disposal of groundwater to the mains drainage system). As a result, use of a provisional design groundwater level equal to ground level is recommended for short-term (total stress) design situations, and equal to 0.5m below ground level for long-term (effective stress) design situations. If the design is undertaken in accordance with the Eurocode 7 (BS EN 1997-1), then groundwater should be taken at ground level in both short-term and long-term situations.

5.2.7 The basement structure must be designed to resist the buoyant uplift pressures which would be generated by groundwater at ground level. The variable depth of the proposed basements means that the uplift pressures will also vary around the basement, up to about 40kPa on the upslope party wall (un-factored).

5.2.8 The standpipes which were installed in boreholes should be maintained so that further readings can be taken immediately prior to the start of the works.

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

5.2.10 Weepholes should be provided in any garden retaining walls which are re-built as part of the proposed works.

5.3 Groundwater Control – Temporary Works

5.3.1 As noted above, perched groundwater may at times occur within the Made Ground. Groundwater entries into the excavations from such perched water, if any, should be amenable to removal by pumping from sump(s).

5.3.2 Groundwater entries into the lower part of the basement excavations must be expected from the sands of the Claygate Member, possibly at multiple levels. Pumping from suitably screened pumps might be adequate to control such entries, subject to ensuring that no fines are removed (see 5.3.4 below). However, it is possible that it will be necessary to use other groundwater control methods such as drawing down the groundwater levels ahead of the excavations using self-jetted, screened, single-stage well points around the perimeter of the basement excavations. These well points should be positioned locally for specific pins as the 'hit and miss' methodology is carried out. Final selection (design) of the groundwater control method(s) to be used should be made by a suitably experienced basement contractor or dewatering specialist following close inspection and monitoring of the first 2-3 underpin excavations (which must include pins beneath both the front and rear walls). The detailed methodologies for dewatering using sump pumps and/or well points should be included in the contractor's Basement Construction Plan, subject to final confirmation following excavation of the initial pins. Well points should be suitably screened in order to minimise the removal of fines, subject to advice from a dewatering specialist.

5.3.3 Pumping from additional screened well points or sumps in the centre of the excavation might also be required to prevent hydraulic heave of the basement formation (the founding soils); monitoring of groundwater pressures will be required to assess the need for such pumping.

5.3.4 A careful watch should be maintained to check that pumping from the well points or sumps does not result in removal of fines from the adjoining ground; if any such removal of fines is noticed, then pumping should stop and the advice of a suitably experienced and competent ground engineer or dewatering specialist should be sought.

5.3.5 The formation onto which the underpins and the basement slab will bear must be protected from water, because they would soften rapidly if water gets onto these surfaces, and disturbance. Thus, the formation should be blinded with concrete immediately following excavation and inspection.

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

5.3.7 Irrigation systems in neighbouring gardens can also contribute significantly to water entries so, if such systems are present in the adjoining gardens, then the owners should be asked to avoid excessive use during the basement construction period.

6. CONCLUSIONS

6.1 These conclusions consider only the primary findings of this desk study; the whole report should be read to obtain a full understanding of the matters considered.

6.2 The desk study has found that while the geology recorded by boreholes at Westfield College, downslope from No.13 Ferncroft Avenue, is consistent with the BGS' Hampstead Heath borehole. Other evidence from the surrounding area suggests that the geology may be more complex than has been mapped by the BGS (Sections 4.5, 4.6 and 5.1).

6.3 Thames Water have informed us that the Kidderpore Reservoir, directly downslope from the site, is purely a storage facility and does not collect groundwater from the Claygate Member (5.1.2).

6.4 The existing foundations to No.13 will already block any groundwater flow through the Made Ground recorded by the investigation, so the proposed basement should not be detrimental to the flow of any perched groundwater in the Made Ground (5.2.1).

6.5 Comparison of the geology recorded by the site-specific ground investigation and the proposed founding levels of the main front and rear parts of the basement indicated that both front and rear parts are likely to be founded in the interlaminated sands of the Claygate Member (5.2.2, 5.2.3).

6.6 The basement will create a minor obstruction to groundwater flow, but this is considered to be acceptable as the groundwater is expected to find an alternative route around the basement (5.2.4, 5.2.5).

6.7 Provisional design groundwater levels equal to ground level (short-term) and 0.5m below ground level (long-term) are proposed, which means that the basement must be able to resist buoyant uplift pressures (un-factored) up to 40kPa (5.2.6, 5.2.7).

6.8 Entries of perched groundwater into the basement excavations are likely to be manageable by sump pumping (5.3.1). Well pointing techniques using suitably screened well points are likely to be required for removal of groundwater from the interlaminated sands of the Claygate Member (5.3.2).

6.9 The pumping must be monitored; if fines start to be removed then pumping should cease and advice should be sought on how to proceed (5.3.4).

6.10 The basement excavations must be blinded with concrete immediately following excavation and inspection (5.3.5).

Keith Gabriel
MSc DIC CGeol FGS
UK Registered Ground Engineering Adviser

References

Arup (November 2010) Camden geological, hydrogeological and hydrological study – Guidance for subterranean development. Issue 01. London.

Barton N (1992) The Lost Rivers of London. Historical Publications Ltd, London.

BS 8102 (2009) Code of practice for protection of below ground structures against water from the ground. British Standards Institution, London.

BS EN 1997-1 (2004) Eurocode 7: Geotechnical Design – Part 1: General rules. British Standards Institution.

Ellison RA et al (2004) Geology of London. Special Memoir for 1:50,000 Geological sheets 256 (North London), 257 (Romford), 270 (South London) and 271 (Dartford) (England and Wales). British Geological Survey, Keyworth.

APPENDIX A

Desk Study – Borehole records from other sites

Project:

13 Ferncroft Avenue, Hampstead, NW3 7PG

16467

GabrielGeo Consulting

13 Ferncroft Avenue

TQ28NE/421 (BH2)

TQ28NE/119 (BHs 1 - 4)

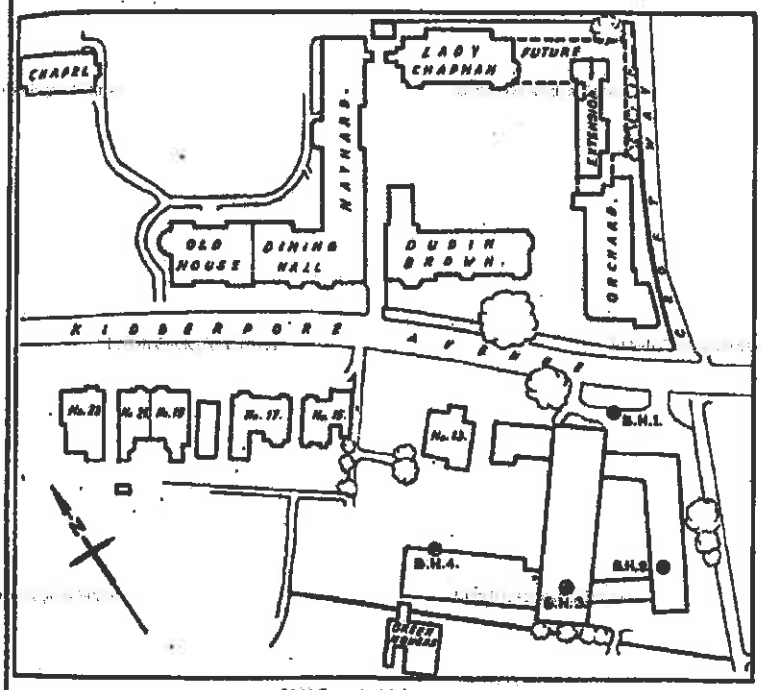
No.69 Redington Road (BH2)

Title:	**Location Plan of Boreholes**			Sheet	**A1**
Date:	**August 2015**	Checked:	Approved: **KRG**	Scale :	**NTS**

TQ/28NE/119

1": 256

Fig. 6.



SCALE:- 1:1000

BOREHOLE	DEPTH Ft.	GROUND LEVEL Ft.	LONDON CLAY Ft.	WATER LEVEL Ft.	TRIAXIAL TEST RESULTS		
					CARRIED DOWN Ft.	SHEAR STRENGTH OF COHESION (C) lbs/sq.ft.	ANGLE OF SHEARING RESISTANCE (Ø)°
1	50·5	71·7	52·7	51·3	8	(1) 3330	0
					16	(2) 3560	
					21	(3) 3690	0
					41	(4) 2290	
2	55·0	82·0	40·0	57·5	-	-	-
3	50·0	82·3	47·3	55·0	7	(1) 780	0
					16	(2) 1980	
					26	(3) 4080	0
4	55·0	82·1	41·1	62·2	10	(1) 2730	0
					29	2230	

NOTE: ALL LEVELS REFERRED TO CLIENT'S DATUM WHICH IS 226·44 ft. ABOVE O.D.

LOC. 3117. WESTFIELD COLLEGE.
HAMPSTEAD N.W.3.
PLAN SHOWING BOREHOLES POSITIONS.
ON SITE OF NEW SCIENCE BUILDING.

SOIL MECHANICS LTD.
85, OLD CHURCH STREET,
LONDON, S.W.3

2119

TQ/2ENG/119

2537.8575

Fig. 1

BOREHOLE LOG

LOCATION NO. 3117 Westfield College, Hampstead, N.W.3.

CARRIED OUT FOR Council of Westfield College.

BOREHOLE NO. 1 DIAMETER : 8 Inch

GROUND LEVEL : 71.7 above Ollents arbitrary datum DATE : 14th to 16th March, 1959

Description	Reduced Level	Legend	Samples	Depth	Thickness	M/c %
Chalk, clinker and gravel MADE GROUND	+71.7		1	0'0"	2'9"	
	+69.9		2	2'9"		26
Firm mottled grey and brown sandy clayey SILT becoming brown and more sandy below 7 ft. (CLAYGATE BEDS)			3			24
			4			28
			5		12'9"	24
			6			25
	+57.2		7	14'6"		24
Firm becoming stiff light grey-brown sandy clayey SILT, more clayey below 17 ft. (Probably Claygate Beds)			8		4'6"	30
	+52.7		9	19'0"		26
Stiff dark grey silty CLAY fissured and very stiff below 40 ft. Fine gypsum throughout. (LONDON CLAY)			10			29
			11			25
			12			29
			13			27
			14		31'6"	26
			15			28
			16			25
			17			24
			18			25
			19			25
			20			25
			22			29
	+21.2		21	50'6"		

END OF EXPLORATION

Water Level Observations

Date	Time	Depth of Borehole	Depth of Casing	Depth to water
14.3.59	0730	14'6"	14'6"	1'4"
17.3.59	0730	50'6"	-	20'6"

Scale: 1 in. = 5 ft. ▪ Disturbed Sample ▮ Core Sample △ Water Sample

SOIL MECHANICS LTD., 65 OLD CHURCH ST., S.W.3

TQ/2NE/119

2537. 8575

Fig. 2

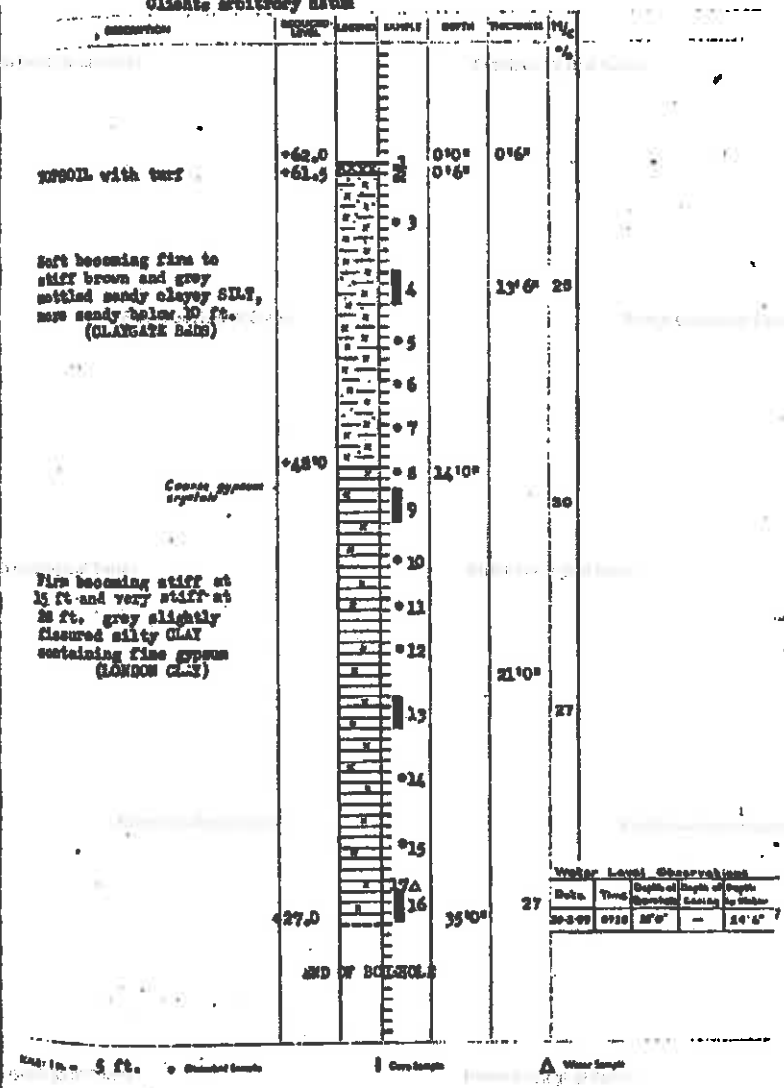
BOREHOLE LOG

LOCATION NO. 3117 Westfield College, Hampstead

CARRIED OUT FOR Council of Westfield College.

BOREHOLE NO. 2 DIAMETER: 2 inches

GROUND LEVEL: 62.0 ft. above Oliente arbitrary datum DATE: 19th March, 1959



SOIL MECHANICS LTD., 65, OLD CHURCH ST., S.W.3.

TQ/28NG/119
2537.8575

Fig. 3

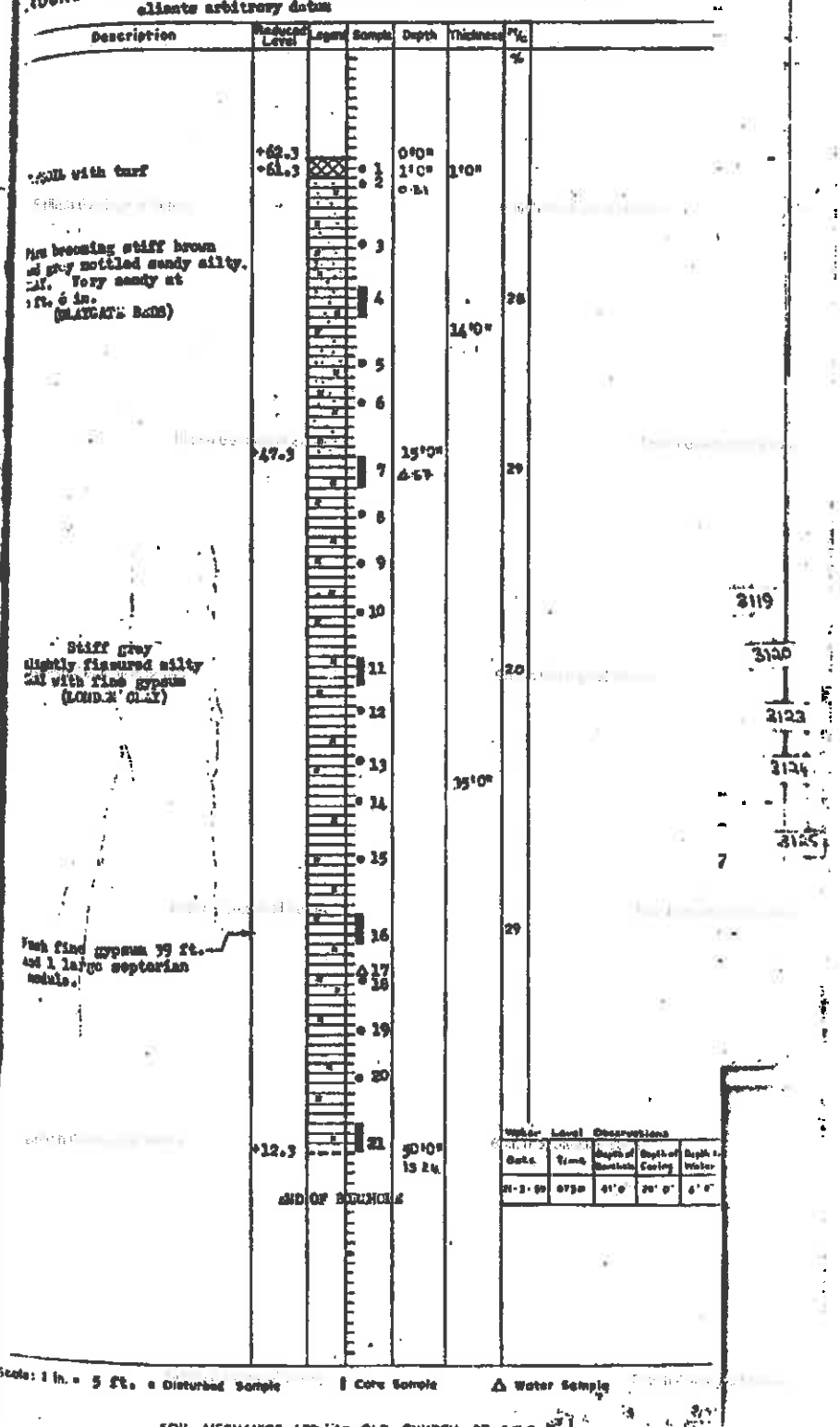
BOREHOLE LOG

LOCATION NO. 3117 Westfield College

CARRIED OUT FOR Council of Westfield College

BOREHOLE NO. 3 DIAMETER : 8 inches

GROUND LEVEL : 62.3 ft. above atlantic arbitrary datum DATE : 20th and 21st March, 1959



TQ/2ENE/49

2537.8575

Fig. 4

BOREHOLE LOG

LOCATION NO. 3117 Westfield College, Hampstead

CARRIED OUT FOR Council of Westfield College.

BOREHOLE NO. 4 DIAMETER: 8 inches

GROUND LEVEL: 69.1 ft. above OBJECTS ORDINARY DATUM DATE: 17th and 18th March, 1959

DESCRIPTION	STRATA LEVEL	GROUND	SAMPLES	DEPTH	THICKNESS	N/ft
TOPSOIL with turf.	+69.1 +68.6		1 2	0'10" 0'6"	0'6"	
Soft becoming firm (below 5 ft.) grey and brown mottled sandy silty CLAY (CLAYGATE BEDS)			3 4 5 6 7		14'6"	30
More sandy						
	+54.1		8	25'10"	3'0"	28
Firm brown and grey mottled sandy clayey SILT (Probably Claygate Beds)	+51.1		9	28'0"		
Firm to stiff grey sandy silty CLAY with shell fragments and fine stones. (LONDON CLAY)			10 11 12 13 14		12'0"	26
	+39.1		15	40'0"		24
Stiff grey slightly fissured silty CLAY with fine silt laminations and shell fragments (LONDON CLAY)			16		5'0"	
	+34.1		17	45'0"	28	

BASE OF BOREHOLE

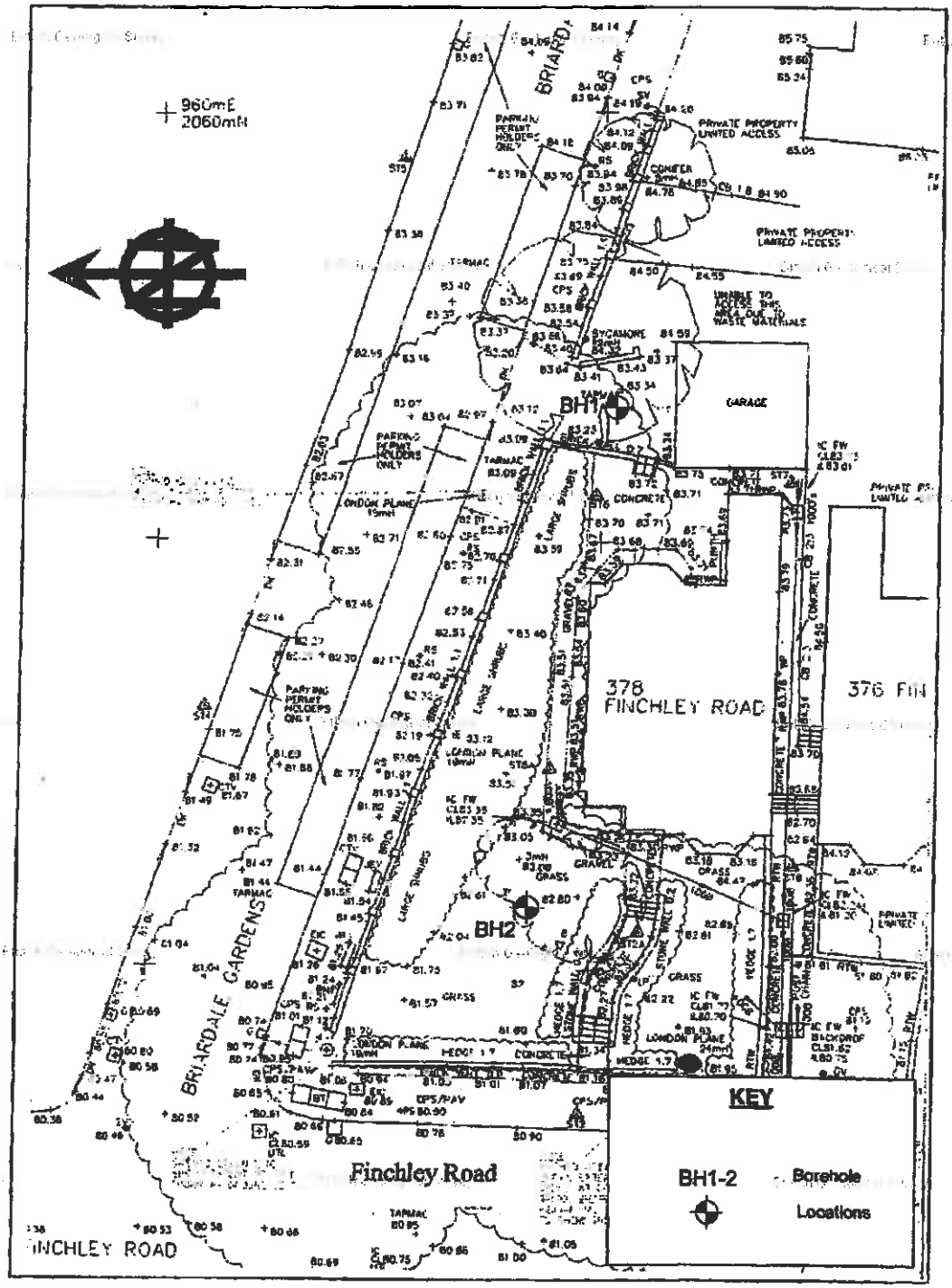
Water Level Observations

Date	Time	Depth of Borehole	Depth of Casing	Depth to Water
9-3-59	0730	35' 0"	-	6' 3"

5 ft. = 1 in. ● Disturbed Sample ▮ Core Sample △ Water Sample

SOIL MECHANICS LTD., 46, OLD CHURCH ST., S.W.3.

Borehole Location Plan



NOT TO SCALE

Project : 378 Finchley Road, NW3 **Client : Mr Manoj Shah**	**GROUND ENGINEERING** Peterborough Tel : 01733 566568	**Project No.** **C10575**

GROUND ENGINEERING

Geo-Environmental Specialists
01733 568568

Site: 378 FINCHLEY ROAD, LONDON NW3

BOREHOLE BH1

Date: 06/06/06

Hole Size: 150mm dia to 20.00m

Ground Level: 83.34m. O.D.

Samples and In-situ Tests			(Date) Casing	Inst.	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Blows						
0.20-0.70	B1				MADE GROUND - CONCRETE		0.20	83.14
					MADE GROUND - Firm, friable, dark brown/brown/grey mottled slightly gravelly, sandy CLAY with occasional brick, concrete, coal and ash fragments			
1.00-1.50	B2							
1.15-1.45	S	N12	0.90		Stiff brown/orange brown/light grey mottled CLAY with occasional selenite crystals. Becoming fissured below 2.50m		1.10	82.24
1.75	D1							
2.00-2.40	U1	38	1.20 ▽s					
2.03	W1							
2.45	D2				(WEATHERED LONDON CLAY)			
2.75	D3							
3.00-3.40	U2	48	1.20					
3.45	D4							
3.75	D5				Very stiff, closely fissured to stiff, brown/orange brown CLAY with occasional selenite crystals		3.60	79.74
4.00-4.40	U3	55	1.20					
4.45	D6				(WEATHERED LONDON CLAY)			
4.75	D7							
5.00-5.40	U4	55	1.20					
5.45	D8				Stiff, becoming very stiff below 7.00m, closely fissured, dark grey CLAY with occasional silt and fine sand seams		5.50	77.84
6.00	D9							
6.50-6.90	U5	60	1.20		(LONDON CLAY)			
6.95	D10							
7.50	D11							
8.00-8.40	U6	62	1.20					
8.45	D12							
9.00	D13							
9.50-9.90	U7	70	1.20					
9.95	D14						10.00	73.34

REMARKS
1. Breaking out concrete from 0.00m to 0.20m for 0.50 hours
2. Excavating a pit from 0.20m to 1.00m for 1 hour
3. Borehole cased to 1.20m depth
4. Fibrous live roots observed to 1.75m depth
5. Standpipe installed to 4.00m depth

Project No 10575

Scale 1:50 | Page 1/2

KEY
D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
S/C - SPT Spoon/Cone
▽ Water Strike
▼ Water Rise
N - SPT Blows for 0.3m
* - Blows for quoted penetration
V - Vane Shear Test Cohesion ( ) kPa
▽c Level on completion
c▽w Level casing withdrawn
▽s Standpipe Level

Groundwater Strikes

No	Depth m Struck	Rose to	Rate	Cased	Sealed

Groundwater Observations

Date	Depth m Hole	Casing	Water
06/06/06	20.00	1.20	dry
06/06/06	20.00	0.00	dry
20/07/06	4.00	0.00	2.03

GROUND ENGINEERING

Geo-Environmental Specialists
01733 568666

Site: 378 FINCHLEY ROAD, LONDON NW3

Date: 06/06/06

Hole Size: 150mm dia to 20.00m

BOREHOLE BH1

Ground Level: 83.34m. O.D.

Samples and in-situ Tests			(Date) Casing	Inst.	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Blows						
					Very stiff, closely fissured to stiff, dark brown/ dark grey CLAY with occasional light brown silt and fine sand seams up to 6mm thick. Rare bivalve shell fragments at 15.00m		10.00	73.34
10.50	D15							
11.00-11.40	U8	78	1.20					
11.45	D16							
12.00	D17							
12.50-12.90	U9	85	1.20					
12.95	D18							
13.50	D19							
14.00-14.40	U10	90	1.20					
14.45	D20							
15.00	D21				(LONDON CLAY)			
15.50-15.90	U11	90	1.20					
15.95	D22							
16.50	D23							
17.00-17.40	U12	95	1.20					
17.45	D24							
18.00	D25							
18.50-18.90	U13	100	1.20					
18.95	D26							
19.55-19.95	U14	100	1.20					
20.00	D27						20.00	63.34

REMARKS: Borehole completed at 20.00m depth

Project No 10575

Scale 1:50 | Page 2/2

KEY

D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
S/C - SPT Spoon/Cone
▽ Water Strike
▼ Water Rise
N - SPT Blows for 0.3m
* - Blows for quoted penetration
V - Vane Shear Test Cohesion ( ) kPa
▽c Level on completion
c▽w Level casing withdrawn
▽s Standpipe Level

Groundwater Strikes						Groundwater Observations			
	Depth m						Depth m		
No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water

GROUND ENGINEERING

Geo-Environmental Specialists
01733 566566

Site: 378 FINCHLEY ROAD, LONDON NW3

BOREHOLE BH2

Date: 05/06/06

Hole Size: 150mm dia to 15.00m

Ground Level: 82.80m. O.D.

Samples and in-situ Tests			(Date) Casing	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Blows					
0.00-0.50	B1			MADE GROUND - Firm, friable, dark brown/black/grey mottled sandy, gravelly CLAY with occasional brick, ash, concrete and coal fragments			
0.50-1.00	B2						
1.00-1.50	B3						
1.15-1.45	S	N15	0.90			1.40	81.40
1.75	D1			Firm, becoming stiff and fissured below 3.50m, brown/orange brown/grey mottled CLAY. Occasional selenite below 3.00m			
2.00-2.30	U1	35	1.50				
2.35	D2			(WEATHERED LONDON CLAY)			
2.75	D3						
3.00-3.40	U2	38	1.50				
3.45	D4						
3.75	D5						
4.00-4.40	U3	42	1.50			4.00	78.80
4.45	D6			Stiff, fissured brown/orange brown CLAY with occasional selenite crystals and orange brown stained fissures			
4.75	D7						
5.00-5.40	U4	46	1.50	(WEATHERED LONDON CLAY)			
5.45	D8						
6.00	D9						
6.50-6.90	U5	50	1.50				
6.95	D10						
7.50	D11					7.50	75.30
8.00-8.40	U6	50	1.50	Stiff, closley fissured to firm, dark grey CLAY with occasional light brown fine sand and silt partings			
8.45	D12			(LONDON CLAY)			
9.00	D13						
9.50-9.90	U7	60	1.50				
9.95	D14					10.00	72.80

REMARKS
1. Excavating a pit from 0.00m to 1.00m for 1 hour
2. Borehole cased to 1.50m depth
3. Fibrous live roots observed to 3.45m depth

Project No 10575

Scale 1:50 | Page 1/2

KEY
D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
S/C - SPT Spoon/Cone
▽ Water Strike
▼ Water Rise
N - SPT Blows for 0.3m
• - Blows for quoted penetration
V - Vane Shear Test Cohesion ( ) kPa
▽c Level on completion
c▽w Level casing withdrawn
▽s Standpipe Level

Groundwater Strikes						Groundwater Observations			
	Depth m						Depth m		
No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water
						05/06/06	15.00	1.50	dry
						05/06/06	15.00	0.00	dry

GROUND ENGINEERING

Geo-Environmental Specialists
01733 566566

Site: 378 FINCHLEY ROAD, LONDON NW3

Date: 05/06/06

Hole Size: 150mm dia to 15.00m

BOREHOLE BH2

Ground Level: 82.80m. O.D.

Samples and In-situ Tests			(Date) Casing	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Blows					
				Very stiff, fissured to stiff, dark grey/dark brown CLAY with occasional brown fine sand and silt partings up to 5mm thick. Occasional bivalve shell fragments at 13.00m. Locally slightly sandy		10.00	72.80
10.50	D15						
11.00-11.40	U8	66	1.50				
11.45	D16						
12.00	D17			(LONDON CLAY)			
12.50-12.90	U9	75	1.50				
12.95	D18						
13.50-13.90	U10	80	1.50				
13.95	D19						
14.50-14.90	U11	82	1.50				
15.00	D20					15.00	67.80
				Borehole completed at 15.00m depth			

REMARKS

Project No 10575

Scale 1:50 | Page 2/2

KEY

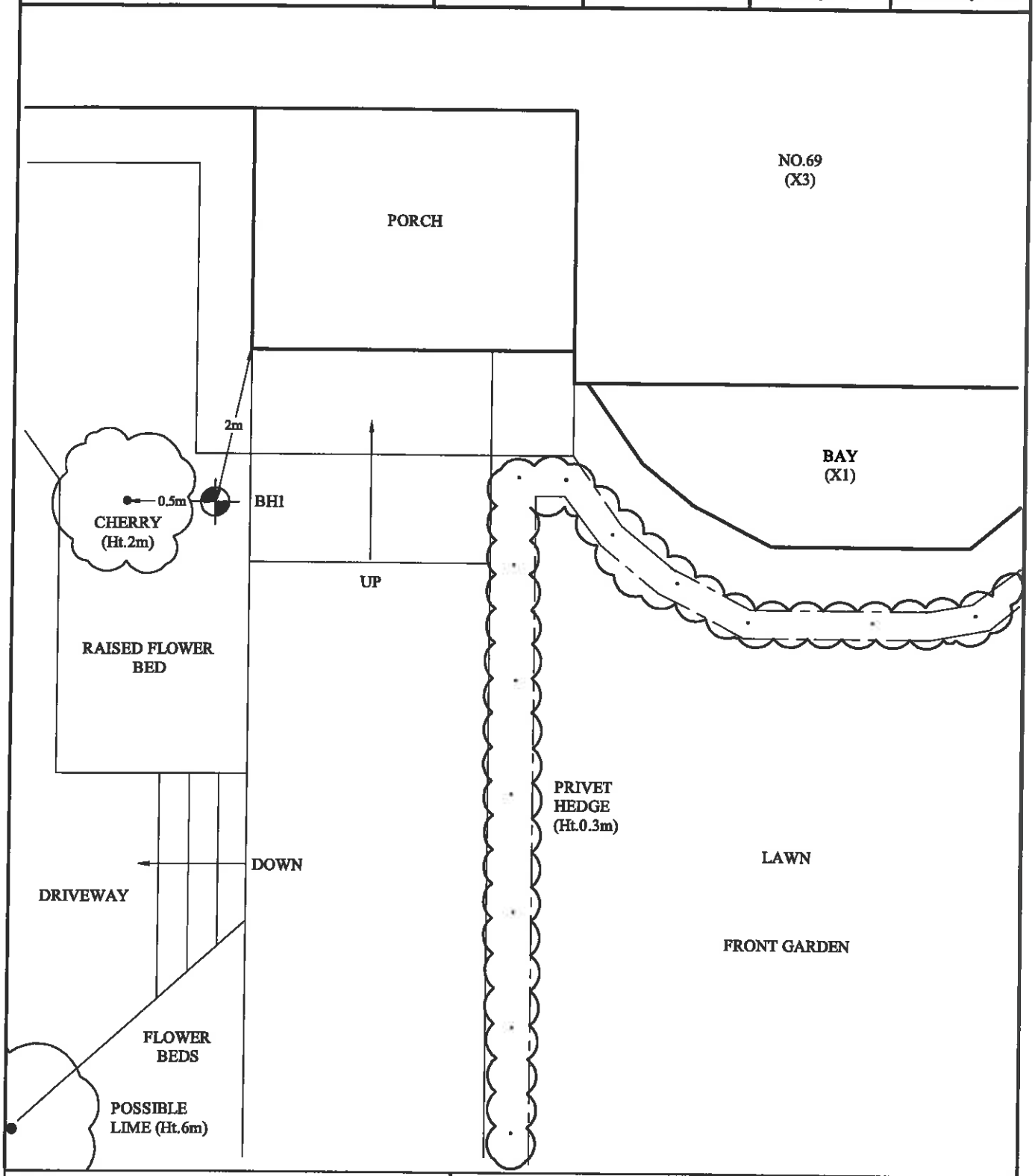
D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
S/C - SPT Spoon/Cone
▽ Water Strike
▼ Water Rise

N - SPT Blows for 0.3m
* - Blows for quoted penetration
V - Vane Shear Test Cohesion ( ) kPa
▽c Level on completion
c▽w Level casing withdrawn
▽s Standpipe Level

Groundwater Strikes						Groundwater Observations			
	Depth m						Depth m		
No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water

Chelmer Site Investigations
Unit 15 East Hanningfield Industrial Estate
Old Church Road, East Hanningfield, Essex CM3 8AB
Telephone: 01245 400930 Fax: 01245 400933
Email: info@siteinvestigations.co.uk Website: www.siteinvestigations.co.uk

Client: London Basement	**Scale:** N.T.S.	**Sheet:** 1 of 2	**Date:** 11.6.12	
Location: 69 Reddington Road, Camden, London NW3	**Job No:** 3230	**Weather:** Rain	**Drawn by:** DB	**Checked by:** ME



Notes:

On site tree identification for guidance only. Not authenticated.

Key:

Tree/Shrub | Borehole | Trial Pit | Gully | Tree Stump | Rain Water/ Soil Pipe | Manhole

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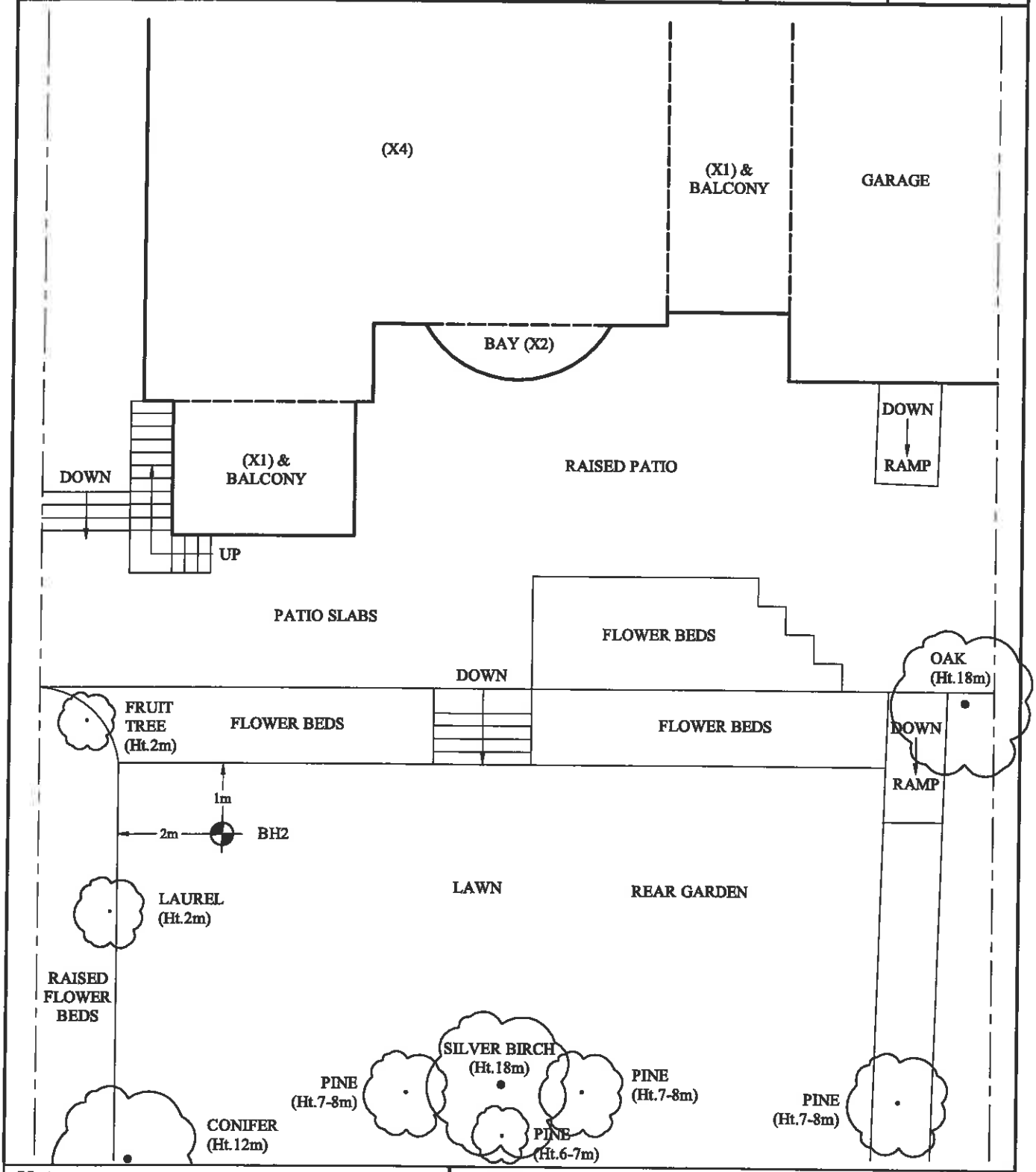
Client: London Basement	Scale: N.T.S.	Sheet: 2 of 2	Date: 11.6.12	
Location: 69 Reddington Road, Camden, London NW3	Job No: 3230	Weather: Rain	Drawn by: DB	Checked by: ME



Notes:

On site tree identification for guidance only. Not authenticated.

Key:

Tree/Shrub | Borehole | Trial Pit | G Gully | Tree Stump | Rain Water/ Soil Pipe | MH Manhole

Chelmer Site Investigations
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Old Church Road, East Hanningfield, Essex CM3 8AB
Telephone: 01245 400930 Fax: 01245 400933
Email: info@siteinvestigations.co.uk Website: www.siteinvestigations.co.uk

Client: London Basement	**Scale:** N.T.S.	**Sheet No:** 1 of 1	**Weather:** Rain	**Date:** 11.6.12	
Site: 69 Redington Road, Camden, London NW3	**Job No:** 3230	**Borehole No:** 1	**Boring method:** Hand auger		

Depth Mtrs.	Description of Strata	Thick-ness	Legend	Sample	Test Type	Test Result	Root Information	Depth to Water	Depth Mtrs
G.L.	Topsoil (300) over MADE GROUND: loose to medium compact mid brown/orange very sandy very silty clay with partings of orange and brown silt and fine sand with occasional fine gravel brick fragments and crystals.	1.5		D	M	02 03 02 04	Roots of live appearance to 2mmØ to 1.3m.		0.5
				D	M	06 09 12 13			1.0
1.5				D	V	86 92	Roots of live appearance to 1mmØ to 1.6m.		1.5
	Stiff mid brown/orange grey veined very sandy very silty CLAY with partings of orange brown and red silt and fine sand with occasional claystone nodules and crystals.	2.3		D	V	102 104	Hair and fibrous roots to 2.1m.		2.0
				D	V	108 118	No roots observed below 2.1m.		2.5
				D	V	120 126			3.0
3.8				D	V	128 134			3.5
	Very stiff as above.	1.4		D	V	140+ 140+			4.0
				D	V	140+ 140+			4.5
				D	V	140+ 140+			5.0
5.2	Borehole ends at 5.2m Obstruction thought to be claystone Too dense to hand auger.								

Drawn by: DB	**Approved by:** ME
Remarks: Borehole dry and open on completion.	

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

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Telephone: 01245 400930 Fax: 01245 400933
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Client: London Basement	**Scale:** N.T.S.	**Sheet No:** 1 of 1	**Weather:** Rain	**Date:** 11.6.12	
Site: 69 Redington Road, Camden, London NW3	**Job No:** 3230	**Borehole No:** 2	**Boring method:** Hand auger		

Depth Mtrs.	Description of Strata	Thick-ness	Legend	Sample	Test Type	Test Result	Root Information	Depth to Water	Depth Mtrs
G.L.									
0.3	Turf over TOPSOIL (300mm)	0.3							
	Firm moist mid brown/orange grey veined sandy very silty CLAY with partings of orange and brown silt and fine sand occasional fine gravel and crystals.	0.6		D	V	68 72	Roots of live appearance to 2mmØ to 1.1m.		0.5
0.9									
	Stiff mid brown/orange grey veined sandy very silty CLAY with partings of orange brown and red silt and fine sand and crystals.	0.9		D	V	96 104			1.0
				D	V	118 122	Roots of live appearance to 1mmØ to 1.7m.		1.5
1.8									
	Stiff mid brown grey veined silty CLAY with partings of orange brown and red silt and fine sand and crystals.	0.5		D	V	126 132	Hair and fibrous roots to 2.2m.		2.0
2.2									
	Very stiff as above.	1.1		D	V	140+ 140+	No roots observed below 2.2m.		2.5
				D	V	140+ 140+			3.0
3.3									
	Very stiff mid grey very silty CLAY with partings of orange and brown silt and fine sand and crystals.	2.7		D	V	140+ 140+			3.5
				D	V	140+ 140+			4.0
				D	V	140+ 140+			4.5
				D	V	140+ 140+			5.0
				D	V	140+ 140+			5.5
6.0									
	Borehole ends at 6.0m			D	V	140+ 140+			6.0

Drawn by: DB **Approved by:** ME

Remarks: Borehole dry and open on completion.

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

D Ground Movement Assessment for Basement, by Gabriel GeoConsulting Ltd, Ref 16457/R1, dated July 2015

Report

Ground Movement Assessment for Basement
at
13 Ferncroft Avenue, Hampstead
London, NW3 7PG

for

Knapp Hicks & Partners Ltd

Ref: 16457/R1

July 2015

Gabriel GeoConsulting Limited
Highfield House, Rolvenden Road, Benenden, Kent TN17 4EH
Company No. 6455714, registered in England and Wales. Registered office as above.
Tel: 01580 241044
e: info@gabrielgeo.co.uk
www.gabrielgeo.co.uk

Project: **Ground Movement Assessment for Basement**

Site: **13 Ferncroft Avenue, Hampstead, London, NW3 7PG**

Client: **Knapp Hicks & Partners Ltd**

Foreword

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

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

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

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

Contents Page

1. INTRODUCTION

1.1 Construction is proposed of a basement beneath the full footprint of No.13 Ferncroft Avenue, NW3 7PG. The basement works and other alterations to the superstructure, are the subject of current planning application 2014/7674/P. The description of the proposed scheme given on the planning application form, as relevant to this report, is "*Excavation of cellar to form basement accommodation with front, side and rear lightwells, demolition of existing lean-to portion at ground floor level,...*". This report is for planning and scheme development purposes and is not a design document.

1.2 A ground movement assessment, including damage category assessment, has been requested in accordance with the requirements set out in LBC's guidance document CPG4 'Basements and Lightwells' (2013) and the associated 'Camden, geological, hydrogeological and hydrological study – Guidance for subterranean development" (Camden GHHS, Arup, November 2010). This report presents the analyses undertaken and the required damage category assessment.

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

- **Bchitecture (Architects):**

Drg No. 1406/101	Existing Location Plan & Site Plan
Drg No. 1406/102	Existing Basement & Ground Floor Plans
Drg No. 1406/104 & 105	Existing Elevations
Drg No. 1406/106	Existing Section AA
Drg No. 1406/110/C	Proposed Site Plan
Drg No. 1406/111/C	Proposed Basement & Ground Floor Plans
Drg No. 1406/113/B & 114/B	Proposed Elevations
Drg No. 1406/115/ A	Proposed Section AA
Drg No. 1406/116/ A	Proposed Sections BB & CC

This report should be read in conjunction with all the documents and drawings listed above. No structural engineering drawings were available at the time of writing.

1.4 This assessment has been prepared by Keith Gabriel, a Chartered Geologist and UK Registered Ground Engineering Adviser with an MSc degree in Engineering Geology. The author has previously undertaken assessments of basements in several London Boroughs including Barnet, Enfield, Lambeth, Hammersmith & Fulham, Haringey, Kensington & Chelsea, Kingston, Richmond, Southwark, Wandsworth and Westminster, as well as Camden. He also undertakes independent reviews of BIA reports on behalf of the London Borough of Camden.

1.5 Instructions to prepare this assessment were received by email from Knapp Hicks & Partners Ltd (KH&P) on 8th July 2015.

2. THE PROPERTY

2.1 No.13 is a large, 3-storey, semi-detached house with a rear projection which includes a 3-storey section beneath a double-pitched roof, a two-storey section beneath a single-pitched roof and a single-storey lean-to. All three parts of the rear projection are believed to be original features because the footprint of the house has not changed since it first appeared on the 1915 Ordnance Survey (OS) map at 1:2,500 scale; the ratio of lengths between the rear projection and the main part of the house on that map is also the same as on Bchitecture's drawings of the existing house.

2.2 There is an original partial cellar/basement along the full length of the flank wall to the 3-storey part of the house. Beneath the suspended timber floors to the Lounge and Dining Room there is a crawl space with a clear height of about 1.25m below the floor joists. In contrast, the single and 2-storey parts of the rear projection are understood to have ground-bearing floor slabs.

2.3 No.13 is located on the downslope south-west side of Ferncroft Avenue, as shown Figure 1. Ground levels are higher in the adjoining No.15's site to the south-east of No.13, although both houses have the same internal floor levels, whereas the ground floor level in No.11, a detached house to the north-west of No.13, is 1.56m below No.13's.

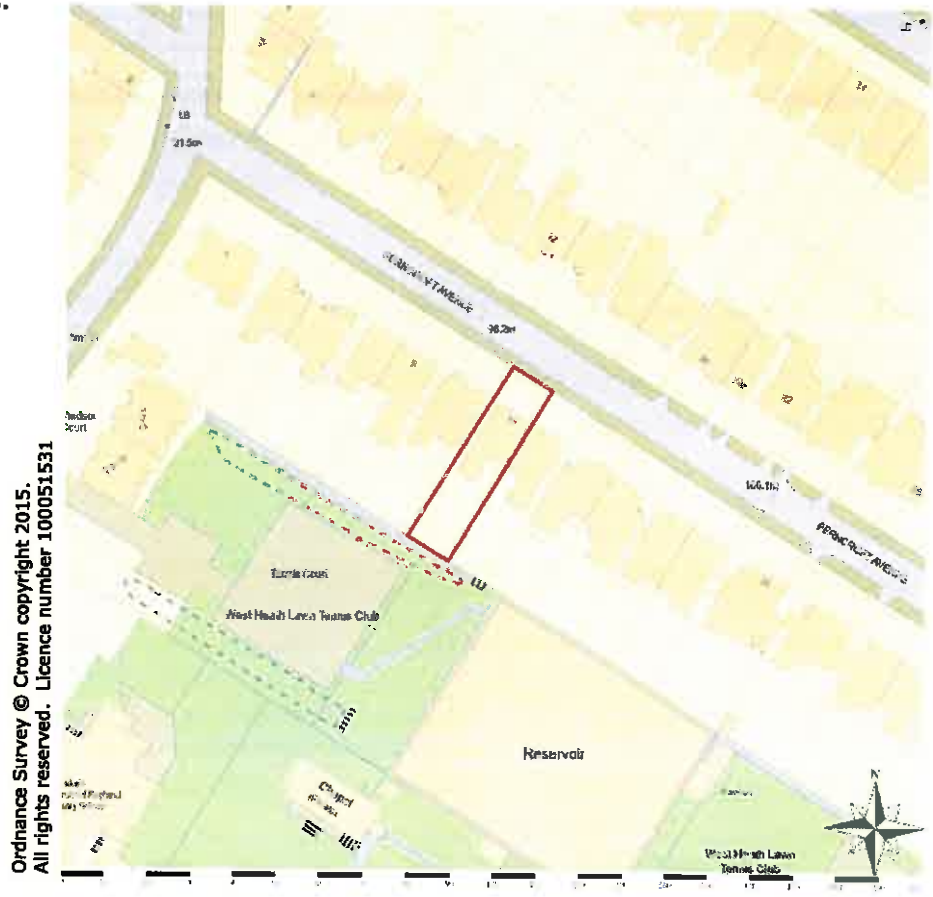


Figure 1: Extract from 1:1,250 OS map (not to scale) with the site edged in red.

2.4 A low retaining wall is present on the 13/15 boundary to the rear of the houses, and another 0.7-0.9m high retaining wall is present on the boundary between the flank walls to No's 13 and 11. The rear gardens to these properties are bounded to the south-west by tennis courts and Thames Water's Kidderpore Reservoir.

3. PROPOSED BASEMENT

3.1 The proposed basement will underlie the full footprint of the existing house and the courtyard alongside the rear projection. The existing rear lean-to will be removed and replaced by a lightwell. Another lightwell will be added alongside the front bay, and the side access path will be lowered by 0.7-1.1m in order to provide access to the bike store at the front right corner of the house, and to allow windows to be fitted to the basement which match the style of the existing windows.

3.2 The basement's finished floor level (FFL) will step down from front to rear, from 48.05m to 47.30m above Site Datum (ASD) respectively. The bike store's FFL, 48.60mASD, will match that of the adjacent part of the side access path.

3.3 The ground levels beneath and around the existing house also vary significantly, so, for ease of reference, both existing and proposed levels are presented in Table 1 below.

Table 1: Existing & Proposed Ground Levels

	Existing GLs (mASD)	Proposed FFLs (mASD)	
		Front	Rear
Garden by front bay/lightwell:	50.35	48.83	
Crawl space below lounge & dining room:	49.7	48.05	47.30
Cellar/basement store:	49.47	48.05	47.30
Rear end of kitchen:	50.81		47.30
Rear lean-to:	49.59-49.78 (say 49.65)		47.30
Side access path:	49.49-49.72 Falling to S	48.60-48.77 Falling to N	
Rear courtyard (alongside rear projection):	50.26-50.32 (50.27 in centre)		47.30

4. GROUND MOVEMENT ASSESSMENT

4.1 Basement Geometry and Stresses:

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

4.1.2 Figure A1 (see Appendix A) illustrates the layout of the underpins and other zones used to model the proposed basement in the PDISP analyses, overlaid on the basement plan from Bchitecture's Drg No.1406/111. Underpin base widths of 1.5m were assumed as a likely minimum, so these should represent a worst-case scenario. Owing to the complexity of the variable levels in both the existing and proposed layouts (see Table 1 in Section 3) all the zones within the building's footprint were modelled at a single level, and then separate 'superimposed' zones were applied to allow for the variations in the existing and/or proposed levels. Those 'superimposed' zones are illustrated in Figure A2. The hand-annotated load takedown summary provided by Knapp Hicks & Partners is presented in Figure A3.

4.1.3 The depths of excavation modelled were increased (below the FFLs given in Table 1) to allow for 0.35m thick underpin bases, and 0.2m thick basement slabs between the bases, together with a 0.2m deep allowance throughout for floor finishes, insulation and a cavity drainage system.

4.1.4 Table 2 presents the co-ordinates of the zones used to input the main elements of the basement's geometry into PDISP, as illustrated in Figures A1 & A2, together with the net changes in vertical pressure for the four stages of the stress changes which will result from excavation and construction of the basement (see 4.3.1 below for details).

Table 2: Coordinates and net pressure changes for PDISP Zones							
ZONE	Centroid		Dimensions		Net change in vertical pressure (kPa)		
#	Xc(m)	Yc(m)	X(m)	Y(m)	Stage 1	Stage 2	Stages 3 and 4
1	-0.75	10.09	1.50	13.03	42.39	42.39	51.39
2	-2.23	2.82	4.46	1.50	6.20	6.20	15.20
3	-6.73	2.82	4.53	1.50	21.56	21.56	30.56
4	-8.24	10.09	1.50	13.03	15.72	15.72	24.72
5	-7.10	17.35	3.78	1.50	48.68	48.68	57.68
7	-4.50	14.13	5.99	1.50	21.56	21.56	30.56
8	-4.46	8.48	1.50	9.81	24.87	24.87	33.87
9	-5.96	15.74	1.50	1.72	24.87	24.87	33.87
11	-9.72	15.10	1.45	6.00	-13.82	-13.82	-13.82
12	-9.72	9.10	1.45	6.00	-9.45	-9.45	-9.45
13	-9.72	3.05	1.45	6.10	-7.31	-7.31	-7.31
14	-5.08	1.04	7.83	2.07	-20.90	-20.90	-20.90
15	-2.61	8.48	2.21	9.81	0.00	-38.95	-33.95
16	-6.35	8.48	2.28	9.81	0.00	-38.95	-33.95
17	-3.36	15.74	3.71	1.72	0.00	-38.95	-33.95
18	-7.10	15.74	0.78	1.72	0.00	-38.95	-33.95
6	Polygonal zone				11.09	11.09	20.09
10	Polygonal zone				-20.03	-20.03	-14.03
19	7.48	16.17	3.03	3.87	14.25	14.25	14.25
20	Polygonal zone				3.80	3.80	3.80
21	Polygonal zone				-10.45	-10.45	-10.45
22	6.58	3.20	4.82	2.25	-35.15	-35.15	-35.15
23	6.58	1.04	4.82	2.07	-10.45	-10.45	-10.45
24					-14.25	-14.25	-14.25
25	Polygonal zone				-25.65	-25.65	-25.65

4.2 Ground Conditions:

4.2.1 The ground profile and geotechnical parameters used for the analyses were based on the site-specific ground investigation by Knapp Hicks & Partners, together with our knowledge of the geology in the vicinity of this site. Below depths of 1.75-2.0m, the boreholes drilled by KH&P recorded predominantly silty fine SANDS with "clayey partings" and interlaminated silty CLAYS, sandy CLAYS and fine SANDS. However, most of the ground of relevance to this assessment lies below that investigated by these 4m deep boreholes. As the site is known to be close to the base of the Claygate Member, a worst case scenario with a full sequence of London Clay beneath the basement has been assumed.

4.2.2 The short-term and long-term geotechnical properties of the soil strata used for the PDISP analyses are summarised in Table 3. They were based on the findings of the site-specific investigation and data from previous projects.

Table 3: Soil parameters for PDISP analyses

Strata	Level (m bgl)	Assumed Cu value (kPa)	Short term, undrained Young's Modulus, Eu (MPa)	Long term, drained Young's Modulus, E' (MPa)
Stiff, silty CLAY (Claygate Fm/ London Clay Fm)	2.0-25.0	70	35 121	21 73

Where:

For granular soils:

Eu = E' = 2 * N

For CLAY:

Undrained Young's Modulus, Eu = 35 + 3.75 z

where z = depth below the top of the stratum.

Drained Young's Modulus, E' = 0.6 Eu

4.3 PDISP Analyses:

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

- Stage 1 – Construction of underpins and strip/pad footings – Short-term condition
- Stage 2 – Bulk excavation of floor areas to basement formation level – Short-term condition
- Stage 3 – Construction of basement slab – Short-term (undrained) condition
- Stage 4 – As Stage 3, except – Long-term (drained) condition.

4.3.2 The results of the analyses for Stages 2 to 4 are presented as contour plots on the appended Figures A4 to A6 respectively.

4.4 Heave / Settlement Assessment

4.4.1 Excavation of the basement will cause immediate elastic heave in response to the stress reduction, followed by long-term plastic swelling as the over-consolidated clays take up groundwater. The rate of plastic swelling in over-consolidated clays will be determined largely by the permeability of the clay and the availability of water. As a result, the rate of swelling may be relatively rapid where water-bearing laminations of silt/sand are present in the sandy clays of the Claygate Member, whereas in the homogenous, unbedded, silty clays in the Claygate Member/London Clay Formation where the permeability is much lower the swelling can take decades to reach full equilibrium.

4.4.2 The ranges of predicted short-term and long-term movements for each of the main areas of the basement are summarised in Table 4 below. All values are approximate owing to the simplification of the stress regime and include only displacements caused by stress changes in the ground beneath the basement.

Table 4: Summary of predicted displacements

Location	Stage 2 (Figure A3)	Stage 3 (Figure A4)	Stage 4 (Figure A5)
Front lightwell	0 – 1mm Settlement	0 – 1.5mm Settlement	0.5 – 2mm Settlement
Front wall	0.5 – 2mm Settlement	1 – 3mm Settlement	1.5 – 5mm Settlement
13/15 party wall	0.5mm Settlement – 1.5mm Heave	2mm Settlement – 1mm Heave	3mm Settlement – 1mm Heave
Flank wall – front part alongside basement at 48.05/48.60mASD	2mm Settlement – 1.5mm Heave	3mm Settlement – 1mm Heave	5mm Settlement – 1mm Heave
Rear part of basement, at 47.30mASD	0.5 – 3.5mm Heave	0 – 2.5mm Heave	0 – 4mm Heave
Central basement slabs in rear section of basement	2 – 4mm Heave	1 – 3mm Heave	1 – 5mm Heave
Rear lightwell	2 – 3mm Heave	1.5 – 3mm Heave	3 – 5mm Heave
Side access path	1mm Settlement – 2mm Heave	1.5mm Settlement – 1.5mm Heave	2mm Settlement – 2mm Heave

4.4.3 The analyses indicated that the underpinned walls are likely to experience movements which range from 5mm settlements at the front of the house to 4mm heave around the rear of the basement. Up to 5mm of heave was predicted beneath the rear lightwell and the beneath the floor slabs to the TV Room and Playroom. The front lightwell and side access path were predicted to undergo even smaller displacements ranging from 2mm heave to 2mm settlement. The stiffness

of the underpin bases is likely to reduce still further the range of displacements actually experienced.

4.4.4 All the short term elastic heave should have occurred before the basement slabs are cast, so only the post-construction incremental heave is likely to be experienced by the slabs. The analyses indicated that the maximum predicted post-construction displacements beneath the basement slab are expected to range from about nil to 2mm heave.

5. Underpinning Methods and associated Ground Movements

5.1 The basement beneath No.13 is expected to be constructed using a combination of underpinning techniques and reinforced concrete (RC) retaining walls for the sections of the basement which extend beyond the footprint of the existing house. Underpinning methods involve excavation of the ground in short lengths, in order to enable:

- the stresses in the ground to 'arch' temporarily onto the ground or completed underpinning on both sides of the excavation; This effect may be very brief or even non-existent in some granular soils, especially if they are water-bearing.
- the loads from the wall being underpinned to span across the unsupported section.

Most, though not all, of the RC retaining walls will have to be constructed in panels of limited width on a 1 to 5 'hit and miss' basis, similar to underpinning techniques.

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

- the geology;
- the adequacy of temporary support to both the underpinning excavations and the partially complete underpins prior to installation of full permanent support;
- the quality of workmanship when constructing the permanent structure;
- maintenance of the temporary support until the full permanent support has been completed, including allowing time for the concrete to gain adequate strength
- the appropriateness of the design.

A high quality of workmanship and the use of high stiffness temporary support systems, installed in a timely manner in accordance with best practice methods, are therefore crucial to the satisfactory control of ground movements alongside basement excavations (see 5.4 to 5.6 below). Any cracks in load-bearing walls which have weakened their structural integrity should be fully repaired in accordance with recommendations from the appointed structural engineers before any underpinning is carried out.

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

5.4 In accordance with normal health and safety good practice, the requirements for temporary support of any excavation must be assessed by a competent person at the start of every shift and at each significant change in the geometry of the excavations as the work progresses. The stiff CLAYS recorded at 0.75-2.00m in borehole BH1 may be fissured; such fissures can cause seemingly strong, stable excavations to collapse with little or no warning. Thus, in addition to normal monitoring of the stability of the excavations, a suitably competent person should check whether such fissuring is present and, if encountered, should assess what support is appropriate.

5.5 For the proposed basement at No.13 Ferncroft Avenue:

- It should be assumed that full support will be required in the excavations for the Made Ground and for the strata below 1.75-2.00m which were predominantly SANDS. The site-specific ground investigation recorded groundwater within the depth of excavation so dewatering will also be required, which is considered further in our separate Hydrogeological Desk Study (report Ref: GGC16467/R2).
- Either closely spaced support or full support should be used as appropriate to the condition of the stiff and firm to stiff CLAYS.
- Temporary support must also be installed to support all the new underpins and RC retaining wall panels and must be maintained until the full permanent support has been completed, including allowing time for the concrete to gain adequate strength.

All temporary support should use high stiffness systems installed in accordance with best practice in order to minimise the ground movements.

5.6 If clays are present at or close beneath formation level they will readily absorb any available water which would lead to softening and loss of strength. It will therefore be important to ensure that the clays at formation level are either protected from all sources of water, with suitable channelling to sumps for any groundwater seeping into the excavations or, where unacceptably soft/weak, they must be excavated and replaced with concrete. Any clays which remain in the formation should be re-inspected and then blinded with concrete immediately after completion of final excavation to grade.

5.7 A construction sequence should be presented in a Construction Method Statement.

6. Damage Category Assessment

6.1 When underpinning it is inevitable that the ground will be un-supported or only partially supported for a short period during excavation of each pin, even when support is installed sequentially as the excavation progresses. This means that the behaviour of the ground will depend on the quality of workmanship and suitability of the methods used, so calculations of predicted ground movements can never be rigorous. However, provided that the temporary support follows best practice as outlined in Section 5 above, then extensive past experience has shown that the bulk movements of the ground alongside the basement caused by underpinning for a single storey basement (typical depth 3.5m) should not exceed 5mm in either horizontal or vertical directions.

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

6.3 For damage category assessments we are interested in the ground movements at the foundation levels of the neighbouring buildings, so it is the depth of excavation below foundation level that must be considered. Separate damage category assessments have been undertaken for each combination of foundation level, depth of excavation and predicted heave/settlement (from the PDISP analyses) which was considered likely to produce the maximum potential deflections below No's 11 & 15.

<u>No.15 Front Wall:</u>

6.4 No.13 is attached to No.15, the upslope property. The ground level steps up in No.15's front garden, and there is a reduction of almost 0.5m in the void height beneath the front reception room to No.15 (to 765mm, rather than 1.25m below No.13), so it is possible that the foundation to No.15's front wall might be as high as 50.0mASD.

6.5 Ground movements associated with the construction of retaining walls in granular soils have been shown to extend to a distance up to 2 times the depth of the excavation (CIRIA Report C580, Figure 2.12); this is likely to be more critical than if the excavation was wholly in clays. The likely formation level for the basement (the level at which it will be founded) beneath the front of No.13 was estimated at 47.50mASD, about 2.5m below the highest likely level of No.15's footings. So, the relevant geometries are as follows:

Depth of excavation =	approx **2.5m**
Zone of influence (horizontal displ't):	2.5 x 4 = 10.0m
Zone of influence (settlement):	2.5 x 2 = 5.0m
Width No.15 (L) =	approx. **9.35m**
Height to eaves, from FFL =	approx 6.3m
Height (H) =	6.3 + 1.5 = **7.8m**
Hence L/H =	**1.20**

6.6 Thus, for an anticipated 5mm maximum horizontal displacement the strain beneath No.15 would, theoretically, be in the order of $\varepsilon_h = 5.0 \times 10^{-4}$ (0.050%).

6.7 The maximum ground surface settlements alongside a supported excavation in sand are typically 0.3% of excavated depth (CIRIA C580, Figure 2.12); the settlement profile is convex and the maximum deflection, Δ = 0.1% of excavated depth (=2.5mm) at the mid-point of the zone of influence. The PDISP analyses indicated 1.5mm of settlement at the front end of the 13/15 party wall, reducing to 1mm within the first metre of No.15's front wall, whereas the zero contour was off-plot. Thus, at 2.5m from the 13/15 party wall where the maximum deflection was predicted, a settlement of 0.5mm has been allowed for. The ground movement profile for the front wall of No.15 was therefore based on a maximum deflection, Δ = 3mm, which represents a deflection ratio, $\Delta/L = 3.21 \times 10^{-4}$ (0.032%).

6.8 Using the graph for L/H = 1.0, which is slightly conservative, these deformations represent a damage category on the boundary between 'very slight' and 'slight' (Burland Categories 1 and 2, ε_{lim} = 0.05-0.075% & 0.075-0.15%), as given in CIRIA SP200 Table 3.1 and illustrated in Figure 2 below.

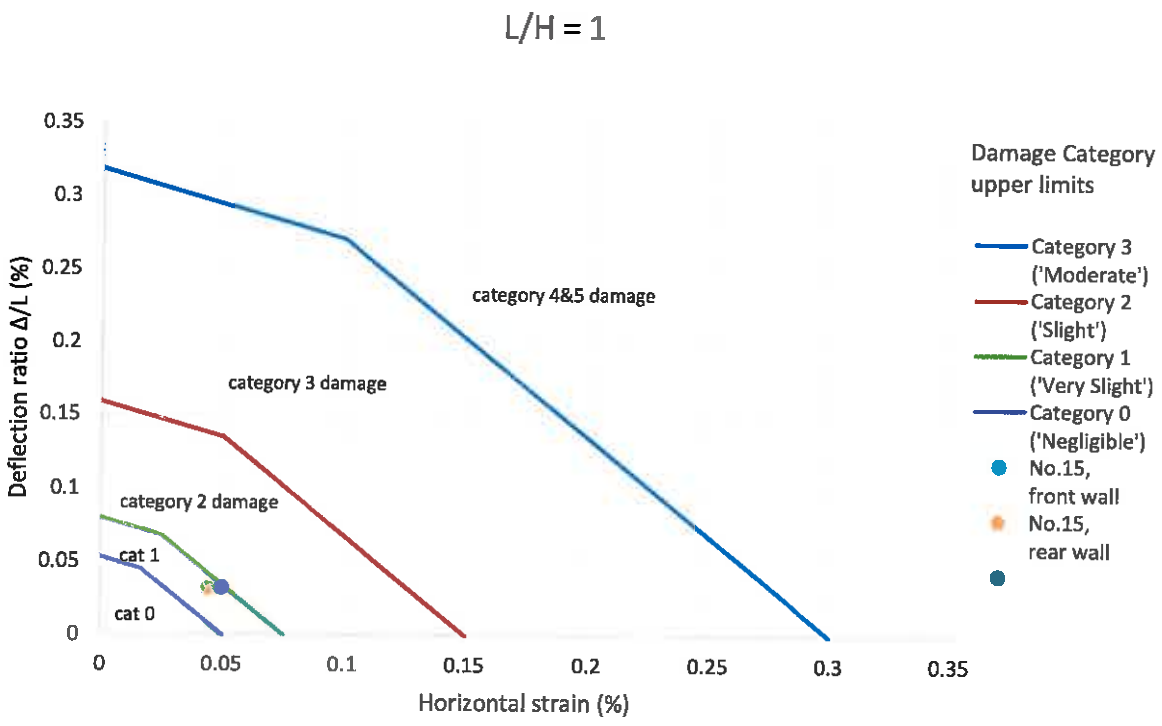


Figure 2: Damage category assessment for front and rear walls of No.15.
See CPG4 (July 2015) Figure 2 and Sections 3.27 to 3.30 for details of Burland categories.

No.15 Internal Transverse Wall:

6.9 The PDISP analyses indicated a larger, 3mm settlement alongside the transverse wall between No.15's front and rear reception rooms. However, at 2.5m from the 13/15 party wall, where the maximum deflection was predicted, the settlement is likely to be about 0.5mm as included in the analysis above. Moreover, the ground level beneath No.15 is known step down beneath the rear reception room because the crawl space height below the joists increased from 765mm to 1095mm (both figures are approximate). As a result, the foundation to that wall is likely to have been taken to a lower level, so the predicted damage category will be the same or less than for the front wall.

No.15 Rear Wall:

6.10 The step down to the lower, rear level of No.13's basement will occur at Y = slightly less than 10.0m on the PDISP model (see Figures No's A3-A6). At that point the predicted settlement for the party wall was 2mm. However, to our knowledge, there is no internal transverse wall in No.15 at that point, so the rear wall has been analysed.

6.11 The highest level at which the rear wall of No.15 might be founded has been estimated as 49.6mASD (approximately 0.25m below the ground level under No.15's rear reception room). The likely formation level for the basement beneath the rear of No.13 was estimated at 46.75mASD, about 2.85m below the highest likely level of No.15's footings. So, the relevant geometries are as follows:

Depth of excavation =	approx **2.85m**
Zone of influence (horizontal displ't):	2.85 x 4 = 11.4m
Zone of influence (settlement):	2.85 x 2 = 5.7m
Width No.15 (L) =	approx. **9.35m**
Height to eaves, from FFL =	approx 6.3m
Height (H) =	6.3 + 1.55 = **7.85m**
Hence L/H =	**1.19**

6.12 Thus, for an anticipated 5mm maximum horizontal displacement the strain beneath the rear of No.15 would, theoretically, be in the order of $\varepsilon_h = 4.39 \times 10^{-4}$ (0.044%).

6.13 Following the same process as above, the maximum deflection, Δ = 0.1% of excavated depth (=2.85mm). The PDISP analyses indicated zero settlement at the rear end of the 13/15 party wall. Thus, the ground movement profile for the rear wall of No.11 is a function solely of the maximum deflection, Δ = 2.85mm, which represents a deflection ratio, $\Delta/L = 3.05 \times 10^{-4}$ (0.031%).

6.14 Using the graph for L/H = 1.0, which is slightly conservative, these deformations represent a damage category of 'very slight' (Burland Category 1, ε_{lim} = 0.05-0.075%), as given in CIRIA SP200 Table 3.1 and illustrated in Figure 2 above.

No.11 Front Wall:

6.15 No.13 is separated from No.11 downslope by a gap of 3.0m (2.75m to the chimneys). No.11 has a basement below its kitchen extension, but that is a rear projection on the far side of the house. The ground levels are understood to be approximately constant along the flank wall of No.11, so its foundations are likely to be at a uniform level. If founded at 0.75m bgl, they would be at approximately 48.10mASD. The basement bike store at the front left corner of No.13 is expected to be founded at 48.05mASD (= 48.60 – 0.55m). The proposed level of the side access path is similar (at the front end, at least) so there is no requirement for a damage category assessment for the front wall of No.11.

No.11 Internal Transverse Walls:

6.16 None of the internal transverse walls in No.11 are opposite the deeper part of No.13's proposed basement, whereas No.11's rear wall is opposite the deepest part of the basement. Thus, No.11's rear wall is likely to represent the worst case situation.

No.11 Rear Wall:

6.17 The anticipated formation level for the basement at the rear of No.13 was estimated at 46.75mASD, about 1.35m below the highest likely level of No.11's footings (48.10mASD, see paragraph 6.15 above). So, the relevant geometries are as follows:

Depth of excavation =	approx **1.35m**
Zone of influence (horizontal displ't):	1.35 x 4 = 5.4m
Zone of influence (settlement, sands):	1.35 x 2 = 2.7m, which would not reach No.11.
Zone of influence (settlement, clays):	1.35 x 4 = 5.4m, relevant because the limited depth of excavation will mainly be in clays.
Width No.11 =	approx. **10.9m**
Width of building potentially impacted (L) =	5.4 – 3.0 = **2.4m**
Height to (central) eaves, from GL =	approx 9.7m
Height (H) =	9.7 + 0.75 = **10.45m**
Hence L/H =	**0.23**

6.18 Thus, for an anticipated 2.5mm maximum horizontal displacement (reduced pro-rata from 5mm for the reduced depth of excavation), the strain beneath No.11 would, theoretically, be in the order of $\varepsilon_h = 4.63 \times 10^{-4}$ (0.046%).

6.19 The maximum ground surface settlements alongside a supported excavation in stiff clay are typically 0.35% of excavated depth (for a low stiffness support system, CIRIA C580, Figure 2.11); the settlement profile is convex and the maximum deflection, Δ = 0.06% of excavated depth at the mid-point of the zone of influence However, the width of No.11 within the basement's zone of influence represents only 44% of the zone of influence, located at 1.8-4.0 times the excavation depth from the excavation; the maximum deflection within this zone, Δ = 0.02% of the

excavated depth, which is 0.3mm. The PDISP analyses indicated 1mm of heave opposite the rear end of the 11's flank wall, reducing to zero at an unknown distance off the contour plot in Figure A6. Thus, at the point of maximum deflection, about 2.5 times the excavation depth measured from the excavation, the heave from the unloading will approximately cancel out the settlement caused by excavation of the underpins. Thus the deflection ratio, $\Delta/L = 0$ and the damage category will be 'negligible' (Burland Category 0), as given in CIRIA SP200, Table 3.1.

6.20 Use of best practice construction methods, as outlined in Section 3 above, will be essential to ensure that the ground movements are kept in line with the above predictions.

7. CONCLUSIONS

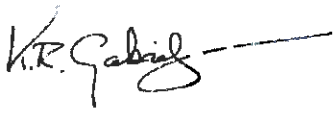
7.1 These conclusions consider only the primary findings of this assessment; the whole report should be read to obtain a full understanding of the matters considered.

7.2 Analyses have been undertaken using PDISP software of the likely heave/settlement in response to the net changes in vertical stress resulting from the construction of the proposed basement. The underpins to the house walls were predicted to undergo between 5mm of settlement and 4mm of heave (see Table 4). The soils beneath the basement floor slabs were predicted to experience in the order of 1 - 5mm of heave, although the RC floor slabs will only experience the post-construction incremental heave of up to about 1 - 2mm (Section 4.4). All these values are approximate owing to the required simplification of the stress changes.

7.3 Damage category assessments were undertaken for the adjoining No.15. These gave damage classifications up to the boundary between Burland Categories 1 & 2, 'very slight' to 'slight' (6.4 to 6.8).

7.4 For the adjacent No.11, which is 1.56m lower than No.13, no damage category assessment was warranted for the front wall because the basement will be founded at about the same level as No.11's footings (6.15). The internal transverse walls are opposite the higher sections of the No.13's basement, so do not represent the worst case (6.16), while for the rear wall of No.11 the predicted heave and the settlement caused by excavation of the basement are expected to cancel the other out. A Burland Category 0, 'negligible' was therefore applicable (6.17 to 6.19).

7.5 All these predicted ground movements will be applicable only if best practice methods of basement construction are used (6.20).



Keith Gabriel
MSc DIC CGeol FGS
UK Registered Ground Engineering Adviser

References

Arup (November 2010) Camden geological, hydrogeological and hydrological study – Guidance for subterranean development. Issue 01. London.

BS EN 1997-1 (2004) Eurocode 7: Geotechnical Design – Part 1: General rules. British Standards Institution.

London Borough of Camden (July 2015) Camden Planning Guidance CPG4– Basements and lightwells.

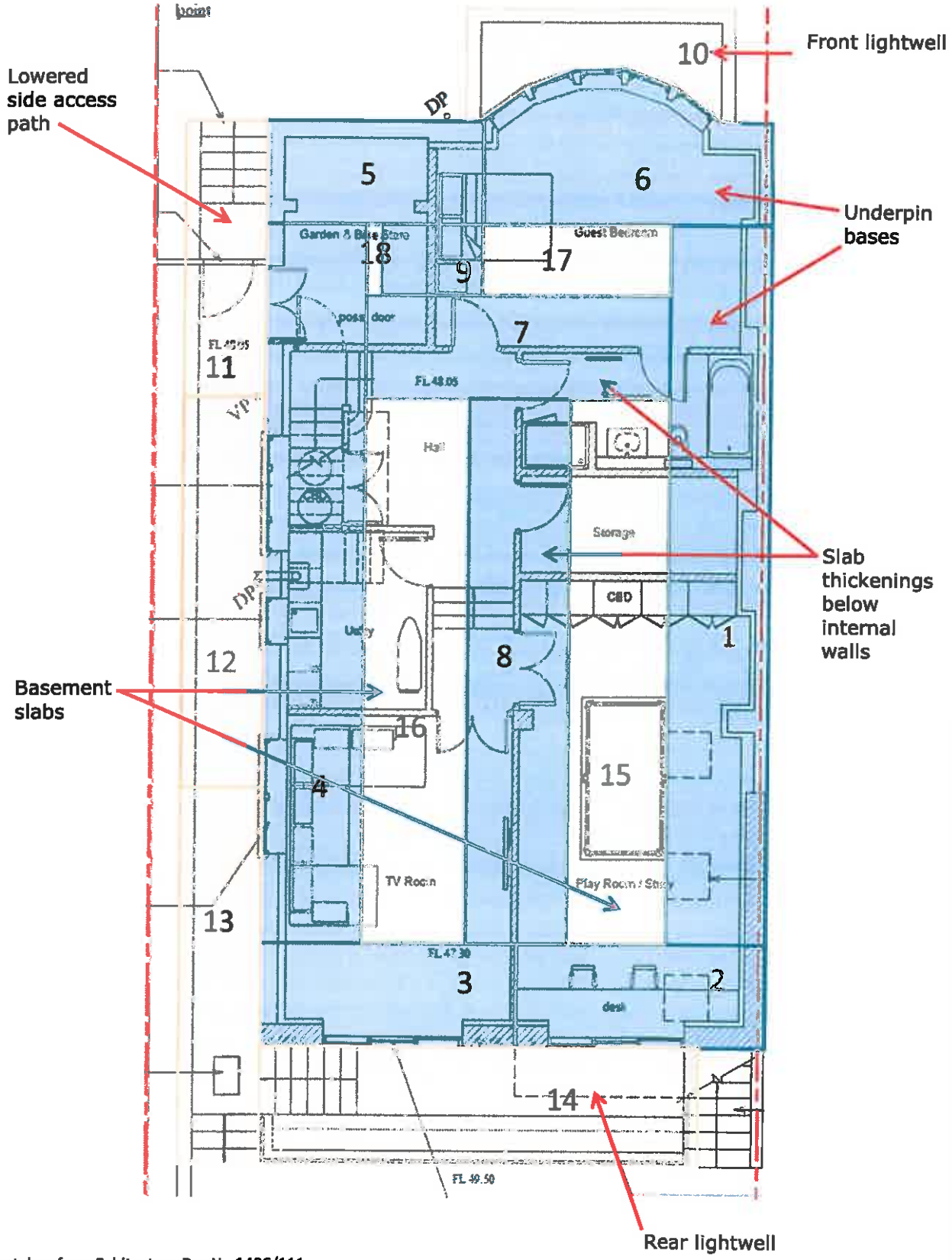
APPENDIX

Project:

13 Ferncroft Avenue, London, NW3 7PG

16467

GabrielGeo Consulting



Plan taken from Bchitecture Drg No.1406/111

Title:	**Layout of Zones used for PDISP Analyses**				Figure:	**A1**	
Date:	July 2015	Checked:	AG	Approved:	KRG	Scale :	NTS

Project:

13 Ferncroft Avenue, London, NW3 7PG

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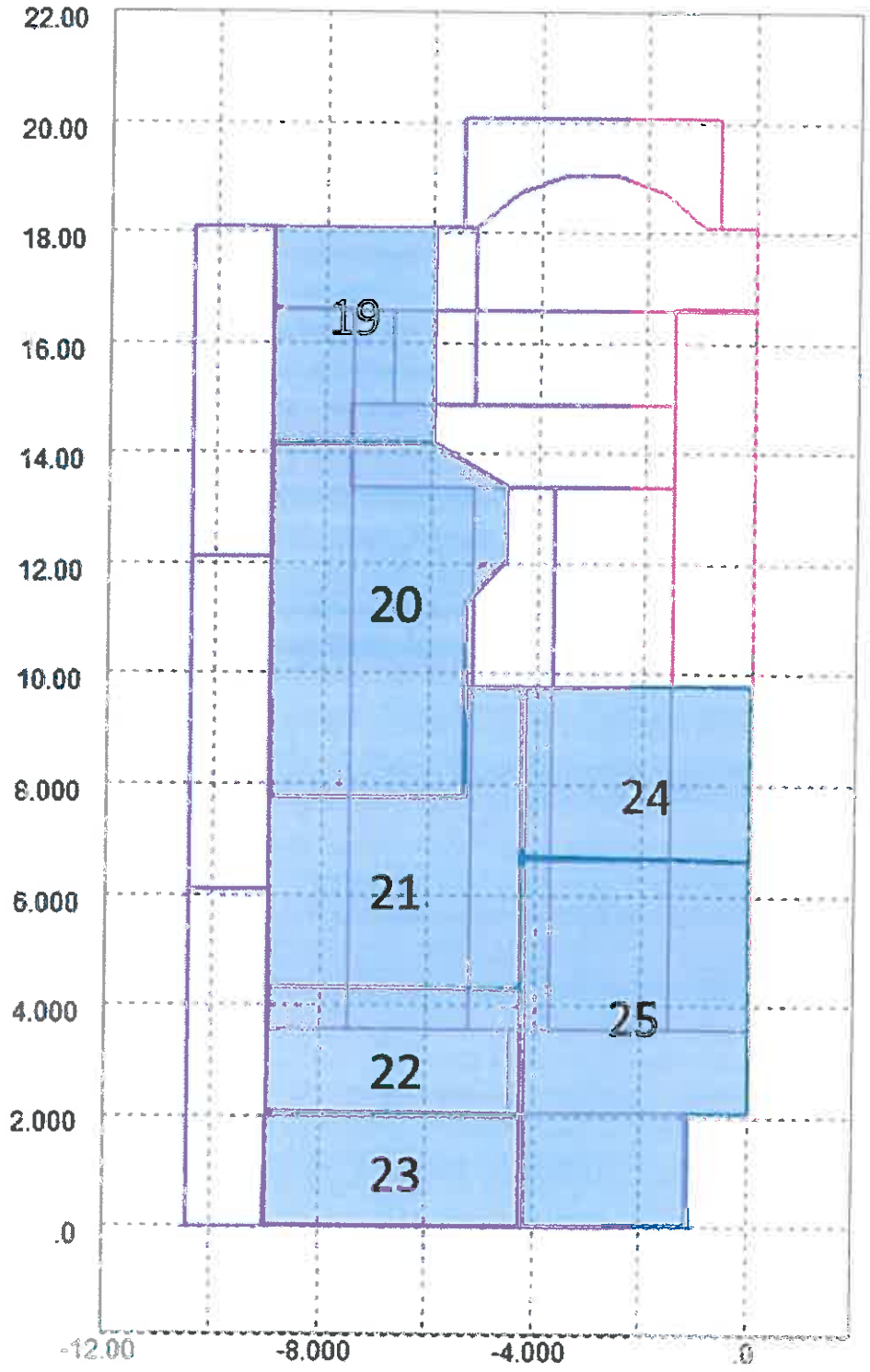

Scale x 1:112 y 1:112

Title:	**Layout of 'Superimposed' Zones used for PDISP Analyses**			Figure:	A2
Date:	July 2015	Checked: AG	Approved: KRG	Scale :	NTS

Project:

13 Ferncroft Avenue, London, NW3 7PG

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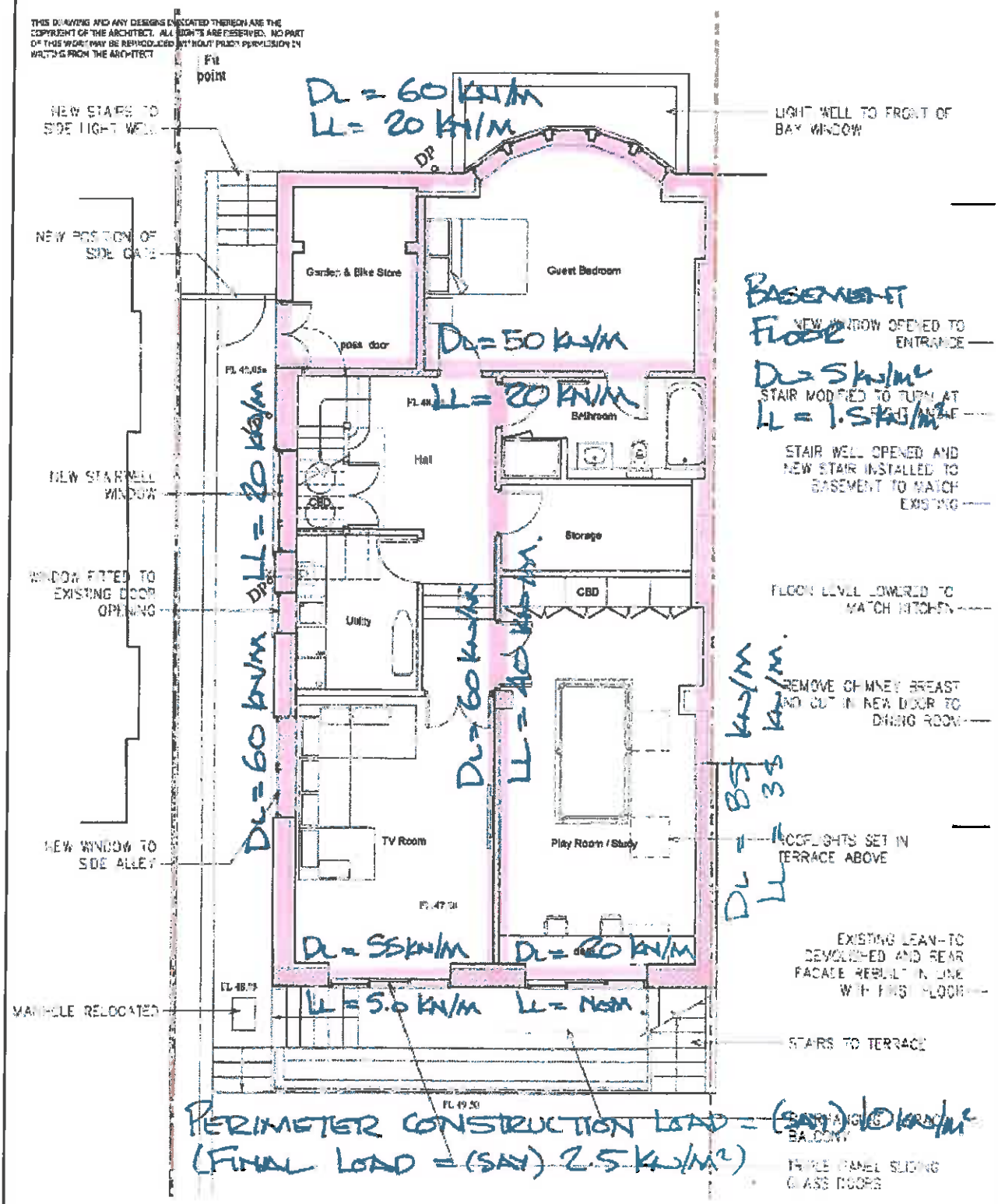

Title:	**Load Takedown at Basement level, by Knapp Hicks & Partners**			Figure:	**A3**
Date:	**July 2015**	Checked:	Approved: **KRG**	Scale :	**NTS**

Project:

13 Ferncroft Avenue, London, NW3 7PG

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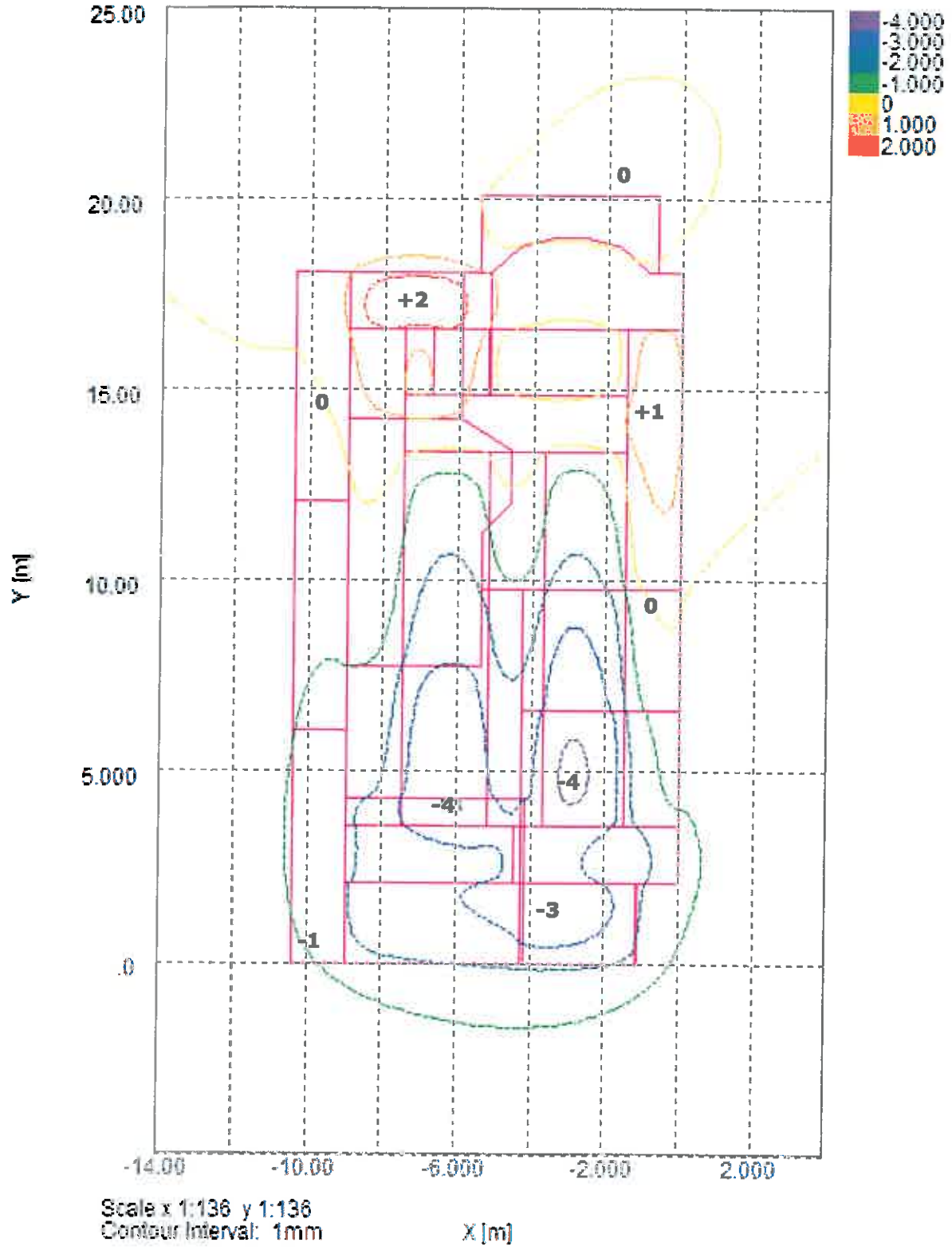
GabrielGeo Consulting

Settlement Contours : Grid 1 at -2.2000m



Scale x 1:136 y 1:136
Contour Interval: 1mm

Title:	**PDISP Output - Contour plot for Stage 2**			Figure:	**A4**
Date:	July 2015	Checked: **AG**	Approved: **KRG**	Scale :	NTS

Project:

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13 Ferncroft Avenue, London, NW3 7PG

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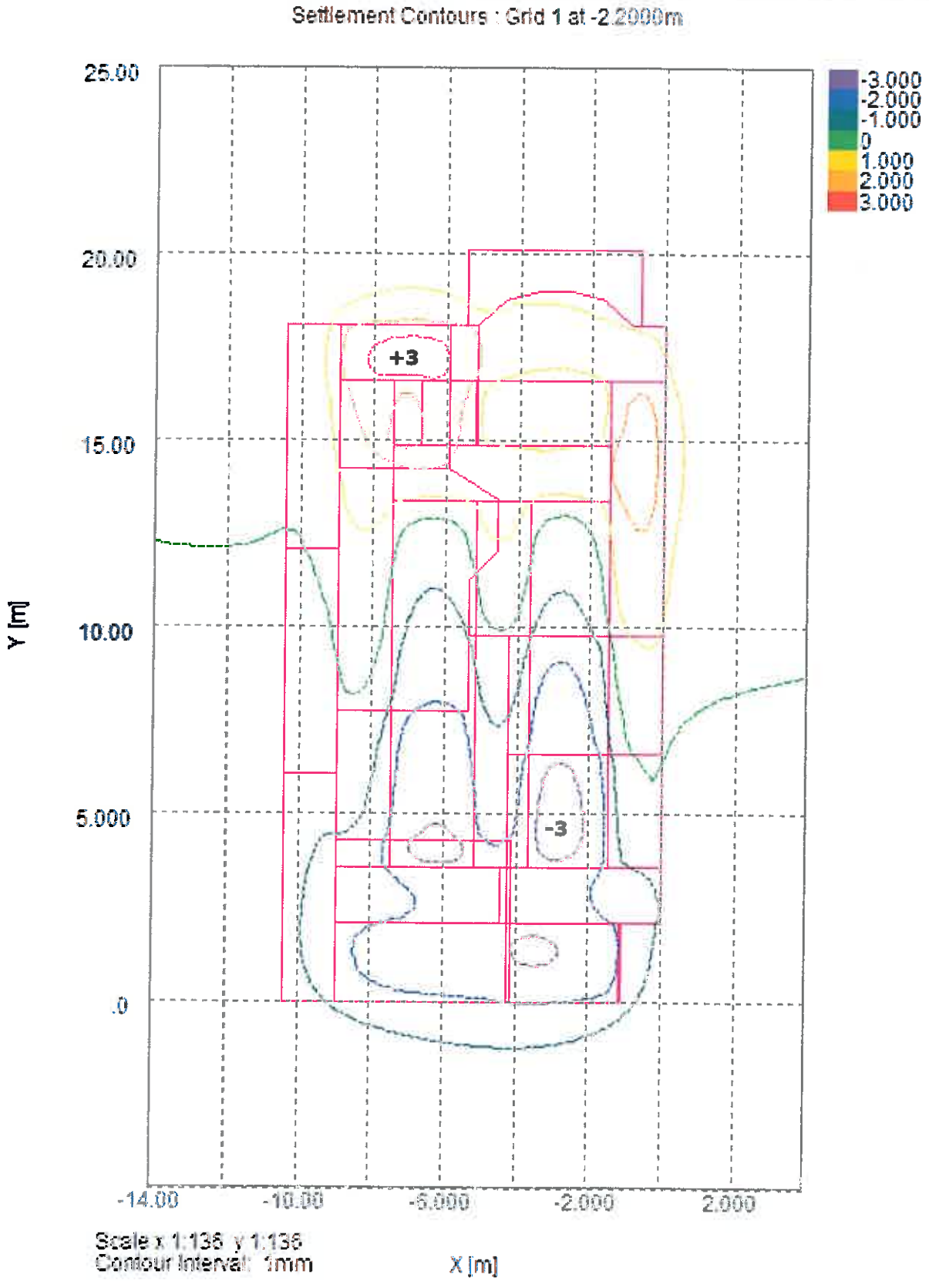


Title:	**PDISP Output - Contour plot for Stage 3**				Figure:	**A5**	
Date:	July 2015	Checked:	**AG**	Approved:	**KRG**	Scale :	NTS

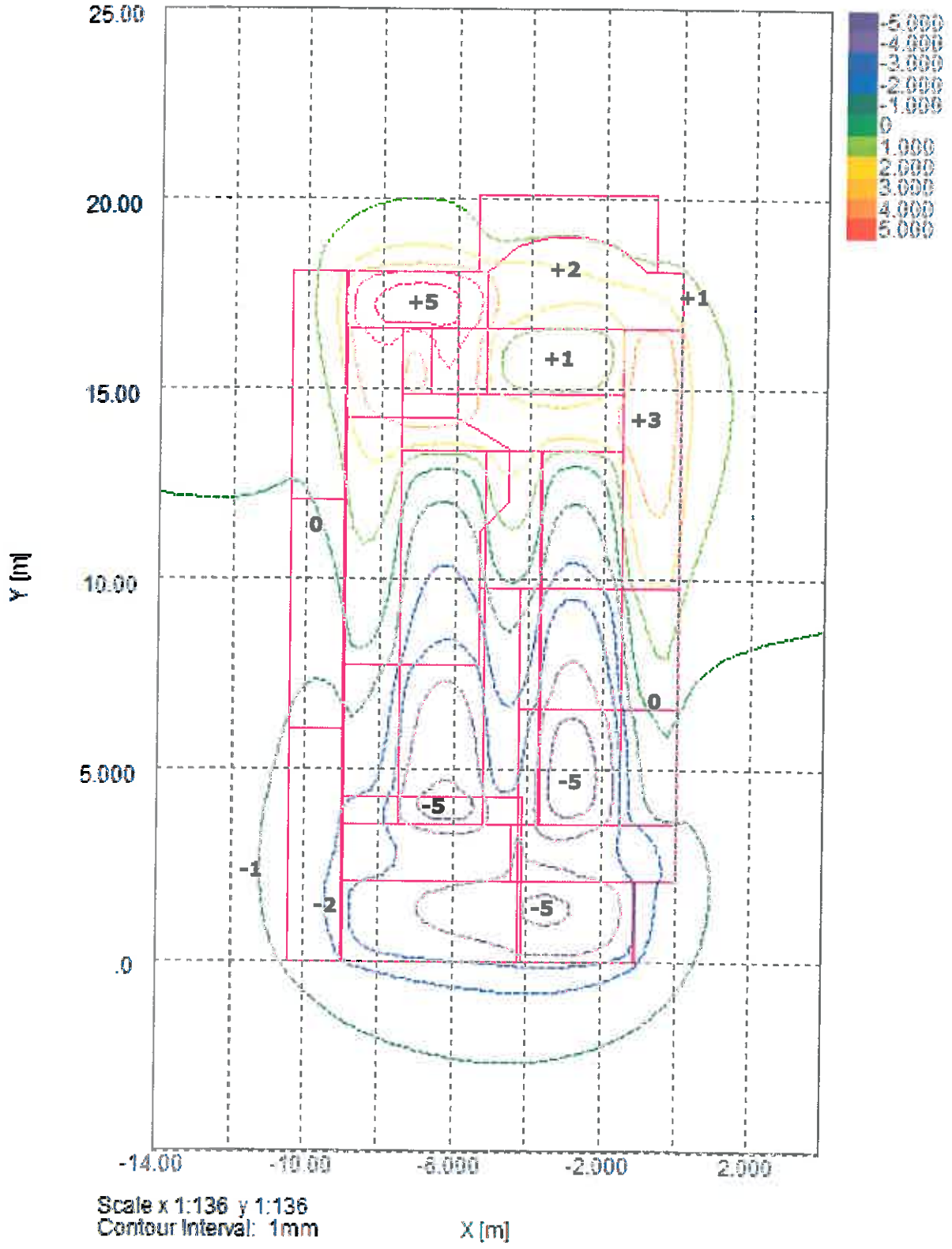
Project:

16467

13 Ferncroft Avenue, London, NW3 7PG

GabrielGeo Consulting

Settlement Contours : Grid 1 at -2.2000m



Scale x 1:136 y 1:136
Contour Interval: 1mm

Title:	**PDISP Output - Contour plot for Stage 4**			Figure:	**A6**
Date:	**July 2015**	Checked: **AG**	Approved: **KRG**	Scale :	**NTS**

32655G/L/003A/RJM
2nd October 2015

E Arboricultural and Planning Integration Report: 13 Ferncroft Avenue, by GHA Trees, Ref GHA/DS/17760:15, dated 11th May 2015

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Arboricultural and Planning Integration Report: 13 Ferncroft Avenue, London, NW3 7PG

11th May 2015

Ref: GHA/DS/17760:15

CONTENTS

Arboricultural Report

Location: 13 Ferncroft Avenue, London, NW3 7PG
Ref: GHA/DS/17760:15
Client: Mr Jim Biek
Date: 11th May 2015
Report Prepared by: Glen Harding Tech Cert (Arbor.A)
Date of Inspection: 8th May 2015

Please note that abbreviations introduced in [Square brackets] *may be used throughout the report.*

Instructions

Issued by – Mr Jim Biek

TERMS OF REFERENCE – GHA Trees were instructed to survey the subject trees within and adjacent to 13 Ferncroft Avenue, London, NW3 7PG, in order to assess their general condition and to provide a planning integration statement for the indicative proposed development that safeguards the long term well being of the retained trees in a sustainable manner.

Executive Summary

The proposal for the site is to construct a new basement beneath the existing house, with lightwells to the front and rear. The proposed scheme requires the removal of a small number of relatively insignificant shrubs, which will not significantly impact the local or wider landscape. The retained trees require protection in accordance with industry best practice and BS 5837: 2012 – Trees in relation to design, demolition and construction – recommendations, in order to ensure their longevity.

Documents Supplied

Mr Jim Biek supplied the following documents:

1. Existing layout plans
2. Proposed layout plans
3. Existing elevation plans
4. Proposed elevation plans

Scope of Survey

1.1 The survey is concerned with the arboricultural aspects of the site only.

1.2 The planning status of the trees was not investigated in detail.

1.3 A qualified Arboriculturist undertook the report and site visit and the contents of this report are based on this. Whilst reference may be made to built structure or soils, these are only opinions and confirmation should be obtained from a qualified expert as required.

1.4 Trees in third party properties were surveyed from within the subject property, therefore a detailed assessment was not possible and some (if not all) measurements were estimated.

1.5 No discussions took place between the surveyor and any other party.

1.6 The trees were inspected on the basis of the Visual Tree Assessment method expounded by Mattheck and Breleor (The body language of tree, DoE booklet Research for Amenity Trees No. 4, 1994)

1.7 The survey was undertaken in accord with British Standard 5837: 2012 – Trees in relation to design, demolition and construction – recommendations

1.8 Pruning works will be required to be in accord with British Standard 3998 – 2010 (Tree Work - Recommendations).

1.9 Underground services near to trees will need to be installed in accord with the guidance given in BS5837 together with the National Joint Utilities Group Booklet 4: 2007 Guidelines for the planning, installation and maintenance of utility services in proximity to trees (NJUG4).

1.10 Where hard surfacing may be required in close proximity to trees, BS5837: 2012, and the principles of Arboricultural Practice Note 12: Through the Trees to Development (AAIS) 2007 (APN12) with regards to "no dig" surfacing will be employed.

1.11 Reference is made to the National House Building Council Standards, 2003, chapter 4.2: Building near trees (NHBC).

1.12 The client's attention is drawn to the responsibilities under the Wildlife and Countryside Act (1981).

Survey Method

2.1 The survey was conducted from ground level with the aid of binoculars.

2.2 No tissue samples were taken nor was any internal investigation of the subject trees undertaken.

2.3 No soil samples were taken.

2.4 The height of each subject tree was estimated using a clinometer.

2.5 The stem diameters were measured in line with the requirements set out in BS 5837: 2012 – Trees in relation to design, demolition and construction – recommendations

2.6 The crown spreads were measured with an electronic distometer. Where the crown radius was notably different in any direction this has been noted on the Plan (appendix A), or in the tree table (Appendix B).

2.7 The Root Protection Area (RPA) for each tree is included in the tree table, both as an area, and as the radius of a circle.

2.8 The crown clearance was measured in metres. Where it is significantly lower in one direction, this is noted within the tree table at appendix B.

2.9 All of the trees that were inspected during the site visit are detailed on the plan at Appendix A. Please note that the attached plans are for indicative purposes only, and that the trees are plotted at approximate positions. The trees on this plan are categorised and shown in the following format: COLOUR CODING AND RATING OF TREES:

Category A – Trees of high quality with an estimated remaining life expectancy of at least 40 years. Colour = light green crown outline on plan.

Category B – Trees of moderate quality with an estimated remaining life expectancy of at least 40 years. Colour = mid blue crown outline on plan.

Category C – Trees of low quality with an estimated remaining life expectancy of at least 40 years, or young trees with a stem diameter below 150mm. Colour = uncoloured crown outline on plan.

Category U – Those in such a condition that they cannot realisitically be retained as living trees in the context of the current land use for longer than 10 years. Colour = red crown outline on plan.

The crowns of those trees that are proposed for removal, or trees where the crown spread is deemed insignificant in relation to the proposed development

are not always shown on the appended plan; however their stem locations are marked for reference.

All references to tree rating are made in accordance with BS 5837: 2012 – Trees in relation to design, demolition and construction – recommendations', Table 1

The Site

3.1 The site is located on Ferncroft Avenue, a residential through road located in the Golders Hill area of north London.

The Subject Trees

4.1 The details of the subject trees are set out in the Schedule at Appendix B.

4.2 The overall quality of the trees is good.

4.3 Of the nine individual trees, and groups of trees surveyed, three have been assessed as BS 5837 category B, with the remaining two trees being assessed as BS 5837 category C.

The Proposal

5.1 The proposal for the site is to construct a new basement beneath the existing house, with lightwells to the front and rear.

5.2 The proposed location of the above structures can be seen on the appended plan.

Arboricultural Impact Assessment

TREE REMOVAL / RETENTION:

6.1 The proposed site layout and all of its associated structures allows for the healthy retention of all of the trees on the site itself, and within nearby adjacent sites; therefore the arboricultural landscape character of the site will be retained.

TREE PRUNING TO ACCOMODATE THE PROPOSAL OR ACCESS TO THE SITE

6.2 The implementation of the proposal does not lead to the requirement to prune any of the retained trees, or shrubs.

ASSESSMENT OF RETAINED TREES ROOT PROTECTION AREAS

6.3 Section 4.6.3 of BS 5837: 2012 states that the Root Protection Area (RPA) of each tree should be assessed by an arboriculturalist considering the likely morphology and disposition of the roots, when known to be influenced by past or existing site conditions.

6.4 T1 and T2 are both in proximity to manmade feature such as footpaths, walls and the nearby public highway. Clearly, these structures may have affected root growth, however it is difficult to determine to what extent as both trees have such structures on all sides of their stems. With this in mind, the RPA's have been drawn as notional circles, as it is felt that these are probably the most reflective assessment of the likely root layout.

6.5 The new lightwell to the front encroaches into an area of the RPA of T2, which equates to less that 1% of the total area; this is deemed to be insignificant.

6.6 The proposed new basement and lightwells are situated outside of the RPA's of all of the other trees proposed for retention, therefore these trees pose no below ground constraints on the new buildings or vice versa.

Post Development Pressure

FUTURE TREE AND STRUCTURE RELATIONSHIPS

7.1 The retained trees are at a satisfactory distance from the proposed new building, and highly unlikely to give rise to any inconvenience.

7.2 Some minor lateral pruning of the retained trees and shrubs may be required in the medium term, however any such work would not have a significant impact on the health or amenity value of these trees.

7.3 The BS3998: 2010 – Recommendations for Tree Work discusses and endorses various methods of pruning that can alleviate the minor inconveniences trees can cause, whilst retaining them in a healthy condition. Methods such as crown reductions (section 13.4) partial or whole, crown lifting (section 13.5) and crown thinning (section 13.6) can be used to both increase light to properties, as well as improve clearances from buildings. Trees in towns are often sited in close proximity to buildings; however residents concerns can be readily appeased with the implementation of regular, well-planned, sensitive pruning.

7.4 Regular inspections of the retained trees by a suitably qualified Arboriculturalist and subsequent remedial works will ensure that the trees are maintained in a suitable manner, to exist in harmony with the new structures and its occupants for many years to come.

SOFT / HARD LANDSCAPING

7.5 All new pathways and soft landscaping areas within the Root Protection Areas (RPA's) of the retained trees should be designed using no-dig, up and over construction and in close co-ordination with the retained Arboriculturalist using porous materials.

Tree Protection Measures and Preliminary Method Statement for Development Works

8.1 TREE PROTECTION BARRIERS
The position of the proposed protective fencing for the site is shown on the plan 'Appendix A' by a pink line. This will be constructed using wooden hoarding to a height of 2metres.

The Fence must be marked with a clear sign reading:

"Construction Exclusion Zone – No Access".

8.2 REMOVAL / DEMOLITION OF THE EXISTING STRUCTURES
Prior to the new buildings construction commencing, the existing buildings will need to be removed. This work must all be undertaken by hand when within the root protection areas of retained trees, with the supervision of the retained arboriculturalist and / or the site manager. The removed material must be stored outside of the RPA of all of the retained trees whilst work commences. Any hard standings which currently support the buildings may need removing in full. These bases must be broken up using a small, lightweight "kango" drill into pieces that can be lifted by hand and removed. If during the work, any roots from the retained trees are discovered in excess of 25mm, the retained arboriculturalist must be contacted immediately to assess the roots and arrange subsequent working methods that will cause no damage to the tree(s).

8.3 GROUND PROTECTION
Where any additional ground protection is required, these areas are to be covered with a permeable membrane, with 100mm layer of compressible woodchip overlaying it; an 18mm marine ply boards will then be secured on top of the woodchip to allow a 1.5tonne mini-digger to access the area without causing major compaction or soil erosion.

8.4 DELIVERY AND STORAGE OF BUILDING MATERIALS
Due to the limited on-site storage space, it may be necessary for bulk deliveries to be split into smaller deliveries. The use of a "just in time" delivery method can also be adopted to reduce the time materials are stored on site before use.

8.5 SITE HUTS, WELFARE FACILITIES AND STORAGE OF EQUIPMENT, MATERIALS AND CHEMICALS
All site huts will be positioned outside of the retained trees RPA's.

8.6 MIXING OF CONCRETE

All mixing of cement / concrete must be undertaken outside of the RPA of all of the retained trees.

8.7 USE CRANES, RIGS AND BOOMS

Precautionary measures must be observed to avoid contact of any retained trees when manoeuvring cranes rigs or booms into position.

8.8 INCOMING SERVICES AND SOAKAWAYS

The existing drainage system has been assessed as suitable for re-use, and it is assumed that the electric and gas cabling is also satisfactory. Any new underground services near to trees will however need to be installed in accord with the guidance given in BS5837 together with the National Joint Utilities Group Booklet 4: 2007 Guidelines for the planning, installation and maintenance of utility services in proximity to trees (NJUG4). When within the RPA of any retained tree, any new service trenches should be excavated using an airspade to avoid any damage to roots. Care must then be taken to ensure the new services are installed so as to avoid any roots present.

8.9 ON SITE SUPERVISION

A detailed supervision programme will be devised by the developer and retained Arboriculturalist, ensuring that Arboricultural supervision is present at the appropriate periods during construction. It is therefore deemed necessary for the retained arboriculturalist to visit the site at the following critical points:

- Erection of protective fencing to ensure it is constructed to the correct specification at the required proximity to ensure the healthy retention of the trees. **Date and time yet to be agreed, however once confirmed, these dates will be sent to the Local Planning Authorities Arboricultural Officer.**

- In addition to the above, random inspections of the site may also be undertaken during construction to ensure the Arboricultural responsibilities are being fulfilled by the developer. A full, written assessment of each visit will be sent the Local Panning Authority and copied to the developer at the expense of the applicant. Any issues relating to tree protection will subsequently be addressed immediately.

Once a commencement date has been confirmed for works on site, a representative from the applicant will contact the relevant officer from the local planning authority to arrange a pre-start site meeting. During this meeting, future requirements for site supervision will be agreed.

8.10 OTHER TREE PROTECTION PRECAUTIONS

- No fires lit on site within 20 metres of any tree to be retained.
- No fuels, oils or substances with will be damaging to the tree shall be spilled or poured on site.
- No storage of any materials within the root protections zone.

8.11 HARD / SOFT LANDSCAPING NEAR RETAINED TREES

All new pathways and hard landscaping areas within the Root Protection Areas (RPA's) of the retained trees should be designed using no-dig, up and over construction techniques, and be specified in close co-ordination with the retained

Arboriculturalist. Porous materials should also be used when surfacing near the trees. No machinery will be used for this work, which must all be done by hand.

8.12 DISMANTLING PROTECTIVE BARRIERS
Protective barriers must only be completely removed when all machinery, and equipment has left site. A minimum of seven days notice must be given to the local planning authority prior to dismantling works begin.

Conclusion

9.1 In conclusion, the principal arboricultural features within the site can be retained and adequately protected during development activities.

9.2 Subject to precautionary measures as detailed above, the proposal will not be injurious to trees to be retained.

9.3 There will be no appreciable post development pressure, and certainly none that would oblige the council to give consent to inappropriate tree works.

Recommendations

10.1 The site works should progress as follows to ensure the healthy retention of the trees.

a. Installation of all tree protection measures.
b. Construction.
c. Soft landscaping.

10.2 Site supervision – An individual e.g. the Site Agent, must be nominated to be responsible for all arboricultural matters on site. This person must:

a. Be present on the site the majority of the time.
b. Be aware of the arboricultural responsibilities.
c. Have the authority to stop any work that is, or has the potential to cause harm to any tree.
d. Be responsible for ensuring that all site personnel are aware of their responsibilities towards trees on site and the consequences of the failure to observe those responsibilities.
e. Make immediate contact with the local authority and / or retained arboriculturalist in the event of any related tree problems occurring whether actual or potential.

10.3 It is recommended, that to ensure a commitment from all parties to the healthy retention of the trees, that details are passed by the architect or agent to any contractors working on site, so that the practical aspects of the above precautions are included in their method statements, and financial provision made for these.

11th May 2015
Signed:

Glen Harding
For and on behalf of GHA Trees

01753643760 / 07884056025

Appendix A

Appendix B

Tree Number	Tree Name (species)	Ht (m)	Calculated Stem Diameter (mm)	Number of Stems	Root Protection Area (Radius, m)	N (m)	E (m)	S (m)	W (m)	Age Class	Clearance (m)	Estimated life expectancy	BS Category	Comments / Recommendations
T1	London Plane	16	750	1	9.00	3.5	3.5	3.5	3.5	M	6	20-40	B1	Local authoirty owned tree; recently crown reduced.
T2	London Plane	16	850	1	10.20	3.5	3.5	3.5	3.5	M	6	20-40	B1	Local authoirty owned tree; recently crown reduced.
G3	Hedge	2.5	50	1	0.60	0.5	0.5	0.5	0.5	M	0	10-20	C2	Screening hedge
T4	Japanese maple	8	100	1	1.20	2	2	2	2	M	2	10-20	C1	Full inspection not possible due to restricted access.
T5	Privet	5	22	5	0.27	2	2	2	2	M	2	10-20	C1	Full inspection not possible due to restricted access. Tree is of little value.
G6	Cypress	6	200	1	2.40	2	2	2	2	M	2	10-20	C2	Full inspection not possible due to restricted access. Trees are of little value.
T7	Japanese maple	6	173	3	2.08	2	2	2	2	M	2	10-20	C1	Full inspection not possible due to restricted access. Tree is of little value.
T8	Cherry	7	206	3	2.47	2.5	2.5	2.5	2.5	M	2.5	10-20	C1	Full inspection not possible due to restricted access. Tree is of little value.
T9	Sycamore	16	800	1	9.60	8	8	8	8	M	4	20-40	Prov B1	Full inspection not possible due to restricted access.

KEY :

Tree No: Tree number (T= individual tree, G= group of trees, W= woodland)

Crown = the leaf bearing part of the tree

Diameter: MS = Multi-stemmed

Age class: Young (Y), Middle aged (MA), Mature (M), Over mature (OM), Veteran (V)

Height (Ht): Measured in metres +/- 1m

Ferncroft Avenue

T2
London Plane
B1

T1
London Plane
B1

G3
Hedge
C2

G6
Cypress
C2

T7
Japanese maple
C1

T8
Cherry
C1

Shrubs

T9
Sycamore
B1

N

5m 10m

9 Pepler Way
Burnham
SLOUGH
SL1 7DS

Tel: 01753 843 760
Mob: 07884 058 025
Email: glen@ghatrees.co.uk
www.ghatrees.co.uk

Site: 13 Ferncroft Avenue, London, NW3 7PG	1-200@A3
Drawing Title: Tree Protection Plan	May 2015

Key:

- Category A
- Category B
- Category C
- Category U

Category
Root Protection Area
Crown Spread
Tree Number
Species
Category
13 Birch B2

Tree Position Approximate (not shown on original survey)

Tree Protection Fencing

32655G/L/003A/RJM
2nd October 2015

F Independent Review of Basement Impact Assessment for Planning application 2014/7674/P, prepared by LBH Wembley, Reference LBH4324, dated March 2015.

Independent Review
of
Basement Impact Assessment for planning application 2014/7674/P
at

13 Ferncroft Avenue
London
NW3 7PG

for
London Borough of Camden

LBH 4324

March 2015

LBH WEMBLEY

Geotechnical & Environmental

Project No: LBH 4324

Report Ref: **LBH 4324 Ver 1.0**

Date: 23rd March 2015

Report approved by:

Digitally signed by Seamus Lefroy-Brooks
DN: cn=Seamus Lefroy-Brooks, o, ou=LBH WEMBLEY, email=seamus@LBHGEO.co.uk, c=GB
Date: 2015.03.23 17:43:59 Z

S R Lefroy-Brooks BSc MSc CEng MICE CGeol FGS CEnv MIEnvSc FRGS SiLC

Principal Engineer

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Contents

Foreword-Guidance Notes

GENERAL

This report has been prepared for a specific client and to meet a specific brief. The preparation of this report may have been affected by limitations of scope, resources or time scale required by the client. Should any part of this report be relied on by a third party, that party does so wholly at its own risk and LBH WEMBLEY Geotechnical & Environmental disclaims any liability to such parties.

The observations and conclusions described in this report are based solely upon the agreed scope of work. LBH WEMBLEY Geotechnical & Environmental has not performed any observations, investigations, studies or testing not specifically set out in the agreed scope of work and cannot accept any liability for the existence of any condition, the discovery of which would require performance of services beyond the agreed scope of work.

VALIDITY

Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances shall be at the client's sole and own risk. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should therefore not be relied upon in the future and any such reliance on the report in the future shall again be at the client's own and sole risk.

THIRD PARTY INFORMATION

The report may present an opinion on the disposition, configuration and composition of soils, strata and any contamination within or near the site based upon information received from third parties. However, no liability can be accepted for any inaccuracies or omissions in that information.

1. Introduction

It is proposed to construct a single storey basement beneath the footprint of the existing house, extending the depth of the existing undercroft/cellar by approximately 2m.

1.1 Brief

LBH WEMBLEY Geotechnical & Environmental have been commissioned to provide an Independent assessment of information submitted against the requirements of LDF policy DP27 (but also including CS5, CS14, CS15, CS17, CS18, DP23, DP24, DP25 and DP26 – as stated at paragraphs 1.5 and 1.6 of CPG4) and with reference to the procedures, processes and recommendations of the Arup Report and CPG4 2013.

1.2 Report Structure

This report commences with a description of the LDF policy requirements, and then considers and comments on the submission made and details any concerns in regards to:

1. The level of information provided (including the completeness of the submission and the technical sufficiency of the work carried out)
2. The proposed methodologies in the context of the site and the development proposals
3. The soundness of the evidence presented and the reasonableness of the assessments made.
4. The robustness of the conclusions drawn and the mitigation measures proposed in regard to:
    a. maintaining the structural stability of the building and any neighbouring properties
    b. avoiding adversely affecting drainage and run-off or causing other damage to the water environment and
    c. avoiding cumulative impacts on structural stability or the water environment in the local area

1.3 Information Provided

The information studied comprises the following:

1. Basement Impact Assessment by Knapp Hicks & Partners Limited, dated October 2014, Ref: 32655/R/001/RJM
2. Design Statement by Bchitecture, dated December 2014, unreferenced
3. Drawings of Existing by Bchitecture, dated September 2014, Ref: 1406 Drawings 101/- to 106/-
4. Drawings of Proposed by Bchitecture, dated September 2014, Ref: 1406 Drawings 110/A to 112/A, 113/B, 114/A, 115/A and 116/-

2. Policy DP27 – Basements and Lightwells

The CPG4 Planning Guidance on Basements and Lightwells refers primarily to Planning Policy DP27 on Basements and Lightwells.

The DP27 Policy reads as follows:

In determining proposals for basement and other underground development, the Council will require an assessment of the scheme's impact on drainage, flooding, groundwater conditions and structural stability, where appropriate. The Council will only permit basement and other underground development that does not cause harm to the built and natural environment and local amenity and does not result in flooding or ground instability. We will require developers to demonstrate by methodologies appropriate to the site that schemes:

a) maintain the structural stability of the building and neighbouring properties;
b) avoid adversely affecting drainage and run-off or causing other damage to the water environment;
c) avoid cumulative impacts upon structural stability or the water environment in the local area;

and we will consider whether schemes:

d) harm the amenity of neighbours;
e) lead to the loss of open space or trees of townscape or amenity value;
f) provide satisfactory landscaping, including adequate soil depth;
g) harm the appearance or setting of the property or the established character of the surrounding area; and
h) protect important archaeological remains.

The Council will not permit basement schemes which include habitable rooms and other sensitive uses in areas prone to flooding. In determining applications for lightwells, the Council will consider whether:

i) the architectural character of the building is protected;
j) the character and appearance of the surrounding area is harmed; and
k) the development results in the loss of more than 50% of the front garden or amenity area.

In addition to DP27, the CPG4 Guidance on Basements and Lightwells also supports the following Local Development Framework policies:

Core Strategies:

- CS5 Managing the impact of growth and development
- CS14 Promoting high quality places and conserving our heritage
- CS15 Protecting and improving our parks and open spaces & encouraging biodiversity
- CS17 Making Camden a safer place
- CS18 Dealing with our waste and encouraging recycling

Development Policies:

- DP23 Water
- DP24 Securing high quality design
- DP25 Conserving Camden's heritage
- DP26 Managing the impact of development on occupiers and neighbours

This report makes some specific further reference to these policies but relies essentially upon the technical guidance provided by the Council in November 2010 to assist developers to ensure that they are meeting the requirements of DP27, which is known as the Camden Geological, Hydrogeological and Hydrological Study, Guidance for Subterranean Development (CGHHS), and was prepared by Arup.

3. Assessment of Adequacy of Information Provided

3.1 Basement Impact Assessment Stages

The methodology described for assessing the impact of a proposed basement with regard to the matters described in DP27 takes the form of a staged approach.

3.1.1 Stage 1: Screening

Screening uses checklists to identify whether there are matters of concern (with regard to hydrogeology, hydrology or ground stability) which should be investigated using a BIA (Section 6.2 and Appendix E of the CGHSS) and is the process for determining whether or not a BIA is required. There are three checklists as follows:

- subterranean (groundwater) flow
- slope stability
- surface flow and flooding

3.1.1.1 Subterranean (Groundwater) Flow

A screening checklist for the impact of the proposed basement on groundwater **is** included in the BIA (Document 1).

This identifies the following potential issues of concern:

- **The site is located directly above an aquifer.**
- **The proposed basement will extend beneath the water table surface.**

3.1.1.2 Stability

A screening checklist for the impact of the proposed basement on land stability **is** included in the BIA (Document 1).

This identifies the following potential issues of concern:

- **There is a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site.**
- **The site is within an aquifer.**
- **The proposed basement will extend beneath the water table such that dewatering may be required during construction.**
- **The proposed basement will significantly increase the differential depth of foundations relative to the neighbouring properties.**

3.1.1.3 Surface Flow and Flooding

A screening checklist for the impact of the proposed basement on surface water flow and flooding **is** included in the BIA (Document 1).

This identifies no potential issues of concern.

3.1.2 Stage 2: Scoping

Where the checklist is answered with a "yes" or "unknown" to any of the questions posed in the flowcharts, these matters are carried forward to the scoping stage of the BIA process.

The scoping produces a statement which defines further the matters of concern identified in the screening stage. This defining should be in terms of ground processes, in order that a site specific BIA can be designed and executed (Section 6.3 of the CGHSS).

Checklists have been provided in the BIA and there **is** scoping stage described in the BIA.

The issues identified from the checklists as being of concern have been assigned bold text in the previous sections and are as follows:

- **The site is located directly above an aquifer.**
  The guidance advises that the basement may extend into the underlying aquifer and thus affect the groundwater flow regime.

- **The proposed basement will extend beneath the water table surface.**
  The guidance advises that the groundwater flow regime may be altered by the proposed basement. Changes in flow regime could potentially cause the groundwater level within the zone encompassed by the new flow route to increase or decrease locally.
  For existing nearby structures then the degree of dampness or seepage may potentially increase as a result of changes in groundwater level.
  The guidance advises that dewatering can cause ground settlement. The zone of settlement will extend for the dewatering zone, and thus could extend beyond a site boundary and affect neighbouring structures. Conversely, an increase in water levels can have a detrimental effect on stability.

- **There is a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site.**
  The guidance advises that there are multiple potential impacts depending on the specific setting of the basement development. For example, in terraced properties, the implications of a deepened basement/foundation system on neighbouring properties should be considered.

- **The proposed basement will significantly increase the differential depth of foundations relative to the neighbouring properties.**
  The guidance advises that excavation for a basement may result in structural damage to neighbouring properties if there is a significant differential depth between adjacent foundations.

3.1.3 Stage 3: Site Investigation and Study

Site investigation and study is undertaken to establish the baseline conditions. This can be done by utilising existing information and/or by collecting new information (Section 6.4 of the CGHSS).

The site investigation submitted comprised two window sampler boreholes constructed to 4m depth and two hand-dug trial pits undertaken to expose existing foundations in October 2014. Standpipes were installed in the two borehole locations and water levels were monitored on three occasions.

3.1.4 Stage 4: Impact Assessment

Impact assessment is undertaken to determine the impact of the proposed basement on the baseline conditions, taking into account any mitigation measures proposed (Section 6.5 of the CGHSS).

The submitted BIA (Document 1) does include an Impact Assessment stage and the following statements are made:

- **The site is located directly above an aquifer.**
- **The proposed basement will extend beneath the water table surface.**
  "...basement excvations (sic) *and associated ground treatment will penetrate below the groundwater by approximately 1m to 1.5m, i.e. to approximately 45.5mASD to 46.0mASD. Note: this will only affect the rear half of the basement as we expect that it wil* (sic) *be possible to construct the front half of the basement by conventional hit and miss underpinning."*

  "The affected strata will be permeable and therefore it is considered that the groundwater will be able to flow around the ground affected by the basement where it intersects the water table"

  "It is considered that, subject to ongoing monitoring and the preparation and approval of a detailed methodology for the construction, the basement will have a negligible impact upon the groundwater flow regime in this area"

  "It is recommended that specialist advice be sought as required to confirm appropriate groundwater control measures both for the temporary and the permanent works. Knapp Hicks recommend grouting to control groundwater during construction, in particular around and underneath the rear half of the proposed basement to ensure stability throughout the works."

- **There is a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site.**
  "...the soils have been classified as typically medium to high shrinkage potential and so it is possible that property on Ferncroft Avenue may have been affected by shrink-swell subsidence."
  "...we would recommend that the structural designer review the tree species and heights along the site boundary and ensure that potential heave I shrinkage is taken into consideration."

- **The proposed basement will significantly increase the differential depth of foundations relative to the neighbouring properties.**

  "It will be necessary to undertake some underpinning of the shared wall with No15 prior to commencement of construction of the proposed basement at No13. Underpinning of No11 should not be required but a party wall investigation is recommended to confirm the detail and depth of foundations to No11."

  "...it is feasible that the proposed scheme can be constructed by a competent contractor without causing damage to adjacent properties and infrastructure. However, this is conditional on the Basement Contractor, and their structural engineers, giving full consideration in their design and construction methodology to the location of the site, and all neighbouring properties and infrastructure, in relation to their proposed method of basement construction, the form of construction of all affected or potentially affected structures and infrastructure, and all appertaining ground and groundwater conditions."

"Assessment of potential movement associated with the proposed methodology should be carried out by the specialist grouting contractor. Movement assessment should also consider the effects of the construction along the change in levels between front and back of the basement."

"...the proposed scheme is expected to have minimal impact upon neighbouring properties on condition that the Construction Method Statement is prepared by a competent individual and strictly adhered to during construction"

3.2 The Audit Process

The audit process is based on reviewing the BIA against the criteria set out in Section 6 of the CGHSS and requires consideration of specific issues:

3.2.1 Qualifications / Credentials of authors

Check qualifications / credentials of author(s):

Qualifications required for assessments

Surface flow and flooding	A Hydrologist or a Civil Engineer specialising in flood risk management and surface water drainage, with either: • The "CEng" (Chartered Engineer) qualification from the Engineering Council; or a Member of the Institution of Civil Engineers ("MICE"); or • The "C.WEM" (Chartered Water and Environmental Manager) qualification from the Chartered Institution of Water and Environmental Management.
Subterranean (groundwater) flow	A Hydrogeologist with the "CGeol" (Chartered Geologist) qualification from the Geological Society of London.
Land stability	A Civil Engineer with the "CEng" (Chartered Engineer) qualification from the Engineering Council and specialising in ground engineering; or A Member of the Institution of Civil Engineers ("MICE") and a Geotechnical Specialist as defined by the Site Investigation Steering Group. With demonstrable evidence that the assessments have been made by them in conjunction with an Engineering Geologist with the "CGeol" (Chartered Geologist) qualification from the Geological Society of London.

Surface flow and flooding: The report meets the requirements.

Subterranean (groundwater) flow: The report meets the requirements.

Land stability: The report meets the requirements.

3.2.2 BIA Scope

Check BIA scope against flowcharts (Section 6.2.2 of the CGHSS).

Document 1 state that "*Some mature trees are present in the gardens to the rear of the site. Root Protection Areas (as derived using BS5837:2005, Trees in relation to construction) will be confirmed in due course but the proposed scheme is not expected to impinge significantly upon them.*" Also stated "*It is not anticipated that any trees will affect or be affected by the proposed scheme but it is recommended that the mature trees located in the neighbouring gardens and along the road are assessed by a suitably qualified arboriculturalist prior to commencement of construction so that Root Protection Areas etc are confirmed and may be clearly marked out.*" It is therefore unclear as to whether the proposed development will fall within a tree protection zone and what impact this may have.

3.2.3 Description of Works

Does the description of the proposed development include all aspects of temporary and permanent works which might impact upon geology, hydrogeology and hydrology?

A specific construction methodology has not yet been developed.

3.2.4 Investigation of Issues

Have the appropriate issues been investigated? This includes assessment of impacts with respect to DP27 including land stability, hydrology, hydrogeology.

A specific ground movement and damage assessment has not yet been undertaken.

3.2.5 Mapping Detail

Is the scale of any included maps appropriate? That is, does the map show the whole of the relevant area of study and does it show sufficient detail?

Yes.

3.2.6 Assessment Methodology

Have the issues been investigated using appropriate assessment methodology? (Section 7.2 of the CGHSS).

A specific ground movement and damage assessment has not yet been undertaken.

3.2.7 Mitigation

Has the need for mitigation been considered and are appropriate mitigation methods incorporated in the scheme? (Section 5 of the CGHSS)

The submission includes recommendations for appropriate mitigation methods but a specific method statement and mitigation has not yet been developed.

3.2.8 Monitoring

Has the need for monitoring been addressed and is the proposed monitoring sufficient and adequate?

The need for structural monitoring has been identified but a detailed scheme has not yet been developed.

3.2.9 Residual Impacts after Mitigation

Have the residual (after mitigation) impacts been clearly identified?

The scheme has not yet been developed to a state where any residual impacts can be fully identified.

4. Assessment of Acceptability of Residual Impacts

4.1 Proposed Construction Methodology

The submission includes recommendations for various possible mitigation methodologies but a specific scheme has not yet been developed.

4.2 Soundness of Evidence Presented

The evidence presented appears sound.

4.3 Reasonableness of Assessments

Specific ground movement and damage assessments have not yet been undertaken.

4.4 Robustness of Conclusions and Proposed Mitigation Measures

In the absence of commitment to a specific methodology, the robustness of the conclusions and proposed mitigation measures cannot be judged at this stage.

5. Conclusions

The submitted BIA does reflect the processes and procedures set out in DP27 and CPG4, and includes recommendations for construction. However, in the absence of commitment to a specific methodology and sequence, the present submission does not demonstrate sufficient detail and certainty to ensure accordance with DP27, in respect of:

a. Maintaining the structural stability of the building and any neighbouring properties
b. Avoiding adverse impact on drainage and run-off or causing other damage to the water environment and
c. Avoiding cumulative impacts on structural stability or the water environment

It is suggested that the concerns about the submission that have been raised in sections 3 and 4 of this document can be addressed by the applicant by way of further submission prior to commencement.

5.1 Further Information Required

It is considered that in order to meet the requirements of DP27 further information is required to be submitted and approved either as a condition of planning approval or by a Basement Construction Plan (BCP) secured by a Section 106 agreement:

- Condition Surveys of 11 and 15 Ferncroft Avenue
- Trial pits to confirm details of the foundations to 11 and 15 Ferncroft Avenue.
- A scheme of groundwater investigation and monitoring, including trial excavations to the proposed formation level, to inform the selection of appropriate groundwater control measures.
- A definitive temporary works design and sequence incorporating the recommendations of the report 3655/R/001/RJM by Knapp Hicks & Partners dated October 2014
- A specific ground movement and damage category assessment.
- A detailed monitoring and contingency plan.
- The appointment of a suitably qualified engineer to take responsibility for the design of the temporary works.

32655G/L/003A/RJM
2nd October 2015