CampbellReith
consulting engineers

29 New End
London NW3 1JD

Basement Impact Assessment
Audit

For

London Borough of Camden

Project Number: 12336-80
Rev: D1

July 2016

Campbell Reith Hill LLP
Friars Bridge Court
41-45 Blackfriars Road
London
SE1 8NZ

T:+44 (0)20 7340 1700
F:+44 (0)20 7340 1777
E:london@campbellreith.com
W:www.campbellreith.com

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Author	A J Marlow, BSc CEng MIStructE FConsE
Project Partner	E M Brown, BSc MSc CGeol FGS
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Contents

Appendices

1.0 NON-TECHNICAL SUMMARY

1.1. CampbellReith was instructed by London Borough of Camden (LBC) to carry out an audit on the Basement Impact Assessment submitted as part of the Planning Submission documentation for 29 New End (planning reference 2016/2833/P). The basement is considered to fall within Category C as defined by the Terms of Reference.

1.2. The Audit reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development in accordance with LBC's policies and technical procedures.

1.3. CampbellReith was obtained the latest revision of submitted documentation from LBC's website and received information directly from the BIA author and reviewed it against an agreed audit check list.

1.4. The BIA and its constituent appendices have been carried out by well-known firms of consultants using individuals who possess suitable qualifications.

1.5. The BIA has confirmed that an existing former nurses home will be demolished and replaced by a seven storey residential building including a basement. The site slopes steeply from rear to front resulting in a 4 metre deep basement at the front and a 10 metre deep, three storey basement at the rear. The proposed basement is approximately 38 metres x 32 metres on plan and is surrounded by listed buildings.

1.6. The BIA identifies that the proposed basement will be founded within the sands and clay bands of the Bagshot Formation and Claygate Member.

1.7. Whilst it is accepted that the approach adopted in the Ground Movement Assessment is appropriate, a number of queries have been raised with respect to the assumptions made including wall stiffness, building and soil parameters. The input and output data are requested.

1.8. It is accepted that the monitoring strategy and trigger levels may be agreed at a later stage. Due to the sensitivity of the surrounding structures, we would concur with ABA's request for the installation of inclinometers in the retaining wall.

1.9. It is agreed that two distinct groundwater bodies existing within the depth of the basement but clarification is requested regarding hydraulic continuity of these together with details of software and input parameters of the Conceptual Site Model contained within the BIA's Hydrology Report.

1.10. The Hydrology Report identifies the need for a groundwater bypass pipework system to be introduced within the building in order to protect Lawn House, the Duke of Hamilton pub and 27 New End. Further information has been requested regarding the proposal's efficiency and construction details.

1.11. The BIA has shown that the area of hard standing will increase and proposed attenuation through adoption of a green roof and, possibly, infiltration SUDS. Clarification of the proposed methodology has been requested.

1.12. It is accepted that the site is not located within the Hampstead Heath pond chain catchment area, has no anticipated risk of groundwater or fluvial flooding and has no past history of flooding.

1.13. Queries and requests for further information are discussed in Section 4 and summarised in Appendix 2.

2.0 INTRODUCTION

2.1. CampbellReith was instructed by London Borough of Camden (LBC) on 8 July 2016 to carry out a Category C Audit on the Basement Impact Assessment (BIA) submitted to discharge the Condition contained in the Planning Approval at Appeal for 29 New End, Camden Reference 2016/2833/P.

2.2. The Audit was carried out in accordance with the Terms of Reference set by LBC. It reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development.

2.3. A BIA is required for all planning applications with basements in Camden in general accordance with policies and technical procedures contained within

- Guidance for Subterranean Development (GSD). Issue 01. November 2010. Ove Arup & Partners.
- Camden Planning Guidance (CPG) 4: Basements and Lightwells.
- Camden Development Policy (DP) 27: Basements and Lightwells.
- Camden Development Policy (DP) 23: Water.

2.4. The BIA should demonstrate 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; and,

c) avoid cumulative impacts upon structural stability or the water environment in the local area

and evaluate the impacts of the proposed basement considering the issues of hydrology, hydrogeology and land stability via the process described by the GSD and to make recommendations for the detailed design.

2.5. LBC's Audit Instruction described the planning proposal as the *"Erection of a 7 storey block to provide 17 self contained residential (Class C3), (comprising 2 x studio, 5 x 2 bedroom, 6 x 3 bedroom, and 4 x 4 bedroom units) with associated roof terraces, plus new vehicular access and basement parking for 17 cars; new pedestrian access, refuse store and substation on front boundary; green roofs; communal open space and landscaping, following demolition of existing nurses' hostel (Sui Generis)."*

and confirmed that the basement proposals did not involve a listed building, although the following listed buildings (designated heritage assets) are in close proximity to the site: Lawn House (grade II), nos. 10-14 Elm Row (grade II); Christ Church Primary School (grade II), Hampstead Parish Workhouse, now known as Kendall's Hall (grade II), nos. 10, 12 & 14 New End (grade II).

2.6. CampbellReith was provided, on 24 May 2016, with a CD providing the following relevant documents for audit purposes:

· Basement Impact Assessment (BIA) dated May 2016 by Fluid Structures

This contained within its appendices the following information:

- Land Stability Assessment dated May 2016 by Soil Consultants.
- Hydrological Study dated May 2016 by Stephen Buss Environmental Consultancy Ltd.
- Ground Movement Assessment dated May 2016 by A-Squared Studios.
- Ground Investigation Report dated May 2016 by Soil Consultants.
- Construction Sequence Methodology undated by Belheim House Construction incorporating Temporary Works Proposals by Wentworth House Partnership.
- Movement Monitoring Method Statement dated April 2016 by Landscape Engineering Ltd.

2.7. CampbellReith was also provided with a letter prepared by Alan Baxter Associates, dated 7 July 2016, which contained an initial structural review of the BIA, together with a response prepared by the applicant's engineer, dated 22 July 2016. These letters are considered in the audit and presented in Appendix 3.

3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are BIA Author(s) credentials satisfactory?	Yes	BIA and Appendices.
Is data required by Cl.233 of the GSD presented?	Yes	
Does the description of the proposed development include all aspects of temporary and permanent works which might impact upon geology, hydrogeology and hydrology?	Yes	
Are suitable plan/maps included?	Yes	BIA Appendix G.
Do the plans/maps show the whole of the relevant area of study and do they show it in sufficient detail?	Yes	
Land Stability Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	BIA Appendix G, Section 3.
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	BIA Section Appendix H, Section 2.
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	BIA Section Appendix H, Section 3.
Is a conceptual model presented?	Yes	BIA Appendix H, Section 4.
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	Yes	BIA Appendix G, Section 4.

Item	Yes/No/NA	Comment
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	Yes	BIA Appendix H, Sections 3 & 4.
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	Yes	BIA Appendix H, Sections 3 &4.
Is factual ground investigation data provided?	Yes	BIA Appendix G, Section 5 & Appendix J.
Is monitoring data presented?	Yes	BIA Appendix H, Section 4.4.
Is the ground investigation informed by a desk study?	Yes	BIA Appendix G, Section 5.
Has a site walkover been undertaken?	Yes	
Is the presence/absence of adjacent or nearby basements confirmed?	Yes	BIA Appendix H, Section 4.5.
Is a geotechnical interpretation presented?	Yes	BIA Appendix J, Section 5.
Does the geotechnical interpretation include information on retaining wall design?	Yes	BIA Appendix J, Section 5.5.
Are reports on other investigations required by screening and scoping presented?	N/A	
Are baseline conditions described, based on the GSD?	Yes	
Do the base line conditions consider adjacent or nearby basements?	Yes	
Is an Impact Assessment provided?	Yes	BIA Appendix G & H.
Are estimates of ground movement and structural impact presented?	Yes	BMA Appendix I.

Item	Yes/No/NA	Comment
Is the Impact Assessment appropriate to the matters identified by screen and scoping?	Yes	
Has the need for mitigation been considered and are appropriate mitigation methods incorporated in the scheme?	Yes	BIA Section 15, Appendix H, Section 6 & Appendix K.
Has the need for monitoring during construction been considered?	Yes	BIA Section 17 & Appendix M
Have the residual (after mitigation) impacts been clearly identified?	Yes	BIA Sections 18-21.
Has the scheme demonstrated that the structural stability of the building and neighbouring properties maintained?	Yes	
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	
Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area?	Yes	
Does report state that damage to surrounding buildings will be no worse than Burland Category 2?	Yes	BIA Section 18.
Are non-technical summaries provided?	Yes	BIA Section 22.

4.0 DISCUSSION

4.1. 29 New End has a complicated planning application history which resulted in a June 2012 Application being approved at Appeal with a Condition that a Basement Impact Assessment (BIA) be submitted and approved by London Borough of Camden. CampbellReith was provided with a CD containing the BIA documents by Savills (UK) Limited, Chartered Surveyors, dated 24 May 2016. CampbellReith was instructed to carry out an audit of this BIA information on 8 July 2016. Further information for review was provided to CampbellReith on 28 July 2016 as described in Section 2.

4.2. The BIA appears to be a revised document since it and all of its constituent appendices are dated May 2016. They have been carried out by well-known firms of consultants who possess suitable qualifications and experience.

4.3. The proposed development comprises the demolition of the former nurses home, which had no basement, and its replacement by a new seven storey reinforced concrete building which incorporates a basement for car parking, plantrooms and gymnasium. The ground slopes steeply from the rear (north) of the site towards the front (south) resulting in the basement depth at the front being approximately 4 metres and at the rear approximately 10 metres. The rear existing ground level is roughly level with the proposed second floor while the proposed front entrance area is level with the new ground floor. New End slopes downwards to the east and so the proposed basement will be approximately 2 metres below highway level rising to approximately 4 metres at the highway access to the building. On plan, the proposed basement is approximately 38 metres x 32 metres and to the east, south and west of the site are neighbouring residential properties (Grade II Listed in part) and gardens, public footpath and Christ Church.

4.4. A soils investigation has been carried out by Soil Consultants Ltd (SCL) consisting of 4 no. boreholes to depths of up to 25 metres and 10 no. trial pits to expose existing foundations. These identified varying depths of Made Ground, up to 3.1 metres below ground level, overlying the sands and clay bands of the Bagshot Formation and Claygate Member, and augmented previous investigations carried out in 2010 and 2011. In total, 7 no. boreholes have been installed on the site, all with standpipes, and the latest standpipes have been monitored on four separate occasions. In addition to geotechnical appraisal carried out by SCL, further assessments of the ground conditions have been made by A-squared Studio Engineers Ltd and Stephen Buss Environmental Consulting Ltd.

4.5. The geology of the site, as described above, indicates granular soil layers and shallow groundwater; the BIA correctly identifies the consequential instability risks associated with these and considers mitigation measures in the Construction Sequence Methodology prepared

by Blenheim House Construction, supported by the Wentworth House Partnership (Appendix L of the BIA). The Sequence is generally as follow:

- The basement will be formed by secant piling with multiple levels of propping, progressive excavation to formation level, and then bottom up construction of the RC frame in conjunction with removal of temporary props. Additional bearing and tension piles will be installed where necessary to resist gravity and uplift actions. Sheet piles and gravity retaining walls will be constructed to facilitate the work.

- Prior, and during, the excavation works, a series of well points will be installed to maintain the equilibrium of the existing ground. Any encountered groundwater will drain into the public sewage system under licence to the Local Authority.

- Under slab drainage is to be installed throughout the substructure level.

4.6. The proposed development involves a large excavation on a sloping site surrounded by numerous properties. A great proportion of the ground movement realised in such construction depends on the way works are managed on site and good workmanship and are thus not quantifiable to model even in sophisticated FE methods. In order to maintain the stability and safety of the neighbourhood, it is considered that moderately conservative assumptions should be made in the assessments to account for unforeseen factors during the work.

4.7. A ground movement assessment (GMA) has been prepared by A-squared Studio Engineers Ltd, which includes prediction of likely ground movements using Plaxis 2D Finite Element (FE) modelling. The results of the Plaxis analysis have been used to validate the implementation of empirical relationships between excavation and ground movement presented in CIRIA C580. Building damage has been predicted for affected structures on the basis of CIRIA relationships using the Oasys software package XDisp. Whilst the input and output data for the software packages is required to complete the audit, an initial review of the GMA has identified a number of queries as follows:

- The building dimensions for New End Theatre, Lawn House, and Christ Church Cottage should be reviewed as smaller elements are more vulnerable to damage. New End Theatre appears to be closer to the edge of the excavation than assumed;

- It is understood that the outcomes of the Plaxis analysis were normalised against the excavation depth. It should be clarified what was assumed for H in figure 4.2 of the GMA report, as it is not the same for prediction curves for installation and excavation. Also, it should be confirmed what depth was assumed for retaining walls piles;

- Justification for the assumptions made in the GMA regarding stiffness of cohesive strata is required with confirmation that the SPT N_{60} design profile represents a ‘cautious assessment’;

- It should be clarified what allowance has been made for ground movements during enabling works, i.e. grubbing out of foundations/ substructures and re-profiling of the site including temporary batters;

- Temporary works drawings appear to show sheet pile walls to act as a cantilever (e.g. section A, stages 2A and 2B). It should be confirmed whether this has been incorporated into the assessment;

- It is noted that the proposed retaining walls in east-west direction, i.e. adjacent to Lawn House and Christ Church Cottage, are not retained by any structural element, and thus, form cantilever walls of up to 6.5m high. The GMA assumes excavation in front of a 'high-stiffness' wall which would require them to be propped at all times.

- It is noted that the GMA uses the assumption of 'contiguous piled wall', whilst the proposed construction consists of 'secant' walls that are known to exhibit larger ground movements. It is not considered that this represents a 'cautious assessment'.

4.8. The methodology adopted in the GMA is queried by ABA. Subject to the resolution of the queries noted above, the approach taken is considered appropriate at this stage. However, it is recommended that the GMA is reviewed and, if necessary, revised to reflect the finally adopted construction methodology. At that stage, consideration should be given to importing the movements predicted in the FE analysis for the damage assessment since the maximum movements in propped walls occur at depth.

4.9. It is proposed in the BIA that adjacent properties are monitored by one or two (depending on location) wirelessly controlled bi-planar inclinometers. Additionally Lawn House will be covered by separate level monitoring using traditional survey techniques. The trigger levels are to be provided under separate cover. This is accepted at this stage although the final monitoring regime will have to be agreed with the neighbours party wall surveyors. ABA recommend that inclinometers are installed in the retaining wall and we would concur with this suggestion.

4.10. The interpretation in the BIA Hydrology Report of two distinct groundwater bodies beneath the site is agreed although, on the basis of the response zone for BH103 being isolated in a deeper sand layer, it is queried whether the groundwater elevation recorded in BH103 actually reflects a discrete water bearing sand/granular lens that is hydraulically isolated from the upper aquifer. It is our understanding that the groundwater elevation in BH103 is used to inform both the 'base case' and constant head applied in the numerical model. We would seek clarification of whether the CSM and numerical model assumptions remain valid if BH103 data is not representative of the upper aquifer.

4.11. It is noted that the Conceptual Site Model assumes a uniform aquifer thickness with uniform properties with groundwater continuously discharging downstream. Based on the data reviewed, it is considered feasible that the upper aquifer could be of limited lateral extent and

that the development may result in excavation and removal of a large proportion of the aquifer. This could potentially cut off / remove the existing downstream groundwater discharge pathway for the upper aquifer, potentially increasing the impact of the proposed basement. It is acknowledged that Fluid Structures have advised their intention to adopt a deep borehole soakaway. This should be addressed in the hydrogeological assessment which should include a review of the potential impacts, including to the pavement vaults referred to in ABA's letter of 7 July.

4.12. It is agreed that the proposed development could result in adverse effects with impacts on local basements / properties unless the infiltration is limited. Again, the uncertainty regarding the lateral extent of the upper aquifer and any downstream groundwater discharge mechanism therein raises the possibility of infiltration drainage gradually saturating the laterally limited sand unit (upper aquifer) and increasing potential for localised impacts / flooding.

4.13. Additionally, applying the parameter values in the text (A*K*I, 1.2*50*2.5*0.05) supports a value for the base flow of 7.5m^3/d not the 26m^3/d quoted in the text. It is requested that this and the items described above are clarified and details of the modelling software and input parameters are provided. Installation details for BHA and BH2 are also requested.

4.14. The Hydrology Report also identifies a mitigation measure to protect basements to the west of the development site (Lawn House, The Duke of Hamilton pub and 27 New End) from additional groundwater ingress should groundwater levels rise due to the proposed basement, by the introduction of piezometers installed through the rear basement retaining wall, connected to groundwater bypass pipework within the proposed building, and back into the ground via a French drain constructed along the front boundary wall. Although a schematic section of this proposal is shown on Fluid Structures drawing no. BIA/015 P1, we agree with ABA that further information is should be provided including consideration of the longevity of such a system involving piezometer heads and their distribution along a 32 metre long wall as only 2no. heads are proposed. Further construction details are also requested of the infiltration "French drain" trench.

4.15. The Hydrology Report confirms that the development will increase the area of hardstanding but proposes to attenuate the additional surface water discharge into the drainage system by the use of a green roof and, possibly, infiltration SUDS. The introduction of the latter proposal appears to increase the potential for increased water ingress into the existing basement of the Duke of Hamilton pub and clarification of the proposed methodology to be incorporated is requested.

4.16. We concur with ABA that the horizontal loads imparted to the structural frame by the retaining walls must be evaluated but consider this is a normal part of detail design development.

4.17. It is accepted that the site is not located within the catchment area of the Hampstead Heath pond chain.

4.18. It is accepted that the development site has no anticipated risk of groundwater or fluvial flooding and has no past history of flooding.

5.0 CONCLUSIONS

5.1. The BIA and its constituent appendices have been carried out by well-known firms of consultants using individuals who possess suitable qualifications.

5.2. The BIA has confirmed that an existing former nurses home will be demolished and replaced by a seven storey residential building including a basement. The site slopes steeply from rear to front resulting in a 4 metre deep basement at the front and a 10 metre deep, three storey basement at the rear. The proposed basement is approximately 38 metres x 32 metres on plan and is surrounded by listed buildings.

5.3. The BIA identifies that the proposed basement will be founded within the sands and clay bands of the Bagshot Formation and Claygate Member.

5.4. Whilst it is accepted that the approach adopted in the Ground Movement Assessment is appropriate, a number of queries have been raised with respect to the assumptions made including wall stiffness, building and soil parameters. The input and output data are requested.

5.5. It is accepted that the monitoring strategy and trigger levels may be agreed at a later stage. Due to the sensitivity of the surrounding structures, we would concur with ABA's request for the installation of inclinometers in the retaining wall.

5.6. It is agreed that two distinct groundwater bodies existing within the depth of the basement but clarification is requested regarding hydraulic continuity of these together with details of software and input parameters of the Conceptual Site Model contained within the BIA's Hydrology Report.

5.7. The Hydrology Report identifies the need for a groundwater bypass pipework system to be introduced within the building in order to protect Lawn House, the Duke of Hamilton pub and 27 New End. Further information has been requested regarding the proposal's efficiency and construction details.

5.8. The BIA has shown that the area of hard standing will increase and proposed attenuation through adoption of a green roof and, possibly, infiltration SUDS. It is acknowledged that a deep borehole soakaway is proposed. This should be considered in the revised hydrogeological assessment.

5.9. It is accepted that the site is not located within the Hampstead Heath pond chain catchment area, has no anticipated risk of groundwater or fluvial flooding and has no past history of flooding.

Appendix 1: Residents' Consultation Comments

Residents' Consultation Comments

Surname	Address	Date	Issue raised	Response
Henderson	Lawn House	07.07.16	Alan Baxter letter report reviewing the effects of BIA proposals on Lawn House	See 4.3 to 4.16

Appendix 2: Audit Query Tracker

Audit Query Tracker

Query No	Subject	Query	Status	Date closed out
1	Stability	Details of sheet pile installation to minimise damage to adjacent structures.	Open	
2	Stability	Ground movement assessment to be resubmitted in accordance with requirements of item 4.7.	Open	
3	Hydrogeology	Clarification of items 4.8 to 4.12 and details of modelling software and input parameters.	Open	
4	Hydrogeology	Installation details for BHA and BH2.	Open	
5	Hydrogeology	Details of longevity of piezometer installation and its distribution. Construction details of French drain.	Open	
6	Hydrology	Clarification of infiltration SUDS methodology.	Open	

Appendix 3: Supplementary Supporting Documents

SCANNED LETTER BY EMAIL

Alan Baxter
INTEGRATED DESIGN

Our Ref: 1675/62/JGa/gg

75 Cowcross Street
London EC1M 6EL

t 020 7250 1555

e aba@alanbaxter.co.uk
w www.alanbaxter.co.uk

Jane Henderson
Lawn House
12 Hampstead Square,
London
NW3 1AB

7 July 2016

Dear Jane,

29 New End, Hampstead, NW3 1JD

As requested we have carried out an initial structural engineering review of the BIA report provided for the proposed development on this site.

The proposal is to redevelop this site by replacing the existing 1950's nurse's home with a new residential building. The new building comprises seven storeys including a basement level car park. The site slopes up approximately 8m from front to back – this means that there is a single storey (basement level car park) of the new building below ground level along the front which increases to three storeys below ground level along the rear. Above ground floor level the building is set back from the sides presumably to allow natural light down to the lower residential floors.

The new building structure is proposed to be reinforced concrete framed supported on piled foundations. The new building excavation below ground level is proposed to be created using a 750mm diameter secant piled retaining wall around the perimeter. The piled retaining wall is generally restrained by the basement level and ground floor level slabs. Where the building is set back from the sides the piled retaining wall cantilevers (i.e. not restrained) up to approximately 6-7m above the ground floor slab.

Here are our general comments/queries of the key engineering issues in relation to the potential impact of the proposed development on the buildings around the site.

- The boreholes, which were carried out at two separate times, indicate notable variations in the soil descriptions over quite short distances. This may be due to different interruptions by the site investigation firms. We suggest that the data is reviewed by a geotechnical consultant.

- The ground movement predictions around the new building have been carried out using the CIRIA C580 guidance and also modelled using a 2d finite element computer analysis programme (Plaxis). The CIRIA guidance relies on certain

assumption being made in relation to the ground conditions, form and shape of the basement, installation of the piled retaining wall, the stiffness of the piled retaining wall, the restraint to the piled retaining wall and the stiffness of the temporary propping system. As such, the CIRIA approach can only give some very initial indication of movements, but in our view they should not be relied on for this project as it is not directly applicable. The output from the computer analysis also depends on the data input in relation to ground conditions, stiffness of the piled retaining wall and the stiffness of the temporary and permanent restraint to the piled retaining wall. This is an unusual basement with significantly different ground levels around each side of the basement, as well as the piled retaining wall being designed to cantilever up to approximately 6-7m above the ground floor slab along the sides and part of the rear of the basement. These factors will lead to unusual ground movements, which are likely be significantly larger in places than the values predicted using the simplified approach set out in the CIRIA guidance.

It is not clear to us what data has been inputted into the Plaxis programme. However, based on our experience of other sites which have different ground levels on either side of the basement, the predicted movements are lower than we would expect to see even if the deflections of the cantilevered perimeter wall are not taken into account. Therefore, we recommend that an independent check of the ground movements is carried out by a geotechnical specialist to verify the ground movements predicted in the BIA. We suspect that they may be an underestimate and, if so the movements to Lawn House in particular will increase.

- The BIA predicts that Lawn House is likely to undergo the largest movement due to the basement construction, which could potentially lead to cracks occurring that are up to 5mm wide (Category 2 change). This obviously depends on the ground movements predicted in the BIA, which should be verified as noted above. Category 2 is the maximum damage category that Camden permits, but this may be an underestimate.

- It appears from the information provided in the BIA that the first and second floor slabs are to be used to restraint the piled retaining wall along the rear of the building. However, it's not clear how these horizontal forces are resolved. Also it's not clear how the piled retaining wall is proposed to be restrained adjacent to the light well, ventilation shaft, lift shaft and stair core along the sides of the basement.

- It is unclear how all the lateral loads from earth pressures are being resolved particularly between the Church and New End. The Engineers need to identify the lateral loads applied at each floor level and demonstrate how they are supported, both in the temporary and permanent case. Also, the lateral loads at New End need to be assessed.

- In the sequence of construction details are required to indicate how the sheet piles are to be installed in order to avoid damaging the listed masonry retaining wall

buttresses along Lawn House. Also, it does not appear that the deflection of the sheet piled retaining wall been considered when predicting the ground movements.

- As part of the movement monitoring regime the west side of Lawn House and east side Christ Church Cottage should also be monitored to measure the differential movements across these buildings. Also Inclinometers should be installed in the piled retaining walls to measure the deflection of the walls.

- What trigger levels are being proposed as part of the movement monitoring regime, and what is the action plan if the trigger levels are reached.

-The ground water assessment suggests that this may not be a major concern. However, it could increase ground water levels particularly close to New End and could cause problems with the pavement vaults on the opposite side of the road.

- The BIA looks into the possibility of using a soakaway infiltration system to discharge rainwater into the ground as part of the SuDS strategy. If this is being proposed details of the proposals should be provided. It would seem logical to avoid putting additional groundwater upstream of the basement.

- A schematic of the relief drainage system has been included in the BIA. Details of this system should be provided as well as the locations of the infiltration trenches along the front of the site?

This is a very unusual and complex basement. It is very important that all lateral pressures are carefully considered and the ground movement analysis accurately reflects the proposals. The CIRIA approach is in our view not appropriate for this project.

We look forward to responses on the comments/queries noted above; however, the key point to consider in our view is a geotechnical specialist carrying out an independent check to verify the ground movements predicted in the BIA.

I have copied this to Simon Levy and I assume that you will pass these comments on to others. Please call me if you wish to discuss the comments.

Yours sincerely,

Jim Gardiner
for Alan Baxter Ltd

24397/RWS

22 July 2016

FLUID.STRUCTURES
ENGINEERS AND TECHNICAL DESIGNERS

Mr Niki O'Hara
New End LLP
C/o The Linton Group
8 Headfort Place,
London. SW1X 7DH

Dear Niki,

Ref : 29 New End, Comments dated 7 July relating to BIA (Rev '0' issued May 2016)

We have reviewed the comments provided by Alan Baxter Associates under cover of their letter of 7 July to Jane Henderson, with the design and construction team, and provide the collated responses below. Text in italics is reproduced from the ABA letter.

The proposal is to redevelop this site by replacing the existing 1950's nurse's home with a new residential building . The new building comprises seven storeys including a basement level car park. The site slopes up approximately 8m from front to back - this means that there is a single storey (basement level car park) of the new building below ground level along the front which increases to three storeys below ground level along the rear. Above ground floor level the building is set back from the sides presumably to allow natural light down to the lower residential floors.

The new building structure is proposed to be reinforced concrete framed supported on piled foundations. The new building excavation below ground level is proposed to be created using a 750mm diameter secant piled retaining wall around the perimeter. The piled retaining wall is generally restrained by the basement level and ground floor level slabs. Where the building is set back from the sides the piled retaining wall cantilevers (i.e. not restrained) up to approximately 6-7m above the ground floor slab.

Here are our general comments/queries of the key engineering issues in relation to the potential impact of the proposed development on the buildings around the site.

- *The boreholes, which were carried out at two separate times, indicate notable variations in the soil descriptions over quite short distances. This may be due to different interruptions by the site investigation firms. We suggest that the data is reviewed by a geotechnical consultant.*

Soil Consultants have confirmed that the borehole records contained in their report have been compiled after drawing together various strands of information which have included the results of drilling observations with regard to ground water inflows, in-situ and laboratory testing and their engineers descriptions of the recovered soil samples. As part of the design process these have also been reviewed by the other members of the design and construction team, including A-Squared Studio. The soils are known to be stratified to a degree, as recorded in the GI.

21 St George's Road London SE1 6ES Telephone: 020 7820 7766
Email: [first name]@fluidstructures.com Web: www.fluidstructures.com
Company Reg N° 3865913

- *The ground movement predictions around the new building have been carried out using the CIRIA C580 guidance and also modelled using a 2d finite element computer analysis programme (Plaxis). The CIRIA guidance relies on certain assumption being made in relation to the ground conditions, form and shape of the basement, installation of the piled retaining wall, the stiffness of the piled retaining wall, the restraint to the piled retaining wall and the stiffness of the temporary propping system. As such, the CIRIA approach can only give some very initial indication of movements, but in our view they should not be relied on for this project as it is not directly applicable. The output from the computer analysis also depends on the data input in relation to ground conditions, stiffness of the piled retaining wall and the stiffness of the temporary and permanent restraint to the piled retaining wall. This is an unusual basement with significantly different ground levels around each side of the basement, as well as the piled retaining wall being designed to cantilever up to approximately 6-7m above the ground floor slab along the sides and part of the rear of the basement. These factors will lead to unusual ground movements, which are likely be significantly larger in places than the values predicted using the simplified approach set out in the CIRIA guidance.*

Early on in the GMA process, the atypical nature of the proposed development and setting was recognised. The GMA methodology was developed with this in mind and the finite element analysis was used as a tool to help capture more realistic patterns of ground deformation. These patterns of ground movement were then compared to the CIRIA curves (which represent an upper bound to the data base of recorded ground movements), which indicated that the patterns of movement were reasonably similar. This provided confidence that the magnitudes of movement predicted by the adopted combination of installation and excavation curves from CIRIA were not unrealistic and would provide a conservative estimate of movement.

Regarding the output from the finite element analysis, it is evident that the analyses will be subject to interpretation of ground conditions, material parameters and simplifications of geometry. Notwithstanding, this line of argument can be applied to all engineering analyses, whether simplified or complex.

It is evident that the patterns of ground movement will not be the same as for a standard rectangular excavation. Notwithstanding, the basis for the conclusion that ground movements are likely to be 'significantly larger' is unsubstantiated.

- *It is not clear to us what data has been inputted into the Plaxis programme. However, based on our experience of other sites which have different ground levels on either side of the basement, the predicted movements are lower than we would expect to see even if the deflections of the cantilevered perimeter wall are not taken into account. Therefore, we recommend that an independent check of the ground movements is carried out by a geotechnical specialist to verify the ground movements predicted in the BIA. We suspect that they may be an underestimate and, if so the movements to Lawn House in particular will increase.*

The material parameters used in the Plaxis analysis are provided in the GMA report. The finite element analysis carried out reflected a realistic sequenced construction, incorporating:

a) stress history
b) steady state seepage analyses of current and temporary dewatering scenarios
c) sequenced installation of temporary and permanent structural members
d) assessment of short term and long term performance

e) asymmetric ground levels

The analyses were carried out in 2D, which considers movement in-the-plane of analysis only. In this respect, the in-plane movements are considered to be conservative. Out-of-plane movements are not captured explicitly. A 3D model has been developed which enables the effects of out-of-plane forces to be assessed directly.

Notwithstanding the above in the context of the analyses performed for the existing GMA the movements, particularly with regards to Lawn House should be conservative as the north and south walls of Lawn house are parallel to the plane of analysis. Tensile strains developed in the ground due to extension and flexural behaviour will thus be conservatively estimated by the adopted CIRIA analyses. It is considered that 3D effects will be on the whole beneficial and therefore primarily indicate an overall reduction in ground movements in the vicinity of Lawn House.

- *The BIA predicts that Lawn House is likely to undergo the largest movement due to the basement construction, which could potentially lead to cracks occurring that are up to 5mm wide (Category 2 change). This obviously depends on the ground movements predicted in the BIA, which should be verified as noted above. Category 2 is the maximum damage category that Camden permits, but this may be an underestimate.*

It should be recognised that the predicted damage categories for Lawn House described in the BIA are either in Category 1 or on the margins of the lower bound for Category 2. Therefore the likelihood of cracks of 5mm is very low, as Category 2 correlates to a range of anticipated cracking from approx. 1mm at the lower bound to approx. 5mm at the upper bound.

It is also noted that an earlier GMA prepared for the project by a well-regarded geotechnical engineering consultancy using a different methodology for the analyses estimated the same damage category for Lawn House.

All analyses of ground movement and building damage will be subject to interpretation. It is the nature of geotechnical engineering that there will always remain some uncertainty. In this respect, the risk mitigation measure is to employ monitoring during construction to enable early identification of adverse ground performance.

- *It appears from the information provided in the BIA that the first and second floor slabs are to be used to restraint the piled retaining wall along the rear of the building. However, it's not clear how these horizontal forces are resolved. Also it's not clear how the piled retaining wall is proposed to be restrained adjacent to the light well, ventilation shaft, lift shaft and stair core along the sides of the basement.*

The basement structure is a wholly monolithic insitu reinforced concrete construction free of building movement joints, therefore all lateral forces are shared by diaphragm action and passed into the perimeter retaining walls which act in passive pressure and in shear. The piled retaining walls are lined by insitu RC, which spans horizontally and/or vertically across voids where necessary, and are also buttressed adjacent to Lawn House by basement RC wall.

- *It is unclear how all the lateral loads from earth pressures are being resolved particularly between the Church and New End. The Engineers need to identify the lateral loads applied at each floor level and demonstrate how they are supported,*

both in the temporary and permanent case. Also, the lateral loads at New End need to be assessed.

Please refer to previous point and to the temporary works proposals included in the BIA.

- *In the sequence of construction details are required to indicate how the sheet piles are to be installed in order to avoid damaging the listed masonry retaining wall buttresses along Lawn House.*

The temporary sheet piles indicated adjacent to Lawn House would be installed working progressively along the line of the piling using a pile press rig (e.g. by Giken, Tosa) mounted on the sheet piles, with piling commenced from a reaction stand as is conventional for this technique.

- *Also, it does not appear that the deflection of the sheet piled retaining wall been considered when predicting the ground movements.*

This is not the case and allowance for this has been made in the GMA included in the BIA. The temporary sheet pile wall was incorporated in the 2D FE section, which was in turn used to justify the selection of the appropriate CIRIA curves.

- *As part of the movement monitoring regime the west side of Lawn House and east side Christ Church Cottage should also be monitored to measure the differential movements across these buildings. Also Inclinometers should be installed in the piled retaining walls to measure the deflection of the walls.*

We do not believe this is necessary

- *What trigger levels are being proposed as part of the movement monitoring regime, and what is the action plan if the trigger levels are reached.*

Trigger levels and action plan will be established in conjunction with the contractor and with review of the baseline monitoring which has been underway over recent weeks and months and will be concluded shortly. Levels will be set with the objective of ensuring that investigations of possible causes of unexpected movement, and planning for any changes in the works, are triggered at “amber” level, significantly below “red” level where significant damage may occur

- *The ground water assessment suggests that this [groundwater] may not be a major concern. However, it could increase ground water levels particularly close to New End and could cause problems with the pavement vaults on the opposite side of the road.*

This has been considered in the Hydrogeological report included in the BIA and is not expected to be an issue.

- *The BIA looks into the possibility of using a soakaway infiltration system to discharge rainwater into the ground as part of the SUDS strategy. If this is being proposed details of the proposals should be provided. It would seem logical to avoid putting additional groundwater upstream of the basement.*

The team concur with the point, as this has been specifically investigated and ruled out. No shallow infiltration systems are therefore being considered as part of the SUDS strategy. A deep borehole soakaway is proposed which would discharge into permeable strata well below proposed basement level.

- *A schematic of the relief drainage system has been included in the BIA. Details of this system should be provided as well as the locations of the infiltration trenches along the front of the site?*

One infiltration trench is proposed to run parallel to New End within the site boundary, as indicated on the schematic section in the BIA, should final groundwater monitoring and detailed design conclude this is necessary. The trench, if required, will extend the along the majority of the frontage so as to mimic the existing downslope groundwater flows

- *This is a very unusual and complex basement. It is very important that all lateral pressures are carefully considered and the ground movement analysis accurately reflects the proposals. The CIRIA approach is in our view not appropriate for this project.*

As discussed above, the adopted procedure has supplemented the CIRIA-based assessment with additional finite element analyses to capture the effects of the atypical setting and ensure the robustness and conservatism of the GMA. The methodology has incorporated both empirical and analytical approaches. It is considered that the analysis as presented are appropriate and that the estimated building damage categories are representative of the proposed scheme and its various complexities.

- *We look forward to responses on the comments/queries noted above; however, the key point to consider in our view is a geotechnical specialist carrying out an independent check to verify the ground movements predicted in the BIA.*

An independent review of the BIA is being implemented by London Borough of Camden and their retained consultant. In light of this, and the consistency of the results of this detailed work with previous assessment by other parties, we understand there is no intention to commission further parties to verify the movements predicted in the BIA

We trust the above is of assistance.

Yours sincerely

Ralph Swallow

FLUID.STRUCTURES
ENGINEERS AND TECHNICAL DESIGNERS
21 St George's Road London SE1 6ES Telephone: 020 7820 7766
Email: [first name]@fluidstructures.com Web: www.fluidstructures.com
Company Reg N° 3865913

London

Friars Bridge Court
41- 45 Blackfriars Road
London, SE1 8NZ

T: +44 (0)20 7340 1700
E: london@campbellreith.com

Birmingham

Chantry House
High Street, Coleshill
Birmingham B46 3BP

T: +44 (0)1675 467 484
E: birmingham@campbellreith.com

Surrey

Raven House
29 Linkfield Lane, Redhill
Surrey RH1 1SS

T: +44 (0)1737 784 500
E: surrey@campbellreith.com

Manchester

No. 1 Marsden Street
Manchester
M2 1HW

T: +44 (0)161 819 3060
E: manchester@campbellreith.com

Bristol

Wessex House
Pixash Lane, Keynsham
Bristol BS31 1TP

T: +44 (0)117 916 1066
E: bristol@campbellreith.com

UAE

Office 705, Warsan Building
Hessa Street (East)
PO Box 28064, Dubai, UAE

T: +971 4 453 4735
E: uae@campbellreith.com