CampbellReith
consulting engineers

The Hall School

23 Crossfield Street, London NW3

Basement Impact Assessment

Audit

For

London Borough of Camden

Project Number: 12466-38

Revision: F3

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Contents

Appendix

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 The Hall School, 23 Crossfield Street NW3 4NT (planning reference 2016/6319/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 able to access LBC's Planning Portal and gain access to the latest revision of submitted documentation and reviewed it against an agreed audit check list.

1.4. The BIA has been prepared by Geotechnical and Environmental Associates (GEA), with supporting documents by Elliott Wood Partnership, using individuals who possess suitable qualifications. Some discrepancies exist between the documents which should be resolved.

1.5. The site is currently occupied by The Hall School, a partly four storey and partly three storey building, including a lower ground level, with a single storey section extending across the south eastern corner of the site. It is proposed that part of the school will be demolished and a two storey basement will be constructed within the footprint of the existing buildings, utilising contiguous bored pile walls and localised underpinning.

1.6. The BIA identified the site is underlain by Made Ground over London Clay. The site specific ground investigation proved that Made Ground extends to depths between 1.00m and 3.80m below ground level. The ground water table was encountered during the site investigation in the Made Ground.

1.7. Clarifications have been received about the preliminary construction sequence, including sketches to identify methodologies to be utilised and indicative temporary works required to stabilise the excavation during the basement works.

1.8. A Ground Movement Analysis has been undertaken concluding that damage to neighbouring properties should not exceed Burland Category 1 with the exception of a substation. Predicted strains for the substation marginally exceed category 1, although it is accepted that the assessment is based on conservative assumptions. Queries raised previously with respect to the modelling of ground movements have been addressed.

1.9. An outline monitoring strategy has been proposed for all the structures within the development's zone of influence and includes appropriate trigger values and contingency action plans.

1.10. It is accepted that the development site will not impact upon slope stability.

1.11. It is accepted that the development will not impact on the wider hydrogeology or hydrology of the area and is at low risk of flooding. It is noted that a Drainage and SUDS Assessment has been completed that concluded SUDS strategies are not practicable to install due to site constraints. It is proposed to maintain existing rates of surface water discharge.

1.12. Numerous technical objections have been raised which have been reviewed by CampbellReith. In summary, it is not considered that the objections provide new evidence that the basement proposals will cause unacceptable damage to the structural stability of surrounding buildings or to the water environment.

1.13. It is confirmed that, with the submission of the documents listed in para 2.9 and subject to the approval of a Basement Construction Plan, the BIA complies with the criteria of CPG4 and the Local Plan with respect to impacts on stability and the water environment.

2.0 INTRODUCTION

2.1. CampbellReith was instructed by London Borough of Camden (LBC) on 15 December 2016 to carry out a Category C Audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for The Hall School, 23 Crossfield Street, NW3 4NT Camden Reference 2016/6319/P. CampbellReith was instructed to undertake a further audit in November 2017 to consider an updated BIA addressing a minor revision to the scheme, and technical reports submitted on behalf of objectors to the basement proposals.

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.
- Local Plan adopted June 2017 (new since F1 audit issued).

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;

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 *"Demolition of the 'Centenary' and 'Wathan Hall' buildings and erection of new four storey building with glazed link to original school building, two storey rear extension with external terrace and enlarged basement, replacing the existing Wathan Hall, and enlargement of rear roof storey and insertion of three*

dormer windows to old school building, all in association with providing additional accommodation for the existing school use (Class D1).”

2.6. The Audit instruction also confirmed that 23 Crossfield Street is not listed, not is it a neighbour to a listed building.

2.7. Following the issue of CampbellReith’s initial audit, CampbellReith accessed LBC’s Planning Portal on 10 April 2017 and gained access to the following additional documents for audit purposes:

- Desk Study and Basement Impact Assessment (ref J15302, issue 2, Final revised) dated 2 March 2017 by Geotechnical and Environmental Associates (GEA).
- Planning Application Drawings consisting of Proposed Basement Propping sequence, drawing no. S-3000-P1, S-3010-P1. S-3020-P1.
- Structural and Civil Engineering Report and Basement Impact Assessment (ref 2150206, rev P5) dated March 2017 by Elliott Wood Partnership.
- Structural Calculations Basement - Preliminary (ref 2150206, rev P1) dated March 2017 by Elliott Wood Partnership.
- Movement Monitoring Report (ref 2150206, rev P1) dated March 2017 by Elliott Wood Partnership.
- Anticipated Construction Programme dated March 2017
- Letter of Response to BIA Audit dated 2 March 2017 by Geotechnical and Environmental Associates (GEA).

2.8. In November 2017 CampbellReith was instructed to review further documents and update the audit report. It should be noted that other reports both by the applicant’s teams and on behalf of the objectors have been submitted to Camden. The documents considered in the F2 audit are listed below:

- Structural and Civil Engineering Report and Basement Impact Assessment (ref 2150206, rev P7), dated October 2017 by Elliott Wood Partnership (which includes site investigation report and Ground Movement Assessment prepared by GEA, dated October 2017.
- Residual differences of technical opinion on the BIA for Hall School, First Steps Ltd, dated 1 November 2017.
- Letter reports, Eldred Geotechnics Ltd, Ref Planning Application 2016/1639/P – 23 Crossfield Road NW3 4NU, dated 2 and 9 November 2017.

2.9. Subsequent to the issue of the F2 audit report, further information was received from EW and GEA in December 2017. These documents, which are listed below, are considered in this updated audit report.

- Elliott Wood letter, reference 2150206 let2, dated 8 December 2017 (presented in Appendix 3)
- GEA letter, reference J15302, dated 6 December 2017 (presented in Appendix 3)
- GEA Desk Study and Basement Impact Assessment Report, Issue 4, dated December 2017
- Email from GEA dated 8 January 2018 (presented in Appendix 3).

2.10. Additionally, a further objection letter from the Hall School Opposition Group, dated 20 December 2017, was forwarded by Camden for consideration. The borough requested that CampbellReith also considers the three previous objections referred to in that letter of 20 December. This F3 audit considers the objections referred to above.

3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are BIA Author(s) credentials satisfactory?	Yes	See BIA Section 9.3.
Is data required by Cl.233 of the GSD presented?	Yes	However, works programme to be provided.
Does the description of the proposed development include all aspects of temporary and permanent works which might impact upon geology, hydrogeology and hydrology?	Yes	See Audit Paragraph 4.3.
Are suitable plan/maps included?	Yes	See GEA report Section 2.
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	See GEA report Section 3.1.2.
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	See GEA report Section 3.1.1 and 3.1.3.
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	See GEA report Section 3.1.1 and 3.1.3.
Is a conceptual model presented?	Yes	See GEA report Section 5 and 7.
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	Yes	See GEA report Section 4.

Item	Yes/No/NA	Comment
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	Yes	See GEA report Section 4.
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	Yes	See GEA report Section 4.
Is factual ground investigation data provided?	Yes	See GEA report appendix.
Is monitoring data presented?	Yes	See GEA report Section 5.3.
Is the ground investigation informed by a desk study?	Yes	Contained in GEA report.
Has a site walkover been undertaken?	Yes	See GEA report Section 1.3.
Is the presence/absence of adjacent or nearby basements confirmed?	Yes	
Is a geotechnical interpretation presented?	Yes	See GEA report Section 5, 7 & 8.
Does the geotechnical interpretation include information on retaining wall design?	Yes	See Audit Paragraph 4.5.
Are reports on other investigations required by screening and scoping presented?	Yes	FRA / Drainage Assessment.
Are the baseline conditions described, based on the GSD?	Yes	Included within BIA.
Do the base line conditions consider adjacent or nearby basements?	Yes	
Is an Impact Assessment provided?	Yes	

Item	Yes/No/NA	Comment
Are estimates of ground movement and structural impact presented	Yes	See GEA report Part 3 – however significant queries are raised in Section 4 of this audit report.
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	Ground monitoring and temporary propping are proposed.
Has the need for monitoring during construction been considered?	Yes	See BIA Section 12.4. and Appendix 7
Have the residual (after mitigation) impacts been clearly identified?	No	There are significant queries on the GMA (see Section 4 of this audit report).
Has the scheme demonstrated that the structural stability of the building and neighbouring properties and infrastructure will be maintained?	Yes	
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	FRA / Drainage Assessment.
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 1?	No	Under a conservative assessment, Category 2 damage is predicted for a single wall of the garages to the rear of 24-26 Crossfield Street.
Are non-technical summaries provided?	No	However a conclusion is provided, see GEA report Section 13.

4.0 DISCUSSION

4.1. The Basement Impact Assessment (BIA) has been produced by structural engineering consultants, Elliott Wood Partnership, with support from Geotechnical and Environmental Associates (GEA). The authors possess relevant qualifications.

4.2. The proposal includes the demolition of part of the existing school building and the increase in area and depth of the single storey basement to provide a two storey basement, approximately 8 metres deep, within the proposed building footprint. The BIA states that the basement retaining wall will be formed through a combination of underpinning of the existing basement wall and a bored pile wall below the remaining footprint of the new section of the building that does not currently include a basement. The new scheme has a slightly smaller footprint than the original and proposes a combination of secant and contiguous piled wall sections.

4.3. The BIA provides outline design information of the retaining wall (i.e. pile length, diameter and spacing) and describes a typical bottom up methodology for the construction. Moreover, the proposal identifies the need for a temporary propping system and outline information is provided. The form of the basement and the sequence of construction described by Elliott Wood have been carried forward to the latest version of the BIA and GMA.

4.4. The relevant maps extracts from the Arup GSD, Camden SFRA and Environment Agency (EA) referenced in the screening process are included and it is accepted that the outcomes of the screening process have been correctly identified.

4.5. A ground investigation has been carried out by GEA through the installation of 4 no. boreholes and the investigation of surrounding party wall foundations by 5 no. trial pits. These have revealed the site stratigraphy to consist of 1.0m to 3.8m of Made Ground underlain by London Clay to depths exceeding 15m. The ground model including the strength profile is considered reasonable based on the ground investigation data. Although groundwater was monitored at shallow depth, the water encountered is considered to be perched water within the more permeable sections of the Made Ground.

4.6. Although Section 8.1 of the BIA anticipates that the impacts of groundwater will be extremely low to negligible, an allowance for dewatering will be made for perched water in the excavation and construction of the basement through the use of strategically placed sumps with intermittent pumping. It is stated that the basement has been designed to resist buoyancy and heave. GEA recommend that groundwater monitoring is continued.

4.7. A Ground Movement Assessment has been carried out by GEA to determine the effect of the piling, underpinning and excavation on the adjoining/adjacent properties. It was accepted in the original BIA that the assumptions and the output of the assessment were in agreement with

industry practice, however, a number of queries are raised with respect to the new GMA/damage assessment.

4.8. The BIA notes that the proposed basement walls will be constructed by a combination of traditional underpinning and bored piles. It is noted that the effect of the underpinning has been considered referencing CIRIA 580 (now CIRIA C760). Although this methodology is designed for embedded retaining walls, it is frequently used as a preliminary assessment for underpinned construction. Predicted movements for the underpinned walls have been reduced in the new GMA when compared to the original and this was queried with GEA. It was subsequently agreed that the modelling should allow for the full basement depth in order to account for any locked in strains resulting from the construction of the existing basement. It is accepted that the movements for the full depth of the basement are in line with those which would typically be associated with two stage underpinning and have been taken forward to the damage assessment.

4.9. The predicted movements due to the piled section of the basement excavation have been evaluated using Wallap and X-Disp adopting the ground movement curves for 'excavations in front of a stiff wall in stiff clay'. An adequate propping system has been proposed to confirm the assumptions made in the GMA, and the X-Disp inputs have been provided. A number of queries were raised, which have been answered as follows:

- A confusing paragraph in Section 11.1.2 has been removed together with reference to 'control of propping'. A further discussion of ground movement predictions is presented to justify the revised assessment.
- In light of Burland Category 2 being predicted for part of No 24 Crossfield Road, which contravenes the Local Plan, a more detailed assessment has been presented, where the movement predicted by Wallap has been imported into X-Disp. It is accepted that the likely damage now does not exceed Burland Category 1 provided there is good control of workmanship and the measures described in the BIA are adopted.
- Queries relating previously to paras 12.3 and 13.1 are superseded by the updated assessment.
- The errors noted previously in the Wallap analysis have been resolved.

4.10. It is accepted that, with the exception of a single garage wall, the ground movement and building damage assessments presented in Rev 4 of GEA's BIA and a subsequent email, demonstrate that damage to neighbouring structures can be restricted to Burland Category 1. The exceedance of the limiting strain for the garage wall is small (equating to less than 1mm movement) and it is acknowledged that a conservative approach to the assessment of strain has been adopted. GEA propose that monitoring is undertaken to ensure that movements of surrounding structures does not exceed acceptable limits.

4.11. A robust propping system is proposed as a mitigation measure. Moreover, an observational approach with regards to monitoring is proposed together with a traffic lights system of trigger levels and contingency measures to be implemented if movements exceed the predictions, in accordance with best industry practice. Final details should be agreed once the final construction sequence is known.

4.12. The BIA had identified the potential for heave of the underlying clay soils to occur and suitable mitigation is proposed. P-Disp inputs have been provided. It is accepted that the installation of piles will limit the heave that will be realised.

4.13. The anticipated construction programme has been submitted.

4.14. A Movement Monitoring Report has been presented, where details of the monitoring strategy and trigger levels are proposed, in agreement with industry practice. Moreover, a pre and post condition survey of the existing structures affected by the proposed basement construction has been suggested in the BIA.

4.15. It is accepted that there are no slope stability concerns regarding the proposed development and it is not in an area prone to flooding.

4.16. It is noted that a Drainage and SUDS Assessment has been completed that concluded SUDS strategies are not practicable to install due to site constraints. It is proposed to maintain existing rates of surface water discharge.

4.17. As noted above, technical reports have been submitted on behalf of objectors to the scheme. Dr de Freitas of First Steps Ltd has four main objections which are that (i) the BIA does not consider the geology beneath the neighbouring structures, (ii) the flow of groundwater has been misunderstood, (iii) the soil properties ascribed are not justified and (iv), there is an unacceptable caveat to GEA's report.

4.18. With respect to the geology, reference is made by First Steps to a borehole available on the BGS website some 300m to the southwest of the site (it should be noted that neighbouring buildings are defined in Camden's Terms of Reference as those within a distance of 4 x the basement depth, i.e. c32m in this instance). It is stated that this borehole is evidence of 'hill wash' deposits being present beneath neighbouring structures. Reference to the borehole shows that the stratum in question extends to a depth of 0.60m and is described as Topsoil. GEA have sunk four exploratory holes on site (i.e. within 32m of the neighbouring structures) and whilst there is reference to occasional sandy lenses, the logs do not appear to show significant thicknesses of significantly weaker 'hill wash' deposits. It is therefore not considered that significant new evidence has been presented.

4.19. It is stated that the flow of water has not been understood in the BIA. Reference to the Environment Agency web site shows that the site is underlain by a 'non-productive' stratum. This is defined as a deposit with "negligible significance for water supply or base flow" reflecting the low permeability of the stratum and the absence of significant volumes of water. The guidance notes provided by Arup to accompany the BIA screening process advise that whether the basement extends below the water table or not is only relevant where the site is underlain by an aquifer. On the basis of these two facts, combined with the relatively limited increase in basement width normal to postulated groundwater flow and the distance to other significant basements, it is accepted that the impact to subterranean flows has been correctly assessed in the BIA as being low.

4.20. With respect to the caveat referred to in para 12.1 of First Steps' report, this is a standard wording. CampbellReith is satisfied that GEA have adopted standard techniques of site investigation and geotechnical evaluation and it is considered that their ground model and the suggested soil parameters should give a reasonable indication of the soil's behaviour.

4.21. In his letter of 2 November 2017, Mr Eldred also raises three main concerns; (i) the prediction of ground movements uses an inappropriate model, (ii) the construction of the existing basement will already have induced movements and strains and (iii) the prediction of damage is not appropriate to the construction of the neighbouring properties.

4.22. With respect to the first item, Mr Eldred appears the say that a retaining wall system can only be considered to be stiff with a top down sequence. Reference to CIRIA C760 shows that the term can be applied to walls with high level permanent and temporary props as is the case here.

4.23. It is also stated that the current basement is supported by a cantilever wall. This is not the case; the wall is propped at the top. It is accepted that the construction of the existing basement will have caused ground movement, however, it is considered that a ground movement prediction based on the full final depth of the basement should capture historic and predicted future movements.

4.24. It is accepted that the cross walls to the properties adjacent to the school building are not equivalent to deep beams, however, it is considered likely that these houses will have spine walls and that the movement and damage assessments are appropriate to those. Further information presented by Mr De Freitas appears to suggest that Nos 24 to 30 Crossfield Road could be piled. This will further reduce their susceptibility to ground movements.

4.25. Further concerns are raised by Mr Eldred in his letter of 9 November. These comprise the impact of heave, the assumptions made in the GMA, practicalities of constructing a working platform for a piling rig, and the effects of concrete shrinkage.

4.26. With respect to the first and second points, it is noted that the retaining wall identified as being at risk of tilting due to heave is propped top and bottom and tied into the piled basement slab. The query on the GMA had previously been raised by CampbellReith and have been addressed in the revised submission. Regarding concrete shrinkage, whilst we would question that the effects could result in a significant increase in movement of the basement walls, it was requested that this was addressed by the applicant's structural engineer. In their letter dated 8 December 2017, EW have calculated the concrete shrinkage to be in the order of 1.5mm. It is accepted that this is not significant in terms of potentially worsening damage to neighbouring properties.

4.27. The question with respect to the working platform is also valid and should be addressed in the Construction Management Plan. It is understood that the CMP has been updated to cover this, however, it lies outside the scope of the audit so has not been reviewed.

4.28. A letter of objection from the Hall School Opposition Group, dated 20 December 2017, restated some of the objections discussed above and expressed concern that objections raised by Messrs de Freitas and Eldred in earlier technical reports had not been considered. The objections referred to were submitted either by Mr Anthony Kay or HSOG on 14 & 18 August and 25 October 2017. CampbellReith was asked to review these additional objections and our comments are provided in the following paragraphs.

4.29. Mr Kay's letters of 14 & 18 August 2017 summarise objections prepared by First Steps Ltd and Eldred Geotechnics and include the supporting technical reports. First Steps Ltd confirmed that their objections related to (i) the strength and stiffness of the ground and (ii) the groundwater. It is considered that these are largely dealt with in preceding paragraphs 4.18 & 4.19. Additional references to 'sandy/silty layers' in the boreholes and high groundwater pressures are not supported by the ground investigation data, with the descriptions of the London Clay being typical of its weathered state.

4.30. The objections raised by Eldred Geotechnics Ltd refer to the assumptions made in the GMA regarding system stiffness, the practicalities associated with the installation of piles from basement level, the efficacy of the capping beam, and instability of the ground. The first point is addressed in preceding paragraph 4.22. The second and third are not supported by the proposed construction sequence; the method statement allows for piles to be installed from high level and it is intended that the beams supporting the ground floor are face fixed to the capping beam or the capping beam is constructed with pockets to receive the floor supports. Finally, the underpins are to be constructed in London Clay which is an ideal stratum for such a technique.

4.31. It is pointed out, correctly, by Mr Kay that the BIA contains some minor errors such as mis-numbering the properties to the south of the school and giving an incorrect address for

Hereward House School. It is also noted that the BIA does not consider a substation adjacent to the Hall School excavation. It is clear from the text and figures in the BIA which surrounding structures have been considered and, with the exception of the substation, the relevant buildings have been assessed. The substation was raised with GEA and is addressed in their email of 8 January 2018. GEA state that, assuming it has a typical construction of a concrete raft, it is not anticipated to be adversely affected by the predicted ground movements.

4.32. In light of the sensitivity of ground movements to the construction sequence and the need to control ground movements, particularly in the vicinity of the garages, it is recommended that a Basement Construction Plan is prepared and agreed in advance of construction. The BCP should include the following:

- Confirmation of ground and groundwater model for design of basement including continued groundwater monitoring
- Design of substructure temporary and permanent works including sequencing and programme
- Confirmation of predicted ground movements and building damage, demonstrating that damage to all neighbouring properties can be limited to agreed limits.
- Monitoring regime including the nature and location of monitoring points and targets, monitoring frequency, trigger levels, roles and responsibility and contingency actions.

5.0 CONCLUSIONS

5.1. The BIA has been carried out by a well-known firm of consultants who possess relevant qualifications and experience.

5.2. The proposed two storey basement utilises a mixture of contiguous and secant bored piled retaining walls installed from existing ground level and underpinning of the existing single storey basement wall. Some discrepancies in the description of the substructure that existed between earlier reports prepared by EWP and GEA have been addressed.

5.3. The BIA has confirmed that the proposed basement will be founded within London Clay.

5.4. The relevant maps extracted from the Arup GSD, Camden SFRA and Environment Agency (EA) identifying the site location have been included, to support statements made in the BIA screening process.

5.5. Outline retaining wall design and a preliminary temporary works scheme including sequencing and propping sketches have been provided, in accordance with CPG4.

5.6. Revised damage assessments confirm that predicted damage to the neighbouring buildings, with the exception of a substation, does not exceed Burland category 1. Predicted strains for the substation marginally exceed category 1, although it is accepted that the assessment is based on conservative assumptions. Queries raised previously with respect to the modelling of ground movements have been addressed.

5.7. It is noted that a robust propping system is proposed as a mitigation measure in conjunction with an observational approach with regards to monitoring and a traffic lights system of trigger levels; in accordance with best industry practice. The BIA proposes to limit building damage to acceptable levels (for example the substation) through monitoring.

5.8. It is accepted that there are no slope stability concerns with respect to the development proposals.

5.9. It is accepted that the development will not impact on the wider hydrogeology or hydrology of the area and is at low risk of flooding.

5.10. It is noted that a Drainage and SUDS Assessment has been completed that concluded SUDS strategies are not practicable to install due to site constraints. It is proposed to maintain existing rates of surface water discharge.

5.11. Numerous technical objections have been raised which have been reviewed by CampbellReith. In summary, it is not considered that the objections provide new evidence that the basement

proposals will cause unacceptable damage to the structural stability of surrounding buildings or to the water environment. It is understood that the construction of the working platform for the piling rig is covered in the revised CMP, however, this lies outside the remit of this audit.

5.12. It is confirmed that, with the submission of the documents listed in para 2.9 and subject to the approval of a Basement Construction Plan, the BIA complies with the criteria of CPG4 and the Local Plan with respect to impacts on stability and the water environment.

Appendix 1: Residents' Consultation Comments

Residents' Consultation Comments

Surname	Address	Date	Issue raised	Response
Wade	12 Crossfield Road	05/01/17	Basement excavation and effect on existing foundations of nearby buildings.	See audit paragraphs 1.8, 1.9, 4.7 and 5.6
Balint-Kurti	40 Eton Court, Eton Avenue	04/01/17	Risk of structural damage to existing garages	See audit paragraphs 1.8, 1.9, 4.7 and 5.6
Mayne	12 Crossfield Road	11/01/17	Basement excavation and effect on existing foundations of nearby buildings	See audit paragraphs 1.8, 1.9, 4.7 and 5.6
The and Loh	Flat 1, 26 Adamson Road	11/01/17	Construction of the basement excavation and effect on existing foundations of nearby buildings	See audit paragraphs 1.8, 1.9, 4.7 and 5.6
Hall School Opposition Group	Not given	Not given	Basement Construction Implications	See audit paragraphs 1.8, 1.9, 4.7 and 5.6
First Steps Ltd	Unit 17, Hurlingham Studios, Ranelagh Gardens, SW6 3PA	01/11/17	Various queries on ground and groundwater model.	See audit paragraphs 4.17 – 4.20
Eldred Geotechnics Ltd	11A Woodside, Chelsfield, Orpington, BR6 6JR	02 and 09/11/17	Various queries on ground movement assessment and structural assessment.	See audit paragraphs 4.21 – 4.28
Kay	26 Crossfield Road	14/08/17	Concerns re impact on property as described in supporting objections by First Steps Ltd and Eldred Geotechnics Ltd Aug 2017	See audit paragraphs 4.28 – 4.31
Kay (on behalf of HSOG)	26 Crossfield Road	18/08/17	Concerns re impact on surrounding properties as described in supporting objections by First Steps Ltd and Eldred Geotechnics Ltd Aug 2017	See audit paragraphs 4.28 – 4.31
Hall School	Not given	25/10/17	Concerns that issued raised in previous	See audit paragraphs 4.28 – 4.31

Opposition Group			objections have not been addressed.	
Hall School Opposition Group	Not given	20/12/17	Concerns that issued raised in previous objections have not been addressed.	See audit paragraphs 4.28 – 4.31

Appendix 2: Audit Query Tracker

Audit Query Tracker

Query No	Subject	Query	Status	Date closed out
1	Stability	Proposed construction methodology and sequence not sufficiently detailed. Structural Engineer to provide indicative temporary works scheme.	Closed – Construction sequence and indicative propping scheme (as 4.3 and 4.7).	13/04/17
2	Stability	Retaining wall	Closed - Outline retaining wall design required (as 4.2 and 4.3).	13/04/17
3	Stability	Damage assessment	Closed – Damage Assessment of The Hall School building to be provided (as 4.11)	13/04/17
4	Stability	Damage assessment	Closed – X-Disp and P-Disp input to be provided (as 4.10 and 4.12).	13/04/17
5	Stability	Monitoring	Closed – Proposals for monitoring. Further detail on trigger levels and pre-condition surveys of affected assets required prior to commencement of the construction works (as 4.14).	13/04/17
6	BIA	Works Programme	Closed – an outline works programme should be provided (as 4.13).	13/04/17
7	BIA	Discrepancies in the description of the scheme and methodology exist between the EWP and GEA documents	Closed – resolved in GEA BIA Rev 4, dated December 2017	21/12/17
8	Stability	Numerous queries raised on GMA/building damage assessment contained within October 2017 BIA	Closed – resolved in GEA BIA Rev 4, dated December 2017 and subsequent emails	08/01/18
9	Stability	Consideration of concrete shrinkage required	Closed – resolved in EW letter dated 8 December 2017	21/12/17

Appendix 3: Supplementary Supporting Documents

6 December 2017

Planning ref: 2016/6319/P
Our ref J15302/ML/Letter3

GEA

Widbury Barn
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Mr Paul Davies
Elliott Wood
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Dear Paul

Re: THE HALL SCHOOL, 23 CROSSFIED STREET, LONDON NW3 4NU

We have now reviewed the comments made within the Basement Impact Assessment (BIA) Audit by Campbell Reith (ref: 12466-38 rev F2, dated November 2017) and this letter accompanies our updated report (ref: J15302 issue 4, dated December 2017) in providing our formal responses to each of the points raised and highlights the relevant sections of our updated report.

4.3 Discrepancies within BIA report

Our report has been updated to reflect the information within the Elliott Wood document, although these have not changed our analysis approach or the results of our analysis. 'Top down construction' has been removed as a typographical error and the mid-slab level has been amended. The correct slab levels were analysed within the original Wallap analysis but miss-quoted within our report; these have been amended. Furthermore, it should be noted that the initial intended construction of the proposed basement was through the use of the combined underpinning and contiguous bored pile wall. However, the building damage assessment of nearby surrounding properties revealed a number of elevations to fall within Category 2, the additional Wallap analysis to determined that sections of secant wall would be required to reduce displacements and the building damage category. A secant piled wall is discussed in Section 13 onwards in our report.

4.8 Predicted underpinning movements

The initial BIA, dated August 2016, was revised and updated following the initial Campbell Reith audit, with the amendments discussed and submitted in our revised BIA report, dated March 2017, and supporting letter (ref J15302/ML/Letter 1, dated 2nd March 2017). It was discussed that for the underpinned section, the first analysis was considered overly conservative, mainly due to the movement curves being applied between the formation level of 8.00 m and ground level. As a single level of basement exists and it is the existing reinforced concrete basement walls being underpinned, this was taken into account in the updated analysis through applying a negative excavation from ground level to 4.00 m. This reduced movements to 5 mm and less for the wall installation phase and 5 mm and less for combined vertical movement, with less than 10 mm horizontal movement for the combined installation and excavation phase. These movements are considered realistic for underpinned walls, albeit still conservative with regard to combined horizontal movement.

The magnitude of the settlement will be controlled to a large extent by the quality of workmanship of the underpins and by the existing basement structure, which is likely to provide additional rigidity. In this respect, there is a wealth of experience with respect to the construction of underpinned retaining walls, which suggests that overall horizontal ground movements should remain typically within the range of 2 mm to 5 mm following completion of the works, provided that they are installed by a reputable and experienced contractor in accordance with the guidelines published by the Association of Specialist Underpinning Contractors. The movements predicted fall within these levels of displacement and are therefore considered to provide an accurate prediction. Full inputs and outputs of our X-Disp models are provided.

4.9 X-Disp and Wallap Analysis

Bullet Point 1 – 'control of propping' has been removed from paragraph 11.1.2 as this is no longer relevant with the additional Wallap analysis. The reduced movements are discussed in the previous point of this letter.

Bullet Point 2 – It is true to say that the initial P-Disp and X-Disp analysis predicted that a single elevation along No 24 Crossfield Road would be susceptible to Category 2 damage. These results are discussed in Section 10 to Section 12 in Part 3 of our report. Section 13 onwards describes the additional Wallap analysis, which has been used to carry out a more detailed analysis of the retaining wall design, including the use of temporary and permanent props. The analysis has indicated that if a 600 mm diameter secant pile wall, with an embedment depth of 18 m below ground level is adopted, it will be possible to reduce the displacements and the damage category to Category 1 and Very Slight, in the line with the requirements of the Council's Local Plan.

Bullet Point 3 – The statement on propping arrangement has been removed from our report as it is not relevant given the Wallap analysis carried out.

Bullet Point 4 – The use of a 250 mm liner wall is discussed within our report. A check was made within the Wallap analysis as to the effect on movements of the installation of a 250 mm liner wall. Outputs for this were not provided due to the size of document, but as would be expected movements were reduced slightly with the increase in stiffness of the wall. This however had no bearing on the building damage assessment for the Category 2 walls as the critical case was in the temporary undrained condition. The Wallap analysis therefore determined that a 250 mm thick liner wall would not be required as part of the permanent retaining wall construction.

Bullet Point 5 – The Wallap analysis elements have been reviewed and the following changes made within Section 13 onwards of our report. A prop spacing of 1 m has been used in the permanent case only, with a prop spacing of 3 m used for temporary props. The garage surcharge has been increased to 12.3 kN/m^2, with an increase in width perpendicular to the excavation to 1.2 m. Wall adhesion coefficient of 0.66 and 0.50 for the active and passive sides respectively has been adopted for the drained condition and zero for the undrained condition. The levels of the topmost temporary prop and ground floor slab have been clarified and are at top of strut levels of 0.48 m and ground level respectively.

With regard to the adopted value of K_0, it is our opinion that a value of 1 is acceptable for the London Clay and one we have adopted within many other analyses, particularly for other Camden BIAs. This opinion is also shared with other professionals within the industry, with whom we have collaborated during party wall assessments and agreements. It is also our experience that this value is adopted by many piling contractors within final detailed design.

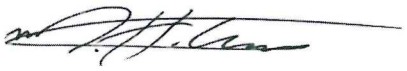
4.10 Damage Categories

Full input parameters and output results from the X-Disp analysis are included in the report appendix, which demonstrate the Building Damage Categories, which are also discussed in Section 12 of our report. The building damage categories for each of the sensitive neighboring elevations are provided within the output tables and the table in Section 12.1 of our report. We refer again to the points raised for Query 4.3 and Query 4.9 Bullet Point 2 within this letter. Due to the change in policy within the

Council's Local Plan, further analysis was carried out using Wallap, which has indicated that the use of a 600 mm diameter secant pile wall, with an embedment depth of 18 m below ground level, will reduce the displacements and therefore the damage category to Category 1 and Very Slight for those elevations indicated to be Category 2 and Slight by the initial X-Disp analysis. This is discussed in Section 13 onwards within our report.

I trust that the above satisfies your current requirements, but should you need anything further then do not hesitate to contact us.

Yours sincerely
GEOTECHNICAL & ENVIRONMENTAL ASSOCIATES



Matt Legg

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08 December 2017

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Mr Rob Tulloch

The Hall School, Hampstead – Planning Application 2016/1639/P – BIA Audit Revision F2

As the project Structural and Civil Engineers appointed for the proposed redevelopment works at The Hall School, Elliott Wood (EW) submitted the Basement Impact Assessment (BIA) as part of the original planning application; 2016/1639/P, in November 2016. Subsequently EW have issued revised reports following previous BIA Audits carried out by Campbell Reith (CR) in January 2017 (revision D1) and April 2017 (revision F1) on behalf of Camden Council in July and to satisfy changes to local policy in October 2017. Following the revised BIA report issued in October, CR issued further technical comments in their audit report revision F2 dated November 2017 and this letter sets out our responses to the latest points raised.
In response to the latest audit Geotechnical & Environmental Associates (GEA) have issued the below:

- Letter dated 6th December, reference J15302/ML/Letter3.
- Report; Desk Study and Basement Impact Assessment Report; J15302 Issue 4, dated 6th December.

In this letter we provide a summary of the queries in the BIA Audit revision F2, below are the four subject areas that have been queried with responses and clarifications:

1. Discrepancies between GEA and EW reports (Refer to CR Audit - 4.3)

GEA have updated their report to more accurately align with EW information, including mid-slab level and sequence of construction. Top down construction was a typographical error in the previous GEA report, which has now been amended in the update please refer to 13.1 in GEA report. Contiguous piled walls were part of the original analysis; following the change in planning policy the Ground Movement Assessment (GMA) has been updated. Contiguous piled walls next to sensitive structure have been revised to secant piled walls. Please refer to section 13 of GEA report for further information.

Refer to GEA letter and report mentioned above for more information.

2. Damage Category (Refer to CR Audit - 4.8, 4.9 and 4.10)

The CR audit makes multiple reference to the Damage Category. GEA have amended and updated their report following the original submission, this has been carried out in response to previous CR Audits. During this period the planning policy regarding allowable damage category has been revised from Category-2, Slight to Category-1, Very Slight. As the requirements have become more onerous the original simplified methods of analysis have not been sufficient for all neighbouring structures; those giving Category-2 results. In such cases GEA have carried out more rigorous analysis and EW have revised the wall construction to suit from contiguous piling to secant piles adjacent to sensitive structures.

All neighbouring structures are now shown to be damage Category-1, Very Slight or Category-0, Negligible in the latest GMA by GEA. The mention of Category-2 damage is in the first round of analysis in section 10 to 12 of the report and is using the more simple P-Disp and X-Disp analysis. In section 13 where Category 2 has occurred the more rigorous / accurate Wallap analysis has been used and where required the wall construction has been changed Category-1 result have been achieved.

GEA have updated the propping scheme in the report and provide clarification in their letter.

GEA have provided clarification of the liner wall thickness and its effect on the damage category in their letter.

Please refer to GEA letter and report mentioned above for more information.

3. Concrete shrinkage effect on wall movement (Refer to CR Audit - 4.26)

Any early age shrinkage stresses will be insignificant to movement as they will be applied to the reinforcement, the amount of long term creep/shrinkage will be minimal depending on the length of the slabs. A conservative allowance for a slab span locally to the secant piled wall is 5m, typically shrinkage is taken as 0.03% of the span, and therefore the total shrinkage is 1.5mm. This gives a lateral movement in the slab of 0.75mm at each end. This is considered to be negligible.

In addition, the method of analysis adopted for predicted movement by GEA is two-thirds of the maximum value from the Wallap analysis taken as acting over the entire wall height, this is done to

account for the limitations of the X-Disp program. The method is considered to be conservative enough that an additional 0.75mm at floor levels is considered to be negligible.

4. Piling platform – Construction Management Plan (Refer to CR Audit - 4.27)

The CMP, which was submitted to the Council on 4th December 2017, has been updated to include the below explanation of the piling platform, this has been added into section 27.b:

Further to, a temporary platform will be designed and constructed by the contractor to suit the loading of the piling rig. The design will likely be sub-contracted to a specialist temporary works engineer. The construction is assumed to be similar to a typical scaffold gantry. It is assumed that it will be supported at ground level either side of the existing hall and at basement / excavation level within the existing hall. The practicalities of the operation of the platform and detail of hoarding requirements or any other occupation or overhang of the public highway, will be developed further once the detailed design is finalised.

I trust that the above response in conjunction with the CMP and GEA report & letter provides sufficient information to answer the queries in the audit and that the scheme in question satisfies the criteria of Camden Council.

Yours sincerely,

Paul Davies

For and on behalf of Elliott Wood Partnership Limited

Enc. GEA Letter dated 06.12.17

C.C Elizabeth Brown – Campbell Reith.

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1 Attachment

Combined Movements Exc 3&4 MC Final.pdf

Dear Liz

It was good to speak with you earlier today and hopefully the information below will be sufficient to address the final queries with respect to the BIA for the Hall School.

1. **Transferal of the Wallap movements into X-Disp**. The ground movements associated with the piled wall are based on the specific Wallap analysis undertaken whereby the peak horizontal deflection of 13 mm has been factored by 2/3 to produce an equivalent uniform deflection of 8.7 mm which when normalised by the excavation depth of 8.2 m gives a relationship of 0.106 % excavation depth. This has been used to produce a new X-Disp movement curve for the excavation phase. Page 310 of the BIA shows where this has been applied together with the pile installation movements to produce a damage assessment.
2. **Clarification of underpinning depth**. Page 196 of our BIA refers; we note your opinion that the full 8.0 m depth of underpinning should be considered rather than just the 4.0 m below the existing basement so that any locked-in strains from the excavation of the original 1980's basement would also be included. We are not entirely sure that we concur with your view but in the interest of expediting approval we have reanalysed that section of underpinning based on the full 8.0 m. Given that the basement has already been in place for 30 years or so this reanalysis must represent a highly conservative approach. The analysis, with movement contours attached, indicates that the is Cat 0 Negligible for 13 of the walls analysed, Cat 1 Very Slight for four of the walls and Cat 2 Slight for one wall. That wall is Wall A of the garages south of the site and the maximum tensile strain is 0.077287%. The upper limit of Cat 1 is 0.075% and the exceedance is 0.002287%; a very small percentage over the allowable limit. A sensitivity analysis has been carried out for this particular 10.0 m length of wall. The allowable increase in length would be 7.50 mm for the damage category to remain as Cat 1; this highly conservative analysis calculates 7.73 mm; a difference of 0.23 mm. On the basis that this movement represents a full new 8.0 m basement excavation where that proposed is only 4.0 m and the wall will, in any case, be subject to monitoring during construction, we consider that the slight exceedance above Cat 1 to be acceptable. The monitoring of movements should, in any case, be such that construction would be halted if the movements were to approach the sort of limits that would cause unacceptable damage.
3. **The presence of a Sub-Station close to No 24 Crossfield Road**. The presence of a substation close to No 24 Crossfield Road has been identified. This had not been considered in our analysis specifically on account of such structures typically comprising a concrete slab upon which a transformer is placed and on which walls are constructed. We expect such a structure to be independent of surrounding buildings and to not affected by the magnitude of ground movements predicted in this analysis. We consider that the substation does not require further consideration.

We trust that the above is satisfactory and look forward to your confirmation in due course.

Kind regards

Martin

GEA

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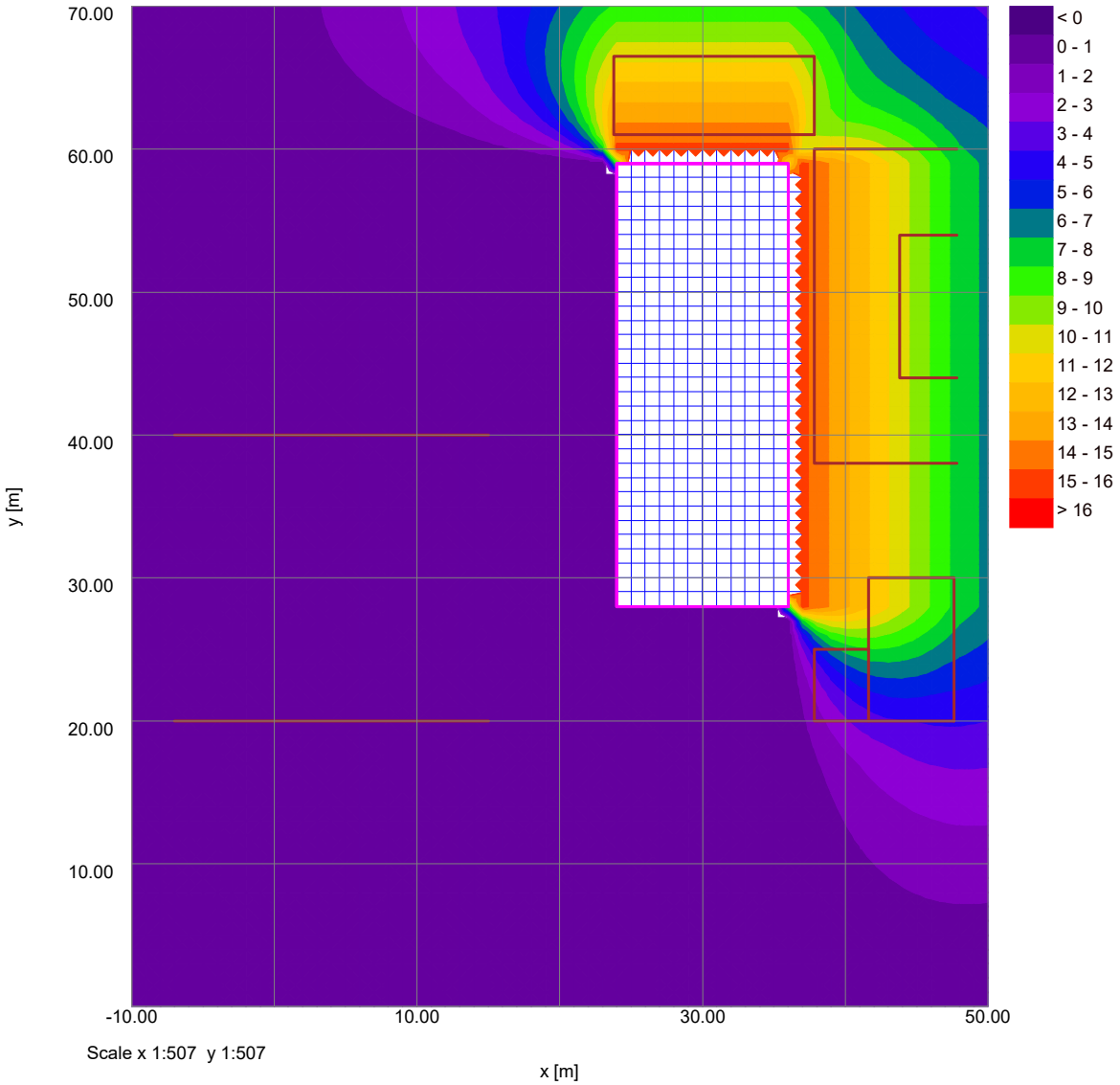
Horizontal Displacement Contours: Grid 1 (level 0.000m) Interval 1mm



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