CampbellReith
consulting engineers

27A Parkway
London
NW1 7PN

Basement Impact Assessment
Audit

For

London Borough of Camden

Project Number: 12336-27
Revision: F1

Date: May 2016

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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 27A Parkway, London NW1 7PN (planning reference 2015/2976/P). The basement is considered to fall within Category B 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. A structural engineering report and subterranean construction method statement has been produced by a well-known firm of consulting engineers, along with a Basement Impact Assessment (BIA) having been produced by a different well known firm of engineers. It has been confirmed that the qualifications of those involved with the production of these reports are appropriate.

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

1.6. It has been concluded that ground water is not likely to be encountered and the wider hydrogeology of the area is not likely to be significantly affected.

1.7. The proposal uses industry standard techniques to form the basement level using a combination of underpinning, reinforced concrete retaining walls, and piling. An appropriate construction method statement has been provided.

1.8. A ground movement assessment has been produced which predicts a low potential for damage to the surrounding buildings and the highway (Arlington Road). An unconventional approach has been taken in the production of this calculation, however it is accepted that given good workmanship and an appropriate detailed design, this conclusion can be accepted.

1.9. A movement monitoring strategy has been produced. This is accepted however further development will be required.

1.10. It is accepted that the surrounding slopes to the development site are stable.

1.11. It is accepted that the development will not impact on the wider hydrogeology of the area and is not in an area subject to flooding.

1.12. Previous requests for further information are summarised in Appendix 2, all of which are now closed. Appendix 3 contains supplementary information that has been received in relation to these. It is accepted that the BIA and supporting documents adequately identify the potential impacts arising out of the basement proposals and describe suitable mitigation.

2.0 INTRODUCTION

2.1. CampbellReith was instructed by London Borough of Camden (LBC) on 11/02/2016 to carry out a Category B Audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for 27A Parkway, London NW1 7PN, planning reference 2015/2976/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 *"Installation of two storey glazed enclosure around existing Routemaster bus, plus formation of additional office floor space within new basement excavation, and associated plant room at basement level."*

The Audit Instruction also confirmed 27A Parkway is within the vicinity of listed buildings.

2.6. CampbellReith accessed LBC's Planning Portal on 23/03/2016 and gained access to the following relevant documents for audit purposes:

- BIA Screening Report, Elliott Wood, March 2015
- Basement Impact Assessment (BIA), Site Analytical Services, January 2016
- Structural Engineering Report and Construction Method Statement, Elliott Wood, January 2016
- Planning Application Drawings by EMRYS dated May 2015 consisting of,

  Existing Plans

  Proposed Plans

  Proposed Sections

  Proposed Elevations

  OS Map
- Planning Comments and Response

2.7. Following issue of the D1 revision of this report the further information was received from the applicant, which is contained in appendix 3;

- Qualifications and experience of those involved in the production of the BIA and structural engineering report.
- Horizontal deflection calculation results and updated conclusions regarding the suitability of the ground movement assessment
- Correction of an error on drawing SK01, and clarification regarding type of underpinning proposed and the philosophy of underpinning and retaining wall design.

3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are BIA Author(s) credentials satisfactory?	Yes	The authors of both the BIA and structural report have been provided and are satisfactory.
Is data required by Cl.233 of the GSD presented?	No	No program has been 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	BIA, structural method statement, and proposed structural drawings.
Are suitable plan/maps included?	Yes	Architectural and Engineering Plans, maps embedded in BIA.
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	Data sources have generally been referenced. An appropriate statement has been provided for each no answers.
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Data sources have generally been referenced. An appropriate statement has been provided for each no answers.
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Data sources have generally been referenced. An appropriate statement has been provided for each no answers.
Is a conceptual model presented?	Yes	BIA Section 5.
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	Yes	A scoping statement has been provided for each item identified by screening.

Item	Yes/No/NA	Comment
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	Yes	A scoping statement has been provided for the single item identified by screening.
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	N/A	No hydrology items were identified by the screening exercise.
Is factual ground investigation data provided?	Yes	'Factual Report on Ground Investigations' appended to the BIA.
Is monitoring data presented?	Yes	Section 3.3 in Factual Report on Ground Investigations.
Is the ground investigation informed by a desk study?	Yes	BIA.
Has a site walkover been undertaken?	Unclear	No explicit reference of a walkover is provided. However from the content of the BIA is it clear that the author has a good understanding of the site.
Is the presence/absence of adjacent or nearby basements confirmed?	Yes	Two adjacent basements are confirmed.
Is a geotechnical interpretation presented?	Yes	Section 6 in the BIA
Does the geotechnical interpretation include information on retaining wall design?	Yes	
Are reports on other investigations required by screening and scoping presented?	Yes	While not flagged as required by the screening and scoping, a ground movement assessment has been produced.
Are the 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	Section 7 in the BIA.

Item	Yes/No/NA	Comment
Are estimates of ground movement and structural impact presented?	Yes	Ground movement assessment report appended to BIA.
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	Movement monitoring during the works and continued ground water level monitoring have been proposed.
Has the need for monitoring during construction been considered?	Yes	Section 8 of the structural method statement report
Have the residual (after mitigation) impacts been clearly identified?	NA	
Has the scheme demonstrated that the structural stability of the building and neighbouring properties and infrastructure will be maintained?	Yes	Ground movement assessment and structural method statement.
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	Discharge into the sewer system is not changing.
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	The ground movement assessment indicates that damage will be no worse than Burland Category 1.
Are non-technical summaries provided?	Yes	Non-technical summaries are provided for each chapter of the BIA.

4.0 DISCUSSION

4.1. The Basement Impact Assessment (BIA) has been carried out by a well-known firm of site investigation and geotechnical engineering consultants, Site Analytical Services Ltd. The accreditation and experience of those responsible for the production of the report has been confirmed as being in accordance with the requirements of CPG4.

4.2. The Structural Engineering Report and Subterranean Construction Method Statement has been carried out by a well-known firm of engineering consultants, Elliott Wood LLP. The accreditation and experience of those responsible for the production of the report has been confirmed as being in accordance with the requirements of CPG4.

4.3. A report titled 'Basement Impact Assessment Stage 1 : Screening Report' prepared by Elliott Wood in March 2015 provides an initial screening exercise that appears to have been used as an initial advisory report. A formal screening exercise has been carried out in accordance with the CPG4 document, however some of the screening outcomes differ from that in the main BIA document produced by Site Analytical Services. It has therefore been considered that the information provided in this report has been superseded by the BIA document.

4.4. The LBC Instruction to proceed with the audit identified that the basement proposal is located within the vicinity of, but is not itself and is not adjoining, listed buildings.

4.5. The existing site is largely undeveloped, with the exclusion of a small lightweight single storey steel framed entrance lobby, and single storey masonry toilet and kitchenette. The remainder of the site contains a double decker London bus on hardstanding.

4.6. The proposal involves the demolition of the single storey structure, and the formation of a single storey basement level, with two storey steel framed glazed enclosure from ground level upwards. The glazed enclosure is to house the existing double decker bus.

4.7. The immediately neighbouring properties, 165 Arlington Road and 27 Parkway, have been confirmed as containing basement levels. The buildings to the rear of the site are reported to be single storey conservatory/masonry structures that are not believed to contain basement levels.

4.8. Site investigations have been carried out and have involved one trial pit to identify the foundations to No 165 Arlington Road, and one borehole located adjacent to this. The trial pit did not reach the underside of the foundation along this boundary, however it confirmed it to be in excess of 1.5m below ground level. No trial pit or investigations of the foundations to No 27 Parkway have been presented, or to the single storey structures along the rear boundary. However reasonable assumptions have been made regarding the foundations to the remaining

properties, based on the properties to the rear not containing basements, and No 27 Parkway containing a basement.

4.9. The site is underlain by 0.6m of made ground, overlaying London Clay to a considerable depth. Water level monitoring was carried out over a 2 week period and was found to remain dry. The proposed basement will founded within the London Clay, and it has been assumed that the surrounding properties are also founded within the London Clay.

4.10. The proposal to form the basement level consists of underpinning the existing foundations to number 27 Parkway, 165 Arlington Road, and the single storey structures to the rear with concrete prior to forming a reinforced concrete liner wall inside of this. The liner wall is to connect into a ground bearing slab forming the floor to the basement level, which also is to be designed as a raft foundation. The raft foundation will contain local thickenings to support internal columns supporting the bus and ground floor structure.

4.11. The basement wall that is along the boundary of Arlington Road is to be formed by the construction of a sheet piled or bored piled wall, with the construction of a reinforced liner wall inboard of this.

4.12. The underpinning to the surrounding walls is identified as being of mass concrete. It has been confirmed that the mass concrete underpinning is in the permanent case designed to resist vertical loads only, with the reinforced concrete liner wall resisting lateral loads. In the temporary case, the mass concrete underpinning is to be laterally propped to resist lateral loads.

4.13. Underpinning has been proposed in a traditional hit and miss sequence in bays of measuring no more than 1m in width. This is accepted as the industry standard technique and is an effective way of minimising movements to the underpinned walls should good workmanship be applied.

4.14. The RC liner wall is to act as a vertical cantilever, with no permanent prop provided at its head. This is acceptable provided the detailed design calculations for the wall reflect this scenario, and the ground movement assessment reflects the low stiffness characteristics of an unpropped cantilever wall in the permanent case.

4.15. A construction method statement has been produced by Elliott Wood. This method sets out a logical sequence of works by constructing the underpinning first, followed by the reduction in ground level with subsequent propping to the underpinning, the formation of the basement ground slab, and finally the formation of the liner wall to resist lateral forces in the permanent case.

4.16. Ground water has been deemed to not be present at the site, due to the basement being formed within the London Clay. This conclusion is supported by the site investigation data that found no ground water present in a monitored standpipe. However it has been advised that the

contractor maintains a method of how to deal with ground water should inflows occur once construction has commenced. It is accepted that ground water is not likely to be present, and it is agreed that a contractor's method statement is prepared should ground water flows be encountered during construction.

4.17. While a ground movement assessment was not deemed necessary by the screening and scoping stages, one has been produced by Applied Geotechnical Engineering who are established geotechnical engineers. It is considered appropriate that a ground movement has been produced due to the increase in the differential foundation level with the surrounding properties.

4.18. The ground movement assessment has predicted vertical and horizontal movements based on wall deflections, wall installations, and movements due to the unloading of the existing ground (heave). For the calculation of ground movements due to wall deflection, values for a high stiffness scenario have been used. The CIRIA C580 document indicates that high support stiffness can be assumed for high propped walls, or top down construction, and that low stiffness should be assumed for cantilever walls. The proposal is to construct a cantilever liner wall inboard of the underpinning, it is therefore considered that the proposal more accurately represents the low stiffness scenario as described by CIRIA C580 and the ground movement assessment should be resubmitted to reflect this. Further information has been provided to demonstrate that under conservative assumptions the maximum deflection at the top of the wall at the mid span between return walls is 6mm. The authors of the ground movement assessment have confirmed that given the relatively low maximum deflection at the head of the wall it is appropriate to consider a low stiffness scenario. While the method presented is not strictly in accordance with CIRIA C580, it is accepted that the potential ground movements are low provided the wall is reinforced in accordance with the assumptions used in the deflection calculation. Building damage to affected structures is predicted not to exceed Burland Category 1.

4.19. Further to the above a formal damage assessment of the highway (Arlington Road) that is adjacent to the basement has not been produced. However the maximum horizontal movement at the top of the basement wall under highway surcharge loading has been used in the above conclusion that the wall can be considered of high stiffness. It is therefore accepted that the damage to the road is likely to be negligible.

4.20. An outline movement monitoring strategy has been produced by Elliott Wood that details actions and movement trigger values. The trigger values given are 5mm and 10mm for amber and red vertical movements, and 4mm and 8mm for amber and red horizontal movements. These values are in excess of those predicted by the current ground movement assessment. It is appreciated this is an outline movement monitoring strategy that is to be developed further

by the contractor; this is accepted and it is recommended that the final movement monitoring strategy adopt trigger values related to the final ground movement assessment.

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

5.0 CONCLUSIONS

5.1. The BIA and Structural Report have been carried out by well-known firms of engineering consultants. The qualifications and experience of those responsible for the production of the reports is appropriate.

5.2. The basement is to be formed using concrete underpinning to the surrounding properties with an inboard reinforced concrete liner wall bearing onto a ground bearing raft foundation.

5.3. The boundary that is adjacent to Arlington Road is proposed as being either sheet piled or bored piled, with a reinforced concrete liner wall constructed inboard of this.

5.4. The method proposed describes the construction being carried out using established construction techniques and a logical sequence of works is proposed.

5.5. The underpinning to the neighbouring properties is to be of mass concrete and is to resist vertical loads only, with the inboard liner wall constructed of reinforced concrete and is designed to resist lateral loads.

5.6. The basement walls are to be designed as unpropped cantilever walls. While no structural calculation have been produced to substantiate the feasibility of this proposal it is accepted that the retained height of a shallow single storey is feasible given the preliminary wall sizes proposed.

5.7. The BIA confirms that the basement will be founded within the London Clay which has been confirmed via site investigations, no ground water flows are anticipated as being interrupted. This conclusion is accepted.

5.8. The ground movement assessment has used a method for calculating movements based on high support stiffness, however the head of the wall will not be propped in the permanent case. It has been demonstrated that the maximum horizontal deflections will be low and that it is acceptable to consider the wall as having high stiffness given the geometry of the basement and the reinforcement proposed. While this does not follow the conventional approach it is accepted in this instance that the damage potential to the neighbouring properties and the highway is low (not worse than Burland Category 1) given good workmanship.

5.9. An outline movement monitoring strategy has been provided. This is accepted and is recommended to be further developed in order to link the trigger values to the movements predicted by the final ground movement assessment.

5.10. It is accepted that the surrounding slopes to the development site are stable.

5.11. It is accepted that the development will not impact on the wider hydrogeology of the area and is not in an area subject to flooding.

5.12. Previous requests for further information are summarised in Appendix 2, all of which are now closed. Appendix 3 contains supplementary information that has been received in relation to these. It is accepted that the BIA and supporting documents adequately identify the potential impacts arising out of the basement proposals and describe suitable mitigation.

Appendix 1: Residents' Consultation Comments

Residents' Consultation Comments

Surname	Address	Date	Issue raised	Response
Haigh (on behalf of the Diocese of Westminster)	165 Arlington Road NW1 7EX	9/06/2015	No method statement detailing excavation for basement level.	An appropriate construction method statement has been provided in the report titled 'Structural Engineering Report and Subterranean Construction Method Statement'.

Appendix 2: Audit Query Tracker

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Audit Query Tracker

Query No	Subject	Query	Status	Date closed out
1	Qualifications	Confirmation that those responsible for the production of the BIA and Structural report has the accreditation as required by CPG4.	Closed	10/05/16
2	Stability	The ground movement assessment has used values for high stiffness walls for the calculation of vertical and horizontal ground movements due to wall deflection. However this is not considered appropriate given that the proposal consists of an unpropped cantilever wall which CIRIA 580 describes as a low stiffness scenario. This should include a damage assessment of the highway (Arlington Road) also.	Closed	10/05/16
3	Stability	The underpinning to the north, south, and eastern perimeters is described as being of mass concrete in paragraph 3.2 of the Structural Engineering Report. However in structural drawing SK-01 the underpinning is indicated as being 400mm thick R.C underpinning. This discrepancy in the specification of the underpinning should be clarified, along with whether or not the underpinning is to resist lateral loads in the temporary case due to the lowering of the ground level prior to the formation of the liner wall.	Closed	10/05/16

Appendix 3: Supplementary Supporting Documents

ElliottWood Responses to Appendix 2 (A2) Basement Impact Assessment Audit Queries

A2 EW Response (1)

Confirmation that those responsible for the production of the BIA and Structural report have the accreditation as required by CPG4.

Mr Neil Smith Eur Ing, BSc (Eng), MSc, CEng, FICE, FGS	40+ years' experience in geotechnics and hydrogeology, British Geotechnical Association Member, International Society for Soil Mechanics and Geotechnical Engineering
Mr Thomas Murray BSc(Hons) MSc FGS	2+ years of hydrogeological experience
Mr Andrew Smith BSc(Hons) FGS MCIWEM	10+ years of hydrogeological experience
Mike Brice BSc MSc DIC CGeol	30+ years of hydrological/geotechnical experience and Member British Geotechnical Association

A2 EW Response (2)

The ground movement assessment has used values for high stiffness walls for the calculation of vertical and horizontal ground movements due to wall deflection. However this is not considered appropriate given that the proposal consists of an unpropped cantilever wall which CIRIA 580 describes as a low stiffness scenario. This should include a damage assessment of the highway(Arlington Road) also.

SAS and their Ground Movement Assessment (GMA) team completed a ground movement assessment and had the following comments;

I understand from the responses below that the steel superstructure above ground level does not have a restraining influence on the walls and the basement 'box' is therefore open-topped. The stiffness of the walls therefore relies on the cantilever off the floor slab, and the propping action in the corners, in the long term.

As a general point, we would suggest that excavations formed adjacent to existing structures should be supported as stiffly as is practical in order to limit the potential for damage to those structures. In the current case, in the short term it is important that the walls are stiffly propped at high and low level until the cantilever action and corner propping described above are developed.

With regard to the stiffness of the long-term propping system, and the ground movements predicted by the CIRIA C580 data we will need the view of the structural engineer; if the structure is likely to limit the horizontal movement of the top of the front and rear retaining walls, at the mid-point of their long sides, to less than 6mm following removal of the temporary strutting then we can consider the wall to be stiffly propped. If greater than 6mm of horizontal deflection is likely then the effects of less-stiff propping will need to be considered.

If the horizontal movement of the top of the wall is likely to be of the order of 12mm , then this corresponds to the behaviour of low-stiffness support. Under these conditions up to 16mm of vertical ground settlement can be expected outside the excavation, rather than the currently predicted 4mm. Overall tilt of nearby walls will be predicted to approach the 1:400 limit requiring remedial action and the predicted damage due to distortion will be 'slight' at best.

So far as we are aware there is only one neighbouring wall that lies near the mid-point of the long (rear) retaining wall and is clearly vulnerable to the above degree of movement - this wall is described in Section 5.7 of our report. We would advise that the area of the site be checked to check whether other vulnerable walls are present. However it would be expected that differential floor settlements, and highway settlements, of the order of 16mm would not go unnoticed, and that in this case the standard Burland Damage Category Assessment method alone is unlikely to fully account for the possible adverse effects.

In the above we have assumed, but would ask the structural engineer to confirm, that at the corners and along the short sides of the excavation, the structure will be sufficiently robust to limit deflection of the walls to well-less than the 6mm limit described above.

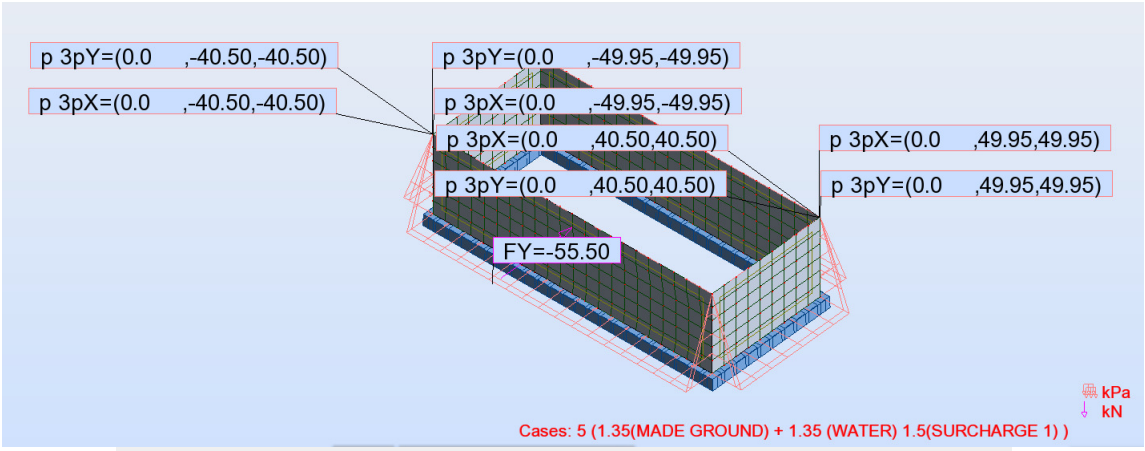
ElliottWood considered SAS's comments (above) and completed an FE analysis of the basement to calculate the expected horizontal movement at the top of the wall.

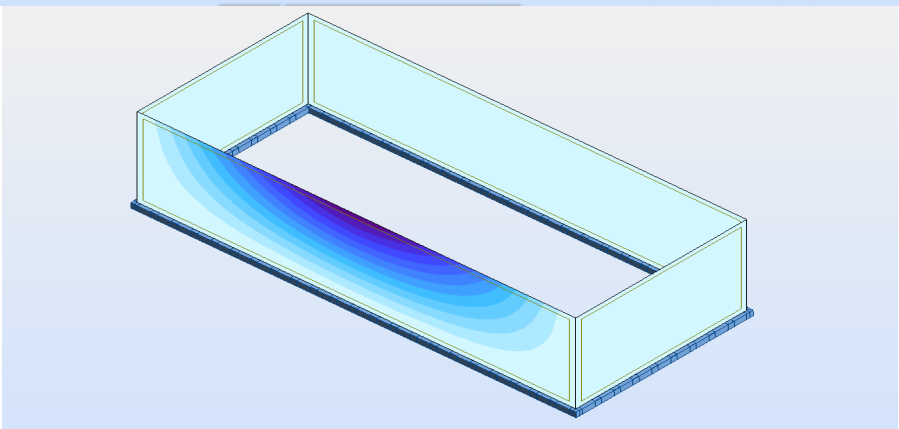
We have considered the GMA team's comments and completed an analysis to calculate expected deflections based on the current thickness of our wall and also determine the steel reinforcement that would be required to limit horizontal movement at the top of the wall.

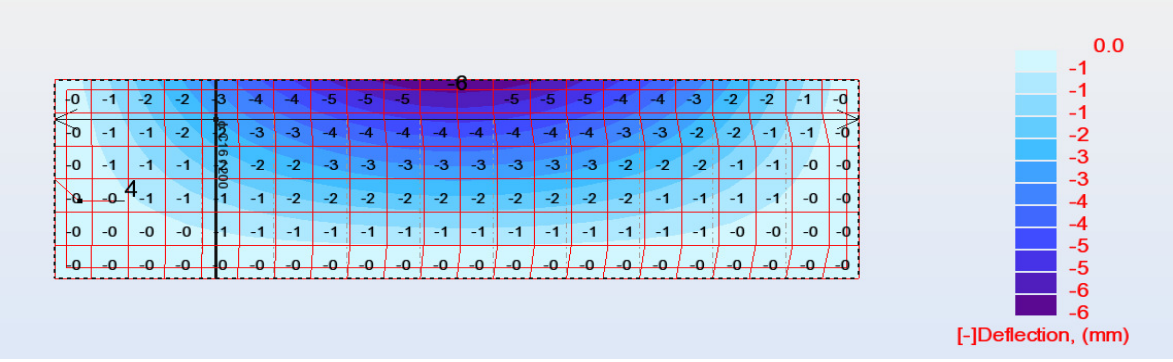
As we expected; despite the basement being "open topped", the stiffness of the raft and the return walls help to keep deflections within acceptable limits. See a screenshot below of the FE model which shows the deflection of the wall adjacent to Arlington Road.

In our analysis we have accounted for the following loading condition;

- Earth Pressure (London Clay)
- Hydrostatic – Whilst the geotechnical investigation did not encounter water, we have allowed for an accidental scenario where the water would rise right up to ground level. This is conservative given our ground conditions.
- Accidental Surcharge – Whilst the area of the road adjacent to the Arlington Road footpath is currently used as vehicle parking bays, we have allowed for a scenario where a heavy vehicle may mount the kerb. We have modelled 100kN axle point loads at 1.5m away from our wall. We have considered various positions of these loads to consider the worst case scenarios.
- We have combined all of the above into one load combination which considers multiple worst case scenarios. This approach is conservative.







SAS and their Ground Movement Assessment (GMA) reviewed the results of our FE model and had the following comments;

The analysis appears to show a maximum horizontal deflection of the order of 5-6mm for the front wall of the basement under adverse temporary conditions. For the damage category assessment it would be expected that only normal long-term loads (earth pressure loads) would be considered (the CIRIA movement profiles on which the damage category assessments are based are themselves based upon a conservative interpretation of case-history data, and it is unlikely that flood conditions or adjacent traffic loads would have been present) therefore the engineer's analysis below can be considered conservative, probably highly so.

Therefore we consider that the displacements indicated are consistent with predictions made on the basis of an assumption of stiffly propped basement walls, as adopted in the existing DCA report.

A2 EW Response (3)

The underpinning to the north, south, and eastern perimeters is described as being of mass concrete in paragraph 3.2 of the Structural Engineering Report. However in structural drawing SK-01 the underpinning is indicated as being 400mm thick R.C underpinning. This discrepancy in the specification of the underpinning should be clarified, along with whether or not the underpinning is to resist lateral loads in the temporary case due to the lowering of the ground level prior to the formation of the liner wall.

Paragraph 3.2 of The Structural Engineering Report is correct in hat, the underpinning to the north, south and eastern perimeters will comprise mass concrete underpins. SK-01 is incorrect and should read "400mm thick mass concrete underpinning" not "400mm thick R.C underpinning".

The mass concrete underpinning will not resist lateral loads and in the temporary case (during excavation) suitable temporary propping will have to be provided, until the R.C liner wall that is to be cast in front of underpins has gained sufficient strength to resist lateral loads.

For clarity, mass concrete underpins will support vertical loads from the existing building above them they will support, and R.C liner walls in front of underpins will resist lateral forces.

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