

35 Greville Road  
London NW6 5JB

Basement Impact Assessment  
Audit

For  
London Borough of Camden

Project Number: 12066-62  
Revision: F1

May 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](mailto:london@campbellreith.com)  
W: [www.campbellreith.com](http://www.campbellreith.com)

### Document History and Status

Revision	Date	Purpose/Status	File Ref	Author	Check	Review
D1	October 2015	Comment	FDfd-12066-62-231015-35 Greville Road-D1.doc	F Drammeh	A Marlow	E Brown
D2	May 2016	Comment	FDfd-12066-62-130516-35 Greville Road-D2.doc	F Drammeh	R Morley	E Brown
F1	May 2016	Planning	FDfd-12066-62-240516-35 Greville Road-F1.doc	F Drammeh	E Brown	E Brown

This document has been prepared in accordance with the scope of Campbell Reith Hill LLP’s (CampbellReith) appointment with its client and is subject to the terms of the appointment. It is addressed to and for the sole use and reliance of CampbellReith’s client. CampbellReith accepts no liability for any use of this document other than by its client and only for the purposes, stated in the document, for which it was prepared and provided. No person other than the client may copy (in whole or in part) use or rely on the contents of this document, without the prior written permission of Campbell Reith Hill LLP. Any advice, opinions, or recommendations within this document should be read and relied upon only in the context of the document as a whole. The contents of this document are not to be construed as providing legal, business or tax advice or opinion.

© Campbell Reith Hill LLP 2015

### Document Details

Last saved	25/05/2016 10:25
Path	FDfd-12066-62-240516-35 Greville Road-F1.doc
Author	F Drammeh, MEng
Project Partner	E M Brown, BSc MSc CGeol FGS
Project Number	12066-62
Project Name	35 Greville Road, London NW6 5JB
Planning Reference	2015/5013/P

**Contents**

1.0 Non-technical summary ..... 1  
2.0 Introduction ..... 4  
3.0 Basement Impact Assessment Audit Check List ..... 7  
4.0 Discussion ..... 11  
5.0 Conclusions ..... 15

**Appendix**

- Appendix 1: Resident’s Consultation Comments
- Appendix 2: Audit Query Tracker
- Appendix 3: Supplementary Supporting Documents

## 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 35 Greville Road (planning reference 2015/5013/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. The BIA was carried out by Croft Structural Engineers with two separate reports considering groundwater and land stability undertaken by H Fraser Consulting Ltd and Ground and Project Consultants Ltd respectively. The authors of the Land Stability and Hydrogeology reports and the reviewer of the Croft report all have suitable qualifications.
- 1.5. The construction method and sequence have been revised subsequent to the initial audit which requested clarity and plans to better indicate the sequence and indicative temporary works proposal which have also been provided. The revised construction methodology and temporary works proposal requires careful workmanship by the Contractor.
- 1.6. Clarification was requested on the impact of surface water entering the ground which was identified in the Hydrogeology screening but not addressed any further. It is now stated this will have minimal effect due to the small change to the impermeable area and the low permeability of the London Clay.
- 1.7. Contradictory information on the risk of surface water flooding was given in Croft's BIA report and clarification was requested. The revised BIA states there will be no notable impacts on surface water flow within or around the site.
- 1.8. A dual pumping mechanism is proposed as a mitigation measure in the event of flooding from infrastructure failure.
- 1.9. The property (No 35) is noted as showing signs of distress with cracking shown on a figure included in the Croft's BIA report although the Land Stability report states there were no signs of distress. Croft have stated in their email response that in the long term, due to the new development, the property will be on a more stable foundation which they conclude reduces the

risk of further cracking. It is accepted that with good workmanship, further damage to the existing building should be limited.

- 1.10. Trial pits were not undertaken to investigate the property or the neighbouring building. Unless this information is forthcoming, the greatest differential depth should be assumed.
- 1.11. The BIA, Land Stability and Hydrogeology reports contain conflicting information with respect to the presence and potential removal of tree of trees and it was requested that these reports are made consistent.
- 1.12. Croft's response states a tree in the rear of the property is to be relocated not felled, however, it should be noted felling or relocation of a tree has the same effect with respect to shrink and swell. The Land Stability report however states the basement will be founded beyond the zone of seasonal shrink or swell.
- 1.13. It was noted the soil parameters in Croft's report, the GIR and the Land Stability report were inconsistent and clarification was requested as to which parameters are to be used in design. Soil parameters are now only given in the Land Stability report with additional information provided in an email (see Appendix 3) from Croft.
- 1.14. The Ground Movement Assessment (GMA) was revised following the initial audit and Category 2 (Slight) damage was predicted. This requires mitigation measures and the impacts to be re-evaluated. Additional props to increase wall stiffness were proposed by Croft, however, this was considered unfeasible as it exacerbated the problem of limited room for construction. It was suggested that the GMA be considered in greater depth to predict more accurately the likely damage. A revised GMA has been undertaken by Croft which indicates Category 1 (Vey Slight) damage for No 37. This is accepted.
- 1.15. The Land Stability report indicates a maximum excavation depth of 4.80m which was used in the analysis, however, up to 6m was indicated in the monitoring proposal. Croft have clarified that the maximum excavation depth is 4.80m and the monitoring proposal has been updated accordingly.
- 1.16. The BIA did not explicitly consider the impact on the adjacent roads and pavements and any possible utilities running beneath them. Additional information was requested to demonstrate the roadways and the utilities running beneath them are not adversely affected by the development. Croft's email response in April stated that with the exception of part of the garage, the new substructure will be more than 5m away from the highway. It is stated in Croft's email (see Appendix 3) that there would be no adverse effect on the roadway.

- 1.17. The suggested method statement in Croft's report was considered confusing as it contains a management plan and a construction sequence. It should be noted that a better laid out construction management plan should detail noise and dust control as well as traffic management and the construction sequence should be separate from this document.
- 1.18. An outline works programme as required by cl. 233 of the Arup GSD has now been provided as requested and it is accepted a more detailed programme may be submitted by the appointed Contractor.
- 1.19. Proposals are provided for a movement monitoring strategy and some contingency measures during excavation and construction and such measures should be adopted. Condition surveys are recommended. Details and trigger levels may be agreed as part of the Party Wall awards.
- 1.20. It is accepted that the revised BIA has adequately identified the potential impacts and together with the supplementary information provided, has provided suitable mitigation.

## 2.0 INTRODUCTION

- 2.1. CampbellReith was instructed by London Borough of Camden (LBC) on 7 October 2015 to carry out a Category B Audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for 35 Greville Road, Camden Reference 2015/5013/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 "*Basement excavation under the footprint and extending into the garden of an existing building.*"
- 2.6. CampbellReith accessed LBC's Planning Portal on 21 October 2015 and gained access to the following relevant documents for audit purposes:
- Basement Impact Assessment Report – Croft Structural Engineers (first issue), dated August 2015

- Basement Impact Assessment Report: Land Stability – Ground and Project Consultants Ltd, dated July 2015.
- Basement Impact Assessment Report: Groundwater – H Fraser Consulting, dated August 2015.
- Ground Investigation Report – Ground and Water, dated August 2015.
- Design and Access Statement
- FK Project Management Ltd’s Drawings (with the same drawing no 71-1)

Existing elevations

Existing plans

Existing sections

Proposed plans

Proposed sections

Proposed elevations

- 2 No Residents’ consultation responses.

2.7. A more up to date version of the Croft BIA report (second issue) was sent to CampbellReith by the Planning Officer. This document was not available on the LBC Planning Portal, however, as it appeared to be more recent version, this document was audited.

2.8. Supplementary information was received on 26 February 2016 in response to queries raised in the initial audit and these are as follows:

- Basement Impact Assessment Report – Croft Structural Engineers (Revision 2), dated February 2016
- Basement Impact Assessment Report: Land Stability (revised) – Ground and Project Consultants Ltd, dated July 2015
- Basement Impact Assessment Report: Groundwater – H Fraser Consulting, dated February 2016
- Ground Investigation Report – Ground and Water (Final), dated August 2015



- 1 No Residents' consultation response

2.9. Further queries were raised on the supplementary information by email to Croft on 15 March 2016 and a response to those queries was received on 13 April 2016 (see Croft email in Appendix 3). The following documents were updated with the relevant sections referenced in Croft's email response:

- Basement Impact Assessment Report – Croft Structural Engineers (Revision 3), dated April 2016
- Basement Impact Assessment Report: Groundwater – H Fraser Consulting, dated April 2016

2.10. The second audit identified a number of concerns with regards to stability and an email response was received from Croft on 23 May 2016 with the following documents:

- Ground Movement Assessment – Croft Structural Engineers, dated May 2016.
- Structural Monitoring Statement (Rev 1) – Croft Structural Engineers, dated May 2016

### 3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are BIA Author(s) credentials satisfactory?	Yes	See Audit paragraph 4.1.
Is data required by Cl.233 of the GSD presented?	Yes	Croft BIA. Outline programme of works 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	Croft BIA Section 1 and supplementary information.
Are suitable plan/maps included?	No	Croft BIA report provides suitable maps, the other reports do not include the relevant Arup GSD map extracts.
Do the plans/maps show the whole of the relevant area of study and do they show it in sufficient detail?	Yes	Croft BIA.
Land Stability Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Ground and Project Land Stability report Section 3 although this contains conflicting information to Croft's BIA report with respect to tree removal (see Audit paragraph 4.16).
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	No	No reference to relevant Arup GSD maps and no justification for 'No' answers.
Hydrology Screening:	Yes	Croft BIA report Section 1.

Item	Yes/No/NA	Comment
Have appropriate data sources been consulted? Is justification provided for 'No' answers?		
Is a conceptual model presented?	Yes	H Fraser Groundwater report Section 4.1, Ground and Project (G&P) Land stability report Section 6 and Ground and Water Limited ground investigation report (GIR) Section 4.
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	No	The Ground and Project Land Stability report does not appear to include a formal scoping.
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	No	Section 4 of the H Fraser Groundwater report appears to include scoping however this is not consistent with the screening (see Audit paragraph 4.8).
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	Yes	Croft BIA report Section 2.
Is factual ground investigation data provided?	Yes	Ground and Water GIR, however it is noted that trial pits to investigate the existing foundations was recommended but this was not undertaken (see Audit paragraph 4.7).
Is monitoring data presented?	Yes	Ground and Water GIR Section 4.4.
Is the ground investigation informed by a desk study?	Yes	Croft BIA Section 3.
Has a site walkover been undertaken?	Yes	Croft BIA Section 3.
Is the presence/absence of adjacent or nearby basements confirmed?	No	Section 3 of the Croft report states a planning application was granted for the construction of a basement but it is unknown if this was constructed (see Audit paragraph 4.7).

Item	Yes/No/NA	Comment
Is a geotechnical interpretation presented?	No	Initially provided in the Ground and Water GIR Section 6 but subsequently removed in the revised report.
Does the geotechnical interpretation include information on retaining wall design?	Yes	Section 6 of the G&P's Land Stability report although this did not include stiffness parameters for the Made Ground and London Clay. Outstanding information provided in Croft email included in Appendix 3.
Are reports on other investigations required by screening and scoping presented?	N/A	No such reports identified.
Are baseline conditions described, based on the GSD?	Yes	Croft BIA and G&P Land Stability report.
Do the base line conditions consider adjacent or nearby basements?	Yes	Considered for No 37 the immediate neighbouring property, but no confirmation of presence or absence (see Audit paragraph 4.7).
Is an Impact Assessment provided?	Yes	G&P Land Stability report, H Fraser Consulting Groundwater report and Croft BIA.
Are estimates of ground movement and structural impact presented?	Yes	Land Stability report Section 8.
Is the Impact Assessment appropriate to the matters identified by screen and scoping	Yes	G&P Land Stability report, H Fraser report and Croft BIA.
Has the need for mitigation been considered and are appropriate mitigation methods incorporated in the scheme?	Yes	Provided in Croft and Land Stability reports with additional mitigation measures on Croft email.
Has the need for monitoring during construction been considered?	Yes	Croft's BIA report provided recommended monitoring with trigger levels although it is not clear what these levels are based on.

Item	Yes/No/NA	Comment
Have the residual (after mitigation) impacts been clearly identified?	Yes	Croft's BIA.
Has the scheme demonstrated that the structural stability of the building and neighbouring properties and infrastructure will be maintained?	Yes	Croft GMA (see Audit paragraphs 4.12, 4.13 and 4.17 and Appendix 3).
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	Croft BIA and email response.
Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area?	Yes	Croft GMA (see Audit paragraphs 4.12, 4.13 and 4.17 and Appendix 3).
Does report state that damage to surrounding buildings will be no worse than Burland Category 2?	Yes	Revised Ground Movement Assessment by Croft predicts Category 1 (Very Slight) damage.
Are non-technical summaries provided?	No	Not provided in G&P's Land Stability report or H Fraser's groundwater report although the reports are easily understandable.  A non-technical/executive summary is provided in Croft's BIA report.

## 4.0 DISCUSSION

- 4.1. The BIA has been carried out by Croft Structural Engineers, who have employed Ground and Project Consultants Ltd and H Fraser Consulting to undertake the Land Stability and Hydrogeology assessments respectively. These are reported under separate covers. The reviewers of the Croft report and the authors of the Land Stability and Hydrogeology reports all have suitable qualifications.
- 4.2. The existing property is described in the Croft BIA as a detached house with three storeys and a loft space area. The existing lower ground floor is indicated to be c.1.60m below ground level (m bgl). It is proposed to construct a new basement below the existing building extending partly beneath the garden with a maximum excavation depth to 4.80m bgl although Section 3 of the monitoring proposals indicated excavation up to 6m bgl to the rear of the property. Clarification was requested and Croft have confirmed the depth is 4.80m and the monitoring statement has been revised accordingly.
- 4.3. Section A of Camden's Audit instruction states that the site does not neighbour a listed building, however, Section 3 of Croft's report states the neighbouring property (37 Greville Road) is listed. A search of the LBC of Camden's listed buildings confirms the neighbouring property is Grade II listed.
- 4.4. The BIA has confirmed that the proposed basement will be located within the London Clay and that the surrounding slopes are stable.
- 4.5. The construction methodology has been revised following the initial audit which requested clarification. It is now proposed to construct the basement using a contiguous pile wall. Subsequent to the initial audit, the indicative temporary works proposal appeared to suggest excavation will be undertaken to formation level prior to propping installed and it was requested the propping arrangements be reconsidered. The proposal has been altered to include tunnelling under the existing lower ground floor with intermediate propping prior to the raking props being installed.
- 4.6. As indicated on Croft's temporary works sequence (SD-12), and Croft's email response (see Appendix 3), it is proposed to retain the existing lower ground floor and form the basement using tunnelling. This means vertical propping needs to be provided for the lower ground floor slab as the basement is excavated. The piled wall will be cross propped until permanent propping is installed. This proposal requires good control of workmanship by the Contractor.
- 4.7. The H Fraser Groundwater report assumes the presence of a basement beneath the neighbouring property, 37 Greville Road extending to 3.15m bgl. It is stated on Section 3 of the revised Croft BIA that planning permission was granted for a basement beneath No 37 Greville Road, however,

- it is unknown if this was constructed or not. Trial pits to investigate the foundations of the property itself (35 Greville Road) or the neighbouring property 37 Greville Road were not undertaken in the ground investigation. It is stated in Section 5 of the Land Stability report that this was due to lack of access. Unless this information is forthcoming, the greatest differential depth should be assumed.
- 4.8. It is noted that groundwater was observed at <1m bgl in the ground investigation undertaken by Ground and Water. Although, the basement is to be founded in the London Clay, the H Fraser report considers the construction of the basement could alter the groundwater flow and that there is a risk of groundwater ingress. The H Fraser report recommends provision of groundwater drainage pathways around the proposed structure and ongoing monitoring of groundwater levels. The issue of increase in the proportion of surface water entering the ground identified in the screening is not addressed in the scoping, however, it is now stated in the change to impermeable areas is small and will have minimal impact.
- 4.9. Croft's BIA screening and scoping notes the risk of flooding from infrastructure failure and a dual pumping mechanism with a non-return valve in the basement is proposed as a mitigation measure. Upstands above ground level are proposed to reduce the likelihood of flooding into the lightwells.
- 4.10. The Ground and Project Land Stability screening states the structural survey of the property (No. 35) did not reveal any apparent sign of distress, however, this information contradicts the Croft report which noted fine to moderate cracking on the property with a photograph presented as Figure 10 showing cracking on the garage walls. It is stated in the Croft report that these cracks are believed to be non-structural. Clarification was requested and Croft have stated in their email response that in the long term, due to the new development, the property will be on a more stable foundation which they conclude reduces the risk of further cracking. As the depths of the existing foundations are not being altered, assuming good workmanship, the long term impact on the stability of the building is low.
- 4.11. Contradictory strength values for the London Clay and retaining wall parameters were given in the ground investigation report and Section 6 of the Land Stability report and it was requested that these are made consistent following the initial audit. Strength values for the London Clay and retaining wall parameters are now only given in the Land Stability report with stiffness parameters for the London Clay on an email from Croft (Appendix 3).
- 4.12. The revised Ground Movement Assessment (GMA) following the initial audit included in the Land Stability report predicted a Category 2 (Slight) damage to No 37. It was stated the suggested values from CIRIA C580 are considered conservative and represents an upper bound. CPG4 requires mitigation measures where damage exceeds Category 1 and the impacts to be re-evaluated. Croft's suggested in an email in April that mitigation measures in the form of

- increasing the number of props to increase wall stiffness. This was not considered feasible as it would lead to a very congested working area during construction. Further details of prop spacing and sizes were required to demonstrate the feasibility of undertaking construction around the propping. The initial audit suggested that the GMA be considered in more detail to provide a more accurate prediction of likely damage.
- 4.13. Subsequent to the second audit, Croft have undertaken a GMA (see Appendix 3) which assumes a wall depth of 14.40m with a maximum excavation depth of 4.80m. Category 1 (Very Slight) damage is now predicted for No 37 which means further mitigation measures are no longer required. This is accepted.
- 4.14. Section 8 of the Land Stability report predicts short term heave movements of 7mm using elastic and consolidation theories and further states this is the maximum figure at the centre of the basement and will reduce towards the edges of the basement.
- 4.15. Croft's report stated that it is not expected that any cracking will occur during the works, however, it is noted that the property (35 Greville Road) already shows signs of distress. Although Section 3 of Croft's report states the cracks are believed to be non-structural, it is noted that there are trees present in the garden along the site boundary as indicated on the tree survey plan.
- 4.16. The Croft report only noted the presence of a tree, shrubs and general vegetation in the neighbouring garden, however, the tree survey (existing plan with trees) shows the presence of trees in the garden of the property itself. A 'No' response is given to Question 6 of the Land Stability screening which relates to whether or not any trees are to be felled as part of the development. Whilst this information is contradictory, Ground and Project's Land Stability report note the basement will be founded beyond the depth of any seasonal shrink/swell zone which is accepted. Croft has responded to a clarification request by stating that *'the tree will be relocated and therefore not be felled in the conventional use of the term'*. It should be noted that a tree being felled or relocated would have the same effect as this relates to the potential for the ground to swell as a result of the excess moisture being retained in the ground.
- 4.17. The basement design and construction impacts discussion in Croft's report gave loadings allowed for highways but did not explicitly consider the impact of the development on the pavements even though it was stated the development is within 5m of the footpath. Additional information was requested to demonstrate the roadways and any utilities running beneath them will not be adversely affected by the development. It was stated in Croft's email response in April that with the exception of the part of the basement beneath the garage, the new substructure will be more than 5m away from the highway, however, the impact on the highway was still not addressed. Croft's email on 23 May 2016 states that *'movement close to the road is of no greater concern than with the ground next to the rest of the basement perimeter'*. It is accepted that with good



- control of workmanship and adequate propping, damage to the roadway and any utilities beneath should be limited.
- 4.18. A suggested method statement is included in Croft's report. This was considered confusing as it contains both a construction management plan and a construction sequence. Details of construction vehicle movements are not included in the construction management plan. Croft have indicated a more detailed construction management plan may be provided by the appointed Contractor and details should be agreed with the Council.
- 4.19. An outline works programme as required by cl. 233 of the Arup GSD has now been provided as requested and it is accepted a more detailed programme may be provided by the appointed Contractor.
- 4.20. Proposals are provided for a movement monitoring strategy together with contingency measures during excavation and construction and such measures should be adopted with details and trigger levels to be agreed as part of the Party Wall awards.

## 5.0 CONCLUSIONS

- 5.1. The reviewers of the BIA and the authors of the Land Stability and Hydrogeology reports all have suitable qualifications.
- 5.2. The construction method and sequence were revised subsequent to the initial audit which requested clarity and plans to better indicate the sequence and indicative temporary works proposal which have also been provided.
- 5.3. The revised construction methodology and temporary works proposal requires good control of workmanship by the appointed Contractor.
- 5.4. Clarification was requested on the issue of more surface water entering the ground which was identified in the Hydrogeology screening but not addressed any further. It is now stated the change to impermeable areas is small and will have minimal effect.
- 5.5. Contradictory information on the risk of surface water flooding was given in Croft's BIA report and clarification was requested. The revised BIA states there will be no notable impacts on surface water flow within or around the site.
- 5.6. A dual pumping mechanism is proposed as a mitigation measure in the event of flooding from infrastructure failure.
- 5.7. The property is noted as showing signs of distress with cracking shown on a figure included in the Croft's BIA report although the land stability report states there were no signs of distress. Croft have stated in their email response that in the long term, due to the new development, the property will be on a more stable foundation which they conclude reduces the risk of further cracking. It is accepted that with good workmanship, further damage to the existing building should be limited.
- 5.8. It is noted that trial pits were not undertaken to investigate the property or the neighbouring building. Unless this information is forthcoming, the greatest differential depth should be assumed.
- 5.9. It was noted that the BIA, Land Stability and Hydrogeology reports contain conflicting information with respect to the presence and potential removal of tree of trees and it was requested that these reports are made consistent.
- 5.10. Croft's response states a tree in the rear of the property is to be relocated not felled, however, it should be noted felling or relocation of a tree has the same effect with respect to shrink and swell. The Land Stability report states the basement will be founded beyond the zone of seasonal shrink or swell.

- 5.11. The soil parameters in Croft's report, the GIR and the Land Stability report were inconsistent and clarification was requested as to which parameters are to be used in design. Soil parameters are now only given in the Land Stability report with additional information on an email (see Appendix 3) from Croft.
- 5.12. The Ground Movement Assessment (GMA) was revised following the initial audit and Category 2 (Slight) damage was predicted. This requires mitigation measures and the impacts to be re-evaluated and additional props to increase wall stiffness were proposed by Croft. Increasing the amount of propping was considered unfeasible as it exacerbated the problem of limited room for construction. It was suggested that the GMA be considered in more detail to provide a more accurate prediction of likely damage.
- 5.13. A revised GMA has been undertaken by Croft which indicates Category 1 (Vey Slight) damage for No 37. Additional mitigation measures are therefore not required.
- 5.14. The Land Stability report indicates a maximum excavation depth of 4.80m which was used in the analysis, however, up to 6m was indicated in the monitoring proposal. Croft have clarified that the excavation depth is 4.80m and the monitoring proposal has been updated accordingly.
- 5.15. The BIA did not explicitly consider the impact on the adjacent roads and pavements and any possible utilities running beneath them. Additional information was requested to demonstrate the roadways and the utilities running beneath them are not adversely affected by the development. Croft's email response states that with the exception of part of the garage, the new substructure will be more than 5m away from the highway. It is stated in Croft's email (see Appendix 3) that there would be no adverse effect on the roadway.
- 5.16. The suggested method statement in Croft's report was considered confusing as it contains a management plan and a construction sequence. It should be noted that a better laid out construction management plan should detail noise and dust control as well as traffic management and the b construction sequence should be separate from this document.
- 5.17. An outline works programme as required by cl. 233 of the Arup GSD has now been provided as requested and it is accepted a more detailed programme may be submitted by the appointed Contractor.
- 5.18. Proposals are provided for a movement monitoring strategy and some contingency measures during excavation and construction and such measures should be adopted. Condition surveys are recommended. Details and trigger levels may be agreed as part of the Party Wall awards.

It is accepted that the BIA has adequately identified the potential impacts and together with the supplementary information provided, provide adequate mitigation.

## **Appendix 1: Residents' Consultation Comments**

Residents' Consultation Comments

Surname	Address	Date	Issue raised	Response
Denndy	12 Broadoak House Mortimer Crescent Kilburn NW6 5PA	21-09-15	Effect on trees and drainage  Presence of a river	See Audit paragraphs 4.8 and 4.16  N/A - The BIA notes there are no surface water features in the vicinity of the site.
Not provided	Greville Road (full address not provided)	19-09-15	Concerns about building damage and notes subsidence further along row of buildings	See Audit paragraphs 4.12 and 4.13

## **Appendix 2: Audit Query Tracker**

Query No	Subject	Query	Status	Date closed out
1	BIA format and stability	Inadequate and unclear construction method and sequence	Closed – Construction method reconsidered. Plans and detailed cross sections provided	13/05/16
2	BIA format	Non technical summaries not provided	Closed - Agreed that existing documents clearly describe outcomes	13/05/16
3	BIA format	Inconsistent baseline conditions in different reports	Closed – Clarification in Croft email	13/05/16
4	BIA format	A works programme has not been submitted	Closed – Outline programme provided with detailed programme to be provided by appointed Contractor.	13/05/16
5	Hydrogeology	Mitigation measure in the groundwater report is unclear and inconsistent with the measures in Croft's report	Closed - Clarification in Croft email	13/05/16
6	Surface water flooding	BIA screening and scoping are inconsistent	Closed - Clarification in Croft email and document revised.	13/05/16
7	Stability	Contradictory maximum excavation depths given in various documents	Closed – Clarification in Croft email and monitoring statement updated to reflect maximum depth (see Appendix 3)	24/05/16
8	Stability	Temporary works proposal in supplementary documents considered inadequate. Proposal revised, however, considered unfeasible and further details requested	Closed – Additional propping no longer required, however, proposed tunnelling and propping requires good control of workmanship	24/05/16
9	Stability	Ground movement and building damage assessment considered incorrect following initial audit. Resubmitted but damage category (Category 2) required further mitigation which was provided by deemed unfeasible.	Closed – GMA re-evaluated and now predicts Category 1 damage, therefore additional mitigation measures not required (see Croft email and revised GMA in Appendix 3)	24/05/16
10	Stability	No explicit impact assessment on the	Closed – Addressed in Croft email (see Appendix	24/05/16

		roadways. Stated in Croft email that only a small section will be within 5m of the roadway but impact still not addressed	3) which states no adverse effect anticipated on roadway.	
11	Stability	BIA offers monitoring of existing building	Condition surveys, monitoring regime and trigger levels to be agreed with Party Wall Surveyor	N/A
12	Construction management plan	Confusing and unclear	Agreed that appointed Contractor may provide more detailed plan. Details to be agreed with Council.	N/A



### **Appendix 3: Supplementary Supporting Documents**

Croft email response dated 23/05/16

Croft Ground Movement Assessment

Croft revised monitoring proposal

Heave parameters



FW: 35 Greville Rd BIA [Camden Ref 2015/5013/P, CampbellReith Ref 12066-62]

Geoff Watson

to:

FatimaDrammeh

23/05/2016 09:32

Cc:

"Irina Bogdanova", nmanzini

Hide Details

From: "Geoff Watson" <gwatson@croftse.co.uk>

To: <FatimaDrammeh@campbellreith.com>

Cc: "Irina Bogdanova" <irina@fkprojectmanagement.com>, <nmanzini@croftse.co.uk>

History: This message has been replied to and forwarded.

## 2 Attachments



image001.jpg image002.jpg 150525 GMA.pdf 150525- 35 Greville Rd - monitoring stmt Rev1.pdf

Hi Fatima,

I think I got your address wrong first time round. Please find our responses below.

Kind regards

Geoff

---

From: Geoff Watson [<mailto:gwatson@croftse.co.uk>]

Sent: Monday, 23 May, 2016 9:22 AM

To: FatimahDrammeh@campbellreith.com

Cc: Irina Bogdanova (irina@fkprojectmanagement.com); nmanzini@croftse.co.uk

Subject: 35 Greville Rd BIA [Camden Ref 2015/5013/P, CampbellReith Ref 12066-62] [Filed 23 May 2016 09:22]

Hi Fatimah,

Thank you for taking my call last week regarding the audit [D2] for the above. Our responses to the remaining open queries are as follows:

### Query 7

With reference Section 3 of the monitoring statement, we note that an incorrect excavation depth was given. This has been revised to refer to a maximum excavation depth of 4.8m. Please find a revised monitoring statement attached confirming this.

### Query 8

Mitigation measures in the form of additional propping are no longer required (see below).

### Query 9

The ground movement analysis has been revised. Please find this attached (this now supersedes the analysis given in Section 8 of the Land Stability BIA, which was submitted previously). The revised ground movement analysis shows that the maximum damage category is 1. Additional mitigation measures are no longer required now that we are not exceeding category 1.

Query 10

The excavations close to the road will be as per the rest of the basement: the maximum excavation depth will be 4.8m. The anticipated ground movements will also be similar. Movement close to the road is of no greater concern than with the ground next to the rest of the basement perimeter.

Kind regards

Geoff Watson  
Structural Engineer



Clock Shop Mews, Rear of 60 Saxon Rd, SE25 5EH

t: 020 8684 4744

e: [gwatson@croftse.co.uk](mailto:gwatson@croftse.co.uk)

w: [www.croftse.co.uk](http://www.croftse.co.uk)

Follow us at @CroftStructures



Click [here](#) to report this email as spam.

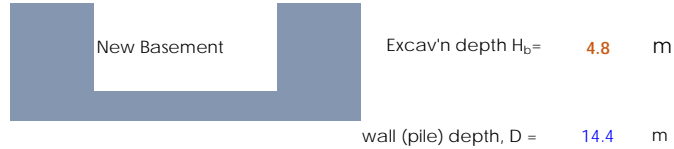
Project: <b>35 Greville Rd</b>		Section	Sheet <b>GMA - 1</b>
Date <b>May-16</b>	Rev	Date	Description
By <b>GW</b>			
Checked <b>NM</b>			
Job No <b>150525</b>	Status		Rev

Ref **Movement of closest neighbouring property (No 37)**

**Neighbouring building**

Building width, L = **8000 mm**  
 Distance to furthest point of building from excavation & installation, L<sub>1</sub> = **9000 mm**  
 Height H = **6000 mm**

L/H = **1.33**



Note: the height of the neighbouring building varies. Conservatively, the lowest height is used (height to eaves)

**Movement Assessment CIRIA C580: Embedded retaining walls - guidance for economic design**

**Potential movement due to installation of wall**

using parameters from Table 2.2 of CIRIA C580 for contiguous bored piles

**Horizontal Surface Movement / wall depth** = -0.04%  
 $\max \delta_h = -0.04\% \times 14400 = -5.76 \text{ mm}$   
 Distance behind wall to negligible movement (multiple of wall depth) = 1.5  
 $L_0 = 14400 \times 1.5 = 21600 \text{ mm}$

linear approximation is used for horizontal movement due to installation [Fig 2.8a].

This gives slightly conservative results.

**Vertical Surface Movement / wall depth** = -0.04%  
 $\max \delta_v = -0.04\% \times 14400 = -5.76 \text{ mm}$   
 Distance behind wall to negligible movement (multiple of wall depth) = 2  
 $L_0 = 14400 \times 2 = 28800 \text{ mm}$

**Table A**

distance from wall in mm (x)	movement due to wall installation	
	horizontal ( $\delta_h$ ) in mm	vertical ( $\delta_v$ ) in mm
0	-5.8	-5.8
2000	-5.2	-5.4
4000	-4.7	-5.0
6000	-4.2	-4.6
8000	-3.6	-4.2
10000	-3.1	-3.8
12000	-2.6	-3.4
14000	-2.0	-3.0
16000	-1.5	-2.6
18000	-1.0	-2.2
20000	-0.4	-1.8
22000	0.0	-1.4
24000	0.0	-1.0
26000	0.0	-0.6
28000	0.0	-0.2
30000	0.0	0.0
32000	0.0	0.0

Potential movement due to excavation of wall

using parameters from Table 2.4 of CIRIA C580

(high stiffness: excavation will be propped during construction)

**Horizontal Surface Movement / excavation depth** = -0.15%

$$\max \delta_h = -0.15\% \times 4800 = -7.2 \text{ mm}$$

Distance behind wall to negligible movement (multiple of excav'n depth) = 4

$$L_0 = 4800 \times 4 = 19200 \text{ mm}$$

**Vertical Surface Movements**

Distance behind wall to negligible movement (multiple of excav'n depth) = 3.5

$$L_0 = 4800 \times 3.5 = 16800 \text{ mm}$$

**Table B**

distance from wall in mm (x)	movement due to wall excavation	
	horizontal ( $\delta_h$ ) in mm	vertical ( $\delta_v$ ) in mm
0	-7.2	-1.9
2000	-6.5	-3.3
4000	-5.7	-3.6
6000	-5.0	-3.4
8000	-4.2	-2.4
10000	-3.5	-1.7
12000	-2.7	-0.96
14000	-2.0	-0.5
16000	-1.2	-0.2
18000	-0.5	0.0
20000	0.0	0.0
22000	0.0	0.0
24000	0.0	0.0
26000	0.0	0.0
28000	0.0	0.0
30000	0.0	0.0
32000	0.0	0.0

**Total differential movement due to excavation and installation**

(from Graph 1, Sheet GMA - 2)

Total Horizontal Movement (excavation and installation)  $\delta_h = 4.9 \text{ mm}$

Total Vertical Movement (excavation and installation)  $\Delta = 1.1 \text{ mm}$

**TOTAL STRAIN (EXCAVATION AND INSTALLATION)**

Table 2.5 CIRIA C580

Category of Damage	Normal Degree	Limiting Tensile Strain %
0	Negligible	0.00% - 0.05%
1	Very slight	0.05% - 0.075%
2	Slight	0.075% - 0.15%
3	Moderate	0.15% - 0.30%
4 to 5	Severe to Very Severe	> 0.30%

Max Anticipated Damage may be categorised as **'Very Slight' ; Category 1**

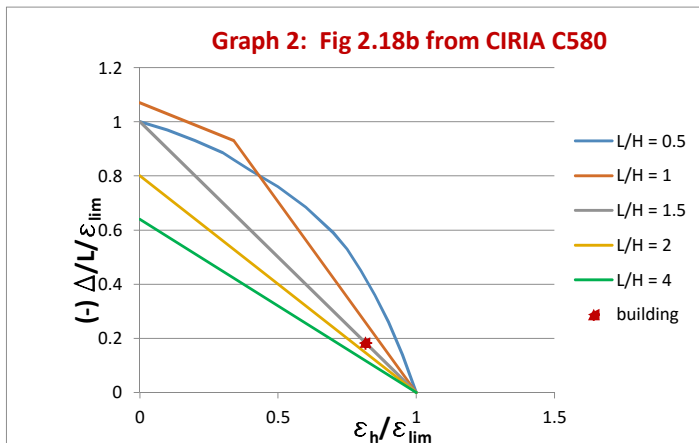
$$\epsilon_{lim} = 0.075\%$$

$$\epsilon_h = 0.061\% \quad \epsilon_h / \epsilon_{lim} = 0.82$$

$$\Delta / L = 0.014\% \quad \Delta / L / \epsilon_{lim} = 0.18$$

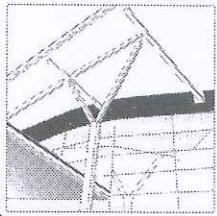
**Table C**

distance from wall in mm (x)	Total Movement	
	horizontal ( $\delta_h$ ) in mm	vertical ( $\delta_v$ ) in mm
0	-13.0	-7.7
2000	-11.7	-8.6
4000	-10.4	-8.6
6000	-9.1	-7.9
8000	-7.8	-6.6
10000	-6.5	-5.4
12000	-5.3	-4.3
14000	-4.0	-3.4
16000	-2.7	-2.8
18000	-1.4	-2.2
20000	-0.4	-1.8
22000	0.0	-1.4
24000	0.0	-1.0
26000	0.0	-0.6
28000	0.0	-0.2
30000	0.0	0.0
32000	0.0	0.0



values above used for Graph 1, GMA - 2 (separate sheet)

For this building, L/H is 1.33. On Graph 2, the plot line for this will be between the plots for L/H = 1 and L/H = 1.5. The plot point for the building (in red), would fall below this, thus the max Damage Category is less than Category 2



enquiries@croft.co.uk

Project: 35 GREVILLE ROAD

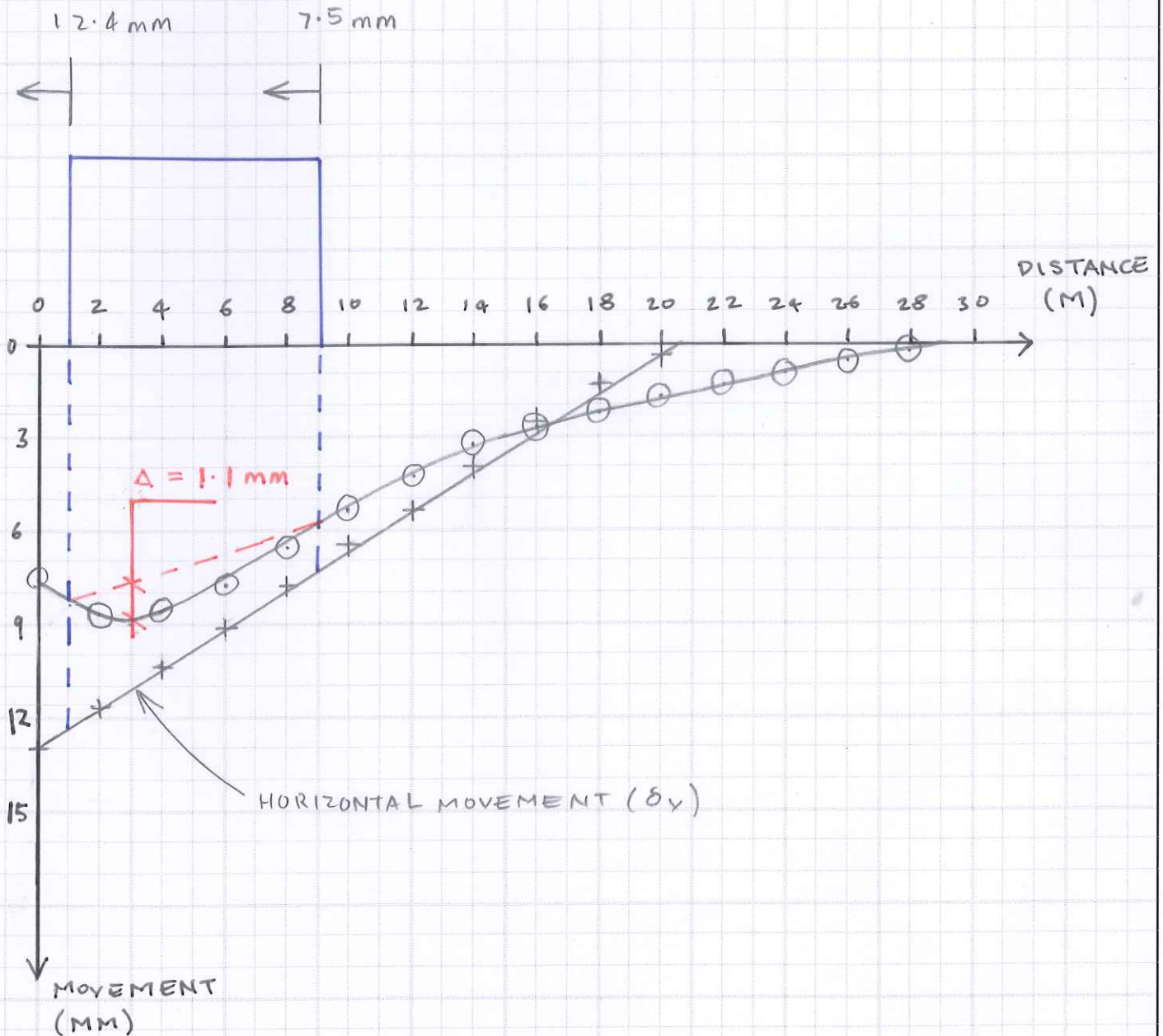
Job Number: 150525

Title: GROUND MOVEMENT ASSESSMENT FOR 37 GREVILLE ROAD

By: GW  
Checked: NM  
Date: '05 2016

Section:  
Sheet: GMA-2  
Rev:

SECTION TAKEN THROUGH WALL CLOSEST TO N° 35



Croft Structural Engineers  
Clock Shop Mews  
Rear of 60 Saxon Road  
London SE25 5EH

T: 020 8684 4744

E: [enquiries@croftse.co.uk](mailto:enquiries@croftse.co.uk)

W: [www.croftse.co.uk](http://www.croftse.co.uk)

# Structural Monitoring Statement

Property:

35 Greville Road  
London  
NW6 5JB

Client:

Igor Goighberg

Revision	Date	Comment
-	18 Feb 2016	First Issue
1	May 2016	Excavation depths clarified

## Contents

1. Introduction .....	2
2. Risk Assessment.....	2
3. Scheme Details .....	4
Scope of Works .....	4
SPECIFICATION FOR INSTRUMENTATION .....	6
General .....	6
Monitoring of existing cracks.....	6
Instrument Installation Records and Reports .....	7
Installation .....	7
Monitoring .....	7
REPORT OF RESULTS AND TRIGGER LEVELS .....	8
General .....	8
Standard Reporting .....	10
Erroneous Data.....	10
Trigger Values .....	11
Responsibility for Instrumentation .....	11
APPENDIX A MONITORING FREQUENCY .....	12
APPENDIX B.....	13
An Analysis on allowable settlements of structures (Skempton and MacDonald (1956)) .....	13



## 1. Introduction

Basement works are intended at 35 Greville Road. The structural works for this require Party Wall Awards. This statement describes the procedures for the Principal Contractor to follow to observe any movement that may occur to the existing properties, and also describes mitigation measures to apply if necessary.

## 2. Risk Assessment

The purpose of this risk assessment is to consider the impact of the proposed works and how they impact the party wall. There are varying levels of inspection that can be undertaken and not all works, soil conditions and properties require the same level of protection.

Monitoring Level Proposed	Type of Works.
<p data-bbox="148 875 344 909"><b>Monitoring 1</b></p> <p data-bbox="148 927 874 1039">Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works.</p>	<p data-bbox="922 938 1406 1010">Loft conversions, cross wall removals, insertion of padstones</p> <p data-bbox="922 1021 1430 1055">Survey of LUL and Network Rail tunnels.</p> <p data-bbox="922 1066 1401 1137">Mass concrete, reinforced and piled foundations to new build properties</p>

<p><b>Monitoring 2</b></p> <p>Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works.</p> <p>Visual inspection of existing party wall during the works.</p> <p>Inspection of the footing to ensure that the footings are stable and adequate.</p>	<p>Removal of lateral stability and insertion of new stability frames</p> <p>Removal of main masonry load bearing walls.</p> <p>Underpinning works less than 1.2m deep</p>
<p><b>Monitoring 3</b></p> <p>Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works.</p> <p>Visual inspection of existing party wall during the works.</p> <p>Inspection of the footing to ensure that the footings are stable and adequate.</p> <p>Vertical monitoring movement by standard optical equipment</p>	<p>Lowering of existing basement and cellars more than 2.5m</p> <p>Underpinning works less than 3.0m deep in clays</p> <p>Basements up to 2.5m deep in clays</p>
<p><b>Monitoring 4</b></p> <p>Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works.</p> <p>Visual inspection of existing party wall during the works.</p> <p>Inspection of the footing to ensure that the footings are stable and adequate.</p> <p>Vertical monitoring movement by standard optical equipment</p> <p>Lateral movement between walls by laser measurements</p>	<p>New basements greater than 2.5m and shallower than 4m Deep in gravels</p> <p>Basements up to 4.5m deep in clays</p> <p>Underpinning works to Grade I listed building</p>
<p><b>Monitoring 5</b></p> <p>Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works.</p> <p>Visual inspection of existing party wall during the works.</p> <p>Vertical &amp; lateral monitoring movement by theodolite at specific times during the projects.</p>	<p>Underpinning works to Grade I listed buildings</p> <p>Basements to Listed building</p> <p>Basements deeper than 4m in gravels</p> <p><u>Basements deeper than 4.5m in clays</u></p> <p>Underpinning, basements to buildings that are expressing defects.</p>
<p><b>Monitoring 6</b></p> <p>Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and</p>	<p>Double storey basements supported by piled retaining walls in gravels and soft</p>

<p>also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical &amp; lateral monitoring movement by electronic means with live data gathering. Weekly interpretation</p>	<p>sands. (N&lt;12)</p>
<p><b>Monitoring 7</b> Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical &amp; lateral monitoring movement by electronic means with live data gathering with data transfer.</p>	<p>Larger multi-storey basements on particular projects.</p>

### 3. Scheme Details

This document has been prepared by Croft Structural Engineers Ltd. It covers the proposed construction of a new basement for 35 Greville Road. The maximum excavation depth will be 4.8m. Therefore monitoring level 5 is proposed for this development.

### Scope of Works

The works comprise:

- Visual Monitoring of the party wall
- Attachment of Tell tales or Demec Studs to accurately record movement of significant cracks.
- Attachment of levelling targets to monitor settlement.
- The monitoring of the above instrumentation is in accordance with Appendix A. The number and precise locations of instrumentation may change during the works; this shall be subject to agreement with the Principal Contractor (PC).
- All instruments are to be adequately protected against any damage from construction plant or private vehicles using clearly visible markings and suitable head protection e.g. manhole rings or similar. Any damaged instruments are to be immediately replaced or repaired at the contractors own cost.
- Reporting of all data in a manner easily understood by all interested parties.
- Co-ordination of these monitoring works with other site operations to ensure that all instruments can be read and can be reviewed against specified trigger values both during and post construction.
- Regular site meetings by the Principal Contractor (PC) and the Monitoring Surveyor (MS) to review the data and their implications.

- Review of data by Croft Structural Engineers

In addition, the PC will have responsibility for the following:

- Review of methods of working/operations to limit movements, and
- Implementation of any emergency remedial measures if deemed necessary by the results of the monitoring.

The Monitoring Surveyor shall allow for settlement and crack monitoring measures to be installed and monitored on various parts of the structure described in Table 1 as directed by the PC and Party Wall Surveyor (PWS) for the Client.

Item	Instrumentation Type
Party Wall Brickwork Settlement monitoring Crack monitoring	Levelling equipment & targets Visual inspection of cracking, Demec studs where necessary

Table 1: Instrumentation

## General

The site excavations and substructure works up to finished ground slab stage have the potential to cause vibration and ground movements in the vicinity of the site due to the following:

- a) Removal of any existing redundant foundations / obstructions;
- b) Installation of reinforced concrete retaining walls under the existing footings;
- c) Excavations within the site

The purpose of the monitoring is a check to confirm building movements are not excessive.

This specification is aimed at providing a strategy for monitoring of potential ground and building movements at the site.

This specification is intended to define a background level of monitoring. The PC may choose to carry out additional monitoring during critical operations. Monitoring that should be carried out is as follows:

- a) Visual inspection of the party wall and any pre-existing cracking
- b) Settlement of the party wall

All instruments are to be protected from interference and damage as part of these works.

Access to all instrumentation or monitoring points for reading shall be the responsibility of the Monitoring Surveyor (MS). The MS shall be in sole charge for ensuring that all instruments or monitoring points can be read at each visit and for reporting of the data in a form to be agreed with the PWS. He shall inform the PC if access is not available to certain instruments and the PC will, wherever possible, arrange for access. He shall immediately report to the PC any damage. The Monitoring Surveyor and the Principal Contractor will be responsible for ensuring that all the

instruments that fall under their respective remits as specified are fully operational at all times and any defective or damaged instruments are immediately identified and replaced.

The PC shall be fully responsible for reviewing the monitoring data with the MS - before passing it on to Croft Structural Engineers - determining its accuracy and assessing whether immediate action is to be taken by him and/or other contractors on site to prevent damage to instrumentation or to ensure safety of the site and personnel. All work shall comply with the relevant legislation, regulations and manufacturer's instructions for installation and monitoring of instrumentation.

## Applicable Standards and References

The following British Standards and civil engineering industry references are applicable to the monitoring of ground movements related to activities on construction works sites:

1. BS 5228: Part 1: 1997 - Noise and Vibration Control on Construction and Open Sites -Part 1.Code of practice for basic information and procedures for noise and vibration control, Second Edition, BSI 1999.
2. BS 5228: Part 2: 1997 - Noise and Vibration Control on Construction and Open Sites -Part 2.Guide to noise and vibration control legislation for construction and demolition including road construction and maintenance, Second Edition, BSI 1997.
3. BS 7385-1: 1990 (ISO 4866:1990) - Evaluation and measurement for vibration in buildings - Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings, First Edition, BSI 1990.
4. BS 7385-2: 1993 - Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from ground-borne vibration, First Edition, BSI 1999.
5. CIRIA SP 201 - Response of buildings to excavation-induced ground movements, CIRIA 2001.

## SPECIFICATION FOR INSTRUMENTATION

### General

The Monitoring Contractor is required to monitor, protect and reinstall instruments as described. The readings are to be recorded and reported. The following instruments are defined:

- a) Automatic level and targets: A device which allows the measurement of settlement in the vertical axis. To be installed by the MS.
- b) Tell-tales and 3 stud sets: A device which allows measurement of movement to be made in two axes perpendicular to each other. To be installed by the MS.

### Monitoring of existing cracks

The locations of tell-tales or Demec studs to monitor existing cracks shall be agreed with Croft Structural Engineers.

## Instrument Installation Records and Reports

Where instrumentation is to be installed or reinstalled, the Monitoring Surveyor, or the Principal Contractor, as applicable, shall make a complete record of the work. This should include the position and level of each instrument. The records shall include base readings and measurements taken during each monitoring visit. Both tables and graphical outputs of these measurements shall be presented in a format to be agreed with the CM. The report shall include photographs of each type of instrumentation installed and clear scaled sections and plans of each instrument installed. This report shall also include the supplier's technical fact sheet on the type of instrument used and instructions on monitoring.

Two signed copies of the report shall be supplied to the PWS within one week of completion of site measurements for approval.

### Installation

All instruments shall be installed to the satisfaction of the PC. No loosening or disturbance of the instrument with use or time shall be acceptable. All instruments are to be clearly marked to avoid damage.

All setting out shall be undertaken by the Monitoring Surveyor or the Principal Contractor as may be applicable. The precise locations will be agreed by the PC prior to installation of the instrument.

The installations are to be managed and supervised by the Instrumentation Engineer or the Measurement Surveyor as may be applicable.

### Monitoring

The frequencies of monitoring for each Section of the Works are given in Appendix A.

The following accuracies/ tolerances shall be achieved:

Party Wall settlement	$\pm 1.5\text{mm}$
Crack monitoring	$\pm 0.75\text{mm}$

## REPORT OF RESULTS AND TRIGGER LEVELS

### General

Within 24 hours of taking the readings, the Monitoring Surveyor will submit a single page summary of the recorded movements. All readings shall be immediately reviewed by Croft Structural Engineers prior to reporting to the PWS.

Within one working day of taking the readings the Monitoring Contractor shall produce a full report (see below).

The following system of control shall be employed by the PC and appropriate contractors for each section of the works. The Trigger value, at which the appropriate action shall be taken, for each section, is given in Table 2, below.

The method of construction by use of sequential piles limits the deflections in the party wall.

Between the trigger points, which are no greater than 2 m apart, there should be no more than:

Allowable movement to BS5950 for brittle finishes

$$\text{Vertical} = \text{Span} / 360 = 4000\text{mm} / 360 = 11.1\text{mm}$$

Croft proposes a tighter recommendation of Span / 500

$$= \text{Span} / 750 = 4000\text{mm} / 750 = \underline{5\text{mm}}$$

Above Monitoring Level 3, lateral movement is required to be measured and the figures should be:

$$\text{Horizontal} = \text{Height} / 500 = 6300\text{mm} / 500 = 13\text{mm}$$

Croft proposes a tighter recommendation of

$$= \text{Height} / 900 = 6300\text{mm} / 900 = \underline{7\text{mm}}$$

The reference height is the sum of the depth of the excavation (4.8m) and the position of the monitoring stud above Lower Ground level (1.5m)

During works measurements are taken, these are compared with the limits set out below:

MOVEMENT		CATEGORY	ACTION
Vertical	Horizontal		
0mm-5mm	0-7mm	Green	No action required
5mm-7mm	7-9mm	AMBER	<p>Detailed review of Monitoring: Check studs are OK and have not moved. Ensure site staff have not moved studs. If studs have moved reposition.</p> <p>Relevel to ensure results are correct and tolerance is not a concern.</p> <p>Inform Party Wall surveyors of amber readings.</p> <p>Double the monitoring for 2 further readings. If stable revert back.</p> <p>Carry out a local structural review and inspection.</p> <p>Preparation for the implementation of remedial measures should be required.</p> <p>Double number of lateral props</p>
7mm-10mm	9-11mm		Implement remedial measures review method of working and ground conditions
>10mm	>11mm	RED	<p>Implement structural support as required;</p> <p>Cease works with the exception of necessary works for the safety and stability of the structure and personnel;</p> <p>Review monitoring data and implement revised method of works</p>

Table 2 – Movement limits between adjacent sets of Tell-tales or stud sets

Any movements which exceed the individual amber trigger levels for a monitoring measure given in Table 2 shall be immediately reported to the PWS, and a review of all of the current monitoring data for all monitoring measures must be implemented to determine the possible causes of the trigger level being exceeded. Monitoring of the affected location must be increased and the actions described above implemented. Assessment of exceeded trigger levels must not be carried out in isolation from an assessment of the entire monitoring regime as the monitoring measures are



inter-related. Where required, measures may be implemented or prepared as determined by the specific situation and combination of observed monitoring measurement data.

## Standard Reporting

1 No. electronic copy of the report in PDF format shall be submitted to the PWS.

The Monitoring Surveyor shall report whether the movements are within (or otherwise) the Trigger Levels indicated in Table 2. A summary of the extent of completion of any of the elements of works and any other significant events shall be given. These works shall be shown in the form of annotated plans (and sections) for each survey visit both local to the instrumentation and over a wider area. The associated changes to readings at each survey or monitoring point shall be then regulated to the construction activity so that the cause of any change, if it occurs, can be determined.

The Monitoring Surveyor shall also give details of any events on site which in his opinion could affect the validity of the results of any of the surveys.

The report shall contain as a minimum, for each survey visit the following information:

- a) The date and time of each reading;
- b) The weather on the day;
- c) The name of the person recording the data on site and the person analysing the readings together with their company affiliations;
- d) Any damage to the instrumentation or difficulties in reading;
- e) Tables comparing the latest reading with the last reading and the base reading and the changes between these recorded data;
- f) Graphs showing variations in crack width with time for the crack measuring gauges; and
- g) Construction activity as described. It is very important that each set of readings is associated with the extent of excavation and construction at that time. Readings shall be accompanied by information describing the extent of works at the time of readings. This shall be agreed with the PC.

Spread-sheet columns of numbers should be clearly labelled together with units. Numbers should not be reported to a greater accuracy than is appropriate. Graph axis should be linear and clearly labelled together with units. The axis scales are to be agreed with the PC before the start of monitoring and are to remain constant for the duration of the job unless agreed otherwise. The specified trigger values are also to be plotted on all graphs.

The reports are to include progress photographs of the works both general to the area of each instrument and globally to the main Works. In particular, these are to supplement annotated plans/sections described above. Wherever possible the global photographs are to be taken from approximately the same spot on each occasion.

## Erroneous Data

All data shall be checked for errors by the Monitoring Surveyor prior to submission. If a reading that appears to be erroneous (i.e. it shows a trend which is not supported by the surrounding instrumentation), he shall notify the PC immediately, resurvey the point in question and the

neighbouring points and if the error is repeated, he shall attempt to identify the cause of the error. Both sets of readings shall be processed and submitted, together with the reasons for the errors and details of remedial works. If the error persists at subsequent survey visits, the Monitoring Surveyor shall agree with the PC how the data should be corrected. Correction could be achieved by correcting the readings subsequent to the error first being identified to a new base reading.

The Monitoring Surveyor shall rectify any faults found in or damage caused to the instrumentation system for the duration of the specified monitoring period, irrespective of cause, at his own cost.

## Trigger Values

Trigger values for maximum movements as listed in Table 2. If the movement exceeds these values then action may be required to limit further movement. The PC should be immediately advised of the movements in order to implement the necessary works.

It is important that all neighbouring points (not necessarily a single survey point) should be used in assessing the impact of any movements which exceed the trigger values, and that rechecks are carried out to ensure the data is not erroneous. A detailed record of all activities in the area of the survey point will also be required as specified elsewhere.

## Responsibility for Instrumentation

The Monitoring Surveyor shall be responsible for: managing the installation of the instruments or measuring points, reporting of the results in a format which is user friendly to all parties; and immediately reporting to all parties any damage. The Monitoring Surveyor shall be responsible for informing the PC of any movements which exceed the specified trigger values listed in Table 2 so that the PC can implement appropriate procedures. He shall immediately inform the PWS of any decisions taken.

## APPENDIX A MONITORING FREQUENCY

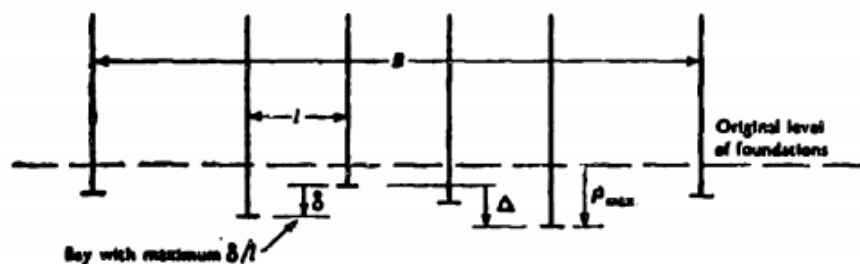
INSTRUMENT	FREQUENCY OF READING
Settlement monitoring and Monitoring existing cracks	<p><b><u>Pre-construction</u></b> Monitored once.</p> <p><b><u>During construction</u></b> Monitored after every pile is cast for first 4 no. piles to gauge effect of piling. If all is well, monitor after every other pile.</p> <p><b><u>Post construction works</u></b> Monitored once.</p>

## APPENDIX B

### An Analysis on allowable settlements of structures (Skempton and MacDonald (1956))

The most comprehensive studies linking self-weight settlements of buildings to structural damage were carried out in the 1950's by Skempton and MacDonald (1956) and Polshin and Tokar. These studies show that damage is most often caused by differential settlements rather than absolute settlements. More recently, similar empirical studies by Boscardin and Cording (1989) and Boone (1996) have linked structural damage to ground movements induced by excavations and tunnelling activities.

In 1955 Skempton and MacDonald identified the parameter  $\delta\rho/L$  as the fundamental element on which to judge maximum admissible settlements for structures. This criterion was later confirmed in the works of GRANT *et al.* [1975] and WALSH [1981]. Another important approach to the problem was that of BURLAND and WROTH [1974], based on the criterion of maximum tensile strains.



**Figure 2.1 – Diagram illustrating the definitions of maximum angular distortion,  $\delta/l$ , maximum settlement,  $\rho_{max}$ , and greatest differential settlement,  $\Delta$ , for a building with no tilt (Skempton and MacDonald, 1956).**

Figure 1: Diagram illustrating the definitions of maximum angular distortion,  $\delta/l$ , maximum settlement,  $\rho_{max}$ , and greatest differential settlement,  $\Delta$ , for a building with no tilt (Skempton and MacDonald, 1956)

The differential settlement is defined as the greatest vertical distance between two points on the foundation of a structure that has settled, while the angular distortion, is the difference in elevation between two points, divided by the distance between those points.

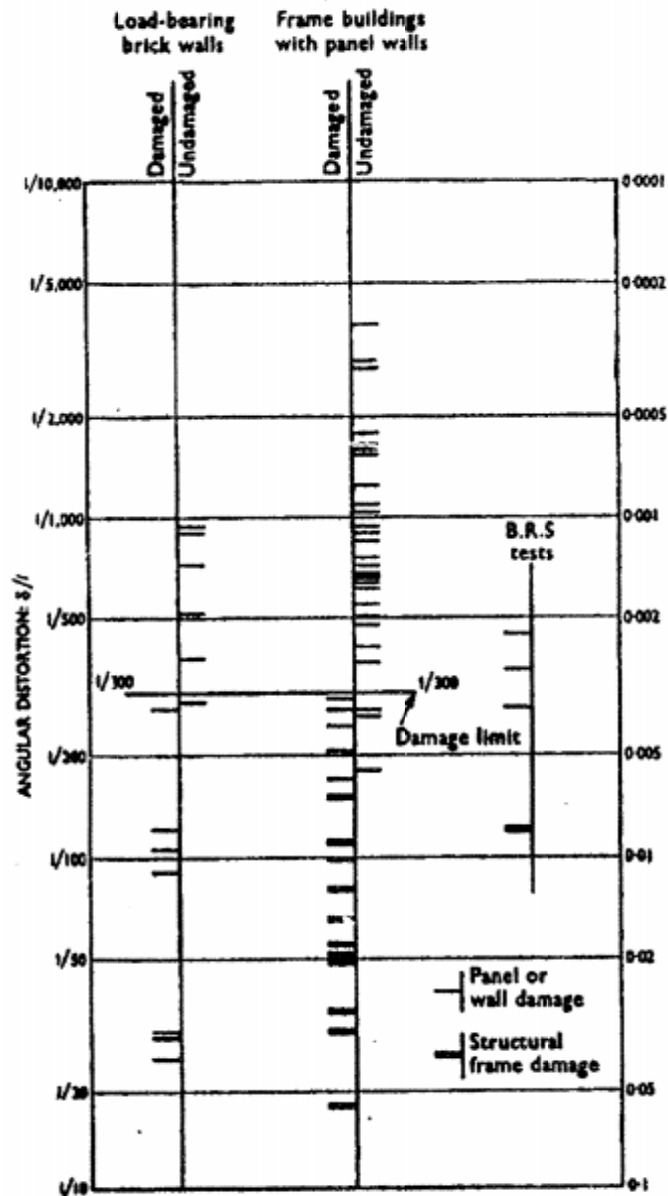
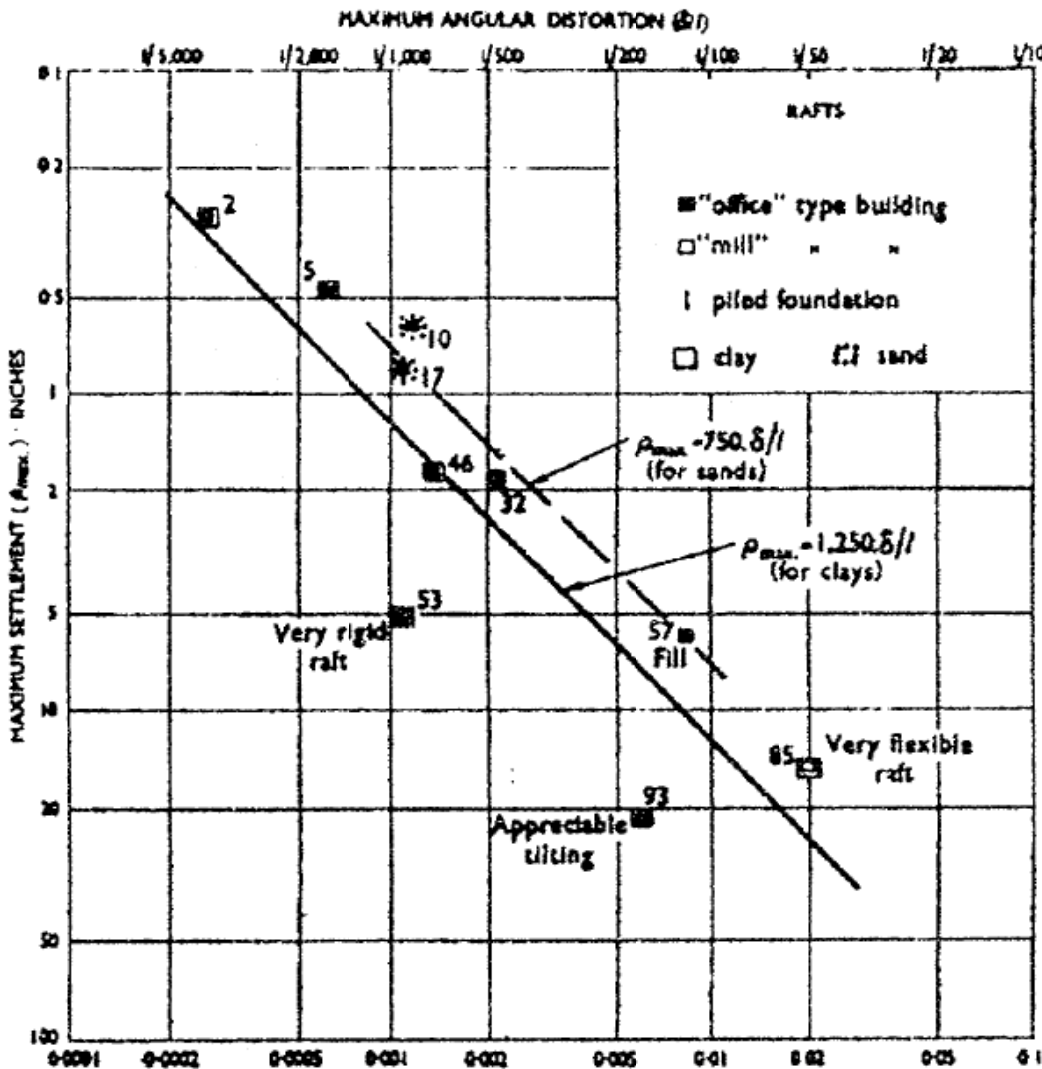
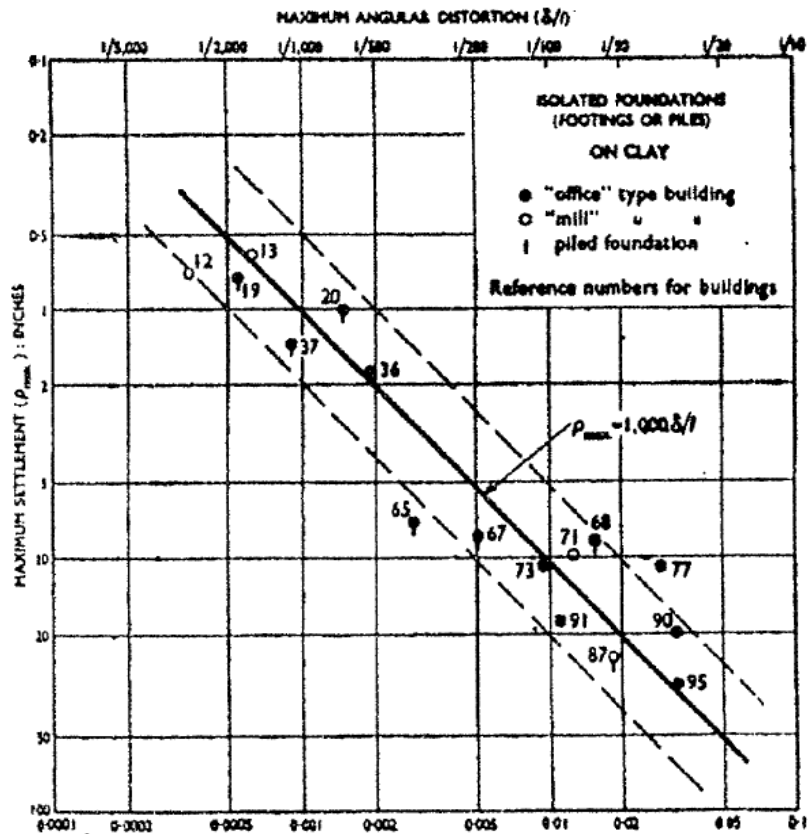
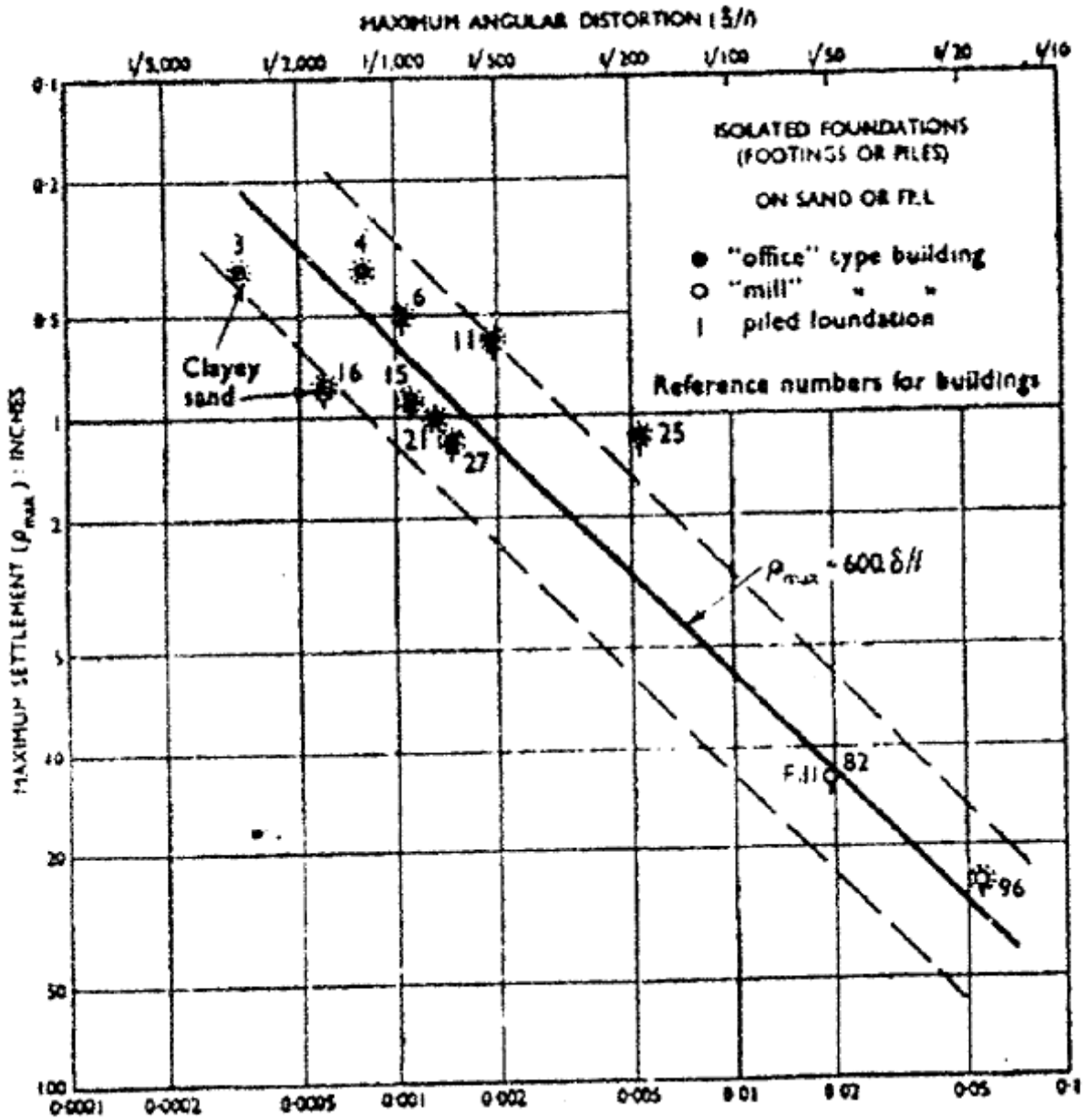


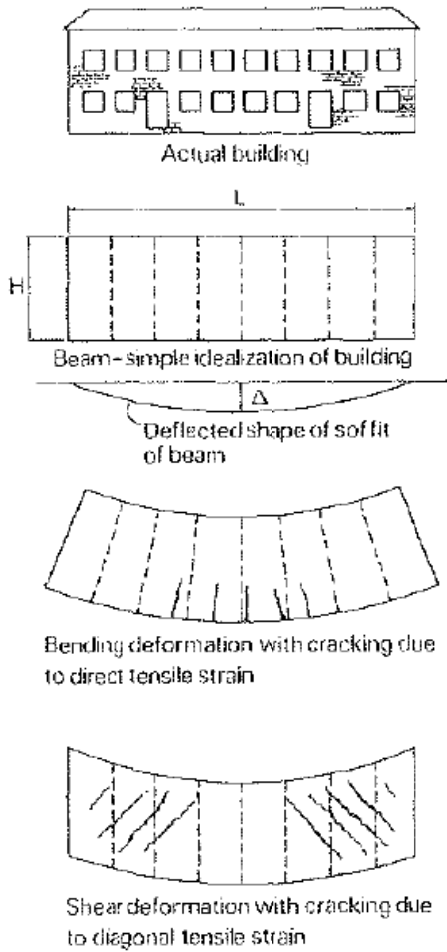
Figure 2: Skempton and MacDonald's analysis of field evidence of damage on traditional frame buildings and loadbearing brick walls

Data from Skempton and MacDonald's work suggest that the limiting value of angular distortion is  $1/300$ . Angular distortion, greater than  $1/300$  produced visible cracking in the majority of buildings studied, regardless of whether it was a load bearing or a frame structure. As shown in the figure 2.

Other key findings by Skempton and MacDonald include limiting values of  $\delta/l$  for structure, and a relationship between maximum settlement,  $p_{max}$  and  $\delta/l$  for structures founded on sands and clays. The charts below show these relations for raft foundations and isolated footings.







**TABLE I**

<b>Angular distortion</b>	<b>Characteristic situation</b>
<b>1/300</b>	<b>Cracking of the panels in frame buildings of the traditional type, or of the walls in load-bearing wall buildings;</b>
<b>1/150</b>	<b>Structural damage to the stanchions and beams;</b>
<b>1/500</b>	<b>Design limit to avoid cracking;</b>
<b>1/1000</b>	<b>Design limit to avoid any settlement damage.</b>



## Geoff Watson

---

**From:** Jon Smithson <jon.smithson@ground-projects.co.uk>  
**Sent:** 12 April 2016 10:12  
**To:** 'Geoff Watson'  
**Subject:** RE: 35 Greville Road - heave  
**Attachments:** params.xlsx

Hi Geoff

Parameters spreadsheet attached. Happy to talk to them direct if this helps.

Regards

Jon

**Jon Smithson**  
Director



Ground and Project Consultants Ltd, Shrewsbury, UK  
Tel: 01743 383155  
Mobile: 07825 819799

[jon.smithson@ground-projects.co.uk](mailto:jon.smithson@ground-projects.co.uk)  
[www.ground-projects.co.uk](http://www.ground-projects.co.uk)  
Follow me at @jonsmithson0305

Ground and Project Consultants Ltd is a limited company registered in England and Wales.  
Company Registration No. 9094820  
Registered Offices: 42 Crosby Road North, Liverpool, United Kingdom. L22 4QQ.

---

**From:** Geoff Watson [<mailto:gwatson@croftse.co.uk>]  
**Sent:** 11 April 2016 16:18  
**To:** 'Jon Smithson' <[jon.smithson@ground-projects.co.uk](mailto:jon.smithson@ground-projects.co.uk)>  
**Subject:** RE: 35 Greville Road - heave

Hi Jon,

Could you include the parameters that you used for the heave please? The auditors expect to see a mention of the soil stiffness for the clay (and for the made ground if applicable). Please could you mention this within the report, or in reply to this e-mail.

Kind regards

**Geoff Watson**  
Structural Engineer

London Clay

**Eu** Undrained Youngs Modulus =  $360 \times C_u$  (CIRIA Special Publication 27)  
From GI  $C_u$  assumed = 50kN/m<sup>2</sup> increasing to 100 at 10m  
Therefore  $E_u = 18000 + 36 \text{ Kn/m}^2$  where  $z_1$  is depth below formation

Mv for long term heave

0.08m<sup>2</sup>/MN at shallow depth

0.05m<sup>2</sup>/MN deeper

Lower strains and stiffer soil at depth

Bulk Unit Weight

Made Ground 17 kN/m<sup>3</sup>

London Clay 20kN/m<sup>3</sup>

---

## 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

Campbell Reith Hill LLP. Registered in England & Wales. Limited Liability Partnership No OC300082  
A list of Members is available at our Registered Office at: Friars Bridge Court, 41- 45 Blackfriars Road, London SE1 8NZ  
VAT No 974 8892 43