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Your Ref:

Our Ref: **Ref: 14/22225-2**
April 2015

Basement Impact Assessment

At

36 Avenue Road, London, NW8 6HS

For

Clayton Business Centre

Original Report issued January 2015

Re-issued amending client details April 2015

CONTENTS

1.0 INTRODUCTION

1.1 Project Objectives

The purpose of this assessment is to consider the effects of a proposed basement construction on the local groundwater regime at the proposed new-build residential property at 36 Avenue Road, London, NW8 6HS. For this assessment a representative of SAS Limited visited the property on 3rd December 2014.

The recommendations and comments given in this report are based on the information contained from the sources cited and may include information provided by the client and other parties including anecdotal information. It must be noted that there may be special conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

1.2 Planning Policy Context

Camden Planning Guidance for Basements and Lightwells has recently been revised (CPG4, September 2013) and requires proposed developments to mitigate against the effects of ground and surface water flooding and to include drainage systems that do not impact neighbouring property of the site or the water environment by way of changing the groundwater regime.

Camden Guidance CPG4 sets out 5 Stages:

1. Screening
2. Scoping
3. Site Investigation
4. Impact Assessment
5. Review and decision making

This report is intended to address the scoping process set out in CPG4 and the Camden Geological, Hydrogeological and Hydrological Study (CGHHS). It will review existing site investigation data and provide a preliminary assessment of the issues identified by the Site Analytical Services Limited screening process.

As part of this guidance a subterranean (groundwater) flow, slope stability and surface water and flooding screening chart is provided (CPG 4, Figures 1, 2 and 3 respectively). The completed charts in relation to this development are provided as Table 1, to this report.

1.3 Qualifications

The report has been prepared by the Mr Andrew Smith, a Fellow of the Geological Society (FGS) and Member of the Chartered Institute of Water and Environmental Management (MCIWEM) in coordination with Mr Mike Brice of Applied Geotechnical Engineering, a Chartered Geologist (CGEOL), Neil Smith of Applied Geotechnical Engineering, a Chartered Civil Engineer (CEng) and Mr Gary Povey of Elliott Wood Partnership Structural Engineers, a Chartered Structural Engineer (CEng).

2.0 SITE DETAILS

(National Grid Reference: TQ 270 837)

2.1 Site Location

The site is located at 36 Avenue Road, London, NW8 6HS. The site comprises of a detached house with a driveway at the front and a rear garden area.

The site is bound to the north east by Radlett House, to the south east by Radlett Place, to the south-west by Avenue Road and to the north-west by 38 Avenue Road. The site is located within the London Borough of Camden.

2.2 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area (Sheet 256, 'North London', Solid & Drift Edition) indicates the site to be underlain by the Eocene London Clay Formation. However, Superficial Head Deposits are located to the east and west of the site.

The BGS 1:625000 Solid Geology Deposits indicate the site to be underlain by the Eocene London Clay Formation.

2.3 Previous Reports

The results from a Phase 1 Preliminary Risk Assessment and Phase 2 Intrusive Investigation are presented under separate cover in Site Analytical Services Limited reports (Project No's. 14/22225-1 and 14/22225 respectively) dated January 2015 (revised April 2015)

2.4 Site Layout and History

The site was attended on 3rd November 2014 for the purposes of conducting the site walkover.

The site is roughly square shaped and comprises of a large three storey house along with garden space occupying the eastern part of the site and a small driveway to the west. The site is cut into two levels, with the ground level of the property approximately 1.0m lower than the site entrance, driveway and garden.

Numerous mature trees are located surrounding the site

The site is essentially flat with no noticeable slope. There is a general slope in the wider hillside setting from north to south down towards the Thames Basin up to approximately 8 degrees.

From a review of the historical maps it appears that there was a property present on site from

1871 until the 1970s when the original property was demolished and replaced by the current building. The current residential building has remained since.

2.5 Proposed Development

The proposed scheme involves the demolition of the existing building on the site and the construction of a new three storey residential building with a two storey basement below encompassing the entire building footprint and a proportion of the back garden. The maximum depth of the basement is expected to be approximately 9.7m below existing ground level (31.90mOD).

2.6 Results of Basement Impact Assessment Screening

A screening process has been undertaken for the site and the results are summarised in Table 1 below:

Table 1: Summary of screening results

Item	Description	Response	Comment
Sub-terranean (Ground water Flow)	1a. Is the site located directly above an aquifer.	No	The Bedrock geology underlying the site (solid permeable formations) associated with the London Clay Formation has been classified as Unproductive Strata; rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.
	1b. Will the proposed basement extend beneath the water table surface.	No	There has been no recorded ground water during site works and from subsequent monitoring visits above the depth of the proposed basement slab at 9.7m below existing ground level (31.92mOD)
	2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line.	Yes - refer to section 4.2 for scoping	The nearest existing surface water feature is recorded as Regents Canal located 519m south east of the site. However, according to the Lost Rivers of London the site is within 100m of one of the tributaries of the former River Tyburn.
	3. Is the site within the catchment of the pond chains on Hampstead Heath.	No	The site is away from this area.
	4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas.	No	The amount of hardstanding on-site is expected to stay the same.
	5. As part of site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS).	No	Soakaways or SUDs are not expected as part of the development due to the presence of cohesive sub strata.
	6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line.	No	The nearest surface water feature is recorded as Regents canal located 519m south east of the site.
Slope Stability	1. Does the existing site include slopes, natural or man-made greater than 1 in 8.	No	The site is essentially flat with only minor undulations present at angles of between 3° and 6°.
	2. Will the proposed re-profiling of landscaping at site change	No	There is no re-profiling of the existing landscaping proposed

	slopes at the property boundary to more than 1 in 8.		
	3. Does the development neighbor land, including railway cuttings and the like, with a slope greater than 1 in 8.	No	The neighbouring land is essentially flat with only minor undulations present, sloping mainly towards the south east, at angles of between 3° and 6°.
	4. Is the site within a wider hillside setting in which the general slope is greater than 1 in 8.	Yes - refer to section 5.2 for scoping	There is a general slight slope in the wider hillside setting from north- west to south-east away from Primrose Hill down towards the Thames Basin up to approximately 8°.
	5. Is the London Clay the shallowest strata at the site.	No	The site is underlain by Made Ground overlying the London Clay Formation; the London Clay is the shallowest natural strata below the site.
	6. Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are to be retained.	Yes - refer to section 5.3 for scoping	It is understood that trees are to be felled as part of the development.
	7. Is there a history of seasonal shink-swell subsidence in the local area and/or evidence of such effects at the site.	Yes - refer to section 5.3 for scoping	The site lies above the London Clay Formation that is well known to have a high tendency to shrink and swell.
	8. Is the site within 100m of a watercourse or a potential spring line.	Yes - refer to section 4.2 for scoping	The nearest surface water feature is recorded as Regents canal located 519m south east of the site. However, according to the Lost Rivers of London the site is within 100m of an ancient river.
	9. Is the site within an area of previously worked ground.	Yes - refer to section 5.5 for scoping	Made Ground has been encountered at the site.
	10. Is the site within an aquifer. If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction.	No	The Bedrock geology underlying the site (solid permeable formations) associated with the London Clay Formation has been classified as Unproductive Strata.
	11. Is the site within 50m of the Hampstead Heath ponds.	No	The site is not located near Hampstead Heath.
	12. Is the site within 5m of a highway or pedestrian right of way.	Yes - refer to section 5.6 for	The site lies adjacent to Avenue Road.

		scoping	
	13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties.	Yes - refer to section 5.7 for scoping	The development will increase the depths of foundation at the site, although the foundation depths of adjacent properties are not known.
	14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines.	No	Communication with LUL Operational Property Division (attached as Appendix A to this report) indicates that the nearest tube line is located over 50m from the site and runs along Finchley Road towards the west of the site.
Surface Water and Flooding	1. Is the site within the catchment of the pond chains on Hampstead Heath.	No	The site is located over 50m from the pond chains on Hampstead Heath.
	2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route.	No	The amount of hardstanding on-site is not expected to increase
	3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.	No	The amount of hardstanding on-site is not expected to increase
	4. Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses.	No	The amount of hardstanding on-site is not expected to increase
	5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses.	No	The amount of hardstanding on-site is not expected to increase
	5. Is the site in an area known to be at risk from surface water flooding.	Yes – See section 6.2	There are no fluvial or tidal floodplains located within 1km of the site. However according to CPG4, September 2013, Avenue Road is on the list of streets at risk from surface water flooding. In addition the Environment Agency's surface water risk mapping shows a 'high' risk of flooding from surface for the adjacent part of the Avenue Road carriageway

The Screening Exercise has indentified the following potential issues which will be carried forward to the Scoping Phase

Subterranean Groundwater Flow

- Is the site within 100m of a watercourse, well (used / disused) or potential spring line

Slope Stability

- Is the site within a wider hillside setting in which the general slope is greater than 1 in 8
- Is there a history of seasonal shink-swell subsidence in the local area and/or evidence of such effects at the site
- Is the site within 100m of a watercourse or a potential spring line
- Is the site within an area of previously worked ground
- Is the site within 5m of a highway or pedestrian right of way
- Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties

Surface Water and Flooding

- Is the site in an area known to be at risk from surface water flooding.

3.0 EXISTING SITE INVESTIGATION DATA

3.1 Records of site investigations

Ground conditions at the site were investigated by Site Analytical Services Limited in June 2014 (SAS Report Reference 14/22225). The ground conditions revealed by the investigation are summarised in the following table.

Strata	Depth to top of strata		Depth to base of strata		Description
	mbgl	mOD	mbgl	mOD	
Made Ground	0.00	0.00	0.50 to 0.80	41.36 to 40.36	Surface layer of tarmacadam or weeds overlying clayey silty sand, old tarmac and brick and concrete fragments
Superficial Head	0.50 to 0.80	41.36 to 40.36	2.50 to 3.80	39.33 to 37.75	Soft and firm high strength silty clay with occasional flint gravel
Weathered London Clay Formation	2.50 to 3.80	39.33 to 37.75	9.30 to 10.0	32.36 to 31.55	Stiff high strength becoming very high strength fissured silty clay with occasional partings of silty fine sand and scattered gypsum crystals
London Clay Formation	9.30 to 10.0	32.36 to 31.55	20.00 (maximum depth of drilling)	21.83 to 21.55	Very stiff very high strength fissured silty clay with occasional partings of silty fine sand and scattered gypsum crystals

Table 1. Summary of Ground Conditions in Exploratory holes

Groundwater was not encountered during drilling of all three boreholes and was not encountered during the post site works monitoring visits which took place over a 6 month period.

4.0 SUBTERRANEAN (GROUNDWATER FLOW) - SCOPING ASSESSMENT

4.1 Introduction

This section addresses outstanding issues raised by the screening process regarding the presence of an ancient watercourse within 100m of the site.

4.2 Springs, Wells and Watercourses

The nearest surface water feature is recorded as a canal located 582m south east of the site.

There are no fluvial or tidal floodplains located within 1km of the site.

With reference to 'The Lost Rivers of London' (Barton, 1992) and 'London's Lost River's (Talling, 2011), the site lies within 100m and between two tributaries of the former River Tyburn, which ran in a southerly direction from Hampstead to Pimlico and Westminster via Regents Park, Marylebone, Mayfair and Buckingham Palace. The River Tyburn is now completely enclosed and flows through underground conduits for its entire length.

Given the predominantly clayey and low permeability nature of the near-surface soils, it is expected that there is very limited surface water infiltration potential and groundwater flow rates in the vicinity of the property will be very low. The historic development of the area for housing will have further limited surface water infiltration.

As a result it is considered that the proposed development will have minimal impact on any nearby watercourses.

5.0 SCOPING ASSESSMENT - SLOPE AND GROUND STABILITY

5.1 Introduction

This section addresses outstanding issues raised by the screening process regarding land stability (see Table 1).

5.2 Slope Stability

The 1:50,000 scale geological map for the area indicates that the site does not lie within an 'Area of Significant Landslide Potential'. No mapped areas of landslips are present in the vicinity of the site and the natural ground stability hazards dataset supplied by the BGS (present in the desk study report for the site (Reference 14/22225-1) gives the hazard rating for landslides in the site area as 'very low'.

Information obtained from the site walkover, site plans and ordnance survey maps indicates that the site itself is essentially flat with only minor undulations present, sloping mainly towards the south-east, at angles of between 3° and 6°. There is however, a greater slope angle across the site from north-west to south-east away from Primrose Hill down towards the Thames Basin up to around 8°, although it should be noted that the immediate site area is heavily urbanised and slopes at the site and in the close vicinity may have been altered historically or as part of developments and landscaping.

The proposed development does not include any remodeling of slopes to angles greater than 7° that could potentially result in slope stability issues. It is therefore considered that slope stability can be maintained through the proper design of any necessary mitigation measures described in Section 4.2.

5.3 Shrinking / Swelling Clays

Atterberg Limit tests were conducted on three selected samples taken from the upper cohesive sections of the natural and made ground soils in Boreholes 1 to 3 and showed the samples tested to fall into Class CV, according to the British Soil Classification System. These are fine grained silty clay soils of very high plasticity and stiff consistency and as such generally have a low permeability and a medium to high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2.

It is understood that trees are to be removed from the site as part of the development. Given the minimum depth of the proposed basement floor is approximately 9.7m below existing ground level (31.92mOD), foundations for the structure are unlikely to be affected by the removal of these trees. However, shallower foundations may need to be taken deeper should they be within the zones of influence of either existing or recently felled trees. The depth of foundation required to avoid the zone likely to be affected by the root systems of trees is shown in the recommendations given in NHBC Standards, Chapter 4.2, April 2010, “Building near Trees" and it is considered that this document is relevant in this situation.

5.4 Springs, Wells and Watercourses

As discussed in Section 4.2 it is considered that the proposed development will have minimal impact on any nearby watercourses.

5.5 Made Ground

In the boreholes drilled at the site, Made Ground was found to extend down to depths of up to 0.80m below ground level and comprised of a surface layer of topsoil underlain by a mixture of medium dense clayey silty sand and sandy silty clay with brick fragments and crushed concrete.

A result of the inherent variability of uncontrolled fill, (Made Ground) is that it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should therefore, be taken through any made ground and either into, or onto suitable underlying natural strata of adequate bearing characteristics.

The bearing capacity of the Made Ground should therefore be assumed to be less than 30kN/m^2 because of the likelihood of extreme variability within the material.

Contamination testing of the Made Ground is likely to be required during any second phase of ground investigation.

5.6 Location of public highway

The proposed basement is not to be extended below Avenue Road and therefore it is suggested that the impact on this local access road is likely to be minimal.

There is nothing unusual in the proposed development that would give rise to any concerns with regard to the stability of public highways.

5.7 Ground Movements

5.7.1 Structural Stability of adjacent properties

The excavation and construction of the basement at the site has the potential to cause some movements in the surrounding ground if not properly managed. However, it is understood that ground movements and/or instability will be managed through the proper design and construction of mitigation measures during the works. This will require close collaboration with the appointed contractor's temporary works coordinator.

The Party Wall Act (1996) will apply to this development because neighbouring houses lie within a defined space around the proposed building works. The party wall process should be followed and adhered to during this development.

The proposed development may also result in differential foundation depths between the site and adjacent property and as such it is recommended that the Party Wall Act will be used and considered during the design phase. For basement developments in densely built urban areas, the Party Wall Act (1996) will usually apply because neighbouring houses would typically lie within a defined space around the proposed building works. Specifically, the Party Wall Act applies to any excavation that is within 3m of a neighbouring structure; or that would extend deeper than that structure's foundation; or which is within 6m of the neighbouring structure and which also lies within a zone defined by a 45° line from the foundation of that structure. The Party Wall process should be followed and adhered to during this development.

A ground movement assessment was carried out at the site by Applied Geotechnical Engineering under the instruction of Site Analytical Services Limited (Report Reference P4087). The report is provided as Appendix B to this report and concludes that given good workmanship, the basement excavations can be constructed without imposing more than a 'very slight' level of damage on the adjoining properties.

5.7.2 Heave/Swell

The upward movement of the base of an excavation occurs as a result of unloading and may be considered as consisting of two parts:

1. A short term movement called heave which occurs as a result of elastic rebound and may typically occur during the construction period

2. A long term movement called swell which occurs as a result of the absorption of water into the pores of the soils as the ground adjusts to new stress conditions.

Heave and its magnitude depends on soil properties and the degree of load that is removed. At this site is understood that a suspended concrete slab over a compressible material (claymaster or similar) will be constructed at basement level and therefore heave is unlikely to be an issue.

6.0 SURFACE WATER AND FLOODING - SCOPING ASSESSMENT

6.1 Introduction

This section addresses outstanding issues raised by the screening process regarding surface water and flooding (see Table 1).

6.2 Flood Risk

Information from the desk study and Environment Agency website indicates that the site does not lie within 250m of any Zone 2 or Zone 3 Environment Agency Flood Zones. Additionally, there are no Environment Agency floodplains, flood defenses, or areas benefitting from flood defences within 250m of the site. Reference to the Environment Agency website also indicates that the site does not lie within an area shown as being at risk from flooding from reservoirs.

However, with respect to potential flooding from surface water run-off, the site lies within an area known to have historically flooded in 2002 according to Figure 15 of the ARUP report (i.e. a primary area). In addition, CPG4 provides a list (p. 29) of streets in the London Borough of Camden that have historically been affected by surface water flooding and Avenue Road appears in this list and the Environment Agency's latest surface water flood risk mapping (available on their website since December 2013) shows a 'high' risk of flooding from surface water for the adjacent part of Avenue Road.

The current data indicates that flood water, like groundwater will flow in a general south westerly direction across the site through the upper permeable made ground in accordance with the topography of the site area.

The flooding of the London Borough of Camden in 2002 was attributed to overland flow and sewer flooding. Avenue Road flooded in 2002 however the site itself is raised above surrounding road levels of Avenue Road. Therefore the risk of surface water and sewer flooding to the site are considered to be low.

British Standard (BS) 8102 (Code of Practice for Protection of Below Ground Structures Against Water from the Ground) offers guidance for the design and waterproofing of basements and defines 3 grades as follows.

- Grade 1: Basic Utility. Car parking, plant rooms (excluding electrical equipment), workshops. Some seepages and damp patches tolerable;

- Grade 2. Better Utility. Workshops and plant rooms that require drier environments. No water penetration but moisture vapor tolerable.

- Grade 3. Habitable. Ventilated residential and working areas including offices. Dry environment. Active measures to control internal humidity may be necessary.

The proposed basement excavation should be designed to the appropriate grade therefore reducing the risk posed to the basement from groundwater flow.

6.0 CONCLUSIONS AND NON TECHNICAL SUMMARY

1. The proposed scheme involves the demolition of the existing building on the site and the construction of a new three storey residential building with a two storey basement below encompassing the entire building footprint and a proportion of the back garden. The maximum depth of the basement is expected to be approximately 9.7m below existing ground level (31.92mOD).

2. Conditions at the site were investigated by Site Analytical Services Limited in June 2014 (SAS Report Reference 14/22225). The exploratory holes revealed ground conditions that were generally consistent with the geological records and known history of the area and comprised up to 1.30m thickness of Made Ground overlying the London Clay Formation.

3. Groundwater was not encountered during the investigation and is expected to be below the floor level of the proposed basement.

4. There is nothing unusual in the proposed development that would give rise to any concerns with regard to the stability of public highways.

5. The excavation and construction of the basement at the site has the potential to cause some movements in the surrounding ground. However, it is understood that ground movements and/or instability will be managed through the proper design and construction of mitigation measures.

6. The proposed basement excavation should be designed to the appropriate grade therefore reducing the risk posed to the basement from groundwater flow.

p.p. SITE ANALYTICAL SERVICES LIMITED

A P Smith BSc (Hons) FGS MCIWEM
Senior Geologist

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APPENDIX A - Email Correspondence between SAS and LUL 17th December 2014

Date 17 December 2014

Our Ref 20878-NG-6-171214

Your Ref

To Andrew Smith
Site Analytical Services Limited
andys@siteanalytical.co.uk

UNDERGROUND
London Underground Limited

Hello Andrew,

36 Avenue Road, London, NW8 6HS.

Thank you for your communication of 15th December 2014.

I can confirm that London Underground has no assets within 50 metres of your site as shown on the plan you provided.

Should you have any further enquiries, please do not hesitate to contact me.

Nicole Gaskin
Assistant Information Manager
LUL Infrastructure Protection
E-mail: Locationenquiries@tube.tfl.gov.uk
Tel: 020 7027 8711

APPENDIX B - Ground Movement Assessment Report

1.0 Introduction

In connection with the proposal to redevelop 36 Avenue Road, London NW8 6HS, including the deepening and lateral extension of an existing basement, Applied Geotechnical Engineering Ltd (AGE) has been instructed by Site Analytical Services Ltd (SAS), on behalf of their client, to provide information on the effect of basement construction on the neighbouring properties at Nos 34 and 38 Avenue Road and No 1 Radlett Place. The structural engineer for the project is Elliott Wood. A plan of the proposed basement of the property is given below in Figure 1.

It is understood that the existing building is to be demolished. The basement is to be extended in plan to occupy a significantly larger footprint. The construction of the basement will involve deepening of the existing basement from a current level of 39.3mOD to a proposed level of 33.3mOD and, at the rear, a basement terrace is to be excavated from a current level of 39.7mOD to a proposed level of 31.9mOD. Elsewhere, excavation will be from general existing ground level, which is taken to lie between 41.6 to 41.9mOD, to 33.3mOD at the front of the basement and 31.9mOD at the rear.

The excavation will be undertaken within a bored pile retaining wall for the most part, with small sections constructed using underpinning techniques. In the absence of definitive information, and for the purposes of this analysis only, the pile wall depth will be taken as 1.4 x adjacent dig depth, calculated from original ground level.

No 36 Avenue Road is a detached property, however the basement of No 38 (to the left) is constructed to the property boundary, and it is understood that the excavation for the basement of No 36 will also extend to that boundary and will therefore expose the existing sheet-pile basement retaining wall at that location. To the right of No 36 lies Radlett Place (a narrow road), beyond which No 34 Avenue Road is set well-within its plot, at a distance from the proposed excavation of approximately 17m.

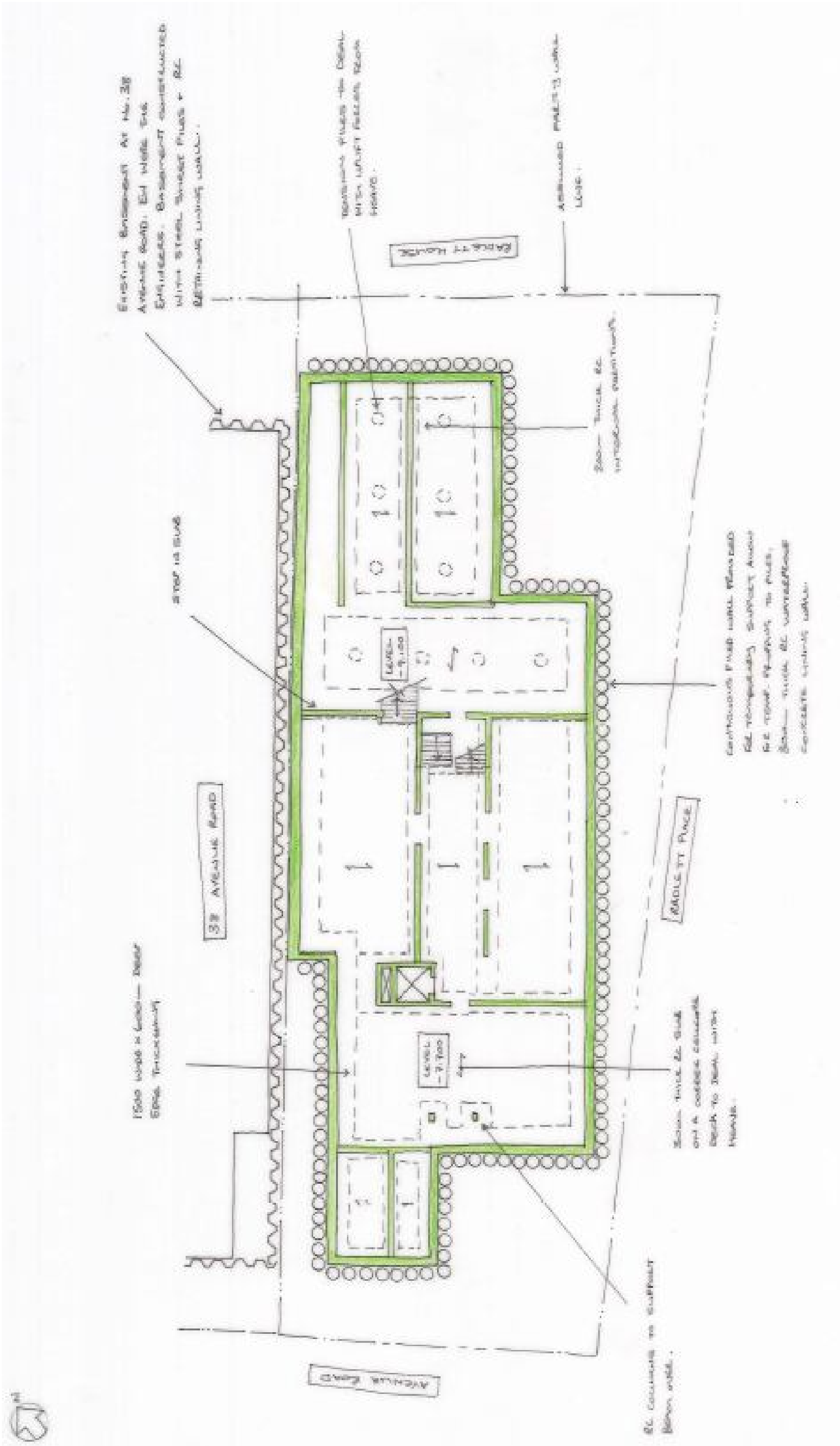
To the rear of No 34, a new development has recently been constructed, or is under construction, this is addressed ‘No 1 Radlett Place’.

Right and left are as viewed from the front of the property on Avenue Road.

It is required that a predicted-damage assessment be made on Nos 34 and 38 Avenue Road, and No 1 Radlett Place.

2.0 Information Provided

The following relevant information has been used for these calculations:-
i) SAS Borehole and trial pit logs.
ii) ElliottWood sketches 2140225 drg S01-S03, S10, S20-29 (Proposed structure).
iii) ElliottWood load sketches; ‘2140225drg existing loads141205.pdf’ (existing); ‘2140225 basement loads ew comments 141204.pdf’ (proposed).
iv) Matrix Surveys drawings 1832_Elevations_1-9; 1832_Basement, 1832_Ground, 1832_Site (existing structure)
v) Email correspondence SAS-AGE dated 2/7/14 to 17/12/14.



Front

Figure 1 –Proposed Basement Plan (extract of dwg 2140225/S01/141205/P1)

3.0 Anticipated Ground Conditions

For the purposes of the current report the original ground surface at the site will be treated as level for practical purposes.

The published geological map (BGS 1:50 000 sheet 256: North London) indicates the site to lie on London Clay. On a developed site such as this Made Ground is also anticipated.

On the basis of the published mapping the base of the London Clay is anticipated to lie at approximately 50m depth.

Ground level at the site, is approximately 41.7mOD.

A ground investigation has been undertaken at the site (Item 'i' in Section 2 above). This comprised three rotary percussion boreholes, each to 20m depth. Water-monitoring standpipes were installed in all the boreholes; to 10m in BH1 and to 5m in BHs 2+3.

Two trial pits were excavated adjacent to the boundary (garden) walls.

The boreholes confirmed approximately 0.5m of clayey Made Ground overlying soft, becoming firm, clayey Head to between 2.5 and 3.8m depth. At this depth, stiff (becoming very stiff) London Clay was encountered.

Groundwater was not encountered during the boring.

On the basis of the above, the soil sequence at the site is taken to be:-

Ground Level 41.7mOD
Base of Made Ground 0.5mbgl (41.2mOD)
Base of Head 3mbgl (37.9mOD)
Base of London Clay approx 50mbgl (-10mOD).

The Made Ground and the Head lie above excavation depth, they do not influence ground movements and will not be considered in detail.

In situ Standard Penetration Tests (SPT) were carried out in the London Clay, and triaxial tests were carried out on samples. The results of these tests are plotted in Figure 2. The SPT results have been converted to undrained strength (Su) values using the method of Stroud (Ref 1) taking f1= 4.5.

The trend-line given in Figure 2 has been adopted.

On the basis of Figure 2, the following undrained strength profile has been adopted for the London Clay (below 3m depth):-

Su = 100 + 7.6z (kPa) (Where z = depth below 3m [top of London Clay]).

No groundwater was encountered during the ground investigation. Subsequent monitoring of the standpipes (in June and December 2014) also indicates dry conditions.

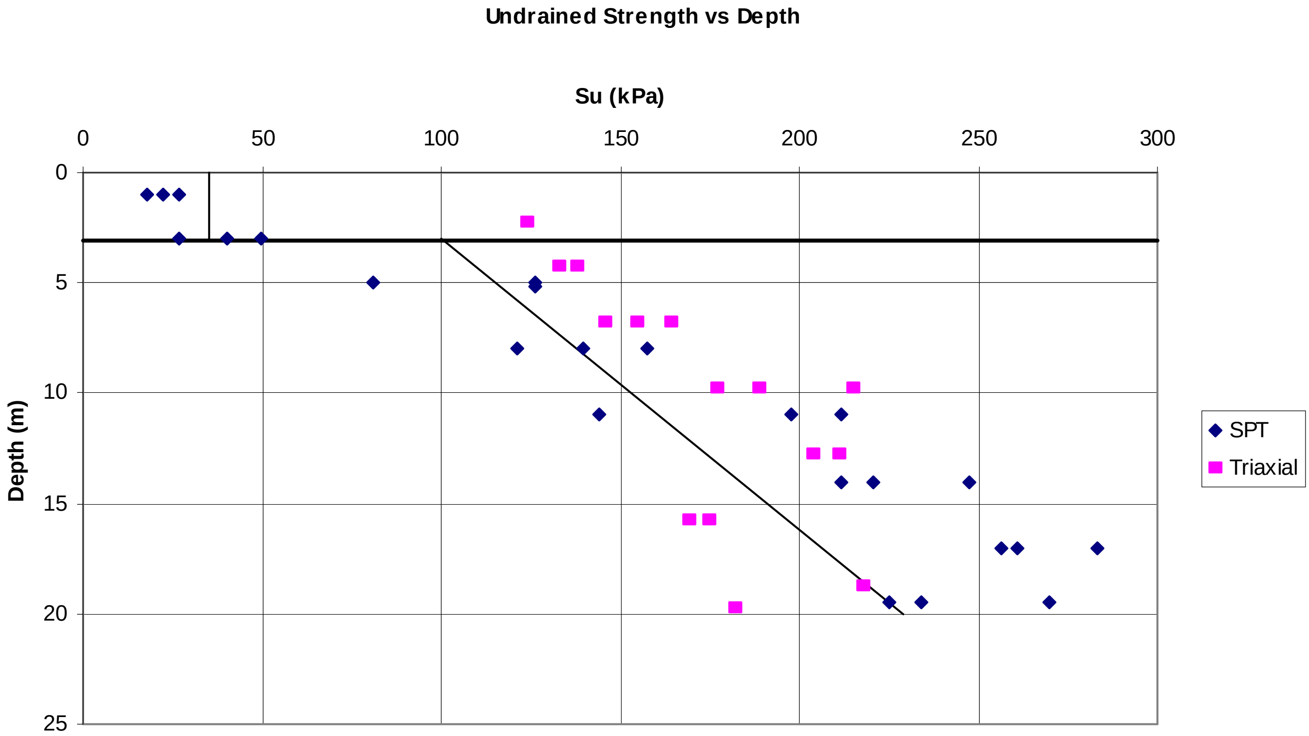


Figure 2
Undrained strength vs depth

4.0 Loads

The current building loads are taken to be imposed on spread footings at 38.8mOD, these loads have been provided by ElliottWood (Item ‘iii’ in Section 2 above). Current ground levels are understood to be 39.3mOD within the existing basement, and have been taken to be 41.7mOD elsewhere.

Demolition will result in the removal of these structural loads, and excavation to the new basement formation level of 33.3mOD at the front of the basement and 31.9mOD at the rear, will further reduce loads. At this stage, 10No heave-reduction piles will be present beneath basement formation level at the rear of the structure. No details are available for these piles, therefore, for the purposes of this assessment only, they are arbitrarily assumed to be 10m long (beneath formation level) and 450mm diameter. These piles are not expected to have a significant impact upon the movement of the neighbouring properties, therefore these assumptions are not considered to be critical to the analysis.

Following excavation to basement formation level the basement structure and the building superstructure will be constructed. The long-term loads have been provided by ElliottWood (Item ‘iii’ in Section 2 above).

The maximum unloading is therefore seen at the end of excavation. The tension-reducing piles are present at this time, but no other structural loads are considered. Short-term ground movement is calculated at this time.

Long-term ground movement is calculated for the condition some time after completion of construction. All loads are taken into account at this stage.

5.0 Estimated movement

5.1 Temporary support to the basement walls.

It is assumed within the following calculations that the basement perimeter retaining walls will be stiffly and safely propped at all stages of construction in line with BS5975:2008 and current good practice. Inadequate propping is likely to result in increased ground movements, and therefore increased damage to adjacent properties, as well as increased risk of injury to personnel.

It is generally recommended that consideration be given to the preloading of temporary basement wall props, and the monitoring of prop loads during critical stages of excavation.

5.2 Soil stiffness values

An equivalent-elastic analysis has been carried out using the program PDisp. The program takes no account of structural (building) stiffness.

The following soil stiffness parameters have been adopted for the purpose of this analysis:-

The London Clay has been treated as a non-linear material. The small-strain stiffness is taken as 80% of the small-strain stiffness calculated from recent high quality data (Bond Street Station). These data yielded E_{uo} = 1940Su, therefore for the purposes of the current analysis take:-

$E_{uo} = 1550 \times Su$; (Poisson's ratio = 0.5)
$E'_o = 1240 \times Su$; (Poisson's ratio = 0.2)

Yielding :-

$E_{uo} = 155 + 11.8z$ (MPa)
$E'_o = 124 + 9.4z$ (MPa)

Where z = depth below top of London Clay in metres.

A non-linear degradation curve relating stiffness to strain based on published data for the London Clay has been used.

5.3 Causes of ground movement outside the excavation

The analysis considers three causes of ground movement outside the excavation, these are:-
i) Vertical ground movement due to vertical changes in load resulting from building works and excavation
ii) Vertical and horizontal movement due to installation of underpins and pile walls
iii) Vertical and horizontal movement due to deflection of underpins and pile walls, following removal of support from in front of underpins and pile walls by excavation.

The first of these causes is investigated using equivalent-elastic analysis in the program PDISP. The second and third are based upon case-history data presented in Figures 2.8, 2.9 and 2.11 in CIRIA C580 (Ref 3) these data relate to installation in stiff clays. It is currently understood that the plots presented by CIRIA in the above figures include short-term movement arising from cause 'i' above. Therefore in this report short-term movements are calculated using the CIRIA data, and subsequent long-term movement is calculated using PDISP.

The CIRIA plots relate vertical and horizontal ground movement to the depth of the wall installed (for Cause 'ii' above), or to the depth of excavation within that wall (for Cause 'iii' above) as appropriate. Data relating to the secant bored pile wall case history in Ref 3 Figure 2.8 are considered to be unreliable and have been ignored. In addition, data relating to counterfort diaphragm walls have not been taken into account in this analysis. No data are presented by CIRIA for underpinned walls, and no other data are available from other sources for underpin walls. Underpin walls are therefore assumed to be similar in behaviour to plane diaphragm walls and bored pile walls.

The CIRIA data indicate that:-

a) Adjacent to the pile wall or underpin, vertical ground settlement resulting from wall installation can be taken to equal 0.04% of wall depth, reducing linearly to zero at a distance of 2 x wall depth from the wall (Ref 3, Figures 2.8b and 2.9b).

b) Adjacent to the pile wall or underpin, vertical ground settlement resulting from wall deflection can be taken to equal 0.04% of excavation depth, increasing to 0.08% of excavation depth at a distance of 0.6 x excavation depth from the wall, then reducing approximately linearly to zero at a distance of 3 x excavation depth from the wall. (Ref 3, Figure 2.11b).

c) Adjacent to the pile wall or underpin, horizontal ground movement resulting from wall installation can be taken to equal 0.04% of wall depth, reducing linearly to zero at a distance of 1.5 x wall depth from the wall (Ref 3, Figures 2.8a and 2.9a).

d) Adjacent to the pile wall or underpin, horizontal ground movement resulting from wall deflection can be taken to equal 0.15% of excavation depth, reducing linearly to zero at a distance of 4 x dig depth from the wall. (Ref 3, Figure 2.11a).

The above trends rely on good workmanship and stiffly-propped, stiff walls. Temporary support of excavations should be designed to BS5975 and BS8002.

Note that, in all the plots of vertical movement, settlement is taken as positive and heave as negative. The CIRIA data is understood to relate to movement at, or close to, ground level.

5.4 Predicted movement – 34 Avenue Road, front and rear elevations

5.4.1 Vertical Movement

Profiles of short- and long-term vertical ground movement along the front and rear elevations of No 34 Avenue Road have been calculated and plotted in Figures 4 and 5 respectively. The plots present the short and long-term heave profiles calculated as described above.

These walls both extend from Y=-17m to Y=-34m, compared to the limit of the basement excavation at No 36 at Y=0m (see plan in Figures 4 and 5).

In calculating the short-term profiles using CIRIA C580, the excavation for the basement at No 36 is taken to descend from an existing ground level at 41.9mOD to a formation level (at the front of No 36) of 33.3mOD; a depth of 8.6m. This takes no account of the existing basement in No 36, and the calculations are therefore conservative in this regard. The depth of the bored pile wall supporting this excavation is taken to be approximately 12m.

The settlement profiles are similar for the front and rear walls, with no practical difference between them. The following comments relate to the front wall.

The analysis indicates a maximum overall tilt of (4.4mm-0.0mm=) 4.4mm over the 17m length of the wall. This equates to a whole-wall gradient of less than 1 in 3800. This is considerably less than the 1:400 gradient recognised as requiring remedial action.

The maximum wall distortion (Delta – as defined by Burland, Ref 2) is 2.1mm within the 17m length of the wall. This equates to a deflection ratio of 2.1/17 000 = 0.012%. Taking the limiting tensile strain between the 'very slight' and 'slight' damage categories as being 0.075% (Ref 2) then the worst-case ratio of deflection ratio to limiting tensile strain = 0.012/0.075=0.16. By reference to Figure 3 (Ref 2 Figure 6) and taking the height of the No 34 front wall as being approximately equal to half of its width, a horizontal strain/limiting tensile strain ratio of 0.85 is obtained, therefore a horizontal strain of 0.85 x 0.075% = 0.064% is acceptable for a 'very slight' category of damage.

5.4.2 Lateral movement.

From Section 5.3 above, taking wall depth to be 12m and excavation depth to be 8.7m, the maximum lateral movement due to bored pile wall installation is calculated to be 4.8mm, reducing to zero at 18m distance. The resulting ground strain of 0.027% therefore decays virtually to zero in the intervening 17m of ground between Nos 36 and 34.

Also from Section 5.3 above, the ground movement due to the subsequent deflection of the bored pile wall, following excavation of the basement, is calculated as 13mm, reducing to zero at a distance of 35m (yielding a strain of 13/35 000 = 0.037%). This lateral ground strain does encompass No 34.

The total lateral ground strain beneath the front and rear walls of No 34 is therefore assessed as 0.037%. This is less than the upper limit of 0.064% for 'very slight' damage derived above.

The predicted level of damage to these walls can therefore be taken as 'very slight'.

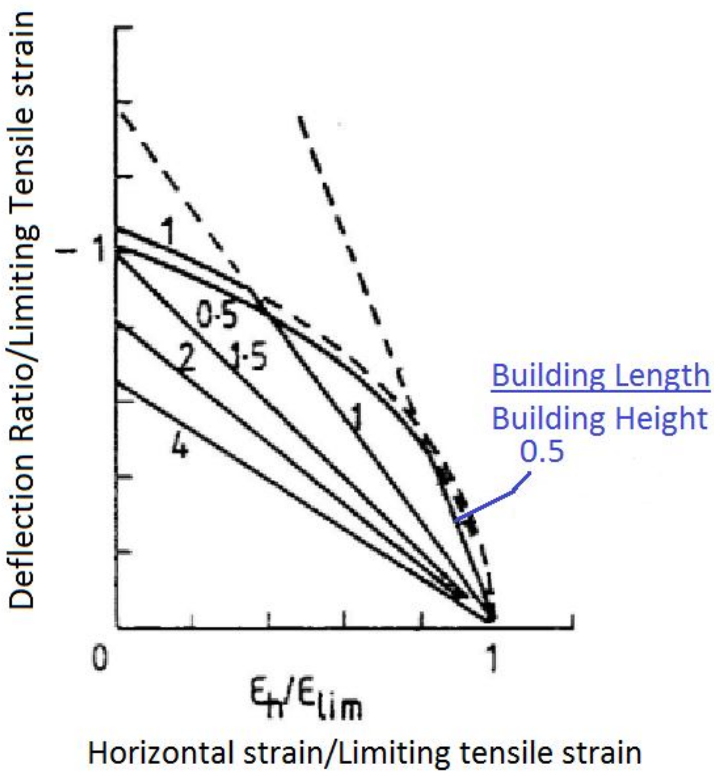


Figure 3 (from Ref 2)

5.5 Predicted movement – No 1 Radlett Place.

5.5.1 Vertical Movement

A new development with an extensive basement is understood to be currently under construction to the rear of No 34 Avenue Road, across Radlett Place from the rear part of the proposed basement to No 36 Avenue Road. The form and basement depth of the Radlett Place development are not clear, therefore for the purposes of the current calculations it will be assumed that a wall will be formed along the 40m length of the South-western boundary of that site. This would represent the most vulnerable structure, located where ground movements arising from the excavation of the basement to No36 would be expected to be greatest.

Profiles of short- and long-term vertical ground movement along the south-western boundary of No 1 Radlett Place have been calculated and plotted in Figure 6. This wall extends from Y = -8m at the frontage on Radlett Place, to Y = -48m at the rear. The excavation for the basement to No 36 lies at Y=0 at this location (ie 8m distant), but very close by (approximately 1m away), there is a corner in the excavation, removing the pile wall and the excavation a further 5.5m from the Radlett Place site. See the plan in Figure 6. The ground movements predicted below are therefore over-estimated to an extent.

The analysis indicates a maximum overall tilt of 9mm over the 40m length of the wall. This equates to a whole-wall gradient of less than 1 in 4000. This is considerably less than the 1:400 gradient recognised as requiring remedial action.

The maximum wall distortion (Delta – as defined by Burland, Ref 2) is 4.8mm within the 40m length of the wall. This equates to a deflection ratio of 4.8/40 000 = 0.012%. Taking the limiting tensile strain between the 'very slight' and 'slight' damage categories as being 0.075% (Ref 2) then the worst-case ratio of deflection ratio to limiting tensile strain = 0.012/0.075=0.16. By reference to Figure 3 (Ref 2 Figure 6) and taking the length of the wall as being approximately equal to four times its height, a horizontal strain/limiting tensile strain ratio of 0.75 is obtained, therefore a horizontal strain of 0.75 x 0.075% = 0.056%, over the full wall length, is acceptable for a 'very slight' category of damage.

5.5.2 Lateral movement.

From Section 5.3 above, taking the depth of the basement wall to No 36 to be 13m at this location, the maximum lateral movement due to bored pile wall installation is calculated to be 5.2mm, reducing to zero at 19.5m distance. The resulting ground strain of 0.027% (=5.2/19500) therefore decays to zero within approximately the first 12m (19.5m-8m) of the Radlett Place wall.

Also from Section 5.3 above, taking the excavation depth to be 7.8m below an existing reduced level (in the rear sunken garden terrace) of 39.7mOD, the ground movement due to the subsequent deflection of the bored pile wall, following excavation of the basement, is calculated as 11.7mm, reducing to zero at a distance of 31m (yielding a strain of 14.5/39 000 = 0.037%). This lateral ground strain encompasses most of the Radlett Place wall.

The ground strain over the first 12m or so of the Radlett Place wall (between Y=-8m and Y= -19.5m) can therefore be taken as a combination of the above, totalling 0.064%. Over this length of wall the vertical distortion of the Radlett Place wall is negligible, therefore the allowable horizontal strain for 'very slight' damage can be taken as 0.075% resulting in a prediction of 'very slight' damage or less. Over the remainder of the Radlett Place wall the horizontal strain reduces to 0.037%, this is less than the allowable limit for the distorted wall of 0.056% calculated above and therefore, again, 'very slight' damage is predicted.

This assessment has been derived for a wall having the least robust geometry in terms of damage from ground movements (length >> height), located in the most adverse location on the Radlett Place site so far as predicted ground movement is concerned. The analysis is additionally conservative insofar as the predicted ground strain is taken to be fully transmitted to the wall, neglecting the considerable stiffness of piled and RC basement walls in the horizontal and vertical directions. The predicted level of damage to this worst-case wall is 'very slight', therefore it is concluded that the level of damage predicted for any concrete or masonry wall within the No 1 Radlett Place will also be 'very slight' or less.

5.6 Predicted movement – 38 Avenue Road, front and rear elevations

5.6.1 Vertical Movement

Profiles of short- and long-term vertical ground movement along the front and rear elevations of No 38 Avenue Road have been calculated and plotted in Figures 7 and 8 respectively. These locations are considered to be the most susceptible to visible damage, being less robust than RC walls forming the basement to No 38.

The existing basement to No 38 is understood to be approximately 8.5m deep, compared to the proposed depth of the No 36 basement of 8.3m at the front and 9.7m at the rear. The basement at No 38 was excavated within sheet pile walls, which are understood to penetrate to appreciable depth below No 38 basement level. It is understood that the front part of the No 36 basement will be constructed within a bored pile wall installed less than 2m away from the No38 basement sheet pile wall, the rear part of the No 36 basement (rearwards of X=17.5m – see plan in Figure 7) will be excavated against the face of the No 38 sheet pile wall. Due to this proximity to the existing basement of similar depth, vertical ground movements are likely to arise only due to the unloading of the ground as calculated by Pdisp (Cause 'i' in Section 5.3 above); movements calculated by reference to Ciria C580 do not apply.

The front wall of No 38 is taken to extend from approximately Y=21m (some 3m from the basement dig for No 36 at Y=18m), while the rear of No 38 is taken to extend from that boundary. Moreover the rear wall is at a more adverse location, being approximately mid-way along the basement dig for No 36 (whereas the front wall is close to a corner). Therefore the movement of the rear wall of No 38 will be more onerous, and the following comments relate to the rear wall.

The analysis indicates a maximum overall tilt of 2.3mm along the 16m length of the wall. This equates to a whole-wall gradient of less than 1 in 6000. This is considerably less than the 1:400 gradient recognised as requiring remedial action.

The maximum wall distortion (Delta – as defined by Burland, Ref 2) is 0.8mm within the 16m wall length. This equates to a deflection ratio of 0.8/16000 = 0.005%. Taking the limiting tensile strain between the 'very slight' and 'slight' damage categories as being 0.075% (Ref 2) then the worst-case ratio of deflection ratio to limiting tensile strain = 0.005/0.075=0.07. By reference to Figure 3 (Ref 2 Figure 6) and taking the length of the No 38 front and rear walls as approximately equal to 1.5x their height, a horizontal strain/limiting tensile strain ratio of 0.95 is obtained, therefore a horizontal strain of 0.95 x 0.075% = 0.07% is acceptable for a 'very slight' category of damage. This analysis does not take account of the presence of the sheet pile wall below basement depth, which would tend to reduce the ground distortion beneath No 38, nor does it take account of the stiffness of the walls of No 38, the result is therefore conservative in both respects.

5.6.2 Lateral movement.

As discussed above, due to the presence of the existing basement to No 38, immediately adjacent to, and of similar depth as, the proposed basement to No 36, the ground movements due to wall installation and basement excavation predicted by Ciria C580 do not apply. Any horizontal movements undergone by No 38 will therefore be the result of the relaxation of that structure, as the earth pressures it is currently subjected to, from the site of No 36, are removed.

The prediction of such movements would require structural analysis, but by inspection would be expected to be considerably less than those resulting from the usual Ciria C580 predictions. Ciria C580 usually predicts a maximum horizontal ground strain of 0.064% this is less than the 0.07% acceptable limit calculated above, therefore the predicted level of damage to the front and rear walls of No 38 can be taken as 'very slight' or less.

5.7 Predicted movement – No 38 Avenue Road, right flank wall.

Profiles of short- and long-term vertical ground movement along the No 38 right flank wall have been estimated and plotted in Figure 9. This wall extends from X = 16.8m at the front, to X= 31.3m at the rear. This wall comprises the boundary wall sitting atop the existing basement wall of No 38. It is understood that the proposed basement to No 36 will be dug to this wall, as discussed above in Section 5.6.

The predicted vertical ground movement therefore comprises only the heave arising from the unloading of the ground due to basement excavation. It can be seen from Figure 9 that both tilt and distortion are negligible, and as the nature of the works will not result in any significant horizontal strains in the plane of this wall the damage classification can be taken, by inspection, as 'very slight' or less.

5.8 Predicted damage summary

On the basis of the above, the level of damage to Nos 34 and 38 Avenue Road, and No 1 Radlett Place is predicted to be 'very slight' or less, as defined in Ref 2. This conclusion assumes a high standard of workmanship and adequate propping of the basement excavation.

6.0 Groundwater

It is proposed to excavate to a maximum depth of approximately 9.7m through 3m of clayey Head into a thick deposit of London Clay. No groundwater was encountered during the ground investigation works, and piezometers installed at 5 and 10m depth were recorded as dry several months after installation (December 2014). It appears that there is no potential for significant groundwater flow within the proposed basement depth, and that therefore the development will not affect the local groundwater regime.

7.0 Conclusions and Recommendations

From the above, it is concluded that, given good workmanship, the basement to 36 Avenue Road can be constructed without imposing more than very slight damage on the adjoining properties. The development is not likely to disrupt any existing local groundwater flows.

References:

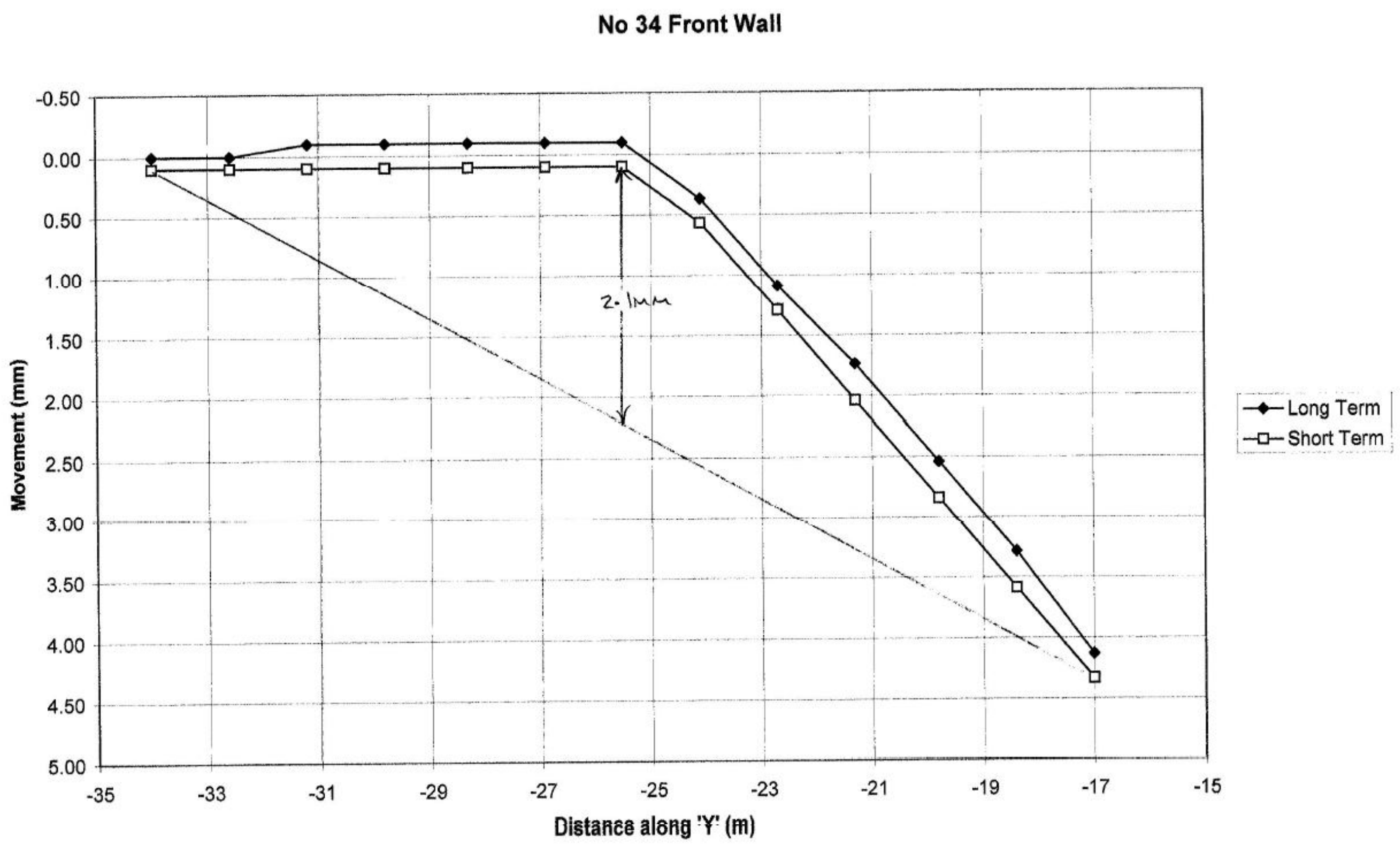
1 Stroud M A (1989) 'The standard penetration test – its application and interpretation'. In 'Penetration testing in the UK', Thomas Telford pub.

2 Burland JB (1997). 'Assessment of risk of damage to buildings due to tunnelling and excavation'. In 'Earthquake Geotechnical engineering' Ishihara (Ed). Balkema pub.

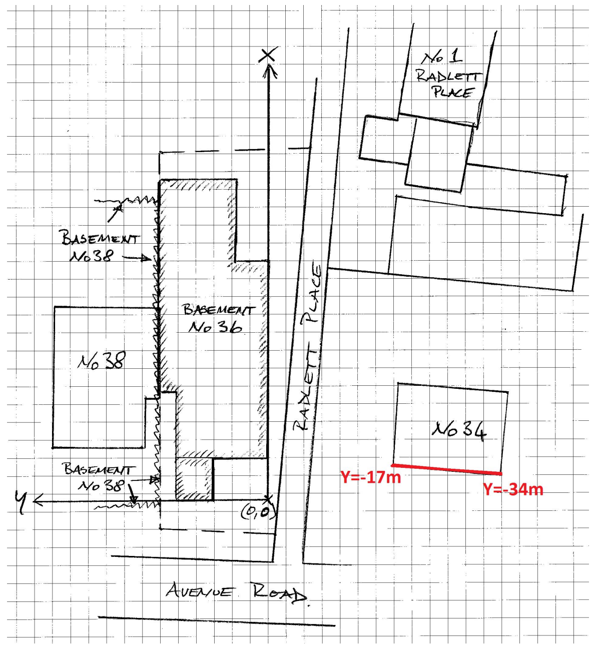
3 Gaba A R, Simpson B, Powrie W, Beadman D R (2003) Embedded retaining walls - guidance for economic design, CIRIA Report C580, London. ISBN: 978-0-86017-580-3.

4 BS5975:2008+A1:2011 Code of practice for temporary works procedures and the permissible stress design of falsework. BSI.

(Figures 4-9 follow below)

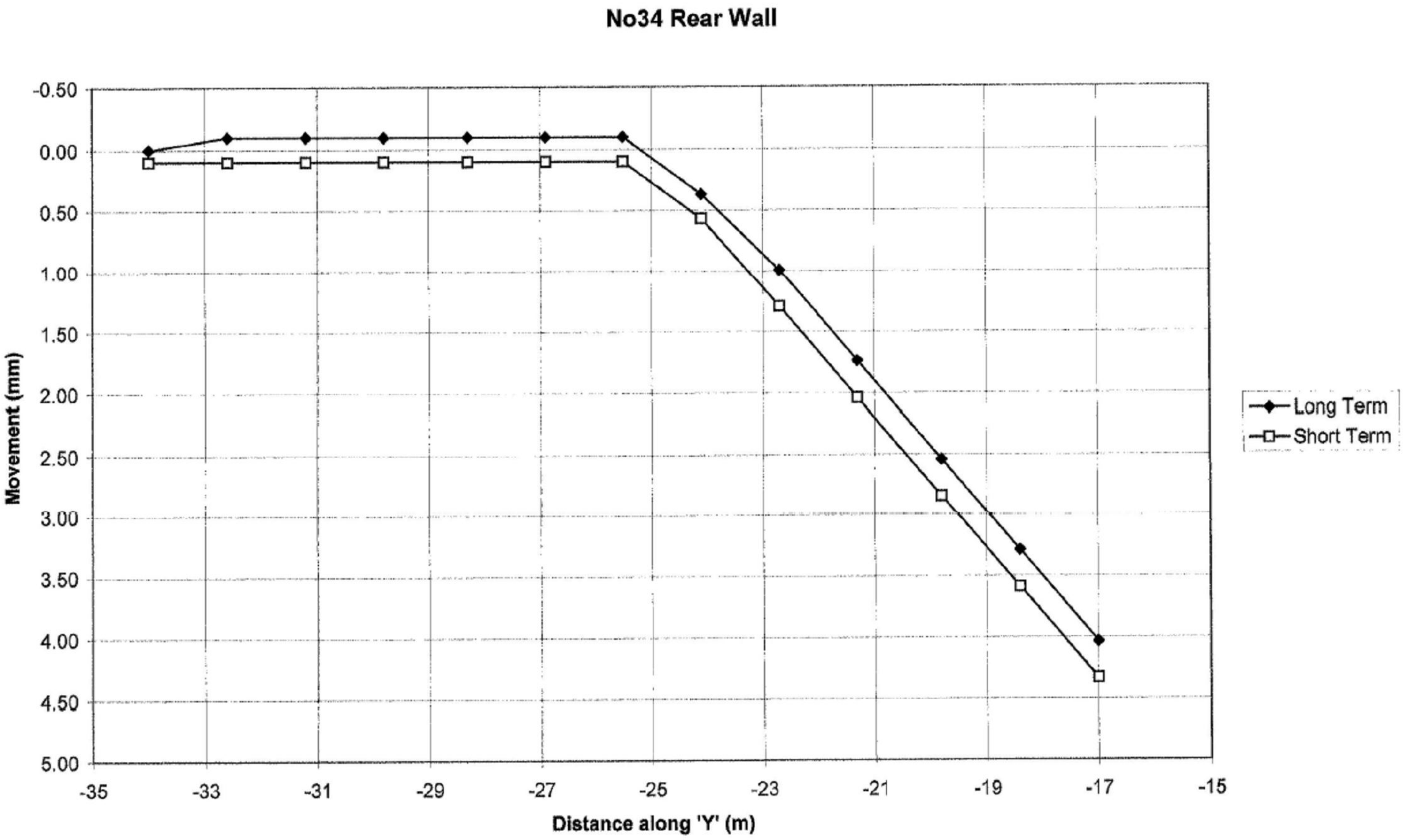


No 34 Front Wall
Movement (mm)
Distance along 'Y' (m)
-0.50
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
-35
-33
-31
-29
-27
-25
-23
-21
-19
-17
-15
2.1MM
Long Term
Short Term

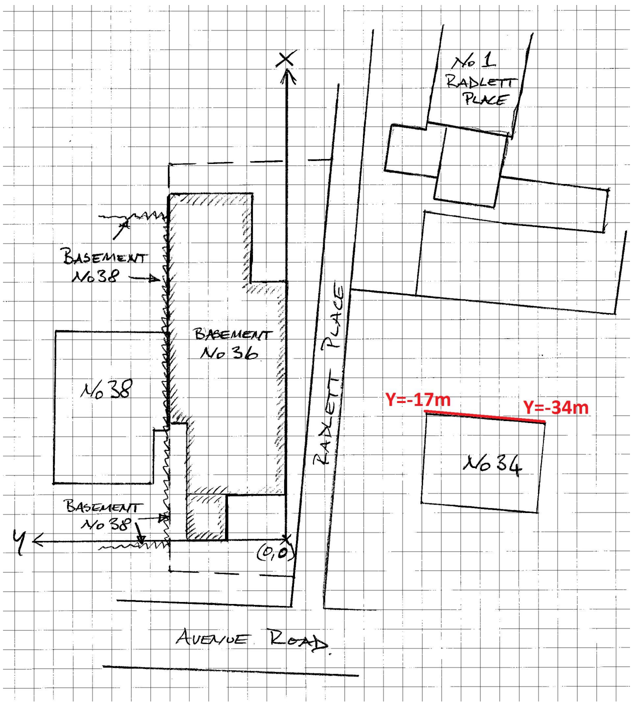


X
No 1 RADLETT PLACE
BASEMENT No 38
BASEMENT No 36
No 38
RADLETT PLACE
No 34
Y=-17m
Y=-34m
BASEMENT No 38
Y
(0,0)
AVENUE ROAD

Figure 4

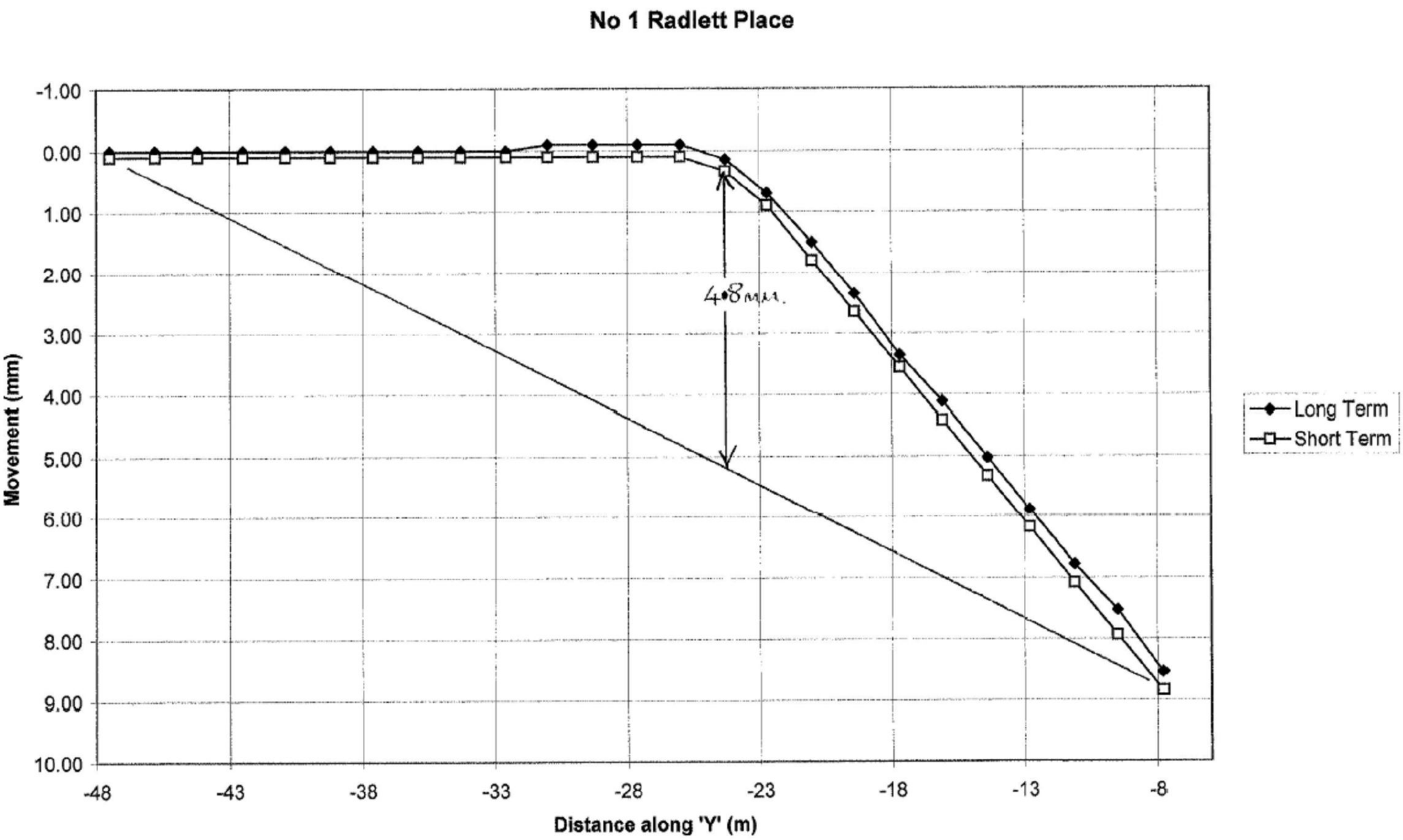


No34 Rear Wall
Movement (mm)
-0.50
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
-35
-33
-31
-29
-27
-25
-23
-21
-19
-17
-15
Distance along 'Y' (m)
Long Term
Short Term

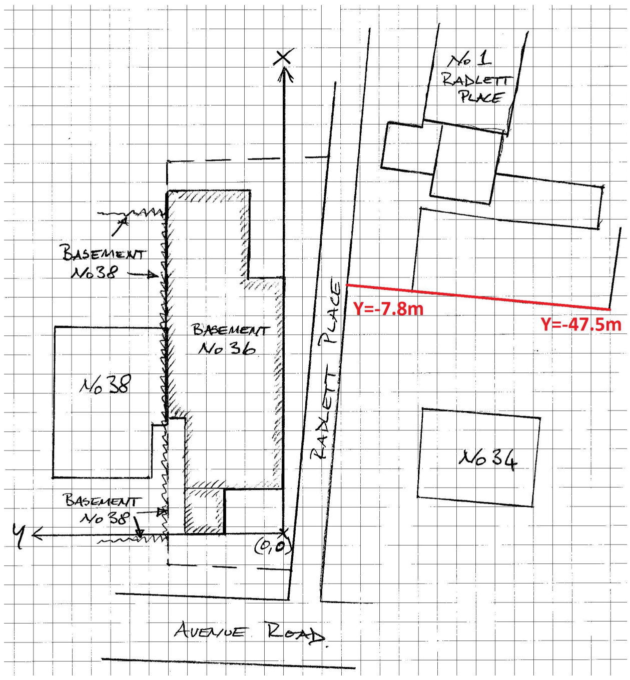


X
No 1 RADLETT PLACE
BASEMENT No 38
BASEMENT No 36
No 38
RADLETT PLACE
Y=-17m
Y=-34m
No 34
BASEMENT No 38
Y
(0,0)
AVENUE ROAD

Figure 5

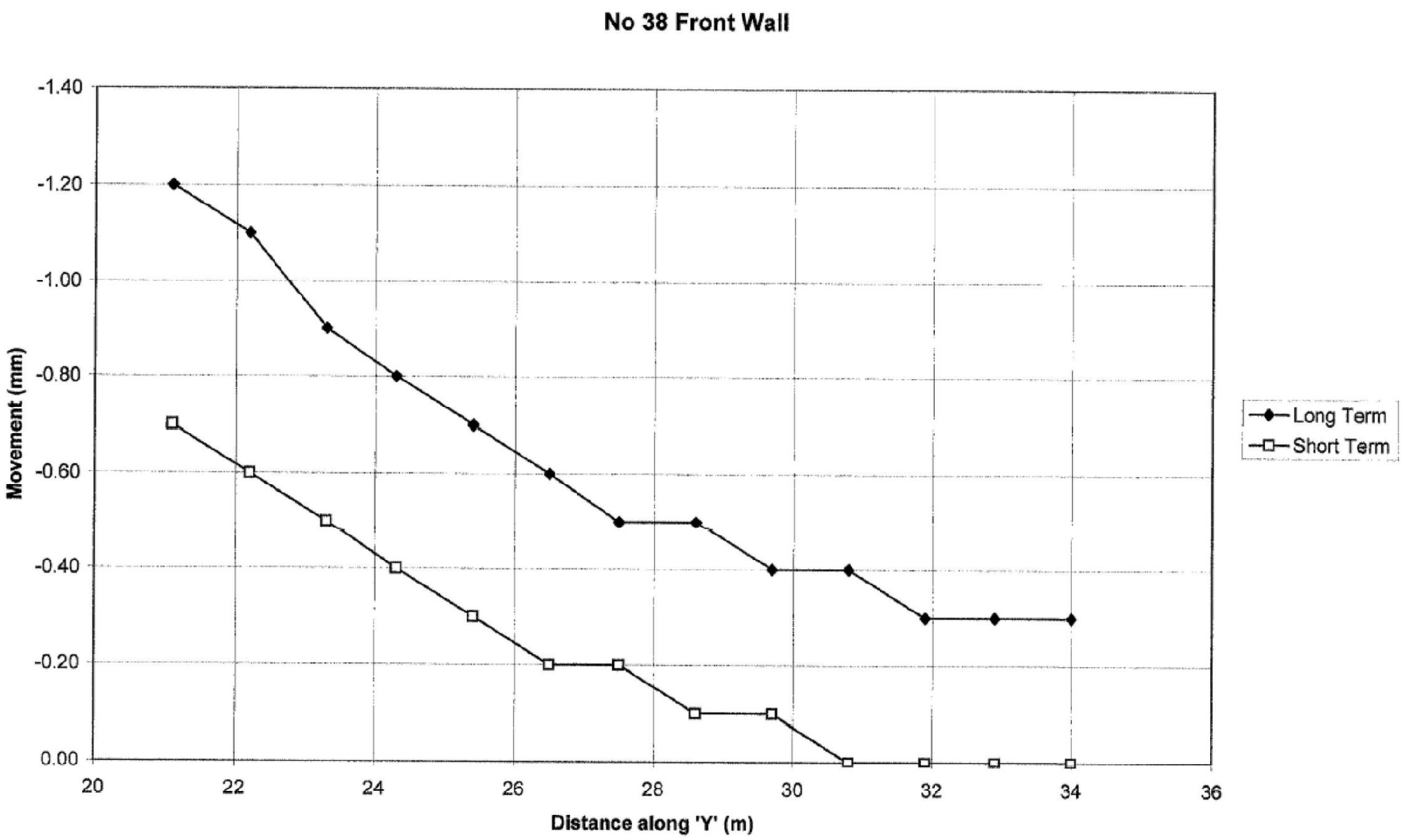


No 1 Radlett Place
Movement (mm)
Distance along 'Y' (m)
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
-48
-43
-38
-33
-28
-23
-18
-13
-8
Long Term
Short Term
4.8mm.

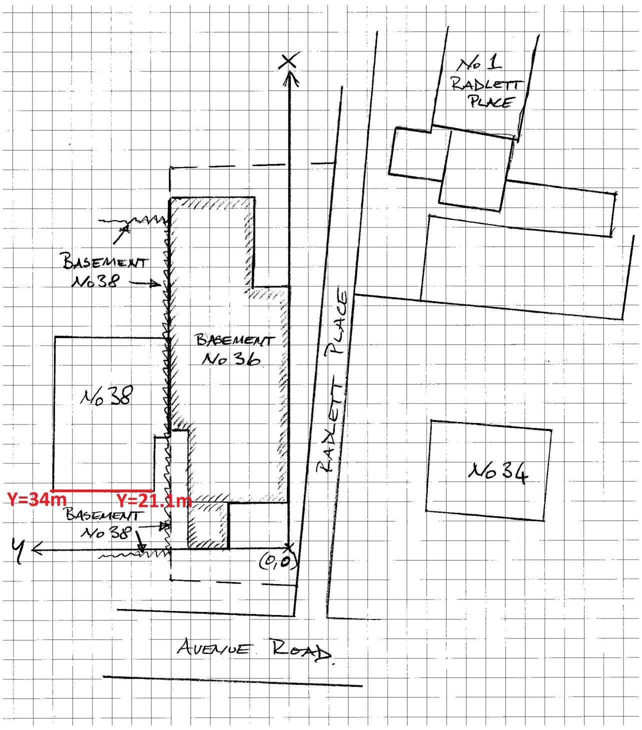


No 1 RADLETT PLACE
X
BASEMENT No 38
BASEMENT No 36
No 38
No 34
RADLETT PLACE
BASEMENT No 38
Y
(0,0)
AVENUE ROAD
Y=-7.8m
Y=-47.5m

Figure 6

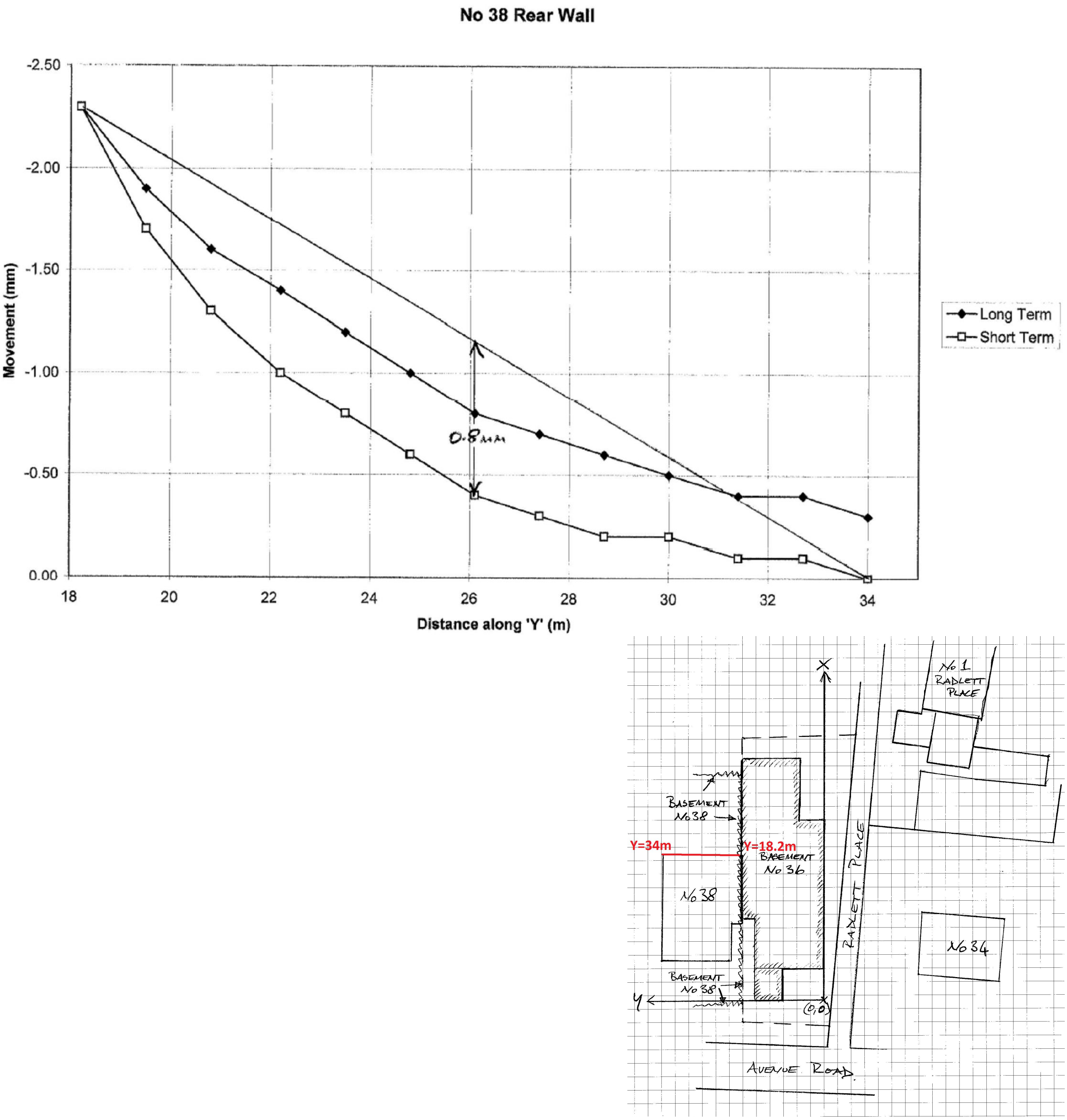


No 38 Front Wall
Movement (mm)
-1.40
-1.20
-1.00
-0.80
-0.60
-0.40
-0.20
0.00
20
22
24
26
28
30
32
34
36
Distance along 'Y' (m)
Long Term
Short Term



X
No 1 RADLETT PLACE
BASEMENT No 38
BASEMENT No 36
RADLETT PLACE
No 38
No 34
Y=34m
Y=21.1m
BASEMENT No 38
Y
(0,0)
AVENUE ROAD.

Figure 7



No 38 Rear Wall
Movement (mm)
-2.50
-2.00
-1.50
-1.00
-0.50
0.00
18
20
22
24
26
28
30
32
34
Distance along 'Y' (m)
Long Term
Short Term
0.8mm
No 1 RADLETT PLACE
X
BASEMENT No 38
Y=34m
Y=18.2m
BASEMENT No 36
No 38
RADLETT PLACE
No 34
BASEMENT No 38
Y
(0,0)
AVENUE ROAD

Figure 8

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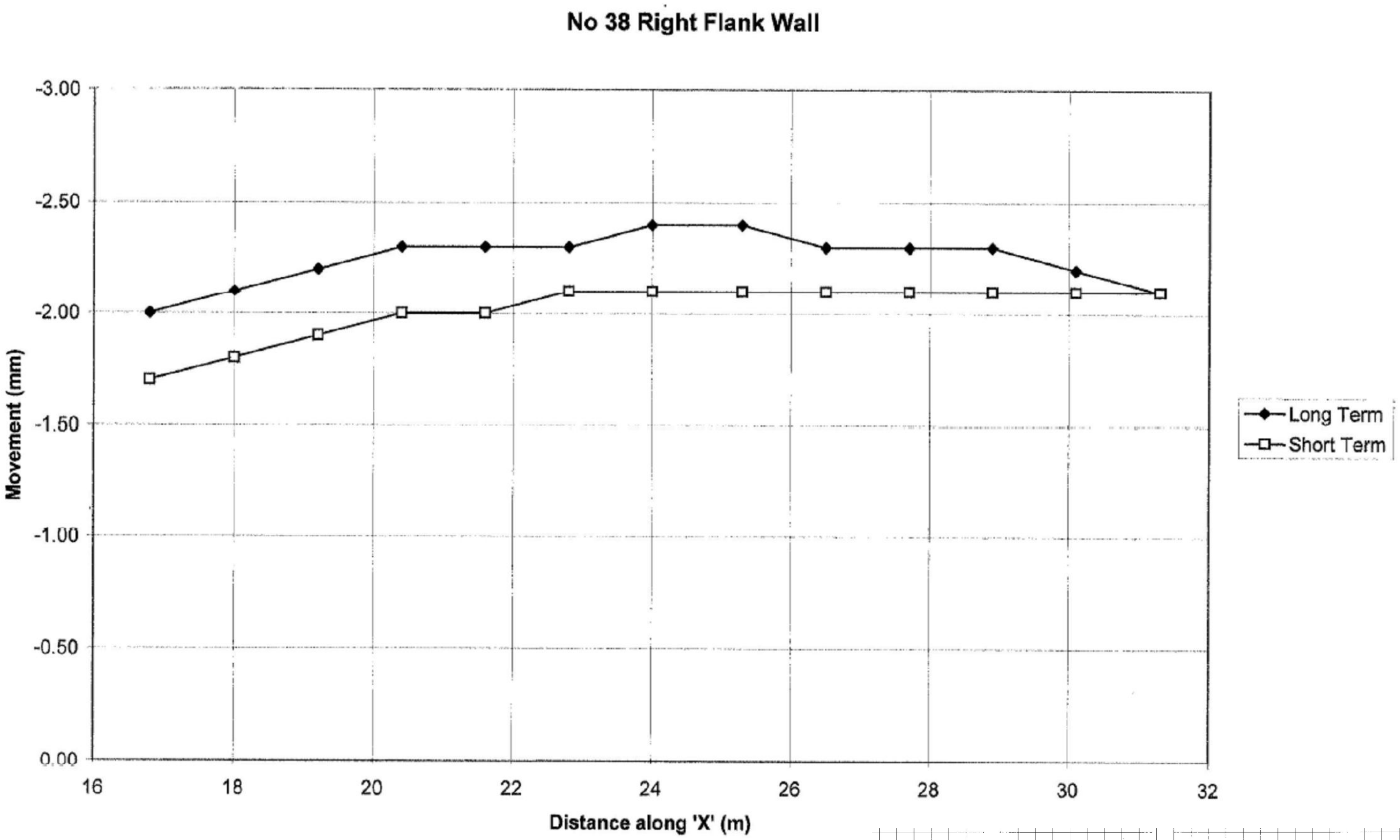
Project: 36 Avenue Road, London	Page 17 of 17		
Section: Calculation of ground movement	By: MB	Date:4/1/15	
	Chk:NS	Date: 8/1/15	



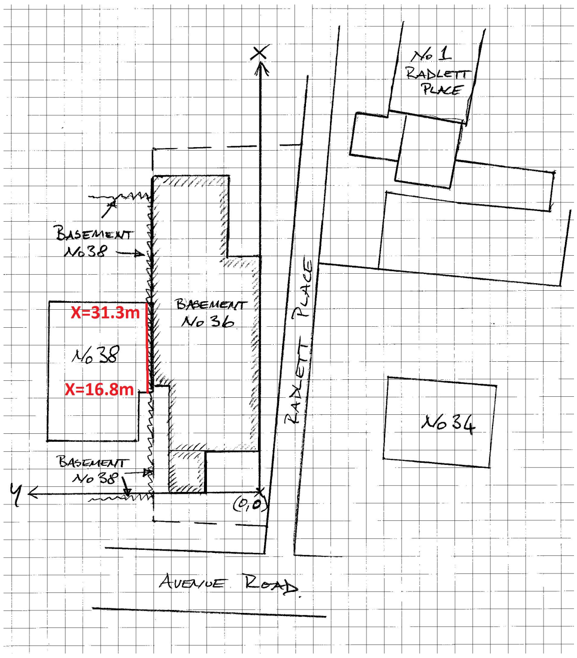


Figure 9