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Your Ref:

Our Ref: **Ref: 14/22906-2**
January 2015

Basement Impact Assessment

At
2-3 Akenside Road, London, NW3 5BS

For

Halstead Associates

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 2-3 Akenside Road, London, NW3 5BS. For this assessment a representative of SAS Limited visited the property on 15th 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.

This report also provides an impact assessment (4) of the geo-environmental impacts on adjacent structures and the surrounding area based on available site investigation data.

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 David Oates of Halstead Associates, a Chartered Structural Engineer (CEng).

2.0 SITE DETAILS

(National Grid Reference: TQ 266 851)

2.1 Site Location

The site is located to the north-east of Akenside Road in the London Borough of Camden at approximate postcode NW3 5BS. The site comprises of two semi-detached houses with driveways at the front and rear garden areas.

The surrounding land use is primarily residential.

2.2 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area (Sheet 256, 'North London', Solid and Drift Edition) indicates the site to be underlain by the Claygate Member with the London Clay Formation at depth. This geological setting is detailed in Figure 1 of this report.

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. 14/22906-1 and 14/22906 respectively) dated December 2014.

2.4 Site Layout and History

The site was attended on 15th December 2014 for the purposes of conducting the site walkover.

The site is roughly square shaped and comprises of adjoined two storey houses along with a garden space occupying the northern part of the site and a driveway to the south. Numerous mature trees are located surrounding the site.

The site is essentially flat although immediately to the west of the rear garden, the ground falls towards the south-west at shallow angles of between 1-4 degrees. There is also a general slope in the wider hillside setting from north to south down towards the Thames Basin up to approximately 10 degrees.

From historical map evidence it would appear that the present property was built between 1896 and 1915 has remained on-site and unchanged since its initial construction. The surrounding area has been primarily residential throughout its history. Pre 1890 the area was also abundant in open spaces and parks. However, during the turn of the century the area went through a rapid expansion and redevelopment.

2.5 Proposed Development

Proposals for the site include the excavation and construction of a single storey basement beneath the footprint of both properties. It is understood that the construction of the basements will involve excavation to a general level of 4m depth within underpin walls excavated to 4.3m depth.

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.	Yes - refer to Section 4.2 for scoping	The site lies above the Bagshot Formation. These deposits have been designated as Secondary A Class; permeable layers capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers
	1b. Will the proposed basement extend beneath the water table surface.	Yes - refer to Section 4.4 for scoping	The maximum depth of the proposed basement will be approximately 4.3m below ground level and will be below the current water level of approximately 2.47m in Borehole 1 and 1.85m in Borehole 2.
	2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line.	Yes - refer to Section 4.3 for scoping	The nearest surface water feature from mapping evidence is the Hampstead No. 1 Pond within Hampstead Heath located 793m north-east. However, according to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011), the site is extremely close to 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. The nearest surface water feature from mapping evidence is the Hampstead No. 1 Pond within Hampstead Heath located 793m north-east.
	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 not expected to change.
	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	Existing drainage paths are to be utilised where possible. Whether soakaways/SUDS are used on the proposed is to be confirmed (beyond the scope of this report). An appropriately qualified engineer should be engaged to ensure mandatory requirements are met.
	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 or spring line.	No	The nearest surface water feature from mapping evidence is the Hampstead No. 1 Pond within Hampstead Heath located 793m north-east.

Slope Stability	1. Does the existing site include slopes, natural or man-made greater than 1 in 8.	No	There is a very mild slope noticed on-site, but only measuring at an average angle of 2-3 degrees, with a maximum reading of 4 degrees.
	2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 1 in 8.	No	Re-profiling of landscaping at the site is not proposed.
	3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 1 in 8.	No	There are no railway cuttings close to the site.
	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 slope across the wider area towards the south at angles of around 10 degrees.
	5. Is the London Clay the shallowest strata at the site.	No	The investigation found that the site is underlain by Made Ground overlying the Claygate member.
	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.	No	It is understood that no trees are to be felled as part of the development.
	7. Is there a history of seasonal shrink-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, 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 4.3 for scoping	The nearest surface water feature from mapping evidence is the Hampstead No. 1 Pond within Hampstead Heath located 793m north-east. However, according to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011), the site is extremely close to one of the tributaries of the former River Tyburn.
	9. Is the site within an area of previously worked ground.	Yes - refer to Section 5.7 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.	Yes - refer to Section 4.4 for scoping	According to the results of the most recent ground investigation the site lies above a Secondary A Aquifer (Claygate Member)

	11. Is the site within 5m of a highway or pedestrian right of way.	Yes - refer to Section 5.8 for scoping	The site lies immediately to the east of Hamilton Terrace
	12. Is the site within 50m of the Hampstead Heath ponds	No	The site is located over 790m south-west from the pond chains on Hampstead Heath.
	13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties.	Yes - refer to Section 5.9 for scoping	The development will increase the depths of foundation at the site, although the foundation depths of adjacent properties are not known.
	13. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines.	Yes – Refer to 5.10 for scoping	London Underground have confirmed that there are no tunnels below the site however Network Rail have stated that they have assets close to the site. Their responses are included as Appendix B to this report.
Surface Water and Flooding	1. Is the site within the catchment of the pond chains on Hampstead Heath.	No	The site is located over 793m south-west 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 changing therefore surface water will not be impacted by the development.
	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	As no changes are occurring above the ground, surface water will not be impacted by the development.
	4. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses.	No	As no changes are occurring above the ground, surface water will not be impacted by the development.
	5. Is the site in an area known to be at risk from surface water flooding.	No	According to the Envirocheck report included as part of the desk study (SAS Report Reference 14/22906-1) the site is not at risk from extreme flooding from rivers or sea with and without defences. According to CPG4, September 2013, Akenside Road is not on the list of streets at risk from surface water flooding. The Environment Agency's latest surface water flood risk mapping shows a 'low' risk of flooding from surface water for the adjacent part of Akenside Road.

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

Subterranean Groundwater Flow

- Is the site located directly above an aquifer
- Will the proposed basement extend beneath the water table surface
- Is the site within 100m of a watercourse, well (used / disused) or potential spring line

Slope Stability

- Is the site within an area of previously worked ground
- Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties
- 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 shrink-swell subsidence in the local area and/or evidence of such effects at the site.
- Is the site within 5m of a highway or pedestrian right of way.
- Is the site within 100m of a watercourse, well (used / disused) or potential spring line
- 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.
- Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties.

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 December 2014 (SAS Report Reference 14/22714). The ground conditions revealed by the investigation are summarised in the following table.

Strata	Depth to top of strata (mbgl)	Depth to base of strata (mbgl)	Description
Made Ground	0.00	0.70 to 0.90	Surface layer of a stone slab or grass surface overlying silty gravelly fine sand and topsoil with brick and concrete fragments.
Claygate Member	0.70 to 0.90	4.00 to 4.60	Stiff to very stiff high strength becoming very high strength mottled orange/brown silty sandy clay.
London Clay Formation	4.00 to 4.60	8.00 (maximum depth of drilling)	Very stiff high strength becoming very high strength fissured silty clay with occasional partings of silty fine sand and scattered gypsum crystals

Groundwater was encountered as a seepage at a depth of 4.00m below ground level in Borehole 2, but was not encountered within Borehole 1.

Groundwater was subsequently found to have stabilised at respective depths of 2.68m and 1.85m below ground level in the monitoring standpipes placed in Boreholes 1 and 2 after a period of approximately five weeks.

In order to assess the soil infiltration characteristics of the natural superficial soils at the site, an in-situ rising head permeability test was carried out in Borehole 2 using the procedures recommended in BS 5930 (2007).

The results of the in-situ permeability test indicate an apparent permeability or soil infiltration rate of 6.29 x 10^{-6} m/sec. This soil infiltration rate lies within the range of published data for fissured and weathered clays and very fine or silty sands and is classed as being low permeability material with good to poor drainage characteristics.

4.0 SUBTERRANEAN (GROUNDWATER FLOW) - SCOPING ASSESSMENT

4.1 Introduction

This section addresses outstanding issues raised by the screening process regarding subterranean (groundwater flow).

4.2 Aquifer designations

The Environment Agency Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) and also their role in supporting surface water flows and wetland ecosystems.

The bedrock geology underlying the site is classified as Secondary Aquifer A class; materials with permeable layers capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

4.3 Springs, Wells and Watercourses

The nearest surface water feature is recorded to be in excess of 100m from 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 50m of a tributary of the River Tyburn, which ran in a south easterly direction from Hampstead Heath through Hampstead, Regents Park, Mayfair, Green Park and out into the River Thames at Westminster. The river is now completely enclosed and used as a sewer.

Given the clayey and low permeability nature of the near-surface Claygate Beds, 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.

4.4 Groundwater Flow and Depth to Groundwater

It is understood that the construction of the basements to Building Nos. 2 and 3 will involve excavation to a general level of 4m depth within underpin walls excavated to 4.3m depth.

Groundwater has been recorded above these levels and at respective depths of 2.47m and 1.72m below ground level in the monitoring standpipes placed in Boreholes 1 and 2. This water level represents a level recharged by the Claygate Member.

Although the proposed development will extend into the uppermost part of the identified water table, given the low permeability of the near-surface soils (see Section 3.1), it is considered that free-flowing groundwater conditions flowing into the excavations is unlikely. The theoretical steady-state radius of influence (R0) of any groundwater level changes (whether drawdown or raised) can be estimated using an empirical relationship derived by Sichardt (CIRIA, 2000). For linear features, R_0 is given by;

$R_0 = C (H – h_w) \sqrt{(6.29 \times 10^{-6} \text{ m/s})}$

$R_0 = 3.76\text{m}$

Where C is an empirical correlation factor taken as 3000
H – h_w is the drawdown or rise in groundwater level (say 0.5m in an extreme case for the site)
K is the permeability (estimated as 6.29×10^{-6} *from field data – see section 3.1)*

This gives a radius of influence (R_0) of 3.76m, which indicates that, even in extreme conditions, any changes to the groundwater table caused by the new structure will be localised to the area immediately surrounding the property.

These calculations are approximate and trial excavations to the proposed basement depth should be carried out to confirm the stability of the soil and to further investigate the presence of any groundwater inflows.

During any dewatering carried out for the trial investigations or indeed the main works it will be necessary to monitor the pumped water for fines. Care must be taken not to allow settlement of the neighbouring structures during any dewatering process and the main contractor should provide details of how they intend to control groundwater and maintain the stability of excavations.

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 (SAS Report Reference 14/22906-1) 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 and neighboring properties are located on an area of high ground north of Hampstead. Immediately to the west, the ground falls towards the south-west at shallow angles of between 1-4 degrees.

There is also a general slope in the wider hillside setting from north to south down towards the Thames Basin up to approximately 10 degrees, 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.

As part of the development it is proposed to excavate below the site by at least 4.20m below ground level, although excavation may locally be to a greater depth to facilitate floor slab and foundation construction. It is anticipated that the natural Claygate Member would be encountered at this depth and therefore 'running sand' conditions and ground instability is possible and therefore some kind of retention will be required for the cuttings. This could take the form of sheet piling employed in the temporary case to exclude water and maintain the stability of excavations.

It is therefore considered that slope stability can be maintained through the proper design and construction of mitigation measures, similar to those outlined above.

All risks related to the stability of the slopes must be identified and managed in accordance with CDM legislation.

5.3 Shrinking / Swelling Clays

As part of the ground investigation at the site (SAS Report Reference 14/22906) Atterberg Limit tests were conducted on four selected samples taken from the upper cohesive sections of the natural soils in Boreholes 1 and 2 and showed the samples tested to fall into Classes CI and CH, according to the British Soil Classification System. These are fine grained silty clay soils of intermediate to high plasticity and as such generally have a low permeability and a low to high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2.

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 Heave of underlying soils

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.

5.5 Compressible / Collapsible Ground

The natural ground stability hazards dataset supplied by the BGS gives the hazard rating for compressible ground as 'no hazard' and collapsible ground at the site is listed as 'very low'.

5.6 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.

5.7 Made Ground

In the boreholes drilled at the site, Made Ground was found to extend down to depths of up to 0.90m below ground level.

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 50kN/m^2 because of the likelihood of extreme variability within the material.

Contamination testing has been carried out in the Made Ground and the results are presented in Site Analytical Report Reference 14/22906 dated January 2015.

5.8 Location of Public Highway

The proposed basement is not to be extended below Akenside 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.

5.9 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. However, it is understood that ground movements

and/or instability will be managed through the proper design and construction of mitigation measures.

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 P4089). The report is provided as Appendix A. The report concludes given good workmanship, the basement to Nos. 2 and 3 Akenside Road can be constructed without imposing more than very slight damage on the adjoining properties. The report also states (in agreement with this report) that the development is not likely to disrupt any existing local groundwater flows.

5.10 Structural Stability of Underground Railways/Tunnels

According to records from Network Rail, the site lies approximately 100m to the south of Newmount Tunnel and 200m to the north of the Belsize Tunnels. These records are included as Appendix C to this report. The site does not lie below any London Underground owned tunnels.

Give the distance of the site from the tunnels it is considered unlikely that the basement will affect the stability of the structures. However Network Rail may need to be informed about the nature of the works.

6.0 CONCLUSIONS

1. Proposals for the site include the excavation and construction of a single storey basement beneath the footprint of both properties. It is understood that the construction of the basements will involve excavation to a general level of 4m depth within underpin walls excavated to 4.3m depth.

2. Conditions at the site were investigated by Site Analytical Services Limited in December 2014 (SAS Report Reference 14/22906). The exploratory holes revealed ground conditions that were generally consistent with the geological records and known history of the area and comprised up to 0.90m thickness of Made Ground overlying materials typical of the Claygate member with the London Clay Formation at depth.

3. The superficial geology underlying the site is classified as Secondary Aquifer A class; materials with permeable layers capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

4. Water levels in the immediate vicinity of the property have been recorded above floor level of the proposed basement.

5. It is considered that slope stability can be maintained through the proper design and construction of mitigation measures for example sheet piling employed in the temporary case to exclude water and maintain the stability of excavations.

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

7. 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.

8. The site lies approximately 100m to the south of Newmount Tunnel and 200m to the north of the Belsize Tunnels but given this distance it is considered unlikely that the basement will affect the stability of the structures.

p.p. SITE ANALYTICAL SERVICES LIMITED

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Geotechnical Engineer

A P Smith BSc (Hons) FGS MCIWEM
Senior Geologist

7.0 REFERENCES

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3. British Standards Institution, 2009. Code of Practice for Protection of Below Ground Structures Against Water from the Ground. BS 8102, BSI, London

4. Camden Planning Guidance, 2011. CPG 4; Basements and lightwells. London Borough of Camden

5. CIRIA Special Publication 69, 1989. The engineering implications of rising groundwater levels in the deep aquifer beneath London

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7. Environment Agency Status Report 2010. Management of the London Basin Chalk Aquifer. Environment Agency

8. Environment Agency, 2006. Groundwater levels in the Chalk-Basal Sands Aquifer in the London Basin

9. NHBC Standards, Chapter 4.1, "Land Quality - managing ground conditions", September 1999.

10. NHBC Standards, Chapter 4.2, "Building near Trees", April 2003.

11. Tomlinson, M J, 2001. “Foundation Design and Construction”, Seventh Edition, Prentice Hall (ISBN 0-13-031180-4).

524000 526000 528000

186000

Approximate Location of Site

524000 526000 528000

Data Source: BGS Mapping - Scale 1:10,000

N

Scale at A3: 1:15,000

Coordinate System:
British National Grid
GCS_OSGB_1936

0 0.25 0.5 1 1.5
Kilometers

Legend

- London Borough of Camden
- Railway Lines
- A Roads

BGS 1:10K Artificial Ground

- MADE GROUND
- WORKED GROUND

BGS 1:10K Drift Geology

- ALLUVIUM
- HACKNEY GRAVEL FORMATION
- LANGLEY SILT FORMATION
- LYNCH HILL GRAVEL FORMATION
- STANMORE GRAVEL FORMATION

BGS 1:10K Solid Geology

- BAGSHOT FORMATION
- CLAYGATE MEMBER
- LAMBETH GROUP
- LONDON CLAY FORMATION

NB. Geological boundaries are largely indicative based on available geological mapping data

2-3 Akenside Road, NW3

Geological Setting

213923 **FIGURE** **1**

Appendix A – Ground Movement Assessment

1.0 Introduction

In connection with the proposal to redevelop Nos 2 and 3 Akenside Road, London NW3 5BS, involving the construction of new basements and ground floor extensions to the rear of both properties, 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. The addresses of these properties are assumed to be No 1a and No 4 Akenside Road, to the left and the right of the site respectively.

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

The structural engineer for the project is Halstead Associates. A plan of the proposed basement of the property is given below in Figure 1.

It is understood that the existing buildings are to be substantially retained. The basement is to be constructed beneath the full, extended building footprint.

The exterior ground level at No 2 is understood to be approximately 86.1mOD and for the purposes of this report the interior finished floor level in both existing and proposed cases will be taken as 86.2mOD. The exterior ground level falls to the right across the width of No 3, being at an estimated level of approximately 85mOD at the right flank wall, but the internal floor levels are understood to be similar to that of No 2. The ground continues to fall to the right, across the frontage of No 4. There is therefore likely to be a decrease in the levels of the existing foundations from No2 to No3 to No4, but this will not be taken into account, this assumption is slightly conservative.

It is understood that the construction of the basements to Nos 2+3 will involve excavation to a general level of 82.2mOD (4m depth) within underpin walls excavated to 81.9mOD (4.3m depth).

It is not known whether the neighbouring properties at Nos 1+4 have basements. For the purposes of the current report it will be assumed that they do not, this is conservative. Both neighbouring buildings will be assumed to be founded at the top of the London Clay.

No 1a Akenside Road lies to the left of the site, aligned slightly obliquely to No 2, at a minimum distance of approximately 3.3m (maximum 4.7m).

No 4 Akenside Road lies to the right of the site and is set back from, but parallel to, No 3, the two buildings being separated by approximately 2m.

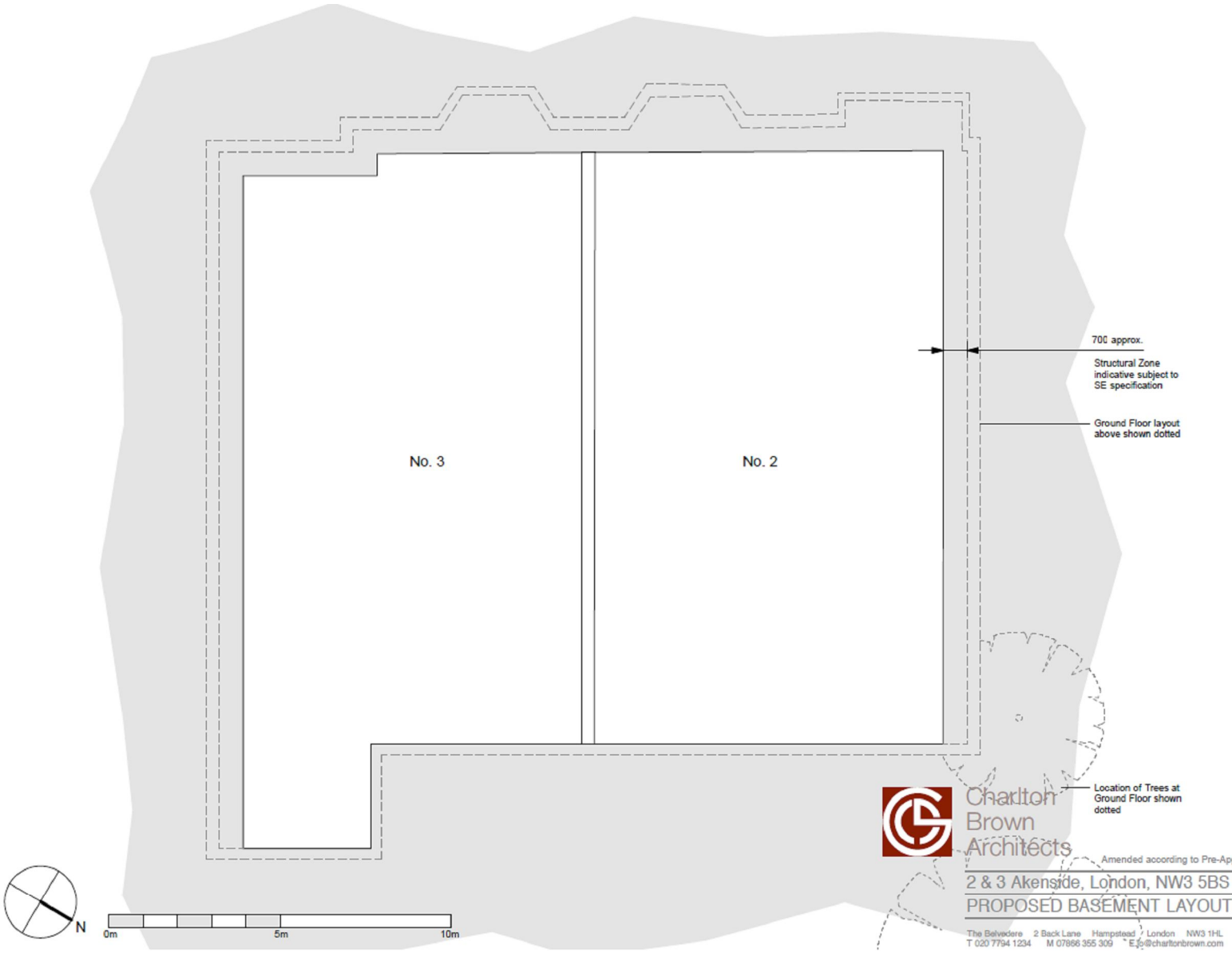
It is required that a predicted damage category assessment be made on Nos 1a and 4 Akenside Road.

2.0 Information Provided

The following relevant information has been used for these calculations:-

i) SAS Borehole and trial pit logs dated December 2014.
ii) Charlton Brown Architects drawings 1256/PL/010 and 100a-110a.
iii) Drawing '16114 underpinning section.pdf'
iv) Sketches of existing and proposed building loads (files 'DOC.pdf' and 'DOC000.pdf')
v) Email correspondence SAS-AGE dated 9/12/14 to 12/1/15.

Front



Rear

Figure 1 –Proposed Basement Plan (extract of CBA dwg 1256 PL 100a)

3.0 Anticipated Ground Conditions

The external ground level across the site varies between approximately 86.1mOD and 85mOD, for the practical purposes of the current report the external ground surface at the site will be treated as horizontal at a level of 86.1mOD.

The published geological map (BGS 1:50 000 sheet 256: North London) indicates the site to lie on the edge of an outcrop of Claygate Beds (silt and fine sand) overlying the London Clay (silty 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 86m depth (0mOD).

A ground investigation was undertaken at the site in December 2014 (Item 'i' in Section 2 above). This comprised a window sampler borehole to 8m depth at the rear of No 3 (BH1), and a continuous flight auger borehole, also to 8m depth, at the front of No2 (BH2). Both boreholes were equipped with water-monitoring standpipes, with response zones from 1m to 5m depth.

A single trial pit was excavated to 1m depth near the rear wall of No 2.

The boreholes confirmed 700-900mm of Made Ground. In BH1 this overlies sand and gravel to 1.1m, this is not typical of the Claygate Beds and is provisionally considered to be Made Ground also. This overlies firm, becoming stiff, silty sandy clay, this latter deposit is interpreted as London Clay, possibly with some Head, or transitional material from the Claygate Beds, at the top.

The Trial Pit revealed Made Ground to a depth of 0.9m, underlain by silty sandy clay.

The top of the London Clay/Head can be taken to lie at approximately 85.1mOD (1m depth).

Groundwater was encountered at 4m depth during the boring of BH2, BH1 was dry during boring. Subsequent readings made in the standpipes (5 January 2015) indicated groundwater levels of 2.68mbgl and 1.85mbgl in BHs 1 and 2 respectively.

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

Ground Level 86.1mOD
Base of Made Ground 1.0mbgl (85.1mOD)
Base of London Clay approx 86mbgl (0mOD).

The Made Ground lies above excavation depth, and adjacent structures are likely to be founded onto the London Clay, therefore the Made Ground does not influence ground movements and will not be considered in detail.

In situ Standard Penetration Tests (SPT) were carried out in the London Clay in BH1 and Vane tests were carried out on the arisings from BH2. 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 f_1= 4.5, based upon a mean plasticity index of 27% (20%-43%, 4 tests). Vane tests typically overestimate the bulk strength of London Clay by a significant degree, therefore more weight has been accorded to the SPT results.

The (solid) trend-line given in Figure 2 has the equation:-

Su = 45 + 15.8z (kPa)

Where z is the depth below the top of the London Clay.

This represents a significantly steeper rate of strength increase than is typically seen in this area of London, and is likely to yield excessive strength values at depth, therefore a more conservative trend line has been adopted for the analysis, this is described by:-

Su = 50 + 8z (kPa)

This strength profile is indicated by the dotted line in Figure 2 below.

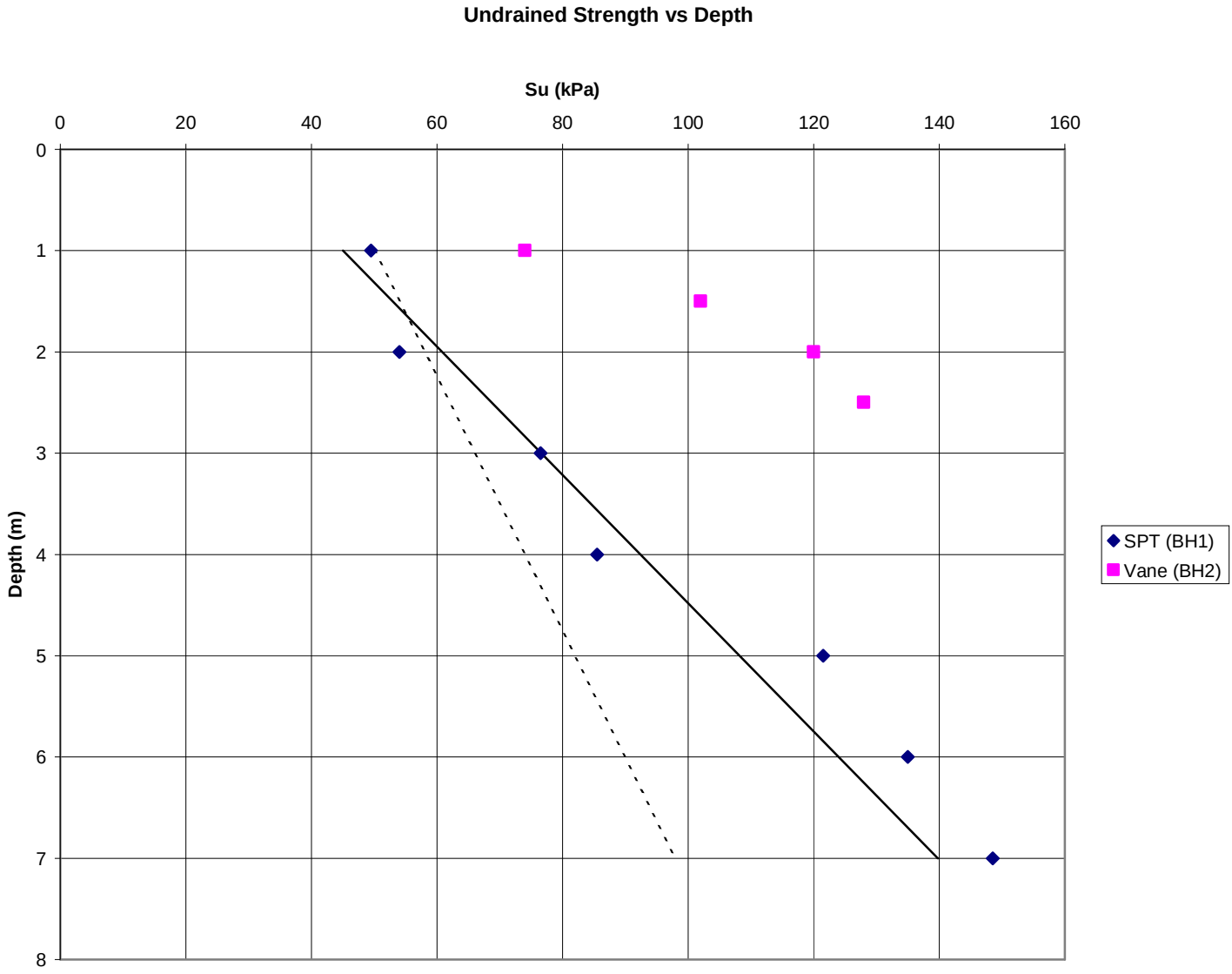


Figure 2
Undrained strength vs depth

4.0 Loads

It is assumed that the current building loads are imposed on spread footings bearing on the top of the London Clay at 85.1mOD (1mbgl). A footing width of 600mm has been assumed.

Existing perimeter wall loads and internal wall loads have been provided by Halstead Associates. These range from 25kN/m to 60kN/m run for the perimeter walls, 80kN/m run for the party wall between the two properties, and 40kN/m to 55kN/m for internal walls (Item 'iv' in Section 2 above).

Following underpinning it is understood that the building loads will be transferred to a level of 81.9mOD, and spread on 'L' shaped underpins of 1.2m base-width (Item 'iii' in Section 2 above).

Proposed perimeter wall loads range from 30kN/m to 60kN/m; the party wall load increases to 85kN/m run, all excluding the self-weight of underpinning. Internal wall loads are borne on columns at basement level, these column loads range from 90 to 280kN.

Excavation from existing floor level to the new basement formation level of 82.2mOD, will yield a significant load reduction; a bulk unit weight of 20kN/m^3 has been adopted for the calculation of this unload.

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 to 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 soil stiffness parameters are as given below.

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 × Su; (Poisson's ratio = 0.5)
E'_o = 1240 × Su; (Poisson's ratio = 0.2)

Yielding :-

E_{uo} = 77.5 + 12.4z (MPa)
E'_o = 62 + 9.9z (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
iii) Vertical and horizontal movement due to deflection of underpins, following removal of support from in front of the underpins 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 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 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 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 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 –1a Akenside Road, front elevation

5.4.1 Vertical Movement

Profiles of short- and long-term vertical ground movement along the front elevation of No 1a Akenside Road have been calculated and plotted in Figure 4. The plot presents the short and long-term settlement profiles calculated as described above.

The front wall is taken to extend 7m from the right front corner of No 1a, to a small return and corner, as shown on the plan in Figure 4. At this point a greater degree of movement-tolerance of the wall is assumed to exist. The right front corner of No 1a is understood to lie approximately 3.3m from the proposed basement of No 2 (at X=-3.3m); the proposed basement of No 2 lies at X=0.

It is not known whether there is a basement beneath no 1a, for the purposes of this analysis it is conservatively assumed that there is not.

In calculating the short-term profiles using CIRIA C580, the excavation for the underpins to No 2 is taken to descend from an existing external ground level at 86.1mOD to a formation level of 81.9mOD; a depth of 4.2m. The basement excavation within the underpins is taken to descend from the same ground level to a formation level of 82.2mOD; a depth of 3.9m.

The analysis indicates a maximum overall tilt of approximately 3.3mm over the 7m length of the wall. This equates to a whole-wall gradient of less than 1 in 2000. This is considerably less than the 1:400 gradient recognised as requiring remedial action.

Distortion of the wall (Delta – as defined by Burland, Ref 2) is seen to be negligible, therefore the upper limit on horizontal strain required to restrict damage to ‘very slight’ or less is 0.075%, as proposed in Ref 2.

5.4.2 Lateral movement.

From Section 5.3 above, taking the underpin wall depth at No 2 to be 4.2m, the maximum lateral movement due to underpin wall installation is calculated to be 1.7mm, reducing to zero at approximately 6.3m distance from the basement. This yields a horizontal ground strain of 1.7/6300 = 0.027% within that 6.3m distance.

Also from Section 5.3 above, taking general excavation depth at No 2 to be 3.9m, the ground movement due to the subsequent deflection of the underpin wall, following excavation of the basement, is calculated as 5.8mm, reducing to zero at a distance of 15.6m (yielding an average strain of 5.8/15600 = 0.037%).

The maximum total horizontal ground strain beneath the front wall of No 1a is therefore assessed as 0.063%. This is less than the upper limit of 0.075% for ‘very slight’ damage derived above for this wall. It will be noted that the maximum horizontal strain applies only to the right-hand end of the wall (to 6.3m distance from No 2).

The predicted level of damage to this wall can therefore be taken as ‘very slight’.

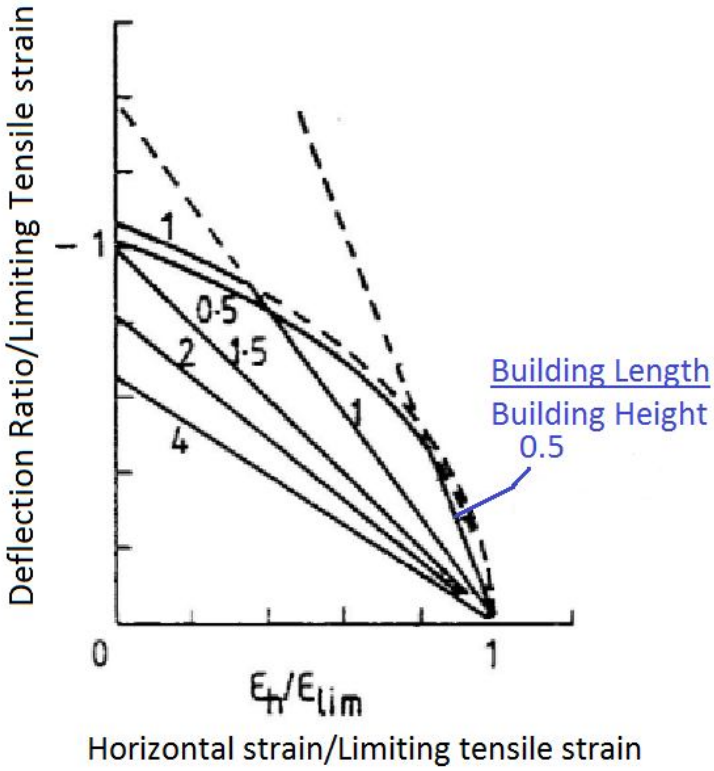


Figure 3 (from Ref 2)

5.5 Predicted movement – No 1a Akenside Road, right flank wall.

Profiles of short- and long-term vertical ground movement along the right flank wall of No 1a Akenside Road have been calculated and plotted in Figure 5. This wall extends from Y = 1.5m at the front, to Y = 7.5m at the rear, as shown on the plan in Figure 5. The wall lies slightly oblique to the nearby left flank wall of No2, being at 3.3m distance at the front of 1a and 4.7m distance at the rear.

The analysis indicates a maximum overall tilt of approximately 0.7mm over the 6m length of the wall. This equates to a whole-wall gradient of less than 1 in 8000. This is considerably less than the 1:400 gradient recognised as requiring remedial action.

The maximum predicted wall distortion (Delta – as defined by Burland, Ref 2) is negligible, and taking into account that there is also likely to be negligible horizontal ground strain along the length of this wall, as a result of the proposed works at No 4a, the predicted damage category can be taken as 'very slight' or less, by inspection.

5.6 Predicted movement – 1a Akenside Road, rear wall.

5.6.1 Vertical Movement

Profiles of short- and long-term vertical ground movement along the rear elevation of No 1a Akenside Road have been calculated and plotted in Figure 6.

The rear wall is taken to extend 9m from the right rear corner of No 1a, to a 90º corner, as shown on the plan in Figure 6. At this point a greater degree of movement-tolerance of the wall is assumed to exist. The right rear corner of No 1a is understood to lie approximately 4.7m from the proposed basement of No 2 (at X=-4.7m); the proposed basement of No 2 lies at X=0.

The analysis indicates a maximum overall tilt of 3.2mm along the 9m length of this wall. This equates to a whole-wall gradient of less than 1 in 2000. 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 9m wall length. This equates to a deflection ratio of 0.8/9000 = 0.009%. 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 = 0.009/0.075=0.12. By reference to Figure 3 (Ref 2 Figure 6) and taking the length of the No 1a rear wall as approximately equal to its height, a horizontal strain/limiting tensile strain ratio of 0.9 is obtained, therefore a horizontal strain of 0.9 x 0.075% = 0.067% is acceptable for a 'very slight' category of damage. This analysis does not take account of the stiffness of the walls of No 1a; the result is therefore conservative in this respect.

5.6.2 Lateral movement.

From Section 5.3 above, taking the underpin wall depth at No 2 to be 4.2m, the maximum lateral movement due to underpin wall installation is calculated to be 1.7mm, reducing to zero at approximately 6.3m distance from the basement. This yields a horizontal ground strain of 1.7/6300 = 0.027% within that 6.3m distance.

Also from Section 5.3 above, taking general excavation depth at No 2 to be 3.9m, the ground movement due to the subsequent deflection of the underpin wall, following excavation of the basement, is calculated as 5.8mm, reducing to zero at a distance of 15.6m (yielding an average strain of 5.8/15600 = 0.037%).

The maximum total horizontal ground strain beneath the front wall of No 1a is therefore assessed as 0.063%. This is less than the upper limit of 0.067% for 'very slight' damage derived above for this wall. It will be noted that the maximum horizontal strain applies only to the right-hand end of the wall (to 6.3m distance from No 2).

The predicted level of damage to this wall can therefore be taken as 'very slight'.

5.7 Predicted movement – No 4 Akenside Road, front and rear walls.

5.7.1 Vertical Movement

Profiles of short- and long-term vertical ground movement along the front and rear elevations of No 4 Akenside Road have been calculated and plotted in Figures 7 and 8. It is understood from the information provided (CBA Drawing 1256/PL/010 – item 'ii' in Section 2 above) that the original rear wall of No 4 is set back from the rear wall of No 3 by approximately 2m (and lies at Y=22m), but a rear extension to No 4 extends a further 6.5m rearwards (to Y=28.5). The works at No 3 extend rearwards to Y=20.3m. Therefore, by inspection, the original rear wall will be more influenced by the works than will the rear wall of the extension, the comments below therefore relate to the original rear wall.

Both the front and rear walls are taken to extend 22m from the left flank wall of No 4, across the full width of Nos 4+5 Akenside Road, as shown on the plans in Figures 7 and 8. The left flank wall of No 4 is taken to lie approximately 2m from the proposed basement of No 3 (at X=25m); the proposed basement of No 3 lies at X=23m.

The plots for the two walls are similar. By inspection the short-term movements are critical in terms of both overall tilt and distortion, and the short–term movements for the two walls are effectively identical. The following comments are based upon the front wall plot, but relate to both walls.

The analysis indicates a maximum overall tilt of 3.1mm along the 22m length of this wall. This equates to a whole-wall gradient of less than 1 in 7000. 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) can be shown to be 1.8mm within a 14m length of the wall. This equates to a deflection ratio of 1.8/14000 = 0.013%. 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 = 0.013/0.075=0.17. By reference to Figure 3 (Ref 2 Figure 6) and taking the 14m length of the No 4 front wall as approximately equal to 1.5 x its height, a horizontal strain/limiting tensile strain ratio of approximately 0.82 is obtained, therefore a horizontal strain of 0.82 x 0.075% = 0.061% is acceptable for a 'very slight' category of damage.

5.7.2 Lateral movement.

From Section 5.3 above, taking the underpin wall depth at No 3 to be 3.2m, the maximum lateral movement due to underpin wall installation is calculated to be 1.3mm, reducing to zero at approximately 4.8m distance from the basement. This yields a horizontal ground strain of 1.3/4800 = 0.027% within that 4.8m distance.

Also from Section 5.3 above, taking general excavation depth at No 3 to be 2.9m, the ground movement due to the subsequent deflection of the underpin wall, following excavation of the basement, is calculated as 4.3mm, reducing to zero at a distance of 11.6m (yielding an average strain of 4.3/11600 = 0.037%).

The maximum total horizontal ground strain beneath the front wall of No 4 is therefore assessed as 0.064%. This is greater than the upper limit of 0.061% for 'very slight' damage derived above for this wall, and suggests damage at the lower end of the 'slight' category, which in the current context would extend from 0.061% to 0.135%.

However, it will be noted that the maximum horizontal strain applies only to the left-hand end of the wall (to 4.8m distance from No 3, ie to X = 27.8m). Over this length the vertical distortion of the wall is negligible, suggesting that horizontal strains of up to 0.075% can be satisfactorily tolerated with only very slight levels of damage. Further to the right along the wall, beyond X=27.8m, the calculated horizontal strain reduces to 0.037%, which is within the limit for 'very slight' strain for the most distorted section of wall.

Furthermore, the analysis is conservative as it takes no account of the stiffness of the wall, either in the vertical, or the horizontal directions.

On the basis of the above it is considered that the predicted level of damage to the front and rear walls can be taken as 'very slight'.

5.8 Predicted movement – No 4 Akenside Road, left flank wall.

5.8.1 Vertical Movement

Profiles of short- and long-term vertical ground movement along the left flank wall of No 4 Akenside Road have been calculated and plotted in Figure 9.

This rear wall is taken to extend 19.2m from the front left corner of No 4, to the rear wall of the rear extension to No 4, as shown on the plan in Figure 9. The wall is understood to lie approximately 2m from the proposed basement of No 3 (at X=25m; the proposed basement of No 3 lies at X=23), and to project rearwards beyond the limit of the basement to No 3 (at Y=23m) to Y=28.5m. In view of this, the buttressing effect of the corner of the excavation has been taken into account, using the method of Fuentes and Devriendt (Ref 4), as this tends to increase the distortion of this wall. Note that this correction was not applied to the rear wall of No 4 (Section 5.7 above), as it would tend to decrease the distortion in that case.

The analysis indicates a maximum overall tilt of 2.4mm along the 19.2m length of this wall. This equates to a whole-wall gradient of less than 1 in 8000. 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 1.25mm within the 19.2m wall length. This equates to a deflection ratio of 1.25/19200 = 0.007%. 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 = 0.007/0.075=0.09. By reference to Figure 3 (Ref 2 Figure 6) and taking the length of the No 4 left flank wall as approximately equal to 2x its height, a horizontal strain/limiting tensile strain ratio of 0.92 is obtained, therefore a horizontal strain of 0.92 x 0.075% = 0.069% is acceptable for a 'very slight' category of damage. This analysis does not take account of the stiffness of the walls of No 4; the result is therefore conservative in this respect.

5.8.2 Lateral movement.

Taking into account the nature of the proposed works at No 3, the horizontal ground strain along the line of the left flank wall of No 4 can be taken as negligible by inspection. The predicted level of damage to this wall can therefore be taken as 'very slight' or less.

5.9 Predicted damage summary

On the basis of the above, the level of damage to Nos 1a and 4 Akenside Road 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.

A plot of the calculated short-term movement contours is presented in Figure 10 below.

6.0 Groundwater

It is proposed to excavate to a maximum depth of approximately 4.2m, and a maximum general excavation depth of 3.9m, through up to 1.1m of Made Ground into a thick deposit of London Clay. Groundwater was encountered in one of the boreholes (BH2) at 4m depth, in a stiff clay sequence. In the absence of detailed information it is assumed this was a limited seepage. The other borehole was dry during the investigation. Subsequent readings in standpipe installations in the two boreholes indicated a maximum groundwater level at 1.85m bgl.

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. However, if the groundwater strike at 4m depth in BH2 was a significant inflow, then measures should be put in hand before the start of construction, to locally dewater the underpin excavations as required.

7.0 Conclusions and Recommendations

From the above, it is concluded that, given good workmanship, the basement to Nos 2 and 3 Akenside 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:

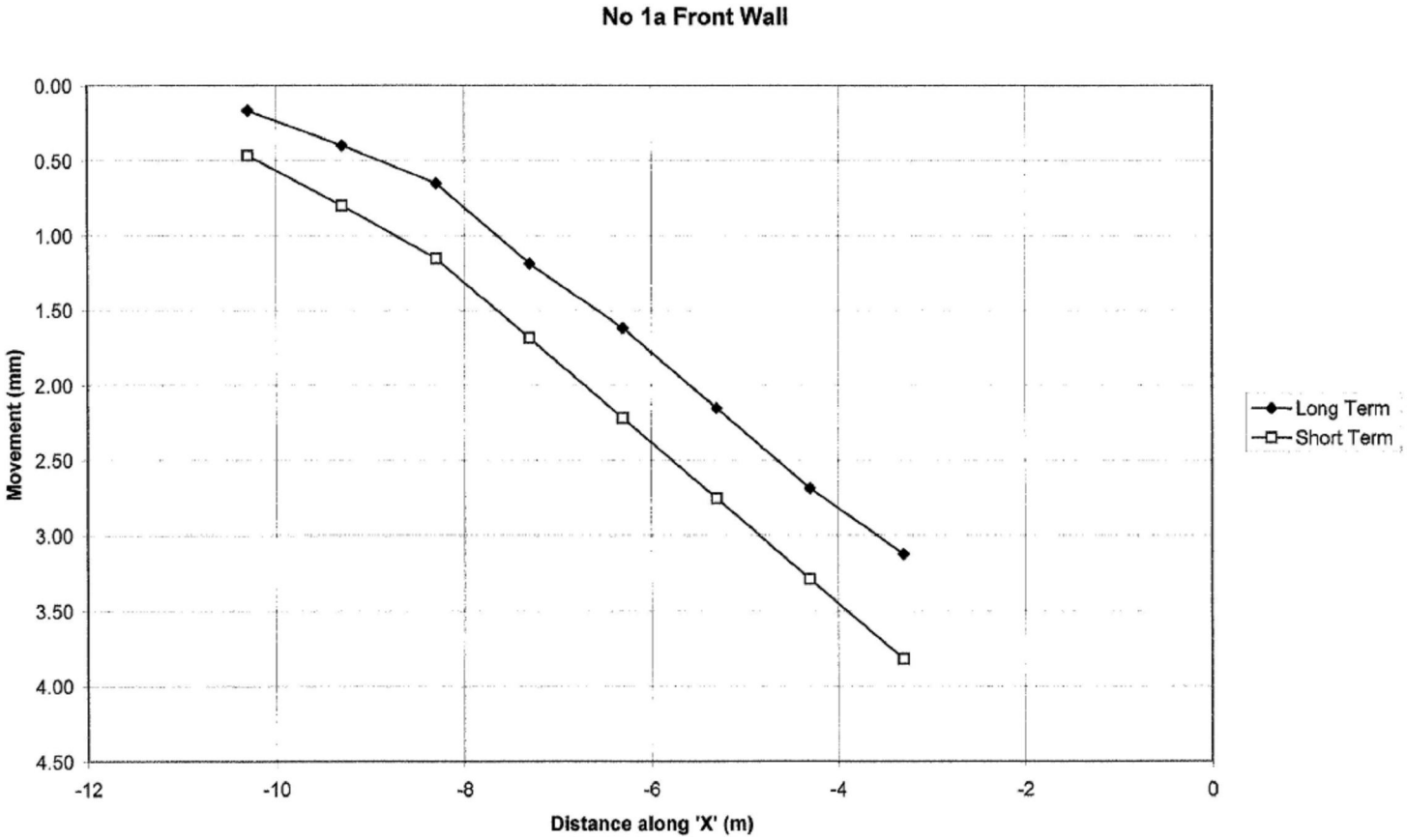
1 Stroud M A (1989) 'The standard penetration test – its application and interpretation'. In 'Penetration testing in the UK', Thomas Telford pub.

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 Fuentes, R. and Devriendt, M (2010). 'Ground movements around the corners of excavations: empirical calculation method'. Journal of geotechnical and geoenvironmental engineering, ASCE v136 Issue 10 pp1414-1424.

(Figures 4-10 follow below)


No 1a Front Wall
Movement (mm)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
-12
-10
-8
-6
-4
-2
0
Distance along 'X' (m)
Long Term
Short Term

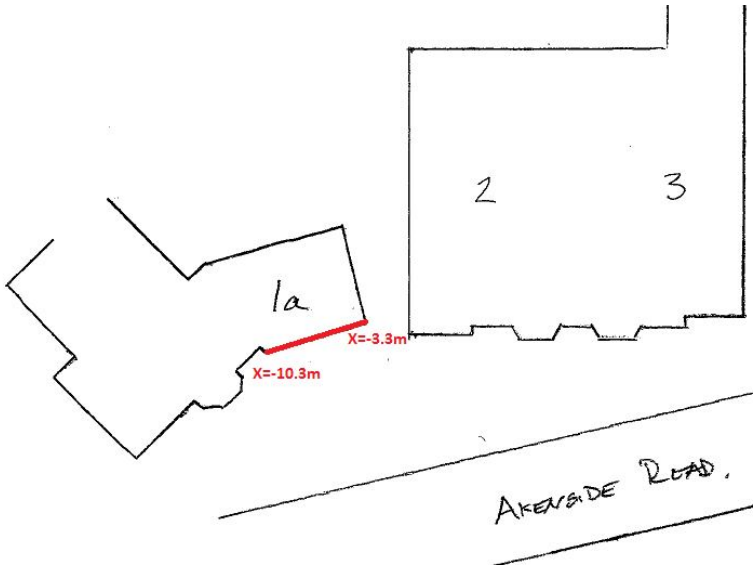
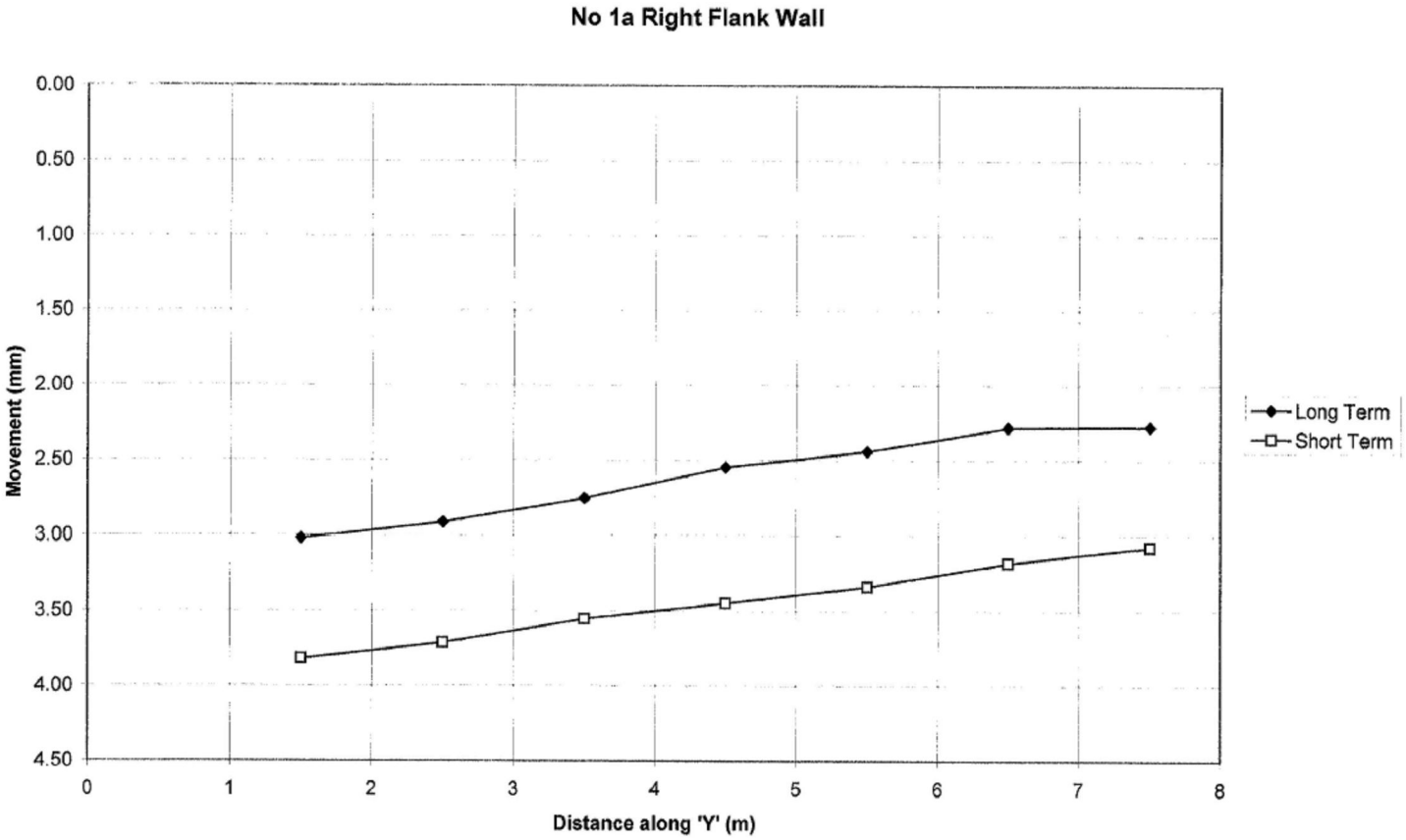

2
3
1a
X=-3.3m
X=-10.3m
AKENSIDE ROAD.

Figure 4


No 1a Right Flank Wall
Movement (mm)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
0
1
2
3
4
5
6
7
8
Distance along 'Y' (m)
Long Term
Short Term

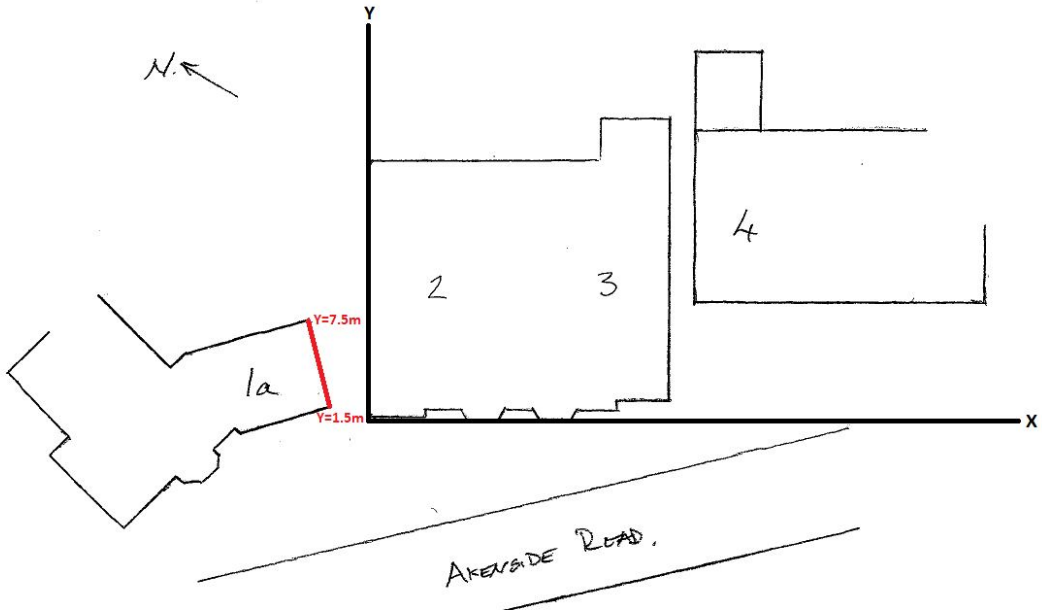

N.
Y
X
2
3
4
1a
Y=7.5m
Y=1.5m
AKENSIDE ROAD.

Figure 5

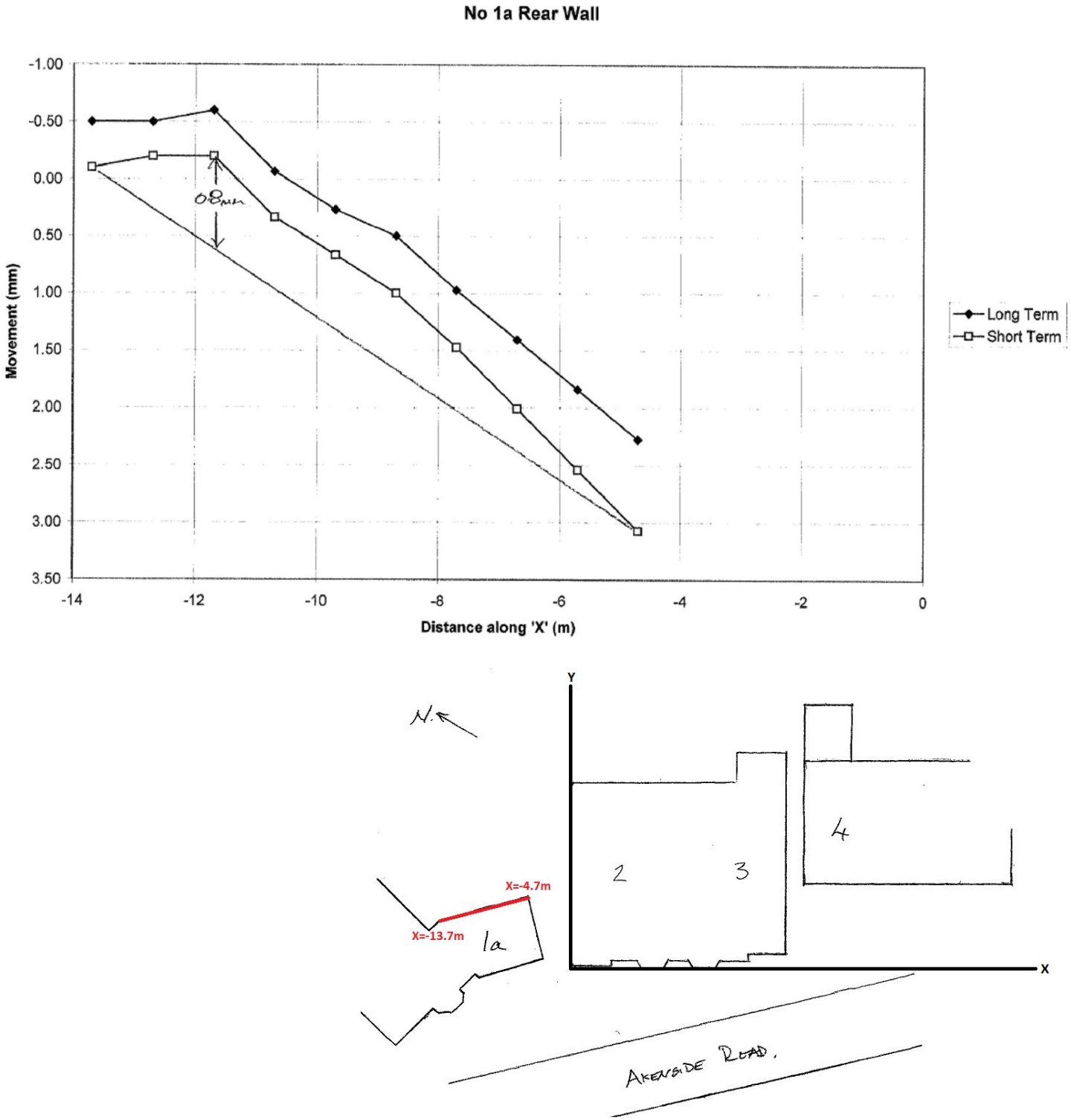

No 1a Rear Wall
Movement (mm)
-1.00
-0.50
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
-14
-12
-10
-8
-6
-4
-2
0
Distance along 'X' (m)
Long Term
Short Term
N.
Y
X
1a
2
3
4
X=-4.7m
X=-13.7m
AKENSIDE ROAD.

Figure 6

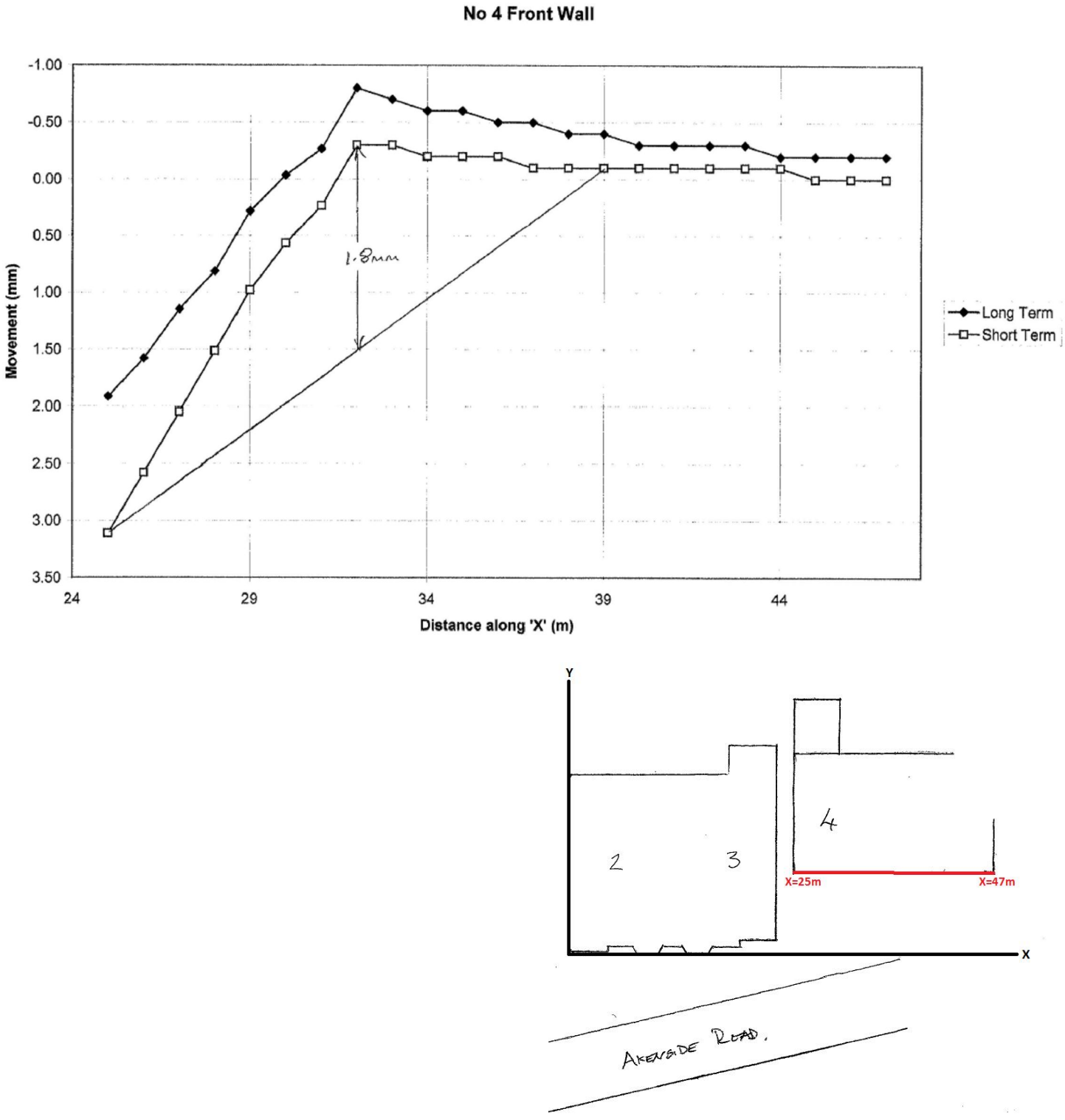
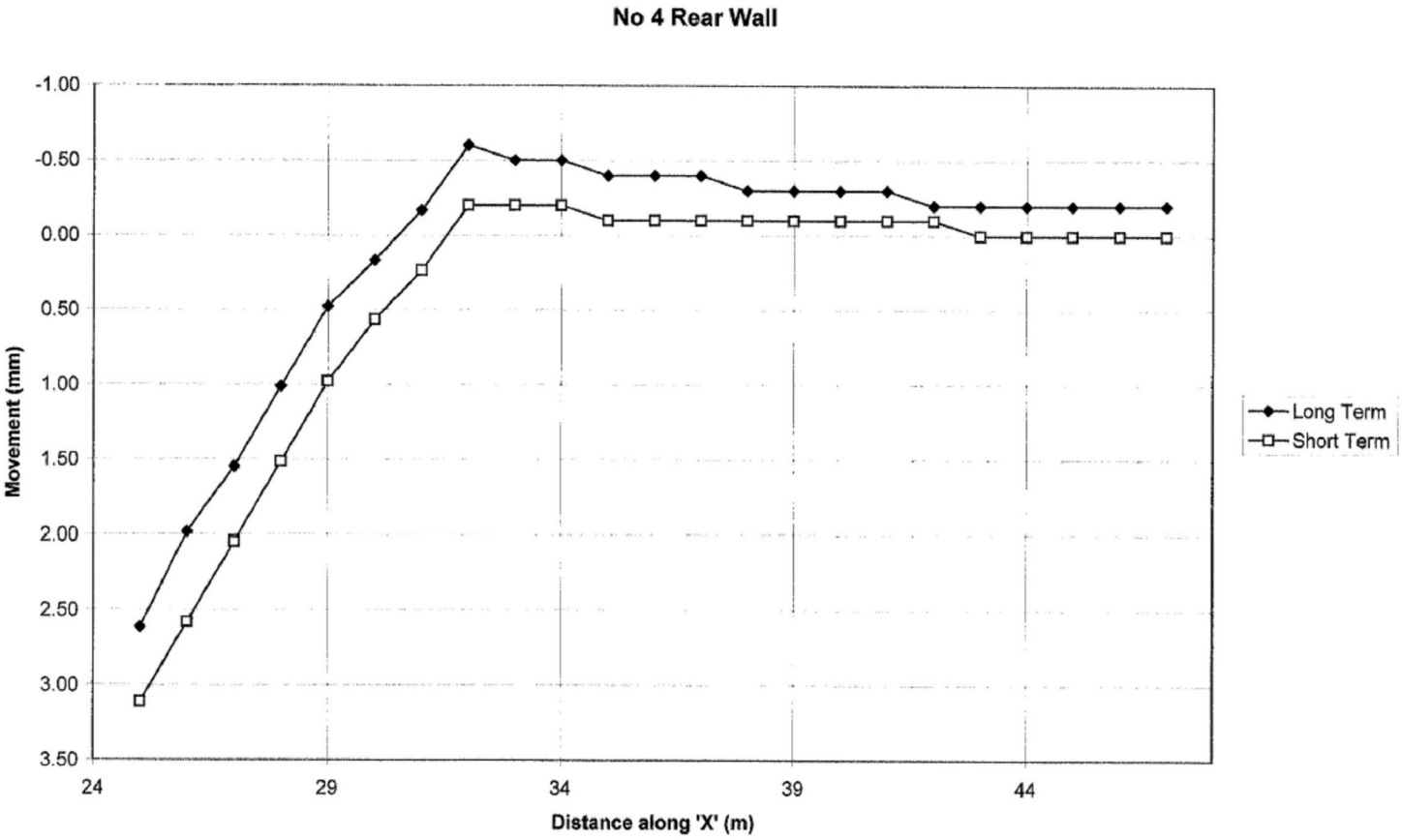

No 4 Front Wall
-1.00
-0.50
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
Movement (mm)
1.8mm
24
29
34
39
44
Distance along 'X' (m)
Long Term
Short Term
Y
2
3
4
X=25m
X=47m
X
AKENSIDE ROAD.

Figure 7


No 4 Rear Wall
-1.00
-0.50
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
Movement (mm)
24
29
34
39
44
Distance along 'X' (m)
Long Term
Short Term

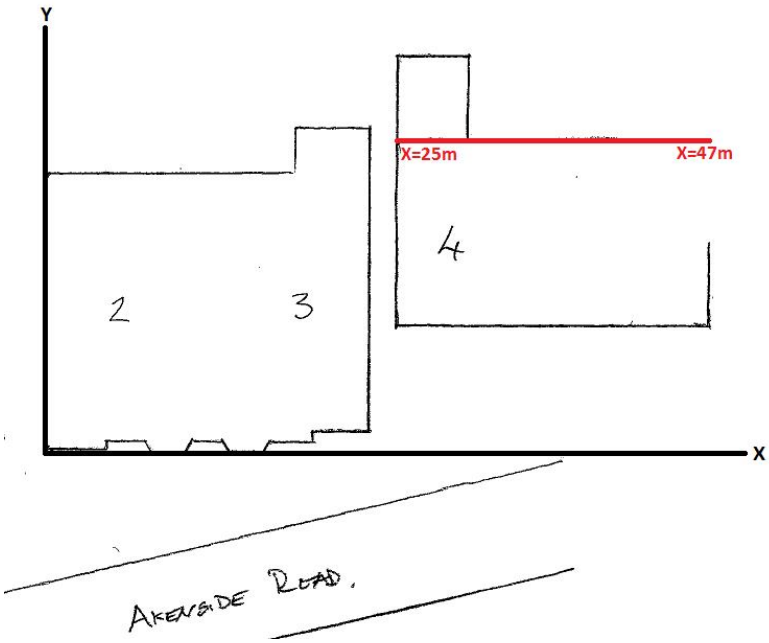

Y
X=25m
X=47m
4
2
3
X
AKENSIDE ROAD.

Figure 8

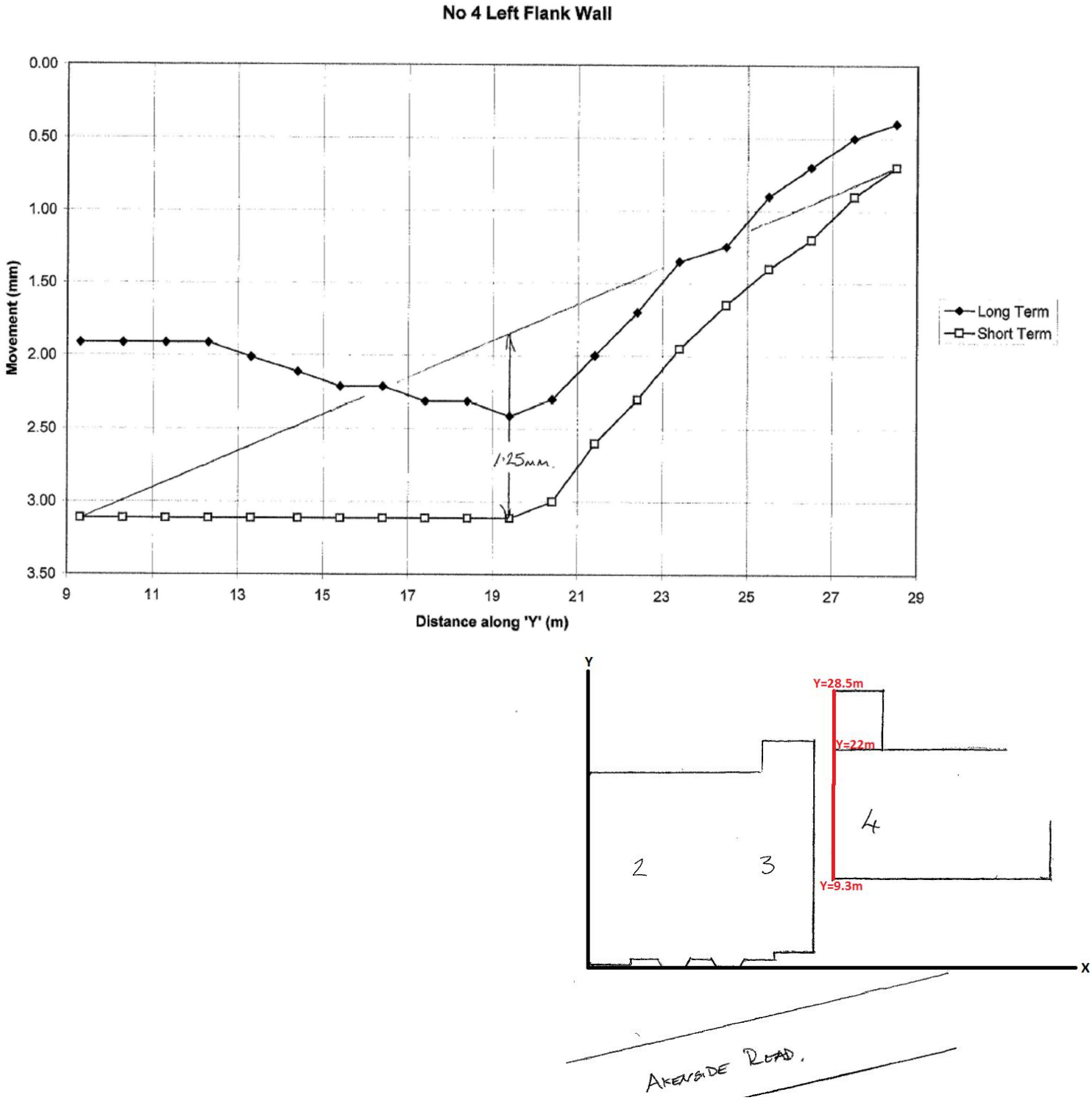

No 4 Left Flank Wall
Movement (mm)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
9
11
13
15
17
19
21
23
25
27
29
Distance along 'Y' (m)
Long Term
Short Term
1·25mm.
Y
X
Y=28.5m
Y=22m
Y=9.3m
2
3
4
AKENSIDE ROAD.

Figure 9

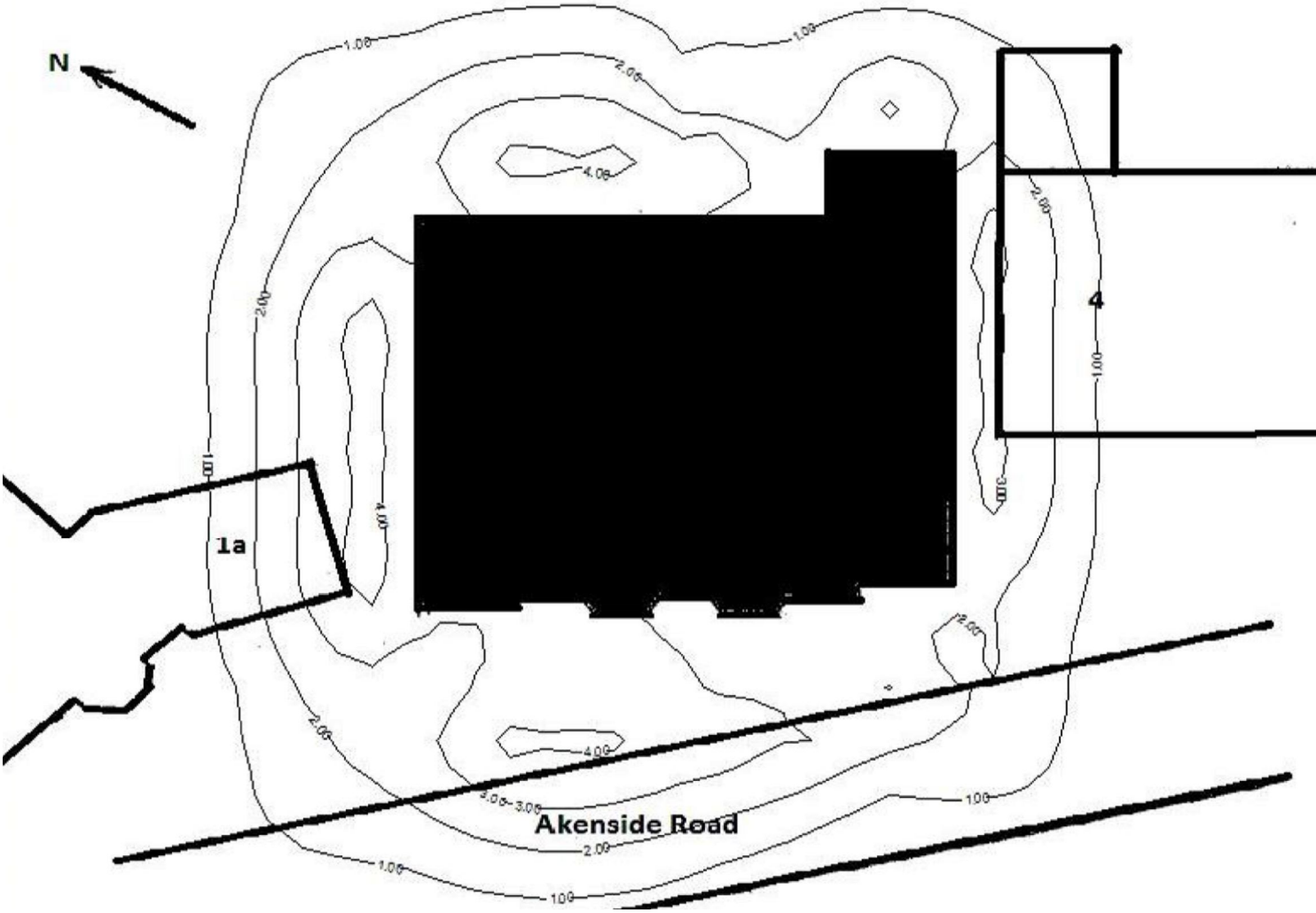


Figure 10

Appendix B – Responses from London Underground Limited and Network Rail

Underground Services Team
National Records Centre
Audax Road
YORK

YO30 4GS

Tel: 01904 386393

NRSWA Asset Enquiries

Date: 29 January 2015

Your Reference **2015_1073**

Our Reference: **SET128395 JK1**

Dear NRSWA,

Re: Underground Services Search: **OP 2-3 Akenside Road, London**

Please find information available as per the checklist.

The information contained herein is based on Network Rail's records and, where appropriate, third parties such as utility companies. The search enclosed does not cover a search of local council records. Also, schematic Signal and Telecom (S&T) cables plans are not provided as part of the search results, therefore you must assume S&T cables are present until proven otherwise.

Although at the date of this letter the information is as up to date as possible, it is **NOT** a statement of validity, accuracy or completeness as to any of the enclosed search information and must not be relied on as such.

Your risk assessment **MUST** take into account:

- That the information supplied, including the services shown on the map from the Geographical Information Portal (GIP), does not provide any guarantee as to the accuracy of the actual location of services on site and **MUST** be considered as for guidance purposes only.
- That new/unrecorded services are likely to be present
- That the enclosed Underground Services search information has been collated only for the ELR and Mileage boundaries as stated on the original request form

Included in your underground services search is a list of local engineers and managers you **MUST** contact before any ground disturbance is carried out, to check whether further information is held locally.

Further guidance can be obtained from the Health and Safety Executive publication HSG47 "Avoiding Danger from Underground Services" and the Network Rail Publication NR/L2/BUS/1030

Should you become aware of any additional underground services or assets within the locality during your investigations and/or works, including redundant assets, please identify them as a matter of urgency to the site manager. Records of the location of these assets should be kept for onward transmission to the Hazard Editor for entry into the Hazard Directory.

Yours sincerely

Jeremy Kettlestring

Distribution Administrator (NRSWA)

GUIDELINES TO BE READ IN CONJUNCTION WITH THE ENCLOSED INFORMATION

The information contained herein is based on Network Rail's records and, where appropriate, third parties such as utility companies. The search enclosed does not cover a search of local council records. Also, schematic Signal and Telecom (S&T) cables plans are not provided as part of the search results, therefore you must assume S&T cables are present until proven otherwise.

Although at the date of this letter the information is as up to date as possible, it is **NOT** a statement of validity, accuracy or completeness as to any of the enclosed search information and must not be relied on as such.

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UNDERGROUND SERVICES INFORMATION CHECKLIST

YOUR REF	2015_1073	**OUR REF**	SET128395
LOCATION	**OP** 2-3 Akenside Road, London	**ELR**	BOK2
MILEAGE FROM	2.0280	**MILEAGE TO**	2.0380

Utility Company/Internal Source	Category	Enc	Notes
GI Portal	Marlin	Yes	
Hazard Directory	Hazard	Yes	
Civils SE	NRG	Yes	
eBrowser	NRG	No	NIL RETURN - see below

NIL RETURN: After interrogating the information made available to us, no records containing underground services information have been returned for this worksite.

However, reference must be made to the guidelines supplied with this underground services search, which contain important information on safe working practices.

Upon receipt can you please check that the information provided agrees with this listing and if there are any discrepancies please contact the Underground Services Team at:

National Records Centre, Audax Road, York. YO30 4GS

buriedservicesnst@networkrail.co.uk

Checklist printed on: 29/01/15

GI Portal

Company Ownership

Bridge (Rail over River)
Bridge (Rail over Road)
Bridge (Road over Rail)
Bridge (Rail over Rail)
Level Crossing
Tunnel
Contracted for Sale
Leasehold Ownership
Freehold Ownership
Prohibitive Interest

Annotation

Points

Bench Mark
Boundary Post or Stone
Historic Site
Disused Feature
General Feature
Positioned Boulder
Positioned Coniferous Tree
Positioned Nonconiferous Tree
Railway Structure
Roadside
Spot Height
Tidal Water
Inland Water
Inland Water

Symbols

Bench Mark
Boundary Half Mereing
Direction of Flow
Switch
Road Related Flow

Line Features

Building
Building
Building Overhead
General Feature Edge
General Feature
General Feature Underground

Top of Slope
Top of Slope
Bottom of Slope
Bottom of Slope
Narrow Gauge Railway
Standard Gauge Railway
Overhead Construction
validate General Feature
Mean High Water
Mean High Water
Mean Low Water
Mean Low Water
Historic Cable Route

Miscellaneous

Business Space
Miscellaneous Asset Portfolio
Easements Wayleaves Telecoms

Utilities

Business Space
Miscellaneous Asset Portfolio
Easements Wayleaves Telecoms

Company Ownership

- Bridge (Rail over River)
- Bridge (Rail over Road)
- Bridge (Road over Rail)
- Bridge (Rail over Rail)
- Level Crossing
- Tunnel
- Contracted for Sale
- Leasehold Ownership
- Freehold Ownership
- Prohibitive Interest

Annotation

Points

- Bench Mark
- Boundary Post or Stone
- Historic Site
- Disused Feature
- General Feature
- Positioned Boulder
- Positioned Coniferous Tree
- Positioned Nonconiferous Tree
- Railway Structure
- Roadside
- Spot Height
- Tidal Water
- Inland Water
- Inland Water

Symbols

- Bench Mark
- Boundary Half Mereing
- Direction of Flow
- Switch
- Road Related Flow

Line Features

- Building
- Building
- Building Overhead
- General Feature Edge
- General Feature
- General Feature Underground
- Top of Slope
- Top of Slope
- Bottom of Slope
- Bottom of Slope
- Narrow Gauge Railway
- Standard Gauge Railway
- Overhead Construction
- validate General Feature
- Mean High Water
- Mean High Water
- Mean Low Water
- Mean Low Water
- Historic Cable Route

Miscellaneous

- Business Space
- Miscellaneous Asset Portfolio
- Easements Wayleaves Telecoms

Utilities

- Business Space
- Miscellaneous Asset Portfolio
- Easements Wayleaves Telecoms

SET128395
2-3 Akenside Road, London

Plot Scale	1:2500
Plot Date	29/1/2015

Centre of Map Window (E,N): 526581 , 185309

Output Created from the GI Portal – A3 Landscape

National Hazard Directory

Terms and Conditions

The National Hazard Directory (NHD) is issued by Network Rail to provide information on those hazards recorded as present on Network Rail's infrastructure. Its' purpose is to alert user(s) to the typical hazards that may be encountered on or around the Infrastructure during works . The NHD is made available to Network Rail employees and Network Rail contractors in order to assist in the identification and design of appropriate safety measures.

Although Network Rail believes its content is reasonably correct as at the date of issue, it includes information from records of varying age and levels of accuracy, and accordingly Network Rail gives no warranty as to accuracy, completeness or suitability for use in any particular circumstances. Users must particularly note that all searches (including searches of utility companies) should be conducted together with a site visit and site specific risk assessment, all as appropriate to the activity concerned. Network Rail accepts no liability in respect of the content or subsequent use of this system or the data held within it.

Users of the Directory must note that when working on or near the line that the appropriate requirements of the Rule Book, especially the provisions of the track safety rules, must be applied as appropriate to the activity concerned.

Technical Indexes do not warrant the use of the Network Rail National Hazard Directory including without limitation, the database, software or equipment will be interpreted or error free or the results obtained will be successful or will satisfy user's requirements. The data should be used as a reference only. No representations or warranties are made as to completeness or accuracy. ALL WARRANTIES (INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY EXPRESSLY EXCLUDED). Technical Indexes accept no responsibility for lost profit or for any other indirect, special, incidental, consequential or punitive damage.

National Hazard Directory

Customised Report

Search Criteria: ELR(s) = BOK2; Mileage From = 2.0280; Mileage To = 2.0380
Date: 29/01/2015

5 Hazards found.

ELR	ELR Name	Mileage From	Mileage To	Hazard Code	Hazard Description	Local Name	Track ID	Free Text
BOK2	CAMDEN RD JN - KENSAL GREEN JN	0.1441	5.0214	HEO	25Kv Overhead Electrification		All/Multiple Tracks	
BOK2	CAMDEN RD JN - KENSAL GREEN JN	1.1386	2.0814	HCC	Restricted Clearance	Hampstead Heath Tunnel	Down Main/Fast	Status =In Use. Safety Validated =Not Available.
BOK2	CAMDEN RD JN - KENSAL GREEN JN	1.1386	2.0814	ESC	Conservation Area	Finchley Road and Frognal	Down Main/Fast	Conservation Area Area above short section of Hamsted Tunnel which runs beneath Frognal NW3. INDEX: CA/418. Status =In Use. Safety Validated =Not Available.
BOK2	CAMDEN RD JN - KENSAL GREEN JN	1.1400	2.1033	HWR	Red Zone Working Prohibited	Hampstead Heath Tunnel	All/Multiple Tracks	Red Zone Working only permitted when Fixed or Semi-Permanent ATWS, or TOWS, or LOWS, or PeeWee in use. Note: No equipment is currently installed by Network Rail.
BOK2	CAMDEN RD JN - KENSAL GREEN JN	1.1400	2.1033	HT	Hazard-Tripping	Hampstead Heath Tunnel	All/Multiple Tracks	Tripping Hazard in Hampstead Heath Tunnel due to cross track cables cleated to slab track at various locations trhough the tunnel.

Kettlestring Jeremy

From: Morris Lee
Sent: 26 January 2015 10:52
To: BS_Transmittals
Subject: Underground Services search: NRS **OP** 2-3 Akenside Road, London (SET128395)

Action taken by NRG:

No records found

NST Ref: SET128395

National Records Group

Joe Shawyer

From: Maree Cridland [MareeCridland@crossrail.co.uk] on behalf of Safeguarding [Safeguarding@crossrail.co.uk]
Sent: 28 January 2015 12:57
To: Joe Shawyer
Subject: CRL-00-132081 - 2-3 Akenside Road, London, NW3 5BS - 15130JS

Dear Joe Shawyer,

Crossrail Ref: CRL-00-132081

2-3 Akenside Road, London, NW3 5BS

Thank you for your enquiry of 21st January 2015 regarding the effect of Crossrail on the above property.

Crossrail is a new railway currently being constructed that will link Reading and Heathrow in the west to Shenfield and Abbey Wood in the east using existing Network Rail tracks and new tunnels under Central London.

The Crossrail Bill which was introduced into Parliament by the Secretary of State for Transport in February 2005 was enacted as the Crossrail Act on the 22nd July 2008. The first stage of Crossrail preparatory construction works began in early 2009. Main construction works have started with works to the central tunnel section to finish in 2018, to be followed by a phased opening of services.

Crossrail Limited (CRL) administers a Direction issued by the Department for Transport on 24 January 2008 for the safeguarding of the proposed alignment of Crossrail.

The above property is outside the safeguarded limits of land as defined by the Safeguarding Direction (the maximum extent of land that may be required for the construction and operation of Crossrail).

You may inspect copies of Plans, Sections, Environmental Statements, Explanatory Notes and Non-Technical Summaries pertaining to the Crossrail proposals on the Crossrail website http://www.crossrail.co.uk/construction/crossrail-act-2008-and-crossrail-bill-supporting-documents.

In addition, the latest project developments can be found on the Crossrail website www.crossrail.co.uk/safeguarding, which is updated on a regular basis.

I hope this information is helpful, but if you require any further assistance then please feel free to contact a member of the Safeguarding Team on 0345 602 3813, or by email to safeguarding@crossrail.co.uk.

Yours sincerely

Maree Cridland | Community Relations Assistant
Crossrail | 25 Canada Square, Canary Wharf, London E14 5LQ | Desk: CS28/G5/16
Tel: 0203 197 5202 | Helpdesk (24hr) 0345 602 3813
Email: Helpdesk@crossrail.co.uk |Web: www.crossrail.co.uk

MOVING LONDON FORWARD

proposals, for maintaining the book of reference of those with relevant interests in the land affected by the proposals (and keeping it up to date) and for the purposes of serving any notices which may require to be served in connection with the proposals.

Date 22 January 2015

Our Ref 20878-NG-7-220115

Your Ref 15130JS

To Joe Shawyer
Groundwise
JShawyer@groundwise.com

London Underground Limited

Hello Joe,

2-3 Akenside Road, London, NW3 5BS.

Thank you for your communication of 21st January 2015.

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: 0207 027 8535