Geotechnical, Hydrogeological, Ground Movement & Land Contamination Assessment

of

Garages to the rear of 26 New End Square London NW3 1LS

for

Urban High Developments Ltd

LBH4379 Ver. 3.0

July 2016

LBH WEMBLEY

Geotechnical & Environmental

Project No: LBH4379

Report Ref: **LBH4379 Ver. 3.0**

Date: 1st July 2016

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Foreword-Guidance Notes

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The report may present an opinion on the disposition, configuration and composition of soils, strata and any contamination within or near the site based upon information received from third parties. However, no liability can be accepted for any inaccuracies or omissions in that information.

DRAWINGS

Any plans or drawings provided in this report are not meant to be an accurate base plan, but are used to present the general relative locations of features on, and surrounding, the site.

1. Introduction

1.1 Background

Following demolition of the existing lock-up garages, it is proposed to redevelop this site by constructing a two-storey dwelling with a basement under the footprint of the existing garages.

1.2 Brief

LBH WEMBLEY Geotechnical & Environmental have been instructed by Urban High Developments Ltd to prepare a geotechnical, hydrogeological, ground movement and land contamination assessment for this project to support a Basement Impact Assessment, part of planning application 2016/0849/P.

1.3 Report Structure

This report initially describes the findings of desk study searches, including the topographical, geological and hydrological setting of the site. The results of the intrusive ground investigations are then discussed and a ground model is presented. Consideration is then given to the geotechnical and hydrogeological aspects of the development, which is followed by a land contamination assessment and remediation strategy.

2. The Site

2.1 Site Location

The site is located on the southern side of an access road titled New End in the London Borough of Camden. The site lies approximately 350m to the southwest of Hampstead Heath.

The site may be located approximately by postcode NW3 1LS or by National Grid Reference 526560,185925

2.2 Topographical Setting

The site and surrounding area is located on the southern slopes of Hampstead Heath.

Street level is measured at a level of approximately +103.4m OD. The site falls to the southeast towards the existing garages, measured at a level of approximately +102.4m OD. Beyond that, the area slopes towards the tributary of the “lost” River Fleet, which is present less than 100m from the southeast of site.

2.3 Site Description

The site is irregular in shape and is currently occupied by six brick-built garages in the southern area of the site. The garages are set approximately 4.5m back from New End and approximately 1m below street level, such that it has a general northwest-southeast sloping driveway. The site is entirely hard-surfaced.

The site is bordered to the north by New End which immediately beyond is a three-storey terraced dwelling with a basement at 20 New End Square. The site is bordered to the east by the rear collective garden of three-storey terraced dwellings at 26-32 New End Square. This garden contains a mixture of mature and semi-mature trees.

To the south, the site is immediately bordered by a two-storey terraced dwelling with a lower ground floor at 7 Flask Cottage, while just to the southeast of the site lies a brick-built warehouse. To the west, the site is bordered by a pathway titled Flash Walk, immediately beyond which is a three-storey detached dwelling at 42 New End.

2.4 Proposed Development

The proposed development will include a two-storey dwelling that will replace the existing garages. Additionally, a basement will essentially occupy the footprint of the existing garages and will be constructed to a depth of approximately 5.5m below the existing street level. Soft landscaping will be present in north-eastern area of the site.

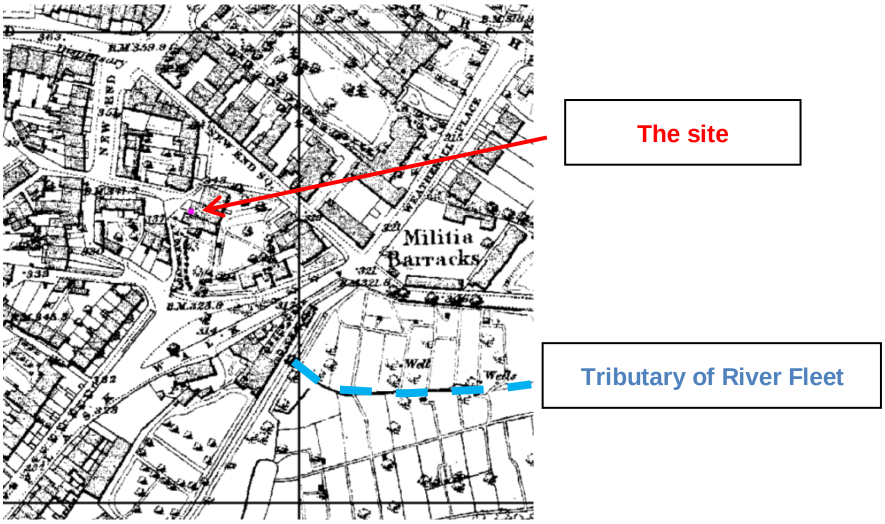
Site Plan showing Proposed Development

3. Desk Study

3.1 Site History

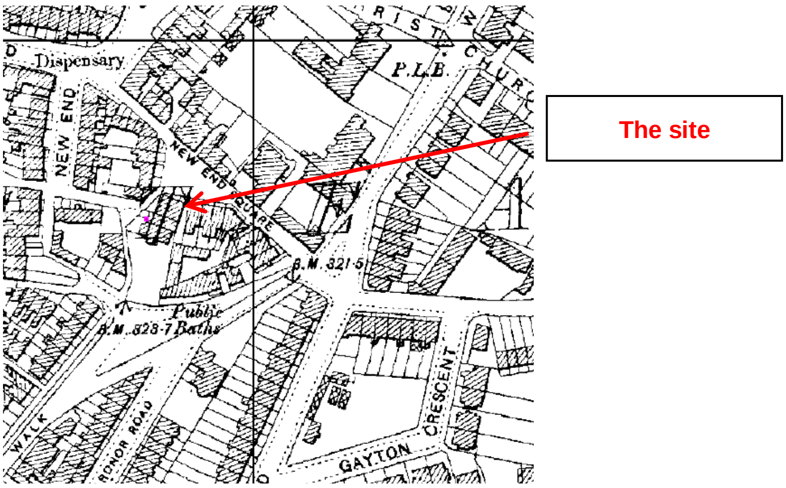
The site lies a short distance upgradient of the former Parish Pond and the spring line that was exploited for chalybeate waters in the 18th Century. The area was already heavily urbanised by the late 19th Century. The site was occupied by two Victorian houses, which were part of a row of terraces fronting on to the existing New End situated just to the north of the site. Flask Walk was also situated just to the west of the site, while New End Square was located roughly 20m to the northeast of the site. Militia barracks were present around 50m to the east of the site.

A tributary of the River Fleet was located around 50m to the southeast of the site and ran through open fields towards the southern end of the Hampstead Ponds to join up with the River Fleet. Several wells were located near the course of this tributary and a pond was situated around 200m to the southeast of the site.



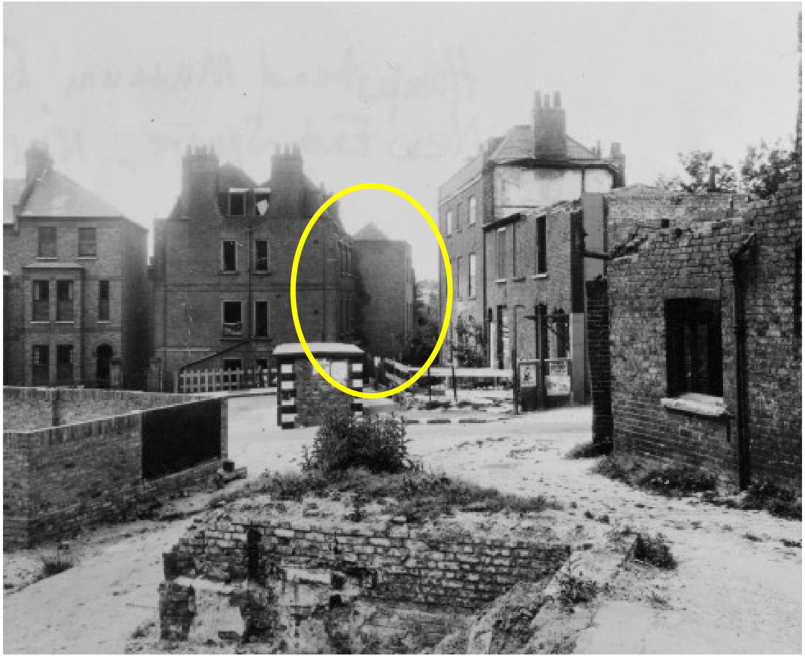
1879

At the end of the 19th Century the pond was filled and, along with the open fields and militia barracks to the southeast of the site, was replaced by further residential development across the surrounding area. It appears that the tributary was also culverted by this time. Public baths were located some 30m to the south of the site.

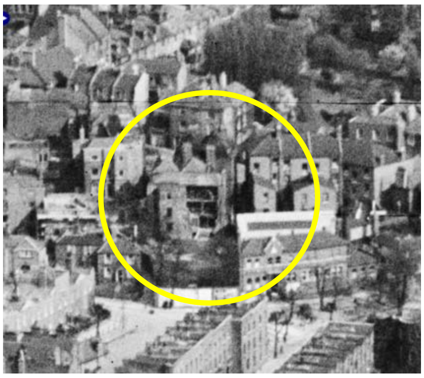


1896

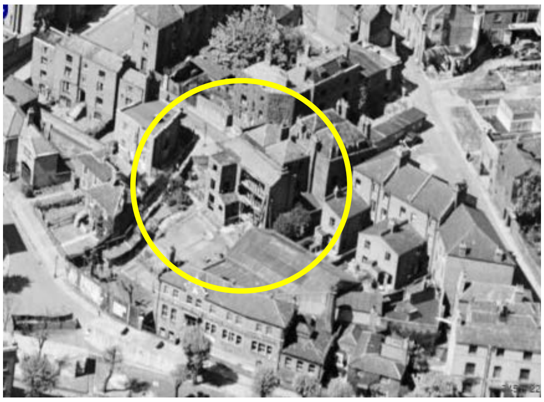
It appears from contemporary photographs and maps that two large three storey possible tenement buildings were present with an associated garden area stretching down to Flask Walk at the time of the Second World War. A high explosive bomb seems to have fallen in New End Square to the northeast of the site causing damage to the buildings to the north and northeast of the site fronting onto New End Square are. The photo below appears to show the building standing with an intact roof.



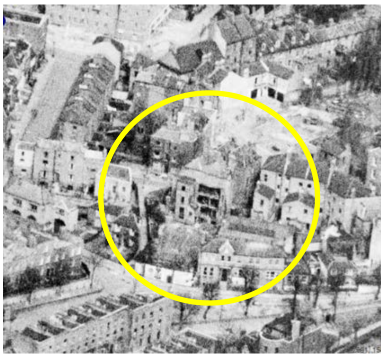
1945 View of site looking south-west from New End Square



1938 view of site



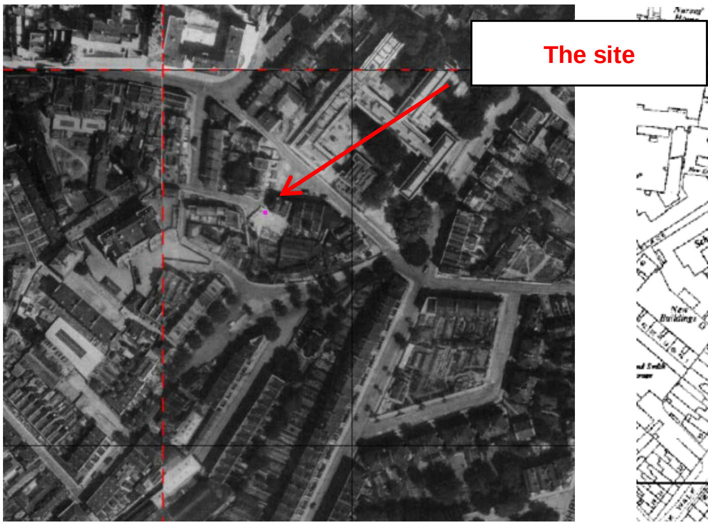
1946 view of site



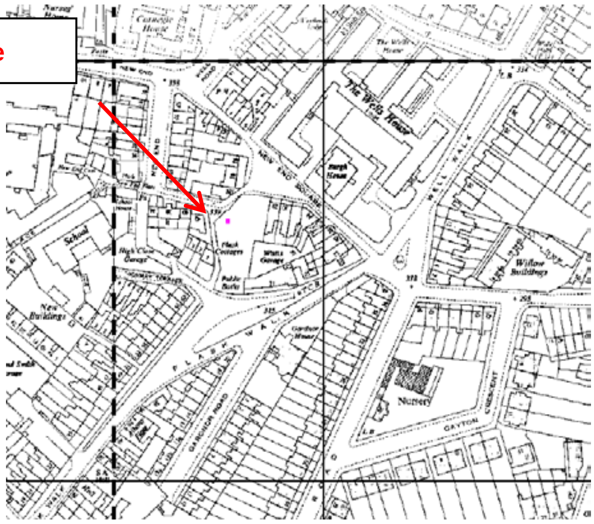
1949 view of site

Plan showing location of previous buildings

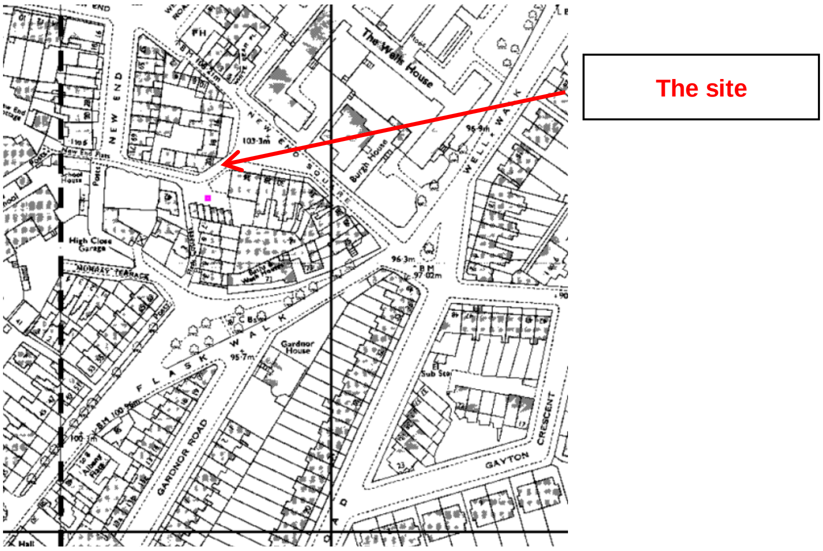
The buildings were cleared after the war and by the 1970s, the existing six garages on the site were built, along with the building at 26 New End Square immediately to the northeast and terraced cottages to south of the site.



1946 – 1949



1954



1974

The site and surrounding area has remained relatively unchanged through to present day.

3.2 Geological Information

British Geological Survey (BGS) maps indicate that the site is directly underlain by Claygate Member, which in turn overlies the London Clay Formation.

3.3 Hydrogeological / Hydrological Information

The nearest surface water feature is the Vale of Heath pond located some 450m to the north of the site, which drains to southeast to the 'lost' River Fleet, situated approximately 650m to the east of the site. A tributary of the "lost" River Fleet is located less than 100m to the southeast of the site.

The Environment Agency (EA) groundwater vulnerability map indicates that the underlying Claygate Member is classified as a 'Secondary A Aquifer'.

The EA records confirm that the site is not located within a Groundwater Source Protection Zone.

The site is not indicated to be liable to flooding from seas or rivers without defences.

There are no licensed groundwater abstractions within the vicinity of the site.

There are no recorded pollution incidents to controlled waters within the vicinity of the site.

3.4 Other Environmental Information

The searches have indicated that there are no historical landfills or other recorded landfill sites, waste management, waste treatment or waste transfer facilities within the vicinity of the site.

There is one contemporary trade directory within 150m of the site, which is classified as domestic cleaning services.

Information provided by the British Geological Survey (BGS) and National Geoscience Information Service indicates that the property is not located in a radon affected area as less than 1% of homes are above the action level. It is further reported that no radon protective measures are necessary in the construction of new dwellings or extensions.

4. Ground Conditions

4.1 Exploratory Work

A total of four window sampler boreholes were drilled across the site to a maximum depth of 6.50m, as shown on the site plan below. The investigation included the recovery of disturbed samples for chemical and geotechnical testing.

Standpipes were installed in two window sampler boreholes to allow for subsequent groundwater monitoring.

Site Plan showing Exploratory Positions

The borehole records, together with the results of the chemical and geotechnical laboratory testing, are included in the Appendix.

The Ordnance Datum (OD) levels shown on the borehole records have been interpolated from a topographical survey drawing provided.

4.2 Geology Encountered

The intrusive investigation confirmed the expected general strata comprising a variable thickness of made ground overlying the Claygate Member.

4.2.1 Made Ground

Across the site there appears to be generally less than 1m of made ground present, although in the southeastern area of the site, deeper areas of made ground were found, extending to approximately 2m depth.

The made ground generally comprised dirty brown sandy clay with abundant fragments of brick, glass, slate, flint and rootlets. The deeper areas of made ground consisted of clayey sandy brick fill with abundant concrete fragments.

It is likely that the material is at least in part, composed of the demolished remains of the previous buildings that stood on the site. The increased depth of made ground in the southeastern area suggests that these previous buildings had basements, which were subsequently infilled following demolition.

The structural trial pits have revealed abnormally deep foundations to the existing garages, together with the remains of what appears to possibly be the foundation remains of an abandoned post War development of the site.

4.2.2 Claygate Member

Beneath the made ground, the Claygate Member was encountered. These soils comprise a typically variable sequence of firm grey mottled orange-brown sandy clay with occasional rootlets, which was found to be locally very sandy. These soils became firm to stiff, grey silty sandy clay with rare pockets of sand at depth.

The Claygate was proved to over 6m depth by the investigation, but extends to around +85m OD, over 10m below the proposed basement.

4.3 Groundwater

During the investigation, groundwater was encountered within the Claygate Member and initial monitoring has indicated the groundwater table to be presently lying at approximately +100m OD.

5. Hydrogeological Assessment

5.1 Hydrological and Hydrogeological Conditions

Current monitoring of the standpipes installed in the boreholes indicates a groundwater table to be lying within the Claygate Member at between +100.1m OD in the southwest and +99.7m OD in southeast. This suggests a hydraulic gradient falling in a general south-easterly direction.

The permeability of the Claygate Member depends entirely upon the connectivity and continuity of the sandier seams and lenses. While larger seams of sand can give initially rise to appreciable volumes of groundwater if intercepted, sustained flow is hampered by the inter-bedded nature of the clays, silts and sand that make up the unit.

The hydrogeological regime beneath the site may be expected to be subject to seasonal and longer term cyclical influences. Further monitoring of the groundwater levels prior to commencement of the development is advisable in order to confirm the prevailing situation.

5.2 Potential Hydrogeological Impacts of the Proposed Development

5.2.1 Impact on Groundwater Flow

It is currently proposed to cut in to the existing slope to construct the new dwelling. It is estimated that the basement floor of the new building will generally lie at around +98m OD, correlating with approximate depths of 5.5m and 4.4m below existing street level in the north and existing ground level in the south respectively.

The proposed basement will extend into the Claygate Member and approximately 2m below the groundwater table. It is therefore envisaged that groundwater flow will be impeded to some extent by the proposed basement construction.

The extent to which the new construction will interrupt the groundwater flow regime below this level in the longer term will depend upon the depth and permanency of the envisaged perimeter cut-off. There does not appear to be any significant sand seams or lenses present within the depth of the proposed basement.

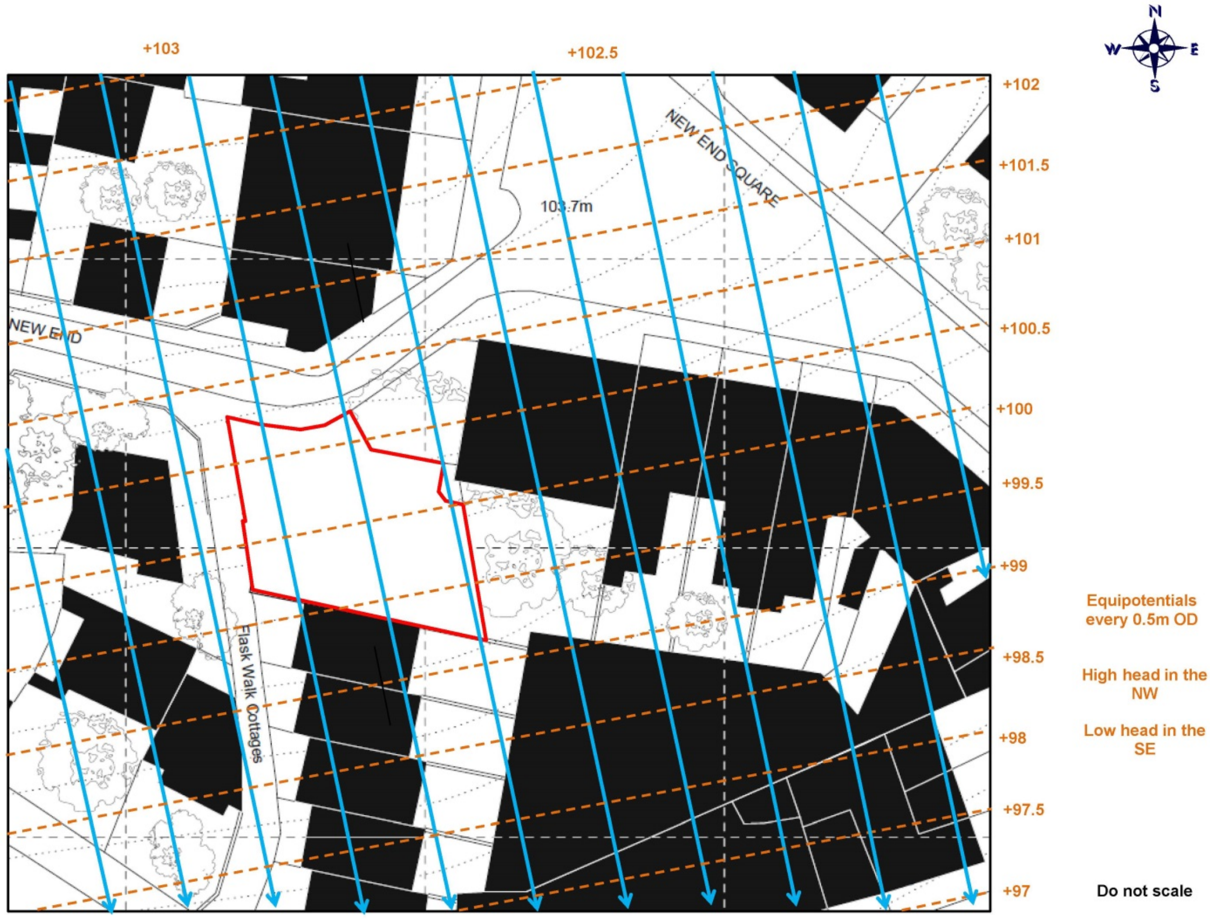
Nevertheless, in order to enable the basement excavation to proceed in the dry, it should be assumed that the perimeter cut-off may have to extend to around +85m OD, 10m below the proposed basement.

5.2.1.1 Modelled Conditions

The hydrogeological conditions have been modelled through the consideration of the measured hydraulic gradient (0.09) being applied to the northwestern edge of the basement. For the purpose of this assessment, it is assumed that the basement forms a complete cut-off through the Claygate Member due to having a secant piled retaining wall down into the London Clay Formation.

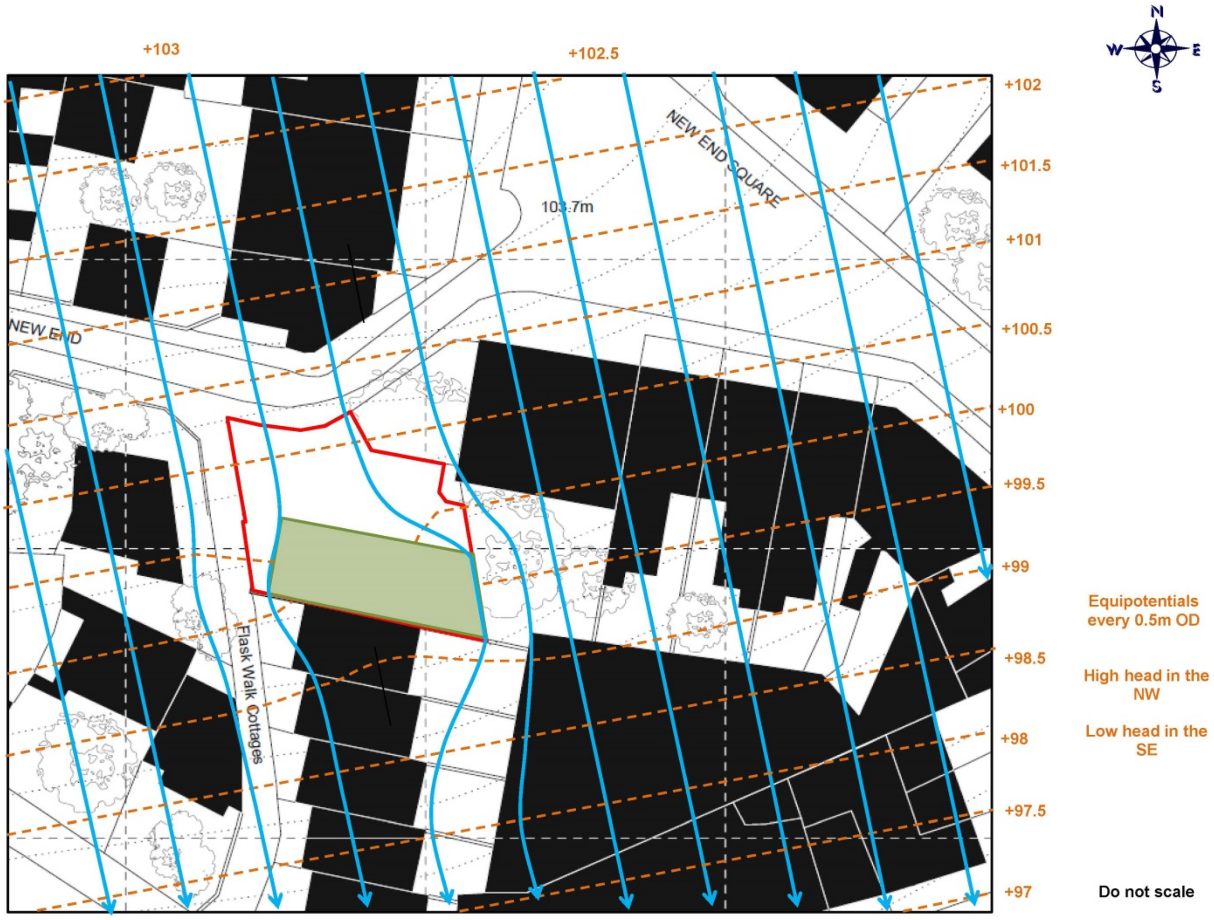
In the following flow nets, equipotentials are spaced at 0.5m intervals with the highest head is in the northwest and the lowest head in the southeast.

The flow net below shows an assumed existing condition (no basement) shows uninterrupted groundwater flow and a linear drop in head.



Flow net showing the modelled existing situation of groundwater flow

The construction of the proposed basement at this site will involve the emplacement of a barrier to groundwater flow, as depicted below. The flow net of the proposed situation (with basement) shows that the basement causes a deviation of groundwater flow around the sides of the basement.



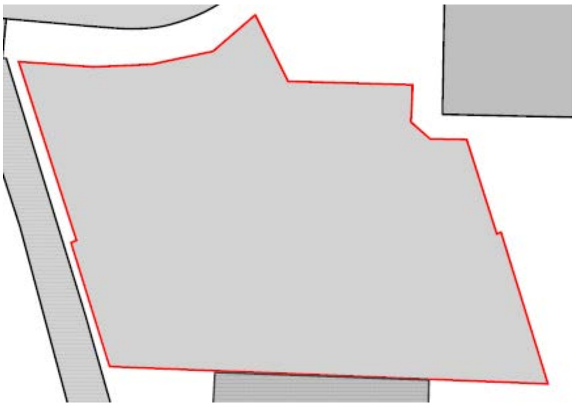
Flow net showing the modelled potential basement impact on groundwater flow

5.2.1.2 Conclusion

It can be seen that, the groundwater level on the up-gradient (northwest) side of the basement may be expected to see a maximum increase in the order of 0.1m. Likewise, the groundwater level on the downgradient (southeast) side of the basement may be expected to fall by less than 0.1m. This is less than the observed seasonal variation of 0.3m and hence is not expected to post any risk of affecting nearby structures.

5.2.2 Impact on Infiltration

The new development will result in a decrease in the proportion of hard surface or paved areas of the property and hence is not envisaged to have a negative effect on infiltration.



Existing Surfacing

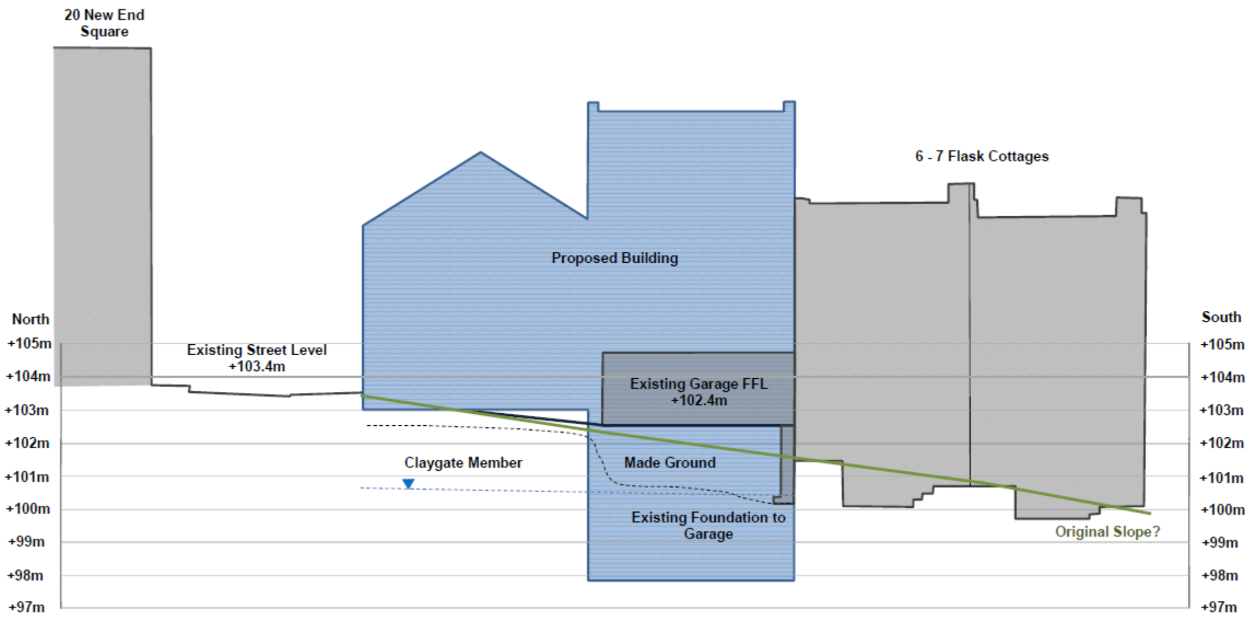
Proposed Surfacing

5.2.3 Impact on Surface Water Flooding and Surface Water Flow

The new development is not expected to have any substantial effect upon the risk of surface water flooding or surface water flow; hence it is envisaged to have negligible effect upon surface water flooding or surface water flow.

6. Geotechnical Assessment

It is anticipated that the lower ground floor will be formed by a basement excavation that will by-pass the made ground and extend down into the Claygate Member, approximately 2m below the groundwater table.



6.1 Basement Construction

Key factors in the design of the new basement construction will be the need to construct the new basement below the groundwater table and to prevent movement of the neighbouring property.

Groundwater lowering by this amount in the Claygate Member is not considered to be a realistic option and is likely to cause unacceptable settlements to neighbouring structures.

Underpinning some 2m below the groundwater table is not considered to be feasible in this case and the preferred solution would therefore be to form a ground water cut-off by means of piling (secant or pressed continuous sheeting) around the basement.

It is not entirely clear whether the structural trial pits have revealed a party wall or a boundary wall along the southern margin of the site. If is a party wall, then it may be necessary to form the new basement through piling in front of this wall, which would inevitably lead to some loss of potential basement space.

The structural loads applied by the building may be accommodated with either a pad or raft foundation solution.

6.2 Spread Foundations

Outside the zone of influence of trees, isolated spread foundations placed in suitably firm natural soils at a minimum depth of 1.5m below ground level may be designed to apply a net allowable bearing pressure of 120kN/m^2. At the depth of the proposed basement, it is envisaged that a higher bearing pressure of 150kN/m^2 may be available.

6.3 Effect of Trees

Laboratory index property determinations confirm that the clay soils are of medium shrinkage potential. There are a number of trees that may either affect or be affected by the development proposal and an arboricultural assessment will be required.

Within the potential zone of influence of trees it is recommended that the minimum founding depths and further precautions provided by the National House Building Council guidance are followed for the new building design.

6.4 Basement Waterproofing

The basement will need to be waterproofed and be designed to withstand hydrostatic pressures in accordance with the guidance provided in BS8102:2009, Code of Practice for the Protection of Below-Ground Structures against Water from the Ground. For the purposes of hydrostatic design a water table standing at 1m depth should be assumed in order to allow for any potential mains burst or surface flooding.

6.5 Retaining Walls

The retaining wall should be designed to prevent any significant lateral movement in both the temporary and long term situations. It will be important to design for k_0 rather than conventional k_a conditions in order to preserve in-situ stress conditions and to limit movements behind the walls. This may be achieved through the provision of continuous positive propping throughout the excavation and construction. The following parameters may be considered in the design of the retaining walls:-

Stratum	Bulk Density	Effective Cohesion	Effective Friction Angle
	(kg/m^3)	(c' - kN/m^2)	(ϕ' - degrees)
Made Ground	1800	Zero	25
Claygate Beds	2000	Zero	23

6.5.1 Basement Heave

Excavation of the basement will result in unloading of the clay and this will lead to some theoretical heave in both the short term and long term, depending upon the reapplication of loading. A ground movement assessment is recommended in order to assess the scope for both heave and settlement to occur and to assist the design of the basement floor.

6.6 Ground Floor Slab

Away from the influence of existing or planned trees, it is anticipated that ground bearing flooring will be feasible for part of the building outside the proposed basement.

6.7 Foundation Concrete

The results of chemical analyses carried out on selected samples of the soils encountered indicate soluble sulphate concentrations falling within Class DS-1 as defined by BRE Special Digest 1 (2005). The recommendations of that guidance for Class DS-1 sulphate conditions should therefore be followed, assuming an Aggressive Chemical Environment for Concrete (ACEC) site classification of AC-3z for mobile groundwater.

6.8 Surface Water Drainage

The predominantly cohesive soils underlying the site essentially preclude the use of conventional soakaways and surface water will therefore need to be discharged off site to a surface water sewer.

7. Ground Movement Assessment

7.1 Existing Foundations

Structural trial pits undertaken by Michael Alexander Engineers indicate that the existing structural loads for the garage are supported by strip foundations extending to a depth of less than 2.5 along the southern margin of the site.

7.2 Neighbouring Structures

There are a number of structures surrounding the site, which have been assessed for the purpose of ground movement.

7.2.1 No. 7 Flask Cottage

No. 7 Flask Cottage is present immediately to the south of the proposed basement, which is a 1970s two storey terraced brick-built building with a lower ground floor level situated at approximately +100.7m OD.

It is uncertain whether the southern wall separating the site and No. 7 Flask Cottage is a party wall or a boundary wall.

7.2.2 No. 42 New End

No. 42 New End is present immediately beyond Flash Walk to the west of the proposed basement, which is a 1930s three storey terraced brick-built building with a lower ground floor situated at approximately +102.3m OD.

7.2.3 Warehouse

The warehouse is situated some 2.5m to the southeast of the proposed basement, which was built in the 1930s.

7.3 No. 20 New End Square

No. 20 New End Square is located approximately 9m to the north of the proposed basement, which is a 19th Century three storey terraced dwelling with a lower ground floor suggested to be situated at approximately +100.5m OD.

7.4 Nos. 26-32 New End Square

Nos. 26-32 New End Square is located approximately 3.5m to the north of the proposed basement, which was built following the Second World War as three storey terraced dwellings with a ground floor level situated at approximately +103m OD.

7.5 Ground Model

Excavation of the basement will result in unloading of the ground leading to theoretical heave movement of the underlying soil in both the short and long term, depending upon the reapplication of loading. An analysis has been carried out for a modelled situation, based on a soil model devised from both the results of the ground investigation and the collection of nearby borehole data. The soil layers of this model are detailed in the table below:

Analysis Layer:	Upper Boundary (m OD)	Thickness (m)	Average C_u (kN/m^2)	Soil Stiffness (kN/m^2)	
				E_u	E'
Claygate Member (cohesive)	+97.90	1.4	75	33750	18750
Claygate Member (cohesive)	+96.50	2	110	49500	27500
Claygate Member (cohesive)	+94.50	3	145	65250	36250
Claygate Member (cohesive)	+91.50	3	180	81000	45000
London Clay Formation (cohesive)	+88.50	3	210	94500	52500
London Clay Formation (cohesive)	+85.50	3	240	108000	60000
London Clay Formation (cohesive)	+82.50	2.5	270	121500	67500
London Clay Formation (cohesive)	+80.00	4.1	295	132750	73750
Assumed Rigid	+75.90				

The Undrained Modulus of Elasticity (Eu) for the clay has been based upon an empirical relationship of Eu = 450 x Cu, and the Drained Modulus of Elasticity (E') has been based upon an empirical relationship of 250 x Cu.

Poisson's Ratios of 0.5 and 0.1 have been used for short term (undrained) and long term (drained) conditions respectively.

7.6 Method of Analysis

The analysis, undertaken using the SAPPER programme, uses classic modified Boussinesq elasticity theory, assuming uniform (fully flexible) loading/unloading of rectangular arears applied to a semi-infinite elastic half-space, using the above parameters for stratified homogeneity and with the introduction of an assumed rigid boundary at 50m depth (+75.90 m OD).

The analysis calculates the theoretical Boussinesq elastic stress decrease due to the applied net unloading beneath the given unloaded areas at the mid-level of each of the 8 No. soil layers defined above.

Short-term and long-term movements are then calculated at each calculation point for each stratum, using the given values of Stiffness Moduli and Poisson's Ratio over the whole area of the site on a 1m by 1m grid.

7.7 Loading / Unloading

When considering the ground movements associated with the proposed development, it has been assumed that the demolition of the existing garages will lead to an unloading of approximately -7kN/m^2. The maximum excavation depth is envisaged to be 4.5m, and is envisaged to -84kN/m^2.

Due to the irregular shape of the proposed excavation, a number of rectangular load/unload areas have been modelled.

7.8 Short Term Movements

There are three components of short term movement that will interact to affect the neighbouring structures. These are settlements and horizontal movements associated with the pile installation, settlements and horizontal movements behind the wall due to yielding of the completed wall as excavation in front of the wall proceeds and lastly vertical heave movements due to demolition and soil unloading as the excavation proceeds.

7.8.1 Settlements & Horizontal Movements due to Pile Installation

The ground surface movements arising from the installation of the bored pile retaining wall may be estimated using Figures 2.8a and 2.8b of CIRIA report C580[1].

It should be noted that the amount of predicted movement is related to the wall depth and for the purposes of this assessment the predictions are made on the basis of a pile depth equivalent to 1.5 times the retained height.

The analysis suggests that as a result of the piling operating during pile installation, No. 7 Flask Cottage, No. 42 New End and the warehouse could experience a maximum of 4mm settlement each. The maximum settlement that could occur at Nos. 26-30 New End Square and No. 20 New End have been assessed as 3mm and 2mm respectively.

The horizontal movements arising from pile installation may also be estimated. The analysis suggests that No. 7 Flask Cottage, No. 42 New End and the warehouse may experience up to 6mm horizontal movement each. Nos. 26-30 New End Square and No. 20 New End may also experience up to 3mm and 1mm horizontal movement respectively.

7.8.2 Heave Movements due to Excavation

The potential effect of the planned basement excavation has been considered applying a net unloading of approximately -7kN/m^2 due to the removal of the existing garage and -84kN/m^2 due to the removal of soil within the basement area.

[1] *CIRIA Report C580 (2003) Embedded Retaining Walls – Guidance for Economic Design*

The analysis suggests that by the time basement excavation is complete, up to a maximum of approximately -8mm of heave may have taken place at the centre of the basement excavation, reducing to approximately -3mm at the periphery of the basement.

7.8.3 Settlements & Horizontal Movements due to Pile Wall Yielding

The ground surface movements arising from excavation in front of the bored pile retaining wall and consequent yielding of the piled may be estimated using Figures 2.11a and 2.11b of CIRIA report C580.

The analysis suggests that, on the basis of a high stiffness wall, No.7 Flask Cottage could experience a maximum of 2mm settlement, whilst No. 42 New End and the warehouse could experience up to 3mm settlement each. In addition, Nos. 26-30 New End Square and No. 20 New End could experience up to 3mm and 2mm settlement respectively.

The horizontal movements arising may also be estimated. The analysis suggests that the structures may experience up to 6mm horizontal movement each. Nos. 26-30 New End Square and No. 20 New End may also experience up to 6mm and 4mm horizontal movement respectively.

7.8.4 Net Short Term Movements

For the purposes of this assessment, the calculated heave is offset by the settlements that have been predicted from CIRIA C580. Therefore the maximum likely vertical ground movements for the following structures have been estimated:

No. 7 Flask Cottage: Maximum vertical ground movements at the wall are estimated to be 5.2-5.1 = 0.1mm and 5.8-1.1 = 4.7mm at 4m away.

No. 42 New End: Maximum vertical ground movements at the wall are estimated to be 5.7-2.2 = 3.5mm, 6.3-1.1 = 5.2mm at 3m away and 2.6-0.2 = 2.4mm at 10m away

Warehouse: Maximum vertical ground movements at the wall are estimated to be 5.2-1.9 = 3.3mm, at 6.1-0.9 = 5.2mm at 2.5m away and 0-0 = 0mm at 18.5m away.

Nos. 26-30 New End Square: Maximum vertical ground movements at the wall are estimated to be 5.3-1.9 = 3.3mm, at 5.8-1.1 = 4.7mm at 3.5m away and 0.5-0.1 = 0.4mm at 14.5m away.

No. 20 New End: Maximum vertical ground movements at the wall are estimated to be 5.2-4.2 = 1mm, at 3.4-0.3 = 3.1mm at 9m away and 0.7-0.1 = 0.6mm at 13.5m away.

7.8.5 Long Term Movements

Following excavation of the new basement, loading will be reapplied to the soil as a result of the weight of the new structure. This will be transferred to the Claygate Member by means of raft foundations.

However, it is evident that there is a mismatch between the weight of soil that is to be removed during the basement excavation and the weight of the new structure that is to replace this. In this situation there will inevitably be a component of long term heave movement that could proceed for several decades. In the case of the northern area, where no basement is proposed, there is also a mismatch, such that there will be a component of long term settlement that could proceed for several decades.

7.8.6 Structural Loading

Loading information provided by the Structural Engineers, Michael Alexander. By convention, when considering the average loading condition for settlement analysis, the loading has been reduced to 100% dead load plus 25% live load.

7.8.6.1 Post Construction Movements

The analysis suggests that an additional long term heave of up to 7mm could be encountered at the centre of the basement, reducing up to 3mm heave at the periphery.

The analysis also suggests that up to 4mm long term settlement will occur at the centre of the proposed building to the north of the basement, reducing up to 2 mm at the periphery.

8. Damage Assessments

The ground movements discussed above have been used to determine a damage category for each of the structures surrounding the site, using the methodology proposed by Burland as described in CIRIA C580.

The deflection ratio (Δ / L) has been calculated from the predicted net movements at either end of the section under assessment.

The length (L) of the neighbouring property (No. 7 Flask Cottage) has been assumed to be 4m with an approximate wall height (H) of 7m. The strain has been assessed over the full length of the property. Similarly, strain has been assessed for the full length over buildings No. 42 New End (L = 7, H = 8) and the warehouse (L = 16, H =6), Nos. 26-30 New End Square (L = 11, H =12) and No. 20 New End (L = 5, H =10).

The calculations used to determine the building damage category for each structure are summarised in the following sections:

8.1 No. 7 Flask Cottage

The maximum horizontal strain, ε_h (δ_h / L) = 0.0975%, and the maximum deflection ratio Δ / L = -0.035 have been calculated over the full length of the property.

Based upon Figure 2.18b for L / H = 0.57, the limiting strain to No. 7 Flask Cottage is assessed as 0.11% less than the upper bound of 'slight' (Burland Category 2).

8.2 No. 42 New End

The maximum horizontal strain, ε_h (δ_h / L) = 0.077%, and the maximum deflection ratio Δ / L = -0.00429 have been calculated over the full length of the property.

Based upon Figure 2.18b for L / H = 0.88, the limiting strain to No. 42 New End is assessed as 0.08% less than the upper bound of 'slight' (Burland Category 2).

8.3 Warehouse

The maximum horizontal strain, ε_h (δ_h / L) = 0.06%, and the maximum deflection ratio Δ / L = 0.00125 have been calculated over the full length of the property.

Based upon Figure 2.18b for L / H = 2.7, the limiting strain to the warehouse is assessed as 0.06% less than the upper bound of 'very slight' (Burland Category 1).

8.4 Nos. 26-30 New End Square

The maximum horizontal strain, ε_h (δ_h / L) = 0.063%, and the maximum deflection ratio Δ / L = 0.0009 have been calculated over the full length of the property.

Based upon Figure 2.18b for L / H = 0.91, the limiting strain to the warehouse is assessed as 0.065% less than the upper bound of 'very slight' (Burland Category 1).

8.5 No. 20 New End

The maximum horizontal strain, ε_h (δ_h / L) = 0.5%, and the maximum deflection ratio Δ / L = 0.004 have been calculated over the full length of the property.

Based upon Figure 2.18b for L / H = 0.5, the limiting strain to the warehouse is assessed as 0.05% less than the upper bound of 'negligible' (Burland Category 0).

9. Mitigation of Movements

9.1 Construction

In order to minimise the effects of any residual net loading or unloading it is suggested that the basement should be designed as rigidly as possible.

The piled basement retaining wall design should similarly be designed and maintained in as rigid a state as is possible, through the installation of appropriate propping prior to any excavation and the installation of additional propping as necessary as the excavation proceeds, with the intention of allowing negligible deflection and yielding at any level.

Consideration could be given to a top-down form of construction whereby the new ground floor is installed as a rigid plate bracing the pile heads prior to any excavation.

It is envisaged that the use of larger diameter bored piles would allow increased reinforcement to be included and increased rigidity to be achieved.

9.2 Monitoring

Monitoring of the neighbouring properties will be an essential tool in the prevention of unacceptable movements. The monitoring plan must include a clear set of achievable contingency actions to be completed as an immediate response to any movement that exceed agreed trigger levels.

10. Land Contamination Risk Assessment

10.1 Hazard Identification

The site does not appear to have had a significantly contaminative history by virtue of its longstanding residential usage. The current garages replaced the Victorian terraced house by the 1970s and the site has remained unchanged since that time.

10.2 Potential Contamination

10.2.1 Potential Soil Contamination

The potential sources of contamination that have been identified at this site are limited to possible contaminants associated with the demolition or clearance of the previous Victorian building following the Second World War, including potential asbestos containing materials (ACM).

10.3 Contamination Encountered

10.3.1 Soil

The investigation found evidence of brick and concrete within the made ground, albeit no visual or olfactory evidence of significant contamination was noted.

Four soil samples were recovered from the made ground and subsequently scheduled for chemical analysis and asbestos screening.

The contamination test results have been compared to C4SLs and commonly accepted screening concentrations produced by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health (CIEH) (2009, Generic Assessment Criteria for Human Health Risk Assessment (2nd Edition)) and if not available then Environment Agency (EA) Soil Guideline Values (SGVS).

The results indicate elevated levels of Lead (up to 1,900 mg/kg) and marginally elevated levels of Mercury (up to 0.9 mg/kg)

10.4 Sensitive Receptors

A number of potential sensitive receptors can be identified for this assessment and include:

- Construction workers
- End-users

- General public
- Controlled groundwater
- Buried services / foundations

10.5 Pollutant Pathways

A direct pathway to any near-surface contamination will be present for construction workers when the soils are exposed during the groundwork.

The residents may be exposed to any near-surface contamination in proposed areas of soft landscaping.

Buried services and foundations could be potentially directed affected by the presence of contaminated soils.

10.6 Conceptual Model

A conceptual model of the envisaged possible contamination has been developed in the form of a source-pathway-receptor pollutant linkage concept. A pollution linkage requires there to be a source of contamination, a sensitive target that can be adversely affected by the contamination and a pathway via which contamination can reach the target.

10.7 Risk Estimation

In order to evaluate the perceived contamination risks at this site the severity of the risk in terms of the magnitude of the potential consequence of the linkage occurring has been compared with the likelihood of the linkage existing. The likelihood and consequence of a problem involving each particular pollutant linkage has been attributed a risk rating as shown in the table below:

RATING	1	2	3	4	5
LIKELIHOOD	Very unlikely	Unlikely	Evens	Probable	Highly probable
CONSEQUENCE	Negligible	Minor minor injury / minimum cost / minor health risk	Mild / Medium chronic health risk / risk of injury / appreciable costs to meet regulatory standards		Severe death / major injury / explosion / maximum cost

On the basis of this qualitative rating system the various potential pollutant linkages have been attributed a risk ranking on the basis of the value of the product of the likelihood and consequence ratings, where a value of less than five is low, between five and ten is medium and above ten is high. A table estimating the risk associated with the envisaged principal possible pollutant linkages for the site, with regard to the proposed end use, is presented below.

SOURCE	RECEPTOR	PATHWAY	LIKELIHOOD	CONSEQUENCE	RISK RANKING
Possible soil contamination	Construction and demolition workers	Oral ingestion of soil or dust, skin contact or vapour inhalation where soil is exposed during groundworks	2	3	6 (MEDIUM)
	General public	Oral ingestion of dust or vapour inhalation where soil is exposed during groundworks	2	3	6 (MEDIUM)
	End users	Oral ingestion of soil or dust, skin contact or inhalation where soil is exposed in soft landscaping	2	3	6 (MEDIUM)
	Groundwater	Leaching and migration of mobile contamination	2	2	4 (LOW)
	Buried services	Direct contact	2	1	2 (LOW)
	Foundation concrete	Direct contact	1	1	1 (LOW)

10.8 Risk Evaluation

There is inevitable uncertainty associated with the above assessment, but it can be stated that those pollutant linkages listed have been assessed as being of a medium or high risk ranking warrant normally some degree of further investigation or mitigation.

11. Remediation Strategy

There are three main ways to reduce or control unacceptable risks in land contamination applications:

- Remove or treat the (source) of pollutant(s)
- Remove or modify the pathway(s)
- Remove or modify the behaviour of receptor(s)

This section sets out a strategy to address the pollutant linkages of concern.

11.1 Contamination of Concern

The investigation has found elevated concentrations of metals within the made ground underlying the site.

11.2 Construction Workers and General Public

Construction methodology, in the form of risk assessments and method statements for each construction activity, must be prepared to ensure the maintenance of a safe environment and to protect the site workers. A suitably trained safety advisor must be engaged to provide site awareness training and assistance with the management of the asbestos risk

11.3 Risk to End Users

The risk to future users can be mitigated by ensuring that, where any made ground is permitted to remain beneath the proposed garden, a minimum cover of 600mm assuredly clean soil is placed to break the potential human health exposure pathway.

11.4 Buried Services

Although the risks to buried services posed by the soils at this site may be considered negligible, the advice of the water supply company must be sought in regard to the contamination encountered. It is anticipated that any perceived issue can be mitigated through the adoption of suitably resistant pipework.

11.5 Imported Materials

It is anticipated that the importation of garden topsoil will be required at this site. This material will require confirmatory testing to check the suitability for use. Testing should include a full suite of contaminants and screening for the presence of asbestos fibres at a suggested frequency of 1 sample every $20m^3$ or one per lorry load, whichever is greater. The results should be submitted to the Local Authority for approval prior to the material being brought on site.

The soil test results should be compared to C4SLs and commonly accepted screening concentrations produced by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health (CIEH) (2009, Generic Assessment Criteria for Human Health Risk Assessment (2nd Edition)) and if not available then Environment Agency (EA) Soil Guideline Values (SGVS).

11.6 Unexpected contamination

As with any site, should any suspicious materials or unexpected contamination be revealed during the course of the redevelopment, then work must be halted and the situation investigated and assessed by a geoenvironmental specialist and notified to the Local Authority environmental health department.

11.7 Waste Disposal

All material to be disposed of off-site should be properly recorded, including the retention of any waste tickets, details of excavated soil export destinations and the waste classification.

The results have suggested that the made ground may potentially be classed as Hazardous for waste disposal purposes due to the presence of elevated lead and zinc levels.

The underlying natural soils may be expected to be Non-Hazardous and provided that they can be adequately separated from any made ground, it may be possible to dispose of these natural soils to a tip licensed to accept Inert material.

11.8 Validation Plan

On completion of the works, a validation report will be required as evidence that the agreed remediation works have been successfully completed.

APPENDIX

SITE PLANS

BOREHOLE RECORDS

DYNAMIC PROBE RESULTS

SULPHATE ANALYSES

INDEX PROPERTIES

CONTAMINATION TEST RESULTS

WASTE ACCEPTANCE CRITERIA TEST RESULTS

ENVIROCHECK REPORT (separate file)

GROUND MOVEMENT ASSESSMENT DIAGRAMS

PROJECT:	Garages at the rear of, 26 New End Square, London, NW3 1LS	LBH4379	SITE PLAN SHOWING EXISTING FEATURES
CLIENT:	Urban High Developments Ltd	04/08/2015	

PROJECT:	Garages at the rear of, 26 New End Square, London, NW3 1LS	LBH4379	SITE PLAN SHOWING PREVIOUS BUILDINGS
CLIENT:	Urban High Developments Ltd	04/08/2015	

LBH WEMBLEY Geotechnical & Environmental

PROJECT:	Garages at the rear of, 26 New End Square, London, NW3 1LS	LBH4379	SITE PLAN SHOWING PROPOSED DEVELOPMENT
CLIENT:	Urban High Developments Ltd	04/08/2015	

PROJECT:	Garages at the rear of, 26 New End Square, London	LBH4379	**BOREHOLE BH01**
CLIENT:	Urban High Developments Ltd		

BORING METHOD:	Dynamic Window Sampler	Date: 27/11/15
GROUND WATER:	Groundwater encountered at 2.3m following completion of fieldwork Groundwater monitored at 2.29m on 02/12/15	
REMARKS:	Inspection pit hand-dug to 1.1m 19mm diameter standpipe installed to 6m, with a response zone between 1m and 6m	

G.L. approx. +102.4m OD

Samples No	Type	Depth m	Tests	Legend	Depth m	Description
					0.15	MADE GROUND (concrete slab)
					0.30	MADE GROUND (crushed concrete with rebar)
1	D	0.60			0.80	MADE GROUND (dirty brown sandy clay with abundant rootlets and brick fragments with occasional fragments of concrete)
2	D	1.50 - 2.00				Firm grey mottled orange-brown sandy clay with occasional rootlets …becoming very sandy clay at 2.0m
3	D	3.50 - 4.00			4.70	
						Firm grey silty sandy clay with rare pockets of sand

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

LBH WEMBLEY Geotechnical & Environmental

PROJECT:	Garages at the rear of, 26 New End Square, London	LBH4379	**BOREHOLE BH01**
CLIENT:	Urban High Developments Ltd		

BORING METHOD:	Dynamic Window Sampler	Date: 27/11/15
GROUND WATER:	Groundwater ncountered at 2.3m following completion of fieldwork Groundwater monitored at 2.29m on 02/12/15	
REMARKS:	Inspection pit hand-dug to 1.1m 19mm diameter standpipe installed to 6m, with a response zone between 1m and 6m	

G.L. approx. +102.4m OD

Samples No	Type	Depth m	Tests	Legend	Depth m	Description
						Firm grey silty sandy clay with rare pockets of sand
4	D	5.50 - 6.00				
					6.00	...becoming firm-stiff grey silty clay at 5.8m

Sheet No: 2 of 2

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

PROJECT:	Garages at the rear of, 26 New End Square, London	LBH4379	**BOREHOLE BH02**
CLIENT:	Urban High Developments Ltd		
BORING METHOD:	Dynamic Window Sampler		Date: 27/11/15
GROUND WATER:	Groundwater encountered at 3.2m following completion of fieldwork Groundwater encountered at 2.7m on 02/12/15		
REMARKS:	Inspection pit hand-dug to 1.2m 19mm diameter standpipe installed to 6m, with a response zone between 2m and 6m		

G.L. approx. +102.4m OD

Samples No	Type	Depth m	Tests	Legend	Depth m	Description
					0.15	MADE GROUND (reinforced concrete slab)
					0.25	MADE GROUND (black ashy sand)
						MADE GROUND (pale brown clayey sandy brick fill with abundant concrete fragments)
1	D	0.50				
2	D	1.00				
3	D	1.50 - 2.00				
					2.00	
						Firm grey mottled orange-brown very sandy clay
4	D	2.50 - 3.00				
5	D	3.50 - 4.00				
					4.60	
						Firm grey silty sandy clay with rare pockets of sand
6	D	5.00				

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

Sheet No: 1 of 2

LBH WEMBLEY **Geotechnical & Environmental**

PROJECT:	Garages at the rear of, 26 New End Square, London	LBH4379	BOREHOLE BH02
CLIENT:	Urban High Developments Ltd		

BORING METHOD:	Dynamic Window Sampler	Date: 27/11/15
GROUND WATER:	Groundwater encountered at 3.2m following completion of fieldwork Groundwater encountered at 2.7m on 02/12/15	
REMARKS:	Inspection pit hand-dug to 1.2m 19mm diameter standpipe installed to 6m, with a response zone between 2m and 6m	

G.L. approx. +102.4m OD

Samples No	Type	Depth m	Tests	Legend	Depth m	Description
						Firm grey silty sandy clay with rare pockets of sand
7	D	5.50				...becoming firm-stiff at 5.5m
					6.00	

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

LBH WEMBLEY Geotechnical & Environmental

PROJECT:	Garages at the rear of, 26 New End Square, London	LBH4379	**BOREHOLE BH03**
CLIENT:	Urban High Developments Ltd		

BORING METHOD:	Dynamic Window Sampler	Date: 27/11/15
GROUND WATER:	Not encountered	
REMARKS:	Inspection pit hand-dug to 0.5m	

G.L. approx. +103m OD

Samples No	Type	Depth m	Tests	Legend	Depth m	Description
					0.15	MADE GROUND (concrete slab)
1	D	0.30			0.50	MADE GROUND (dirty brown very sandy clay with abundant fragments of brick, concrete, glass, flint and brick cobbles)
						Refused at 0.5m

Sheet No: 1 of 2

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

LBH WEMBLEY **Geotechnical & Environmental**

PROJECT:	Garages at the rear of, 26 New End Square, London	LBH4379	**BOREHOLE BH04**
CLIENT:	Urban High Developments Ltd		

BORING METHOD:	Dynamic Window Sampler	Date: 27/11/15
GROUND WATER:	Groundwater encountered at 4m following completion of fieldwork	
REMARKS:	Inspection pit hand-dug to 1.2m	

G.L. approx. +103m OD

Samples No	Type	Depth m	Tests	Legend	Depth m	Description
					0.15	MADE GROUND (reinforced concrete slab)
					0.35	MADE GROUND (pale brown clayey sandy brown fill)
1	D	0.80			1.10	MADE GROUND (dirty brown sandy clay with abundant fragments of brick, glass, slate and flint)
2	D	3.00 - 3.50				Firm grey mottled orange-brown sandy clay with occasional rootlets …becoming locally very sandy between 4.0m and 5.0m

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

LBH WEMBLEY Geotechnical & Environmental

PROJECT:	Garages at the rear of, 26 New End Square, London	LBH4379	**BOREHOLE BH04**
CLIENT:	Urban High Developments Ltd		

BORING METHOD:	Dynamic Window Sampler	Date: 27/11/15
GROUND WATER:	Groundwater encountered at 4m following completion of fieldwork	
REMARKS:	Inspection pit hand-dug to 1.2m	

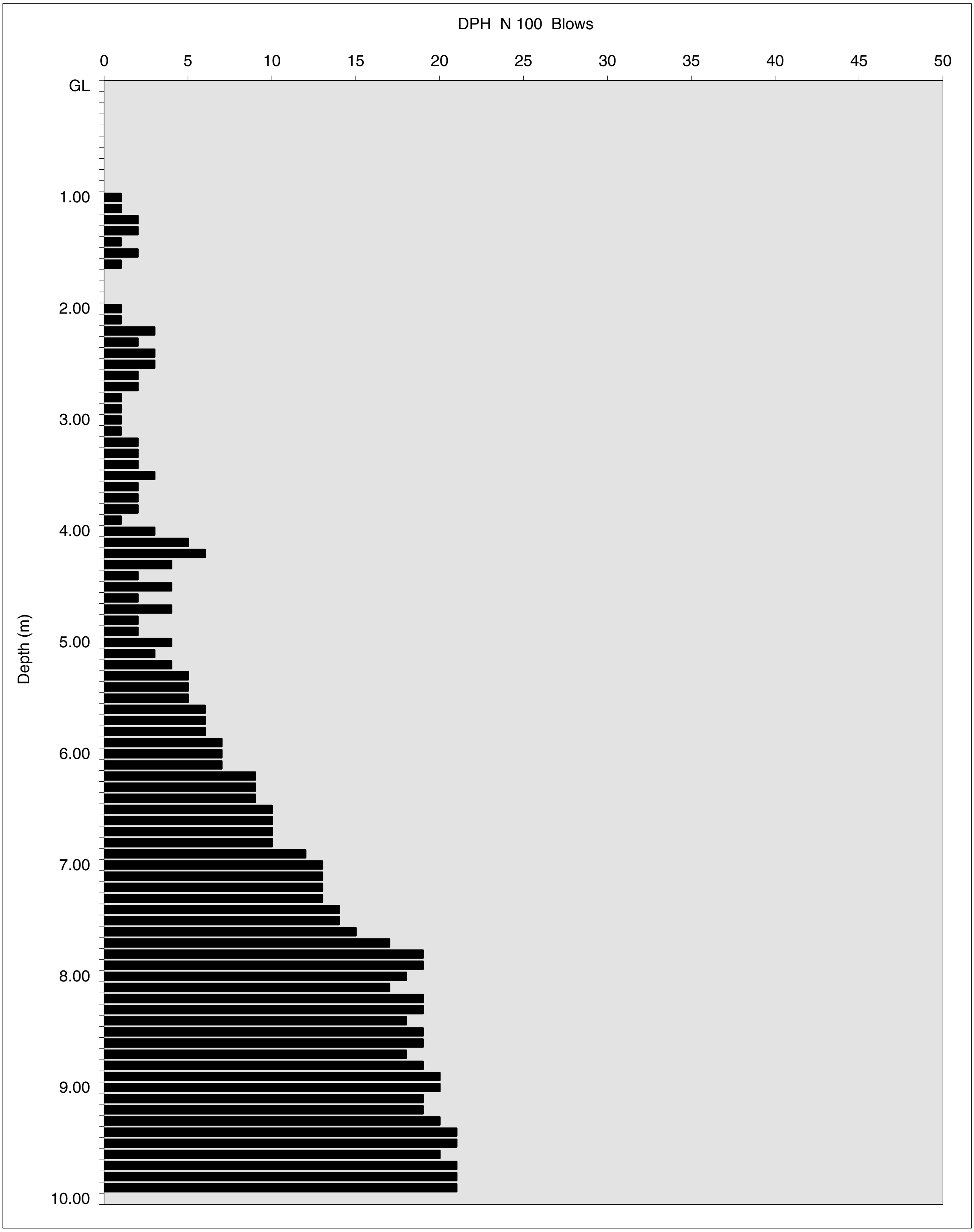
G.L. approx. +103m OD

Samples No	Type	Depth m	Tests	Legend	Depth m	Description
					5.50	Firm grey mottled orange-brown sandy clay with occasional rootlets
3	D	6.00 - 6.50			6.50	Firm-stiff grey silty sandy clay with rare pockets of sand

U=Undisturbed
B= Bulk
D=Disturbed
W=Water

PROJECT:	Garages at the rear of, 26 New End Square, London	**DYNAMIC PROBE RESULTS**
CLIENT:	Urban High Developments Ltd	

Probe No: BH1 Date: 27/11/2015



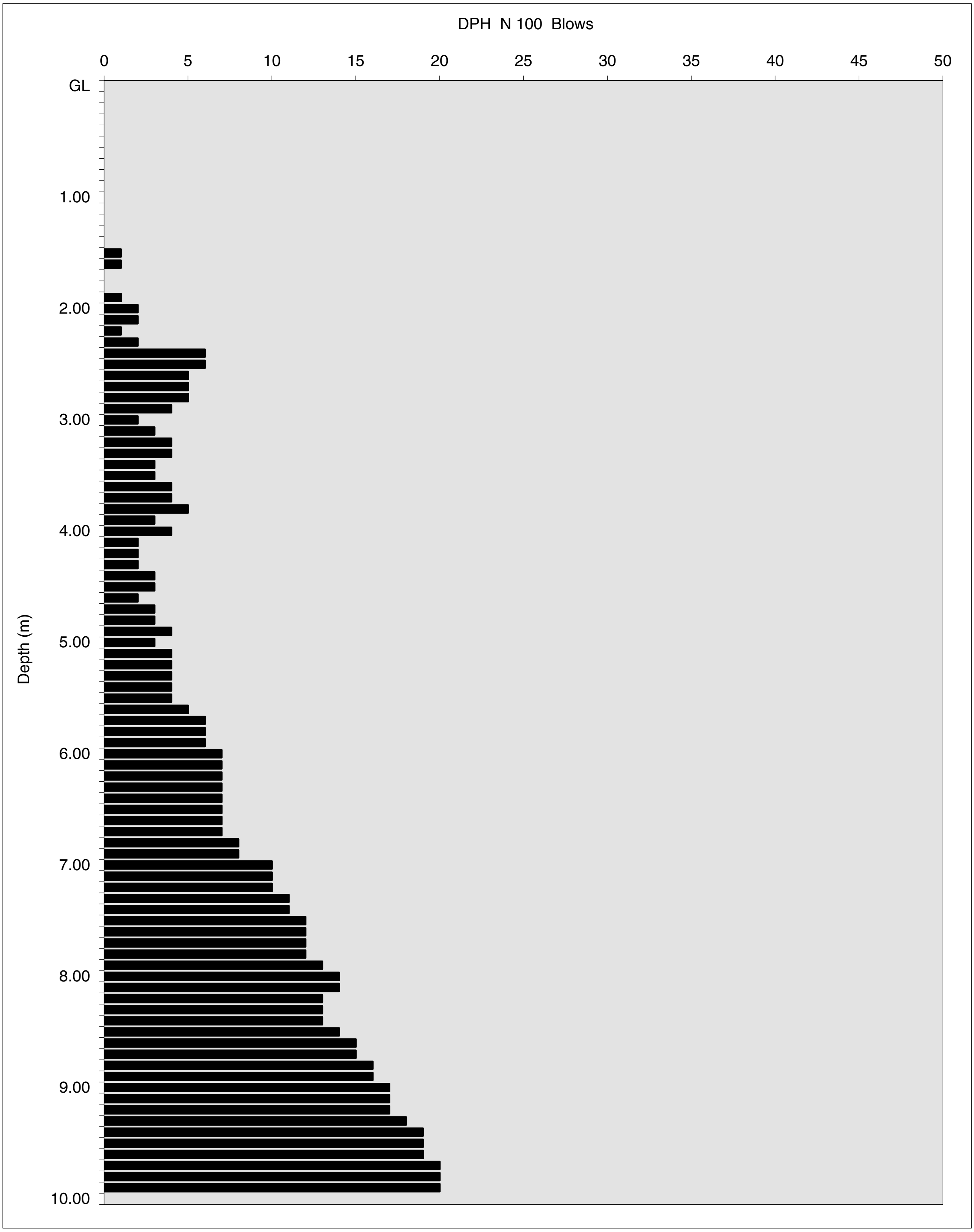
Remarks : Apparatus BS1377:Part 9:1990 - DPH.

Project No	**LBH WEMBLEY Geotechnical & Environmental**
LBH4379	

PROJECT:	Garages at the rear of, 26 New End Square, London	**DYNAMIC PROBE RESULTS**
CLIENT:	Urban High Developments Ltd	

Probe No: BH2

Date: 27/11/2015



Remarks : Apparatus BS1377:Part 9:1990 - DPH.

GroundTech Laboratories

Geotechnical Testing Facility

Slapton Hill Barn, Blakesley Road, Slapton, Towcester, Northants. NN12 8QD

Telephone:- 01327 860947/860060 Fax:- 01327 860430 Email: groundtech@listersgeotechnics.co.uk

PROJECT INFORMATION	SAMPLE INFORMATION

Site Location:- The rear of 26 New End Square, London

Client Reference:- -

Date Samples Received:- 3rd December 2015

Date Testing Completed:- 9th December 2015

Laboratory Tests Undertaken:-

TEST TYPE	TEST METHOD	TESTED
Natural Moisture Contents (MC%)	(BS 1377:Part 2:1990 Clause 3.2)	✓
Liquid Limits (%)	(BS 1377:Part 2:1990 Clause 4.3)	✓
Plastic Limits (%)	(BS 1377:Part 2:1990 Clause 5.3)	✓
Plasticity Index (%)	(BS 1377:Part 2:1990 Clause 5.4)	✓
Linear Shrinkage (%)	(BS 1377:Part 2:1990 Clause 6.5)	
PSD - Wet Sieving	(BS 1377:Part 2:1990 Clause 9.2)	
Engineering Sample Descriptions	(BS 5930 : Section 6)	
Passing 425/63 (µm)	-	✓
Hydrometer	(BS 1377:Part 2:1990 Clause 9.5)	
Loss on Ignition (%)	-	
Soil Suctions (kPa)	BRE Digest IP 4/93, 1993	
Bulk Density (Mg/m^3)	(BS 1377:Part 2:1990 Clause 7.2)	
Strength Tests	(BS 1377:Part 7:1990 Clause 8 & 9)	
Soluble Sulphate Content (SO^4g/l)	(BS 1377:Part 3:1990 Clause 5.3)	✓
pH value	(BS 1377:Part 3:1990 Clause 9.4)	✓
California Bearing Ratios (CBR)	(BS 1377:Part 4:1990 Clause 7)	
Compaction Tests	(BS 1377:Part 4:1990 Clauses 3.0-3.6)	

The results relate only to the samples tested

Laboratory testing in accord with BS EN ISO/IEC 17025-2000 and Quality Management in accord with ISO 9001

Signed on behalf of GroundTech Laboratories:- A.D. **Technical Signatory**

Quality Assured to ISO 9001

GEOTECHNICAL LABORATORY TEST RESULTS

Project Ref: 15.12.001

GroundTech Laboratories

Geotechnical Testing Facility

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Telephone: 01327 860947/860060 Fax: 01327 860430 Email: groundtech@listersgeotechnics.co.uk

Quality Assured to ISO 9001

SAMPLES				CLASSIFICATION TESTS							CLASSIFICATION TESTS							STRENGTH TESTS					CHEMICAL TESTS	
Test Location	Sample Type	Sample Depth -m	Test Type	MC %	LL %	PL %	PI %	Passing 425 µm %	Modified PI %	Class	Passing 63 µm %	MC/ LL	PL+ 2%	Liquidity Index	Loss on Ignition %	Soil Suction kPa	Bulk Density Mg/m3	Test Type	Cell Pressure kN/m2	Deviator Stress kN/m2	Apparent Cohesion kN/m2	ϕ	pH Value	Soluble Sulphate Content SO4 g/l
BH 1	D	1.50	PI/63	33	45	19	26	100	26	CI	49	0.73	21	0.54									6.2	0.12
	D	3.50	PI/63	31	32	29	3	100	3	ML	42	0.97	31	0.67									6.2	0.19
BH 2	D	5.00	PI/63	29	36	22	14	100	14	CI	56	0.81	24	0.50									5.5	0.15
BH 4	D	6.00	PI/63	29	35	23	12	100	12	CL	74	0.83	25	0.50									6.2	0.13

Symbols:

U	Undisturbed Sample	R	Remoulded	PI	Plasticity Index	T	Triaxial Undrained	L	100mm specimen
D	Disturbed Sample	63	Passing 63µm	F	Filter Paper Suction Tests	M	Multistage Triaxial	S	38mm specimen
B	Bulk Sample	H	Hydrometer	CC	Continuous Core	HP	Hand Penetrometer		
W	Water Sample	PSD	Wet Sieving			V	Vane Test		

LABORATORY TEST RESULTS

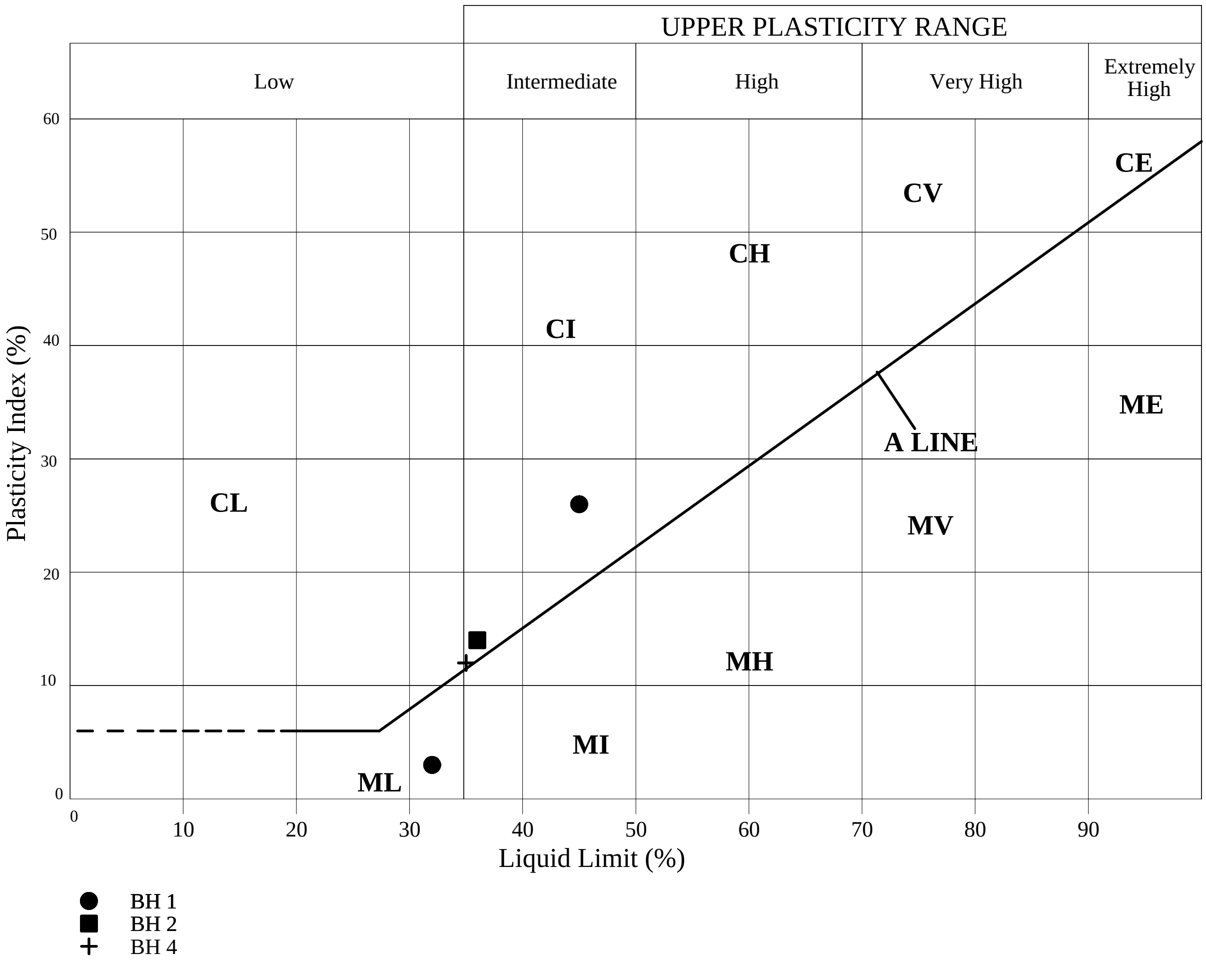
Project Reference
15.12.001

GroundTech Laboratories

Geotechnical Testing Facility
Slapton Hill Barn, Blakesley Road, Slapton, Towcester, Northants. NN12 8QD
Telephone:- 01327 860947/860060 Fax:- 01327 860430

Quality Assured to ISO9001

Site: The rear of 26 New End Square, London



PLASTICITY CHART

Lab. Ref. 15.12.001

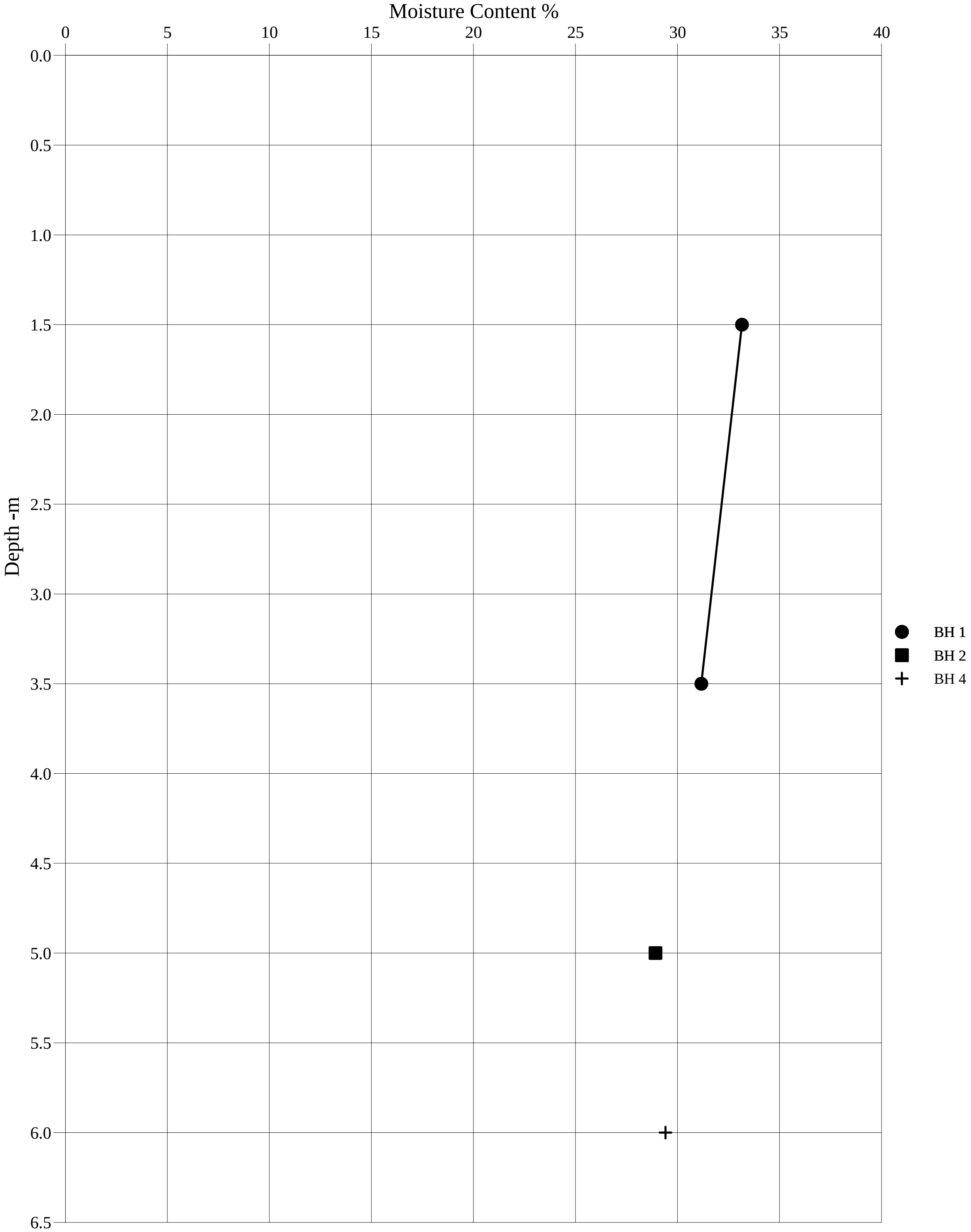
GroundTech Laboratories

Geotechnical Testing Facility

Slapton Hill Barn, Blakesley Road, Slapton, Towcester, Northants. NN12 8QD
Telephone:- 01327 860947/860060 Fax:- 01327 860430

Quality Assured to ISO9001

Site: The rear of 26 New End Square, London



MOISTURE CONTENT v DEPTH

Lab Ref. 15.12.001

Derwentside Environmental Testing Services

Certificate of Analysis

Certificate Number 15-52264

10-Dec-15

Client	LBH Wembley Unit 12 Little Balmer Buckingham Industrial Park Buckingham MK18 1TF
Our Reference	15-52264
Client Reference	LBH4379
Order No	LBH4379
Contract Title	Garages to Rear of 26 New End Square, London
Description	4 Soil samples, 2 Leachate samples.
Date Received	03-Dec-15
Date Started	03-Dec-15
Date Completed	10-Dec-15
Test Procedures	Identified by prefix DETSn (details on request).
Notes	Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Rob Brown
Business Manager

UKAS TESTING
2139

Summary of Chemical Analysis
Soil Samples

Our Ref 15-52264
Client Ref LBH4379
Contract Title Garages to Rear of 26 New End Square, London

Test	Method	LOD	Units				
			Lab No	909786	909787	909788	909789
			Sample ID	BH1	BH2	BH3	BH4
			Depth	0.60	1.50-2.00	0.30	0.80
			Other ID				
			Sample Type	SOIL	SOIL	SOIL	SOIL
			Sampling Date	27/11/15	27/11/15	27/11/15	27/11/15
			Sampling Time	n/s	n/s	n/s	n/s
Preparation							
Moisture Content	DETSC 1004*	0.1	%	25	20	23	22
Metals							
Arsenic	DETSC 2301#	0.2	mg/kg	19	8.5	11	21
Boron (water soluble)	DETSC 2123#	0.2	mg/kg	1.5	1.4	1.2	1.4
Cadmium	DETSC 2301#	0.1	mg/kg	0.3	0.2	0.3	0.7
Chromium	DETSC 2301#	0.15	mg/kg	28	17	14	25
Hexavalent Chromium	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	39	14	20	190
Lead	DETSC 2301#	0.3	mg/kg	490	170	1900	1300
Mercury	DETSC 2325#	0.05	mg/kg	0.90	0.20	0.39	0.70
Nickel	DETSC 2301#	1	mg/kg	12	11	8.1	16
Selenium	DETSC 2301#	0.5	mg/kg	0.7	< 0.5	< 0.5	< 0.5
Zinc	DETSC 2301#	1	mg/kg	290	68	110	370
Inorganics							
pH	DETSC 2008#			8.0	11.2	9.5	8.8
Cyanide Total	DETSC 2130#	0.1	mg/kg	0.3	0.2	0.2	0.2
Cyanide Free	DETSC 2130#	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Thiocyanate	DETSC 2130#	0.6	mg/kg	0.9	1.1	1.2	1.4
Total Organic Carbon	DETSC 2002	0.1	%	1.3	0.4	0.7	1.2
Organic matter	DETSC 2002#	0.1	%	2.2	0.7	1.2	2.1
Sulphide	DETSC 2024#	10	mg/kg	< 10	< 10	< 10	12
Sulphur (free)	DETSC 3049*	0.75	mg/kg	< 0.75	< 0.75	< 0.75	< 0.75
Total Sulphate as SO4	DETSC 2321#	0.01	%	0.05	0.18	0.15	0.22

Key: * -not accredited. # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

Derwentside Environmental Testing Services

Summary of Chemical Analysis
Soil Samples

Our Ref 15-52264
Client Ref LBH4379
Contract Title Garages to Rear of 26 New End Square, London

			Lab No	909786	909787	909788	909789
			Sample ID	BH1	BH2	BH3	BH4
			Depth	0.60	1.50-2.00	0.30	0.80
			Other ID				
			Sample Type	SOIL	SOIL	SOIL	SOIL
			Sampling Date	27/11/15	27/11/15	27/11/15	27/11/15
			Sampling Time	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**				
Petroleum Hydrocarbons							
Aliphatic C5-C6	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C6-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C10-C12	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5	< 1.5	< 1.5
Aliphatic C12-C16	DETSC 3072#	1.2	mg/kg	< 1.2	< 1.2	< 1.2	< 1.2
Aliphatic C16-C21	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5	< 1.5	< 1.5
Aliphatic C21-C35	DETSC 3072#	3.4	mg/kg	< 3.4	< 3.4	< 3.4	< 3.4
Aliphatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10	< 10	< 10
Aromatic C5-C7	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C7-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C10-C12	DETSC 3072#	0.9	mg/kg	< 0.9	< 0.9	< 0.9	< 0.9
Aromatic C12-C16	DETSC 3072#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Aromatic C16-C21	DETSC 3072#	0.6	mg/kg	< 0.6	< 0.6	< 0.6	< 0.6
Aromatic C21-C35	DETSC 3072#	1.4	mg/kg	< 1.4	< 1.4	< 1.4	< 1.4
Aromatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10	< 10	< 10
TPH Ali/Aro	DETSC 3072*	10	mg/kg	< 10	< 10	< 10	< 10
Benzene	DETSC 3321#	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Ethylbenzene	DETSC 3321#	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Toluene	DETSC 3321#	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
Xylene	DETSC 3321#	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
MTBE	DETSC 3321	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01
PAHs							
Naphthalene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Acenaphthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Fluorene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Phenanthrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.27	0.12
Anthracene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	0.05	< 0.03
Fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	0.05	0.45	0.38
Pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	0.06	0.39	0.35
Benzo(a)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.13	0.13
Chrysene	DETSC 3303	0.03	mg/kg	< 0.03	< 0.03	0.13	0.16
Benzo(b)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.12	0.16
Benzo(k)fluoranthene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.05	0.06
Benzo(a)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.09	0.11
Indeno(1,2,3-c,d)pyrene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.06	0.07
Dibenzo(a,h)anthracene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03
Benzo(g,h,i)perylene	DETSC 3303#	0.03	mg/kg	< 0.03	< 0.03	0.05	0.06
Total PAH - USEPA 16	DETSC 3303	0.1	mg/kg	< 0.10	0.10	1.8	1.6

Key: * -not accredited. # -MCERTS (accreditation only implied if report carries the MCERTS logo). n/s -not supplied.

Derwentside Environmental Testing Services

Summary of Chemical Analysis
Soil Samples

Our Ref 15-52264
Client Ref LBH4379
Contract Title Garages to Rear of 26 New End Square, London

			Lab No	909786	909787	909788	909789
			Sample ID	BH1	BH2	BH3	BH4
			Depth	0.60	1.50-2.00	0.30	0.80
			Other ID				
			Sample Type	SOIL	SOIL	SOIL	SOIL
			Sampling Date	27/11/15	27/11/15	27/11/15	27/11/15
			Sampling Time	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**				
Phenols							
Phenol - Monohydric	DETSC 2130#	0.3	mg/kg	< 0.3	< 0.3	< 0.3	< 0.3

Summary of Asbestos Analysis
Soil Samples

Our Ref 15-52264
Client Ref LBH4379
Contract Title Garages to Rear of 26 New End Square, London

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
909786	BH1 0.60	SOIL	NAD	none	Andrew Little
909787	BH2 1.50-2.00	SOIL	NAD	none	Andrew Little
909788	BH3 0.30	SOIL	NAD	none	Andrew Little
909789	BH4 0.80	SOIL	NAD	none	Andrew Little

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

WASTE ACCEPTANCE CRITERIA TESTING
ANALYTICAL REPORT

Our Ref 15-52264
Client Ref LBH4379
Contract Title Garages to Rear of 26 New End Square, London
Sample Id BH2 1.50-2.00
Sample Numbers 909787 909790 909791
Date Analysed 09/12/2015

Test Results On Waste

Determinand and Method Reference	Units	Result	WAC Limit Values: Inert Waste	SNRHW	Hazardous Waste
DETSC 2084* Total Organic Carbon	%	0.4	3	5	6
DETSC 2003# Loss On Ignition	%	2.1	n/a	n/a	10
DETSC 3321# BTEX	mg/kg	< 0.04	6	n/a	n/a
DETSC 3401# PCBs (7 congeners)	mg/kg	< 0.01	1	n/a	n/a
DETSC 3311# TPH (C10 - C40)	mg/kg	< 10	500	n/a	n/a
DETSC 3301 PAHs	mg/kg	< 1.6	100	n/a	n/a
DETSC 2008# pH	pH Units	11.2	n/a	>6	n/a
DETSC 2073* Acid Neutralisation Capacity (pH4)	mol/kg	< 1	n/a	TBE	TBE
DETSC 2073* Acid Neutralisation Capacity (pH7)	mol/kg	< 1	n/a	TBE	TBE

Test Results On Leachate

Determinand and Method Reference	Conc in Eluate ug/l		Amount Leached mg/kg		WAC Limit Values (Limit values for LS10 Leachate)		
	2:1	8:1	LS2	LS10	Inert Waste	SNRHW	Hazardous Waste
DETSC 2306 Arsenic as As	4.7	3.9	0.009	0.04	0.5	2	25
DETSC 2306 Barium as Ba	16	9.8	0.03	0.11	20	100	300
DETSC 2306 Cadmium as Cd	< 0.03	< 0.03	< 0.004	< 0.02	0.04	1	5
DETSC 2306 Chromium as Cr	4.2	1.6	< 0.02	< 0.1	0.5	10	70
DETSC 2306 Copper as Cu	1	0.8	< 0.004	< 0.02	2	50	100
DETSC 2306 Mercury as Hg	0.04	0.04	< 0.0004	< 0.002	0.01	0.2	2
DETSC 2306 Molybdenum as Mo	< 1.05	< 1.05	< 0.02	< 0.1	0.5	10	30
DETSC 2306 Nickel as Ni	< 0.5	< 0.5	< 0.02	< 0.1	0.4	10	40
DETSC 2306 Lead as Pb	6.7	5.5	0.01	0.057	0.5	10	50
DETSC 2306 Antimony as Sb	< 0.17	< 0.17	< 0.01	< 0.05	0.06	0.7	5
DETSC 2306 Selenium as Se	0.3	< 0.25	< 0.006	< 0.03	0.1	0.5	7
DETSC 2306 Zinc as Zn	< 1.25	< 1.25	< 0.002	< 0.01	4	50	200
DETSC 2055 Chloride as Cl	3500	990	< 20	< 100	800	15,000	25,000
DETSC 2055* Fluoride as F	180	190	0.36	1.89	10	150	500
DETSC 2055 Sulphate as SO4	12000	4900	24	< 100	1000	20,000	50,000
DETSC 2009* Total Dissolved Solids	57000	47000	114	483.9	4000	60,000	100,000
DETSC 2130 Phenol Index	< 100	< 100	< 0.2	< 1	1	n/a	n/a
* Dissolved Organic Carbon	2700	2300	< 10	< 50	500	800	1000

Additional Information

DETSC 2008 pH	7.7	8
DETSC 2009 Conductivity uS/cm	81.3	66.6
* Temperature*	5.5	15

Mass of Sample Kg	0.140
Mass of dry Sample Kg	0.121

Stage 1

Volume of Leachant L2	0.222
Volume of Eluate VE1	0.168

Stage 2

Volume of Leachant L8	0.965
Volume of Eluate VE2	0.925

TBE - To Be Evaluated
SNRHW - Stable Non-Reactive Hazardous Waste

Information in Support of the Analytical Results

Our Ref 15-52264
Client Ref LBH4379
Contract Garages to Rear of 26 New End Square, London

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
909786	BH1 0.60 SOIL	27/11/15	GJ 250ml, GJ 60ml, PT 1L		
909787	BH2 1.50-2.00 SOIL	27/11/15	GJ 250ml, GJ 60ml, PT 1L		
909788	BH3 0.30 SOIL	27/11/15	GJ 250ml, GJ 60ml, PT 1L		
909789	BH4 0.80 SOIL	27/11/15	GJ 250ml, GJ 60ml, PT 1L		
909790	BH2 1.50-2.00 LEACHATE	27/11/15	GJ 250ml, GJ 60ml, PT 1L		
909791	BH2 1.50-2.00 LEACHATE	27/11/15	GJ 250ml, GJ 60ml, PT 1L		

Key: G-Glass P-Plastic J-Jar T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

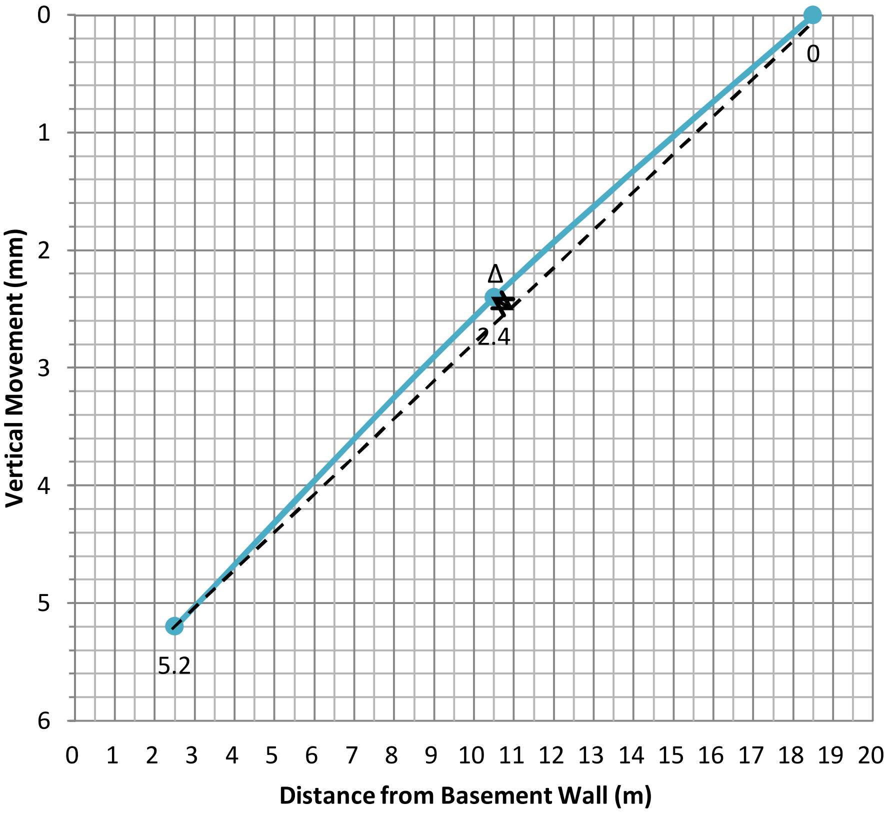
Reference: **LBH 4379**
Site: **New End Square**
Section: **Warehouse (front wall)**
Date of analysis: **26th June 2016**
Project Engineer: **RL**

The damage category can be assessed from the calculated horizontal strain and deflection ratio of a "beam" under hogging or sagging.

Length of wall	**L =**	**16**	**m**
Height of wall	**H =**	**6**	**m**
Horiz. deflection	**Δ_{horiz} =**	**9.6**	**mm**
Vert. deflection	**Δ =**	**0.2**	**mm**

x	y	distance from wall	Vert. mov'nt	Horiz. mov'nt
m	m	m	mm	mm
26	10	2.5	5.2	9.8
34	10	10.5	2.4	2.9
42	10	18.5	0	0.2

Vertical movement along Section

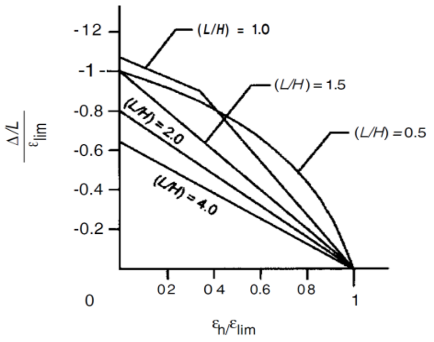


Reference: **LBH 4379** Section: **Warehouse (front wall)**

L/H = 2.6667

Horiz. Strain ε_h = 0.06 % ε_{lim} = 0.060 %

Deflection ratio Δ/L = -0.00125



0.050 **CATEGORY 0 NEGLIGIBLE**

DAMAGE LEVEL -->

0.075 **CATEGORY 1 VERY SLIGHT**

0.150 **CATEGORY 2 SLIGHT**

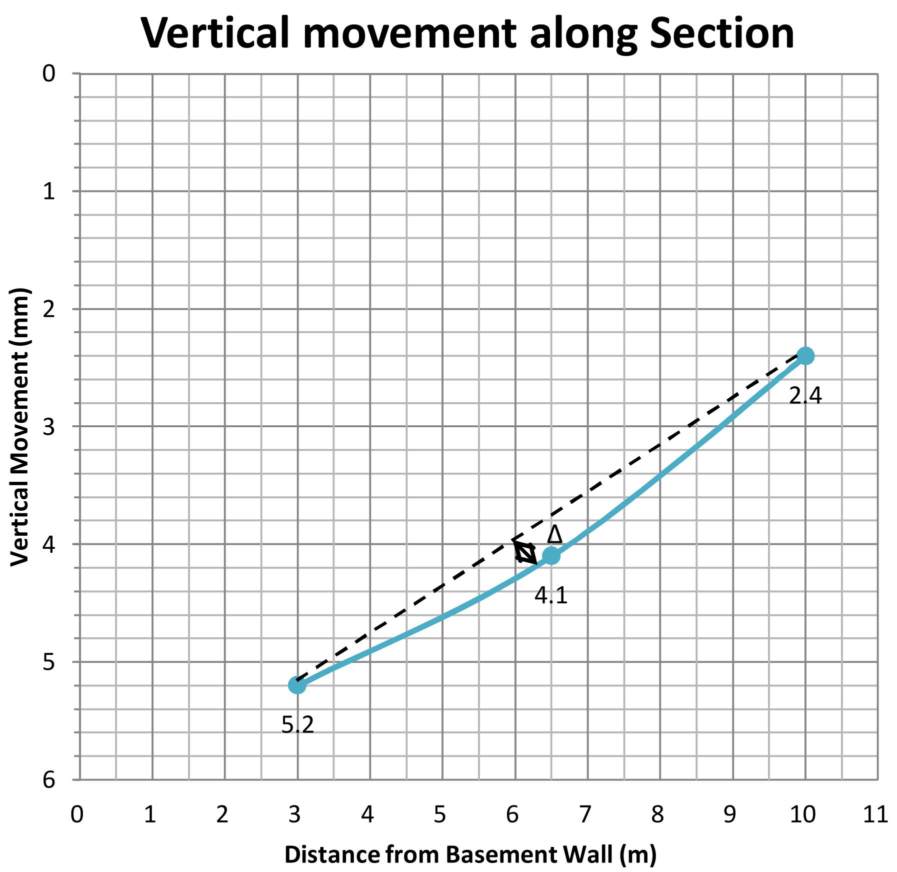
CATEGORY 3 MODERATE

Reference: **LBH 4379**
Site: **New End Square**
Section: **No. 42 New End (front wall)**
Date of analysis: **26th June 2016**
Project Engineer: **RL**

The damage category can be assessed from the calculated horizontal strain and deflection ratio of a "beam" under hogging or sagging.

Length of wall	**L =**	**7**	**m**
Height of wall	**H =**	**8**	**m**
Horiz. deflection	**Δ horiz =**	**5.4**	**mm**
Vert. deflection	**Δ =**	**0.3**	**mm**

x	y	distance from wall	Vert. mov'nt	Horiz. mov'nt
m	m	m	mm	mm
9	9	3	5.2	8.6
5.5	9	6.5	4.1	5.8
2	9	10	2.4	3.2

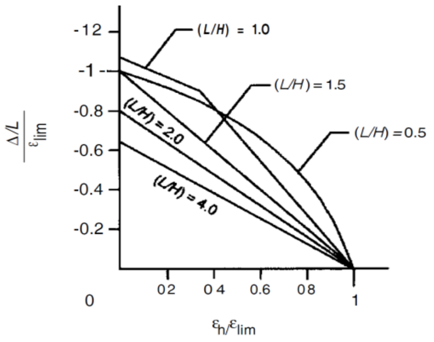


Reference: **LBH 4379** Section: **No. 42 New End (front wall)**

L/H = 0.8750

Horiz. Strain ε_h = 0.077143 % ε_{lim} = 0.080 %

Deflection ratio Δ/L = -0.00429



0.050

CATEGORY 0
NEGLIGIBLE

0.075

CATEGORY 1
VERY SLIGHT

DAMAGE LEVEL -->

0.150

CATEGORY 2
SLIGHT

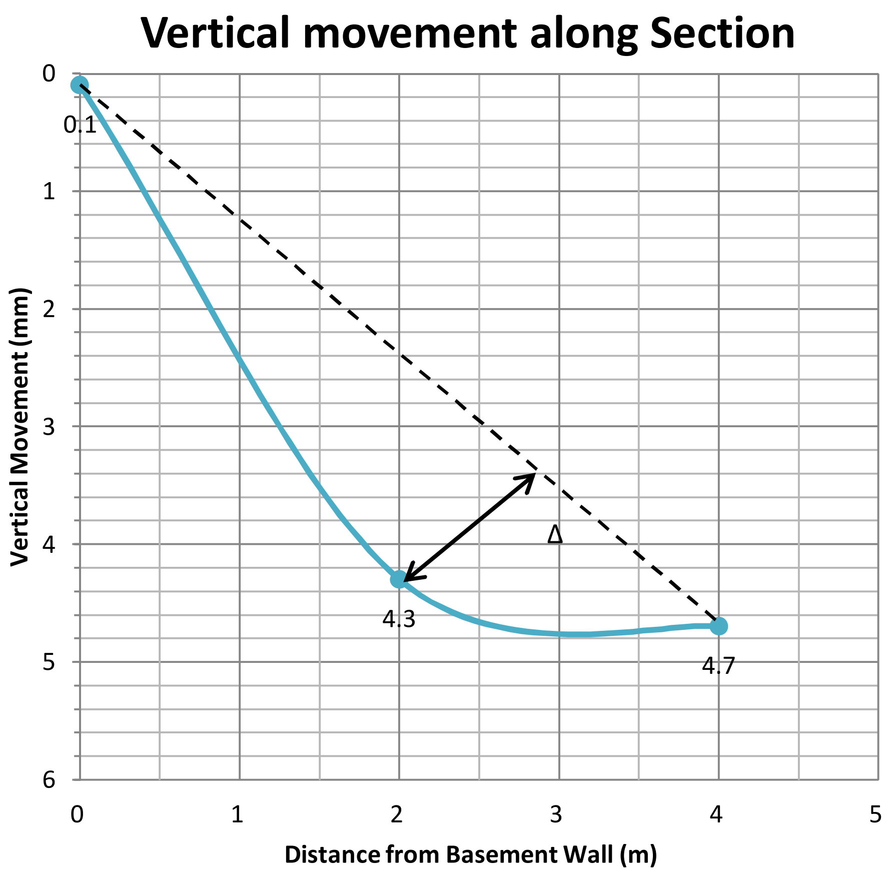
CATEGORY 3
MODERATE

Reference: **LBH 4379**
Site: **New End Square**
Section: **No. 7 Flask Cottage (front wall)**
Date of analysis: **26th June 2016**
Project Engineer: **RL**

The damage category can be assessed from the calculated horizontal strain and deflection ratio of a "beam" under hogging or sagging.

Length of wall	**L =**	**4**	**m**
Height of wall	**H =**	**7**	**m**
Horiz. deflection	**Δ_{horiz} =**	**3.9**	**mm**
Vert. deflection	**Δ =**	**1.4**	**mm**

x	y	distance from wall	Vert. mov'nt	Horiz. mov'nt
m	m	m	mm	mm
18	10	0	0.1	11.9
18	8	2	4.3	10.3
18	6	4	4.7	8

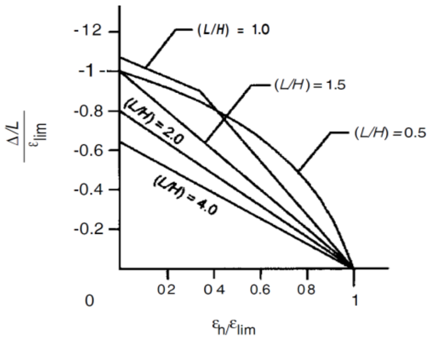


Reference: **LBH 4379** Section: **No. 7 Flask Cottage (front wall)**

L/H = 0.5714

Horiz. Strain ε_h = 0.0975 % ε_{lim} = 0.110 %

Deflection ratio Δ/L = -0.035



0.050	**CATEGORY 0 NEGLIGIBLE**
0.075	**CATEGORY 1 VERY SLIGHT**
0.150	**CATEGORY 2 SLIGHT**
	CATEGORY 3 MODERATE

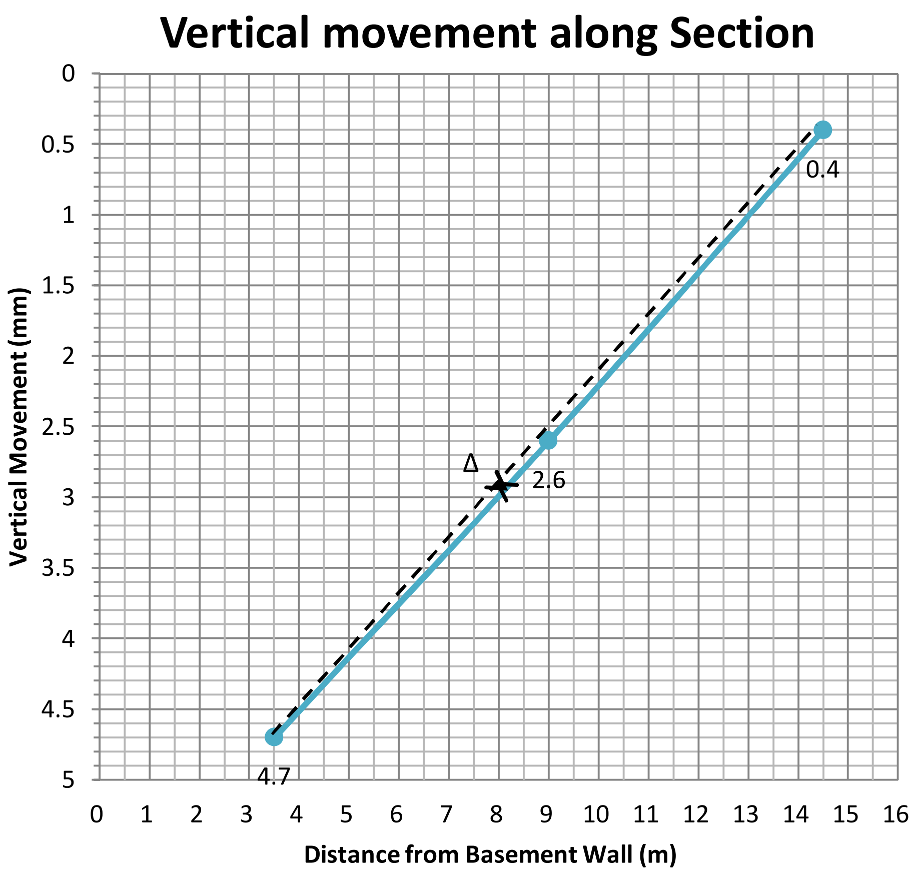
DAMAGE LEVEL --> (CATEGORY 2 SLIGHT)

Reference: **LBH 4379**
Site: **New End Square**
Section: **Nos. 26-30 New End Square (front wall)**
Date of analysis: **26th June 2016**
Project Engineer: **RL**

The damage category can be assessed from the calculated horizontal strain and deflection ratio of a "beam" under hogging or sagging.

Length of wall	**L =**	**11**	**m**
Height of wall	**H =**	**12**	**m**
Horiz. deflection	**Δ horiz =**	**6.9**	**mm**
Vert. deflection	**Δ =**	**0.1**	**mm**

x	y	distance from wall	Vert. mov'nt	Horiz. mov'nt
m	m	m	mm	mm
20	18	3.5	4.7	8.2
20	23.5	9	2.6	3.8
20	29	14.5	0.4	1.3

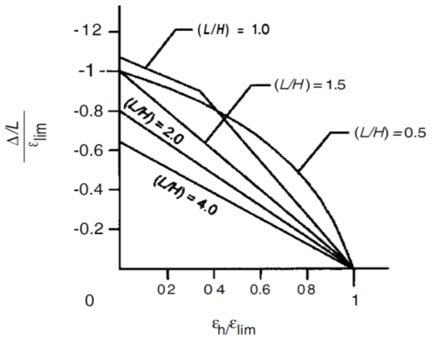


Reference: **LBH 4379** Section: **Nos. 26-30 New End Square (front wal**

L/H = 0.9167

Horiz. Strain ε_h = 0.062727 % ε_{lim} = 0.065 %

Deflection ratio Δ/L = -0.00091



0.050 — **CATEGORY 0 NEGLIGIBLE**

DAMAGE LEVEL -->

0.075 — **CATEGORY 1 VERY SLIGHT**

0.150 — **CATEGORY 2 SLIGHT**

CATEGORY 3 MODERATE

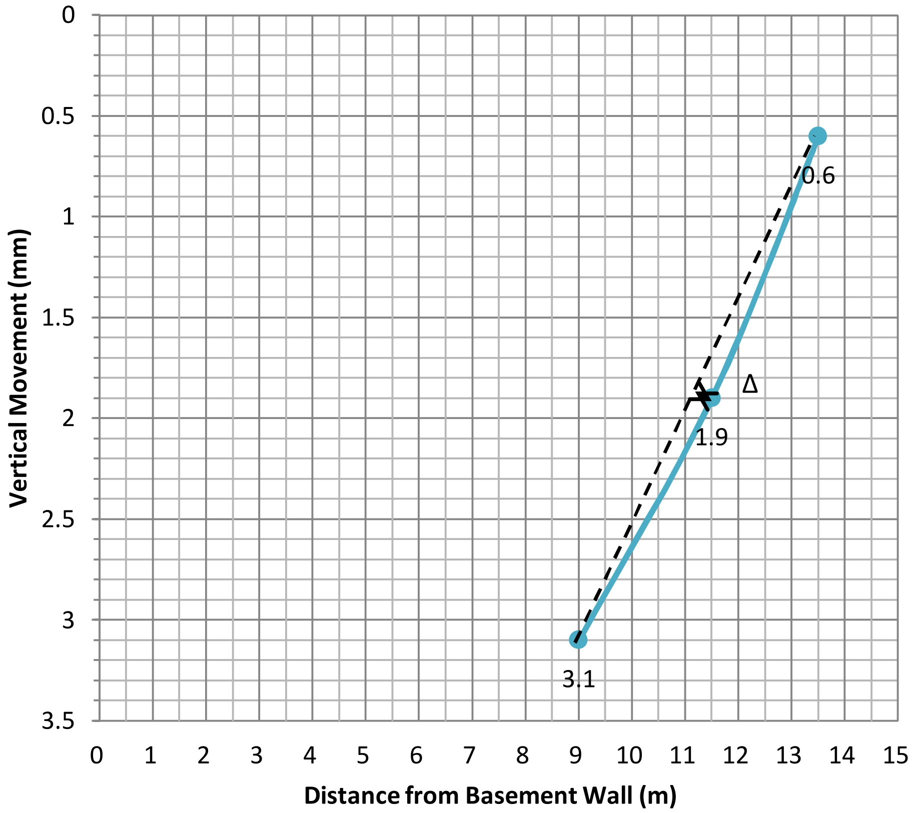
Reference: **LBH 4379**
Site: **New End Square**
Section: **No. 20 New End (front wall)**
Date of analysis: **26th June 2016**
Project Engineer: **RL**

The damage category can be assessed from the calculated horizontal strain and deflection ratio of a "beam" under hogging or sagging.

Length of wall	**L =**	**5**	**m**
Height of wall	**H =**	**10**	**m**
Horiz. deflection	**Δ horiz =**	**2.5**	**mm**
Vert. deflection	**Δ =**	**0.2**	**mm**

x	y	distance from wall	Vert. mov'nt	Horiz. mov'nt
m	m	m	mm	mm
12	23	9	3.1	4.1
12	25.5	11.5	1.9	2.6
12	28	13.5	0.6	1.6

Vertical movement along Section

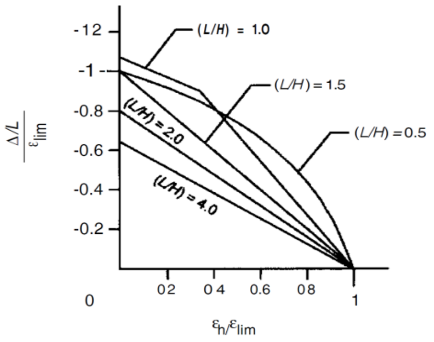


Reference: **LBH 4379** Section: **No. 20 New End (front wall)**

L/H = 0.5000

Horiz. Strain ε_h = 0.05 % ε_{lim} = 0.050 %

Deflection ratio Δ/L = -0.004



CATEGORY 0
NEGLIGIBLE

DAMAGE LEVEL --> 0.050

CATEGORY 1
VERY SLIGHT

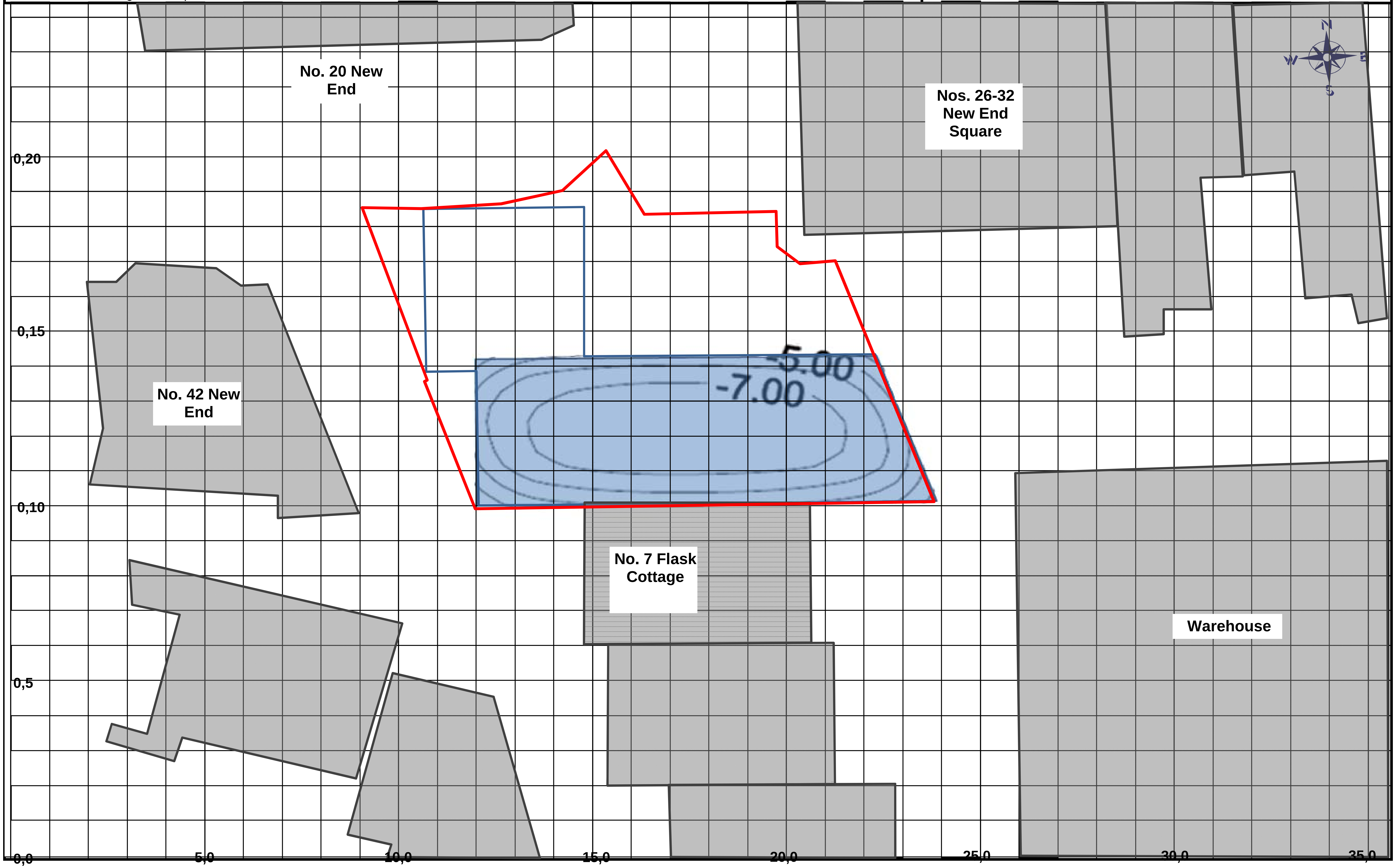
0.075

CATEGORY 2
SLIGHT

0.150

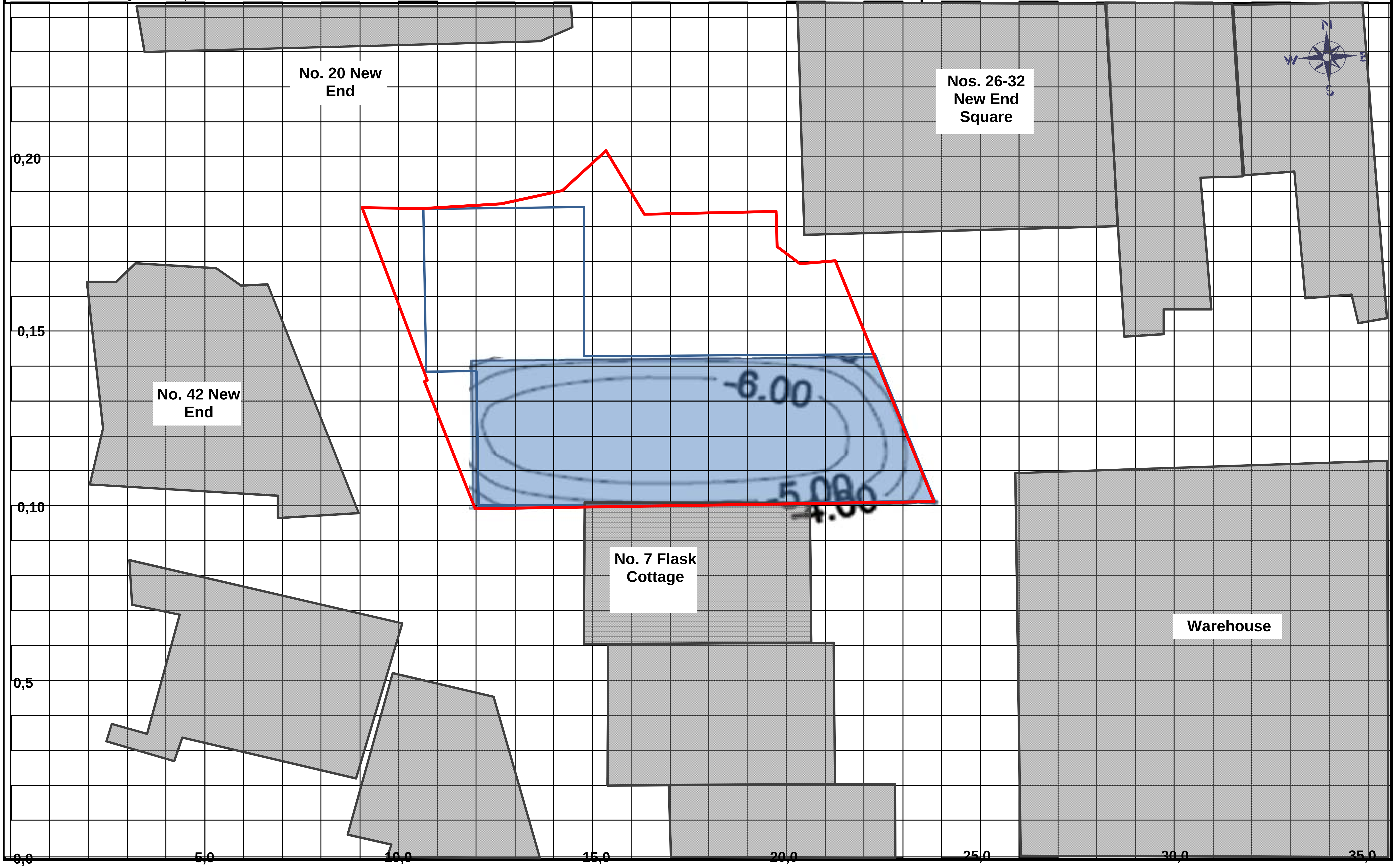
CATEGORY 3
MODERATE

PROJECT:	Garages to the rear of, 26 New End Square, London, NW3 1LS	4379	**Short Term Heave due to Demolition & Excavation - mm**
CLIENT:	Urban High Developments Ltd		



LBH WEMBLEY Geotechnical & Environmental

PROJECT:	Garages to the rear of, 26 New End Square, London, NW3 1LS	4379	**Long Term Heave (Post Construction) - mm**
CLIENT:	Urban High Developments Ltd		



LBH WEMBLEY **Geotechnical & Environmental**