GROUND INVESTIGATION & GROUND MOVEMENT ASSESSMENT REPORT

7 Denmark Street London WC2

Client: Cord Contracting Co Limited

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This report is intended as a Ground Investigation Report (GIR) as defined in BS EN1997-2, unless specifically noted otherwise. The report is not a Geotechnical Design Report (GDR) as defined in EN1997-2 and recommendations made within this report are for guidance only.

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EXECUTIVE SUMMARY

This executive summary contains an overview of the key findings and conclusions. No reliance should be placed on any part of the executive summary until the whole of the report has been read. Other sections of the report may contain information that puts into context the findings that are summarised in the executive summary.

BRIEF

This report describes the findings of a ground investigation and ground movement assessment carried out by Geotechnical and Environmental Associates Limited (GEA) on the instructions of Cord Contracting Co Ltd with respect to the construction of a two-storey extension to the rear of the existing property, including an extension to the existing single level basement. The site has previously been the subject of a Basement Impact Assessment (BIA) by Engenuiti (ref 029-S-REP010 Rev01, dated December 2017), which was submitted in support of the planning application for the proposed development and has been audited on behalf of London Borough of Camden by Campbell Reith. The purpose of this investigation has been to review the screening and scoping elements of the previous BIA, provide supplementary desk study information, to determine the ground conditions and to provide an assessment of the potential impact of the proposed basement on the hydrogeological setting of the site and the surrounding built environment. Contamination testing did not form part of the project brief.

GROUND CONDITIONS

Beneath a nominal to significant thickness of made ground, Lynch Hill Gravel was encountered over the London Clay Formation, which was proved to the maximum depth investigated, of 5.00 m (17.34 m OD). The made ground generally comprised light grey silty clayey sand with frequent fragments of brick, clinker, flint gravel and concrete, and extended to depths of between 0.40 m (21.94 m OD) and 2.50 m (22.54 m OD). The Lynch Hill Gravel consisted of light orange-brown, grey and light yellowish grey, locally clayey, silty gravelly sand which extended to the maximum depth investigated in Borehole No 1, of 5.00 m (20.04 m OD) and to 2.50 m (19.84 m OD) in Borehole No 2, which was advanced from existing basement level. The London Clay was found to comprise soft light brown silty clay to a depth of 3.00 m (19.34 m OD) over firm fissured grey silty clay to the maximum depth investigated of 5.00 m (17.34 m OD).

Groundwater was only encountered during drilling in Borehole No 1, from within the Lynch Hill Gravel at a depth of approximately 1.80 m below basement level (20.54 m OD), and was subsequently measured at a depth of 2.19 m (20.15 m OD) on a single occasion.

SUMMARY OF BIA SCREENING STAGE

On the basis of the review of the previous BIA, the following screening subterranean groundwater and slope stability questions were carried forward to the scoping stage, which have each been assessed on the basis of the supplementary desk study information and ground investigation.

- > The site is located within the Secondary 'A' Aquifer of the Lynch Hill Gravel Member.
- > Denmark Street runs parallel to the northern boundary of the site.

BIA CONCLUSIONS

The ground investigation has confirmed the findings of previous investigations carried out on adjacent sites, in that the Lynch Hill Gravel is present over the London Clay Formation. Groundwater has been measured at a depth of 2.19 m below existing basement level, approximately 4.70 m below ground level and therefore the proposed basement extension will not extend below the groundwater table and will not have an impact on the local hydrogeological setting.

GROUND MOVEMENT ASSESSMENT

The analysis has predicted that the proposed basement construction should result in a building damage category for sensitive structures of no greater than Category 0 (negligible). Therefore, the movements associated with the proposed basement excavation are considered to be acceptable and within the limits required by the London Borough of Camden for basement developments. The proposed development is not considered to pose a risk to the stability of the neighbouring properties or the footway or carriageway of Denmark Street.

Part 1: INVESTIGATION REPORT

This section of the report details the objectives of the investigation, the work that has been carried out to meet these objectives and the results of the investigation. Part 2 of this report comprises the ground movement assessment and Basement Impact Assessment conclusions.

1.0 INTRODUCTION

Geotechnical and Environmental Associates (GEA) has been commissioned by Cord Contracting Co Ltd to carry out a review of a previous Basement Impact Assessment (BIA) report carried out for No 7 Denmark Street, London WC2H 8LZ.

The BIA (ref: 029-S-REP010 Rev01, dated December 2017) was carried out by the structural engineers for the project, Engenuiti, and was submitted in support of the planning application for the proposed basement development. The report has subsequently been audited on behalf of London Borough of Camden by Campbell Reith as part of the application validation process, with the findings and conclusions documented in their Basement Impact Assessment Audit report (ref: 12727-48, dated April 2008). The audit concluded that a site-specific ground investigation should be carried out, in addition to a ground movement analysis (GMA).

On the basis of the above, the review of the previous BIA has been supplemented with additional desk study research of the site, a ground investigation and a ground movement analysis (GMA). The review of the BIA has principally been carried out to assess the previous answers to the subterranean (groundwater) and slope stability screening questions, in order to provide the relevant qualifications in accordance with the planning guidelines from the London Borough of Camden. Contamination testing did not form part of the project brief.

1.1 **Proposed Development**

It is understood that it is proposed to refurbish the existing building through the construction of a two-storey rear extension, which will include the extension of the existing single level basement beneath the entire footprint of the site. The basement extension will extend to approximately 3.50 m (18.74 m OD) below ground floor level, approximately 1.00 m below existing basement level, as shown by the cross section below.



This report is specific to the proposed development and the advice herein should be reviewed if the proposals are amended.



1.2 **Purpose of Work**

The principal technical objectives of the work carried out were as follows:

- □ to research the history of the site;
- to review previous ground investigations and the previous BIA;
- to determine the ground conditions and hydrogeological conditions; and
- □ to assess the possible impact of the proposed development on the surrounding structures and local hydrogeology.

1.3 Scope of Work

In order to meet the above objectives, a limited desk study was carried out in addition to a ground investigation. The following activities were carried out:

- a review of readily available geological maps;
- □ a review of historical Ordnance Survey (OS) maps sourced from the Envirocheck database; and
- two window sample boreholes advanced to 5.00 m,
- □ the installation of two groundwater monitoring standpipes to depths of 3.80 m and 4.35 m and two subsequent monitoring visits;
- a Ground Movement Analysis (GMA) and building damage assessment; and
- □ provision of a report presenting and interpreting the above data, together with our advice and recommendations with respect to the proposed development.

The exploratory methods adopted in this investigation have been selected on the basis of the constraints of the site including but not limited to access and space limitations, together with any budgetary or timing constraints. Where it has not been possible to reasonably use an EC7 compliant investigation technique a practical alternative has been adopted to obtain indicative soil parameters and any interpretation is based upon engineering experience, local precedent where applicable and relevant published information.

1.3.1 Basement Impact Assessment

The work carried out also includes a review of the previous Hydrogeological Assessment and Land Stability Assessment (also referred to as Slope Stability Assessment), all of which form part of the BIA procedure specified in the London Borough of Camden (LBC) Planning Guidance¹ and their Guidance for Subterranean Development² prepared by Arup ('the Arup Report'). The aim of the work is to provide information on groundwater and land stability and in particular to assess whether the development will affect neighbouring properties or groundwater movements and whether any identified impacts can be appropriately mitigated by the design of the development.

Ove Arup & Partners (2010) Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development. For London Borough of Camden November 2010



London Borough of Camden Planning Guidance (CPG) Basements and lightwells March 2018
 Ove Arup & Partners (2010) Camden geological, hydrogeological and hydrological study. Gui

1.3.2 Qualifications

The land stability element of the BIA has been carried out by Martin Cooper, a BEng in Civil Engineering, a chartered engineer (CEng), member of the Institution of Civil Engineers (MICE), and Fellow of the Geological Society (FGS) who has over 25 years' specialist experience in ground engineering. The subterranean (groundwater) flow assessment has been carried out by John Evans, MSc in Hydrogeology, Chartered Geologist (CGeol) and Fellow of the Geological Society of London (FGS).

The assessments have been made in conjunction with Steve Branch, a BSc in Engineering Geology and Geotechnics, MSc in Geotechnical Engineering, a Chartered Geologist (CGeol) and Fellow of the Geological Society (FGS) with over 30 years' experience in geotechnical engineering and engineering geology.

All assessors meet the qualification requirements of the Council guidance.

1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of soil, gas or groundwater samples tested; no liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

2.0 THE SITE

2.1 Site Description

The site is located in the London Borough of Camden, approximately 150 m southeast of Tottenham Court Road London Underground station and 420 m northwest of Covent Garden London Underground station. It may additionally be located by National Grid Reference 529893, 181237.

A walkover of the site was carried out by a geotechnical engineer from GEA at the time of the fieldwork. The site is roughly rectangular in shape, measuring approximately 23 m northwest-southeast, 7 m east-west, narrowing to a square shaped area measuring roughly 3 m by 3 m at the rear, and is within a mixed use commercial and residential setting. The site is occupied by a four-storey, Grade II listed building with a single level basement, which extends to a depth of 2.7 m (22.34 m OD) below ground level and is present below the front third of the site and out below the footway of Denmark Street as a vault.

The site fronts onto Denmark Street to the northeast and is bounded by a four-storey building to the east and a five-storey building to the west, which are occupied by music shops on the ground floors with residential apartments above. The site abuts 'No 122 Charing Cross' and 'Book Mews' to the rear, a concrete covered courtyard occupied by a single-storey outbuilding. No 6 Denmark Street and No 122 Charing Cross both include single level basement.

The site is essentially level and is accessed off Denmark Street. No areas of soft landscaping were noted on site.



2.2 Site History

The history of the site and surrounding area has been researched by reference to online data and historical Ordnance Survey (OS) maps sourced from archive Envirocheck database.

The earliest map studied, dated 1875, shows the site and the surrounding area to have been developed with rows of terraced houses fronting onto Denmark Street and Flitcroft Street. A brewery was present to 170 m northeast, St Giles Church and a disused graveyard approximately 60 m to the southeast and St Giles Hospital approximately 40 m to the southeast. By 1896, the site and surrounding buildings along Denmark Street are shown in the existing configuration. On the map dated 1953 the buildings east of No 7 are labelled as the site of St Giles Hospital. Online information indicates Nos 4, 5 and 6 were part of the hospital's grounds till the end of the 19th Century, primarily used by leper patients. The site and immediate surrounding area have remained essentially unchanged from the 1950s to the present day.

2.3 **Other Information**

A review of environmental information held by the Environmental Agency (EA) has indicated that there are no existing or historical landfill sites, waste management, transfer or disposal sites within 500 m of the site.

2.4 Geology

The British Geological Survey (BGS) map of the area (sheet 256) indicate that the site is underlain by Lynch Hill Gravel over the London Clay Formation. The Lynch Hill Gravel comprises of sand and gravel, locally with lenses of silt, clay or peat. The London Clay typically comprises bioturbated or poorly laminated, blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt with layers of sandy clay.

Both GEA and Concept Site Investigations have carried out a ground investigation within Book Mews directly to the southeast of the site. Copies of the borehole records from the Concept Site Investigation have been provided by Engenuiti. The investigations generally encountered the expected ground conditions in that a significant thickness of made ground was encountered to 2.70 m and 4.50 m, whereupon medium dense to very dense brown and light orange-brown and brown gravelly sand, sandy gravel and sand and gravel of the Lynch Hill Gravel extended to depths of between 4.80 m and 5.77 m. The underlying London Clay Formation generally comprised firm becoming stiff and very stiff fissured brown mottled grey silty clay with occasional partings of orange-brown fine sand and silt with rare carbonaceous material and was proven to the maximum depth of investigation, of 30.35 m.

2.5 Hydrology and Hydrogeology

The Lynch Hill Gravel is classified as a Secondary 'A' Aquifer by the EA, which refers to 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. The London Clay is classified as a Non-Aquifer and Unproductive Stratum, which refers to a soil or rock with low permeability that has a negligible effect on local water supply or river base flow.

The permeability of the Lynch Hill Gravel is expected to range between about $1 \ge 10^{-6}$ m/s and $1 \ge 10^{-4}$ m/s. Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between $1 \ge 10^{-10}$ m/s and $1 \ge 10^{-8}$ m/s, with an even lower vertical permeability. The London Clay is not capable of supporting a continuous groundwater table, although isolated pockets of perched groundwater do occur within fissures and silt and sand partings.



Within the aforementioned previous ground investigations, groundwater was encountered within the Lynch Hill Gravel at depths of between 3.66 m and 4.40 m. Groundwater would be expected to be flowing in a generally southeasterly direction towards the River Thames, located approximately 920 m to the southeast of the site.

Flood data obtained from the EA shows that the site is not within the likely zone of flooding or extreme flooding from rivers or seas without defences, whilst surface water flooding maps published by the EA indicate that the site is located in an area at low to medium risk from surface water flooding, although the site itself is not shown to have suffered from surface water flooding in 1975 and 2002 on Figure 15 of the Arup Report.

The site is entirely covered in hardstanding, such that infiltration of rainwater in to the ground beneath the site is limited to cracks or damage in the hardstanding, the majority of surface runoff is therefore likely to drain into combined sewers.

Reference to Figure 11 of the Arup Report in the Camden Basement Planning Guidance indicates the site is not located 500 m of any historical river courses.

3.0 SCREENING

GEA has carried out a review of the answers given for the subterranean and stability screening questions within the Engenuiti BIA report. The flowchart questions and responses to these questions are tabulated below.

3.1 Subterranean (groundwater) Screening Assessment

Question	Response for 7 Denmark Street
1a. Is the site located directly above an aquifer?	Yes. The site is on the Lynch Hill Gravel Formation classified as a Secondary 'A' Aquifer. This has been confirmed through desk study research
1b. Will the proposed basement extend beneath the water table surface?	Unlikely. Groundwater monitoring from the nearby previous boreholes indicate groundwater to be present within the Lynch Hill Gravel at depths of between 3.7 m and 4.4 m below ground level
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	No.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No. The site is entirely covered in hardstanding, a condition that will remain post-development.
5. As part of the 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. The existing surface drainage regime will be maintained.
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. There are no surface water features within 500 m of the site.

The answers given in the Engenuiti BIA are considered to be correct and acceptable and therefore the assessment has identified the following potential issues that need to be assessed:



- Q1a The site is located directly above the Lynch Hill Gravel Member, which is a Secondary 'A' Aquifer.
- Q1b Although unlikely, there is a requirement to determine whether or not the basement structure will extend below the water table.

3.2 Stability Screening Assessment

Question	Response for 7 Denmark Street
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No. A site walkover and topographical maps confirm that there are no slopes on the site.
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No. See structural drawings within the Engenuiti BIA.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	A site walkover and topographical maps confirm that there are no slopes on neighbouring sites.
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No, as above.
5. Is the London Clay the shallowest strata at the site?	No. The geological map and previous investigations confirm that the Lynch Hill Gravel is the shallowest stratum.
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	No. No tree will be felled as part of the proposed basement development.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	No. There is no evidence of heave related movement in the existing buildings.
8. Is the site within 100 m of a watercourse or potential spring line?	No, as confirmed through topographical and historical maps of the area.
9. Is the site within an area of previously worked ground?	Possibly. The boreholes from the previous investigations indicate significant thicknesses of made ground, although a review of historical maps did not indicate any potential areas of worked ground.
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 constructions.	Yes. The site is underlain by an aquifer and the basement structure could possibly extend below the water table
11. Is the site within 50 m of Hampstead Heath ponds?	No.
12. Is the site within 5 m of a highway or pedestrian right of way?	Yes. The site fronts onto Denmark Street to the north.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	No. The basement will be constructed down to similar levels as the adjacent buildings which also have single storey basements. The proposed founding depth will be lower than the foundations to some buildings on Denmark Street
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No. See information contained within the Engenuiti BIA

The answers given in the Engenuiti BIA are considered to be correct and acceptable and therefore the assessment has identified the following potential issues that need to be assessed:

- Q9 There is the possibility that there is a significant thickness of made ground present below the site.
- Q10 The site is located within the Secondary 'A' Aquifer of the Lynch Hill Gravel Member.
- Q12 Denmark Street runs parallel to the northern boundary of the site.

4.0 SCOPING AND SITE INVESTIGATION

The purpose of scoping is to assess in more detail the factors to be investigated in the impact assessment. Potential impacts are assessed for each of the identified potential impact factors.

4.1 **Potential Impacts**

The following potential impacts have been identified by the screening process

Potential Impact	Consequence
The site is located directly above an aquifer	The site is underlain by the Lynch Hill Gravel Member, which is classified as a Secondary 'A' Aquifer. This has the potential of being able to support local water supplies as well as forming an important source of base flow for local rivers. There is the potential for the hydrogeological setting to be affected by a basement structure that extends below the groundwater table.
There is the potential for significant thicknesses of made ground to be present below the site.	Poorly compacted made ground can give rise to instabilities within excavations and it is not uncommon for existing buildings and structures in London to be founded on such soils. Stability of the excavation and surrounding properties can be an issue in such circumstances.
The site located within 5 m of Denmark Street public highway and pedestrian right of way.	The public walkway of Denmark Street borders the site to the north and the excavation of a basement can cause instability of such structures. However, the proposed basement expansion is actually over 5 m away from the footway.

These potential impacts have been investigated through the site investigation, as detailed below.

4.2 **Exploratory Work**

Access to the rear of the property was limited by the presence of the existing house. Therefore, in order to meet the objectives described in Section 1.2, as far as possible within the access restrictions, two boreholes were drilled to a depth of 5.00 m using window sampling equipment to allow the logging of the underlying geology and the recovery of disturbed samples. Two standpipes were installed in each of the boreholes to depths of 3.80 (21.24 m OD) and 4.35 m (17.99 m OD), which have been monitored on two occasions, one week and three weeks after installation.

All of the above work was carried out under the supervision of a geotechnical engineer from GEA.

The borehole records are enclosed, together with a site plan indicating the exploratory positions. The Ordnance Datum (OD) level shown on the borehole have been interpolated from spot heights shown on site survey drawings (ref 07397 01 - 02, dated Jan 2008), which were provided by Engenuiti.



4.3 Sampling Strategy

Borehole No 1 was advanced from existing basement level to 5.00 m (17.34 m OD), whilst Borehole No 2 was advanced to 5.00 m (20.04 m OD) from ground floor level at the rear of the site, in the area of the proposed excavation. The borehole positions were positioned on site by GEA, whilst avoiding areas of known services.

5.0 GROUND CONDITIONS

Beneath a nominal to significant thickness of made ground, Lynch Hill Gravel was encountered over the London Clay Formation, which was proved to the maximum depth investigated, of 5.00 m (17.34 m OD).

5.1 Made Ground

Beneath the existing ground floor and basement floor slabs, the made ground generally comprised light grey silty clayey sand with frequent fragments of brick, clinker, flint gravel and concrete, and extended to depths of between 0.40 m (21.94 m OD) and 2.50 m (22.54 m OD).

Apart from the presence of extraneous material, no visual or olfactory evidence of contamination was noted in the made ground.

5.2 Lynch Hill Gravel

The Lynch Hill Gravel generally comprised light orange-brown, grey and light yellowish grey, locally clayey, silty gravelly sand which extended to the maximum depth investigated in Borehole No 1, of 5.00 m (20.04 m OD) and 2.50 m (19.84 m OD) in Borehole No 2, which was advanced from existing basement level. The density of the granular soils prevented further progress of Borehole No 2.

These soils were observed to be free of any evidence of soil contamination.

5.3 London Clay

The London Clay was encountered in Borehole No 2 only and soft light brown silty clay to a depth of 3.00 m (19.34 m OD) over firm fissured grey silty clay to the maximum depth investigated of 5.00 (17.34 m OD).

These soils were observed to be free of any evidence of soil contamination.

5.4 Groundwater

Groundwater was only encountered during drilling in Borehole No 1, from within the Lynch Hill Gravel at a depth of approximately 1.80 m below basement level (20.54 m OD), and was subsequently measured at a depth of 2.19 m (20.15 m OD) on a single occasion.



Part 2: GROUND MOVEMENT ASSESSMENT & BIA CONCLUSIONS

This section of the report comprises an analysis of the ground movements arising from the proposed basement and foundation scheme and the information obtained from the investigation, presented in Part 1 of the report.

6.0 INTRODUCTION

The sides of a basement excavation will move to some extent regardless of how they are supported. The movement will typically be both horizontal and vertical and will be influenced by the engineering properties of the ground, groundwater level and flow, the efficiency of the various support systems employed during underpinning and piling and the efficiency or stiffness of any support structures used.

An analysis has been carried out of the likely movements arising from the proposed basement excavation and the results of this analysis have been used to predict the effect of these movements on surrounding structures.

It is understood that it is proposed to excavate a single level basement extension below the rear of the site, which will extend to a depth of 3.50 m below ground floor level. It is currently proposed to form the basement retaining walls using conventional underpinning.

6.1 Basis of Ground Movement Assessment

6.1.1 Nearby Sensitive Structures





Sensitive structures relevant to this assessment are Nos 6 and 8 Denmark Street to the east and west respectively, 122 Charing Cross Road to the south and the retained Grade II listed structure of No 7 Denmark Street, which is adjacent to the northern extent of the proposed basement extension. A plan showing the locations of the site and neighbouring buildings is shown on the previous page.

Each of the surrounding structures include basement levels and the heights of the buildings have been provided on survey drawings provided by Engenuiti, who have also supplied existing foundation levels. The heights and foundation levels of each of the nearby sensitive structures are summarised in the table below, with the diagram below showing the sensitive structures in relation to the proposed basement excavation.

Sensitive Structure	Structure Reference	Foundation level (m AOD)	Height of building above ground level (m)
	А	-2.50	15
No 6 Denmark St	B to D	-0.70	9
	E to F	-2.50	15
No 7 Denmark St	A to D	-3.50	15
No 8 & No 9 Denmark St	9A, 9B & 8A	-3.50	18
No 122 Charing Cross Rd	A to B	-3.50	18

The diagram below details the sensitive structures in relation to the proposed excavation.



The following drawings have been referred to, where relevant, to model the sensitive structures and proposed excavation.

Drawing Reference	Drawing Title
1401_7D(00)000, dated August 2014	Existing Location Plan
1401_7D(00)200, dated August 2014	Proposed Basement and Ground Floor Plan
1401_7D(00)231, dated August 2014	Proposed Section
07397-01B, dated January 2008	Basement Plan
07397-02F, dated January 2008	Ground Floor and Site Plan
07397-05A, dated January 2008	Denmark Street Elevation 1

6.2 Construction Methodology

It is proposed to construct the 3.50 m deep basement excavation through localised underpinning of the existing foundations using a hit and miss approach, with panels of no more than 1.2 m in length. The underpinning will be carried out in a single stage from the base of the existing foundations, of 1.80 m below ground level, down to formation level. Temporary support and propping will be adopted to maintain stability. The underpins will be adequately laterally propped and sufficiently dowelled together, and the concrete will be cast and adequately cured prior to excavation of the basement and removal of the formwork and supports. It is assumed that the corners of the excavation will be locally stiffened by cross-bracing or similar and that the new retaining walls will not be cantilevered at any stage during the construction process.

7.0 GROUND MOVEMENTS

An assessment of ground movements within and surrounding the excavations has been undertaken using the X-Disp and P-Disp computer programs licensed from the OASYS suite of geotechnical modelling software from Arup. These programs are commonly used within the ground engineering industry and are considered to be appropriate tools for this analysis.

The X-Disp program has been used to predict ground movements likely to arise from the construction of the proposed through lateral movement (horizontal movement) of soil behind the proposed bored pile and insitu reinforced concrete retaining walls. The analysis of potential ground movements within the excavation and vertical movements outside of the retaining walls, as a result of unloading of the underlying soils, has been carried out using the Oasys P-Disp Version 19.3 – Build 12 software package and is based on the assumption that the soils behave elastically, which provides a reasonable approximation of soil behaviour at small strains. The ground movements predicted by P-Disp have then been imported into the X-Disp program, which has then been used to undertake the subsequent damage assessment associated with the construction of the proposed underpins.

For the purpose of these analyses, the corners have been defined by x and y coordinates, with the x-direction approximately parallel with the orientation east-west, whilst the y-direction is approximately parallel with the orientation of north-south. Vertical movement is in the z-direction. Wall lengths of less than 10 m have been modelled as 1 m long structural elements, while greater than 10 m wall lengths have been modelled as 2 m elements to reflect the greater stiffness of the longer walls.

The full outputs of all the analyses are included within the appendix.

7.1 Movements within the Excavation (Heave)

Model Used

Unloading of the London Clay will take place as a result of the proposed excavation and the reduction in vertical stress in the short term will cause heave to take place. Undrained soil parameters have been used to estimate the potential short-term movements, which include the "immediate" or elastic movements as a result of the basement excavation. Drained parameters have been used to provide an estimate of the total movement, which includes long term swelling that will continue for a number of years.

The elastic analysis requires values of soil stiffness at various levels to calculate displacements. Values of stiffness for the soils at this site are readily available from published data and we have used a well-established method to provide our estimates. Published data³ indicates stiffness values of 750 x Cu for the London Clay and a ratio of E' to Eu of 0.75, and it is considered that this provides a sensible approach. The strength profile of the underlying clay has been extrapolated from the results of the aforementioned nearby GEA ground investigations. The results show a typical profile for London Clay.

For granular soils of the Kempton Park Gravel, a relationship of 2000 x SPT 'N' has been used to obtain values of Youngs Modulus.

The proposed basement excavation will result in an unloading of around 60 kN/m^2 . The existing loads, as provided by the structural engineers, have been taken into consideration in analysing the short-term heave, as the building will remain in place during excavation. These loads, in addition to the new proposed loads, have also been taken into account in analysing the total drained movements.

The soil parameters used in this assessment have been established from the investigation on site and previous cable percussion boreholes advanced during the Concept site investigation in the adjacent Book Mews; they are tabulated below.

Stratum	Depth range (m)	Eu (MPa)	E' (MPa)
Made Ground	GL to 2.5	7.5	4.5
Lynch Hill Gravel	2.5 to 6.0	54	54
London Clay	6.0 to -30.0	41.5 to 112.5	24.5 to 67.5

A rigid boundary for the analysis has been set at 30 m below the site, at which depth the London Clay is expected to be essentially incompressible and not affected by the basement excavation.

Results

The predicted movements are summarised in the table below; the results are presented below and in subsequent tables to the degree of accuracy required to allow predicted variations in ground movements around the structure(s) to be illustrated, but may not reflect the anticipated accuracy of the predictions.



³ Burland JB, Standing, JR, and Jardine, FM (2001) Building response to tunnelling, case studies from construction of the Jubilee Line Extension CIRIA Special Publication 200

	Heave Movement (mm)*			
Location	Short-term Heave (Excavation Phase)	Long-term Heave (post construction)	Total Heave	
Centre of main excavation	6	1	7	
Edge of excavations	3	1	4	
At 5 m from edge of excavations	0 to 1	0 to 1	0 to 2	

The P-Disp analysis indicates that, by the time the basement excavation and construction is complete, up to 6 mm of heave is likely to have taken place across the centre of the excavation, reducing to less than 5 mm at the edges. Following completion of the basement construction, taking into consideration the proposed loads, 7 mm of heave is likely to occur across the centre of the excavation, reducing to 4 mm at the edges.

If a compressible material is used beneath the slab, it will need to be designed to be able to resist the potential uplift forces generated by the ground movements. In this respect, potential heave pressures are typically taken to equate to around 40% of the total unloading pressure.

7.2 **Ground Movements – Surrounding the Excavation**

Model Used

For the X-Disp analysis, the soil movement relationships used for the embedded retaining walls are the default values within CIRIA report C760⁴, which were derived from a number of historic case studies. Published data for ground movements associated with underpinned retaining walls and the subsequent excavation of a new basement is limited compared to other types of retaining wall discussed above. It is possible to use the well-documented predictions and movement curves for embedded retaining walls contained within CIRIA C760, although this approach is considered to be conservative. Therefore, the analysis of potential ground movements associated with the underpinned basement, as a result of unloading of the underlying soils has been carried out using the Oasys P-Disp software package as discussed previously. The analysis of potential horizontal ground movements associated with the basement and lower ground floor excavations have been modelled using Oasys X-Disp using a ratio of horizontal movement of 0.015% of the basement excavation depth relative to the underside of the foundations of the adjacent structures. The movements predicted by the P-Disp assessment for vertical movement were imported into the X-Disp model and a combined model and building damage assessment completed.

Results

The predicted movements are based on the worst case of the individually analysed segments of 'hogging' and 'sagging' and these are summarised in the tables below. It should be noted that the combined effect of segments acting together typically improves the resultant movements and therefore these values are deemed to be conservative. The structures location plan in the appendix details the position of each of the walls.

The results discussed below and have been presented to the degree of accuracy required to allow predicted variations in ground movements around the structures to be illustrated, but may not reflect the anticipated accuracy of the predictions.



Gaba, A, Hardy, S, Powrie, W, Doughty, L and Selemetas, D (2017) *Embedded retaining walls – guidance for economic design* CIRIA Report C760

The analysis has indicated that the maximum horizontal settlements that will result from the construction of underpinning installation are less than 5 mm.

8.0 BUILDING DAMAGE ASSESSMENT

In addition to the above assessment of the likely movements that will result from the proposed development, the neighbouring buildings are considered to be sensitive structures, requiring Building Damage Assessments, on the basis of the classification given in Table 6.4 of C760¹. The structures location plan in the appendix details the position of each of the walls.

8.1 **Damage to Neighbouring Structures**

The movements resulting from the wall installation phase and the combined retaining wall installation and basement excavation phases, have been estimated using the X-Disp modelling software to carry out an assessment of the likely damage to adjacent properties and the results are summarised for the combined wall installation and excavation in the table below.

Sensitive Structure	Structure Reference	Category of Damage*
6 Denmark Street	A to F	Category 0 – Negligible
Retained elevations of 7 Denmark Street	A, C and D	Category 0 – Negligible
8 Denmark Street	А	Category 0 – Negligible
9 Denmark Street	A and B	Category 0 – Negligible
122 Charing Cross Road	A and B	Category 0 – Negligible

*From Table 6.4 of $C760^{1}$: Classification of visible damage to walls.

The analysis has predicted that the proposed basement construction may result in a building damage category for sensitive structures of Category 0 (negligible). These movements reflect the relatively minor excavation required and are within the acceptable limits required by the London Borough of Camden.

8.2 Monitoring of Ground Movements

The predictions of ground movement based on the ground movement analysis should be checked by monitoring of adjacent properties and structures. The structures to be monitored during the construction stages should include all of the sensitive structures included within the assessment. Condition surveys of the existing structures should be carried out before and after the proposed works.

The precise monitoring strategy will be developed at a later stage and it will be subject to discussions and agreements with the owners of the adjacent properties and structures. Contingency measures will be implemented if movements of the adjacent structures exceed predefined trigger levels. Both contingency measures and trigger levels will need to be developed within a future monitoring specification for the works.



9.0 BIA CONCLUSIONS

The ground investigation has confirmed the findings of previous investigations carried out on adjacent sites, in that the Lynch Hill Gravel is present over the London Clay Formation. Groundwater has been measured at a depth of 2.19 m below existing basement level, approximately 4.70 m below ground level, and therefore the proposed basement extension will not extend below the groundwater table and will therefore not have an impact on the local hydrogeological setting.

The analysis has predicted that the proposed basement construction may result in a building damage category for sensitive structures of no greater than Category 0 (negligible). Therefore, the movements associated with the proposed basement excavation are considered to be acceptable and within the limits required by the London Borough of Camden for basement developments. The proposed development is not considered to pose a risk to the stability of the neighbouring properties or the footway or carriageway of Denmark Street.

10.0 OUTSTANDING RISKS AND ISSUES

This section of the report aims to highlight areas where further work is required as a result of limitations on the scope of the investigation and analysis, or where issues have been identified by the work that warrant further consideration. The scope of risks and issues discussed in this section is by no means exhaustive, but covers the main areas where additional work may be required.

The ground is a heterogeneous natural material and variations will inevitably arise between the locations at which it is investigated. This report provides an assessment of the ground conditions based on the discrete points at which the ground was sampled, but the ground conditions should be subject to review as the work proceeds to ensure that any variations from the Ground Model are properly assessed by a suitably qualified person.

A detailed monitoring regime is recommended at detailed design stage in order to ensure ground movements are restricted to acceptable limits.



APPENDIX

Borehole Records

Site Plan

Archive Borehole Records

P-DISP ANALYSIS:

Short Term Movement Plot

Total Movement Plot

X-DISP ANALYSIS

Wall Installation and Basement Excavation combined Contour Plots of Horizontal Movements (underpinning)

BUILDING DAMAGE ASSESSMENT – RESULTS TABLE



		Coot	appier & Environment		iata		Site		Numbor	
	GEA	Geote	Barn Widbury Hill Ware SG12 7QE	al Assoc	lates	5	7 Denmark Street, London, WC2H 8LZ		BH1	
Excavation	Method dowless Sampler	Dimens	ions	Ground Level (mOD) 22.34		l (mOD)	Client Cord Contracting Co Ltd		Job Number J18119	
		Locatio	n sement lightwell	Dates 25	/05/2	018	Engineer Engenuiti		Sheet	
Depth (m)	Sample / Tests	Water Depth	Field Records	Level (mOD)	D	epth (m)	Description		Legend Safe	
				21.94		(0.40)	MADE GROUND (fine grained concrete to 100 mm c light grey silty gravelly sand with lumps pf clay and fr gragments of cocnrete, flint, brick and clinker).	over requent		
				21.54		(0.40)	Light orange-brown sandy slightly gravelly CLAY. Gra fine subrounded flint. Sand is fine to coarse.	avel is	· · · · · · · · · · · · · · · · · · ·	
1.00	D1			21.34		(0.20)	Light orange-grey clayey SAND. Sand is fine to coars	rse i ne i	**	
				20.74		(0.60) 1.60	subrounded flint. Sand is fine to coarse, (Damp).	4	× · · · · · · · · · · · · · · · · · · ·	
2.00	D2		Water strike(1) at 1.80m.			(0.90)	Light yellow-grey sitty Sand. Sand is line to coarse.	• •	∑ × ∑ 1	
0.50	52			19.84		2.50	Soft light brown silts CLAV	•	× × ×	
2.50	D3					(0.50)	Solt light brown silty CLAY	-	×	
				19.34		3.00	Firm fissured light grey silty CLAY.		×	
3.50	D4							-	×	
4.00	D5					(2.00)			×	
								-	×	
				17.24		5.00		-	×	
				17.34		5.00	Complete at 5.00m			
Remarks Borehole fell	back from 3.80 m to	94.00 m.			<u>F</u>		(a	Scale approx)	Logged By	
								1:50	LS	
								Figure No J1811	o. 9.BH1	

		Contor	chnical & Environment		iatos	Site		Number
	GEA	Widbury Ba	arn Widbury Hill Ware SG12 7QE	ai Assuc	Idles	7 Denmark Street, London, WC2H 8LZ		BH2
Excavation	Method dowless Sampler	Dimensio	ons	Ground Level (mOD) 25.04		Client Contracting Co Ltd		Job Number J18119
		Location Gro	und floor	Dates 25	/05/2018	Engineer Engenuiti		Sheet 1/1
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description		Kater V
3.00	D1 D2			24.24 22.54 22.54 20.04	(Thičkićess)	MADE GROUND (dark grey black silty sand with fr of brick and flint). MADE GROUND (light grey clayey sand with frequ fragments of clinker, brick, flint and rare concrete). becoming sandy clay at 1.40 m. Light yellow-grey very sandy slighty gravelly CLAY. is fine subrounded flint. Sand is fine to coarse. Light orange silty gravelly SAND. Gravel is fine to r subrounded flint. becoming green grey at 3.00 . becoming sand only at 3.80 m.	agments eent Gravel medium	
Remarks Borehole terr	minated due to dens	e sand.					Scale (approx)	Logged By
							1:50	LS
						-	Figure N	о.
							J181 ⁻	19.BH2



Dasys

GEA LIMITED (GEOTECHNICAL &ENV ASSOC)

7 Denmark Street, London WC2H 8LZ

Undrained short-term movement

Job No.	Sheet No.	Rev.
J18119		
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Undrained short-term movement

Job No.	Sheet No.	Rev.
J18119		
Drg. Ref.		
Made by ML	Date	Checked



Dasys

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Drained total movement

Job No.	Sheet No.	Rev.
J18119		
Drg. Ref.		
Made by ML	Date	Checked



)asys

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Drained total movement

Job No.	Sheet No.	Rev.
J18119		
Drg. Ref.		
Made by ML	Date	Checked



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7 Denmark Street, London WC2H 8LZ			k	
	Made by ML	Date 14-Jun-2018	Checked	

Horizontal Displacement Contours: Grid 1 (level 0.000m) Interval 0.5mm





Job No.

heet No.	Rev.

Checked

(GEOTECHNICAL & ENV ASSOC)

GEA LIMITED

7 Denmark Street, London WC2H 8LZ

ISVS

Combined lateral and horizontal movements

Drg.	Ref.
Made	by

ML

J18119

14-Jun-2018

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Date

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Specific Building Damage Results - Horizontal Displacements

Structu	Structure: No 6 Denmark Street Sub-structure: No6 A							
Dist.	Co	oordinates	5		Di	splacements		
	x	У	z	x	У	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]	
0.0	30.80000	37.20000	-2.50000	0.0	0.0	0.0	0.0	d
1.9328	31.98750	35.67500	-2.50000	0.0	0.0	0.0	0.0	d
3.8656	33.17500	34.15000	-2.50000	0.0	0.0	0.0	0.0	d
5.7985	34.36250	32.62500	-2.50000	0.0	0.0	0.0	0.0	d
7.7313	35.55000	31.10000	-2.50000	0.0	0.0	0.0	0.0	d
9.6641	36.73750	29.57500	-2.50000	0.13457	-0.19703	0.23814	-0.014876	d
11.597	37.92500	28.05000	-2.50000	0.34961	-0.54554	0.64523	-0.059331	d
13.530	39.11250	26.52500	-2.50000	0.021970	-0.65695	0.53183	-0.38628	d
15.463 d - Dis	40.30000 splacement	25.00000 ts include	-2.50000 e imported	-1.0749 d displace	-0.85992 ements.	0.018074	-1.3764	d

Structure: No 6 Denmark Street | Sub-structure: No6 C

Dist.	C	oordinates	5		Displacements					
	x	У	z	x	У	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line			
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]			
0.0	43.10000	21.10000	-0.70000	-0.15186	-0.12149	-0.19438	-0.0060743	d		
1.5000	44.30000	22.00000	-0.70000	-0.047847	-0.037126	-0.060553	-992.73E-6	d		
3.0000	45.50000	22.90000	-0.70000	0.0	0.0	0.0	0.0	d		
4.5000	46.70000	23.80000	-0.70000	0.0	0.0	0.0	0.0	d		
6.0000 d - Di:	47.90000 splacement	24.70000 ts include	-0.70000 e imported	0.0 d displacer	0.0 ments.	0.0	0.0	d		

Structure: No 6 Denmark Street | Sub-structure: No6 D

Dist.	Co	ordinates	5			Displacement	ts	
	x	У	z	x	У	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]	
0.0	47.90000	24.70000	-0.70000	0.0	0.0	0.0	0.0	d
0.57255	47.56250	25.16250	-0.70000	0.0	0.0	0.0	0.0	d
1.1451	47.22500	25.62500	-0.70000	0.0	0.0	0.0	0.0	d
1.7176	46.88750	26.08750	-0.70000	0.0	0.0	0.0	0.0	d
2.2902	46.55000	26.55000	-0.70000	0.0	0.0	0.0	0.0	d
2.8627	46.21250	27.01250	-0.70000	0.0	0.0	0.0	0.0	d
3.4353	45.87500	27.47500	-0.70000	0.0	0.0	0.0	0.0	d
4.0078	45.53750	27.93750	-0.70000	0.0	0.0	0.0	0.0	d
4.5804	45.20000	28.40000	-0.70000	0.0	0.0	0.0	0.0	d
d - Disp	placement:	s include	imported	displ	laceme	nts.		

Structure: No 6 Denmark Street | Sub-structure: No6 E

Dist.	Ce	oordinate	5			Displacement	ts	
	x	У	z	x	У	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]	
0.0	45.20000	28.40000	-2.50000	0.0	0.0	0.0	0.0	d
2.6433	43.61667	30.51667	-2.50000	0.0	0.0	0.0	0.0	d
5.2867	42.03333	32.63333	-2.50000	0.0	0.0	0.0	0.0	d
7.9300	40.45000	34.75000	-2.50000	0.0	0.0	0.0	0.0	d
10.573	38.86667	36.86667	-2.50000	0.0	0.0	0.0	0.0	d
13.217	37.28333	38.98333	-2.50000	0.0	0.0	0.0	0.0	d
15.860	35.70000	41.10000	-2.50000	0.0	0.0	0.0	0.0	d
d - Di	splacement	ts include	e imported	l dist	lacer	ments.		

Structure: No 6 Denmark Street | Sub-structure: No6 F

Dist.	Coordinates			Displacements				
	x	У	z	x	У	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line	
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]	
0.0	35.70000	41.10000	-3.50000	0.0	0.0	0.0	0.0	
1.0438	34.88333	40.45000	-3.50000	0.0	0.0	0.0	0.0	
2.0875	34.06667	39.80000	-3.50000	0.0	0.0	0.0	0.0	
3.1313	33.25000	39.15000	-3.50000	0.0	0.0	0.0	0.0	
4.1751	32.43333	38.50000	-3.50000	0.0	0.0	0.0	0.0	
5.2188	31.61667	37.85000	-3.50000	0.0	0.0	0.0	0.0	
6.2626	30.80000	37.20000	-3.50000	0.0	0.0	0.0	0.0	

Structure: No 9 Denmark Street | Sub-structure: No9 A

Dist.	C	oordinate	5			Displacement	ts
	x	У	z	x	У	Horizontal displacement along the Line	Horizontal displacement perpendicular
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	20,60000	29,40000	-3.50000	0.0	0.0	0.0	0.0
1.8118	21.71429	27.97143	-3.50000	0.0	0.0	0.0	0.0
3.6235	22.82857	26.54286	-3.50000	0.0	0.0	0.0	0.0
5.4353	23.94286	25.11429	-3.50000	0.0	0.0	0.0	0.0
7.2470	25.05714	23.68571	-3.50000	0.0	0.0	0.0	0.0
9.0588	26.17143	22.25714	-3.50000	0.0	0.0	0.0	0.0
10.871	27.28571	20.82857	-3.50000	0.0	0.0	0.0	0.0
12.682	28.40000	19.40000	-3.50000	0.0	0.0	0.0	0.0
Struct: Dist.	ure: No 9 Ce	Denmark :	Street S	Sub-st	ructi	<pre>Displacement</pre>	ts.
	x	У	z	x	У	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	28.40000	19.40000	-3.50000	0.0	0.0	0.0	0.0

>	No.			

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			ML 14-00/2018
Dist.	Coordinates x y z	Displacements x y Horizontal Horizontal displacement displacement along the perpendicular	
1.0888 2 2.1776 2 3.2664 3 4.3552 3 5.4441 3 6.5329 3 7.6217 3	29.07143 18.54286 -3.5000 29.74286 17.68571 -5.5000 30.41429 16.82857 -3.5000 31.08571 15.97143 -3.5000 31.75714 15.1429 -3.5000 32.42857 14.25714 -3.5000 33.10000 13.40000 -3.50000	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	
Structur	re: No 8 Denmark Street	Sub-structure: No8 A	
Dist.	Coordinates x y z	Displacements x y Horizontal Horizontal displacement along the perpendicular	
[m] 0.0 2 1.0600 2 2.1200 2 3.1800 2 4.2400 2 5.3000 2 6.3600 2	$ \begin{bmatrix} m \\ 25,7000 & 3,2000 & -3,5000 \\ 24,85000 & 32,56667 & -3,50000 \\ 24,0000 & 31,9333 & -3,50000 \\ 23,15000 & 31,30000 & -3,50000 \\ 22,30000 & 30,66667 & -3,50000 \\ 21,45000 & 0,03333 & -3,50000 \\ 20,60000 & 29,40000 & -3,50000 \\ 20,60000 & 29,40000 & -3,50000 \\ 20,60000 & 29,40000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & 20,6000 & -3,50000 \\ 21,60000 & -3,50000 \\ 21,60000 & -3,50000 \\ 21,6000 & -3,50000 \\ 21,6000 & -3,50000 \\ 21,6000 & -3,5000 \\ 21,6000 $	$ \begin{bmatrix} \text{Imm} \end{bmatrix} \\ \text{Imm} \end{bmatrix} \begin{bmatrix} \text{Imm} \end{bmatrix} \begin{bmatrix} \text{Imm} \end{bmatrix} \begin{bmatrix} \text{Imm} \end{bmatrix} \begin{bmatrix} \text{Imm} \end{bmatrix} \\ \text{Imm} \end{bmatrix} \begin{bmatrix} \text{Imm} \end{bmatrix} \begin{bmatrix} \text{Imm} \end{bmatrix} \begin{bmatrix} \text{Imm} \end{bmatrix} \\ \text{Imm} \end{bmatrix} \begin{bmatrix} \text{Imm} \end{bmatrix} \begin{bmatrix} \text{Imm} \end{bmatrix} \\ \text{Imm} \end{bmatrix} \\ \text{Imm} \end{bmatrix} \begin{bmatrix} \text{Imm} \end{bmatrix} \\ \text{Imm} \end{bmatrix} \begin{bmatrix} \text{Imm} \end{bmatrix} \\ \text{Imm} \end{bmatrix} \\ \text{Imm} \end{bmatrix} \begin{bmatrix} \text{Imm} \end{bmatrix} \\ \text{Imm} \\ \text{Imm} \\ $	
Structur	re: 122 Charing Cross Rd	Sub-structure: 122A	
Dist.	Coordinates x y z	Displacements x y Horizontal Horizontal displacement displacement along the perpendicular Line to Line	
[m] 0.0 2 2.1314 3 4.2629 3 6.3943 3	[m] [m] [m] 29.30000 10.20000 -3.50000 31.00000 11.48571 -3.50000 32.70000 12.77143 -3.50000 34.40000 14.05714 -3.50000	[mm] [mm] [mm] 0.0 <td></td>	
10.657 3 12.789 3 14.920 4 d - Disp	37.80000 16.62857 -3.50000 39.50000 17.91429 -3.50000 41.20000 19.20000 -3.50000 placements include importe	0.0 0.0 0.0 0.0 d d displacements. 0.0 0.0 0.0 d	
Structur	re: 122 Charing Cross Rd	Sub-structure: 122B	
Dist.	Coordinates x y z	Displacements x y Horizontal Horizontal displacement along the perpendicular	
[m] 0.0 4 1.2494 4 2.4988 4 3 7482 4	[m] [m] [m] 41.20000 19.20000 -3.50000 41.97778 18.22222 -3.50000 42.75556 17.24444 -3.50000	Ine to line [mm] [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	
4.9976 4 6.2470 4 7.4964 4 8.7458 4 9.9952 4	44.31111 15.28889 -3.50000 45.08889 14.31111 -3.50000 45.86667 13.33333 -3.50000 46.64444 12.35556 -3.50000 47.42222 11.37778 -3.50000	0.0 0.0 0.0 0.0 d. 0.0 0.0 0.0 0.0 d. d. 0.0 0.0 0.0 0.0 d. d. 0.0 0.0 0.0 d. d. d. 0.0 0.0 0.0 d. d. d. 0.0 0.0 0.0 d. d. d. d. 0.0 0.0 0.0 d. d. <td></td>	
11.245 4 d - Disp	48.20000 10.40000 -3.50000 placements include importe	0.0 0.0 0.0 0.0 d displacements.	
Structur	re: No 7 Retained Sub-st Coordinates	ructure: No7 A Displacements	
	х у z	x y Horizontal Horizontal displacement displacement along the perpendicular	
[m] 0.0 2 1.9233 2 3.8465 2 5.7698 2 7.6931 3	[m] [m] [m] 25.70000 33.20000 -2.50000 26.88571 31.68571 -2.50000 28.07143 30.17143 -2.50000 29.25714 28.65714 -2.50000 0.44296 -27.14296 -2.50000	Line Colline [mm] [mm] [mm] 0.0 0.0 [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	
9.6164 3 11.540 3 13.463 3 d - Disp	31.62857 25.62857 -2.50000 32.81429 24.11429 -2.50000 34.00000 22.60000 -2.50000 placements include importe	0.15972 -0.21906 0.27094 -0.0033003 d 0.37659 -0.51926 0.64224 -0.022045 d 0.88803 -0.36061 0.83140 0.47687 d d displacements.	
Structur	re: No 7 Retained Sub-st	ructure: No7 C	
Dist.	Coordinates x y z	Displacements x y Horizontal Horizontal displacement displacement along the perpendicular Line to Line	
[m] 0.0 3 1.9800 3 3.9600 3 5.9400 3	[m] [m] [m] 39.10000 26.10000 -2.50000 37.91429 27.68571 -2.50000 36.72857 29.27143 -2.50000 35.54286 30.85714 -2.50000		
7.9200 3 9.9000 3 11.880 3 13.860 3 d - Disp	34.35714 32.44286 -2.50000 33.17143 34.02857 -2.50000 31.98571 35.61429 -2.50000 30.80000 37.20000 -2.50000 placements include importe	0.0 0.0 0.0 0.0 0.0 d 0.0 0.0 0.0 0.0 0.0 d 0.0 0.0 0.0 0.0 0.0 d 0.0 0.0 0.0 0.0 0.0 d d displacements.	
Structur	re: No 7 Retained Sub-st	ructure: No7 D	
Dist.	Coordinates x y z	Displacements x y Horizontal Horizontal displacement displacement along the perpendicular	
[m] 0.0 3 1.0803 2 2.1605 2 3.2409 2	[m] [m] [m] 30.80000 37.20000 -2.50000 29.95000 36.53333 -2.50000 29.10000 35.86667 -2.50000 28.25000 35.20000 -2.50000	Line to Line [mm] [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	
4.3210 2 5.4013 2 6.4815 2 d - Disp	27.40000 34.53333 -2.50000 26.55000 33.86667 -2.50000 25.70000 33.20000 -2.50000 placements include importe	0.0 0.0 0.0 0.0 0.0 d 0.0 0.0 0.0 0.0 0.0 d 0.0 0.0 0.0 0.0 0.0 d d displacements.	
Specific	Building Damage Results - Ve	ertical Displacements	
Structur	re: No 6 Denmark Street	Sub-structure: No6 A	
Dist.	Coordinates	Displacements	

GEA LIMITED

(GEOTECHNICAL & ENV ASSOC)

Job	No

i	Sheet No.	F	lev.

Checked

7 Denmark Street, London WC2H 8LZ

ISVS

Combined lateral and horizontal movements

Made by ML

Drg. Ref.

J18119

Date 14-Jun-2018

[m]	x [m]	y [m]	z [m]	z [mm]	
Vertical	Offset	1			
0.0 30	.80000	37.20000	-2.50000	-0.36396 d -0.12971 d	
3.8656 33	.17500	34.15000	-2.50000	-0.18673 d	
7.7313 35	.55000	31.10000	-2.50000	-0.40522 d	
11.597 37	.92500	28.05000	-2.50000	-0.95219 d	
13.530 39 15.463 40	.30000	26.52500	-2.50000	-1.3819 d -1.8711 d	
d - Displ	acement	s include	imported	displacement	s.
Structure	: No 6	Denmark S	treet S	ub-structure:	No6 C
Dist.	Co	ordinates		Displace	ements
[m]	x [m]	Y [m]	z [m]	z [mm]	
Vertical	Offset	1			
0.0 43	.10000	21.10000	-0.70000	-3.9354 d	
3.0000 45	.50000	22.90000	-0.70000	-0.80501 d	
6.0000 47	.90000	24.70000	-0.70000	-0.78577 d	
d - Displ	acement	s include	imported	displacement	s.
Structure	: No 6	Denmark S	treet S	ub-structure:	No6 D
Dist.	c	Coordinate	s	Displac	cements
[m]	x [m]	Y [m]	z [m]	z [mm]	
Vertical	Offset	1			
0.0 4	7.90000	24.70000	-0.70000	-0.78577 d	
1.1451 4	7.22500	25.62500	-0.70000	-0.41394 d	
1.7176 4	6.55000	26.08750	-0.70000	-0.42034 d -0.42369 d	
2.8627 4 3.4353 4	6.21250 5.87500) 27.01250) 27.47500	-0.70000	-0.42394 d -0.42112 d	
4.0078 4	5.53750	27.93750	-0.70000	-0.41537 d -0.40691 d	
d - Displ	acement	s include	imported	displacement	s.
Structure	: No 6	Denmark S	treet S	ub-structure:	No6 E
Dist.	Сс •	ordinates	-	Displace	ements
[m]	[m]	[m]	[m]	[mm]	
Vertical	Offset	1			
0.0 45 2.6433 43	.20000	28.40000 30.51667	-2.50000	-0.40691 d -0.34446 d	
5.2867 42	.03333	32.63333 34.75000	-2.50000	-0.26332 d	
10.573 38	.86667	36.86667	-2.50000	-0.12949 d	
15.860 35	70000	41 10000	0 50000	0 11550 3	
d - Displ	acement	s include	imported	displacement	s.
d - Displ	acement	s include	imported	displacement	s.
d - Displ Structure	acement	Denmark S	imported	-0.11552 d displacement ub-structure:	s. No6 F
d - Displ Structure Dist.	acement : No 6 Co	Denmark S	-2.50000 imported treet S z	-U.11552 d displacement ub-structure: Displaceme z	no6 F
d - Displ Structure Dist. [m]	: No 6 Cc x [m]	Denmark S ordinates y [m]	z [m]	-0.11552 d displacement ub-structure: Displaceme z [mm]	s. No6 F
d - Displ Structure Dist. [m] Vertical 0.0 35	: No 6 : No 6 Cc x [m] Offset .70000	Denmark S y [m] 1 41.10000	-2.30000 imported treet S [m] -3.50000	-0.11552 d displacement ub-structure: Displaceme z [mm] 0.0	no6 F
<pre>d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34</pre>	. No 6 . No 6 . (m) . 70000 . 88333 . 06667	<pre>41.10000 cs include Denmark S pordinates y [m] 1 41.10000 40.45000 39.80000</pre>	-2.50000 imported treet S [m] -3.50000 -3.50000	-0.11552 d displacement ub-structure: Displaceme z [mm] 0.0 0.0 0.0	no6 F
<pre>d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 3.1313 33</pre>	: No 6 : No 6 Co x [m] Offset .70000 .88333 .06667 .25000 43333	<pre>110000 s include Denmark S y [m] 1 41.10000 40.45000 39.80000 39.15000</pre>	-2.30000 imported treet S [m] -3.50000 -3.50000 -3.50000 -3.50000	-0.11552 d displacement ub-structure: Displaceme z [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0	s. Nof F
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 3.1313 33 4.1751 32 5.2188 31	: No 6 : No 6 Cc x [m] Offset .70000 .88333 .06667 .25000 .43333 .61667	<pre>11.0000 cs include Denmark S y [m] 1 41.10000 40.45000 39.80000 39.80000 39.5000 37.85000 37.85000</pre>	z [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000	-0.11552 d displacement ub-structure: Displaceme z [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	no6 F
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 3.1313 33 4.1751 32 5.2188 31 6.2626 30	: No 6 x [m] Offset .70000 .88333 .06667 .25000 .43333 .61667 .80000	A1.10000 cs include Denmark S pordinates y [m] 1 41.10000 40.45000 39.15000 39.15000 37.85000 37.20000	-2.50000 imported treet S [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000	-0.11552 d displacement ub-structure: [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	s. Nof F
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 3.1313 33 4.1751 32 5.2188 31 6.2626 30 Structure	: No 6 x [m] Offset .70000 .88333 .06667 .25000 .43333 .61667 .80000 : No 9	Al.10000 s include Denmark S ordinates y [m] 1 41.10000 40.45000 39.80000 39.15000 37.85000 37.20000 Denmark S	2.50000 imported treet S [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000	-0.11522 a displacement ub-structure: Displacement z [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	:S. : No6 F ents : No9 A
d - Displ Structure Dist. [m] Vertical 0.035 1.043834 2.087534 3.131333 4.175132 5.218831 6.262630 Structure Dist.	: No 6 x [m] offset .70000 .88333 .06667 .25000 .43333 .61667 .80000 : No 9 cc	<pre>41.10000 s include Denmark S pordinates y [m] 1 41.10000 40.45000 39.15000 37.85000 Denmark S pordinates y</pre>	<pre>2.3000 imported treet S [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000</pre>	-0.11522 ad displacement ub-structure: Displacement g [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	:: No6 F ents :: No9 A ents
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 3.1313 33 4.1751 32 5.2188 31 6.2626 30 Structure Dist. [m]	: No 6 Cc x [m] Offset .70000 .88333 .06667 .25000 .43333 .61667 .80000 : No 9 Cc x [m]	A.10000 Denmark S Sordinates Y [m] 1 1 41.10000 40.45500 39.85000 39.85000 37.85000 37.85000 37.85000 37.85000 Denmark S Sordinates Y [m]	2.3000 imported treet S [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 treet S [m]	-0.11522 ad displacement Displacement [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	:: No6 F ents : No9 A ents
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 2.0875 34 1.0438 34 2.1875 32 5.2188 31 6.2626 30 Structure Dist. [m] Vertical Vertical (m) Vertical (m) Vertical (m) Vertical (m) Vertical (m) Vertical (m) Vertical (m) Vertical (m) (m) (m) (m) (m) (m) (m) (m)	: No 6 Cc x [m] Offset .70000 .88333 .06667 .25000 .43333 .61667 .80000 : No 9 Cc x [m] Ofset	<pre>41.10000 s include Denmark S cordinates y [m] 1 41.10000 40.45000 39.85000 37.85000 37.85000 37.85000 Denmark S cordinates y [m] 1 1</pre>	-2.50000 imported treet S [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 treet S [m]	-0.11522 at displacement Displacement g [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	:s. : No6 F ents : No9 A ents
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 3.1313 33 4.1751 32 5.2188 31 6.2626 30 Structure Dist. [m] Vertical 0.0 20 1.8118 21	<pre>. No 6</pre>	4.10000 4.10000 Denmark S bordinates y [m] 1 1 41.10000 40.45000 39.15000 39.15000 37.85000 37.85000 37.85000 Denmark S bordinates y [m] 1 29.40000 27.97143	-2.50000 imported treet S [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 treet S [m] -3.50000 -3.50000 -3.50000	-0.11522 at displacement ub-structure: Displaceme g [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	:: No6 F ents : No9 A ents
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 3.1313 33 4.1751 32 5.2188 31 6.2626 30 Structure Dist. [m] Vertical 0.0 20 1.8118 21 3.6225 22 5.4353 23 5.4353 23	x No 6 x (m) 06667 .25000 .43333 .61667 .80000 x No 9 cc x (m) cc x (4.10000 4.10000 Denmark S 5000 1 1 1 1 1 1 1 1 1 1 1 1 1	2.30000 imported imported [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000	-0.11522 d displacement ub-structure: Displaceme [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	:s. : No6 F ents : No9 A ents
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 1.0438 34 1.0	<pre>. No 6</pre>	<pre>4.10000 4.1000 Denmark S y [m] 4.10000 40.45000 33.8000 33.8000 37.85000 37.85000 37.85000 Denmark S p [m] 1. 1. 2. 3.0000 2. 3.1200 Denmark S 2. 3.2000 Denmark S 2. 3.2000 Denmark S 2. 3.2000 Denmark S 2. 3.2000 Denmark S 3.2000 Denmark</pre>	2.30000 imported treet S [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000	-0.11522 ad displacement Displacement [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	:s. : No6 F ents : No9 A ents
d - Displ Structure Dist. [m] Vertical 0.035 1.0438 34 2.0673 33 4.1751 32 5.2188 31 6.2626 30 Structure Dist. [m] Vertical 0.035 0.0438 34 0.2626 30 Structure Dist. [m] Vertical 0.035 0.0438 34 0.2626 30 Structure Dist. [m] Vertical 0.025 0.035	x x x [m] Offset x x [m] Offset x x [m] 0667 x x x (m] x (m) x (m) x 06667 x (m) x 00000 x x x (m) x 0045et x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x	<pre>4.10000 4.1000 Denmark S y [m] 1 1 41.10000 39.5000 39.5000 37.20000 Denmark S y [m] 1 29.40000 27.97143 26.54286 25.11429 23.68571 22.68573</pre>	2.30000 imported treet S [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000		:S. NOG F NOG A NOG A
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 3.1313 32 4.1718 32 6.2626 30 Structure Dist. [m] Vertical 0.0 25 0.0438 34 0.1318 21 3.0235 22 5.4335 32 7.2470 25 9.0588 26 10.871 27 12.662 28	acement acement x [m] Offset 70000 88333 .61667 .25000 .6667 .25000 .6667 .25000 .6667 .25000 .6667 .25000 .6667 .25000 .0667 .25000 .0667 .25000 .0667 .25000 .0667 .25000 .0667 .25000 .0667 .25000 .0667 .25000 .0667 .250000 .25000 .25000 .25000 .25000 .25000 .25000 .25000 .250000 .250000 .250000 .250000 .250000000000	<pre>4.10000 4.1000 2.1000 2.1000 4.1</pre>	2.30000 imported treet S [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000	-0.11522 ad displacement ub-structure: Displacement z [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	:8. : No6 F ents : No9 A ents
d - Displ Structure Dist. [m] Vertical 0.035 1.043834 2.087534 3.131333 4.175132 5.218831 6.262630 Structure Dist. [m] Vertical 0.0254 0.02543 Structure Dist. [m] Vertical 0.02543 5.218832 7.247025 9.0588266 1.87127 12.669228 Structure	acement acement x [m] Offset 70000 88333 .61667 .25000 0.6667 .25000 .6667 .25000 .6667 .25000 .6667 .25000 .6667 .25000 .6667 .25000 .0667 .25000 .0667 .25000 .0667 .25000 .0667 .25000 .0667 .25000 .0667 .250000 .250000 .250000 .250000 .250000 .250000 .250000 .250000 .250000 .250000000 .250000000000	4.10000 4.10000 Denmark S y [m] 1 1. 41.10000 40.45000 39.15000 39.15000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 Denmark S y [m] 1 29.40000 27.97143 26.54286 25.11429 23.68571 12.2.825714 20.82857 19.40000 Denmark S	2.30000 imported treet S [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000	-0.11522 ad displacement Displacement z [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 3.1313 33 4.1751 32 5.2188 31 6.2626 30 Structure Dist. [m] Vertical 0.0 20 0.0 32 0.0 35 0.0 812 0.0 81	x Coement x Cc	4.10000 4.10000 benmark S y 1 1 1 1.10000 40.45000 39.85000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 29.40000 29.40000 29.40000 20.5225 20.65225 20.65225 20.65257 19.40000 Denmark S Sordinates Sordinates Sordinates Sordinates	2.30000 imported treet S [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000		
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 3.1313 33 4.1751 32 5.2188 31 6.2626 30 Structure Dist. [m] Vertical 0.0 20 0.8118 21 3.6235 22 5.4353 23 7.2470 25 9.0588 26 10.871 27 12.682 28 Structure Dist. [m]	Image: None of the system Image: None of the system Image: None of the system None of the system Offset None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system	4.10000 4.10000 bernark S y [m] 1 41.10000 40.45000 39.80000 39.15000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 20.40000 29.40000 29.40000 20.8287 19.40000 Denmark S y [m] Denmark S y [m] 20.8287 19.40000 Denmark S y [m] Denmark S y [m]	2.30000 imported freet S [m] -3.5000000000 -3.500000 -3.50000000000000 -3	-0.11522 ad displacement ub-structure: Displaceme z [mm] 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	8. No6 F nnts No9 A nnts No9 B ents
d - Displ Structure Dist. [m] Vertical 0.035 1.043834 2.087534 3.131333 4.175132 5.218831 6.262630 Structure Dist. [m] Vertical Vertical Structure Dist. [m] Vertical Structure Dist. [m] Vertical	Image: None of the second se	4.10000 4.10000 bernmark S bordinates y [m] 1 41.10000 40.45000 39.15000 39.15000 37.85000 37.20000 Denmark S bordinates y [m] 1 20.40000 20.82571 19.40000 Denmark S bordinates y [m] 1 1	2.30000 imported freet S r [m] -3.500000 -3.500000000 -3.500000 -3.500000000000000		S. No6 F F No6
d - Displ Structure Dist. [m] Vertical 0.035 1.043034 2.087534 2.087534 2.087534 0.03054 2.087534 3.131333 4.175132 5.218831 6.262630 Structure Dist. [m] Vertical 0.020 1.045222 Structure Dist. [m] Vertical 0.038229 Vertical 0.028 1.045222 Structure Dist. [m]	Image: None of the system Image: None of the system Image: None of the system None system </td <td>4.10000 4.10000 bernmark S bordinates y [m] 1 1 41.10000 39.80000 39.15000 39.15000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 Denmark S bordinates y [m] 1 29.40000 Denmark S bordinates y [m] 1 19.40000 Denmark S bordinates [m] 1 19.40000 Denmark S bordinates [m] 1 19.40000 Denmark S [m] 1 19.40000 Denmark S [m] 1 19.40000 Denmark S [m] 1 19.40000 Denmark S [m] 1 19.40000 Denmark S [m] 1 19.40000 Denmark S [m] 1 19.40000 Denmark S [m] 19.40000 Denmark S [m] 19.400000 Denmark S [m] 19.400000 Denmark</td> <td>2.30000 imported freet S r [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000</td> <td></td> <td>. No6 F No9 F No9 A No9 B No9 B No9 B</td>	4.10000 4.10000 bernmark S bordinates y [m] 1 1 41.10000 39.80000 39.15000 39.15000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 37.85000 Denmark S bordinates y [m] 1 29.40000 Denmark S bordinates y [m] 1 19.40000 Denmark S bordinates [m] 1 19.40000 Denmark S bordinates [m] 1 19.40000 Denmark S [m] 1 19.40000 Denmark S [m] 1 19.40000 Denmark S [m] 1 19.40000 Denmark S [m] 1 19.40000 Denmark S [m] 1 19.40000 Denmark S [m] 1 19.40000 Denmark S [m] 19.40000 Denmark S [m] 19.400000 Denmark S [m] 19.400000 Denmark	2.30000 imported freet S r [m] -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000 -3.50000		. No6 F No9 F No9 A No9 B No9 B No9 B
d - Displ Structure Dist. [m] Vertical 0.035 1.043834 1.043834 1.043834 1.043834 1.043834 1.043834 1.043834 1.043834 1.043834 1.043844 1.043844 1.043844 1.043844 1.043844 1	: No 6 C C x (m) Offset 70000 06667 70000 83333 06667 70000 06667 83333 10574 83333 10567 10574 10574 107143 107145 107145 107145 107145 107145 107145 107145 107145 107145	<pre>4.10000 4.1000 4.1000 Denmark S y [m] 1 4.10000 3.5000 3.5000 3.5000 3.5000 Denmark S y [m] 2.9,40000 27.57143 20.55143 20.45571 2.2,257143 22.257144 20.4557 1 9.40000 Denmark S pordinates y [m] 1 9.40000 Denmark S pordinates</pre>	2.30000 imported treet S [m] -3.500000 -3.500000 -3.500000 -3.500000 -3.5000000000000000000000000000000000000		: No9 A nts No9 A nts No9 B nts
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d - Displ Structure Dist. [m] Vertical 0.035 1.043834 2.087534 3.131333 4.175132 5.218831 6.262630 Structure Dist. [m] Vertical 0.0252 4.35323 7.247025 Structure Dist. [m] Vertical 0.02628 Structure Dist. [m] Vertical 0.026428 Structure Dist. [m] Vertical 0.0264828 Structure Dist. [m] Vertical 0.02728 Structure Dist. [m] St	x No 6 Cc Cc x (m) Offset 70000 1 70000 43333 06667 3 70000 x (m) Cc x x (m) Offset (m) (m) (m)	<pre>4.10000 4.1000 4.1000 Denmark S y y [m] 1 4.10000 40.45000 39.80000 39.15000 37.85000 37.85000 37.85000 Denmark S primi 1 29.40000 27.97143 26.54286 (5.11429 23.68571 19.40000 Denmark S p [m] 1 10.1000 Denmark S p [m] 10.1000 Denmark S</pre>	-3.50000 imported treet S [m] -3.500000 -3.50000 -3.50000 -3.500000 -3.500000 -3.5000000000000000000000000000000000000		8. No6 F F No9 A No9 A No9 B No5 B No5 B
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 3.1313 33 4.1751 32 5.2188 31 6.2626 30 Structure Dist. [m] Vertical 0.0 20 1.8118 21 3.6235 22 9.0588 26 10.871 27 12.662 28 Structure Dist. [m] Vertical 0.0 20 2.4335 23 Structure Dist. [m] Vertical 0.0 20 2.4352 31 5.4345 22 7.6247 33 Structure	Image: None of the second se	<pre>4.10000 4.1000 4.1000 Denmark S y 1 1 41.10000 40.45000 39.80000 39.15000 37.20000 Denmark S y [m] 1 20.40000 27.97143 26.54286 25.11429 23.68571 19.40000 Denmark S y [m] 1 19.40000 Denmark S y [m] 1 19.40000 Denmark S </pre>	2.30000 imported treet S [m] -3.500000 -3.500000000 -3.500000 -3.500000 -		 No6 F No6 F No9 A No9 A No9 B No9 B No8 A No8 A
d - Displ Structure Dist. [m] Vertical 0.0 35 1.0438 34 2.0875 34 3.1313 33 5.2188 31 6.2626 30 Structure Dist. [m] Vertical 0.0 20 0.8118 21 3.6235 22 5.4353 23 7.2470 25 9.0588 26 10.871 27 12.6692 28 Structure Dist. [m] Vertical 0.0 20 2.4352 31 5.444 31 6.4352 31 5.444 31 5.4352 37 5.436 43 3.4352 31 5.444 31 5.4327 33 Structure Dist.	. No 6 . No 6 . Ca caement . No 6 . Caement . No 6 . Caement . Caement	<pre>4.10000 4.1000 4.1000 Denmark S y [m] 1 1 41.10000 40.45000 39.85000 39.15000 37.20000 Denmark S y [m] 1 20.40000 27.97143 26.54286 25.11429 23.68571 12.225714 20.82857 19.40000 Denmark S y [m] 1 19.40000 Denmark S y [m] 1 19.40000 Denmark S S S S S S S S S S S S S S S S S S S</pre>	2.30000 imported treet S [m] -3.500000 -3.500000000 -3.500000 -3.500000 -		 No6 F No6 F No9 A No9 A No9 B No9 B No8 A No8 A
d - Displ Structure Dist. [m] Vertical 0.035 1.0430 34 2.0875 34 2.0875 34 2.0875 34 3.1313 33 4.1751 32 5.2188 31 6.2626 30 Structure Dist. [m] Vertical 0.0 20 10.622 34 2.4352 32 5.4353 23 5.4354 23 Structure Dist. [m] Vertical 0.0 28 10.622 45 10.622 45	Image: None of the system Image: None of the system Image: None of the system None of the system Offset None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system Image: None of the system None of the system	4.10000 4.10000 4.10000 Denmark S y [m] 1 1 41.10000 39.80000 39.15000 37.85000 37.20000 Denmark S y [m] 1 29.40000 27.97143 26.54286 25.11429 23.68571 19.40000 Denmark S y [m] 1 19.40000 Denmark S y [m] 1 1.4257	2.30000 imported treet S [m] -3.500000 -3.500000000 -3.500000 -3.50000000		 No6 F No9 A No9 B No9 B No9 B No8 A No8 A nnts
d - Displ Structure Dist. [m] Vertical 0.035 1.0439 2.0875 34 2.0875 34 2.0875 34 2.0875 34 3.1313 33 4.1751 32 5.2188 31 6.2626 30 Structure Dist. [m] Vertical 0.028 1.0875 25 2.5.4351 23 Structure Dist. [m] Vertical 0.028 1.0888 29 2.1776 29 3.2664 30 Structure Dist. [m] Vertical Vertical Vertical 0.2875 32 3.2644 30 Structure Dist. [m] Vertical Vertical 0.328 32 3.2644 30 Structure Vertical Vertical Vertical Vertical Vertical Vertical Vertical Vertical Vertical Vertical Vertical Vertical Vertical	: No 6 Cc : No 6 Cc : No 6 Cc : No 6 Sc : No 6 Sc : No 7 Sc : No 9 Cc : No 8 Cc : No 8<	<pre>4.10000 4.10000 4.10000 benmark S bordinates y [m] 1 41.10000 40.45000 39.15000 37.85000 37.20000 benmark S bordinates y [m] 1 20.40000 benmark S bordinates y [m] 1 19.40000 benmark S bordinates y [m] 1 10.40000 benmark S bordinates y [m] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</pre>	2.30000 imported retet S r [m] -3.500000 -3.500000000 -3.500000 -3.500000		 No6 F No9 A No9 B No9 B No9 B No8 A No8 A No8 A
d - Displ Structure Dist. [m] Vertical 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.025 0.025 0.025 0.025 0.035 0.025 0.035 0.025 0.035	: No 6 Cc : No 6 Cc : No 6 Cc : No 6 Cc : No 7 Sc : No 9 Cc : No 8 Cc : No 8 Cc : No 8 Cc : No 9 Cffsact : No 8 Cc : Status Scatus : Status Scatus	<pre>4.10000 4.1000 4.11000 Denmark S y [m] 1 4.10000 3.5000 3.5000 3.5000 3.5000 3.5000 Denmark S y [m] 2.94000 27.97143 22.5512 4.0000 27.97143 22.5512 4.0000 Denmark S prim 1.940000 Denmark S prim 1.940000 Denmark S</pre>	2.30000 imported treet S [m] -3.500000 -3.50000 -3.500000 -3.500000 -3.5000000000000000000000000000000000000		 No9 A No9 A nnts No9 B nnts No8 A ants
d - Displ Structure Dist. [m] Vertical 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.0458 0.0458 0.0458 0.020 Structure Dist. [m] Vertical 0.020 0.0458 0.0582 0.0582 0.0582 0.0582 0.020 0.0582 0.020 0.020 0.0582 0.020 0.0582 0.022		<pre>4.10000 4.11000 4.11000 Denmark S y [m] 1 1 4.110000 3.50000 3.50000 3.15000 3.15000 Denmark S y [m] 1 2.9.40000 27.97143 26.54286 25.14429 20.42257 19.40000 Denmark S ordinates y [m] 1 9.40000 Denmark S ordinates y [m] 1 9.40000 Denmark S ordinates y [m] 1 1.3.40000 Denmark S ordinates y [m] 1 3.40000 Denmark S</pre>	2.30000 imported freet S [m] -3.500000 -3.500000 -3.500000 -3.5000000000000000000000000000000000000		 No9 A No9 A nnts No9 B ints No8 A ints

(GEOTECHNICAL & ENV ASSOC)

b	No.		

Sheet No.	Rev.	

Checked

7 Denmark Street, London WC2H 8LZ

ISVS

Combined lateral and horizontal movements

GEA LIMITED

Drg.	Ref.
Made	by

Jo

Dy

J18119

ML

Date 14-Jun-2018

st.	x	Coordinates Y	z	Displacements z									
mj 3000 2	[m]	[m] 10 30.03333 -	(m) -3.50000	[mm]									
3600 2	20.6000	0 29.40000	-3.50000	0.0									
tructur	re: 122	2 Charing Cro	oss Rd	Sub-structure: 122A									
Dist.		Coordinates	_	Displacements									
[m]	x [m]	y [m]	z [m]	z [mm]									
Vertical	0ffse	et 1 00 10.20000 ·	-3.50000	-0.16452 d									
2.1314 3 4.2629 3	81.0000 82.7000	00 11.48571 · 00 12.77143 ·	-3.50000	-0.24889 d -0.38558 d									
5.3943 3 8.5258 3	84.4000 86.1000	00 14.05714 - 00 15.34286 -	-3.50000 -3.50000	-0.61841 d -1.0428 d									
0.657 3	87.8000 89.5000	00 16.62857 - 00 17.91429 -	-3.50000	-1.8750 d -3.1917 d									
1 - Disp	laceme	ents include	importe	d displacements.									
Structur	e: 122	2 Charing Cro	oss Rd	Sub-structure: 122B									
Dist.		Coordinates	_	Displacements									
[m]	[m]	y [m]	[m]	[mm]									
Vertical 0.04	0ffse	et 1 00 19.20000 ·	-3.50000	-6.7078 d									
1.2494 4 2.4988 4	11.9777	78 18.22222 - 56 17.24444 -	-3.50000	-1.9764 d -1.2729 d									
.7482 4	4.3111	11 15.28889 -	-3.50000	-0.61876 d									
.4964 4	15.8666	57 13.333333 · 14 12.35556 ·	-3.50000	-0.34088 d -0.26004 d									
.9952 4 1.245 4	7.4222	22 11.37778 · 00 10.40000 ·	-3.50000	-0.20083 d -0.15657 d									
- Disp	laceme	ents include	importe	d displacements.									
tructur	e: No	7 Retained	Sub-st	ructure: No7 A									
ist.	x	Coordinates Y	z	Displacements z									
[m]	[m]	[m]	[m]	[mm]									
0.0 2	25.7000	00 33.20000 · 71 31.68571 ·	-2.50000	-0.19281 d -0.13851 d									
.8465 2	28.0714	43 30.17143 - 14 28.65714 -	-2.50000	-0.20175 d -0.29997 d									
.6931 3 .6164 3	80.4428 81.6285	36 27.14286 - 57 25.62857 -	-2.50000 -2.50000	-0.45983 d -0.73827 d									
1.540 3 3.463 3	82.8142 84.0000	29 24.11429 · 00 22.60000 ·	-2.50000	-1.2715 d -4.9721 d									
- uisp	/iaceme	mus include	importe	a uispiacements.									
Structur	re: No	7 Retained	Sub-st	ructure: No7 C									
ist.	x	Coordinates Y	z	Displacements z									
ertical	(m) L Offse	et 1	[111]	[mur]									
0.0 3 1.9800 3	89.1000 87.9142	00 26.10000 · 29 27.68571 ·	-2.50000	-2.8012 d -1.0633 d									
3.9600 3 5.9400 3	86.7285 85.5428	57 29.27143 · 36 30.85714 ·	-2.50000 -2.50000	-0.66625 d -0.42796 d									
.9200 3 .9000 3	84.3571 83.1714	14 32.44286 - 13 34.02857 -	-2.50000	-0.28276 d -0.19100 d									
11.880 3 13.860 3	31.985/ 30.8000	/1 35.61429 - 00 37.20000 -	-2.50000 -2.50000	-0.13110 d -0.36396 d									
. Diop		inco include	imporce	a aropracemento.									
tructur	e: No	7 Retained	Sub-st	Displacements									
[m]	x [m]	y [m]	z [m]	z [mm]									
ertical	Offse	et 1		0.00000									
0.0 3 1.0803 2 2.1605 9	29.9500 29.1000	0 37.20000 - 0 36.53333 - 0 35.86667 -	-2.50000 -2.50000 -2.50000	-0.094844 d -0.097651 d									
.2408 2	28.2500	00 35.20000 - 00 34.53333 -	-2.50000	-0.099264 d -0.099597 d									
.4013 2 .4815 2	26.5500	00 33.86667 - 00 33.20000 -	-2.50000	-0.098627 d -0.19281 d									
- Disp	laceme	ents include	importe	displacements.									
pecific	Buildin	ng Damage Re	esults - Al	Segments									
tructur	e: No	6 Denmark St	treet	Sub-structure: No6 A									
Vertical	Offse	et Segmen	nt S	tart Length Curvature	Deflection	Average Horizontal	Max Tereilo	Max Gradien	t Max Gradient	Min Radius of	Damage		
Verti Movem	cal ment	-			indered in	Strain	Strain	Horizontal Displacemen	Displacement t Curve	Curvature	cuttyor}		
Calcula	ations			[m] [m]	[%]	[%]	[%]	Curve		[m]			
Ó.	. O	and should	1	0.0 15.460 Sagging	0.0046004	121.27E-6	0.0058543	3 265.88E-	6 253.18E-6	10468.	(Negligible)		
ensile	norizo	ntai strain:	s are +v	≥, compressive horizo	ncai strains	are -ve.							
Structur	e: No	6 Denmark St	treet	Sub-structure: No6 C									
Vertical from Li	Offse ne for	et Segmen r	nt S	tart Length Curvature	Deflection Ratio	Average Horizontal	Max Tensile	Max Gradient of	Max Gradient of Vertical	Min Radius of	Damage Category		
Verti Movem	ical ment					Strain	Strain	Horizontal Displacement	Displacement Curve	Curvature			
Carcula [m	n] .0		1	[m] [m] 0.0 5.9900 Saccinc	[%] 0.032031	[%] 0.0032451	[%] 0.032698	-89.209E-6	-0.0018072	[m] 797.30	0		
J. Tensile	horizo	ontal strain:	s are +v	e, compressive horizo	ntal strains	are -ve.				((Negligible)		
tructur	re: No	6 Denmark St	treet	Sub-structure: No6 D		•		Mar					
ertical from Li	ne for	et Segmen C	nt S	cart Length Curvatur	e Deflection Ratio	Average Horizonta	Max 1 Tensile	Max Gradie e of	of Vertical	c Min Radius of	Damage E Category		

GEA	

Job No.

Boy

(GEOTECHNICAL & ENV ASSOC)

7 Denmark Street, London WC2H 8LZ

asys

Combined lateral and horizontal movements

J18119		
Drg. Ref.		
Made by ML	Date 14-Jun-2018	Checked

Vertical Movement Calculations				Strain	Strain	Horizontal Displacemen Curve	Displacemer t Curve	t Curvature	•
[m] 0.0	1	[m] [m] 0.0 1.7001 Sagging	[%] 0.015018	[%] 3 0.0	[%] 0.01488	81 0.	0 -665.57E-	[m] 6 670.91	. (Neelisihle)
	2	1.7001 2.8799 Hogging	317.28E-6	5 0.0) 315.18E-	-6 0.	0 -14.760E-	6 106420.	(Negligible) (Negligible)
Tensile horizontal st	trains are	+ve, compressive horizon	tal strains	are -ve.					
Structure: No 6 Denma Vertical Offset	ark Street	Sub-structure: No6 E Start Length Curvature	Deflection	Average	Max	Max Gradien	t Max Gradier	t. Min	Damage
from Line for Vertical Movement Calculations			Ratio	Horizontal Strain	Tensile Strain	e of Horizontal Displacemen Curve	of Vertical Displacement Curve	Radius of t Curvature	Category
[m] 0.0	1	[m] [m] 0.0 4.8542 Hogging	[%] 174.83E-6	[%] 5 0.0	[%]) 173.63E-	-6 0.	0 -30.692E-	[m] 6 280980.	(Nogligible)
	2	4.8542 11.006 Sagging	609.50E-6	5 0.0	604.57E-	-6 0.	0 -30.692E-	6 82751.	(Negligible)
Tensile horizontal st	trains are	+ve, compressive horizon	tal strains	are -ve.					
Structure: No 6 Denma	ark Street	Sub-structure: No6 F	Deflection	Average	Max	Max Gradient	Max Gradient	Min	Damago
from Line for Vertical Movement	segment	Start Length Curvature	Ratio	Horizontal Strain	Tensile Strain	of Horizontal Displacement	of Vertical Displacement Curve	Radius of Curvature	Category
[m] 0.0 All s	settlements	[m] [m] are less than the Settle	[%] ement Troug	[%] gh Limit Sen	[%] sitivity.	Curve		[m]	
Tensile horizontal st	trains are	+ve, compressive horizon	tal strains	are -ve.					
Structure: No 9 Denma	ark Street	Sub-structure: No9 A							
Vertical Offset S from Line for Vertical	Segment	Start Length Curvature 1	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal	Max Gradient of Vertical Displacement	Min Radius of Curvature	Damage Category
Movement Calculations						Displacement Curve	Curve		
[m] 0.0 All s Tensile horizontal st	settlements trains are	[m] [m] are less than the Settle +ve, compressive horizon	[%] ement Troug tal strains	[%] Jh Limit Sen are -ve.	[%] nsitivity.			[m]	
Champhone No. 6 -	anh Chui	I Cub about the intricol	otrailb	'C.					
Vertical Offset S from Line for	ark Street Segment	Sub-structure: No9 B Start Length Curvature N	Deflection Ratio	Average Horizontal	Max Tensile	Max Gradient	Max Gradient of Vertical	Min Radius of	Damage Category
vertical Movement Calculations				strain	strain	HOTIZONTAL Displacement Curve	Curve	curvature	
[m] 0.0 All s	settlements	[m] [m] are less than the Settle	[%] ement Troug	[%] gh Limit Sen	[%] nsitivity.			[m]	
Tensile norizoncal sc	ciains are	ive, compressive norizon	cai sciains	are ve.					
Vertical Offset	ark Street Segment	Sub-structure: No8 A Start Length Curvature 1	Deflection	Average	Max	Max Gradient	Max Gradient	Min	Damage
from Line for Vertical Movement			Ratio	Horizontal Strain	Tensile Strain	of Horizontal Displacement	of Vertical Displacement Curve	Radius of Curvature	Category
[m] 0.0 All s	settlements	[m] [m] are less than the Settle	[%] ement Trouç	[%] jh Limit Ser	[%] sitivity.	Curve		[m]	
Tensile horizontal st	trains are	+ve, compressive horizon	tal strains	are -ve.					
Structure: 122 Charin	ng Cross Rd	Sub-structure: 122A							_
Vertical Offset S from Line for Vertical Movement	Segment	Start Length Curvature 1	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m] 0.0	1	[m] [m] 0.0 14.920 Sagging	[%] 0.019826	[%]	[%] 0.021495	0.0	0.0016496	[m] 1728.6	0
Tensile horizontal st	trains are	+ve, compressive horizon	tal strains	are -ve.				(Negligible)
Structure: 122 Charir	ng Cross Rd	Sub-structure: 122B							
Vertical Offset S from Line for Vertical Movement	Segment	Start Length Curvature 1	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
Calculations		[m] [m]	[%]	[%]	[%]	Curve	-0 0027070	[m] 214 70	0
U.U Tensile horizontal st	1 trains are	+ve, compressive horizon	U.U35601 tal strains	0.0 s are -ve.	u.U32365	0.0	-0.0037870	314.72 (0 Negligible)
Ctructure, Mr. 7 D	ined 1 Sub	etructure, N=7 3							
Vertical Offset	inea Sub-	Structure: No/ A Start Length Curvature I	Deflection	Average	Max	Max Gradient	Max Gradient	Min	Damage
from Line for Vertical Movement			Ratio	Horizontal Strain	Tensile Strain	of Horizontal Displacement	of Vertical Displacement Curve	Radius of Curvature	Category
[m] 0.0	1	[m] [m] 0.0 13.460 Sagging	[%] 0.022322	[%] 0.0061747	[%] 0.031717	-193.02E-6	0.0019239	[m] 949.18	0
Tensile horizontal st	trains are	+ve, compressive horizon	tal strains	s are -ve.				(Negligible)
Structure: No 7 Retai	ined Sub-	structure: No7 C							
Vertical Offset	Segment	Start Length Curvature	Deflection	Average	Max	Max Gradient	Max Gradient	Min	Damage
Vertical Movement			RATIO	Strain	Strain	or Horizontal Displacement	Displacement Curve	Curvature	category
Calculations		[m] [m]	[%]	[%]	[%]	Curve	022 00- 1	[m]	~
0.0 Tensile horizontal et	1 trains are	+ve, compressive horizon	0.010372	0.0044648	U.016561	-332.67E-6	-877.92E-6	2395.0	0 Negligible)
		., compressive norrhoir							
Structure: No 7 Retai	ined Sub-	structure: No7 D							

Strain

Start Length Curvature Deflection Average Max Ratio Horizontal Tensie

GEA LIMITED (GEOTECHNICAL & ENV A

Max Gradient

Displacement

of Strain Horizontal

7	Denmark	Street.	I ondon	WC2H	81 7
	Deriniark	JUCCL	LUIGUI	VVOZII	ᇇᆮᄼ

Segment

Segment

Vertical Offset

from Line for

Vertical

Movement

Vertical Offset from Line for

Offs

Combined	lateral	and	horizontal	movements
Complified	alerai	anu	nonzontai	movementa

	Job No.	Sheet No.	Rev.		
SSOC)	J18119				
	Drg. Ref.				
	Made by ML	Date 14-Jun-2018	Checked		
Max Gradient of Vertical Rad Displacement Cur Curve	Min Damage lius of Category vature				
ent Max Gradient of Vertical al Displacement ment Curve	Min Damage Radius of Category Curvature				
0.0 -249.13E-6	[m] 3430.1 0 (Negligible)				
0.0 1.4939E-6	925330. 0				
0.0 87.190E-6	(Negligible) 9778.6 0 (Negligible)				

Start Length Curvature Deflection Average Max Max Gradi Ratio Horizontal Tensile of Strain Strain Horizont Displacem Vertical Movement Calculations Curve [m] [m] [%] [%] [%] 1 0.0 3.2208 Sagging 0.0055644 0.0 0.0054994 [m] 0.0 2 3.2208 0.076665 Hogging 22.806E-6 0.0 22.781E-6 3 3.2974 3.1826 Sagging 0.0019470 0.0 0.0019248 Tensile horizontal strains are +ve, compressive horizontal strains are -ve. Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure Structure: No 6 Denmark Street | Sub-structure: No6 A Vertical Deflection Average Max Slope Max Max Max Gradient Max Gradient Min Min ffset from Ratio Horizontal Settlement Tensile of of Vertical Radius of Radius of Line for Strain Horizontal Displacement Curvature Damage Category Vertical Displacement Curve Curve (Hogging) (Sagging) Calculations [m] 0.0 [%] [%] [mm] [%] [m] [m] 0.0046004 121.27E-6 253.18E-6 1.8705 0.0058543 265.88E-6 253.18E-6 - 10468. 0 (Negligible) Structure: No 6 Denmark Street | Sub-structure: No6 C Vertical Deflection Average Max Slope ffset from Ratio Horizontal
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 Settlement
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 Curging)
 (Sagging)
 Damage Category Offset from Line for Strain Displacement Curve Vertical Movement Calculations [m] [%] [%] [mm] [%] [m] [m] 0.0 0.032031 0.0032451 -0.0018072 3.9354 0.032698 -89.209E-6 -0.0018072 - 797.30 0 (Negligible) Structure: No 6 Denmark Street | Sub-structure: No6 D Vertical Deflection Average Max Slope Max Max Max Gradient Max Gradient Min Min Damage Category Offset from Ratio Horizontal Settlement Tensile of of Vertical Radius of Radius of Line for Strain Strain Horizontal Displacement Curvature Curvature Vertical Displacement Curve (Hogging) (Sagging) Movement Curve Movement Calculations [%] [%] [mm] [%] 0.015018 0.0 -665.57E-6 0.78577 0.014881 [m] 0.0 [m] [m] 0.0 -665.57E-6 106420. 670.91 0 (Negligible) Structure: No 6 Denmark Street | Sub-structure: No6 E Max Gradient Max Gradient Min Min of of Vertical Radius of Radius of Horizontal Displacement Curvature Curvature Displacement Curve (Hogging) (Sagging) Curve Vertical Deflection Average Max Slope Max Max Offset from Ratio Horizontal Settlement Tensile Line for Strain Strain Damage Category Vertical Movement Calculations [%] [%] [mm] [%] 609.50E-6 0.0 -30.692E-6 0.40691 604.57E-6 [m] 0.0 [m] [m] 0.0 -30.692E-6 280980. 82751.0 (Negligible) Structure: No 6 Denmark Street | Sub-structure: No6 F Vertical Deflection Average Max Max Max Max Gradient Max Gradient Min Min ffset from Ratio Horizontal Slope Settlement Tensile of of Vertical Radius of Radius of Line for Strain Strain Horizontal Displacement Curvature Curvature Vertical Displacement Curve (Hogging) (Sagging) Movement Curve Damage Category Offset from Movement Calculations [%] [%] [mm] [%] [m] [m] Structure: No 9 Denmark Street | Sub-structure: No9 A Vertical Deflection Average Max Max Max Max Gradient Max Gradient Min Min ffset from Ratio Horizontal Slope Settlement Tensile of of Vertical Radius of Radius of Line for Strain Strain Horizontal Displacement Curvature Curvature Vertical Displacement Curve (Hogging) (Sagging) Movement Curve Damage Category Offset from Line for Vertical Movement Calculations [%] [%] [mm] [%] [m] [m] Structure: No 9 Denmark Street | Sub-structure: No9 B Vertical Deflection Average Max Max Max Max Gradient Max Gradient Min Min Offset from Ratio Horizontal Slope Settlement Tensile of of Vertical Radius of Radius of Line for Strain Horizontal Displacement Curvature Curvature Vertical Movement Curva (Hogging) (Sagging) Curve Damage Category Calculations [%] [%] [mm] [%] [m] [m] [m] Structure: No 8 Denmark Street | Sub-structure: No8 A Vertical Deflection Average Max Max Max Max Gradient Max Gradient Min Min Offset from Ratio Horizontal Slope Settlement Tensile of of Vertical Radius of Radius of Line for Strain Strain Horizontal Displacement Curvature Curvature Vertical Displacement Curve (Hogging) (Sagging) Movement Curve Damage Category Calculations [%] [%] [mm] [%] [m] [m] Structure: 122 Charing Cross Rd | Sub-structure: 122A Vertical Deflection Average Max Slope Max Max Max Gradient Max Gradient Min Min ffset from Ratio Horizontal Settlement Tensile of of Vertical Radius of Radius of Line for Strain Borizontal Displacement Curvature Curvature Displacement Curve (Hogging) (Sagging) Damage Category Offset from Line for Displacement Curve Calculations [%] [%] [mm] [%] 0.019826 0.0 0.0016496 6.7076 0.021495 [m] [m] 0.0 0.0016496 - 1728.6 0 (Negligible) [m] 0.0 Structure: 122 Charing Cross Rd | Sub-structure: 122B

ombined	Denmark Street, London WC2H 8LZ ombined lateral and horizontal movements									J1811	19			
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				00					Ma Mi	ade by L		Date 14-Jun-2018	C	hecked
Vertical De ffset from Line for Vertical Movement	eflection Avera Ratio Horizo Stra	ge Max Slope ntal in	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage C	Category				
[m] 0.0	[%] [%] 0.035601	0.0 -0.0037870	[mm] 6.7078	[%] 0.032365	0.0	-0.0037870	[m] –	[m] 314.72	0 (Negligi	ble)				
vertical D	7 Retained Sub	-structure: No7	A	Max	Max Gradient 1	Max Gradient	Min	Min	Damage Ca	tegory				
ffset from Line for Vertical Movement	Ratio Horizo Stra	ntal :	Settlement 1	ensile Strain	of Horizontal Displacement Curve	of Vertical Displacement Curve	Radius of H Curvature ((Hogging)	Radius of Curvature (Sagging)	Damage Ca	legory				
[m] 0.0	[%] [%] 0.022322 0.006	1747 0.0019239	[mm] 4.9665 ([%] .031717	-193.02E-6	0.0019239	[m] _	[m] 949.18 0	(Negligib	ole)				
cructure: No '	7 Retained Sub	-structure: No7	С											
Vertical De ffset from Line for Vertical Movement alculations	eflection Avera Ratio Horizo Stra	ge Max Slope ntal in	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage C	Category				
[m] 0.0	[%] [%] 0.010372 0.004	4648 -877.92E-6	[mm] 2.8012	[%] 0.016561	-332.67E-6	-877.92E-6	[m] _	[m] 2395.0	0 (Negligi	ble)				
ructure: No '	7 Retained Sub	-structure: No7	D											
Vertical De ffset from Line for Vertical Movement	eflection Avera Ratio Horizo Stra	ge Max Slope ntal in	Max Settlement	Max Tensile Strain	Max Gradien of Horizontal Displacemen Curve	t Max Gradien of Vertical Displacemen t Curve	t Min Radius of t Curvature (Hogging)	Min f Radius of e Curvature) (Sagging)	Damage	Category				
[m] 0.0 /	[%] [%] 0.0055644	0.0 -249.13E-6	[mm] 0.36396	[%] 0.005499	4 0.	0 -249.13E-	[m] 6 925330	[m] . 3430.1	0 (Neglig	(ible)				
necific Buildin	n Damage Results	- Critical Segment	ts within Fac	Structur	e									
tructure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End Curvatu	re Max Slope	Max	Max	Min	Min	Damage Cated	ory		
			,				Settlement	Tensile Strain	Radius of Curvature (Hogging)	Radius of Curvature (Sagging)				
0 6 Denmark	Max Slope	No6 C	1	[m] 0.0 5	[m] .9900 Sagging	0.0018072	[mm] 3.9354	[%] 0.032698	Radius of Curvature (Hogging) [m] -	Radius of Curvature (Sagging) [m] 797.30 0	(Negligible)			
o 6 Denmark treet	Max Slope Max Settlement Max Tensile	No6 C No6 C No6 C	1	[m] 0.0 5 0.0 5 0.0 5	[m] .9900 Sagging .9900 Sagging .9900 Sagging	0.0018072 0.0018072 0.0018072	[mm] 3.9354 3.9354 3.9354	[%] 0.032698 0.032698 0.032698	Radius of Curvature (Hogging) [m] - -	Radius of Curvature (Sagging) [m] 797.30 0 797.30 0 797.30 0	(Negligible) (Negligible) (Negligible)			
o 6 Denmark treet	Max Slope Max Settlement Max Tensile Strain Min Radius of Curvature	No6 C No6 C No6 C No6 D	1 1 1 2	[m] 0.0 5 0.0 5 0.0 5 1.7001 4	[m] .9900 Sagging .9900 Sagging .9900 Sagging .5800 Hogging	0.0018072 0.0018072 0.0018072 14.760E-6	[mm] 3.9354 3.9354 3.9354 3.9354 0.42394	Tensile Strain [%] 0.032698 0.032698 0.032698 315.18E-6	Radius of Curvature (Hogging) [m] - - 106420.	Radius of Curvature (Sagging) [m] 797.30 0 797.30 0 797.30 0 - 0	(Negligible) (Negligible) (Negligible) (Negligible)			
o 6 Denmark treet	Max Slope Max Settlement Max Tensile Strain Min Radius of Curvature (Hogging) Min Radius of Curvature (Sagqing)	No6 C No6 C No6 D No6 D	1 1 1 2 1	[m] 0.0 5 0.0 5 1.7001 4 0.0 1	[m] .9900 Sagging .9900 Sagging .9900 Sagging .5800 Hogging .7001 Sagging	0.0018072 0.0018072 0.0018072 14.760E-6 665.57E-6	Settlement [mm] 3.9354 3.9354 3.9354 0.42394 0.42394 0.78577	Tensile Strain [%] 0.032698 0.032698 0.032698 315.18E-6 0.014881	Radius of Curvature (Hogging) [m] - - 106420.	Radius of Curvature (Sagging) [m] 797.30 0 797.30 0 797.30 0 670.91 0	(Negligible) (Negligible) (Negligible) (Negligible) (Negligible)			
o 6 Denmark treet > 9 Denmark ;reet	Max Slope Max Settlement Max Tensile Strain Min Radius of Curvature (Bogging) Min Radius of Curvature (Sagging) All settlement	No6 C No6 C No6 D No6 D s are less than	1 1 2 1 the Settler	[m] 0.0 5 0.0 5 1.7001 4 0.0 1	[m] .9900 Sagging .9900 Sagging .9900 Sagging .5800 Hogging .7001 Sagging gh Limit Sens	0.0018072 0.0018072 0.0018072 14.760E-6 665.57E-6 itivity.	Settlement [mm] 3.9354 3.9354 0.42394 0.78577	Tensile Strain [%] 0.032698 0.032698 0.032698 315.18E-6 0.014881	Radius of Curvature (Hogging) [m] - - 106420.	Radius of Curvature (Sagging) [m] 797.30 0 797.30 0 797.30 0 - 0 670.91 0	(Negligible) (Negligible) (Negligible) (Negligible) (Negligible)			
o 6 Denmark reet > 9 Denmark reet > 8 Denmark	Max Slope Max Settlement Max Tensile Strain Min Radius of Curvature (Bagging) All settlement All settlement All settlement All settlement All settlement All settlement All settlement	No6 C No6 C No6 D No6 D s are less than s are less than s are less than s are less than s are less than	1 1 2 1 the Settler the Settler the Settler the Settler the Settler	[m] 0.0 5 0.0 5 0.0 5 1.7001 4 0.0 1 went Trou- went Trou- went Trou- went Trou- went Trou- went Trou-	[m] 9900 Sagging 9900 Sagging 9900 Sagging .5800 Hogging .7001 Sagging gh Limit Sens gh Limit Sens Jh Limit Sens gh Limit Sens gh Limit Sens gh Limit Sens	0.0018072 0.0018072 0.0018072 14.760E-6 665.57E-6 itivity. itivity. itivity. itivity. itivity.	Settlement [mm] 3.9354 3.9354 3.9354 0.42394 0.78577	Tensile Strain [%] 0.032698 0.032698 0.032698 315.18E-6 0.014881	Radius of Curvature [Hogging] [m] - - 106420.	Radius of Curvature (Sagging) [m] 797.30 0 797.30 0 797.30 0 - 0 670.91 0	(Negligible) (Negligible) (Negligible) (Negligible) (Negligible)			
o 6 Denmark treet > 9 Denmark reet > 8 Denmark reet	Max Slope Max Settlement Max Tensile Strain Min Radius of Curvature (Rogging) Min Radius of Curvature (Sagging) All settlement All settlement	No6 C No6 C No6 D No6 D s are less than s are less than	1 1 1 2 1 the Settler the Settler the Settler the Settler the Settler the Settler the Settler the Settler	[m] 0.0 5 0.0 5 1.7001 4 0.0 1 eent Trou- eent Trou-	[m] .9900 Sagging .9900 Sagging .9900 Sagging .5800 Hogging dh Limit Sens dh Limit Sens	0.0018072 0.0018072 14.760E-6 665.57E-6 itivity. itivity. itivity. itivity. itivity. itivity. itivity. itivity.	Settlement [mm] 3.9354 3.9354 3.9354 0.42394 0.78577	Trensile Strain (%) 0.032698 0.032698 315.18E-6 0.032698 315.18E-6	Radius of Curvature (Hogging) [m] - - 106420.	Radius of (Sagging) [m] 797.30 0 797.30 0 797.30 0 670.91 0	(Negligible) (Negligible) (Negligible) (Negligible) (Negligible)			
o 6 Denmark reet > 9 Denmark reet > 8 Denmark :reet !2 Charing res P4	Max Slope Max Settlement Max Tensile Strain Min Radius of Curvature (Sagging) All settlement All settlement	No6 C No6 C No6 D No6 D s are less than s are less than	1 1 2 1 the Settler the Settler	[m] 0.0 5 0.0 5 1.7001 4 0.0 1 eent Trou- eent Trou-	[m] .9900 Sagging .9900 Sagging .5800 Hogging .7001 Sagging .7001 Sagging .7001 Sagging .7001 Limit Sens .7001 Limit Sens	0.0018072 0.0018072 0.0018072 14.760E-6 665.57E-6 itivity. itivity. itivity. itivity. itivity. itivity. itivity. itivity. itivity. itivity. itivity. itivity.	Settlement (nm) 3.9354 3.9354 0.42394 0.78577 6.7078	Trensile Strain [%] 0.032698 0.032698 315.18E-6 0.014881 0.014881	Radius of Curvature (Hogging) [m] - - 106420.	Radius of (sagging) [m] 797.30 0 797.30 0 797.30 0 670.91 0 670.91 0	(Negligible) (Negligible) (Negligible) (Negligible) (Negligible)			
<pre>b 6 Denmark treet b 9 Denmark treet b 8 Denmark treet 22 Charing coss Rd</pre>	Max Slope Max Settlement Max Tensile Strain Min Radius of Curvature (Hogging) Min Radius of Curvature (Sagging) All settlement All settlement All settlement All settlement All settlement All settlement All settlement All settlement All settlement Max Slope Max Tensile Strain Min Radius of Curvature	No6 C No6 C No6 D No6 D No6 D s are less than s are less than s are less than s are less than s are less than s are less than s are less than s are less than s are less than s are less than	1 1 1 2 1 the Settler the Settler the Settler the Settler the Settler the Settler the Settler 1 1 1 1 1 1 1 1 1 1 1 1 1	[m] 0.05 0.05 0.05 1.7001 4 0.0 1 ent Trou- ent Trou- en	[m] .9900 Sagging .9900 Sagging .900 Sagging .7001 Sagging gh Limit Sens gh Limit Sens jh Limit S	0.0018072 0.0018072 14.760E-6 665.57E-6 itivity. itivity. itivity. itivity. itivity. itivity. itivity. itivity. 0.0037870 0.0037870	Settlement [mm] 3.9354 3.9354 0.42394 0.78577 0.78577 6.7078 6.7078 6.7078	Trensile Strain (%) 0.032698 0.032698 315.182-6 0.014881 0.014881 0.032365 0.032365	Radius of Curvature (Hogging) [m] - - 106420. - - - - - - - - - - - - - - - - - - -	Radius of (sagging) [m] 797.30 0 797.30 0 797.30 0 797.30 0 797.30 0 670.91 0 670.91 0 314.72 0 314.72 0	(Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible)			
 6 Denmark reet 9 Denmark reet 8 Denmark reet 2 Charing coss Rd 	Max Slope Max Settlement Max Tensile Strain Min Radius of Chyature (Hogding) of Cayaging) All settlement All settlement All settlement All settlement All settlement All settlement All settlement All settlement All settlement Max Slope Max Settlement Max Slope Max Settlement Max Settlement Max Stope Max Settlement Max Sope Max Sope Max Settlement Max Sope Max Sope Max Sope Max Sope Min Radius of Curvature (Hogging) Min Radius of Curvature	No6 C No6 C No6 D No6 D s are less than s are less than 122B 122B	1 1 1 2 1 the Settler the Settler the Settler the Settler the Settler the Settler the Settler 1 1 1 1 1 1 1 1 1 1 1 1 1	[m] 0.0 5 0.0 5 0.0 5 1.7001 4 0.0 1 ent Trou ent Trou en	<pre>[m] .9900 Sagging .9900 Sagging .5800 Hogging .7001 Sagging gh Limit Sens gh Limit Sens 1.240 Sagging 1.240 Sagging .240 Sagging .240 Sagging</pre>	0.0018072 0.0018072 0.0018072 14.760E-6 665.57E-6 itivity. itivity	Settlement [mm] 3.9354 3.9354 0.42394 0.78577 0.78577 6.7078 6.7078 6.7078 6.7078	Trenile Strain (%) 0.032698 0.032698 0.032698 0.032698 0.014881 0.014881 0.014881 0.014881 0.032365 0.032365 - 0.032365	Radius of Curvature (Hogging) [m] - - - 106420. - - - - - - - - - - - - - - - - - - -	Radius (curvature) (sagging) (m) 797.30 (797.30 (797.30) (797.30 (797.3	(Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible)			
 6 Denmark reet 9 Denmark reet 8 Denmark reet 2 Charing coss Rd 7 Retained 	Max Slope Max Settlement Max Tensile Strain Min Radius of Curvature (Rogging) Min Radius of Curvature (Sagging) All settlement All settlement All settlement All settlement All settlement All settlement All settlement All settlement Max Slope Max Settlement Max Slope Max Settlement Max Slope Max Settlement Min Radius of Curvature (Rogging) Min Radius of Cargging) Max Slope Max Settlement Min Radius of Curvature (Rogging) Max Slope Max Settlement Max Slope Max Settlement Min Radius of Curvature (Rogging) Max Slope Max Settlement Max Slope Max Settlement Max Slope Max Settlement Max Slope Max Settlement Max Slope Max Settlement Max Slope Max Slope Max Settlement Max Slope Max Settlement Max Slope Max Settlement Max Slope Max Slope Max Slope Max Settlement Max Slope Max Slope Max Slope Max Settlement Max Slope Max Slope	No6 C No6 C No6 C No6 D No6 D s are less than s are less than 122B 122B 122B	1 1 1 1 2 1 the Settler the Settler the Settler the Settler the Settler the Settler the Settler 1 1 1 1 1 1 1 1 1 1 1 1 1	[m] 0.0 5 0.0 5 0.0 5 1.7001 4 0.0 1 ent Trou- tent Tent Tent Tent Tent Tent Tent Tent	<pre>[m] .9900 Sagging .9900 Sagging .9900 Sagging .5800 Hogging .7001 Sagging gh Limit Sens gh Limi</pre>	0.0018072 0.0018072 0.0018072 14.760E-6 665.57E-6 itivity. itivity. itivity. itivity. itivity. itivity. itivity. 0.0037870 0.0037870 0.0037870 0.0037870	Settlement [mm] 3.9354 3.9354 0.42394 0.785777 0.78577 0.78577 0.785777 0.785777 0.785777 0.785777 0.785777 0.785777 0.785777 0.785777 0.785777 0.785777 0.785777 0.785777 0.785777 0.785777 0.7857777 0.7857777 0.7857777 0.79577777 0.795777777 0.79577777777777777777777777777777777777	Trensile Strain (%) 0.032568 0.032568 0.032568 0.014881 0.014881 0.014881 0.032365 0.032365 0.032365 0.032365 0.032365	Radius of Curvature (Hogging) [m] - - - 106420. - - - - - - - - - - - - - - - - - - -	Radius ((sagging) [m] 797.30 0 797.30 0 797.30 0 670.91 0 670.91 0 670.91 0 314.72 0 314.72 0 314.72 0 949.18 0 949.18 0 949.18 0	<pre>(Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible)</pre>			
<pre>0 6 Denmark reet > 9 Denmark treet > 8 Denmark treet 22 Charing ross Rd > 7 Retained</pre>	Max Slope Max Settlement Max Tensile Strain Min Radius of Curvature (Sagging) All settlement All settlement All settlement All settlement All settlement All settlement All settlement All settlement All settlement All settlement Max Slope Max Slope Max Settlement Min Radius of Curvature (Bogging) Min Radius of Curvature (Bagging) Max Stope Max Settlement Max Settlement Max Settlement Min Radius of Curvature (Sagging) Max Slope Max Settlement Max Settlement Max Settlement Max Settlement Max Settlement Min Radius of Max Slope Max Sope Max Settlement Max Tensile Strain Min Radius of	No6 C No6 C No6 D No6 D s are less than s are less than 122B 122B 122B 122B	1 1 1 1 2 1 the Settler the Settler the Settler the Settler the Settler the Settler the Settler 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2	[m] 0.0 5 0.0 5 0.0 5 1.7001 4 0.0 1 ent Trou ent Trou en	<pre>[m] 9900 Sagging 9900 Sagging 9900 Sagging .5800 Hogging gh Limit Sens gh Limit Sens J.240 Sagging 1.240 Sagging 1.240 Sagging 3.460 Sagging 3.460 Sagging 3.460 Sagging 3.460 Sagging</pre>	0.0018072 0.0018072 0.0018072 14.760E-6 665.57E-6 itivity. itivity. itivity. itivity. itivity. itivity. 0.0037870 0.0037870 0.0037870 0.0019239 0.0019239 1.4939E-6	Settlement [mm] 3.9354 3.9354 0.42394 0.78577 0.78577 6.7078 6.7078 6.7078 4.9665 4.9665 4.9665 0.099282	Trensile Strain [%] 0.032698 0.032698 0.032698 315.18E-6 0.014881 0.014881 0.014881 0.014881 0.032365 0.032365 0.032365 0.032365 0.032365 0.032365 0.032365	Radius of Curvature (Hogging) [m] - - - 106420. - - - - - - - - - - - - - - - - - - -	Radius ((sagia) (m) 797.30 0 797.30 0 797.30 0 670.91 0 670.91 0 670.91 0 314.72 0 314.72 0 314.72 0 314.72 0 949.18 0 949.18 0	(Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible) (Negligible)			