Geo-Environmental

GROUND APPRAISAL REPORT

for the site at

1 WADHAM GARDENS

LONDON

NW3 3DN

on behalf of

MARCUS COOPER GROUP

Report:	**GROUND APPRAISAL REPORT**
Site:	**1 WADHAM GARDENS LONDON NW3 3DN**
Client:	**MARCUS COOPER GROUP**
Date:	**OCTOBER 2015**
Reference:	**GE10977 – GARv2JT151005**
Version:	**1.0**
Prepared by:	
	Luke Stock BSc (Hons) **Consultant Engineer**
	Jonathan Tingley CEnv, BEng (Hons), MSc, FGS, MIEnvSc **Technical Director**
Reviewed by:	
	Gavin Roberts CGeol, BEng (Hons), MSc, FGS **Technical Director**

Geo-Environmental Services Ltd
Unit 7, Danworth Farm, Cuckfield Road, Hurstpierpoint, West Sussex, BN6 9GL
T: 01273 832 972 E: mail@gesl.net W: www.gesl.net

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1.0 INTRODUCTION

1.1 General

Geo-Environmental was instructed by Quadrant Harman on behalf of Marcus Cooper Group to investigate the geotechnical and geo-environmental factors pertaining to the proposed redevelopment of 1 Wadham Gardens, London, National Grid coordinates at centre: 527040, 183950, see Figure 1.

1.2 Form of Development

It was understood that it was intended to partly demolish the existing detached house, extend and construct a basement below the retained building. The superstructure is load bearing masonry which is to be supported by the new basement. It is understood from the Client that the new basement is anticipated to be formed by underpinning the perimeter walls.

1.3 Objectives

The investigation was to comprise a desk study of geotechnical and environmental factors pertaining to the site, including a site walkover survey, a review of available historical maps and an examination of other sources of geo-environmental and geotechnical information. Subject to the findings of the desk study, an intrusive investigation was to be undertaken into the geotechnical and geo-environmental conditions pertaining to the site.

The data from the geotechnical investigation was to form the basis of an interpretation with respect to foundation design, basements, retaining walls, concrete specification and excavation stability.

In terms of the environmental investigation, a Preliminary Risk Assessment (PRA) was undertaken as part of the desk study in accordance with CLR11, in order to provide a basis for the scope and rationale of the subsequent Phase II ground investigation. The data from Phase I and Phase II were then to form the basis of a subsequent Generic Quantitative Risk Assessment (GQRA). The objective of the risk assessments was to evaluate the risks posed to the proposed redevelopment, adjacent land uses, and the wider environment, in the context of the development options, immediate liabilities under the Environment Act 1990, and risks posed to Controlled Waters under the Water Resources Act.

1.4 Site Description

The site comprised an approximately rectangular shaped parcel of land which was occupied by a large one to two storey residential property, which at the time of the investigation was divided into apartments. The property was constructed of load bearing masonry with the footprint of the structure occupying the majority of the plot. Around the perimeter of the property there were areas of hard landscaping covered by gravel and paving with occasional semi-mature trees on and around the boundaries. The topography of the site was relatively flat and level although there was a small retaining wall at the northern end of the site with a step-up of approximately one metre to a higher level adjacent to the boundary.

To the north the property was bounded by the garden of a residential property with the house beyond. On the eastern side, the property was bounded by Wadham Gardens with further residential properties beyond. Elsworthy Road was located to the south of the property with further residential properties beyond. Beyond the western boundary of the site was a further residential property of a similar size and scale to 1 Wadham Gardens. The party wall was estimated to be approximately 2m remote from the proposed excavation.

1.5 Standards

Where practicable, the ground investigation and subsequent environmental assessments were undertaken in accordance with the following documents and guidance:

- British Standards Institute - Code of Practice for Site Investigations (BS5930:2015).
- British Standards Institute - Code of Practice for the Characterisation and Remediation from Ground Gas in Affected Developments (BS8485:2015).
- British Standards Institute - Eurocode 7 – Geotechnical Design - Parts 1 & 2 (BS EN1997-1:2004 & BS EN1997-2:2007).
- British Standards Institute - Investigation of Potentially Contaminated Sites - Code of Practice (BS10175:2011).
- British Standards Institute - Soils for Civil Engineering Purposes (BS1377:1990).
- Building Research Establishment - The Performance of Building Materials in Contaminated Land (BRE255) (1994).
- Construction Industry Research and Information Association - Assessing risks posed by hazardous ground gases to buildings (C665) (2007).
- Department for Communities and Local Government - National Planning Policy Framework (2012).
- Department for Environment Food and Rural Affairs and Environment Agency - Model Procedures for the Management of Contaminated Land (CLR11) (2004).
- Department of Environment - Industry Profiles (1995 - 1996).
- Environment Agency - Guidance for waste destined for disposal in landfills (2006).
- Environment Agency - Guidance on Requirements for Land Contamination Reports (2005).
- National House Building Council, Environment Agency & Chartered Institute of Environmental Health - Guidance for the Safe Development of Housing on Land Affected by Contamination (R&D Publication 66) (2008).
- National House Building Council - Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present (10627-R01[04]) (2007).
- National House Building Council – Standards, Chapter 4.1 Land Quality - Managing Ground Conditions (1999).

1.6 Conditions

The data collected from the investigations have been used to provide an interpretation of the environmental conditions pertaining to the site. The recommendations and opinions expressed in this report are based on the data obtained. Geo-Environmental takes no responsibility for conditions that either have not been revealed in the available records, or that occurs between or under points of physical investigation. Whilst every effort has been made to interpret the conditions, such information is only indicative and liability cannot be accepted for its accuracy.

It should be noted that in particular the concentrations and levels of mobile liquid and gaseous materials are likely to vary with time. The results obtained may therefore only be representative of the conditions at the time of sampling. This report should not be taken as any guarantee that a site is free of hazardous or potentially contaminative materials.

Information contained in this report is intended for the use of the Client, and Geo-Environmental can take no responsibility for the use of this information by any party for uses other than that described in this report. Geo-Environmental makes no warranty or representation whatsoever express or implied with respect to the use of this information by any third party. Geo-Environmental does not indemnify the Client or any third parties against any dispute or claim arising from any finding or other result of this investigation report or any consequential losses.

Assessment criteria or other parameters developed for the evaluation of contamination on this site are based on a number of assumptions regarding exposure and toxicology, and exposure to contaminants and levels of adverse effects may therefore vary. Whilst every care and expertise has been employed in the development of such criteria, no liability is accepted in this respect. Other criteria or guidance on the development of assessment criteria may be published in the future, and no liability is accepted in this respect.

2.0 DESK STUDY SUMMARY

The findings of the Phase I desk study are presented in the following section. A copy of the historical maps and other information obtained as part of the desk study are presented in Appendix A. Comments made in the following section regarding possible ground conditions on the site are based purely on the desk study.

2.1 Historical Mapping

Historic map extracts dating back to 1850 were obtained as part of the desk study. A summary of the apparent key features noted on the map extracts both on the site and within the local area is presented in Table 2.1.

Date	On Site	Off Site
1850	The site was shown to comprise a large field.	Expansive open fields surround the site.
1871	No changes shown.	The immediate surrounding area was shown to comprise mainly residential developments to the north, south and west. East of the site comprised open fields with occasional trees.
1873-1882	No changes shown.	No significant changes shown.
1896	No changes shown.	A plot labelled as "nursery" and a small property immediately north of the site.
1915	Site comprises of a small property on Wadham Gardens.	Surrounding fields converted into residential areas as "Wadham Gardens" and "Elsworthy Road".
1920	No changes shown.	No significant changes shown.
1935	The building appeared to have been extended further to the north.	No significant changes shown.
1946	Map depicts a number of trees on the property.	No significant changes shown.
1951	No changes shown.	No significant changes shown.
1953-1955	No changes shown.	No changes shown.
1957-1958	No changes shown.	No changes shown.
1960-1966	No changes shown.	Small residential development approximately 100m north-west of the site.
1967-1972	No significant changes shown.	Development immediately north of the site.
1974-1976	No changes shown.	No significant changes shown.
1985	Maps lack sufficient detail to determine if any changes of significance are shown.	Maps lack sufficient detail to determine if any changes of significance are shown.
1991-1996	No changes shown.	No significant changes shown.
2006	No changes shown.	No significant changes shown.
2015	No changes shown.	School roughly 200m north-west has appeared to have been extended.

Table 2.1: Summary of Historical Map Extracts

2.2 Geology

With reference to British Geological Survey (BGS) mapping, the geology of the site was anticipated to comprise the London Clay Formation.

The **London Clay Formation** comprises brown to bluish grey clay, often weathering to brown. It contains variable amounts of fine-grained sand and silt; and beds of calcareous 'cementstone' occur throughout the formation. Due to the degradation of pyrite found within the weathered portion of the London Clay, selenite crystals (calcium sulphate) occur frequently.

Using historic borehole records obtained from the BGS website, a general summary of the likely geological stratum beneath the site and in the surrounding area is presented in Table 2.2.

Made Ground		London Clay Formation		Location from Site
Top (m bgl)	Base (m bgl)	Top (m bgl)	Base (m bgl)	
0.00	3.00	3.00	15.00+	283m east
N/A	N/A	0.30	18.00+	293m North-west
0.00	0.40	0.40	35.00+	500m south

Table 2.2: Summary of Historical Borehole Logs

2.3 Hydrogeology

With reference to Envirocheck data, the bedrock geology (London Clay Formation) beneath the site is indicated to be an Unproductive stratum. No superficial deposits were anticipated on site.

Unproductive strata are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Furthermore, reference has been made to the historical borehole records with regards to potential groundwater. There were no historic occurrences of groundwater within the borehole records viewed as part of the desk study.

The site is indicated to fall within the Barrow Hill Source Protection Zone (SPZ), under authority of the Environment Agency. An SPZ is a protection zone placed around a well or borehole that supplies groundwater of potable quality. However, it is anticipated that the SPZ designation would relate to groundwater within the Chalk which is located at considerable depth beneath the London Clay Formation, the latter and underlying Lambeth Group being considered as aquitards and thus providing separation from the groundwater at depth beneath the site.

No recorded pollution incidents, licensed abstraction points or discharge consents to controlled groundwater were identified as part of the desk study within a 250m radius of the site boundary.

2.4 Hydrology

With reference to the Landmark dataset, no surface water features were identified on site or within a 250m radius of the site boundary. The nearest surface water feature is 394m north-west of the site.

The site is indicated to be outside of any current indicative tidal or fluvial flood plain, or any associated flood warning area.

With reference to the publication “The Lost Rivers of London” two tributaries of the River Tyburn formerly flowed north to south in the area. The eastern portion was indicated to be located c.120m to the east and crossed Wadham Gardens and Elsworthy Road. The western arm of the Tyburn flowed north to south approximately 150m to the west of the site before joining the eastern arm and flowing into the boating lake in Regent’s Park.

No recorded pollution incidents, licensed abstraction points or discharge consents to controlled surface waters were identified as part of the desk study within a 250m radius of the site boundary.

2.5 Geochemistry

A large portion of the UK’s urban soils have naturally elevated concentrations of some potentially harmful chemicals. In some cases these exceed the respective generic assessment criteria (GAC) or Defra’s Category 4 Screening Levels (C4SLs). A summary of the estimated urban soil chemistry for the area is presented on the Table 2.3:

Determinant	Concentration (mg/kg)	In Excess of Threshold*?
Arsenic	15	No
Cadmium	0.30	No
Chromium	110	No
Lead	2419	Yes
Nickel	40	No

NOTE: * Comparative threshold concentrations are for a residential end use with plant uptake

Table 2.3: Summary of Site Geochemistry

It should be noted that these values are not necessarily representative of the site’s soil chemistry. Furthermore, GACs and C4SLs are dependent on pH and soil organic matter content. Therefore, concentrations of specific determinants and the utilised threshold cannot be determined without site specific investigation and analysis.

2.6 Sensitive Land Uses

A search was made of environmentally sensitive areas, including areas of green belt, scenic or natural beauty, parks, reserves, nitrate zones, protected conservation and scientific areas.

The site was not indicated to occupy any such land uses/designations. Nor were any identified within a 250m radius of the site boundary.

2.7 Environmental Data

Searches of other various environmental databases were made as part of the desk study, including air pollution control sites, Part IIA contaminated land, Integrated Pollution Control (IPC) and Integrated Pollution Prevention and Control (IPPC) sites, registered radioactive substances, COMAH sites, explosives sites, Notification of Installations Handling Hazardous Substances (NIHHS) sites, planning permissions for sites involving hazardous substances, contemporary trade directories and fuel station registers.

The desk study did not identify any Local Authority Pollution Prevention and Controls entries within a 250m radius of the site boundary:

In addition, the desk study did not identify any potentially contaminative contemporary trade directory entries within a 250m radius of the site:

No other such potentially contaminative land uses were identified as part of the desk study within a 250m radius of the site boundary.

2.8 Geotechnical Data

The site lies within an area considered by the Coal Authority as an area that might not be affected by coal mining.

National databases for a number of different geological hazards have been compiled by the British Geological Survey (BGS), and a summary of the hazard data pertaining to the site itself is presented on Table 2.4:

Hazard	Designation
Collapsible ground	Very Low
Compressible ground	No Hazard
Ground dissolution	No Hazard
Landslide	Very Low
Running sand	No Hazard
Swelling clay	Moderate

Table 2.4: Summary of BGS Geological Hazards

2.9 Ground Gases

A search of BGS recorded landfill sites, IPC registered waste sites, licensed waste management facilities, local authority recorded landfill sites, other registered landfill sites, waste transfer stations, and other waste treatment or disposal sites was undertaken as part of the desk study. Such sites may form an artificial source of ground gases, such as carbon dioxide and methane, where wastes are buried or disposed of to landfill.

No such facilities or land uses were identified within a 250m radius of the site boundary.

2.10 Radon

Reference has been made to the Envirocheck data report, which indicates that the site lies in an area where radon protection measures are not required.

2.11 Previous Ground Investigations

Geo-Environmental was not aware of any previous ground investigations which may have been undertaken on the site.

2.12 Generic Contamination

The site has been a residential plot since the earliest map extracts of 1869. This land use is not covered by the National House Building Council (NHBC), Environment Agency (EA) and Chartered Institute of Environmental Health (CIEH) publication '*Guidance for the Safe Development of Housing on Land Affected by Contamination*' (2008), provides a summary of industrial profiles (1995 - 1996) published by the former Department of the Environment (DoE) (now part of the Department for Environment, Food and Rural Affairs [DEFRA]).

However, the near surface soils may have been impacted by heavy metals and organic pollutants such as polyaromatic hydrocarbons (PAHs) through direct placement (in the form of ash or clinker) or through aerial deposition. The buildings on site may have been constructed using asbestos containing materials and therefore the potential presence of this contaminant within the near surface soils cannot be discounted.

3.0 PRELIMINARY RISK ASSESSMENTS

Based on the findings of the desk study, the following sections summarise the anticipated geotechnical and environmental factors likely to impact the site.

3.1 Preliminary Geotechnical Risk Assessment

Hazards identified as being potentially present on site could have implications for foundation design and construction. A summary of commonly occurring geotechnical hazards is given in Table 3.1:

Geotechnical Hazard	Probability	Engineering Implications
Shrinkable soils	High	The London Clay Formation is likely to be shrinkable and may affect depth and type of foundations and floor slab design.
Aggressive chemical ground conditions (sulphates)	Likely	The possible presence of aggressive chemical ground conditions may affect foundation design and construction.

Table 3.1: Possible Geotechnical Hazards

3.2 Environmental Conceptual Model

3.2.1 Methodology

A Preliminary Risk Assessment (PRA) and Conceptual Site Model (CSM) have been prepared in accordance with CLR11 based on information obtained as part of the desk study. Possible risks associated with potential sources of contamination and sensitive receptors identified have been assessed following a source-pathway-receptor (SPR) approach in accordance with current UK protocols.

A risk may only exist where a plausible SPR linkage is present, and where the quantity or concentration of a contaminant is sufficient so as to pose harm. Under the statutory definition, "Contamination" may only strictly exist where contaminants pose a risk of harm to a receptor. Risk may be defined as a function of the likelihood and severity of any adverse effects arising from contamination. The risk classification has been assessed in accordance with CIRIA C552 (Rudland *et al*., 2001). A summary of how the risks are derived and their definitions are presented in Table 3.2 and 3.3 below:

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	Very high risk	High risk	Moderate risk	Moderate/low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low Likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

Table 3.2: Risk Ratings Matrix

Risk Rating	Definitions
Very high risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not already undertaken) and remediation are likely to be required.
High risk	Harm is likely to arise to a designated receptor from an identified hazard Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not already undertaken) is required and remediation works may be necessary in the short term and are likely over the longer term.
Moderate risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.
Moderate to low risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is unlikely that any such harm would be severe, or if any harm were to occur it is probable that the harm would be relatively mild.
Low risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very low risk	There is low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Table 3.3: Risk Ratings Definition

3.2.2 Summary of Plausible Sources

Possible sources of contamination identified or discounted as part of the desk study are summarised on Table 3.4:

Source	Description	Comments
Made Ground and near surface soils	General background chemical quality of the near surface soils	Possible elevated metals, organic and inorganic contaminants

Table 3.4: Possible Sources of Contamination

3.2.3 Summary of Plausible Pathways

The plausible pathways are summarised below:

- direct contact (soil, dust and vegetable ingestion, dermal contact and dust inhalation);
- vertical and lateral migration including leaching;
- root uptake; and
- chemical attack of infrastructure (including water supply pipes) and building foundations.

3.2.4 Summary of Plausible Receptors

Potential receptors associated with the site and its development, identified or otherwise discounted, are summarised on Table 3.5:

Receptor	Description	Comments
End Users	Occupants of the proposed residential development.	The development will have a private gardens.
Adjacent Land Users	Sensitive land uses identified within the immediate vicinity.	Adjacent land uses are generally commensurate with the proposed development i.e. residential.
Soft Landscaping	Areas of planting including lawns, shrubs, trees, etc.	A private garden is proposed.
Water Supply Pipes	New water pipes.	Pipes may be laid within Made Ground.
Infrastructure	Buried concrete for foundations, etc.	Significant depths of Made Ground are not anticipated; limited chemical degradation of the near surface soils may have taken place
Groundwater	Controlled waters contained within the aquifer(s) beneath the site.	The site lies upon an Unproductive stratum but is within a SPZ. The SPZ is thought to relate to an abstraction from the Chalk aquifer at a significant depth beneath the site and overlain by >80m of London Clay acting as an aquitard.
Surface Water	Controlled waters within lakes, rivers, and ponds, etc., or coastal waters.	No surface water features were identified within 250m of the site.

Table 3.5: Possible Receptors of Contamination

Site workers involved in the preparation and construction of the development have not been considered in this assessment as the principal contractor is duty bound under the current CDM Regulations to undertaken their own risk assessments with respect to their employees.

Whilst the above sources and receptors have been identified, Table 3.6 summarises the identified plausible pollution linkages:

Potential Source/Media	Potential Receptors	Possible Pathways	Probability	Consequence	Risk & Justification
Made Ground & near surface soils/Soil	End Users	Direct contact	Likely	Mild	Moderate to Low Future residents are likely to come into contact with soils via direct contact in the private garden or home. The consequence is likely to be mild.
	Adjacent Land Users	Direct contact	Low	Mild	Low It is considered a low probability that adjacent site users will come into contact with soils on site. The consequence affected is likely to be mild.
	Soft Landscaping	Root uptake	Likely	Minor	Low Root uptake is likely for plants but any consequence is likely to be minor.
	Water Supply Pipes	Chemical Attack	Likely	Mild	Moderate to Low Water pipes are likely to come into contact with impacted soils depending upon depth of installation and extent of soil impact. However, the consequence is anticipated to be mild.
	Infrastructure	Chemical Attack	Likely	Mild	Moderate to Low Foundations are likely to come into contact with aggressive soils depending upon depth of installation and extent of soil impact. However, the consequence is anticipated to be mild.

Table 3.6: Plausible Pollution Linkages

3.3 Preliminary Risk Assessment Summary

The PRA and CSM developed from the information gathered as part of the desk study process have identified several plausible pollutant linkages that exist in relation to the proposed redevelopment of the site. However, the preliminary risk rating for each linkage has been classified as moderate to low or low.

4.0 BASEMENT IMPACT ASSESSMENT SCREENING

The London Borough of Camden guidance suggests that any development proposal that includes a subterranean basement should be screened to determine whether or not a full Basement Impact Assessment (BIA) is required.

4.1 Screening Assessment

A number of screening tools are included in the Camden Borough Council document and for the purposes of this report reference has been made to Figures 1 to 3 of their report which include a series of questions within a screening flowchart for three categories: groundwater flow, land stability, and surface water flow. Responses to the questions are presented in Tables 4.1 to 4.3.

4.1.1 Subterranean (Groundwater) Screening Assessment

Question	Response for Site	Action
1a. Is the site located directly above an aquifer?	No. The underlying geology (London Clay Formation) is designated as an Unproductive Stratum and considered to represent an aquitard.	None
1b. Will the proposed basement extend beneath the water table surface?	No. Borehole records do not indicate the presence of groundwater within or at shallow depth beneath the anticipated construction depth zone.	None
2. Is the site within 100m of a watercourse, well (used/ disused) or potential spring line?	No known spring or well was identified within 100m of the site. The nearest surface water feature was >300m from the site.	None
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No. Site is at an elevation of c.44mOD compared to c.62mAOD for the lowest Hampstead Heath pond.	None
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No. The basement extension is beneath the existing ground floor.	None
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 new soakaways or SUDs are planned as part of the proposed development. Proposed site drainage will be connected to the existing mains sewers.	None
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.	None

Table 4.1: Screening Assessment for Groundwater Flow

The above assessment has not identified any potential issues with regard to groundwater.

4.1.2 Stability Screening Assessment

Question	Response for Site	Action
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No.	None
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No.	None
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No.	None
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No.	None
5. Is the London Clay Formation the shallowest strata at the site?	**Yes**, although some Made Ground may be present.	**Investigation**
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. Any existing trees on site will be retained as part of the development.	None
7. Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?	No subsidence history is known at the time of writing.	None
8. Is the site within 100m of a watercourse or potential spring line?	No.	None
9. Is the site within an area of previously worked ground?	No.	None
10. Is the site within an aquifer?	No. The underlying geology (London Clay Formation) is designated as an Unproductive Stratum and considered to comprise and aquitard.	None
11. Is the site within 50m of Hampstead Heath ponds?	No.	None
12. Is the site within 5m of a highway or pedestrian right of way?	**Yes, it is within 5m of Wadham Gardens.**	**Investigation& Assessment**
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	**Yes**, the proposed basement foundation will be deeper than the existing neighbouring properties.	**Investigation& Assessment**
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No.	None

Table 4.2: Screening Assessment for Land Stability

The above assessment has identified the following potential issues that need to be assessed:

Q5	The London Clay Formation is the shallowest stratum at the site.
Q12	The site is within 5m of Wadham Gardens.
Q13	The proposed basement foundation will be deeper than the existing neighbouring properties.

4.1.3 Surface Flow and Flooding Screening Assessment

Question	Response for Site	Action
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No.	None
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	No. Storm water will utilise existing sewer connections.	None
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No. Basement is beneath footprint of existing ground floor. Infiltration properties of the site will remain unchanged.	None
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	No. Basement is beneath footprint of existing ground floor.	None
5. Will the proposed basement result in changes to the quantity of surface water being received by adjacent properties or downstream watercourses?	No. Basement is beneath footprint of existing ground floor.	None
6. Is the site in an area known to be at risk from surface water flooding, or is it at risk of flooding because the proposed basement is below the static water level of a nearby surface water feature?	No.	None

Table 4.3: Screening Assessment for Surface Water Flow

The above assessment has not identified any potential issues with regard to surface flow and flooding.

5.0 SCOPING

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

5.1 Potential Impacts

The following potential impacts have been identified. It should be noted that all potential impacts were identified within the land stability screening process.

Question	Comment
The London Clay Formation is the shallowest stratum at the site	The London Clay Formation is prone to seasonal shrink-swell (subsidence and heave).
Is the site within 5m of a highway or pedestrian right of way?	The site is within 5m of Wadham Gardens.
The proposed basement foundation will be deeper than the existing neighbouring properties	Excavation for a basement may result in structural damage to neighbouring properties if there is a significant differential depth between adjacent foundations.

Table 5.1: Summary of Potential Impacts

These potential impacts have been assessed by a site investigation, as detailed in the following section.

6.0 GROUND INVESTIGATION

6.1 Scope of Works

In summary, the following scope of works for the intrusive investigation was specified by the Client:

- The construction of four window sample boreholes to a depth of 5.00m with regular sampling and in situ testing as appropriate to the conditions encountered.
- The installation of two groundwater and ground gas monitoring standpipes with four return monitoring visit. This was agreed with the Client prior to completing the desk study or intrusive investigation and thus enabled monitoring to be undertaken if a plausible pollutant linkage was identified during the desk study or intrusive investigation.
- The excavation of three trial pits to reveal and record the foundations of the existing building on site.
- Laboratory based testing for geotechnical and environmental parameters.

It should be noted that access to the site was restricted which resulted in the window sampling method being limited to hand-held equipment rather than a tracked rig. As a result, the depth the boreholes could be drilled to was limited.

6.2 Investigation Strategy

Tables 6.1 and 6.2 summarise the strategy of the preliminary environmental and geotechnical investigations.

Environmental Area of Concern	Investigation	Positions
Made Ground & Near Surface Soils	Window sample boreholes located across the site, coupled with sampling and laboratory analysis	WS1 – WS4

Table 6.1: Summary of Environmental Investigation Strategy

Geotechnical Area of Concern	Investigation	Positions
Shrinkable Soils	Window sample boreholes located across the site, coupled with regular sampling and laboratory analysis	WS1 – WS4
Existing Foundations	Hand excavated trial pits located adjacent to the building to reveal and plot the existing foundations	TP1 – TP4
Groundwater	A standpipe was installed in order to record water levels.	WS2 & WS4

Table 6.2: Summary of Geotechnical Investigation Strategy

Based on the agreed scope of works, it was possible to make a preliminary appraisal for each area of geotechnical and environmental concerns identified as part of the investigation.

7.0 ENCOUNTERED CONDITIONS

A factual record of the conditions encountered during the physical investigation of the site is presented in the following sections.

For further details of the ground conditions, reference should be made to the exploratory hole logs and foundation sketches/photographs presented in Appendix B, the groundwater/gas monitoring assessment presented in Appendix C, the geotechnical testing results in Appendix D, and the chemical testing results in Appendix E.

The physical ground investigation works were undertaken during September 2015. Both geotechnical and contamination testing was undertaken by UKAS accredited laboratories.

Unless stated otherwise, all depths are reported as metres below ground level (m bgl).

7.1 Ground Conditions

According to published information the anticipated geological succession beneath the site was indicated to comprise the London Clay Formation. The investigation encountered the London Clay Formation beneath variable thicknesses of Topsoil and/or Made Ground in all locations. A summary of the encountered soil conditions is presented in Table 7.1.

Top (m bgl)	Base (m bgl)	Description	Position
0.00 – 0.10	0.30 – 0.40	Topsoil: black very silty clay with occasional brick fragments.	WS2, WS3 & WS4
0.00 – 0.40	0.55 – 0.60	Made Ground: heterogeneous comprising reworked orangish brown clay, gravel and demolition rubble.	All
0.55 – 0.60	3.00 - 4.50	London Clay Formation: firm to very stiff orangish brown silty CLAY	All

Table 7.1: Summary of Ground Conditions

For further details of the ground conditions encountered, reference should be made to the borehole logs presented in Appendix B.

7.2 Existing Foundations

Four hand excavated pits were located adjacent to buildings on site to reveal and plot the profiles of the existing foundations. A summary of the existing foundations encountered within the hand pits (referenced TP1 to TP4) is presented in Table 7.2.

Location	Total Depth (mm bgl)	Total Step-Out (mm)	Founding Stratum	Comments
TP1	980	90	London Clay Formation	N/A
TP2	680	60	Unproven	Foul water ingress into pit. Pit terminated on H&S grounds.
TP3	1620	240	London Clay Formation	N/A
TP4	1102	150	London Clay Formation	N/A

Table 7.2: Summary of Existing Foundations

For further details, reference should be made to the foundation sketches and photographs in Appendix B.

7.3 Groundwater

Groundwater was not encountered in the boreholes during the intrusive investigation. However, what appeared from the odour to be foul water was encountered in TP2, which prevented further excavation.

Two groundwater monitoring standpipes were installed in WS2 and WS4 to a depth of 3.0m and 4.50m respectively and were monitored on four occasions during September 2015.

During the first return visit each standpipe was recorded as being dry. During the subsequent monitoring visits, groundwater was recorded as depths of between 2.12m and 3.16mbgl. However, it is likely that this represents an accumulation of perched water, e.g. from a possible leaking drain as tentatively identified in TP2, or infiltration from within the Made Ground and is not necessarily the true groundwater level.

However, changes in groundwater levels do occur for a number of reasons including seasonal effects and variations in drainage. Such fluctuations may only be recorded by the measurement of the groundwater level within a standpipe or piezometer.

7.4 Obstructions

No obstructions were not encountered during the intrusive investigation. However, the presence of obstructions elsewhere on site cannot be discounted.

7.5 Geochemical Analysis

In order to assess the general chemical quality of the strata encountered, samples of soils recovered from the exploratory holes were submitted for analysis for a range of potential contaminants selected on the basis of the findings of the desk study and supported by the joint National House Building Council (NHBC), Environment Agency (EA) and Chartered Institute of Environmental Health (CIEH) publication, '*Guidance for the Safe Development of Housing on Land Affected by Contamination*' (2008).

Soil samples were placed into plastic containers for general inorganic analysis and into amber jars for organic analysis. Samples were stored in temperature controlled conditions from sampling until receipt at the laboratory from which time sample preparation and storage was determined by testing requirements and in line with the laboratory's protocols.

Four soil samples were submitted for analysis of a comprehensive suite of commonly occurring brownfield contaminants based upon determinants listed within the above guidance. In addition, asbestos screens were undertaken on all of the above samples.

7.6 Geotechnical Laboratory Results

Atterberg Limit tests were undertaken on eight samples of the London Clay Formation, with the results indicating Plasticity Indices ranging between 30 and 52. The corresponding Moisture Content analyses indicated moisture contents ranging between 20% and 30%.

pH and water soluble sulphate determinations were undertaken on four samples of the London Clay Formation. The results indicate pH values of between pH7.86 and pH8.0, with water soluble sulphate concentrations of between 0.33g/l and 1.18g/l.

7.7 Geotechnical Design Parameters

Geotechnical design parameters for the proposed development are summarised in Tables 7.3 and 7.4 below, they are based on the results of laboratory and in-situ testing and published data for the well-studied London Geology.

Strata	**Level at top (bgl))**	**Young's Modulus (kPa)**		**Poisson's ratio**
		Top	**Bottom**	
Made Ground	0	20,000	20,000	0.5
London Clay	0.6	30,000	350,000	0.5

Rigid boundary taken as -80.0mbgl, inferred base of London Clay.

Table 7.3: Undrained Parameters

Strata	**Level at top (mOD)**	**Young's Modulus (kPa)**		**Poisson's ratio**
		Top	**Bottom**	
Made Ground	0	15,000	15,000	0.13
London Clay	0.6	22,500	262,000	0.13

Rigid boundary taken as -80.0mbgl, inferred base of London Clay.

Table 7.4: Drained Parameters

8.0 ENGINEERING CONSIDERATIONS

Subsequent to intrusive investigation of the site and receipt of the laboratory results, the following interpretative assessments have been made with respect to engineering considerations. It is understood that plunge piles are likely to be used to support loads from the upper floors of the development during construction, and may at the end of construction be used as tension piles beneath the basement. In order to obtain the necessary geotechnical parameters for a pile design further investigation by means of a cable percussion rig is likely once the site has been secured for construction.

8.1 Traditional Foundations

It is understood that it is proposed to underpin the existing foundations with underpins taken down to bear at a depth of c. 3.5-4.0mbgl.

Based on the ground conditions and results of the dynamic probe tests, a net allowable bearing capacity of 160kPa is recommended for 700mm wide underpinning bearing at approximately 4.0mbgl within the stiff clay of the London Clay Formation. For raft foundations the net allowable bearing capacity should be limited to 40kPa in order to limit total and differential settlements. These bearing capacities will ensure that settlements remain within tolerable limits.

Based on the encountered conditions within the hand excavated trial pits the existing foundations appear to be bearing onto the London Clay Formation. Conventional underpinning or piled underpinning techniques are likely to be appropriate for the construction of the new basement level and for party wall issues.

It has been assumed that the existing party wall foundations are bearing at a depth of c.1.0mbgl.

8.2 Excavations

Shallow excavations within the Made Ground are likely to remain stable in the short term. However, longer deeper excavations within these strata are unlikely to remain stable and some form of temporary support will be necessary. However, the conditions encountered in TP2 were considered likely to indicate a leak from a foul water pipe and this could have resulted in the presence of saturated and/or softened ground, or the presence of a potentially significant volume of perched foul water within the proposed excavation area. This should be investigated further and relevant repairs and construction precautions/contingency measures put in place.

Both shallow and deeper excavations within the cohesive London Clay Formation should remain relatively stable in the short to medium term. However, the clays will soften rapidly when in contact with water and all foundation trenches should be concreted or blinded immediately upon excavation.

Appropriate Health and Safety precautions should be adopted where man entry into excavations is required. However, groundworks should be designed in such a manner to avoid man entry into excavations.

8.3 Basement Construction

Table 8.1 summarises the groundwater conditions anticipated at this site.

Groundwater	No	Standing groundwater is not anticipated within the depth of basement construction.
Perched water	Yes	Perched water may occur locally within any more granular Made Ground overlying the London Clay Formation, though these water bodies are anticipated to be limited in volume. There is also potential for an existing foul water pipe to be leaking and this should be investigated prior to construction.

Table 8.1:Summary of Anticipated Groundwater Conditions

Some limited groundwater control may be required where excavations intercept any perched water trapped within any more granular superficial deposits.

Based on the results of the investigation and the general hydrological conditions within the surrounding environs, it is considered that the construction of the basement will have a negligible effect on the existing groundwater regime in respect of the wider environment.

The basement should be fully tanked and therefore should be designed to resist hydrostatic pressures. It is recommended that the worst case water level is assumed to be ground level.

8.4 Basement Retaining Walls

The full design of any proposed retaining structures was beyond the scope of the report. However, the following values are given as a guide to assist in the design of retaining walls. These parameters assume a level surface to the rear of the retaining wall. The values have been obtained from British Standard 8002:1994 entitled "Earth Retaining Structures", based on concrete retaining wall construction.

London Clay Formation	Value
Critical state angle of shearing resistance, ϕ' (degrees)	21
Effective Cohesion kN/m^2	0
Saturated Bulk Weight (γ_{sat}) kN/m^3	19.0

Table 8.2 Summary of Values for Design of Retaining Walls

8.5 Sub-Surface Concrete

The result of the sulphate and pH analyses showed the soil samples tested to have water soluble sulphates ranging between design sulphate (DS) class DS-1 and DS-2 of BRE Special Digest 1. It is recommended that the soils on site be classified *en masse* as DS-2. An aggressive environment for concrete (ACEC) classification of AC-1s is deemed appropriate for the site.

The advice of this publication should be taken for the design and specification of all sub-surface concrete.

9.0 GROUND MOVEMENTS

There is the potential for ground movements due to the proposed development, from the excavation process, including formation of underpins, and from the changes in vertical stress within the soil resulting from the changes in loading from the development.

The effect of excavating soil is to cause a reduction in stress at the new formation level, due to the weight of the overburden removed. Since typically, construction follows on shortly after excavation, this unloading of the ground is normally modelled as producing a short term (undrained) response. However, if there is a delay in the construction phase, a fully drained response to the unloading may develop. In the case of the proposed development, it is assumed that basement excavation will be quickly followed by construction and hence modelling an undrained response is applicable.

The loading that results from the new construction will apply in the long term, over the structure's lifetime. Hence there will be both a short term and long term response. Generally, the long term behaviour results in larger movements. The overall movement of the ground following construction is, however, driven by the total changes in loading that have occurred; thus it is a combination of the unloading caused by demolition and excavation of soil and the imposed loading from the new structure.

The ground response to stress changes have therefore been modelled in the short term for the unloading caused by excavation and removal of overburden pressure. The long term response has been modelled for the net stress change caused by the combination of demolition, the excavation and new loading.

9.1 Vertical Movements Due to Excavation (Short Term)

The OASYS Software PDISP (V19.3) has been used to model the ground movements associated with the changes in stress calculated for the basement excavation and subsequent development. PDISP assumes a linear elastic behaviour of the soil and a flexible structure. In reality, the stiffness of the structures will tend to redistribute the movements, when compared to those predicted by PDISP. The movement calculations therefore represent free field movements unaffected by the stiffness of the structures and are likely to be conservative (i.e. the distortions of the structure would be less than those obtained from the predicted movements).

It is understood that tension piles are likely to be used at the base of the excavation, but the analysis has taken no account of these.

The assessments were undertaken using soil parameters (undrained and drained) derived from the ground investigation to model the stiffness behaviour. A rigid base for the analysis was taken as -80mbgl, which was the inferred depth to the geological boundary with the Lambeth Group beneath the London Clay.

It was estimated that the stress relief due to unloading would be c. 70kPa. Based on an excavation measuring c.32m by 12m, the short term analysis estimated a maximum short term heave of about 9mm occurring within the centre of the excavation (see Figure 3). Predicted heave movements beneath the party walls ranged between a minimum of 1mm at the corners to a maximum of 3mm at the midpoint of the excavation.

It should be noted that the values of heave given at the party walls do not take into account any restraining effect the proposed underpins would have on vertical movements.

It should be noted that in practice, the heave movements that develop from unloading the soil do not occur in isolation from other ground movements (settlements) associated with basement construction so it is unlikely the magnitudes of movement calculated around the perimeter of the excavation would be realised.

9.2 Vertical Movements Due to Excavation (Long Term)

The movements of the ground following construction were also analysed for the long term (drained) case. The analyses were undertaken for the combination of the unloading due to demolition / excavation and then the reloading for the new construction.

The analyses using PDISP indicated that peak heave movements in the long term would occur under the area of greatest vertical stress removal, with a magnitude of about 12mm. The long term heave along party wall was predicted to have the same pattern as that for the short term unloading (see Figure 4). Predicted heave movements the beneath the party walls ranged between a minimum of 5mm at the corners to a maximum of 10mm at the midpoint of the proposed excavation.

However, it should be reiterated that in practice, the heave movements that develop from unloading the soil do not occur in isolation from other ground movements (settlements) associated with basement construction so it is unlikely the magnitudes of movement calculated around the perimeter of the excavation would be realised.

9.3 Movements due to pile installation, underpin construction and basement excavation.

In addition to the movements due to the changes in vertical stress which have been modelled using Pdisp, the ground movements around the excavation have also been modelled using OASYS Xdisp. Each wall around an excavation is assigned as horizontal and vertical ground movement curve that are used to calculate the displacements at various distances from the excavation.

Ground movements resulting from underpinning are not well documented, and there is no specific method for assessing their magnitude. When underpinning is carried out in a well-controlled manner, movements are typically small.

To provide some basis of estimating likely movements and damage resulting from excavating the basement in front of the underpinning, and in the absence of underpinning-specific guidance, the underpinned sections of the new basement have been treated as bored piles.

The assessment of the ground movements due to the construction of the underpins and subsequent excavation has been undertaken in accordance with methodology provided in CIRIA guide C580, “Embedded retaining walls – guidance for economic design”. This provides guidance on the horizontal and vertical movements at the soil surface adjacent to an embedded retaining wall as a result of pile installation and of excavation in front of the wall. The guidance is based on numerous case histories, and based on the construction methodology proposed in this case a high stiffness (propped) retaining wall has been assumed. The guidance states that few walls are constructed entirely in stiff overconsolidated fine-grained soils. Although walls may be embedded into such soils, it is likely that they will also retain other soils such as Made Ground, River Terrace Deposits and other alluvial soils. The guidance and principles presented in the guidance also apply to these ground conditions. It is therefore considered a suitable methodology for the ground conditions encountered at Wadham Gardens.

The walls are proposed to be underpinned, rather than piled. It is intended that the underpins will be constructed following a typical underpin ‘hit-and-miss’ sequence. It is expected that the underpins will be constructed to full depth in a number of stages of pin construction. It is assumed that a high stiffness support system will be applied to the underpins when the main excavation works are undertaken.

Ground movement guidance in C580 is divided into movements resulting from pile installation and from the mass excavation in front of the wall.

Based on the proposed excavation depth of c.3.5m the Xdisp analyses indicates settlements around the perimeter of the excavation (at ground level) of 3-4mm. Settlements are likely to become negligible (<1mm) at a distance of 6m from the excavation. A contour plot of the settlements is presented in Figure 5.

The movements given by CIRIA are for excavations with straight walls; corners tend to restrict movements, such that horizontal deflections towards an excavation in the vicinity of a corner to the excavation are typical reduced to about half that predicted from ‘plane strain’ movements, though this does not apply for re-entrant corners. The effect of the corner stiffening is calculated in Xdisp in accordance with the methodology derived by Fuentes R. and Devriendt M. (2010).

Horizontal movements in towards the excavation have also been analysed using Xdisp and are likely to be in the order of 6mm at the perimeter of the excavation, becoming negligible at 12m from the excavation. As stated above the Xdisp analyses has considered corner stiffening which serve to restrict movements at the corners of excavations. A contour plot of the settlements is presented in Figure 6.

The movements derived from Xdisp is based on the surface ground movement curves presented in the CIRIA guidance which are based on empirical data. As such, it is assumed that they include any short-term element of ground movement due to vertical stress change. However, it is unlikely that the C580 data includes the long term movements resulting from stress changes. Total ground movements resulting from the proposed development are therefore taken as the sum of the predicted ground movements using C580, plus the difference in movement between short and long term. However, in this case the differences in the heave movements was of the order of a few millimetres and would serve to reduce the overall settlements predicted. As such not considering them further is conservative.

9.4 Building Damage Assessment.

The adjoining structures have been modelled in Xdisp in order to assess the potential category of damage in accordance with the criteria derived by Burland (1997) presented overleaf:

Building / Structure Damage Risk Classification (Burland (1997))

Damage Category	Category of damage	Description of typical damage+ (Ease of repair is underlined)	Approx. crack width* (mm)	Limiting tensile strain (%)
0	Negligible	Hairline cracks	< 0.1	< 0.05
1	Very Slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in buildings. Cracks in external brickwork visible on inspection.	< 1	0.05 - 0.075
2	Slight	Cracks easily filled. Redecorating probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weather tightness. Doors and windows may stick slightly.	< 5	0.075 - 0.15
3	Moderate	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weather tightness often impaired.	5 - 15 or a number of cracks > 3	0.15 – 0.3
4	Severe	Extensive repair work involving breaking out and replacing sections of walls, especially over doors and windows. Windows and door frames distorted, floor sloping noticeably. Walls leaning and bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15 - 25 but also depends on number of cracks	> 0.3
5	Very Severe	This requires a major repair job involving partial or complete rebuilding. Beams lose bearing, walls lean badly and require shoring. Windows broken due to distortion. Danger of instability.	Usually > 25 but depends on number of cracks.	-

Table 9.1 summarises the walls assessed and the worst case category of damage calculated.

Property	Structure	Predicted Peak Settlement (mm)	Predicted Peak Horizontal Movement (mm)	Category of Damage	Figure No.
Neighbouring House	Party Wall	2.5	4.5	Negligible	7
Neighbouring House	Front Facade	2.5	4.5	Negligible	8
Neighbouring House	Internal Perpendicular Wall	2.5	4.5	Negligible	9

Table 9.1 Damage category summary

In summary, the analysis indicates that the predicted ground movements in response to the basement excavation would cause negligible damage to the adjoining structures. It is anticipated that cross-propping of the excavation will be introduced early in the works, providing a very stiff support system to the walls. Furthermore, it has been assumed that the underpinning will be undertaken to a high standard of workmanship and measures are taken to avoid instability of excavations and keep ground loss to a minimum.

Full details of the Xdisp results are available on request.

9.5 Monitoring

The results of the Xdisp analyses indicate that with good construction control, damage to adjacent structures generated by the assumed construction methods and sequence are likely to be (within Category 0) 'Negligible'. A formal monitoring strategy is recommended in order to observe and control ground movements during construction. This should ensure movement do not start to fall outside of that predicted.

It is recommended that the monitoring system be designed and operated broadly in accordance with the 'Observational Method' as defined in CIRIA Report 185. Regular monitoring of positions will determine if any horizontal translation, tilt or differential settlement of the neighbouring structures is occurring as the construction progresses. Monitoring data should be checked against predefined trigger limits and should also be further analysed to assess and manage the damage category of the adjacent building as construction progresses.

10.0 ENVIRONMENTAL CONSIDERATIONS

A Generic Quantitative Risk Assessment (GQRA) incorporating the results of the desk study and ground investigation was undertaken in accordance with CLR11, the findings of which are presented in the following sections.

10.1 Outline Risk Assessment

A number of plausible pollutant linkages were identified as part of the desk study, as summarised in Section 3.

10.2 Soil Contamination vs. End Users

Based on a visual assessment of the soils encountered, in conjunction with the known site history and proposed development, it was considered that the risk from any potentially contaminated soils at shallow depth was of a moderate to low order. On this basis, and given the sensitivity of the proposed development, a total of three soil samples were submitted to a UKAS accredited laboratory for general chemical screening including common zootoxic and phytotoxic elements and asbestos screening.

The presence of a possible contaminant does not necessarily imply that a site or area is contaminated or that there is any unacceptable risk to human health. A Preliminary Quantitative Risk Assessment has been undertaken in accordance with CLR11, in order to evaluate any unacceptable risks posed to human health with respect to the proposed redevelopment. It should be noted that this assessment is protective of the chronic long-term effects of contaminants, which is also likely to be protective of any possible immediate acute effects.

A quantitative risk assessment has been undertaken by comparing the results of the laboratory chemical testing of shallow Made Ground soils against Site Specific Assessment Criteria (SSAC) generated using the Contaminated Land Exposure Assessment (CLEA) model v1.06 published by the Environment Agency, or against Defra's Category 4 Screening Levels (C4SL).

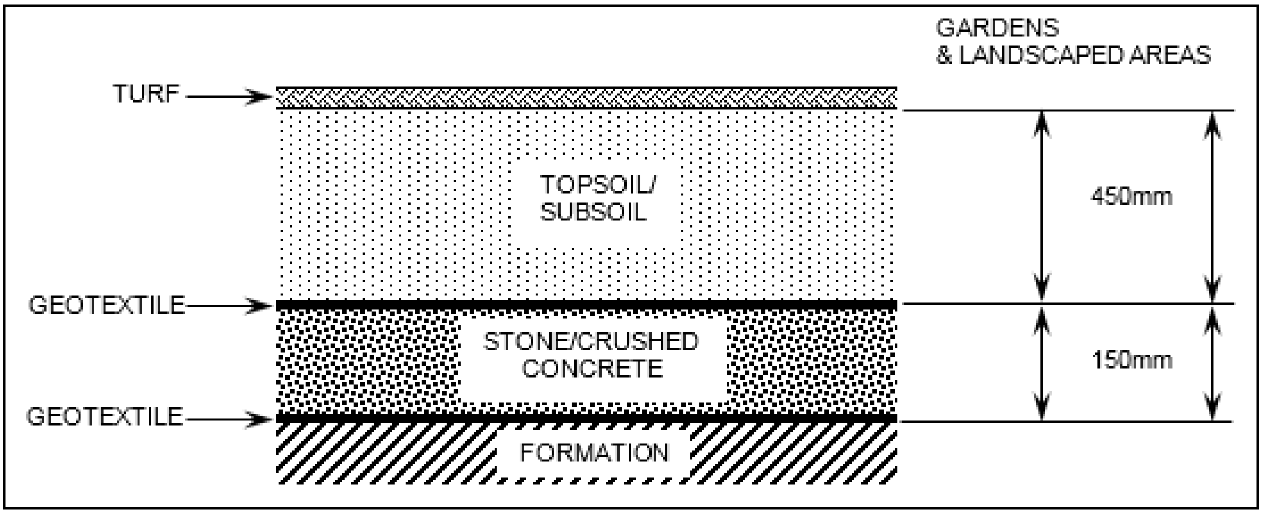
The assumptions made as part of the CLEA v1.06 calculations for a residential end use with plant uptake are presented in Table 10.1.

	Assumptions			Comments
Land Use	Residential with home grown produce			Commensurate with proposed development.
Receptor	Female (res)			A conservative assumption using the most sensitive possible receptor.
Receptor Age	1 to 6			Critical receptor age from birth to age 6.
Building	Detached House			A conservative assumption of the private residences proposed
Soil Type	Silty clay loam	pH 7.5	SOM 1.2%	Based on an average of the chemical laboratory results.
Exposure Pathways	Oral	Direct soil & dust ingestion; consumption of home grown produce & soil attached to home grown produce		Default setting for land use.
	Dermal	Indoor & outdoor		Default setting for land use.
	Inhalation	Indoor & outdoor dust & vapour		Default setting for land use.
Occupancy	days/year	hours/day (indoors)	hour/day (outdoors)	Default settings for the critical receptor.
	180 - 365	19 - 23	1	

Table 10.1: Assumptions for SSAC Calculation (CLEA v1.06 Software)

Statistical analysis of the non-targeted samples within the dataset has been undertaken in accordance with guidance contained in the CIEH/CL:AIRE report '*Comparing Soil Contamination Data with a Critical Concentration*' (May 2008). If the contamination status of the soils is considered in a planning context, the null hypothesis tested by the analysis is whether the true mean concentration is equal to or greater than the critical concentration for a given determinand, with the critical concentration being the relevant SSAC or GAC (the soil screening value) for that determinand in the context of the intended end use of the site. If the analysis shows that the true mean concentration is less than the critical concentration the null hypothesis can be rejected. The guidance recommends that for the null hypothesis to be rejected the analysis should show that there is a 95% (or higher) likelihood that the true mean concentration is below the critical concentration. Where this is the case the site is considered to be acceptable for the planned end use without further remediation.

The results of the statistical analysis indicated that the null hypothesis could be rejected for all of the determinands with the exception lead. No outliers were detected for lead, though there were two results (761mg/kg and 2400mg/kg) which significantly exceeded the C4SL of 200mg/kg. The proposed landscaping plans indicate that much of the external garden areas are to be hard paved, which would effectively sever the pathway to the end users. However, within areas of proposed soft landscaping within the private gardens a cover system is recommended.



Within root protection areas (RPAs) it may not be feasible to implement the above cover system and the advice of an arboriculutralist should be sought. Remedial measures in RPAs are likely to comprise the following:

- Removal of 50mm of turf using a mechanical excavator fitted with a toothless bucket, standing outside of the RPA and excavating to within 500mm of the trunks or edges of buttress roots.
- Ground beneath to be covered with semi-impermeable geotextile membrane (Treetex T-300 or similar).
- 150mm of topsoil to be placed above and lightly compacted.

The remediation should be undertaken in accordance with a Regulatory Approved Remedial Strategy and Verification Plan.

In addition, all samples submitted for asbestos screens were returned with no asbestos fibres identified.

10.3 Soil Contamination vs. Adjacent Land Users

Surrounding land uses were identified to mostly comprise residential properties analogous with the proposed development of the site. No significant concentrations of potentially mobile contamination were encountered as part of the investigation. Therefore, no remedial action is considered necessary to protect adjacent land users from soils on site.

However, it is recommended that dust suppression techniques, e.g. damping down exposed soils, are employed during the demolition and construction phases on site in order to minimise the potential for airborne migration of specific hazards and to manage potential nuisance issues for adjacent land users.

10.4 Soil Contamination vs. Soft Landscaping

British Standard BS3882:2015 '*Specification for topsoil and requirements for use'* provides assessment criteria for a number of potentially phytotoxic contaminants in terms of new planting.

The results of the chemical analysis for determinants known to pose a potential phytotoxic risk to plant growth are summarised in Table 10.2, together with the respective adopted Generic Assessment Criteria (GAC) for plant growth. The compliance criteria set out in BS3882:2015 are pH dependent and thus the GAC used relate to the pH range measured on samples recovered from the site.

Determinand	Phytotoxicity GAC (mg/kg)			GAC Exceedances
	pH <6.0	pH 6.0-7.0	pH >7.0	
Zinc	200	200	300	No
Copper	100	135	200	No
Nickel	60	75	110	No

Table 10.2: Summary of Plant Phytotoxicity Assessment

The phytotoxicity assessment did not identify the presence of any concentrations of concern, nor any need for further assessment or remedial action to protect plants.

10.5 Soil Contamination vs. Infrastructure

Recommendations with respect to sulphate and buried concrete are made in Section 8.5. The current guidance on selection of materials for water supply pipes to be laid in contaminated land is contained in UKWIR Report 10/WM/03/02 (re-issued 2010). However, the guidance is not mandatory and there has been concerns raised by various industry technical associations regarding the document and the methodologies proposed.

Although there are concerns regarding the document, in lieu of any further guidance in the first instance the results of this investigation have been compared with the proposed thresholds published in UKWIR Table 3.1. Localised exceedances were recorded within the Made Ground for SVOCs (PAHs >2mg/kg).

The presumption in the guidance is that barrier pipe will be adopted for any brownfield site. It is therefore recommended that the results of this investigation be presented to the water utility company as soon as reasonably practical in order to confirm the pipe material.

As a matter of good practice, and to maximise the protection to utilities, it is recommended that clean, granular backfill is used in service runs and that marker tapes are used for all buried services.

10.6 Ground Gases

The desk study and preliminary risk assessment did not identify a plausible pollutant linkage between ground gases and end users due to the absence of a source. Four rounds of monitoring were included within the original scope of works (as stated in Section 3.4) and this verified the preliminary risk assessment.

Therefore, on the basis of the ground gas assessment and supported by the data presented in Appendix D, it is considered that the site's gassing regime is representative of Characteristic Situation 2 (BS8485 and CIRIA) for which gas protection measures would be required.

The proposed building would be classified as a Type B building for which the gas protection measures would be required to score a minimum of 3.5 points in accordance with the scoring system in BS8485.

Based on the calculated hazardous gas flows for carbon dioxide, together with the overall concentrations encountered it is recommended that ground gas protection measures be installed in accordance with Characteristic Situation 2.

The gas protection measures should comprise at least two different elements from structural barriers, ventilation measures and membranes. It should be noted that basement floor and walls conforming to BS8102:2009, Grade 2 waterproofing would score 2 points and those conforming to Grade 3, 2.5 points.

10.7 Waste

10.7.1 Reuse of Material

In accordance with CL:AIRE Code of Practice (2011) materials are only considered waste if 'they are discarded, intended to be discarded or required to be discarded by the holder'.

The Code of Practice therefore allows soils to be reused on site where the following criteria are met:

- Pollution of the environment and harm to human health is prevented in reusing the excavated materials;
- The material are suitable for use (without any further processing);
- There is certainty of use; and
- The quantity that is absolutely necessary (and no more) is used.

In order to comply with the Code of Practice, a material management plan that confirms the above criteria are met has to be prepared. The material management plan must be reviewed by a 'Qualified Person' who then issues a declaration to the Environment Agency. Geo-Environmental can provide this service should it be required.

Where materials do not meet the required criteria, it may be possible to treat them under an environmental permit so that they may be re-used on site.

10.7.2 Reuse of Waste

Where material is discarded as waste, it may still be possible to reuse the waste on site under a standard rules environmental permit or a U1 waste exemption. However, strict limits on the volumes that can be reused apply in these cases.

10.7.3 Disposal to Landfill

Under current legislation, where wastes are to be disposed of to landfill they may, depending on their classification, require pre-treatment. Pre-treatment shall comprise a chemical, physical (including sorting), thermal or biological process. The pre-treatment is required to change the characteristics of the waste, reduce its volume, reduce its hazardous nature, and facilitate its handling and enhance its recovery.

10.7.4 Waste Classification

The following information is provided for preliminary guidance purposes, as different landfill facilities or operators may have differing acceptance criteria.

It is likely that the Made Ground from around the perimeter of the building would attract a premium for disposal on account of the elevated lead concentrations. However, the soils beneath the building footprint may not have been impacted as the source of the lead is most likely from aerial deposition. It is recommended that further chemical testing is undertaken on soils removed from beneath the building in order to correctly classify the soils from the basement excavation. Additional testing of soils from beneath the building would be prudent and is likely to reduce the overall cost of waste soil disposal

10.8 Discovery Strategy

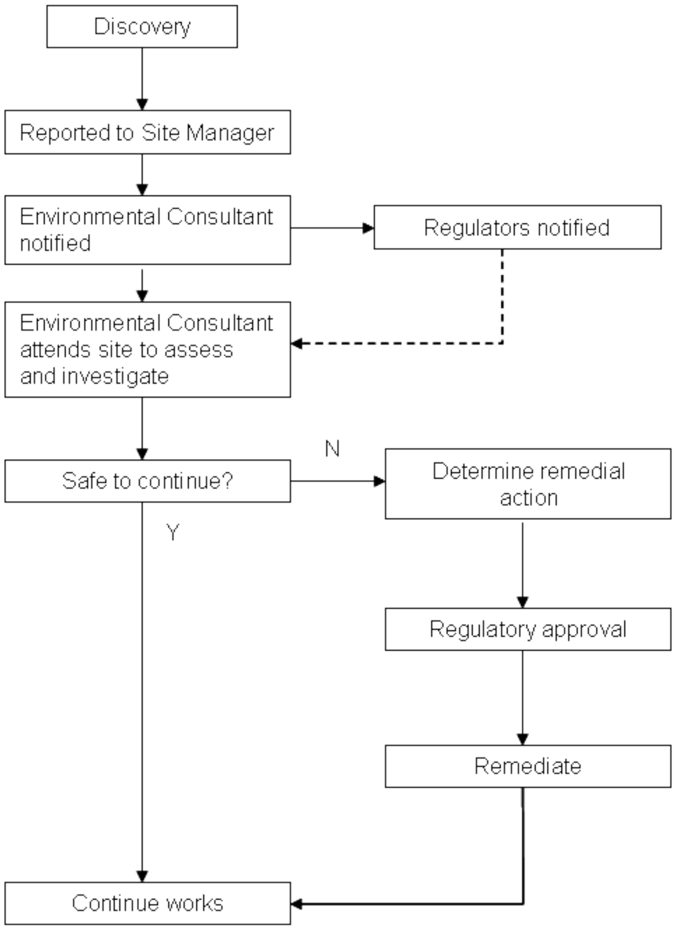
Whilst the investigation undertaken on the site to date is considered to be thorough, it remains possible that previously unexpected soil conditions may be encountered during the process of site demolition and construction.

Examples may include oily pockets within the soil, pockets of cement boarding or fibrous materials within the soil, black ashy materials, soils exhibiting strong odours, brightly coloured materials, and former structures or brickwork.

Should previously undiscovered contamination be encountered during the demolition/construction of the new buildings the following course of action should be adhered to:

- Works in the area of the suspected contamination should seize immediately. The ground workers should report any suspected contamination immediately to the Client’s site supervisor. The supervisor should contact the Environmental Consultant, who should visit the site to assess the extent of the ‘contamination’.
- The Environmental Consultant shall make records of their inspection, and pass details of these to the Local Authority.
- Where the conditions revealed differ from those previously anticipated, the Environmental Consultant shall take samples as deemed appropriate to be dispatched for appropriate chemical testing.
- Depending on the results of the testing either: 1) no further work will be required; 2) a further detailed risk assessment will be required; and/or 3) localised specific remedial measures will be necessary. Appraisal criteria will vary depending on the nature of the assessment.
- The results of any such testing will be sent to the Regulatory Authority for consultation. If remediation is required, the Regulatory Authority will be informed of the date and time of the proposed works.
- Remediation will be undertaken in accordance with a method statement submitted to the Local Authority for approval. The works shall be supervised by the Environmental Consultant who shall provide a Validation Report for the Local Authorities purposes.

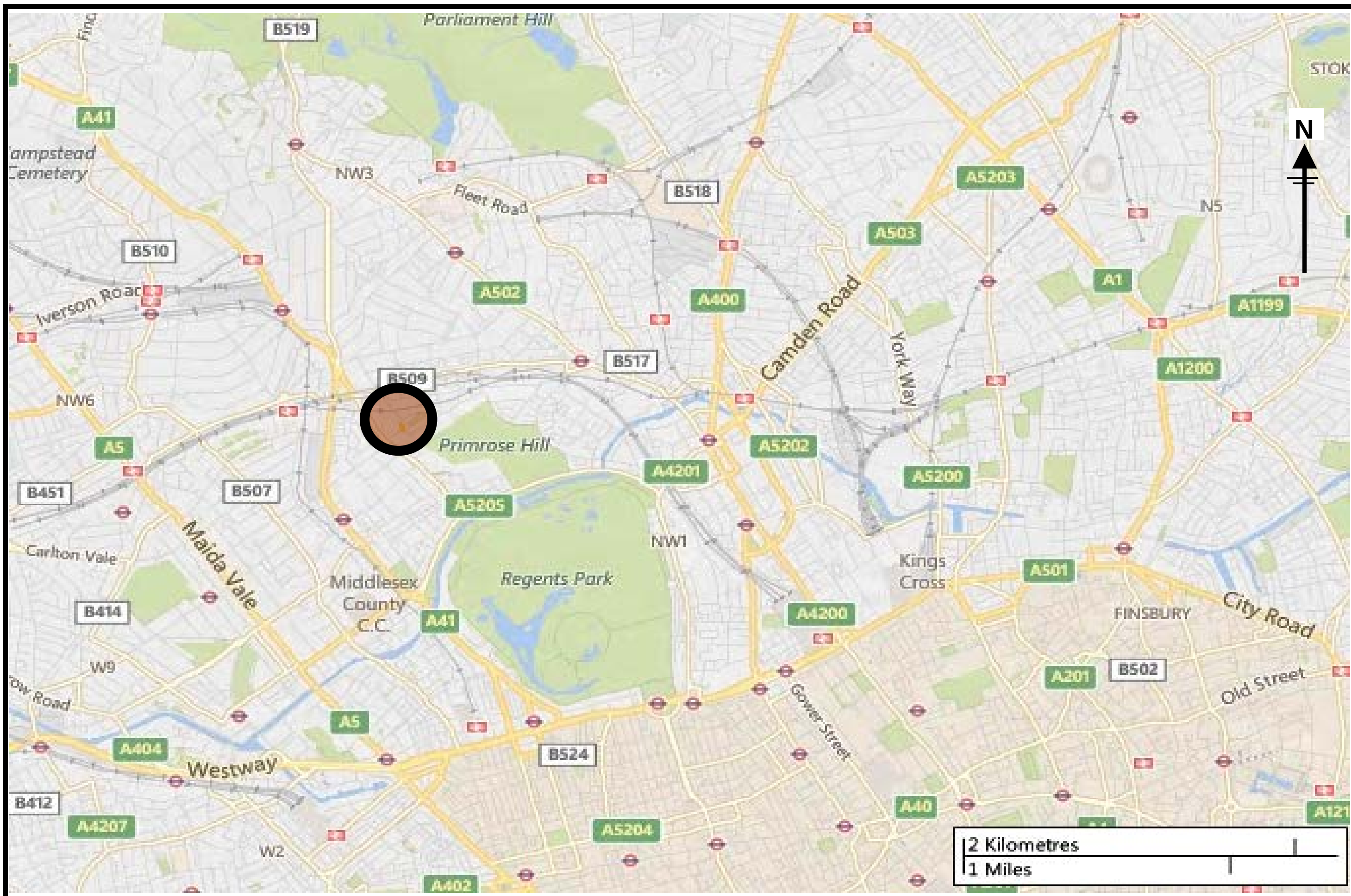
The process is summarised overleaf:

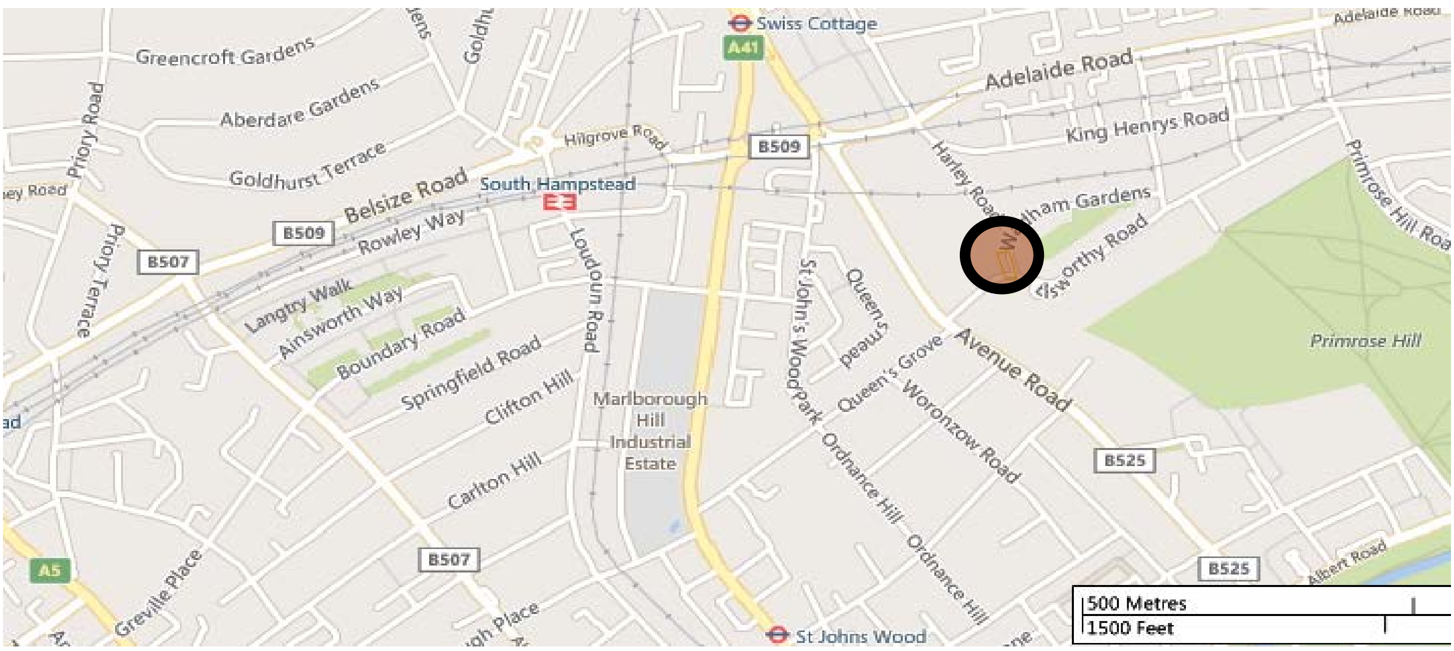


A copy of this strategy should be lodged on site, and provisions made to ensure that all workers are made aware of their responsibility to observe, report, and act on any potentially suspicious or contaminated materials they may encounter.

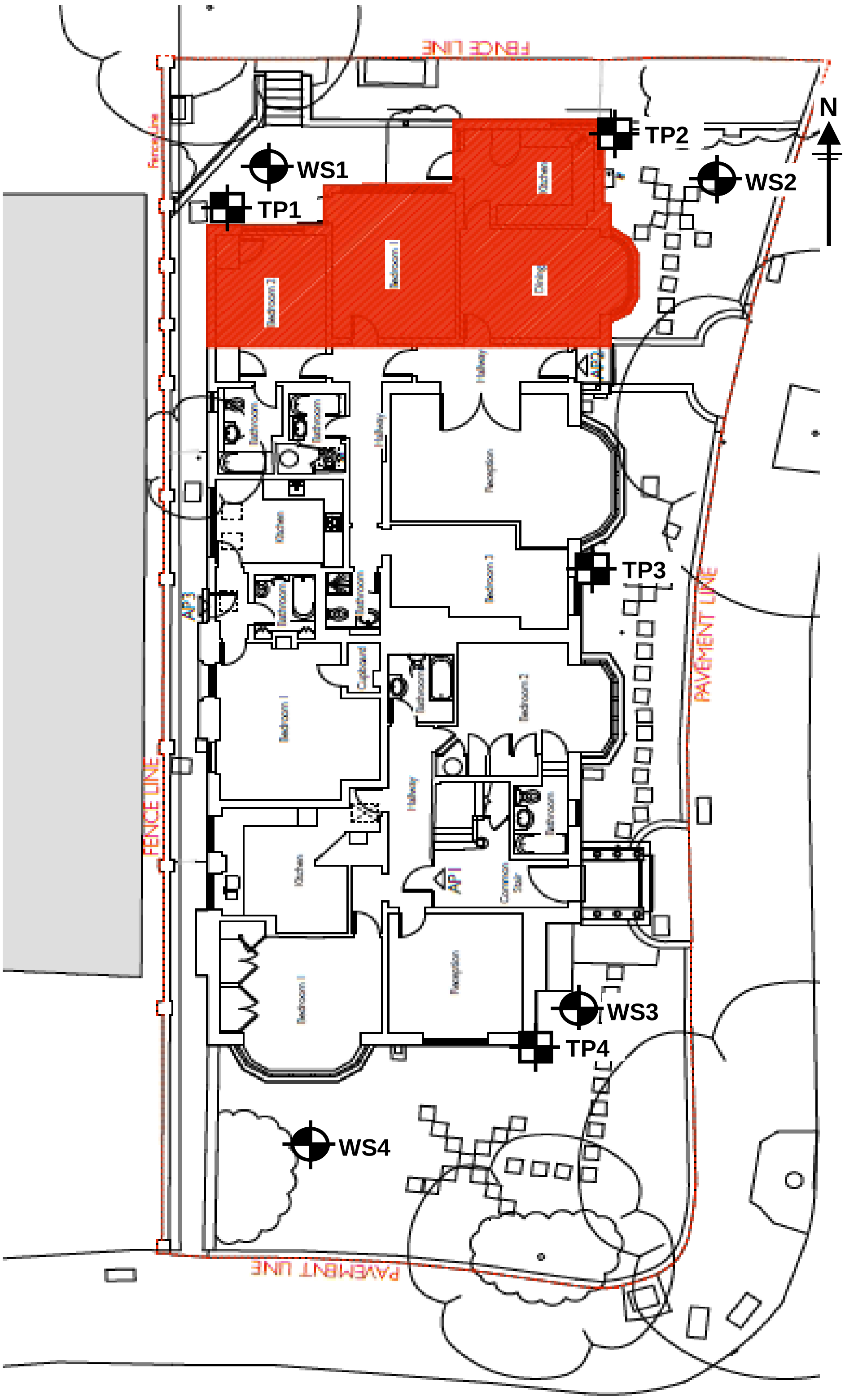
FIGURES

Geo-Environmental





Project:	1 Wadham Gardens			**Title**	Site Location Plan
Client:	Marcus Cooper Group			**Geo-Environmental Services Ltd**	
Ref No:	GE10977	**Revision:**	-	**Unit 7, Danworth Farm, Cuckfield Road,**	
Drawn:	-	**Date:**	Oct 15	**Hurstpierpoint, West Sussex, BN6 9GL**	
Figure:	1	**Scale:**	Not To Scale	**E: mail@gesl.net T: 01273 832972**	



Project:	1 Wadham Gardens			Title	Exploratory Hole Location Plan
Client:	Marcus Cooper Group			Geo-Environmental Services Ltd	
Ref No:	GE10977	Revision:	-	Unit 7, Danworth Farm, Cuckfield Road,	
Drawn:	-	Date:	Oct 15	Hurstpierpoint, West Sussex, BN6 9GL	
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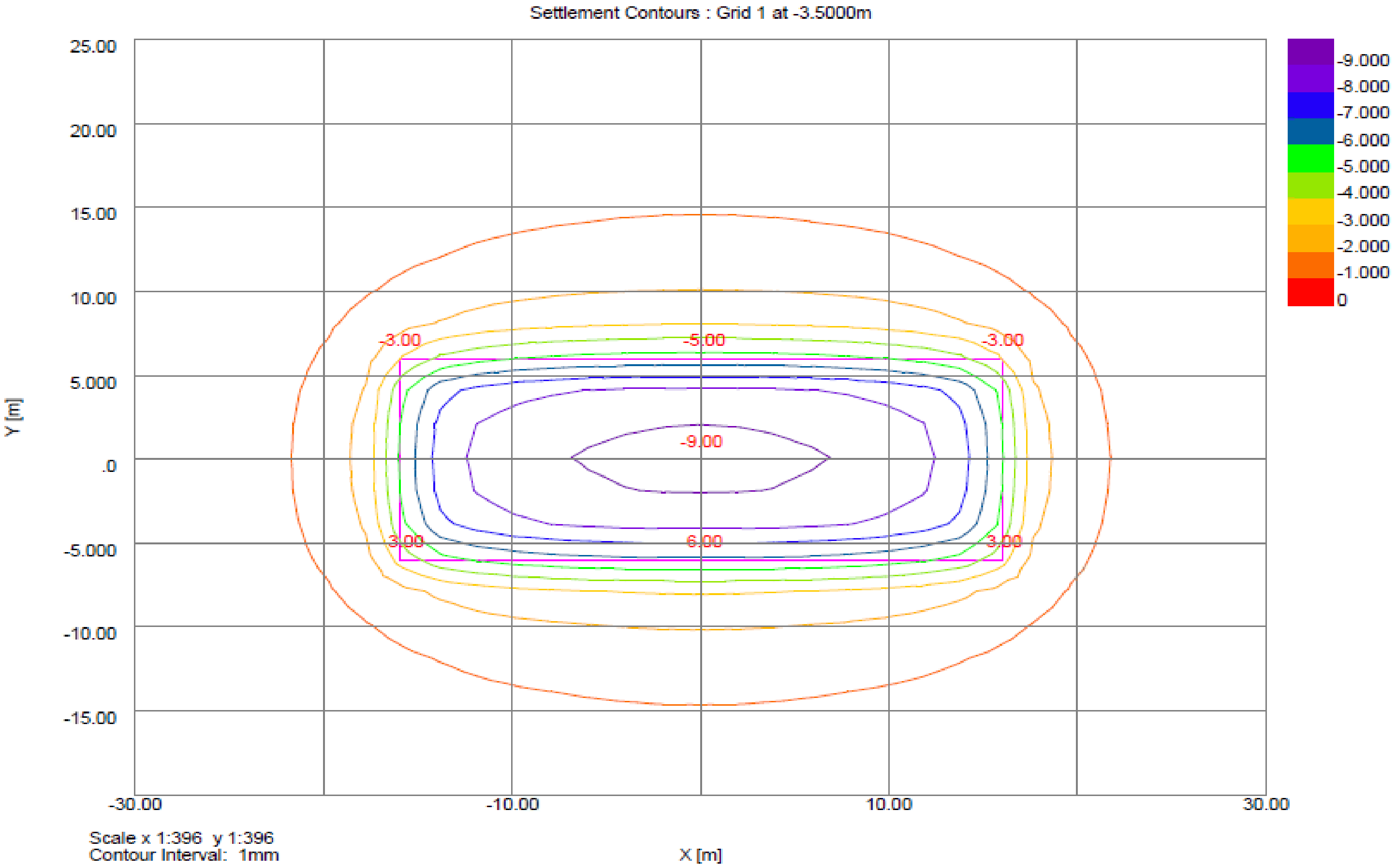
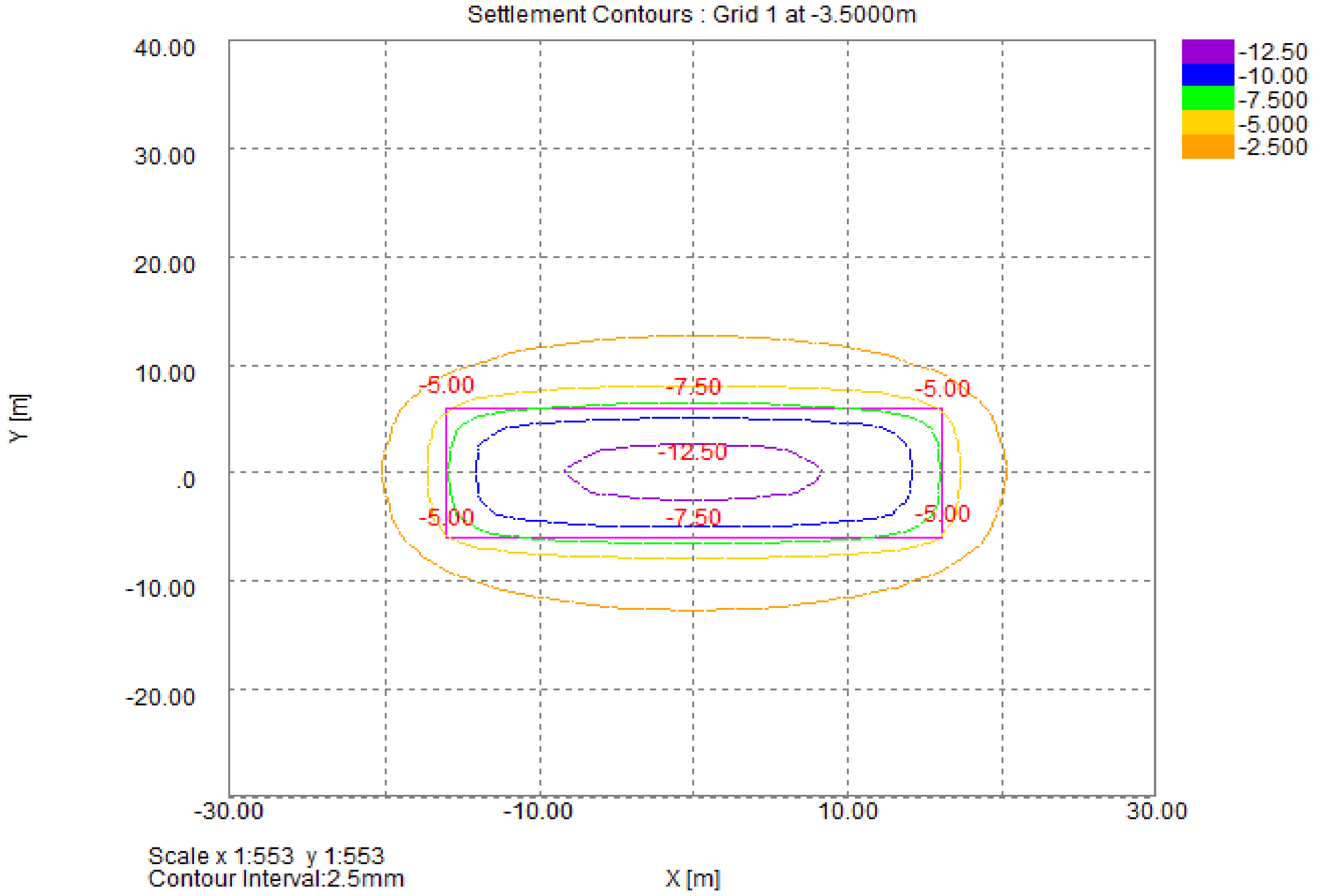
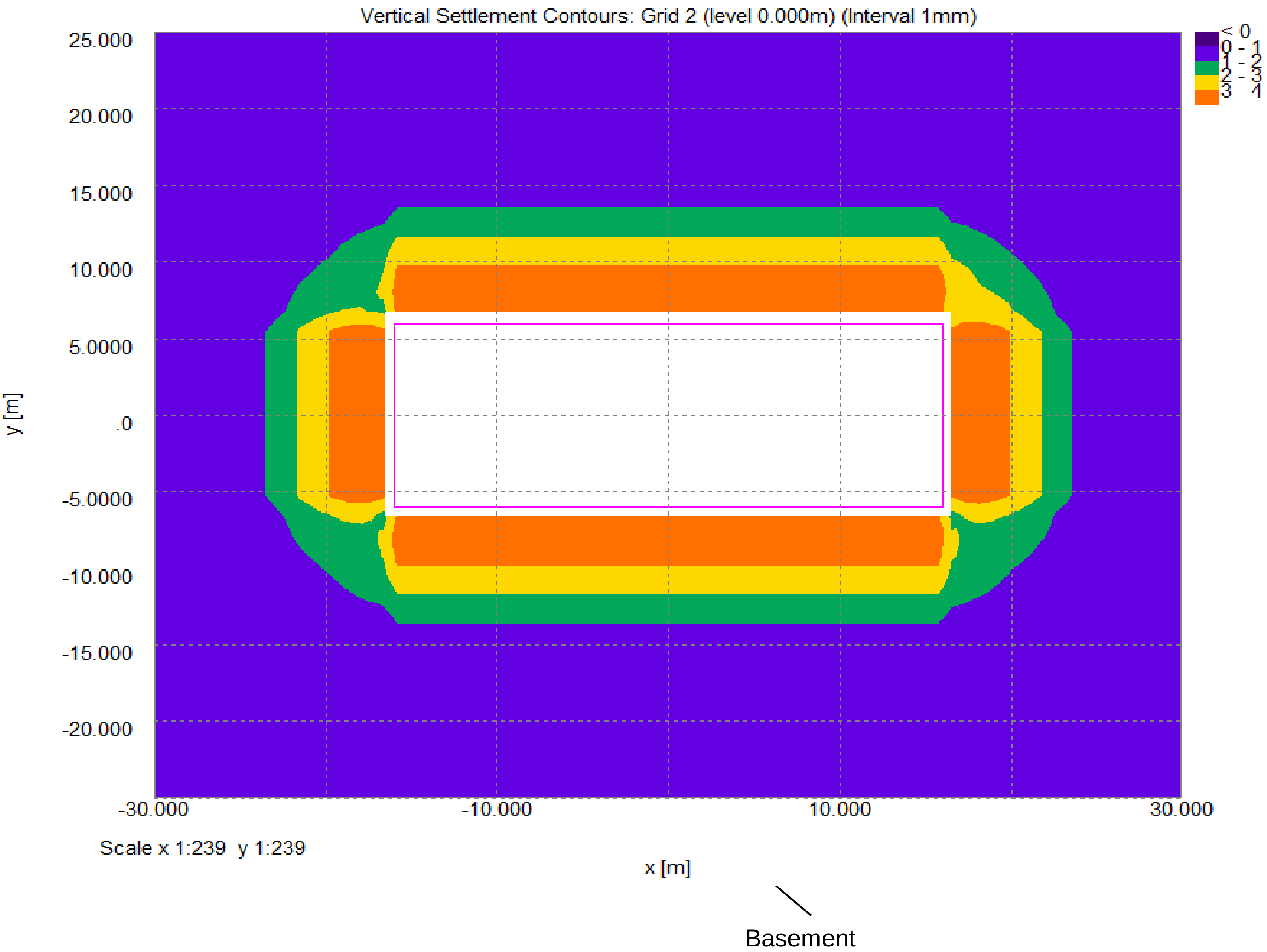


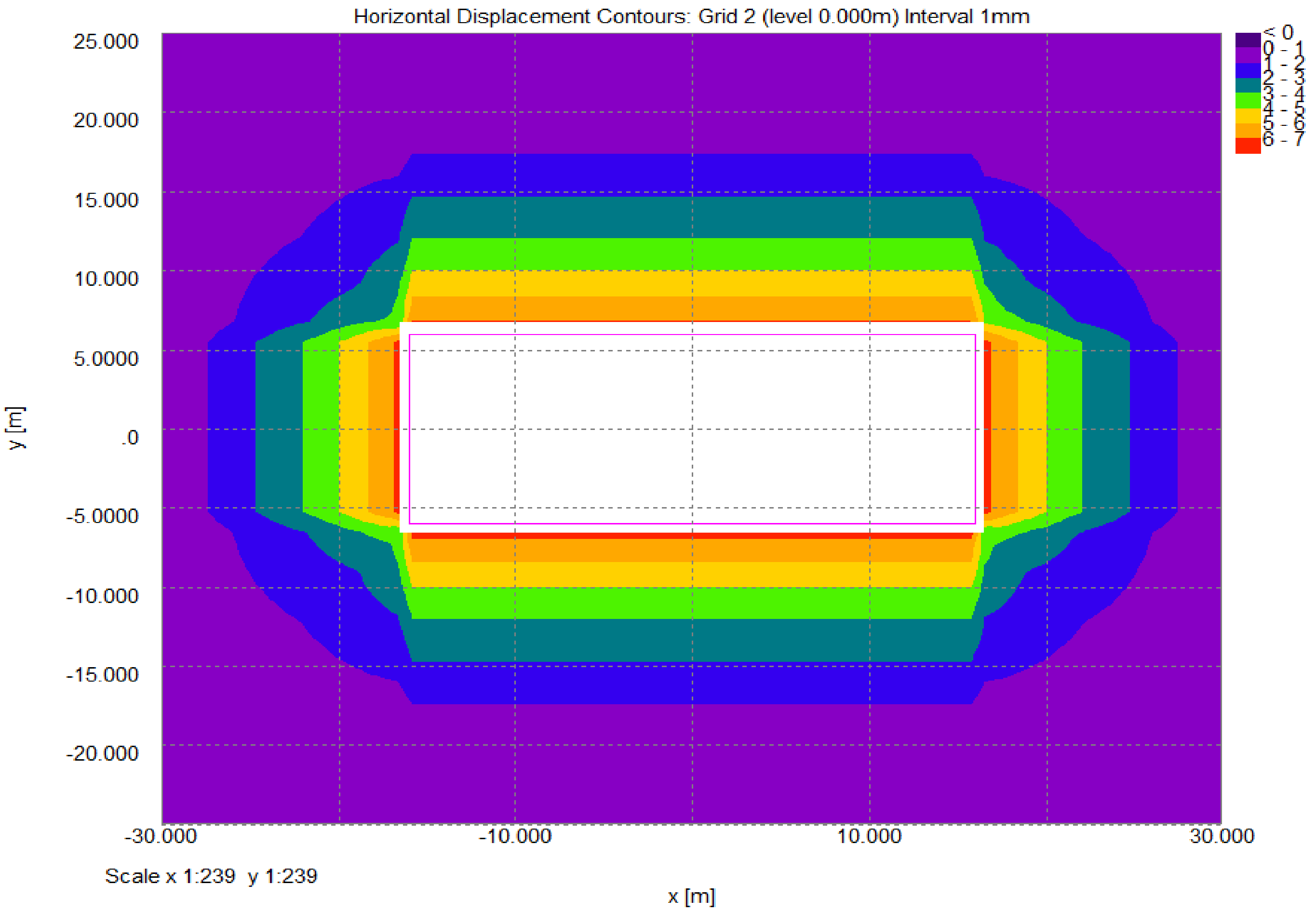
Project:	1 Wadham Gardens, London			**Title**	Short Term Heave of Excavation
Client:	Marcus Cooper Group			**Geo-Environmental Services Ltd**	
Ref No:	GE10977	**Revision:**	-	**Unit 7, Danworth Farm, Cuckfield Road,**	
Drawn:	-	**Date:**	Oct 15	**Hurstpierpoint, West Sussex, BN6 9GL**	
Figure:	3	**Scale:**	Not To Scale	**E: mail@gesl.net T: 01273 832972**	



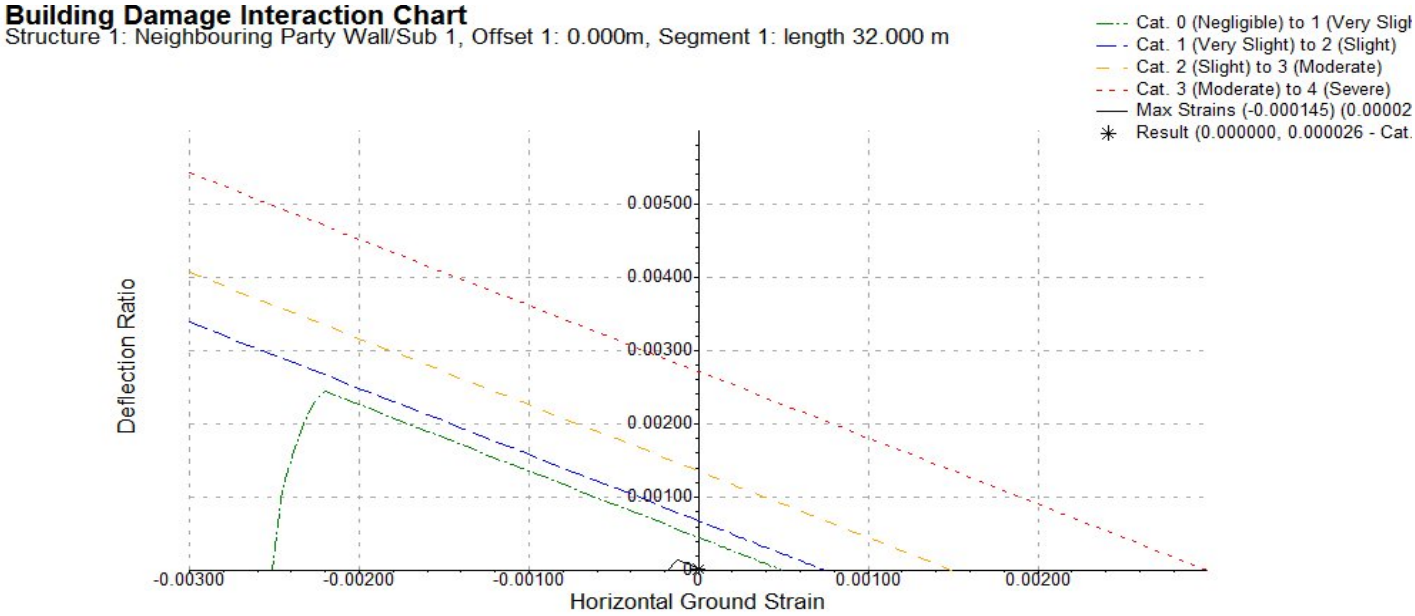
Project:	1 Wadham Gardens, London			**Title**	LongTerm Heave of Excavation
Client:	Marcus Cooper Group			**Geo-Environmental Services Ltd**	
Ref No:	GE10977	**Revision:**	-	**Unit 7, Danworth Farm, Cuckfield Road,**	
Drawn:	-	**Date:**	Oct 15	**Hurstpierpoint, West Sussex, BN6 9GL**	
Figure:	4	**Scale:**	Not To Scale	**E: mail@gesl.net T: 01273 832972**	



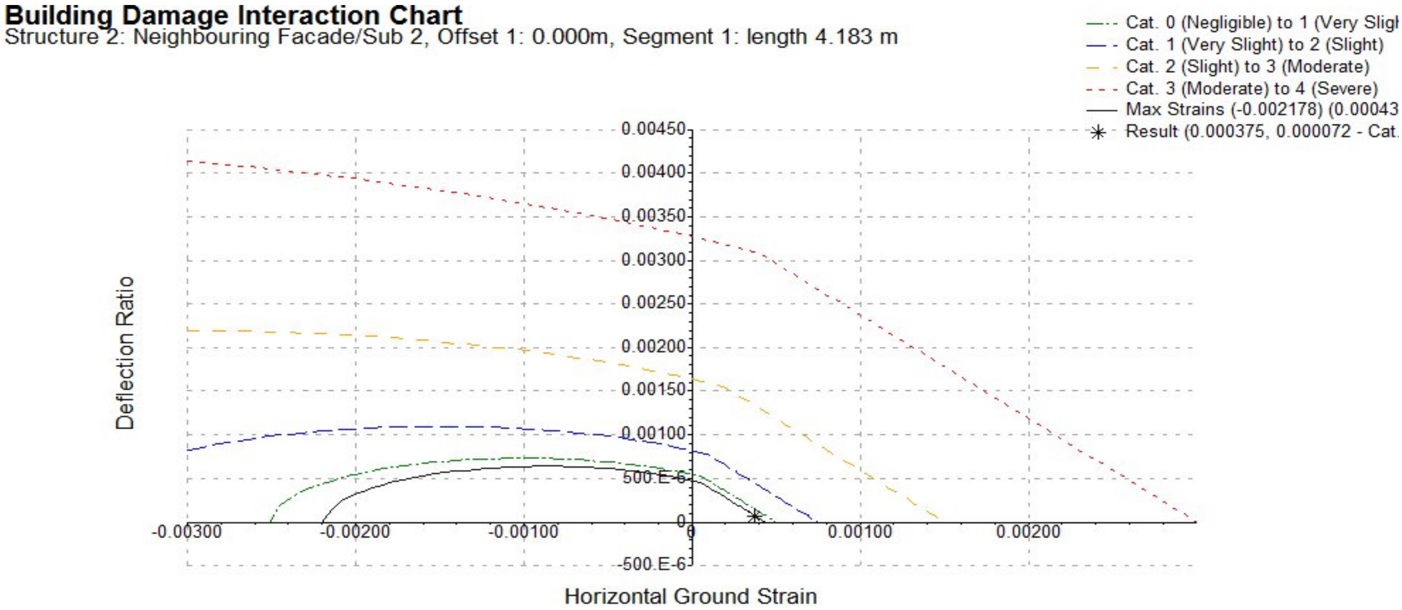
Project:	1 Wadham Gardens, London			**Title**	Vertical Settlement Around Excavation
Client:	Marcus Cooper Group			**Geo-Environmental Services Ltd**	
Ref No:	GE10977	**Revision:**	-	**Unit 7, Danworth Farm, Cuckfield Road,**	
Drawn:	-	**Date:**	Oct 15	**Hurstpierpoint, West Sussex, BN6 9GL**	
Figure:	5	**Scale:**	Not To Scale	**E: mail@gesl.net T: 01273 832972**	

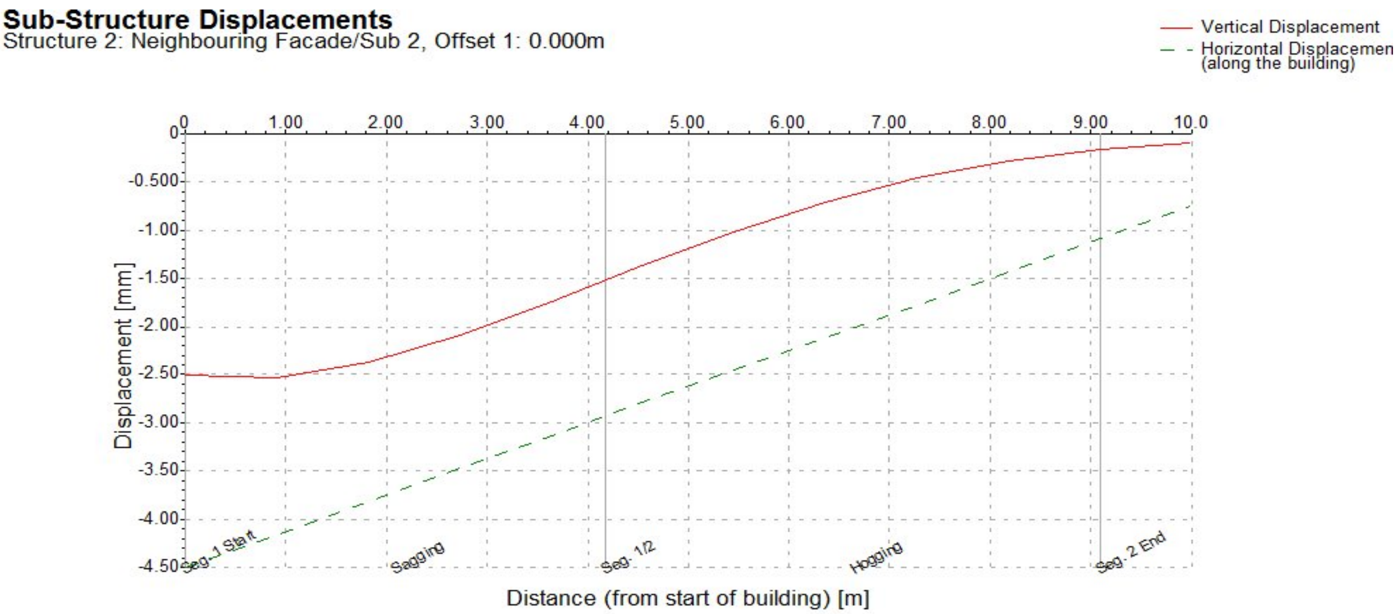


Project:	1 Wadham Gardens, London			**Title**	Horizontal Movement Around Excavation	
Client:	Marcus Cooper Group			**Geo-Environmental Services Ltd**		
Ref No:	GE10977	**Revision:**	-	**Unit 7, Danworth Farm, Cuckfield Road,**		
Drawn:	-	**Date:**	Oct 15	**Hurstpierpoint, West Sussex, BN6 9GL**		
Figure:	6	**Scale:**	Not To Scale	**E: mail@gesl.net T: 01273 832972**		



Project:	1 Wadham Gardens			**Title**	Neigbouring Party Wall
Client:	Marcus Cooper Group			**Geo-Environmental Services Ltd**	
Ref No:	GE10977	**Revision:**	-	**Unit 7, Danworth Farm, Cuckfield Road,**	
Drawn:	-	**Date:**	Oct 15	**Hurstpierpoint, West Sussex, BN6 9GL**	
Figure:	7	**Scale:**	Not To Scale	**E: mail@gesl.net T: 01273 832972**	

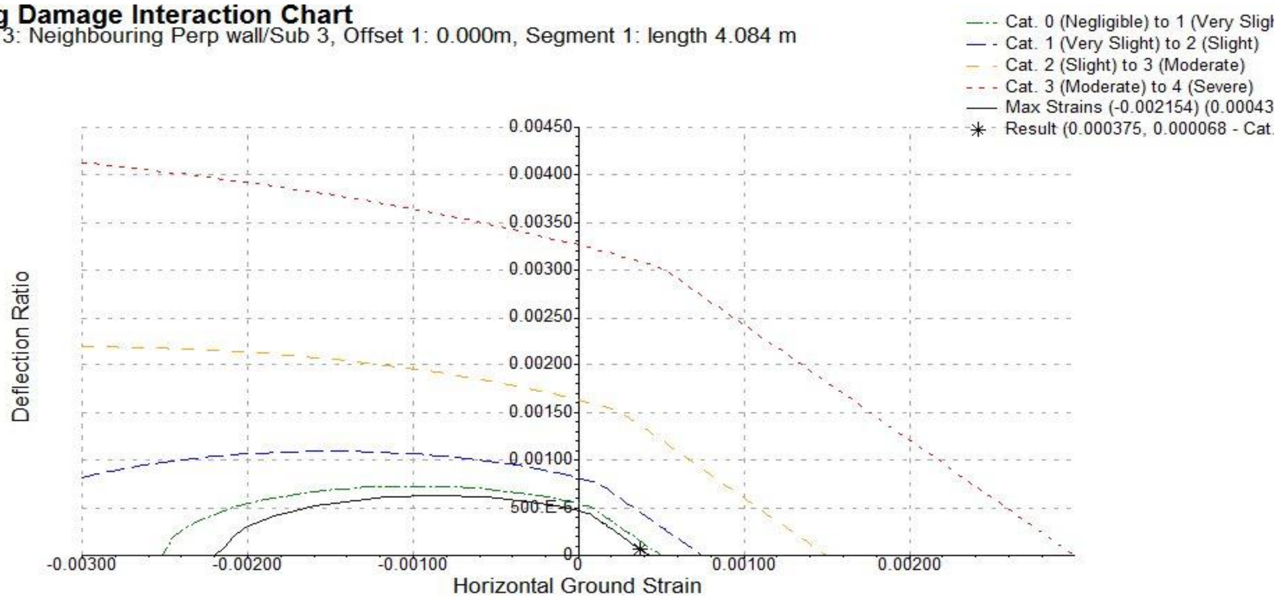




Project:	1 Wadham Gardens			Title	Neigbouring Front Façade
Client:	Marcus Cooper Group			Geo-Environmental Services Ltd	
Ref No:	GE10977	Revision:	-	Unit 7, Danworth Farm, Cuckfield Road,	
Drawn:	-	Date:	Oct 15	Hurstpierpoint, West Sussex, BN6 9GL	
Figure:	8	Scale:	Not To Scale	E: mail@gesl.net T: 01273 832972	

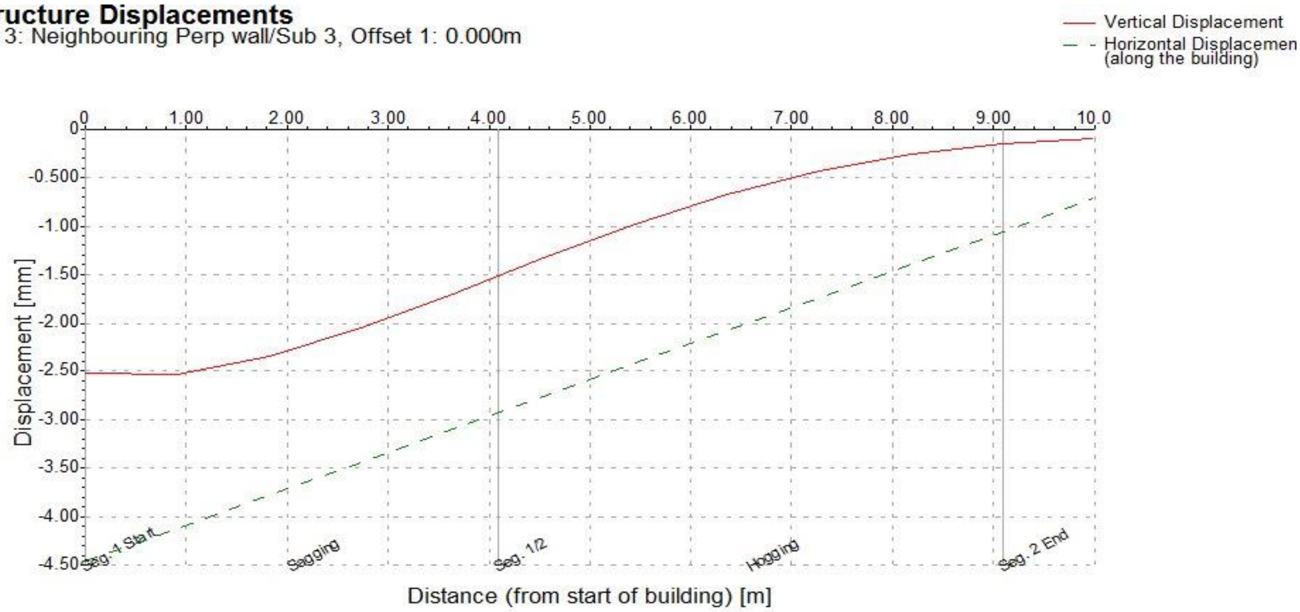
Building Damage Interaction Chart

Structure 3: Neighbouring Perp wall/Sub 3, Offset 1: 0.000m, Segment 1: length 4.084 m



Sub-Structure Displacements

Structure 3: Neighbouring Perp wall/Sub 3, Offset 1: 0.000m



Project:	1 Wadham Gardens			**Title**	Neigbouring Wall Perpendicular to Excavation
Client:	Marcus Cooper Group			Geo-Environmental Services Ltd	
Ref No:	GE10977	**Revision:**	-	Unit 7, Danworth Farm, Cuckfield Road,	
Drawn:	-	**Date:**	Oct 15	Hurstpierpoint, West Sussex, BN6 9GL	
Figure:	9	**Scale:**	Not To Scale	E: mail@gesl.net T: 01273 832972	