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Your Ref:

Our Ref: Ref: 15/23908-2
February 2021

15 LYNDHURST TERRACE,

LONDON NW3 5QA

BASEMENT IMPACT ASSESSMENT

Original Submission: November 2015

Previously Revised Submission: January 2018

New Scheme Submission: February 2021

Prepared for

Emanuel and Carmel Mond

CONTENTS

1.0 NON-TECHNICAL EXECUTIVE SUMMARY

1.1 Brief

At the request of Emanuel and Carmel Mond, a Basement Impact Assessment has been carried out at 15 Lyndhurst Terrace, London, NW3 5PB in support of a planning application for a proposed development to the property which includes the extension of the existing property at the site and construction of a new single storey basement to 3.20m maximum depth (46.80mSD).

1.2 Desk Study Findings

From historical map evidence it would appear that the current property was constructed between 1974 and 1979 and has remained unchanged since its initial construction. Prior to the 20th century, the surrounding area was mostly agricultural followed by a large amount of urbanisation around the turn of the century. The surrounding area has been predominantly residential for the last 100 years or so.

1.3 Ground Conditions

The investigation has confirmed the expected ground conditions in that, below a small thickness of Made Ground, the Claygate Member was encountered overlying the London Clay, which was proved to the full depth investigated. The Made Ground extended to depths of between 0.40m to 1.20m depth below ground level (48.90 to 49.54mSD) and comprised pea gravel or brick paving over silty sandy clay with brick fragments. The underlying Claygate Member comprised soft becoming firm and then stiff silty sandy clay with lenses of clayey silty fine sand which extended to depths/levels of 9.40m (40.10mSD) in Borehole 1 and to the full depths of investigation of 8.30m in Boreholes 2 and 3 (41.30 to 42.20mSD) and 0.85m in Trial Pit 1 (49.24mSD). The London Clay Formation was encountered below the Claygate Member and consisted of stiff silty clay with occasional partings of silty fine sand and scattered gypsum crystals which extended down to the full depth of investigation of 15.00m below ground level in Borehole 1 (34.50mSD). All the boreholes were equipped with water monitoring standpipe piezometers with the response zones being from 3-6m depth. Groundwater was not subsequently encountered in these monitoring standpipes in July, August and September 2015 with return visits in December 2016, February 2017 and February 2021.

1.4 Recommendations

Formation level of the 3.20m deep basement is likely to be within the Claygate Member. Groundwater was not encountered below the depth of the basement, although it would be recommended to continue to monitor the standpipes for as long as possible. Monitoring has been carried out over three seasons, with no groundwater encountered and give a good indication of seasonal variation on site. The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

Trial excavations to the proposed basement depth could be carried by the main contractor to confirm the stability and composition of the soil and to further investigate the presence of any groundwater inflows.

1.5 Previous Planning Application

The first previous planning application (Ref: 2015/6278/P) was registered in December 2015 and refused in February 2016.

The second previous planning condition (Ref: 2017/2471/P) was registered in April 2017, with approval of the Basement Impact Assessment by Camden Reith given in July 2017.

The contents and revision of this report address the updated scheme and are in line with comments made in relation to the two previous applications.

2.0 INTRODUCTION

2.1 Project Objectives

At the request of Emanuel and Carmel Mond, a Basement Impact Assessment has been carried out at the above site in support of a planning application.

The purpose of this assessment is to consider the effects of a proposed basement construction on the local slope stability, surface water and groundwater regime at the existing residential property.

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

This report does not constitute a full environmental audit of either the site or its immediate environs.

This report is a revision of the previously accepted Basement Impact Assessment, approved by Campbell Reith in July 2017. The revisions made, reflect the change of scheme from new build with basement to side and rear extension (which has been approved by Camden (Ref:2020/0746/P) with a single storey basement. The proposed basement is shallower than the previous proposed basement.

2.2 Planning Policy Context

The information contained within this BIA has been produced to meet the requirements set out by Camden Planning Guidance – Basements and Lightwells (CPG4) including Camden Development Policies DP27 – Basements and Lightwells (July 2015) in order to assist London Borough of Camden with their decision making process.

As recommended by the Guidance for Subterranean Development (Ref 1) the BIA comprises the following steps

1. Initial **screening** to identify where there are matters of concern
2. **Scoping** to further define the matters of concern
3. **Site Investigation and study** to establish baseline conditions
4. **Impact Assessment** to determine the impact of the basement on baseline conditions
5. **Review and Decision Making** (to be undertaken by LBC)

2.3 Qualifications

The qualifications required by Camden are fulfilled as documented in Table A below. All assessors meet the qualification requirements of the Council guidance.

Subject	**Qualifications Required by CPG4**	**Relevant persons and qualifications/experience**	
		Name/Qualifications	**Experience**
Surface flow and flooding	A hydrologist or a Civil Engineer specialising in flood risk management and surface water drainage, with either: • The 'CEng' (Chartered Engineer) qualification from the Engineering Council; or a Member of the Institution of Civil Engineers ('MICE') • The CWEM (Chartered Water and Environmental Manager) qualification from the Chartered Institution of Water and Environmental Management	Mr Christopher Grey BEng, CEng, MIStructE, MIEI	15+ years structural engineering experience
		Ms Roni Savage BEng (hons) MSc SiLC CGEOL MCIWM	25+ years of hydrogeological experience
		Mr Andrew Smith BSc(Hons) CGEOL MCIWEM	15+ years of hydrological/geotechnical experience
		Mr Thomas Murray MSc BSc(Hons) FGS	7 years of hydrogeological / geotechnical experience
Subterranean (ground water flow)	A hydrogeologist with the 'CGeol' (Chartered Geologist) qualification from the Geological Society of London	Ms Roni Savage BEng (hons) MSc SiLC CGEOL MCIWM	25+ years of hydrogeological experience
		Mr Andrew Smith BSc(Hons) CGEOL MCIWEM	15+ years of hydrological/geotechnical experience
Land Stability	A Civil Engineer with the 'CEng (Chartered Engineer) qualification from the Engineering Council or specialising in ground engineering; or A Member of the Institution of Civil Engineers ('MICE') and a Geotechnical Specialist as defined by the Site Investigation Steering Group	Mr Andrew Smith BSc(Hons) CGEOL MCIWEM	15+ years of hydrological/geotechnical experience
		Mr Christopher Grey BEng, CEng, MIStructE, MIEI	15+ years structural engineering experience

Table A – Qualification Summary

3.0 SITE DETAILS

(National Grid Reference: 526672, 185227)

3.1 Site Location

The site is located on the western side of Lyndhurst Terrace in Hampstead, North London, NW3 5QA and comprises a two-storey residential property with front and rear garden areas. The site covers an area of approximately 0.03 hectares and the general area is under the authority of the London Borough of Camden.

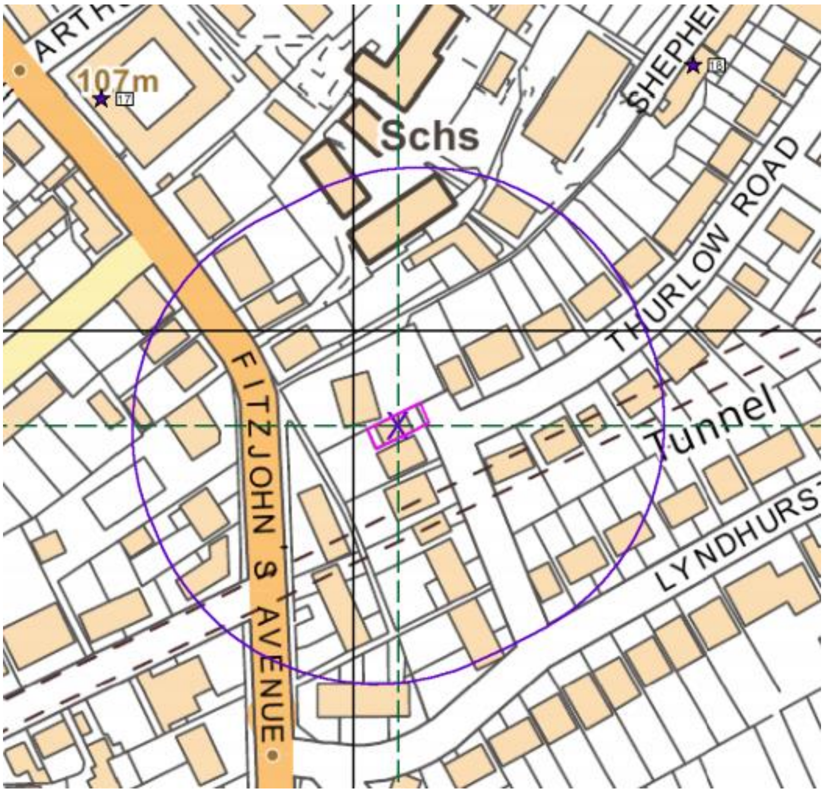


Figure 1. Site Location Plan

3.2 Site Layout and History

The site is accessed from Lyndhurst Terrace to the east and comprises of a two-storey residential property with front and rear garden areas. The front yard is covered by tarmacadam hardstanding and the rear is covered by shingle.

The site is bound by Lyndhurst Terrace to the immediate east, Spring Path to the west, Heath House (Language Studies International building) to the south and a residential property (Elm Bank) to the north. There is a single storey garage adjacent to the garden wall of No. 15 immediately to the north of the site.

The existing site is constructed on ground which slopes gently to the east with approximate Site Datum elevations of 50.20m at the rear (western) side of the site and 49.50mSD at the front (eastern) side of the site.

The existing ground level in the area of the proposed basement is believed to be approximately 95mOD. Available drawings relate levels to a site datum (SD), which will also be used for this assessment. The site slopes gently upward from front to rear; the ground level in the area of the proposed basement excavation is approximately 49.6mSD at the front to 50.5mSD at the rear.

It is understood that the proposed excavation level is to be taken as deep as 46.8mSD.

The neighbouring property at No.13 is understood to have a lower ground floor.

The above levels are related to an arbitrary site datum (SD); the general site level to Ordnance Datum is taken to be approximately 98mOD.

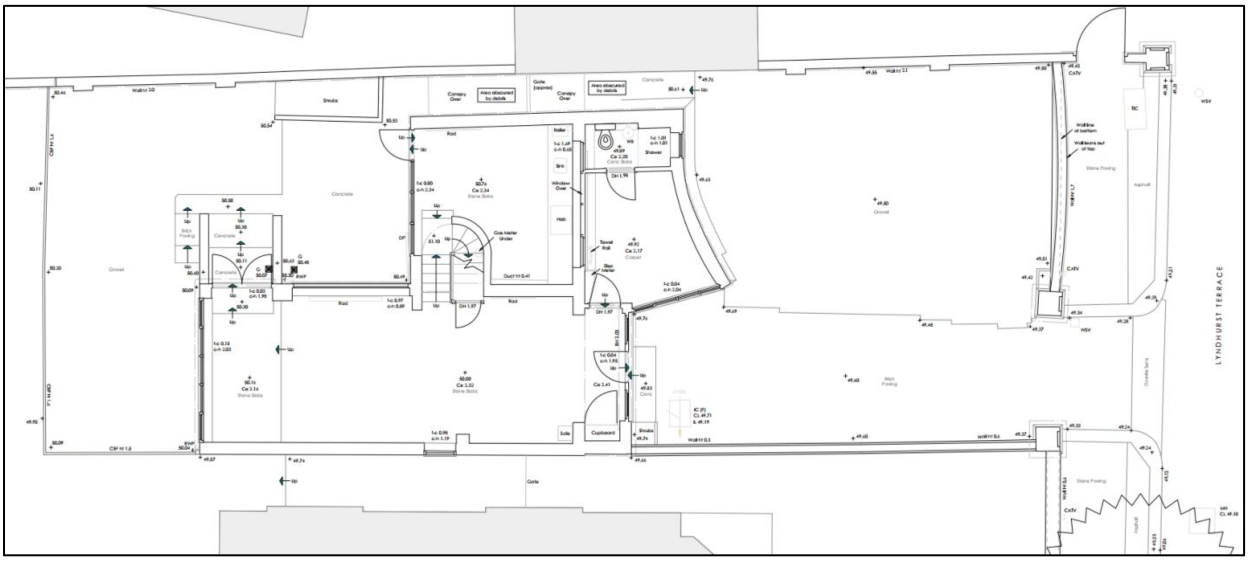


Figure 2. Site Survey showing differences in levels across site
(Arbitrary Datum of 50mSD used)

In the wider area, Lyndhurst Terrace slopes gently towards the south-east with an approximate slope of 1/16 to 1/30 recorded based on the available OS Maps and Figure 10 of the Camden Hydrogeological and Hydrological Study (Arup 2010) (replicated as Figure 3 below).

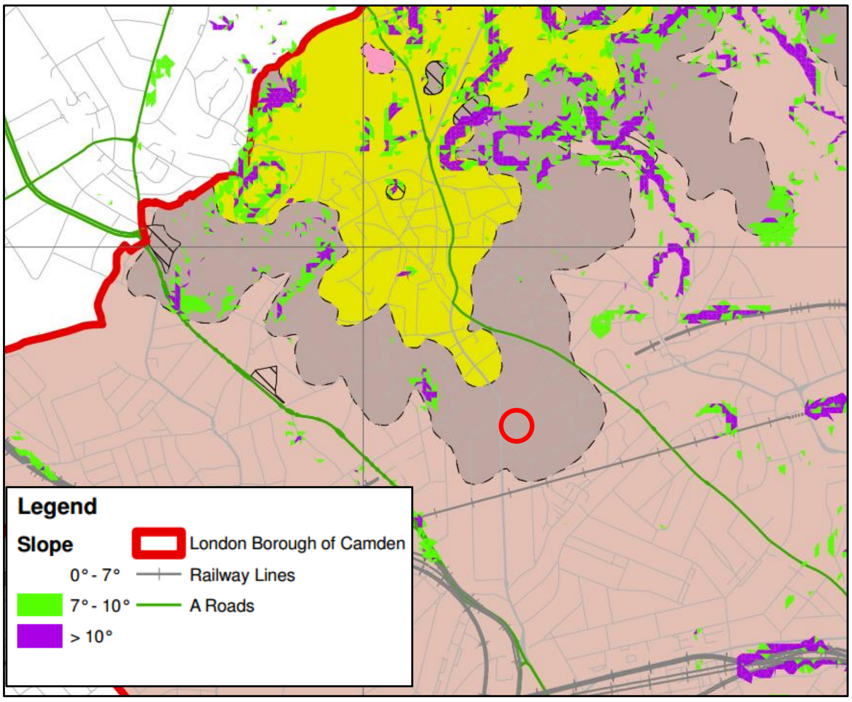


Figure 3. Exact from Figure 17 of the Camden CPG4 showing slope angles within the borough

There are no trees on-site, the closest being a Horse Chestnut located 1m to the north in the Garden of No. 17 and a Poplar located on the pavement outside Heath House 5m to the south. None of these nearby trees are being removed as part of the proposed works.

Network Rail, Transport for London and Cross Rail have all been contacted as part of this study. Whilst Transport for London and Cross Rail have confirmed that they do not have any assets within 50m of the site the site is located approximately 25m to the north of a Network Rail Tunnel which connects Hampstead Heath and Finchley Road & Frognal overground stations, which were constructed in 1879.

Elevation of the tunnel is not confirmed by factual data, but the Basement Impact Assessment presented in October 2011 by Michael Alexander Consulting Engineers at 22 Thurlow Road approximately 65m south-east of the site (document available on LBC Planning Portal) stated that the tunnel 'was found to be around 35m below existing ground level at the site'. A preliminary check on topography of the area seems to confirm such statement.

An exclusion zone of 10 m from the tunnel edge should be maintained at all times

The responses from Network Rail about the tunnel are included in this report as Appendix A, whilst plan of the site relative to the tunnel is detailed below as Figure 4.

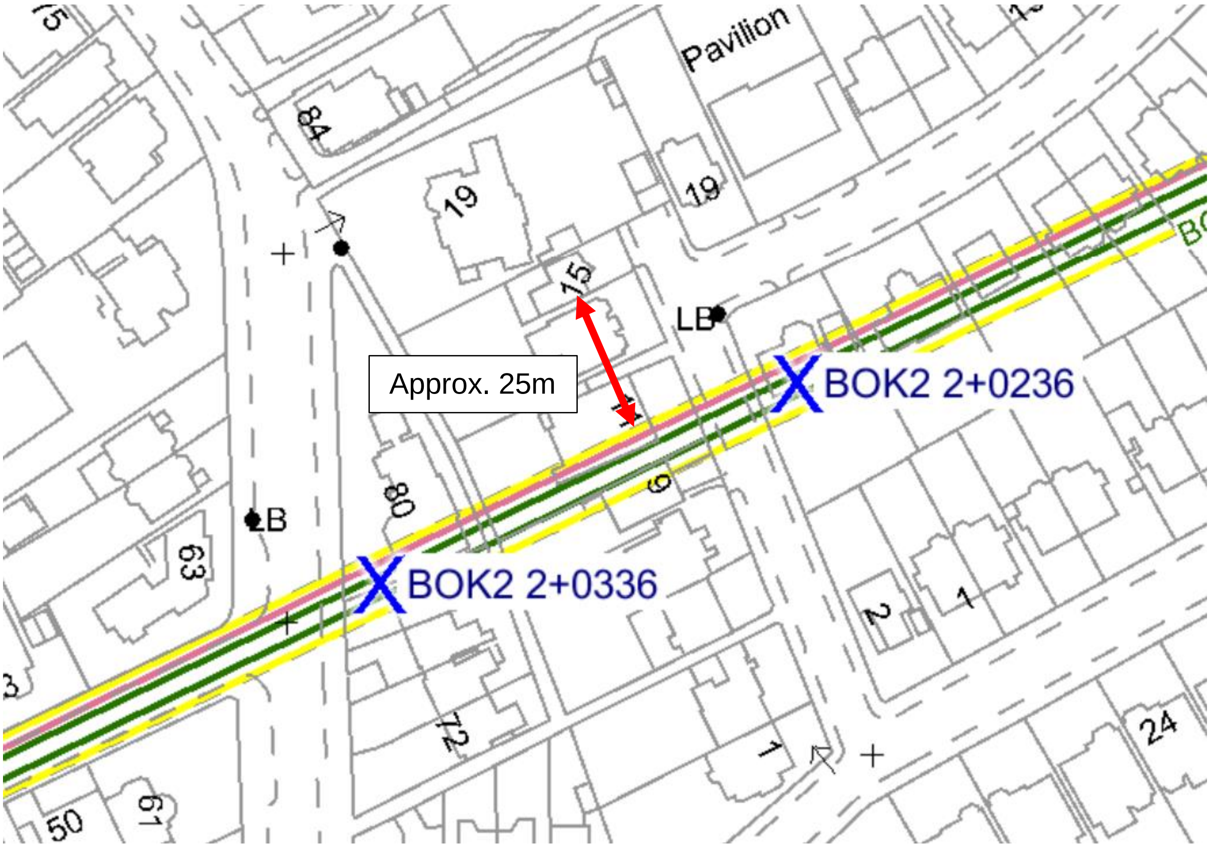


Figure 4. Detailing location of Network Rail owned tunnel approximately 25m to the south of the site.

From historical map evidence it would appear that the current property was constructed between 1974 and 1979 and has remained unchanged since its initial construction. Prior to the 20th century, the surrounding area was mostly agricultural followed by a large amount of urbanisation around the turn of the century. The surrounding area has been predominantly residential for the last 100 years or so.

3.3 Previous Reports

A Phase 1 Preliminary Risk Assessment (PRA) (SAS Report Ref: 15/23902-1) and Phase 2 Site Investigation (SAS Report Ref: 15/23902) has been undertaken across the site by Site Analytical Services Limited in between July and September 2015 and the results are discussed in this BIA.

3.4 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area is detailed in Figure 5 below and indicates the site to be underlain by the Claygate Member with the London Clay Formation at depth. Deposits of the overlying Bagshot Formation are indicated to be approximately 200m to the north-west of the site, whilst the boundary to the underlying London Clay Formation is approximately 250m to the south-west.

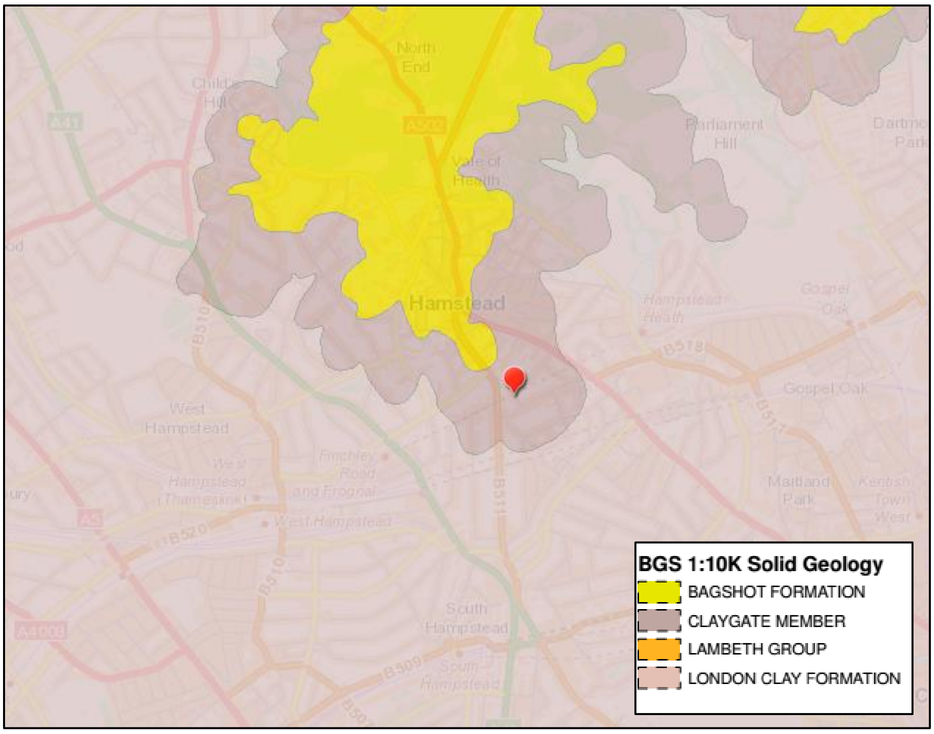


Figure 5. Geology of the Site (Ref. BGS Geoindex)

The British Geological Survey's online records indicate there are no boreholes located within 150m of the site, however a ground investigation undertaken in at 22 Thurlow Road (located 65m east of the site) was conducted by GEA in July 2011 and reported on by Arup in a Basement Impact Assessed dated July 2014 (reports available on LBC Planning Website).

The investigations by GEA were conducted over two visits (in July and October 2011) and included the drilling of 4 cable percussive boreholes to 15.0m maximum depth, the drilling of 5 window sample boreholes to 5.0m depth and the installation of groundwater monitoring standpipes in four of the boreholes. The ground investigation was referenced by GEA to an arbitrary datum considered to be more or less at the location of Borehole 1 and assigned 100mTBM. The elevations of the data given in mTBM were then corrected by 5.3m by Arup to give elevations in mOD (Note: the general site level at No.15 to Ordnance Datum is taken to be approximately 98mOD).

The ground parameters encountered in the investigation are summarised in the table below

Stratum	Top Level (mOD)	Thickness	Description
Made Ground	97.3	0.5	Clayey silt with gravel, root and rootlets, fine brick and charcoal fragments
Claygate Beds	96.8	9.0	Silty sandy clay, clayey silty sand and silty sandy clay
London Clay Formation	88.7	-	Stiff becoming very stiff clay

The boundary between the Claygate Member and London Clay Formation is interpreted to be at a level of 88.7mOD by Arup although, as the report states, the precise location of the boundary between the Claygate Member and London Clay can be difficult to determine as it is a gradational contact.

Arup measured the groundwater level in the four existing standpipes in June 2014. The maximum groundwater level was found at 7.9mbgl, i.e. at +89.4mOD.

In addition to these boreholes, the results from 26 Lyndhurst Road, NW3 located 150m south of the site (SAS 2015, available on LBC planning website) is summarised below. The results shows the interface between the Claygate Member and underlying London Clay Formation to decrease in level with the general topography of the area being at a level of between 88.70mOD within the vicinity of the site and then 78.08mOD to the south of the site.

Strata	22 Thurlow Road (BH1) (65m E of site)		26 Lyndhurst Road (SAS) (BH1) (150m S of site)	
	mBGL	mOD	mBGL	mOD
Made Ground	0.60	96.80	2.90	90.18
Claygate Member	8.10	88.70	10.60	82.48
London Clay Formation	15.00*	82.40	15.00*	78.08

Table 1. Summary of relevant historical boreholes (depths / levels to base of strata) (*maximum depth of drilling)

3.5 Hydrology and drainage

3.5.1 Surface Water

According to Mayes (1997), rainfall in the local area averages around 610mm and significantly less than the national average of around 900mm.

Evapotranspiration is typically 450 mm/yr resulting in about 160 mm/year as ‘hydrologically effective’ rainfall which is available to infiltrate into the ground or run-off as surface water flow.

With reference to Camden Geological, Hydrogeological and Hydrological Study (1999), Talling (2011) and Barton (1992) springs that sourced tributaries of the ‘lost rivers’ River Westbourne and River Tyburn were located approximately 200m south-west and 150m south of the site respectively (Figure 6). Both spring lines are shown on the annotated historical OS map dated 1871-79 (Figure 7).

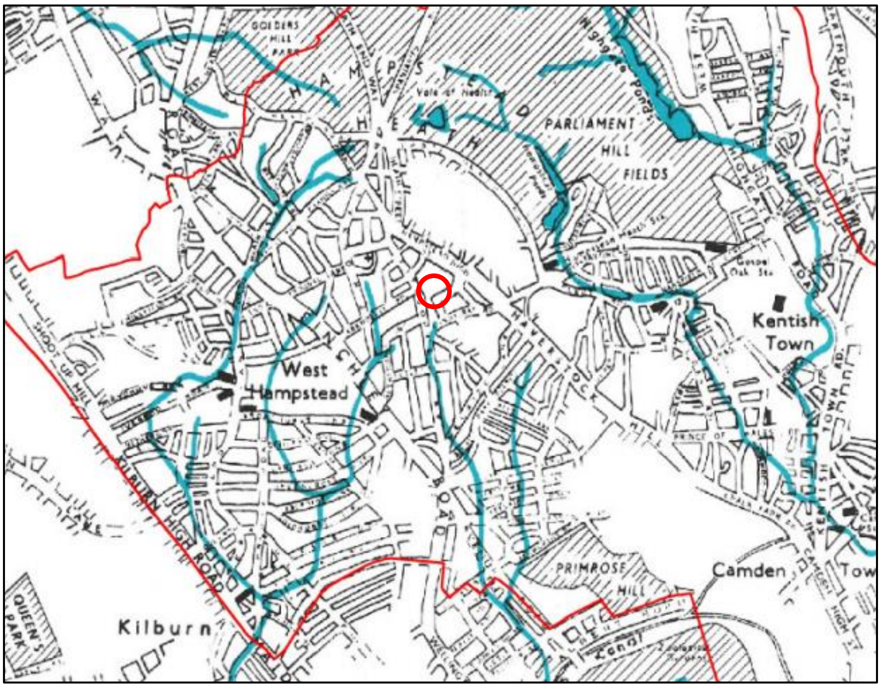


Figure 6. Location of site (circled) relative to the 'Lost Rivers' of London (Source: Barton, 1992)

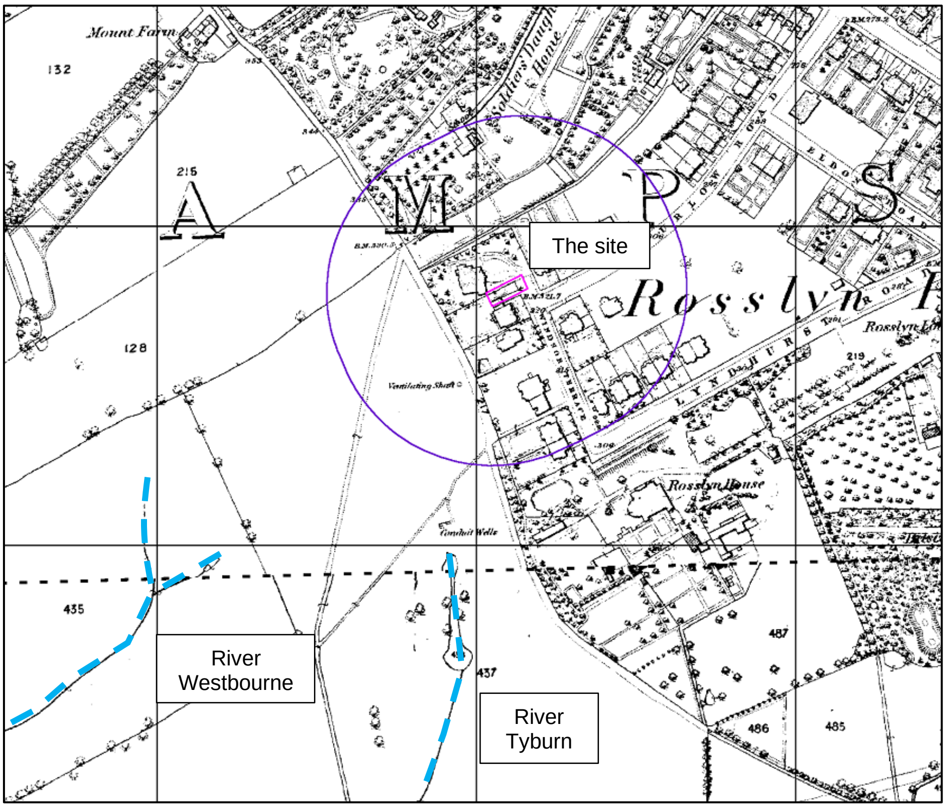


Figure 7. Location of River Tyburn and River Westbourne with respect to the site from OS map dated 1871 (Purple boundary indicates >100m distance)

The River Tyburn flowed in a southerly direction from Shepherds Well (or Conduit Well) located to the south of Spring Path as detailed is detailed on the 1879 OS map and also Stanford's 1896 map (Figure 8). A plaque on the corner of Fitzjohn's Avenue and Lyndhurst Road marks the approximate location of the well and from here it flowed southwards down Fitzjohn's Avenue, through Swiss Cottage and into Regent's Park, where it entered into a large lake (Barton, 1992). From the lake it flowed southwards through the West End and the City of Westminster, before issuing into the River Thames close to Vauxhall Bridge.

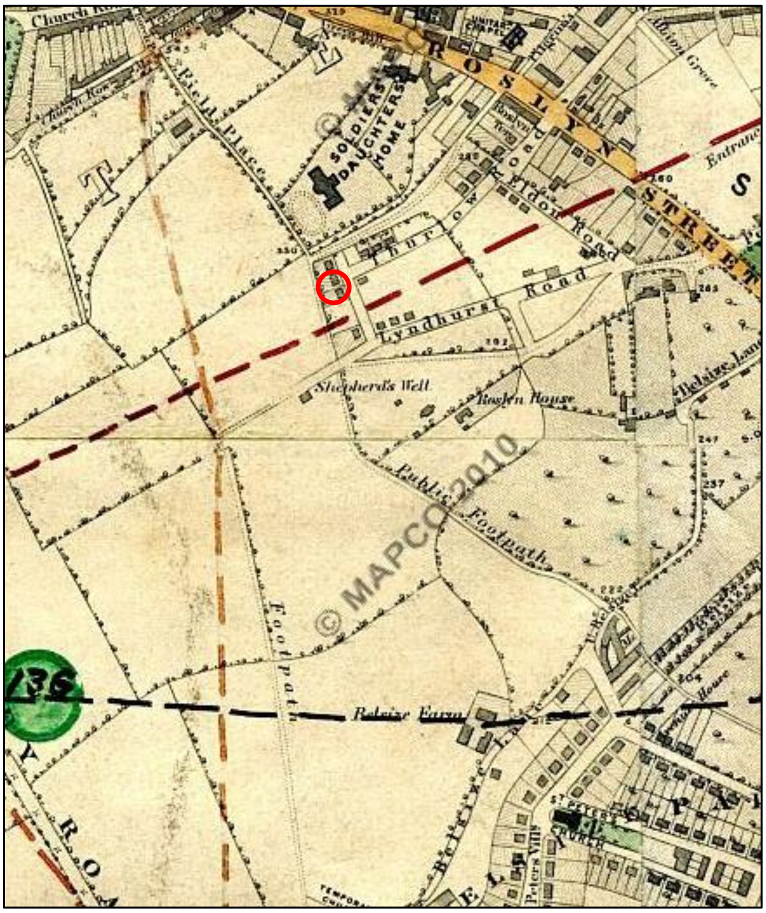


Figure 8. Former Location of Shepherd's Well relative to the site (circled)
(Source: Stanford, 1868, available online http://london1864.com/stanford)

The River Westbourne also flowed in a southerly direction, combining with the other tributaries in West Hampstead and then flowing through Kilburn and Paddington before issuing into the Serpentine in Hyde Park. From there the river flowed south through Chelsea before flowing into the River Thames opposite Battersea Park.

The watercourses have since been largely lost through a culverting system as the urban extent of the Borough has grown over time.

The nearest surface water feature from mapping evidence is the Hampstead No. 1 Pond within Hampstead Heath located 742m north-east of the site.

The area located immediately around the site is highly developed with more than 80% of the surface covered with hardstanding. Most of the rainfall in the area will run-off hard surface areas and be collected by the local sewer network.

Surface drainage from the site is assumed to be directed to drains flowing downhill to the south along Lyndhurst Terrace to Lyndhurst Road.

3.5.2 Flood Risk

3.5.2.1 River or Tidal flooding

According to Environment Agency Flood maps, the site lies within Flood Zone 1 which is defined as areas where flooding from rivers and the sea is very unlikely, with less than a 0.1 per cent (1 in 1000) chance of such flooding occurring each year. The EA's website also shows that this area does not fall within an area at risk of flooding from reservoirs. Based on this information a flood risk assessment will not be required.

3.5.2.2 Surface water flooding

Figure 9 shows that Lyndhurst Road did not flood during either the 1975 or the 2002 flood events. The closest road to the property which flooded in either of these events is Arkwright Road located 130m to the north-west which flooded in 1975 and 2002.

Figure 9. Extract from Figure 15 of the Camden CPG4 showing roads which flooded in 1975 (light blue), in 2002 (dark blue) and 'areas with potential to be at risk from surface water flooding' (wide light blue bands)

Further modelling of surface water flooding has been undertaken by the Environment Agency and was published on its website in January 2014; an extract from their model is presented in Figure 10. Whilst this map identifies four levels of risk (high, medium, low and very low) it is understood that it is based at least in part on depths of flooding. This modelling shows a ‘Very Low’ risk of flooding (the lowest category for the national background level of risk) for No.15 and the surrounding area.

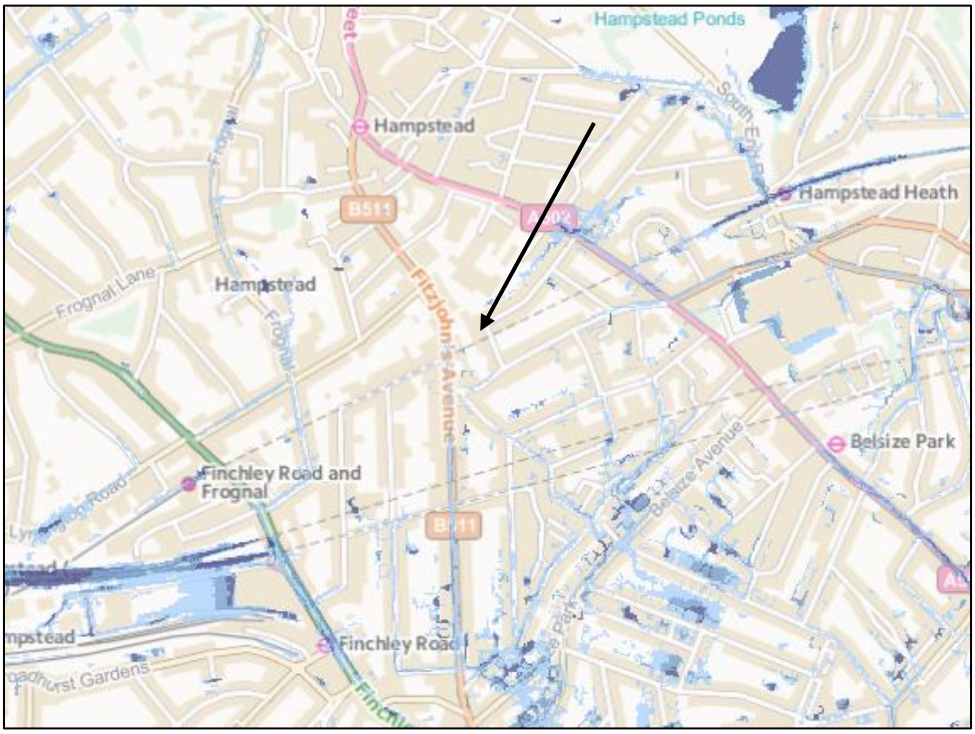


Figure 10. Extract from the Environment Agency’s ‘Risk of Flooding from Surface Water’. Ordnance Survey Crown copyright 2015. All rights reserved.

As detailed in Table 2 below, due to the presence of a green roof within the proposed, the scheme will result in an increase in permeable areas of approximately 37m^2.

Element	Existing (m^2)	Proposed (m^2)
Impermeable (hardstanding - building footprint, concrete areas)	129	92
If basement involved: permeable (at least 1m of soil above basement structure with permeable surface above this area (if applicable to new / extended basement application)	0	0
Permeable (soft landscaping - grassed areas, (including green roof), permeable and porous paving)	91	128
Total (should be the site area and remain the same)	220	220

Table 2. Existing and Proposed Permeable Areas.

3.5.2.3 Sewer flooding

The London Regional Flood Risk Appraisal (2009) advises that foul sewer flooding is most likely to occur where properties are connected to the sewer system at a level below the hydraulic level of the sewage flow, which in general are often basement flats or premises in low lying areas. There is no record of sewer flooding having occurred at 26 Lyndhurst Road and therefore the risk of sewer flooding is considered low.

3.6 Hydrogeological setting

The Environment Agency Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) and also their role in supporting surface water flows and wetland ecosystems. The Claygate Member is permeable, capable of storing and transmitting groundwater and is considered to be a Secondary A Aquifer; The underlying London Clay Formation is classed as unproductive strata or a non-aquifer. These are deposits with a low permeability that have negligible significance for water supply or river base flow.

Groundwater within the silty sandy clays of the Claygate Member is considered to be dominated by fissure flow. The absence of any significant sand bed horizons reduces the water bearing potential of the Claygate Member to that similar to the underlying London Clay. Due to the very low permeability of the London Clay, any groundwater flow will be at very low rates. Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1×10^{-10} m/s and 1×10^{-8} m/s, with an even lower vertical permeability. However, the Claygate Member is sandier in composition and permeability is expected to be higher.

Local perched groundwater may occur near surface in Made Ground and possibly also in any Head deposits which overlie the Claygate Member, in at least the winter and early spring seasons.

The presence of interbedded sands, silts and clays of the Claygate Member gives rise to various springs. The River Tyburn rises at the Shepherd’s Well near Fitzjohn's Street and is located approximately 150m south of the site. The direction of groundwater flow within the Claygate Member beneath the site is likely to be controlled by the local topography and is therefore likely to be in a southerly direction, in the direction that the former river flowed.

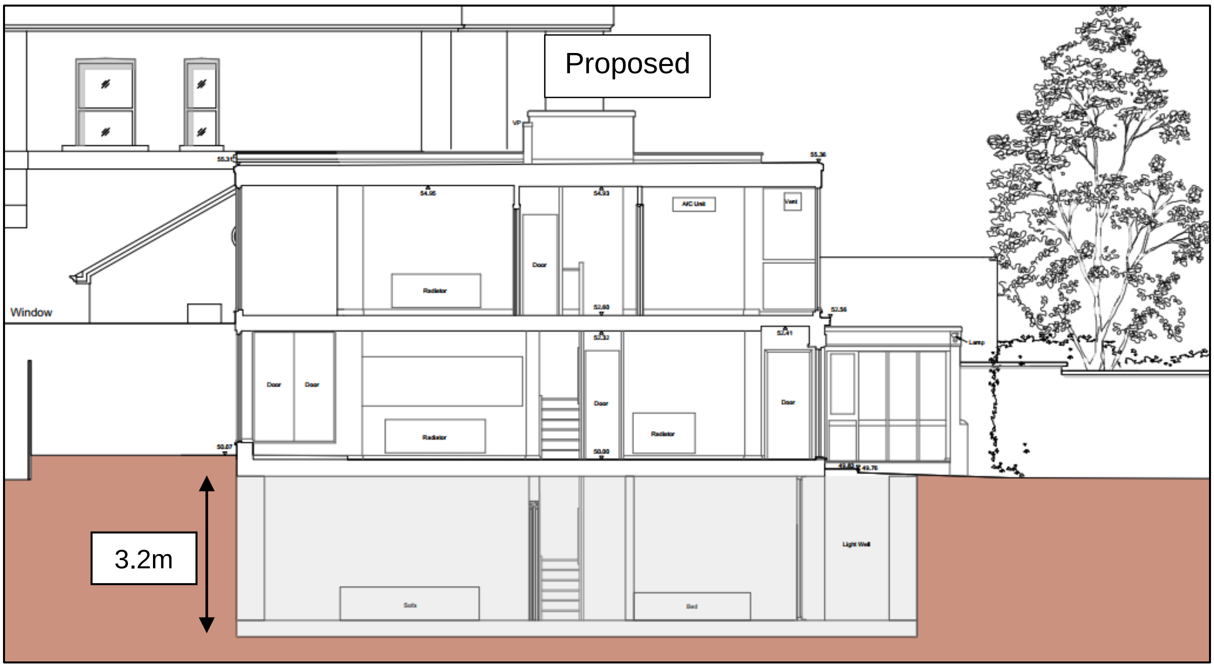
Based on the available data, the site is in considered to be at low risk from all sources of flooding. The replacement dwelling and basement can be constructed and operated safely in flood risk terms without increasing flood risk elsewhere and is therefore considered NPPF compliant.

Other hydrogeological data obtained from the Phase 1 Preliminary Risk Assessment (PRA) (SAS Report Ref: 15/23908-1) for the site include:

- The underlying soil classification of the site is of high leaching potential.
- There is a Zone II (Outer protection zone) source zone located 770m south of the site.
- There are no groundwater abstraction licences listed within one kilometre of the site.
- There are no surface water abstraction licences within 1km of the site.
- There are no public potable water supply abstraction licences within 1km of the site.

3.7 Proposed Development

It is proposed to extend the existing property at the site and construct a new single storey basement to 3.20m maximum depth (46.80mSD). Sections showing the existing and proposed layouts are detailed in Figure 10 below.



3.8 Results of Basement Impact Assessment Screening

A screening process has been undertaken for the site and the results are summarised in Table 3 below:

Table 3: Summary of screening results

Item	Description	Response	Comment
Sub-terranean (Ground water Flow)	1a. Is the site located directly above an aquifer.	Yes	The site lies above the Claygate Member. These deposits have been designated as Secondary A Class; permeable layers capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.
	1b. Will the proposed basement extend beneath the water table surface.	Unknown – to be confirmed by Ground Investigation	Given the presence of an aquifer below the site it is possible that groundwater will be encountered during any excavations for the proposed basement, however this will be confirmed by the ground investigation.
	2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line.	No	The nearest surface water feature from mapping evidence is the Hampstead No. 1 Pond within Hampstead Heath located 742m north-east of the site. According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011) and Stanford (1868) the site is 150m north from the River Tyburn (Figures 5 and 6 of this report).
	3. Is the site within the catchment of the pond chains on Hampstead Heath?	No	With reference to the Camden Geological, Hydrogeological and Hydrological Study, the site is not within the catchment of the pond chains on Hampstead, nor the Golder's Hill Chain.
	4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas.	Yes	The scheme will result in a decrease in impermeable areas of approximately 37m2.
	5. As part of site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS).	No	Existing drainage paths are to be utilised where possible. Whether soakaways/SUDS are used on the proposed development is to be confirmed (beyond the scope of this report). An appropriately qualified engineer should be engaged to ensure mandatory requirements are met.
	6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond or spring line.	No	The nearest surface water feature is recorded is located 742m north-east of the site.

Slope Stability	1. Does the existing site include slopes, natural or man-made greater than 7 degrees (approximately 1 in 8).	No	The existing site is constructed on ground which slopes gently to the east with approximate Site Datum elevations of 50.20m at the rear (western) side of the site and 49.50mSD at the front (eastern) side of the site. This slope is less than 7 degrees.
	2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7 degrees (approximately 1 in 8).	No	Re-profiling of landscaping at the site is not proposed.
	3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7 degrees (approximately 1 in 8).	No	The surrounding area drops to the south-east, but from survey information and with reference to Figure 17 from Camden CPG 4 this is at angles of less than 7 degrees.
	4. Is the site within a wider hillside setting in which the general slope is greater than 7 degrees (approximately 1 in 8).	No	There is a general slope in the area towards the south down to the south-east, but this is at an angle of less than 7 degrees.
	5. Is the London Clay the shallowest strata at the site.	No	The 1:50000 Geological Survey of Great Britain (England and Wales) indicates the site is underlain by the Claygate Member with the London Clay Formation at depth. Deposits of the overlying Bagshot Formation are indicated to be approximately 200m to the north-west of the site, whilst the boundary to the underlying London Clay Formation is approximately 250m to the south-west.
	6. Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are to be retained.	No	There are no trees on-site, the closest being a Horse Chestnut located 1m to the north in the Garden of No. 17 and a Poplar Tree located on the pavement outside Heath House 5m to the south. None of these nearby trees are being removed as part of the proposed works. The basement does extend over a root protection zone of the horse chestnut tree, but an agricultural report was carried out by Dr Frank Hope which notes that horse chestnut tree is in poor condition and can be removed.
	7. Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site.	Unknown – to be confirmed by Ground Investigation	The Claygate Beds do have cohesive layers which can be prone to shrinking and swelling.

	8. Is the site within 100m of a watercourse or a potential spring line.	No	The nearest surface water feature from mapping evidence is the Hampstead No. 1 Pond within Hampstead Heath located 742m north-east of the site. According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011) and Stanford (1868) the site is 150m north from the River Tyburn (Figures 5 and 6 of this report).
	9. Is the site within an area of previously worked ground.	No	The site is not in the vicinity of any recorded areas of worked ground, the nearest recorded on the geological map are close to Finchley Road and to the south of West Heath Road.
	10. Is the site within an aquifer. If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction.	Yes	According to the results of the most recent ground investigation the site lies above a Secondary A Aquifer (Claygate Member). However, the depth to the groundwater level is unknown and will be determined by the site investigation.
	11. Is the site within 50m of the Hampstead Heath Ponds	No	With reference to the Camden Geological, Hydrogeological and Hydrological Study, the site is not within the catchment of the pond chains on Hampstead, nor the Golder's Hill Chain.
	12. Is the site within 5m of a highway or pedestrian right of way.	No	The proposed development is set back approximately 6.60m from Lyndhurst Terrace.
	13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties.	Yes	The neighbouring property at No. 13 to the south is understood to have a lower ground floor. It is unknown whether No. 17 to the north has a basement level, but for the purposes of this report it is assumed to have one.
	14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines.	Yes	Network Rail, Transport for London and Cross Rail have all been contacted as part of this study. Whilst Transport for London and Cross Rail have confirmed that they do not have any assets within 50m of the site, the site is located approximately 25m to the north of a Network Rail Tunnel which connects Hampstead Heath and Finchley Road and Frognal overground stations and which was constructed in 1879.
Surface Water and Flooding	1. Is the site within the catchment of the ponds chains on Hampstead Heath	No	With reference to the Camden Geological, Hydrogeological and Hydrological Study, the site is not within the catchment of the pond chains on Hampstead, nor the Golder's Hill Chain.

	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	On completion of the development the surface water flows will be routed similarly to the existing condition, with rainwater run-off collected in a surface water drainage system and discharged to a combined sewer. Any groundwater flows will not be impeded by the basement. The scheme offers betterment and reduces flood risk overall by in increasing permeable areas on the site. The basement will be beneath the footprint of the new dwelling therefore the 1m distance between the roof of the basement and ground surface as recommended by Chapter 5 of the Arup report, does not apply in these areas.
	3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.	Yes	The scheme will result in a decrease in impermeable areas of approximately 37m2.
	4. Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses.	No	All surface water for the site will be contained within the site boundaries and collected as described above; hence there will be no change from the development on the quantity or quality of surface water being received by adjoining sites. The basement will be beneath the footprint of the dwelling therefore the 1m distance between the roof of the basement and ground surface as recommended by Chapter 5 of the Arup report does not apply across these areas.
	5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses.	No	The surface water quality will not be affected by the development as in the permanent condition collected surface water will generally be from roofs, domestic hard landscaping or collected from beneath the landscaping layer over the basement.
	6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature.	No	Lyndhurst Terrace did not flood during either the 1975 or the 2002 flood events. Also according to modelling by the Environment Agency, there is a 'Very Low' risk of surface water flooding (the lowest category for the national background level of risk) for No.15 and the surrounding area. There are no surface water features within 100m of the site which could create a flood risk for the proposed basement.

3.9 Non Technical Summary of Chapter 3.0

The site is located on the west side of Lyndhurst Terrace in Hampstead, North London, NW3 5QA and comprises a two-storey residential property with front and rear garden areas. The site covers an area of approximately 0.03 hectares and the general area is under the authority of the London Borough of Camden. It is proposed to extend the existing residential property and construct a single storey basement to 3.20m maximum depth beneath the current property (46.80mSD).

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area indicates the site to be underlain by the Claygate Member with the London Clay Formation at depth. The Claygate Member is permeable, capable of storing and transmitting groundwater and is considered to be a Secondary A Aquifer; The underlying London Clay Formation is classed as unproductive strata or a non-aquifer.

With reference to Camden Geological, Hydrogeological and Hydrological Study (1999), Talling (2011) and Barton (1992) springs that sourced tributaries of the ‘lost rivers’ River Westbourne and River Tyburn were located approximately 200m south-west and 150m south of the site respectively.

The nearest surface water feature from mapping evidence is the Hampstead No. 1 Pond within Hampstead Heath located 742m north-east of the site.

According to Environment Agency Flood maps the site lies within Flood Zone 1, which is defined as areas where flooding from rivers and the sea is very unlikely, with less than a 0.1 per cent (1 in 1000) chance of such flooding occurring each year. Lyndhurst Terrace did not flood during either the 1975 or the 2002 flood events. Modelling of surface water flooding by the Environment Agency shows a ‘Very Low’ risk of flooding (the lowest category for the national background level of risk) for No. 26 and the surrounding area.

The scheme will result in a decrease in impermeable areas of approximately 37m^2.

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

Subterranean Groundwater Flow

- Is the site located directly above an aquifer
- Will the proposed basement extend beneath the water table surface

Slope Stability

- Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site.
- Is the site within an aquifer. If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction.
- Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties.

- Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines.

Surface water and flooding

- Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.

4.0 SCOPING PHASE

4.1 Introduction

This purpose of the scoping phase is to assess in more detail the factors to be investigated in the impact assessment. Potential impacts are assessed for each of the identified impact factors and recommendations are stated.

A conceptual ground model is usually complied at the scoping stage however, because the ground investigation has already been undertaken for this project, the conceptual ground model including the findings of the ground investigation is described under Chapter 4.

Subterranean (Groundwater Flow)

Potential Issue (Screening Question)		Potential impacts and actions
1a	Is the site located directly above an aquifer	**Potential impact:** Infiltration could be reduced. **Action:** Ground Investigation required, then review.
1b	Will the proposed basement extend beneath the water table surface?	**Potential impact:** Local restriction of groundwater flows (perched groundwater or below groundwater table). **Action:** Ground investigation required, then review.

Slope Stability

7	Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?	**Potential Impact:** Ground movements will occur during and after the basement construction. **Action:** Ground investigation required, then review.
10	Is the site within an aquifer. If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction.	**Potential impact:** Infiltration could be reduced. **Action:** Ground Investigation required, then review.
13	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	**Potential impact:** Loss of support to the ground beneath the new foundations to neighbouring properties if basement excavations are inadequately supported. **Action:** Ensure adequate temporary and permanent support by use of best practice methods.

14	Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines.	**Potential impact:** Excavation of basement damages the underlying tunnels **Action:** Ensure foundation solution is agreed with Network Rail prior to commencing on-site

Surface Water and Flooding

Potential Issue (Screening Question)		Potential impacts and actions
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.	**Potential impact:** The proportional decrease in hardstanding could potentially increase rates of recharge increasing groundwater flow to a nearby watercourse. **Action:** Ground investigation required, then review.

These potential impacts have been further assessed through the ground investigation, as detailed in Section 4 below.

4.2 Non-Technical Summary of Chapter 4.0

The scoping exercise has reviewed the potential impacts for each of the items carried forward from Stage 1 screening, and has identified the following actions to be undertaken:

- A ground investigation is required (which has already been undertaken).
- Review of site's hydrogeology and groundwater control requirements.
- Review flood risk and include appropriate flood resistance and mitigation measures in the scheme's design.

All these actions are covered in Stage 4 or in Stage 3 for the ground investigation.

5.0 SITE INVESTIGATION DATA

5.1 Records of site investigation

A site-specific ground investigation was undertaken by Site Analytical Services Limited (SAS) in July 2015 and included one rotary percussive borehole (Borehole 1) drilled to 15m below ground level, two continuous flight auger boreholes (Boreholes 2 and 3) drilled to 8.30m below ground level and one hand dug trial pit (Trial Pit 1) excavated to 0.85m depth.

The factual findings from the investigation are presented in Appendix B, including a site plan, exploratory hole logs, groundwater monitoring and laboratory test results.

5.2 Ground conditions

The boreholes and trial pit revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 1.20m in thickness resting on deposits of the Claygate Member with the London Clay Formation at depth.

5.2.1 Made Ground

The Made Ground extended down to depths of between 0.40m and 1.20m below ground level (48.90 to 49.54mSD) in the boreholes and trial pit and comprised pea gravel or brick paving over silty sandy clay with brick fragments.

5.2.2 Claygate Member

The Claygate Member comprised soft becoming firm and then stiff silty sandy clay with lenses of clayey silty fine sand which extended to depths/levels of 9.40m (40.10mSD) in Borehole 1 and to the full depths of investigation of 8.30m in Boreholes 2 and 3 (41.30 to 42.20mSD) and 0.85m in Trial Pit 1 (49.24mSD) in the rear garden area.

5.2.3 London Clay Formation

The London Clay Formation was encountered below the Claygate Member and consisted of stiff silty clay with occasional pockets and partings of silty fine sand and scattered gypsum crystals. These deposits extended down to the full depth of investigation of 15.00m below ground level in Borehole 1 (34.50mSD).

5.3 Groundwater

Groundwater was not encountered in the trial pit and Boreholes 2 and 3 and the soils remained essentially dry throughout. Groundwater was encountered in the Borehole 1 as detailed in Table 4 below.

Exploratory Hole	Depth (m)	Level (mSD)	Notes	Stratum
BH1	15.00	34.50	Very slight seepage	London Clay Formation

Table 4: Groundwater Strike Summary

It must be noted that the speed of excavation is such that there may well be insufficient time for further light seepages of groundwater to enter the boreholes and trial pit and hence be detected, particularly within more cohesive soils.

Isolated pockets of groundwater may also be present perched within any less permeable material found at shallower depth on other parts of the site especially within any Made Ground.

All the boreholes were equipped with water monitoring standpipe piezometers with the response zones being from 3-6m depth. Groundwater was not subsequently encountered in these monitoring standpipes.

BH	Ground Level	30/07/15	21/08/15	28/08/15	12/12/16	22/02/17	02/02/21
	mSD	m	m	m	m	m	m
1	49.50	Dry	Dry	Dry	Dry	Dry	Dry
2	49.60	Dry	Dry	Dry	Dry	Dry	Dry
3	50.50	Dry	Dry	Dry	Dry	Dry	Dry

Table 5. Groundwater Monitoring Results.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (July, August and September 2015 with return visits in December 2016, February 2017 and February 2021) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions. Monitoring has been carried out within three seasons, and no distinct changes have occurred, with no presence of groundwater beneath the site.

5.4 Foundations

Trial Pit 1 was excavated adjacent to the rear wall of the existing property on the site in order to expose the foundations and founding soils. The trial pit showed the rear wall is supported on mass concrete foundations resting on the Claygate Member at a depth of approximately 0.55m below ground level (49.54mSD).

5.5 In-Situ and Laboratory Testing

The results of the laboratory and in-situ tests are presented in the factual report contained in Appendix A.

5.5.1 Standard Penetration Tests

The results of the Standard Penetration Tests carried out in the natural soils are shown on the exploratory hole records in Appendix A. SPT ‘N’ values range between 11 and 31 which a general increase in depth apparent.

5.5.2 Undrained Triaxial Compression Test Results

Undrained Triaxial Compression tests was carried out on two undisturbed 100mm diameter samples taken from Borehole 1. The results indicate the samples to be of a high strength in accordance with BS 5930 2015.

5.5.3 Classification Tests

Atterberg Limit tests have been conducted on three selected samples taken from Boreholes 1 and 2, and showed the sample tested to fall into Classes CI according to the British Soil Classification System.

These are fine grained silty clay soils of intermediate plasticity and as such generally have a low permeability and a medium susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2. The results indicated Plasticity Index values of between 21% and 25%, with all of the samples being below the upper 40% boundary between soils assessed as being of medium swelling and shrinkage potential and those assessed as being of high swelling and shrinkage potential. These results are typical of the Claygate Beds.

5.5.4 Sulphate and pH Analyses

The results of the sulphate and pH analyses show the natural soil samples to have water soluble sulphate contents of up to 0.04g/litre associated with slightly acidic to acidic pH values.

5.6 Non-Technical Summary of Chapter 5.0

The boreholes and trial pit revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 1.20m in thickness resting on deposits of the Claygate Member with the London Clay Formation at depth.

Boreholes 1, 2 and 3 were equipped with water monitoring standpipe piezometers with the response zones being from 3-6m depth. Groundwater was not subsequently encountered in these monitoring standpipes.

Trial Pit 1 was excavated adjacent to the rear wall of the existing property on the site in order to expose the foundations and founding soils. The trial pit showed the rear wall is supported on mass concrete foundations resting on the Claygate Member at a depth of approximately 0.55m below ground level (49.54mSD).

6.0 FOUNDATION DESIGN

6.1 Introduction

It is proposed to extend the existing property at the site and construct a new single storey basement to 3.20m maximum depth (46.80mSD).

6.2 Site Preparation Works

The Main Contractor should be informed of the site conditions and risk assessments should be undertaken to comply with the Construction Design Management (CDM) regulations. Site personnel are to be made aware of the site conditions. It is recommended that extensive searches of existing man-made services are undertaken over the site prior to final design works.

6.3 Ground Model

On the basis of the fieldwork, the ground conditions at the site can be characterised as follows:

- Made Ground extends to depths of between 0.40m to 1.20m depth below ground level (48.90 to 49.54mSD).

- The Claygate Member comprising soft becoming firm and then stiff silty sandy clay with lenses of clayey silty fine sand to a depth of 9.40m below ground level (40.10mSD).

- The London Clay Formation comprising stiff silty sandy clay with gypsum crystals to the full depth of investigation of 15.00m below ground level (34.50mSD).

- Groundwater was not encountered in the monitoring standpipes installed above 6.0m depth in Boreholes 1, 2 and 3. This suggests that the water table is deeper than 6.0m below ground level (i.e. below the base of the standpipe) across the site.

6.4 Construction Method Statement

A full Construction Method Statement (CMS) will be provided under a separate document by Concept Consultancy Structural Designers Ltd.

6.5 Spread Foundations

Based on the ground and groundwater conditions encountered in the boreholes and trial pits, it should be possible to support the proposed new development on conventional strip or basement raft foundations taken down below the Made Ground and any weak superficial soils and placed in the natural firm sandy silty clay deposits which occur at a depth of approximately 3.00m below ground level over the site. Foundations should be placed in the natural deposits at a minimum depth of 1.00m below final ground level in order to avoid the zone affected by seasonal moisture content changes.

Using theory from Terzaghi (1943), strip foundations placed within natural soils may be designed to allowable net bearing pressures of approximately 140kN/m^2 at 3.00m depth in order to allow for a factor of safety of 2.5 against general shear failure. The actual allowable bearing pressure applicable will depend on the form of foundation, its geometry and depth in accordance with classical analytical methods, details of which can be obtained from “Foundation Design and Construction”, Seventh Edition, 2001 by M J Tomlinson (see references) or similar texts.

Any soft or loose pockets encountered within otherwise competent formations should be removed and replaced with well compacted granular fill.

In addition, foundations may need to be taken deeper should they be within the zones of influence of both existing or recently felled trees and any proposed tree planting. The depth of foundation required to avoid the zone likely to be affected by the root systems of trees is shown in the recommendations given in NHBC Standards, Chapter 4.2, April 2010, “Building near Trees" and it is considered that this document is relevant in this situation.

6.6 Piled Foundations

In the event that the use of conventional spread foundations proves either impracticable or uneconomical due to the size and depth of foundation required, then a piled foundation will be required. In these ground conditions, it is considered that some form of bored and in-situ cast concrete piled foundation with reinforced concrete ground beams should prove satisfactory.

The construction of a piled foundation is a specialist activity and the advice of a reputable contractor, familiar with the type of soil and groundwater conditions encountered at this site should be sought prior to finalising the foundation design. The actual pile working load will depend on the particular type of pile chosen and method of installation adopted.

To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of about 0.8 and a calculation made to check the factor of safety against block failure.

Driven piles could also be used and would develop much higher working loads approximately 2.5 to 3 times higher than bored piles of a similar diameter at the same depth. However, the close proximity of adjacent buildings will in all probability preclude their use due to noise and vibration.

6.7 Retaining Walls

Several methods of retaining wall construction could be considered. These may include retaining structures cast in an underpinning sequence, or the use of temporary or sacrificial works to facilitate the retaining structure’s construction. The excavation of the basement must not compromise the integrity of adjacent structures.

The full design of temporary and permanent retaining structures is beyond the scope of this report. However, the following design parameters for each element of soil recorded in the relevant exploratory holes are provided in Table 5 below to assist the design of these structures.

Stratum	Depth to top (mSD)	Bulk Density (Mg/m3) (ɣ)	Effective Angle of Internal Friction (Φ)
Made Ground	49.50 to 50.50	1.70	20
Claygate Member	48.90 to 49.54	1.85	25
London Clay Formation	40.10	2.00	25

Table 5. Retaining Wall Design Parameters

The designer should use these parameters to derive the active and passive earth pressure coefficients ka and kp. The determination of appropriate earth pressure coefficients, together with factors such as the pattern of the earth pressure distribution, will depend upon the type/geometry of the wall and overall design factors.

6.8 Chemical Attack on Buried Concrete

The results of the chemical analyses show the natural soil samples tested to have water soluble sulphate contents of up to 0.04g/litre associated with slightly acidic to acidic pH values.

In these conditions, it is considered that deterioration of buried concrete due to sulphate or acid attack is unlikely to occur. The final design of buried concrete according to Tables C1 and C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-1 conditions.

However, segregations of gypsum were noted within the London Clay and also are well known to occur within London Clay deposits. Consequently, it is considered that any buried concrete at depth may be attacked by such sulphates in solution and that it would be prudent to design any such concrete in accordance with full Class DS-2 conditions.

6.9 Non-Technical Summary of Chapter 6.0

It is proposed to extend the existing property at the site and construct a new single storey basement to 3.20m maximum depth (46.80mSD).

The boreholes and trial pit revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 1.20m in thickness resting on deposits of the Claygate Member with the London Clay Formation at depth.

The Claygate/London Clay boundary follows the general topography of the area decreasing in level towards the south-east of the site.

Groundwater is not expected to be encountered in the basement excavation, but it would be prudent for the chosen contractor to have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

In accordance with general basement flood policy and basement design, the proposed development will utilise the flood resilient techniques recommended in the NPPF Technical Guidance where appropriate and also the recommendations that have previously been issued by various councils

Based on the ground and groundwater conditions encountered in the boreholes and trial pit, it should be possible to support the proposed new development on conventional strip or basement raft foundations taken down below the Made Ground and any weak superficial soils and placed in the natural firm sandy silty clay deposits which occur at depths of between approximately 3.00m below ground level over the site.

In the event that the use of conventional spread foundations proves either impracticable or uneconomical due to the size and depth of foundation required, then a piled foundation will be required.

Several methods of retaining wall construction could be considered. These may include retaining structures cast in an underpinning sequence, or the use of temporary or sacrificial works to facilitate the retaining structure's construction. The excavation of the basement must not compromise the integrity of adjacent structures.

7.0 BASEMENT IMPACT ASSESSMENT

7.1 Summary

The screening identified a number of potential impacts. The table below summarises the previously identified potential impacts and the additional information that is now available from the site investigation in consideration of each impact.

Potential Impact	Site Investigation conclusions	Impact sufficiently addressed without further justification?
The site is directly above an aquifer.	The most recent soils investigation has proven that the site lies above the Claygate Member. These are generally aquifers formerly classified as minor aquifers.	No – see below for further details.
The proposed basement extends beneath the water table surface.	Groundwater was not encountered in the monitoring standpipes installed above 6.0m depth. This suggests that the water table is deeper than 6.0m below ground level (i.e. below the base of the standpipe) across the site. This is below the depth of the proposed basement at 46.80mSD and therefore the influence of the development on groundwater is expected to be minimal.	Yes
There a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site.	The Claygate Member was proven below the site and was recorded as having a medium susceptibility to shrinkage and swelling. However, the base of proposed basement will extend well below the potential depth of root action.	Yes
The proposed basement will significantly increase the differential depth of foundations relative to neighbouring properties.	The development will result in the extension of the foundation depth of the basement relative to neighbouring properties.	No – see below for further details.
The site is within 50m of a Network Rail tunnel	The retention system will ensure the stability of the nearby tunnels at all times. Correspondence with Network Rail must be undertaken prior to and during the final design of the basement to insure the safety of the underlying tunnel.	Yes

7.2 Outstanding risks and issues

The Site is located directly above a Secondary A Aquifer

Formation level of the 3.20m deep basement is likely to be within the Claygate Member. Groundwater was recorded as being below the depth of the proposed basement at 46.80mSD although it would be recommended to continue to monitor the standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations. The groundwater regime has been assessed over three seasons, with no groundwater being present throughout, and any seasonal changes being negligible if any at all. The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

The Claygate Member underlying the site is able to transmit small to medium quantities of groundwater and recharge would be by leakage and vertical infiltration across the aquifer outcrop area. Groundwater will also be able to flow through the largely granular Made Ground. Groundwater gradients will follow the local topography and flows and will generally be from north-west to south-east. The groundwater will eventually discharge from the aquifer at a series of small springs and wells located to the edge of its outcrop area around 250m south-west of the site.

The presence of sandy lenses within the Claygate Member means the natural flow of groundwater below the site will be able to continue to flow around the new basement. This behaviour is acknowledged in the Camden GHHS which noted that even extensive excavations for basements in the City of London have not caused any serious problems in ‘damming’ groundwater flow, with groundwater simply finding an alternative route (Arup, 2010, paragraph 205). On this basis, it is not considered that the proposed basement would result in a significant change to the groundwater flow regime in the vicinity of the proposal.

The proposed basement will need to be fully waterproofed in order to provide adequate long-term control of moisture ingress from the groundwater. Detailed recommendations for the waterproofing system are beyond the scope of this report, although it is noted that as a minimum, it would be prudent for the system to be designed in compliance with the requirements of BS8102:2009.

Due care and attention should be paid to ensure that no contamination incidents occur as a result of the development. No change to the existing drainage arrangements is proposed and therefore existing rates of rainfall infiltration and groundwater recharge will remain unchanged.

The proposed basement will significantly increase the differential depth of foundations relative to neighbouring properties.

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

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

A ground movement assessment was carried out at the site by Curtins under the instruction of Site Analytical Services Limited (Report Reference P4118/03). The report is provided as Appendix C to this report and concludes the predicted level of damage to the houses at Nos 13 and 17 Lyndhurst Terrace, arising from the excavation of a basement at No 15, is 'very slight' or less, on the Burland Scale.

The above assumes a high standard of workmanship.

Damage to the separate garage structure at No 17 is predicted to lie near to the boundary between 'very slight' and 'slight', but this structure is understood to be of basic bare-brick construction and in a condition indicating limited past maintenance. The predicted level of damage, which is aesthetic only and intended for application in buildings with fine plaster finish. The predicted level of damage to the garage would therefore appear to be inconsequential and may go unnoticed.

7.3 Advice on Further Work and Monitoring

A monitoring plan should be set out at design stage and should include a monitoring strategy, instrumentation and monitoring plans and action plans. Trigger levels on movements will need to be defined. Precise levelling or reflective survey targets should be installed at the garden walls and neighbouring buildings. Monitoring should take place in advance of the proposed works as a base-line survey, during the works and for a period following the completion of the works, to understand the long term effects.

It would be prudent to continue to monitor the standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations. The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

Trial excavations to the proposed basement depth could be carried by the main contractor to confirm the depth of made ground and stability of the soil specifically at the locations of the excavations and to further investigate the presence of any groundwater inflows.

7.4 Non-Technical Summary of Chapter 7.0

The excavation and construction of the basement at the site has the potential to cause some movements in the surrounding ground if not properly managed. However, it is understood that ground movements and/or instability will be managed through the proper design and construction of mitigation measures during the works.

It is not considered that the proposed basement would result in a significant change to the groundwater flow regime in the vicinity of the proposal. Also, given limited scope of the scheme and no increase in impermeable areas, the scheme is also considered compliant with the surface water management and flood risk elements of NPPF and Camden policy.

The predicted level of damage to the houses at Nos 13 and 17 Lyndhurst Terrace, arising from the excavation of a basement at No 15, is 'very slight' or less, on the Burland Scale.

The above assumes a high standard of workmanship.

Damage to the separate garage structure at No 17 is predicted to lie near to the boundary between ‘very slight’ and ‘slight’, but this structure is understood to be of basic bare-brick construction and in a condition indicating limited past maintenance. The predicted level of damage, which is aesthetic only and intended for application in buildings with fine plaster finish. The predicted level of damage to the garage would therefore appear to be inconsequential and may go unnoticed.

It would be prudent to continue to monitor the standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations. The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

Trial excavations to the proposed basement depth could be carried by the main contractor to confirm the composition and stability of the soil and to further investigate the presence of any groundwater inflows.

8.0 REFERENCES

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

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

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

4. British Standards Institution, 2015. Code of Practice for Site Investigations, BS5930, BSI, London

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

7. CIRIA, 2000. Sustainable Urban Drainage Systems: Design Manual for England and Wales. CIRIA C522, Construction Industry Research and Information Association, London

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

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

10. NHBC Standards, Chapter 4.2, "Building near Trees", April 2010.

Appendix A. Responses from Network Rail, TFL and Crossrail

Debbie Miller

From:	Rachael Katz <RachaelKatz@crossrail.co.uk> on behalf of Safeguarding <Safeguarding@crossrail.co.uk>
Sent:	23 July 2015 16:01
To:	Debbie Miller
Subject:	CRL-00-141210 Ref: 16405DM - Site : 15 Lyndhurst Terrace, London, NW3 5QA

Dear Debbie Miller

Crossrail Ref: CRL-00-141210

Ref: 16405DM - Site : 15 Lyndhurst Terrace, London, NW3 5QA

Thank you for your letter dated 23 July 2015, requesting the views of the Crossrail Project Team on the above.

The area in question is outside the limits of consultation shown in the Safeguarding Direction issued by the Secretary of State for Transport on 24 January 2008.

The implications arising from Crossrail have been considered, and we do not wish to make any comments.

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

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

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

Yours sincerely

Rachael Katz | Community Relations Assistant
Crossrail | 25 Canada Square, Canary Wharf, London E14 5LQ
Helpdesk (24hr) 0345 602 3813
helpdesk@crossrail.co.uk | www.crossrail.co.uk

MOVING LONDON FORWARD

Transport for London
London Underground

Your ref: 16405DM
Our ref: 20878-SI-3-050815

London Underground
Infrastructure Protection

3rd Floor
Albany House
55 Broadway
London SW1H 0BD

www.tfl.gov.uk/tube

Debbie Miller
Groundwise Searches
DMiller@groundwise.com

05 August 2015

Dear Debbie,

15 Lyndhurst Terrace London NW3 5QA

Thank you for your communication of 23rd July 2015.

I can confirm that London Underground assets will not be affected by works at the above location.

However, there are Network Rail assets close to this site.

Please contact the following to query what affect if any your proposals will have on the railway:

Asset Protection Anglia Route
Network Rail
Floor 11
One Stratford Place
Stratford
London
E20 1EJ

Telephone number 0203 356 2510

Email: AssetProtectionLNEEM@networkrail.co.uk

If I can be of further assistance, please do not hesitate to contact me.

Yours sincerely

Shahina Inayathusein
Information Manager
Email: locationenquiries@tube.tfl.gov.uk
Direct line: 020 7918 0016

Network Rail

Underground Services Team
National Records Centre
Audax Road
YORK

YO30 4GS
Tel:

NRSWA Asset Enquiries

Date: 03 August 2015

Your Reference **2015_8011**
Our Reference: **SET137867 JD5**

Dear NRSWA,

Re: Underground Services Search: **OP 15 Lyndhurst Terrace, London**

Please find information available as per the checklist.

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

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

Your risk assessment MUST take into account:

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

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

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

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

Yours sincerely

John Devanney

Distribution Administrator

GUIDELINES TO BE READ IN CONJUNCTION WITH THE ENCLOSED INFORMATION

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

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

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

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

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

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

UNDERGROUND SERVICES INFORMATION CHECKLIST

Network Rail

YOUR REF	2015_8011	**OUR REF**	SET137867
LOCATION	**OP** 15 Lyndhurst Terrace, London	**ELR**	BOK2
MILEAGE FROM	2.0236	**MILEAGE TO**	2.0336

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

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

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

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

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

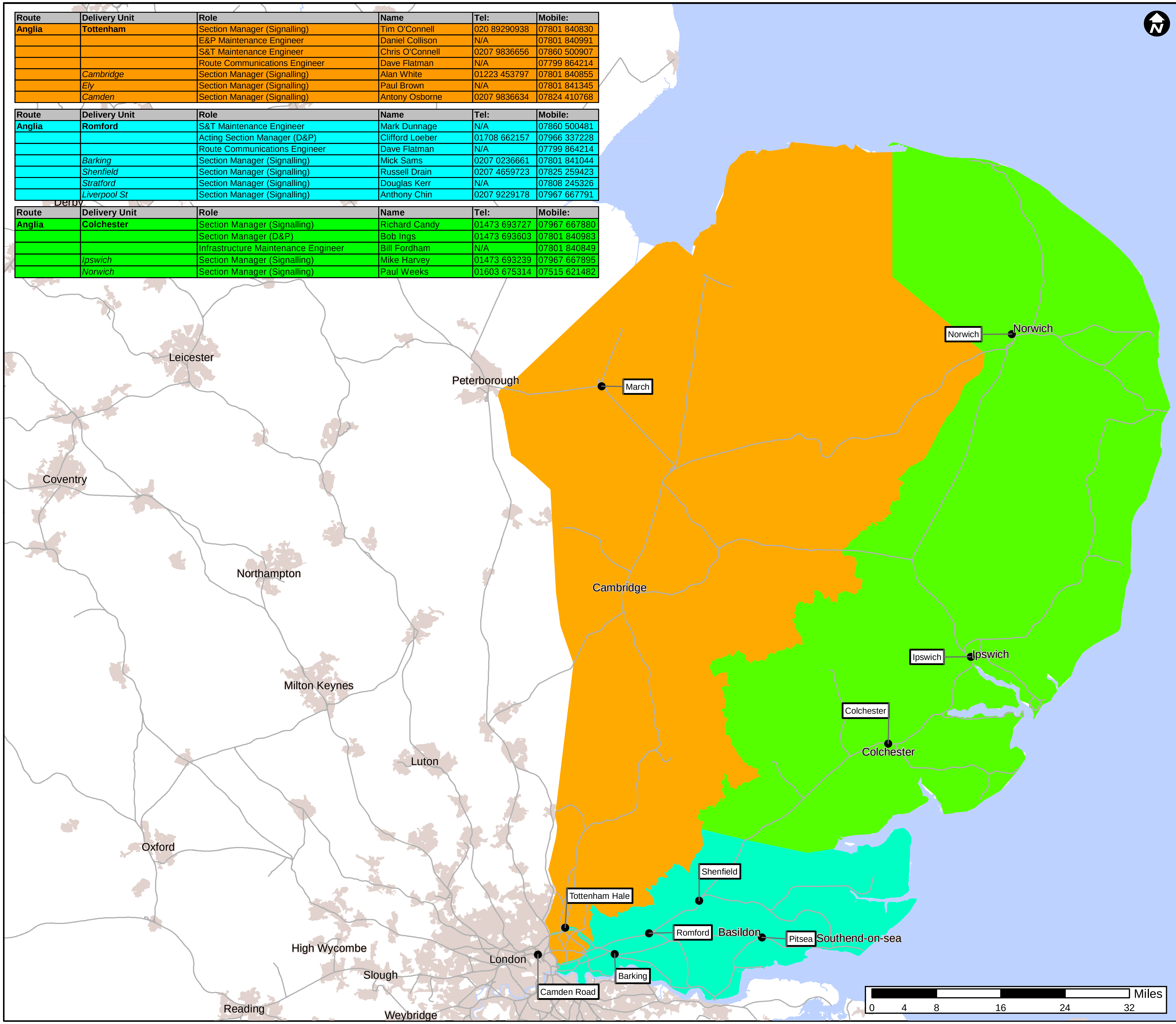
buriedservicesnst@networkrail.co.uk

Checklist printed on: 03/08/15

Route	Delivery Unit	Role	Name	Tel:	Mobile:
Anglia	**Tottenham**	Section Manager (Signalling)	Tim O'Connell	020 89290938	07801 840830
		E&P Maintenance Engineer	Daniel Collison	N/A	07801 840991
		S&T Maintenance Engineer	Chris O'Connell	0207 9836656	07860 500907
		Route Communications Engineer	Dave Flatman	N/A	07799 864214
	Cambridge	Section Manager (Signalling)	Alan White	01223 453797	07801 840855
	Ely	Section Manager (Signalling)	Paul Brown	N/A	07801 841345
	Camden	Section Manager (Signalling)	Antony Osborne	0207 9836634	07824 410768

Route	Delivery Unit	Role	Name	Tel:	Mobile:
Anglia	**Romford**	S&T Maintenance Engineer	Mark Dunnage	N/A	07860 500481
		Acting Section Manager (D&P)	Clifford Loeber	01708 662157	07966 337228
		Route Communications Engineer	Dave Flatman	N/A	07799 864214
	Barking	Section Manager (Signalling)	Mick Sams	0207 0236661	07801 841044
	Shenfield	Section Manager (Signalling)	Russell Drain	0207 4659723	07825 259423
	Stratford	Section Manager (Signalling)	Douglas Kerr	N/A	07808 245326
	Liverpool St	Section Manager (Signalling)	Anthony Chin	0207 9229178	07967 667791

Route	Delivery Unit	Role	Name	Tel:	Mobile:
Anglia	**Colchester**	Section Manager (Signalling)	Richard Candy	01473 693727	07967 667880
		Section Manager (D&P)	Bob Ings	01473 693603	07801 840983
		Infrastructure Maintenance Engineer	Bill Fordham	N/A	07801 840849
	Ipswich	Section Manager (Signalling)	Mike Harvey	01473 693239	07967 667895
	Norwich	Section Manager (Signalling)	Paul Weeks	01603 675314	07515 621482



NetworkRail

Asset Information - Data Services

GeospatialReportingAnalysis@NetworkRail.co.uk

LEGEND

- Stations
- Rail Network

IMDM Boundaries

- IMDM Colchester
- IMDM Romford
- IMDM Tottenham

Local Contacts List - Anglia IMDMs

Client: Buried Services

Job No: 10104 101 [Internal Use Only]

Scale : 1 : 1 700 000

Date : 16/07/2015

GI Portal

This material is a guide only and although every effort will be made to ensure that the information is correct you should be aware that the information may be incomplete, inaccurate or out of date. Network Rail shall not be liable for any loss or damage, which may arise from the use of any information, contained.

Company Ownership

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

Annotation

Points

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

Symbols

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

Line Features

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

Historic Cable Route

Miscellaneous

Business Space
Miscellaneous Asset Portfolio
Easements Wayleaves Telecoms

Utilities

Business Space
Miscellaneous Asset Portfolio
Easements Wayleaves Telecoms

Centre of Map Window (E,N): 526581 , 185298

Company Ownership

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

Annotation

Points

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

Symbols

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

Line Features

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

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

Miscellaneous

- Business Space
- Miscellaneous Asset Portfolio
- Easements Wayleaves Telecoms

Utilities

- Business Space
- Miscellaneous Asset Portfolio
- Easements Wayleaves Telecoms
- Track Link

SET137867 15 Lyndhurst Terrace, London	
Plot Scale	1:2500
Plot Date	3/8/2015
Network Rail	

Output Created from the GI Portal – A3 Landscape

National Hazard Directory

Terms and Conditions

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

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

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

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

National Hazard Directory

Customised Report

Search Criteria: ELR(s) = BOK2; Mileage From = 2.0236; Mileage To = 2.0336
Date: 03/08/2015

5 Hazards found.

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

Devanney John (York)

From: Morris Lee
Sent: 30 July 2015 07:57
To: BS_Transmittals
Subject: Underground Services search: NRS **OP** 15 Lyndhurst Terrace, London (SET137867)

Action taken by NRG:

No records found

NST Ref: SET137867

National Records Group

Appendix B. Ground Investigation Factual Report

Site Analytical Services Ltd.

Site Investigations, Analytical & Environmental Chemists, Laboratory Testing Services.

Units 14 + 15, River Road Business Park,
33 River Road, Barking, Essex IG11 0EA

Directors: J. S. Warren, M.R.S.C., P. C. Warren, J. I. Pattinson, BSc (Hons). MSc
Consultants: G. Evans, BSc., M.Sc., P.G. Dip., FGS., MIEnvSc. A. J. Kingston, BSc C.Eng. MIMM
F. J. Gibbs, F.I.B.M.S. F.I.F.S.T., F.R.S.H. K. J. Blanchette

Tel: 0208 594 8134
Fax: 0208 594 8072
E-Mail: services@siteanalytical.co.uk

Your Ref: Our Ref:

Ref: 15/23908
November 2015

15 LYNDHURST TERRACE, LONDON NW3 5QA

FACTUAL REPORT ON A GROUND INVESTIGATION

Prepared for

Emanuel and Carmel Mond

CONTENTS

1.0 INTRODUCTION

1.1 Outline and Limitations of Report

At the request of Richard Mitzman Architects LLP, acting on behalf of Emanuel and Carmen Mond, a ground investigation was carried out in connection with a proposed residential basement development at the above site. A Phase 1 Preliminary Risk Assessment (Desk Study) is presented under separate cover in Site Analytical Services Limited Report Reference 15/23908-1.

The information was required for the design and construction of foundations and infrastructure for the proposed development at the existing site.

The recommendations and comments given in this report are based on the ground conditions encountered in the exploratory holes made during the investigation and the results of the tests made in the field and the laboratory. It must be noted that there may be special conditions prevailing at the site remote from the exploratory hole locations which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

2.0 SITE DETAILS

(National Grid Reference: TQ 266 853)

2.1 Site Location

The site is located on the west side of Lyndhurst Terrace in Hampstead, North London, NW3 5QA and comprises a two-storey residential property with front and rear garden areas. The site is bound by residential properties to the north, south and west.

The site covers an area of approximately 0.03 hectares and the general area is under the authority of the London Borough of Camden.

2.2 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area indicates the site to be underlain by the Claygate Member with the London Clay Formation at depth.

2.3 Previous Investigations

A Phase 1 Preliminary Risk Assessment (PRA) (SAS Report Ref: 15/23908 dated August 2015) has been undertaken across the site by Site Analytical Services Limited.

3.0 SCOPE OF WORK

3.1 Site Works

The proposed scope of works was agreed by the Client prior to the commencement of the investigation. To achieve this, the following works were undertaken:-

- The drilling of one rotary percussive borehole to a depth of 15.00m below ground level (Borehole 1).
- The drilling of two continuous flight auger boreholes to 8.00m below ground level (Boreholes 2 and 3)
- The excavation of one trial pit to 1.50m maximum depth to expose existing foundations at the site (Trial Pit 1).
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the boreholes and trial pit.
- Laboratory testing to determine the engineering properties of the soils encountered in the exploratory holes.
- Factual reporting on the results of the investigation.

3.2 Ground Conditions

The locations of the exploratory holes are shown on the site sketch plan, Figure 1.

The boreholes revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 1.20m in thickness resting on deposits of the Claygate Member with the London Clay Formation at depth.

These ground conditions are summarised in the following table. For detailed information on the ground conditions encountered in the boreholes, reference should be made to the exploratory hole records presented in Appendix A.

The levels described in the table are related to an arbitrary site datum (SD); the general site level to Ordnance Datum is taken to be approximately 98mOD.

Strata	Depth to top of strata (mbgl)	Level to top of strata (mOD)	Depth to base of strata (mbgl)	Level to base of strata (mbgl)	Description
Made Ground	0.00	-	0.40 to 1.20	48.90 to 49.54	Pea gravel/brick paving over silty sandy clay with brick fragments.
Claygate Member	0.40 to 1.20	48.90 to 49.54	0.25 (Base of TP1) to 9.40	49.24 (Base of TP1) to 40.10	Soft becoming firm and then stiff silty sandy clay with lenses of clayey silty fine sand
London Clay Formation	9.40	40.10	15.00 (Base of BH 1)	34.50	Firm becoming stiff silty sandy clay with gypsum crystals

Table A: Summary of Ground Conditions in Exploratory Holes

3.3 Groundwater

Groundwater was not encountered within Boreholes 2 and 3 or the trial pit and the soils remained essentially dry throughout. Groundwater was encountered in the Borehole 1 as detailed in Table B below.

Exploratory Hole	Depth (m)	Level (mOD)	Notes	Stratum
BH1	15.00	34.50	Very Slight Seepage	London Clay Formation

Table B: Groundwater Strike Summary

It must be noted that the speed of excavation is such that there may well be insufficient time for further light seepages of groundwater to enter the boreholes and trial pit and hence be detected, particularly within more cohesive soils.

Isolated pockets of groundwater may also be present perched within any less permeable material found at shallower depth on other parts of the site especially within any Made Ground.

Following drilling operations groundwater monitoring standpipes were installed in Boreholes 1, 2 and 3 to approximately 6.00m below ground level (43.4 to 44.49mSD). Groundwater was not subsequently encountered in these monitoring standpipes after a period of approximately two months.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (July, August and September 2015) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

4.0 IN-SITU TESTING AND LABORATORY TESTS

4.1 Standard Penetration Tests

The results of the Standard Penetration Tests carried out in the natural soils are shown on the exploratory hole records in Appendix A. SPT 'N' values range between 11 and 31 with a general increase in depth apparent.

4.2 Mackintosh Probe / Hand Vane Tests

Mackintosh Probe tests were made at regular depth increments in order to assess the relative density of the soils encountered in Boreholes 2 and 3. The results can be interpreted using the generally accepted correlation for Mackintosh Probe Tests which is as follows:

Mackintosh N75 X 0.38 = SPT 'N' Value

or

Mackintosh N300 X 0.1 = SPT 'N' Value

The results of the in-situ tests are shown on the appropriate exploratory hole records contained in Appendix A.

4.3 Undrained Triaxial Compression Test Results

Undrained Triaxial Compression tests was carried out on two undisturbed 100mm diameter samples taken from Borehole 1.

The results of the tests are presented on Table 1, contained in Appendix B.

4.4 Classification Tests

Atterberg Limit tests were conducted on three samples taken at depth in Boreholes 1, 2 and 3 and showed the samples tested to fall into Class CI according to the British Soil Classification System.

Particle size distribution tests were conducted on two selected samples taken from the natural essentially granular soils present in the borehole using wet sieving methods.

The test results are given in Table 2, contained in Appendix B.

4.5 Sulphate and pH Analyses

The results of the sulphate and pH analyses made on three soil samples are presented on Table 3 contained in Appendix B.

p.p. SITE ANALYTICAL SERVICES LIMITED

A P Smith BSc (Hons) FGS MCIWEM
Senior Geologist

5.0 REFERENCES

1. British Standards Institution, 1986. Code of practice for foundations, BS 8004, BSI, London.

2. British Standards Institution, 1990. Methods for test for soils for civil engineering purposes, BS1377, BSI, London

3. British Standards Institution, 1994. Code of practice for earth retaining structures, BS8002, BSI, London

4. British Standards Institution, 20. Code of Practice for Site Investigations, BS5930: 2015, BSI, London

5. British Standards Institution, 2004. Geotechnical Design, BS EN 1997-1 BSI, London

6. Building Research Establishment Special Digest 1, 2005, "Concrete in Aggressive Ground – Third Edition."

7. Driscoll, R (1983) "The influence of vegetation on the shrinking and swelling of clay soils in Great Britain", Geo-technique 33, 93-107

8. Eurocode 1: Actions on structures – BS EN 1991-1-1:2002: General actions – Densities, self weight and imposed loads, BSI, London

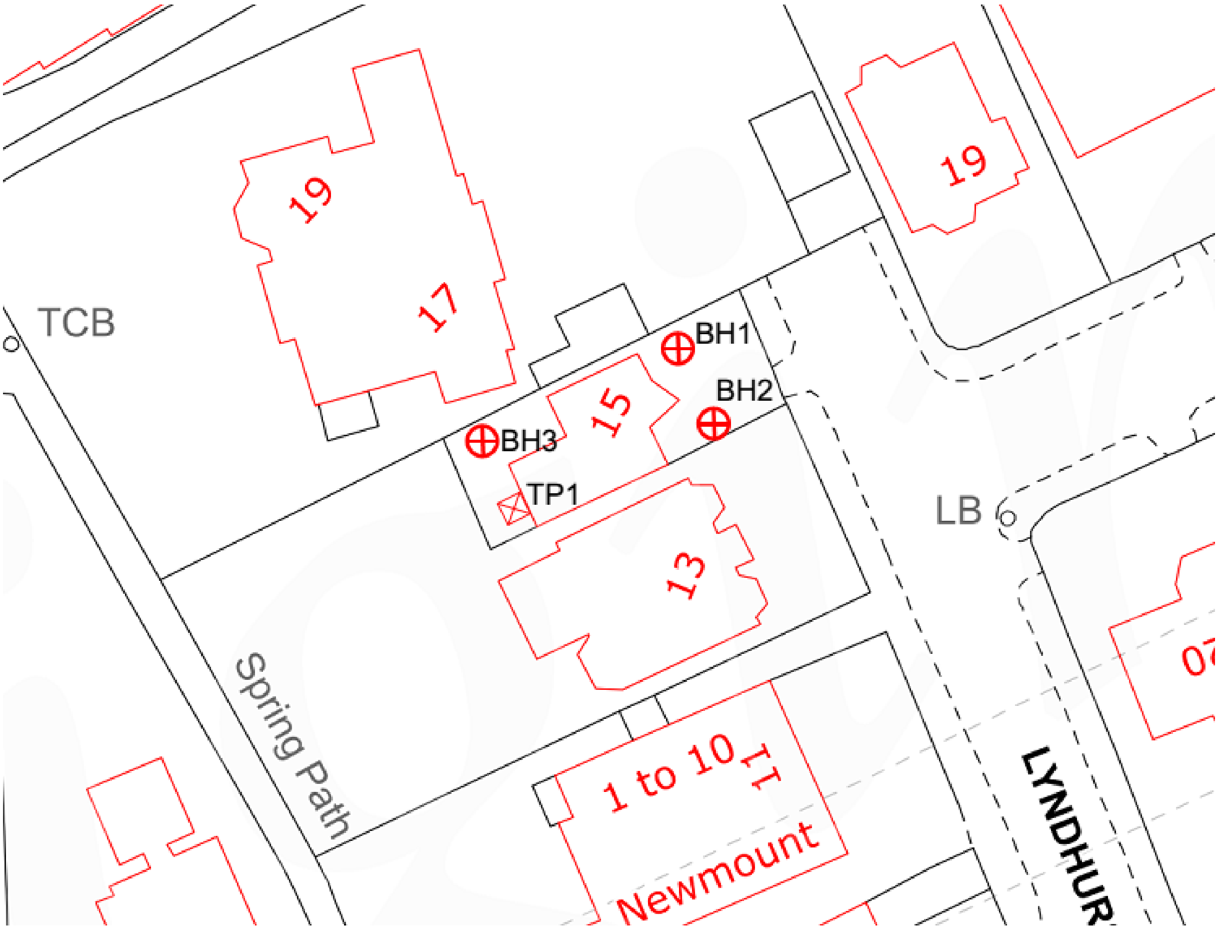
9. NHBC Standards, Chapter 4.1, "Land Quality - managing ground conditions", September 1999.

10. NHBC Standards, Chapter 4.2, "Building near Trees", April 2010.

11. Stroud M.A. and Butler F.G. (1975) Symposium on the Engineering Behaviour of Glacial Materials; the Midland Soil Mechanics and Foundation Engineering Society; pgs 124 et seq.

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

Site Analytical Services Ltd.			REF: 15/23908
LOCATION:	15 Lyndhurst Terrace, London, NW3 5QA		FIG: 1
TITLE:	Site Sketch Plan	DATE: Nov' 2015	SCALE: NTS



A P P E N D I X `A’

Borehole / Trial Pit Logs

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH1

Boring Method	Casing Diameter	Ground Level (mSD)	Client	Job Number
ROTARY PERCUSSIVE	128mm cased to 0.00m	49.50	EMMANUEL AND CARMEN MOND	1523908
	Location	**Dates**	**Architect**	**Sheet**
	TQ266853	24/07/2015	RICHARD MITZMAN ARCHITECTS LLP	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mSD)	Depth (m) (Thickness)	Description	Legend	Water
					49.35	(0.15) 0.15	MADE GROUND: Pea gravel over a brick and hardcore rubble.		
0.25	D1					(0.25)			
					49.10	0.40	MADE GROUND: Silty sandy clay with occasional brick fragments.		
0.50	D2								
0.75	D3						Firm very silty very sandy CLAY with frequent laminations of yellow silty fine sand.		
1.00-1.45 1.00	SPT(C) N=11 D4		DRY	1,2/3,2,3,3					
1.75	D5								
2.00-2.45 2.00	SPT N=27 D6		DRY	3,6/7,6,7,7		(3.35)			
2.75	D7								
3.00-3.45 3.00	SPT N=25 D8		DRY	3,4/5,6,7,7					
					45.75	3.75	Medium dense slightly clayey silty fine SAND		
3.75	D9								
4.00-4.45 4.00	SPT N=17 D10		DRY	3,3/4,5,4,4					
4.75	D11					(2.15)			
5.00-5.45 5.00	SPT N=16 D12		DRY	3,3/4,4,4,4					
					43.60	5.90	Firm becoming stiff very silty very sandy CLAY with occasional laminations of yellow silty fine sand.		
6.00	D13								
6.50-6.95 6.50	SPT N=16 D14		DRY	2,3/3,4,4,5					
7.50	D15					(3.50)			
8.00-8.45 8.00	SPT N=16 D16		DRY	2,3/4,4,4,4					
9.00	D17								
					40.10	9.40	Stiff dark grey brown blue silty sandy CLAY with occasional partings of silty fine sand and occasional gypsum crystals.		
9.50-9.95	U1			100 blows		(0.60)			

Remarks
SPT = Standard Penetration Test
SPT(C) = Standard Penetration Test (Cone)
D = Disturbed sample
U = Undisturbed 100mm diameter sample
Excavating from 0.00m to 1.00m for 1 hour.

Scale (approx)	Logged By
1:50	TM

Figure No. 1523908.BH1

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH1

Boring Method	Casing Diameter	Ground Level (mSD)	Client	Job Number
ROTARY PERCUSSIVE	128mm cased to 0.00m	49.50	EMMANUEL AND CARMEN MOND	1523908
	Location	**Dates**	**Architect**	**Sheet**
	TQ266853	24/07/2015	RICHARD MITZMAN ARCHITECTS LLP	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mSD)	Depth (m) (Thickness)	Description	Legend	Water
					39.50	10.00	Stiff dark grey brown blue silty sandy CLAY with occasional partings of silty fine sand and occasional gypsum crystals.		
10.50	D18								
11.00-11.45 11.00	SPT N=27 D19		DRY	3,4/5,7,7,8					
12.00	D20								
12.50-12.95	U2			110 blows		(5.00)			
13.75	D21								
14.55-15.00 14.55	SPT N=31 D22		15.00	5,6/7,7,8,9					
				Very slight seepage(1) at 15.00m. 24/07/2015:15.00m	34.50	15.00	Complete at 15.00m		∇1

Remarks
SPT = Standard Penetration Test
SPT(C) = Standard Penetration Test (Cone)
D = Disturbed sample
U = Undisturbed 100mm diameter sample

Scale (approx)	Logged By
1:50	TM

Figure No. 1523908.BH1

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH2

Boring Method	Casing Diameter	Ground Level (mSD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m	49.60	EMMANUEL AND CARMEN MOND	1523908
	Location	**Dates**	**Architect**	**Sheet**
	TQ266853	24/07/2015	RICHARD MITZMAN ARCHITECTS LLP	1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mSD)	Depth (m) (Thickness)	Description	Legend	Water
					49.55	0.05	MADE GROUND: Brick paving		
0.25	D1					(0.65)	MADE GROUND: Brown silty sandy gravelly brown clay containing brick fragments. Gravel is fine to medium of subrounded to sub angular flint		
0.50	D2								
0.75	D3				48.90	0.70	Soft becoming firm orange brown very silty very sandy CLAY with frequent laminations of yellow silty fine sand.		
1.00	D4								
1.00-1.30	M1 85/300								
1.50	D5								
1.50-1.80	M2 82/300								
2.00	D6								
2.00-2.30	M3 97/300					(3.30)			
2.50	D7								
2.50-2.80	M4 91/300								
3.00	D8								
3.00-3.30	M5 107/300								
3.50	D9								
3.50-3.80	M6 120/300								
4.00	D10				45.60	4.00	Medium dense yellow brown slightly clayey silty fine SAND		
4.00-4.30	M7 131/300								
4.50	D11								
4.50-4.80	M8 149/300								
5.00	D12								
5.00-5.30	M9 158/300					(2.50)			
6.00	D13								
6.00-6.30	M10 164/300								
					43.10	6.50	Firm becoming stiff orange brown and grey very silty very sandy CLAY with occasional laminations of yellow silty fine sand.		
7.00	D14								
7.00-7.30	M11 173/300					(1.80)			
8.00	D15								
8.00-8.30	M12 186/300			24/07/2015:DRY	41.30	8.30	Complete at 8.30m		

Remarks
D = Disturbed sample
M = Mackintosh Probe - Blows/Penetration (mm)
Groundwater was not encountered during the excavation
Excavating from 0.00m to 1.00m for 1 hour.

Scale (approx)	Logged By
1:50	TM

Figure No. 1523908.BH1

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH3

Boring Method	Casing Diameter	Ground Level (mSD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m	50.50	EMMANUEL AND CARMEN MOND	1523908
	Location	**Dates**	**Architect**	**Sheet**
	TQ266853	24/07/2015	RICHARD MITZMAN ARCHITECTS LLP	1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mSD)	Depth (m) (Thickness)	Description	Legend	Water
					50.45	0.05	MADE GROUND: Pea gravel over concrete underlay		
0.25	D1						MADE GROUND: Brick rubble		
0.50	D2					(1.15)			
0.75	D3								
1.00 1.00-1.30	D4 M1 111/300				49.30	1.20	Soft orange brown very silty very sandy CLAY with frequent laminations of yellow silty fine sand.		
1.50 1.50-1.80	D5 M2 80/300								
2.00 2.00-2.30	D6 M3 85/300								
2.50 2.50-2.80	D7 M4 97/300					(2.80)			
3.00 3.00-3.30	D8 M5 106/300								
3.50 3.50-3.80	D9 M6 102/300								
4.00 4.00-4.30	D10 M7 125/300				46.50	4.00	Firm becoming stiff orange brown very silty very sandy orange brown CLAY with laminations of yellow silty fine sand.		
4.50 4.50-4.80	D11 M8 130/300								
5.00 5.00-5.30	D12 M9 140/300								
6.00 6.00-6.30	D13 M10 158/300					(4.30)			
7.00 7.00-7.30	D14 M11 162/300								
8.00 8.00-8.30	D15 M12 184/300			24/07/2015:DRY	42.20	8.30	Complete at 8.30m		

Remarks
D = Disturbed sample
M = Mackintosh Probe - Blows/Penetration (mm)
Groundwater was not encountered during the excavation
Excavating from 0.00m to 1.00m for 1 hour.

Scale (approx)	Logged By
1:50	TM

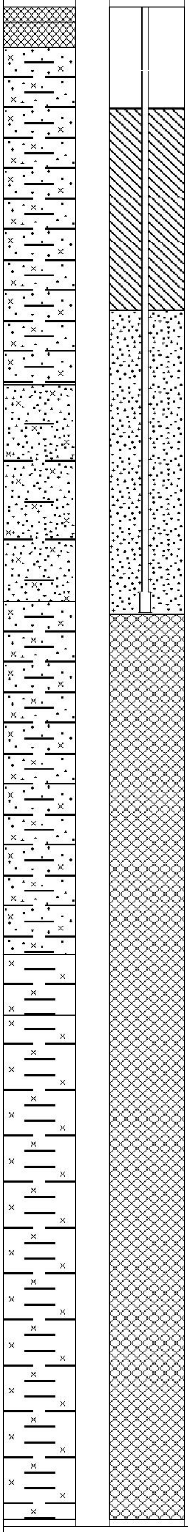
Figure No. 1523908.BH3

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH1

Installation Type	Dimensions	Client	Job Number
Single Installation	Internal Diameter of Tube [A] = 19 mm Diameter of Filter Zone = 128 mm	EMMANUEL AND CARMEN MOND	1523908

Location	Ground Level (mSD)	Architect	Sheet
TQ266853	49.50	RICHARD MITZMAN ARCHITECTS LLP	1/1



Legend	Water	Instr (A)	Level (mSD)	Depth (m)	Description
					Bentonite Seal
			48.50	1.00	
					Cement/Bentonite Grout
			46.50	3.00	
					Sand Filter
			43.70	5.80	
			43.50	6.00	Piezometer Tip
					General Backfill
			34.50	15.00	

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)
24/07/15		15.00	0.00	Very slight seepage					

Groundwater Observations During Drilling

Date	Start of Shift					End of Shift				
	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
24/07/15				DRY			15.00		15.00	34.50

Instrument Groundwater Observations

Inst. [A] Type : Standpipe Piezometer

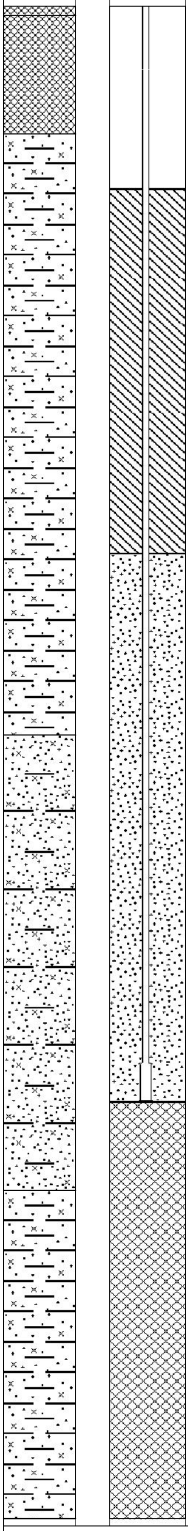
Date	Instrument [A]			Remarks
	Time	Depth (m)	Level (mOD)	

Remarks
Lockable cover set in concrete.

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH2

Installation Type	Dimensions		Client	Job Number
Single Installation	Internal Diameter of Tube [A] = 19 mm Diameter of Filter Zone = 128 mm		EMMANUEL AND CARMEN MOND	1523908
	Location	**Ground Level (mSD)**	**Architect**	**Sheet**
	TQ266853	49.60	RICHARD MITZMAN ARCHITECTS LLP	1/1



Legend	Water	Instr (A)	Level (mSD)	Depth (m)	Description
					Bentonite Seal
			48.60	1.00	
					Cement/Bentonite Grout
			46.60	3.00	
					Sand Filter
			43.80	5.80	
			43.60	6.00	Piezometer Tip

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)

Groundwater Observations During Drilling

Date	Start of Shift					End of Shift				
	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
24/07/15				DRY			8.30		DRY	

Instrument Groundwater Observations

Inst. [A] Type : Standpipe Piezometer

Date	Instrument [A]			Remarks
	Time	Depth (m)	Level (mOD)	

Remarks
Lockable cover set in concrete.

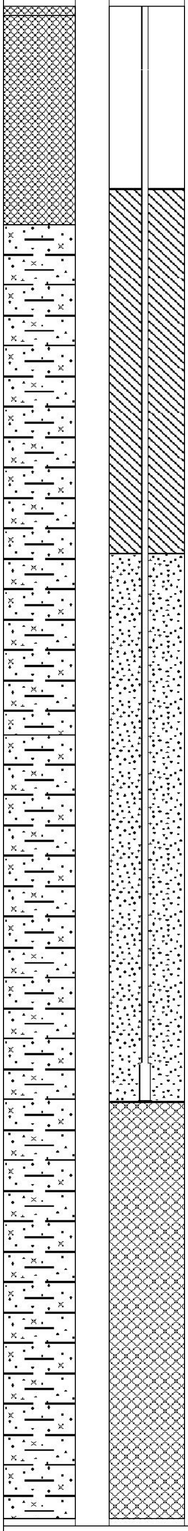
Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH3

Installation Type	Dimensions	Client	Job Number
Single Installation	Internal Diameter of Tube [A] = 19 mm Diameter of Filter Zone = 128 mm	EMMANUEL AND CARMEN MOND	1523908

Location	Ground Level (mSD)	Architect	Sheet
TQ266853	50.50	RICHARD MITZMAN ARCHITECTS LLP	1/1

Legend	Water	Instr (A)	Level (mSD)	Depth (m)	Description
					Bentonite Seal
			49.50	1.00	
					Cement/Bentonite Grout
			47.50	3.00	
					Sand Filter
			44.70	5.80	
			44.50	6.00	Piezometer Tip



Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	Readings 10 min	Readings 15 min	Readings 20 min	Depth Sealed (m)

Groundwater Observations During Drilling

Date	Start of Shift					End of Shift				
	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
24/07/15				DRY			8.30		DRY	

Instrument Groundwater Observations

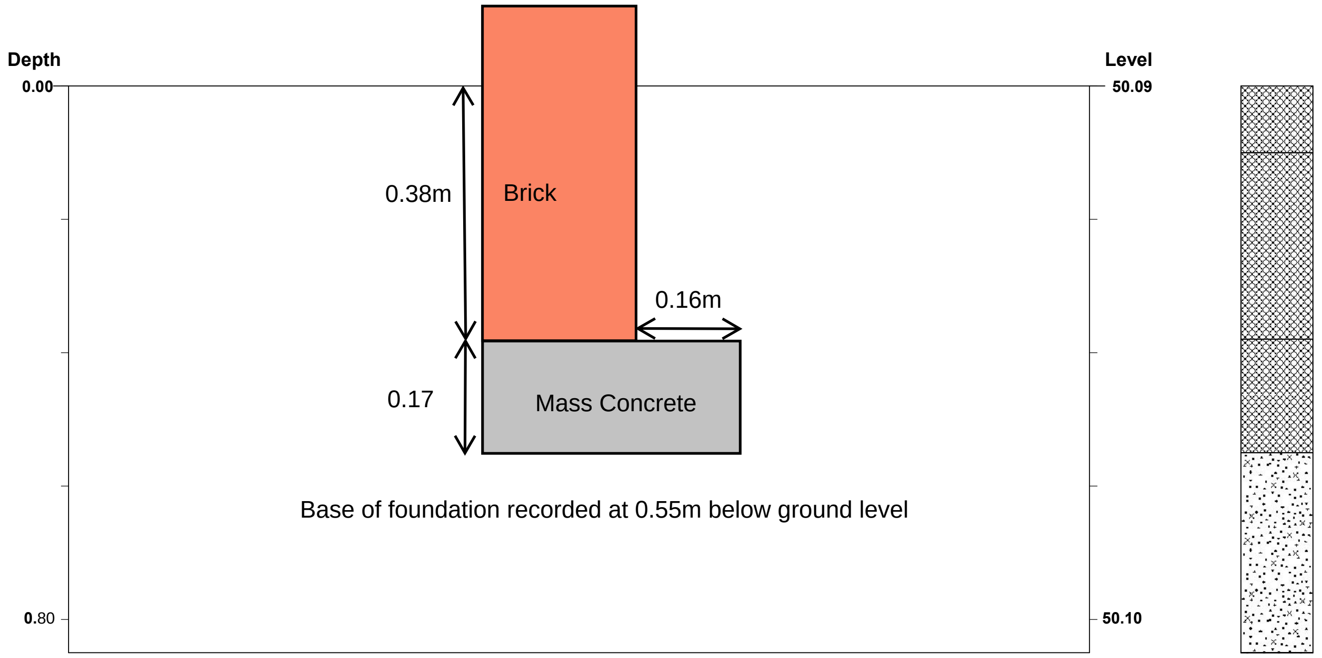
Inst. [A] Type : Standpipe Piezometer

Date	Instrument [A]			Remarks
	Time	Depth (m)	Level (mOD)	

Remarks
Lockable cover set in concrete.

Site Analytical Services Ltd.

Site 15 LYNDHURST TERRACE, LONDON, NW3 5QA					**Trial Pit Number** TP1
Method Trial Pit	**Dimensions** 300 x 300	**Ground Level (mSD)** 50.09	**Client** EMMANUEL AND CARMEN MOND		**Job Number** 1523908
Orientation A, B, C, D	**Location** TQ 266 853	**Dates** 24/07/2015	**Architect** RICHARD MITZMAN ARCHITECTS LLP		**Sheet** 1/1



Strata

Depth (m)	No.	Description
0.00-0.10	1	MADE GROUND : Pea gravel over brick paving underlay
0.10-0.38	2	MADE GROUND : Soft silty very sandy clay
0.38-0.55	3	MADE GROUND : Loose silty fine sand with occasional brick fragments
0.55-0.85	4	Loose yellow brown silty fine sand

Samples and Tests

Depth (m)	Type	Field Records
0.25	D1	
0.55	D2	
0.55-0.85	M1 45/300	

Excavation Method:
HAND EXCAVATION

Shoring / Support:
N/A

Stability:
Good

Backfill:
Arisings

Remarks
Groundwater was not encountered during the excavation
M = Mackintosh Prove - Blows/Penetration (mm)
For details of foundation exposed - see sketch

Logged By : APS
Checked By : JW
Figure No. : 1523908.TP1

Site Analytical Services Ltd.

Site	15 LYNDHURST TERRACE, LONDON, NW3 5QA		**Trial Pit Number**	TP1
Excavation Method	HAND EXCAVATION			
Dimensions	300 x 300			
Ground Level (mSD)	50.09			
Client	EMMANUEL AND CARMEN MOND		**Job Number**	1523908
Location	TQ 266 853			
Dates	24/07/2015			
Architect	RICHARD MITZMAN ARCHITECTS LLP		**Sheet**	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mSD)	Depth (m) (Thickness)	Description	Legend	Water
				49.99	0.10	MADE GROUND : Pea gravel over brick paving underlay		
0.25	D1			49.71	(0.28) 0.38	MADE GROUND : Soft silty very sandy clay		
0.55	D2			49.54	(0.17) 0.55	MADE GROUND : Loose silty fine sand with occasional brick fragments		
0.55-0.85	M1 45/300							
			24/07/2015:DRY	49.24	(0.30) 0.85	Loose yellow brown silty fine sand		
						Complete at 0.85m		

Plan

Remarks

Groundwater was not encountered during the excavation
M = Mackintosh Prove - Blows/Penetration (mm)
For details of foundation exposed - see sketch

Scale (approx)	Logged By	Figure No.
1:50	APS	1523908.TP1

A P P E N D I X `B'

Laboratory Test Data

Ref: 15/23908

UNDRAINED TRIAXIAL COMPRESSION TEST

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

BH/TP No.	MOISTURE CONTENT %	BULK DENSITY Mg/m^3	LATERAL PRESSURE kN/m^2	COMPRESSIVE STRENGTH kN/m^2	COHESION kN/m^2	ANGLE OF SHEARING RESISTANCE degrees	DEPTH m
BH1	23	2.04	250	196	98		9.75
	24	2.01	190	298	149		12.75

Ref: 15/23908

PLASTICITY INDEX & MOISTURE CONTENT DETERMINATIONS

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

BH/TP No.	Depth m	Natural Moisture %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Passing 425 μm %	Class
BH1	1.75	21	39	18	21	100	CI
BH2	3.00	19	41	16	25	100	CI
	4.00	19	39	15	24	97	CI

Ref: 15/23908

SULPHATE & pH DETERMINATIONS

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

BH/TP No.	DEPTH BELOW GL m	SOIL SULPHATES AS SO_4 TOTAL %	SOIL SULPHATES AS SO_4 WATER SOL g/l	WATER SULPHATES AS SO_4 g/l	pH	CLASS	SOIL - 2mm %
BH1	6.00		0.04		5.4	DS-1	100
BH2	2.00		0.02		4.1	DS-1	100
BH3	8.00		0.03		4.9	DS-1	100

Classification – Tables C1 and C2 : BRE Special Digest 1 : 2005

Ref: 15/23908

GROUNDWATER MONITORING

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

MONITORING DATE 30th July 2015

BOREHOLE REF:		**BH1**	**BH2**	**BH3**
Water Level	(m.bgl)	DRY	DRY	DRY
Depth to base of well	(m.bgl)	6.10	6.19	6.01
Depth to base of well	(mSD)	43.4	43.41	44.49

Table 4

Ref: 15/23908

GROUNDWATER MONITORING

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

MONITORING DATE 21st August 2015

BOREHOLE REF:		**BH1**	**BH2**	**BH3**
Water Level	(m.bgl)	DRY	DRY	DRY
Depth to base of well	(m.bgl)	6.10	6.19	6.01
Depth to base of well	(mSD)	43.4	43.41	44.49

Table 4a

Ref: 15/23908

GROUNDWATER MONITORING

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

MONITORING DATE 28th September 2015

BOREHOLE REF:		**BH1**	**BH2**	**BH3**
Water Level	(m.bgl)	DRY	DRY	DRY
Depth to base of well	(m.bgl)	6.10	6.19	6.01
Depth to base of well	(mSD)	43.4	43.41	44.49

GROUNDWATER MONITORING

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

MONITORING DATE 12th December 2016

BOREHOLE REF:		**BH1**	**BH2**	**BH3**
Water Level	(m.bgl)	DRY	DRY	DRY
Depth to base of well	(m.bgl)	6.10	6.19	6.01
Depth to base of well	(mSD)	43.40	43.41	44.49

Table 4c

Ref: 15/23908

GROUNDWATER MONITORING

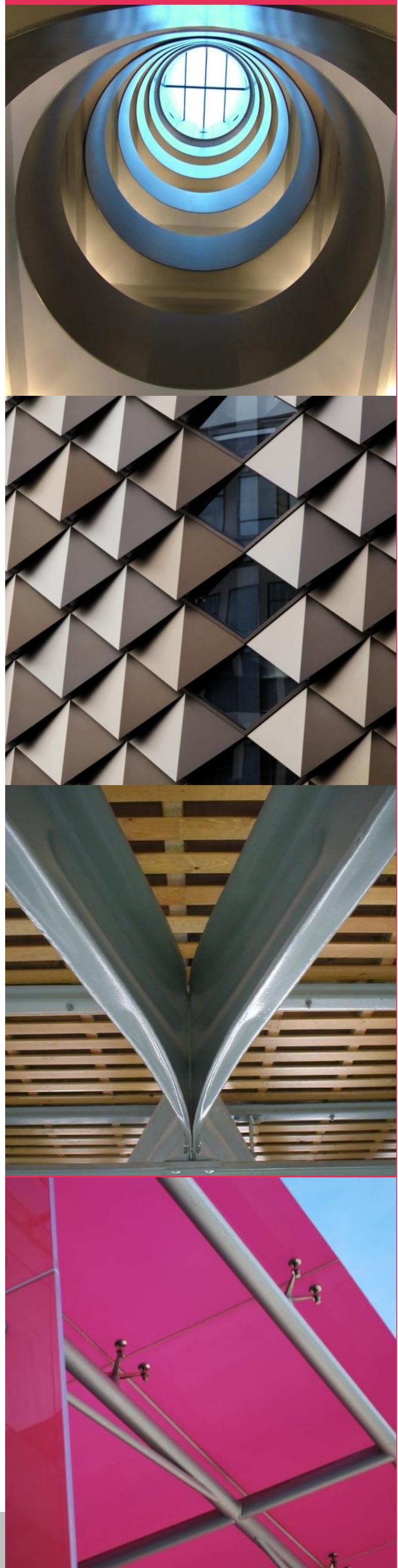
LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

MONITORING DATE 22nd February 2017

BOREHOLE REF:		**BH1**	**BH2**	**BH3**
Water Level	(m.bgl)	DRY	DRY	DRY
Depth to base of well	(m.bgl)	6.10	6.19	6.01
Depth to base of well	(mSD)	43.40	43.41	44.49

Table 4d

Appendix C. Ground Movement Assessment



15 Lyndhurst Terrace, NW3

Ground Movement Assessment

Curtins Ref: 078070-CUR-00-XX-RP-GE-001

Revision: 01

Issue Date: 04 February 2021

Client Name: Site Analytical Services Limited

Client Address: River Road Business Park, River Rd, Barking IG11 0EA

Site Address: 15 Lyndhurst Terrace, London, NW3

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Rev	Description	Issued by	Checked	Date
00	Final Issue	AS	DH	3rd February 2021
01	Minor amendment to text	AS	DH	4th February 2021

This report has been prepared for the sole benefit, use, and information for the client. The liability of Curtins Consulting Limited with respect to the information contained in the report will not extend to any third party.

Author	Signature	Date
Andrew Smith BSc Hons CGeol FGS MCIWEM RoGEP Principal Geotechnical Engineer		3rd February 2021

Reviewed	Signature	Date
David Hammond BSc (Hons) MSc DIC CGeol FGS RoGEP Associate - Geotechnical		3rd February 2021

Table of Contents

Appendices

1.0 Introduction

1.1 Brief

Curtins have been commissioned by Site Analytical Services Limited (SASL) to complete a Ground Movement Assessment (GMA) in connection with a proposed residential development at 15 Lyndhurst Terrace, London, W8. The location of the site is detailed on Figure 1-1. The purpose of this assessment is to determine what effects the permanent construction may have on permanent structures.

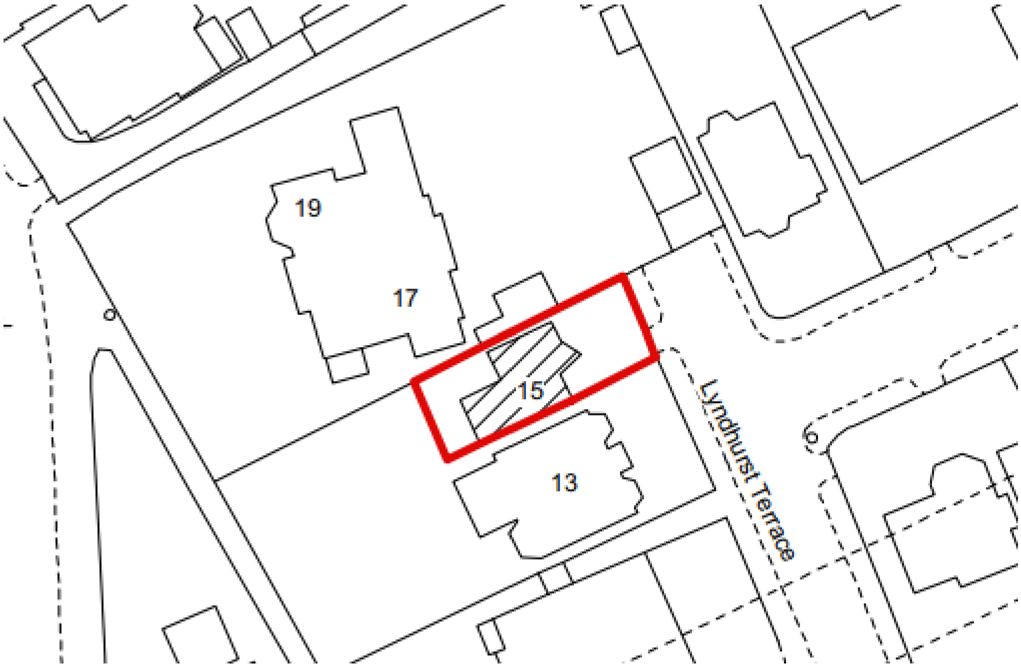


Figure 1-1 *Assessment Location Plan.*

A site-specific Ground Investigation has previously been carried out by SASL in July 2015 at the site. Groundwater monitoring was undertaken for a period of approximately two weeks following the intrusive works followed by an additional visit in February 2021. The ground investigation was designed by SASL and results have been used in the derivation of parameters utilised in this assessment. Curtins cannot be held responsible for any inaccuracy in the factual data provided.

It is understood that this report will be included as part of a Basement Impact Assessment (BIA) to be submitted to the Camden Council by the client.

The work contained in this GMA aims to satisfy the relevant elements of Camden Basement Impact Assessment: Defining the scope of Engineering Input (Guidance Note 1v0) namely the requirement of an *'Assessment of expected ground movements (short and long term) using analytical or empirical means, and how these will affect adjoining or adjacent properties'.*

A previous Ground Movement Assessment was carried out at the site by Applied Geotechnical Engineering (AGE) in January 2018 (Reference P4118/03) (1) and contained in a Basement Impact Assessment by Site Analytical Services Reference 15/23908-2 also dated January 2018 (2). This assessment was with reference to a previous planning application which included the demolition of the existing building. This application was not taken forward.

1.2 Development Proposals

The new development includes the extension of the existing building at No. 15 Lyndhurst Terrace and construction of a basement below the property.

The existing ground level in the area of the proposed basement is believed to be approximately 95mOD. Available topographic data from the earlier schemes relate levels to a site datum (SD) which will also be used for this assessment. The site slopes gently upward from front to rear. The ground level in the area of the proposed basement excavation is approximately 49.6mSD at the front, 50m SD below the existing property and increasing to 50.5mSD at the rear.

Based on the proposed architectural drawings contained within Appendix A It is understood that the proposed excavation level is to be taken as 3.2m below external ground level as detailed in Figure 1-2 below. An excavation level of 46.8mSD has been adopted for this report.

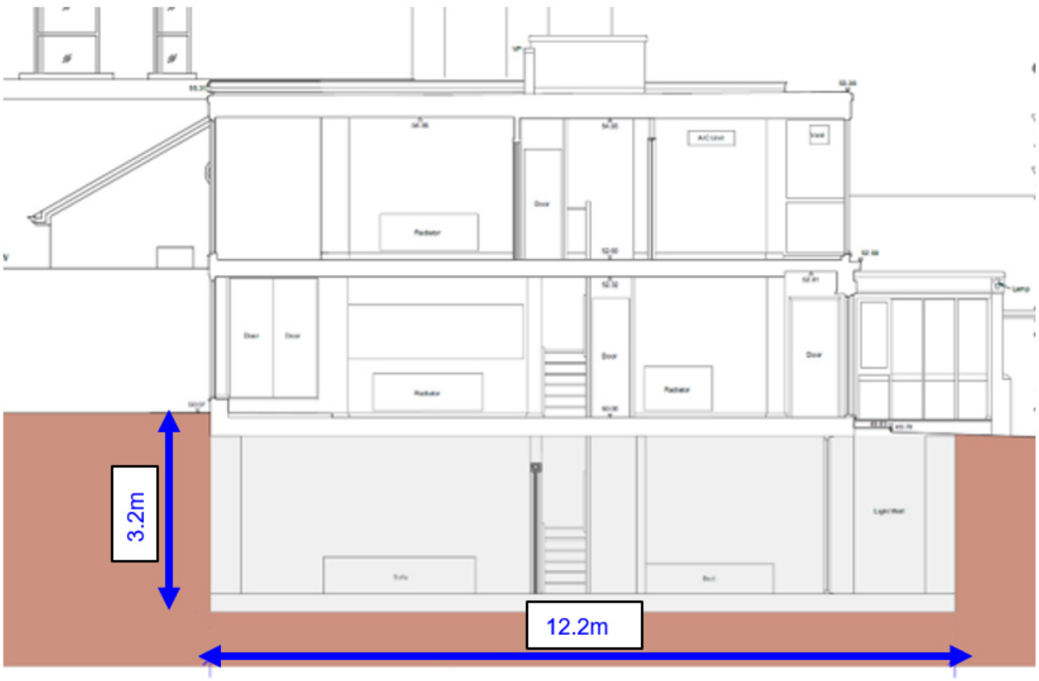


Figure 1-2. *Summary of Proposed Development*

1.3 Limitations

The conclusions and recommendations made in this report are made on the basis of the site-specific ground investigations undertaken by SASL undertaken in July 2015 and February 2021. The ground investigation was designed by SASL and the results of the work should be viewed in the context of the range of data sources consulted and the information provided along with the number of locations where the ground was sampled. No liability can be accepted for inaccuracies in the factual data, information in other data sources or conditions not revealed by the sampling or testing.

The effect of the proposed construction on existing subterranean assets (including services and tunnels) is outside the scope of this report.

It should be noted that the movements described in this report are indicative only for the purposes of providing pre-planning guidance with regards to the development and should not be relied upon for detailed design. It is anticipated the actual movement observed on site will be heavily affected by the level of workmanship and therefore should be reviewed at detailed design following discussions with the structural engineer and appointed contractor.

2.0 Baseline Conditions

2.1 Site Description

The site is located on the west side of Lyndhurst Terrace in Hampstead, North London, NW3 5QA and comprises a two-storey residential property dated from the 1960's with front and rear garden areas. The site is bound by residential properties to the north, south and west.

The site covers an area of approximately 0.03 hectares and the general area is under the authority of the London Borough of Camden.

Details of the buildings located in close proximity to the property which have been considered in the analysis are summarised in Table 2-1 below and in Appendix B.

Table 2-1 *Summary of buildings surrounding the site*

Building Name	Description	Approximate Height (from ground level)	Distance from the proposed basement
No. 13 Lyndhurst Terrace	Three storey property with existing lower ground floor	11m	1.50m
No. 17 Lyndhurst Terrace (ELM)	Two storey property with roofspace	8m	2.5m at closest point
Garage for No's 17-19 Lyndhurst Terrace	Single Storey	4m	0.75m at closest point

2.2 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area (3) indicates the site to be underlain by the Claygate Member with the London Clay Formation at depth. Deposits of the overlying Bagshot Formation are indicated to be approximately 200m to the north-west of the site, whilst the boundary to the underlying London Clay Formation is approximately 250m to the south-west.

A historical borehole from the British Geological Survey (Ref. TQ28NE449, available online: http://mapapps.bgs.ac.uk/geologyofbritain3d/) located approximately 350m to the north west of the site recorded 0.50m of Made Ground underlain by London Clay to 125m with the Thanet Sand below which extended to depths of at least 135m.

3.0 Ground Investigation

A site-specific Ground Investigation was undertaken by SASL at the site in July 2015 with further groundwater monitoring carried out in February 2021. Elevations have been taken from the relevant borehole logs.

The investigation comprised the following:

- The drilling of one rotary percussive borehole to a depth of 15.00m below ground level (Borehole 1).
- The drilling of two continuous flight auger boreholes to 8.00m below ground level (Boreholes 2 and 3)
- The excavation of one trial pit to 1.50m maximum depth to expose existing foundations at the site (Trial Pit 1).
- The installation of groundwater monitoring standpipes within all boreholes;
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the boreholes and trial pit;
- Laboratory testing to determine the engineering properties of the soils encountered in the exploratory holes;
- Factual reporting on the results of the investigation.

The factual SASL Ground Investigation data is included within the SASL Factual report (Appendix C)

3.1 Encountered Ground Conditions

A summary of the ground conditions encountered as part of the SASL investigations undertaken within the site area is presented in Table 3-1 below.

Table 3.1 *Summary of Ground Conditions Encountered*

Stratum	Depth to top of strata		Depth to base of strata		General Description
	m BGL	m AOD	m BGL	m AOD	
Made Ground	0.00	49.50 – 50.50	0.40 to 1.20	48.90 to 49.54	Pea gravel/brick paving over silty sandy CLAY with brick fragments.
Claygate Member	0.40 to 1.20	48.90 to 49.54	0.25 (Base of TP1) to 9.40	49.24 (Base of TP1) to 40.10	Soft becoming firm and then stiff silty sandy clay with lenses of clayey silty fine sand between 1.5 to 2.1m in thickness
London Clay Formation	9.40	40.10	>15.00*	>34.50	Firm becoming stiff silty sandy CLAY

Notes - **Maximum thickness of London Clay Formation not proven*

3.2 Groundwater

Groundwater was encountered as a 'very slight' seepage at 15m depth in BH1, but otherwise the boreholes were dry during excavation.

All the boreholes were equipped with water-monitoring standpipe piezometers. The response zones were from 3-6m depth in all three boreholes.

Subsequent monitoring of the standpipes, from July 2015 to February 2021 indicated them to be dry.

3.3 In Situ and Laboratory Testing

A summary of laboratory and in-situ test results undertaken within the geological strata encountered during the SASL ground investigation is presented below. Further detailed results are available in the SASL Factual Report (Appendix C).

Mackintosh Probe Testing

Mackintosh Probe tests were undertaken at regular depth increments in order to assess the relative density of the soils encountered in BH2 and BH3.

By comparison of the SPT results from BH1 with the Mackintosh Probe results from the nearby BH2 and BH3 it was found that a reasonable correlation between the two tests can be had by taking $N_{300}/10$ = SPT'N' (where N_{300} is the number of blows of the Mackintosh probe hammer required to advance the probe 300mm).

The results of the probe tests, converted to SPT 'N' values, are summarised on Figure 3.3.

Standard Penetration Testing

Standard Penetration testing (SPT) was undertaken in BH1 at regular intervals with the results summarised on Figure 3.3. 5 No. SPT's were carried out in the Claygate Member (Cohesive) with 'N' values of between 11 and 25 recorded. Between 2 and 3m BGL much higher SPT values were recorded potentially due to desiccation from a nearby tree according to AGE (1).

2 No. SPTs were carried out in the Claygate Member (Granular) with 'N' values of between 16 and 17 recorded corresponding to medium dense material in accordance with BS 5930:2015+2020 (4). 2 No. SPT's were also recorded in the underlying London Clay Formation with 'N' values of between 27 and 31 recorded.

Undrained Triaxial Testing

Undrained triaxial compression tests were carried out on 2 No. undisturbed 100mm diameter samples taken from within BH1. Both samples were taken from the London Clay Formation at depths of 9.75m and 12.75m bgl. Undrained shear strengths ranged from 98kPa (at 9.75m) to 149kPa (at 12.75m) corresponding to high strength material in accordance with BS 5930:2015+2020 (4).

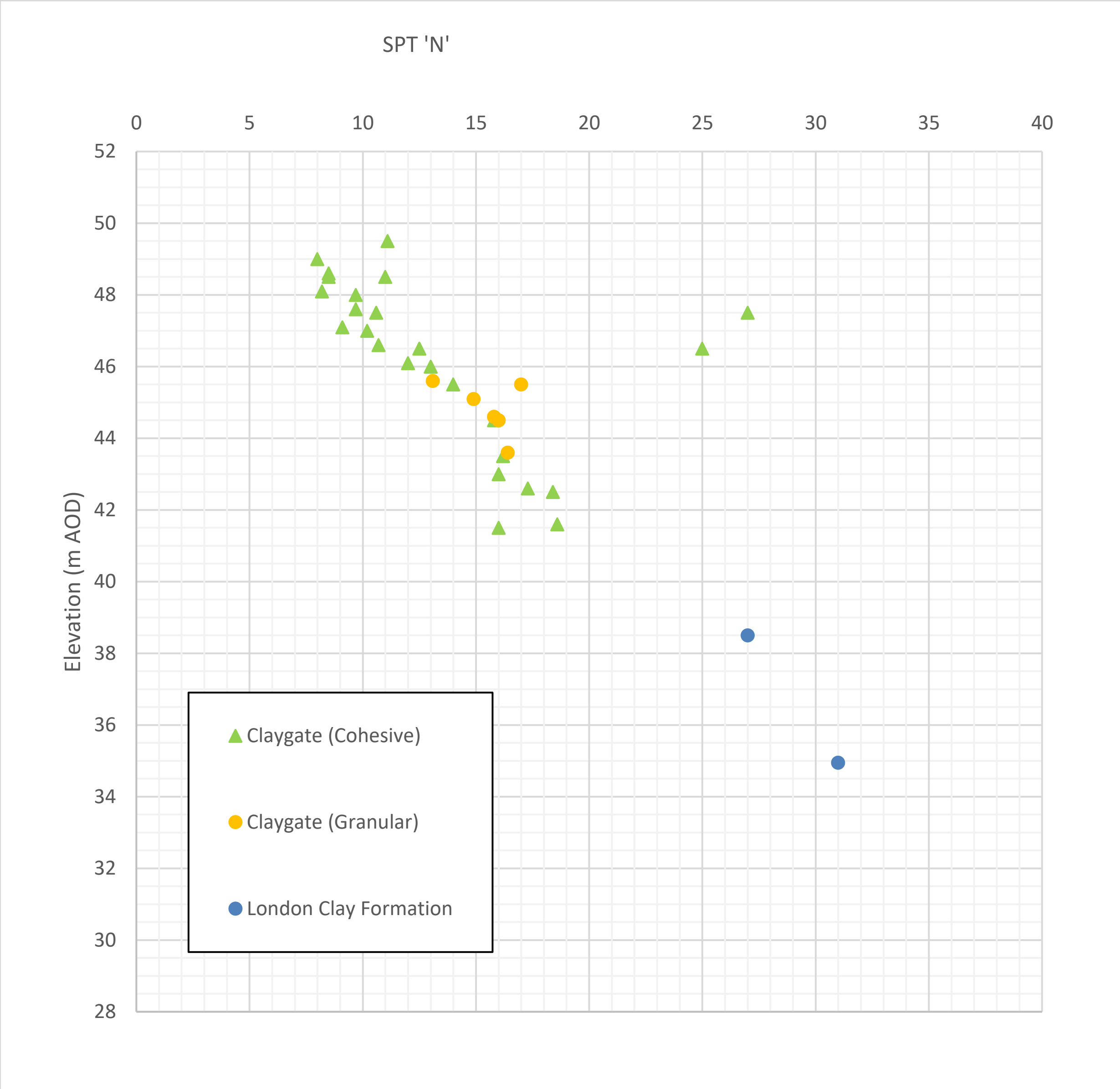


Figure 3.3 *SPT 'N' V Elevation*

4.0 Prediction of Ground Movements and Damage Assessment

4.1 Introduction

In connection with the proposed basement construction, a ground movement and damage assessment has been undertaken at the site. The purpose of this assessment is to determine the effects of the proposed basement excavation upon neighbouring structures.

The soil behaviour over the footprint of the excavated area is different from the behaviour outside and the associated ground movements require assessment using different approaches.

In the area of the new basement the soil will tend to move as a result of change in vertical load on the ground due to excavation and demolition. Movements in the long term would also be expected as a result of changes in the pore pressure in the clay layer/cohesive band under the basement.

Around the site the construction activities that may result in ground movements during and after the works are mainly related to the excavation, which would induce a reduction of vertical and lateral stresses in the ground along the excavation boundaries.

The magnitude and distribution of ground movements inside and outside the excavated area are a function of changes of load in the ground and also, critically, are a function of workmanship.

Ground movements within the area of the proposed excavation have been estimated using Geotechnical Software (PDISP by OASYS) whilst the expected movements and impact assessment of the area around the site and surrounding structures have been estimated using Geotechnical Software (XDISP by OASYS). The latter software relies on CIRIA report C580 Embedded Retaining Walls - Guidance for Economic Design (superseded by C760, 2017 (5)) which is based on field measurements of movements from a number of basement constructions across London.

The calculations provided are specific to the proposed development and the advice herein should be reviewed if the development proposals are amended.

4.2 Adjacent Properties

The properties or structures more likely to be affected by the ground movements associated with the proposed basement construction are shown in Appendix B and include the following:

- No. 13 Lyndhurst Terrace (1.50 from basement)
- No. 17 Lyndhurst Terrace (2.50 from basement)
- Garage belonging to No. 17 and 19 Lyndhurst Terrace (0.75 from basement)

Note it is not clear that the damage category assessment for the property needs to include the separate garage structure. However, for completeness, it has been considered here.

4.3 Ground Model

The ground model utilised for this assessment is based on the site-specific ground investigation undertaken by SASL at the site. It should be noted that Curtins can take no liability for inaccuracies in the factual data from the SASL investigation.

The ground conditions adopted within the model and analysis are in accordance with the ground conditions inferred from borehole BH1 as a conservative case and comprise:

- General surrounding ground level: 50mSD (Approximately 95mOD)
- Base of Made Ground: 49.1mSD
- Base of Claygate Beds 40.1mSD
- Base of London Clay -75mSD (-30mOD).

The method of Ground Movement Analyses undertaken requires soils stiffness parameters to be used. In accordance with BS8004:2015 (6) section 4.3.1.6 'Soil Stiffness' it is acknowledged that both the drained and undrained stiffness moduli of soils (E', Eu) are highly dependent on the strain level applicable to the engineering problem considered. The change in axial strain will directly influence the resultant stiffness of the soil, and in turn the stiffness of the soil will influence the strain exhibited.

Therefore, in order to define stiffness modulus applicable to the engineering problem considered, it is necessary to assess the magnitude of axial strain which the soil will be subjected to. In accordance with the recommendations made in BS8004:2015 (6) the strain generally applicable to foundations design is in the range of 0.075 to 0.2%.

The material properties used for the analysis of the ground movements have been interpreted. Where necessary, determination of characteristic parameters has been based on a cautious estimate of results derived from laboratory, published correlations and field tests, complemented with engineering judgement. The parameters are not considered to be absolute and should not be used for design.

<u>Made Ground</u>

The Made Ground at the site was typically described in the exploratory logs as gravelly fine to coarse grained sand containing brick fragments or gravelly sandy clay. Standard Penetration Testing is available in the Made Ground but not in the cohesive soils recorded in BH1. Elastic modulus values for a soft clay typically range from 2 to 7MPa (short term, E_u) and 1 to 5MPa (long term, E') . Taking a conservative approach of 'soft clay', an undrained elastic modulus of 5MPa is considered appropriate reducing to 3MPa for the drained elastic modulus (7).

Poisson's ratio for extremely high plasticity soils (PI>32%) are typically 0.45 (short term) and 0.40 (long term) (7).

A bulk unit weight of 16kN/m3 is considered appropriate for design based on guidance from BS8004 (2015) (6).

Claygate Member / London Clay Formation

For the purposes of this report, and in accordance with the previous work on the site by AGE (1) the Claygate Beds and the London Clay are taken to act as a single unit, and the stiffness of that combined unit can be taken to be represented by the stiffness of the London Clay.

The results of SPT can be correlated to an Undrained Shear Strength (cu) when undertaken within cohesive deposits. For consolidated clays, Stroud (1975) (8) reported good correlations between N and cu, were cu = f1 x N where values of f1 are a factor of the plasticity of the clay. Based on an average plasticity Index of 23% recorded in the investigation and utilising an f1 factor of 4.5, correlated undrained shear strengths ranged from 25kPa and 122kPa indicative of a low to high strength clay in accordance with BS5930:2015+2020 (4). These results are detailed on Figure 4-1.

On the basis of Figure 4-1, and for the purposes of this report only, an undrained strength (Su) combined profile for the Claygate Member and London Clay has been taken as:- Su = 35 + 7.4z (kPa) where z is the depth in metres below the top of the Claygate Beds,

This profile has been adopted for the top 30m of the combined strata.

Based on experience relating to the back analysis of case studies in clay and guidance from CIRIA C760 (5) (Section 5 and Appendix A11) the following relationship is proposed between undrained shear strength and the Young's modulus in the clay strata below the site.

Eu = 1000cu

E′ = 750cu

This relationship is more conservative than that used by AGE (1) but deemed to be more relevant to this site based on experience with projects local to the site and engineering judgement.

Stiffness parameters EU and E' have been assessed based on the undrained shear strength profile of the Claygate Member / London Clay Formation inferred from both the triaxial testing and SPT data and are summarised in Table 4-1 below.

A bulk unit weight of 20kN/m3 is considered appropriate for design based on BS8002 (2015) guidance (6). Table 4-1 below shows the design parameters adopted for this analysis.

In addition a drained (υ') and undrained (υ) Poisson's ratio of 0.2 and 0.5 respectively were utilised as specified in Tomlinson 7th ed (page 74) (9)

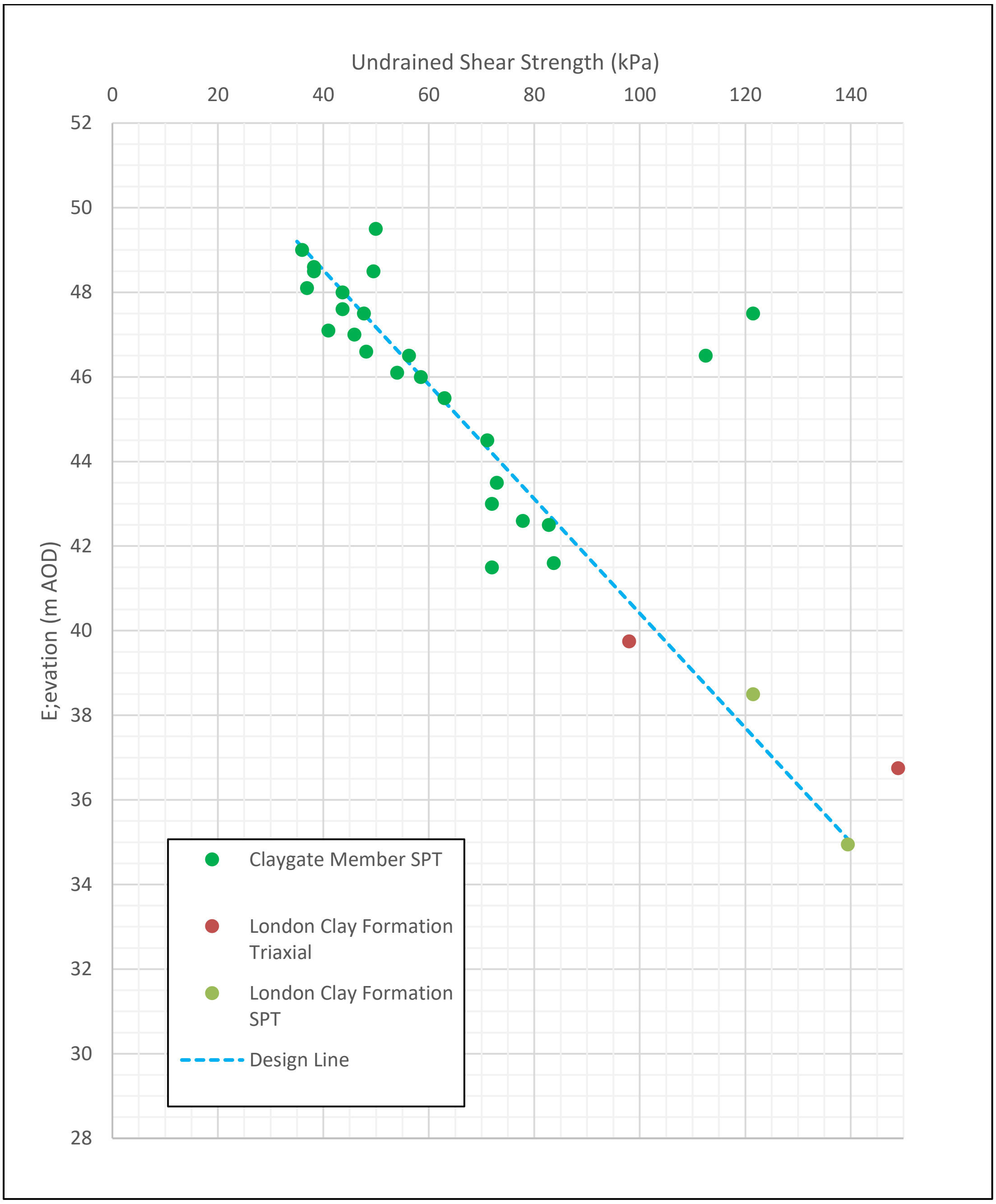


Figure 4.1 *Undrained Shear Strength V Elevation*

Table 4-1 *Summary of design parameters*

Stratum	Bulk Density (kN/m3)	Level at top (m SD)	Short-term (Undrained)		Long-term (drained)	
			Eu (kPa)	Poisson's Ratio (υ)	E' (kPa)	Poisson's Ratio (υ')
Made Ground	16	50.00	5,000	0.45	3,000	0.40
Claygate Member/ London Clay Fm	20	49.1	35000+7400z*	0.50	26250+5550z*	0.20

*Eu and E' limited to a maximum of 257,000kPa and 192,750kPa respectively below 19.1m SD.

4.4 Construction and Load Cases

With reference to the proposed drawings presented within Appendix A, the construction sequence is expected to take the following form:

1. Design of Temporary Works:
   - All temporary works should be designed by an appropriately qualified structural engineer. It is likely that the designs may require checking by a party wall surveyor on the neighbouring properties;
   - The chosen contractor should have a plan in place to deal with groundwater inflows.
2. Excavation for underpins & temporary foundations & installation of temporary works:
3. Construction/installation of basement ground floor wall.
4. Excavation down to underside of basement and associated temporary works;
5. Reloading:
   - Construction of foundation slab to proposed basement. Construct load-bearing external RC walls & internal walls/columns.
   - Construct new ground floor slab to provide permanent horizontal support to underpinnings and basement wall as required.
   - Removal of any temporary props once permanent supports are in place.

Structural Loading at foundation level for use in the ground movement analysis has been calculated by the structural engineer as shown in Appendix D. This assessment is specific to the construction sequence and load case described above. If any changes are made to the proposed development then this assessment should be revised and updated accordingly.

4.5 Ground Movement inside the proposed basement

Following excavation to the proposed foundation formation level the soil at this level and along the boundary of the excavation will tend to heave as a result of the change in the soil stress conditions. The magnitude and distribution of ground movements inside the excavated area are a function of the excavation size and shape.

The stress conditions and resultant settlement/heave have been assessed using the Boussinesq's method and geotechnical software PDISP by Oasys. PDISP calculates vertical movements due to a uniformly distributed load applied to a specified plane of geometry within a 3-D space. The Boussinesq analysis method is used in this analysis.

The following assumptions have been made within the PDISP analysis;

- Assumes Boussinesq stress distributions;
- Uniform pressure loading;
- No allowance is made for the stiffness of the structures (foundation slab).

Two load cases have been set up for both the basement excavation and basement construction to create a simplified model of the redevelopment. Structural loading at foundation level and calculations for use in the ground movement analysis have been provided by the structural engineer (Appendix D).

The vertical boundary of the model was fixed at 19.1m AOD (30m bgl). At this depth the effective vertical stress due to foundation unloading decreases to in excess of 20% of the effective overburden as required in EC7.

The results of the PDISP analysis are based on an unrestrained excavation as the model is unable to take account of the mitigating effect of the temporary works bounding the excavation, which in reality will combine to restrict these movements within the basement excavation. The movements predicted at or just beyond the site boundaries are unlikely to be realised and should not therefore have a detrimental impact upon any nearby structures.

Load case 1 (Excavation unloading, short term): A first load has been analysed to simulate excavation across the site with unloading due to the removal of soil. Assuming that no delays occur during the construction process, this load case has been simulated using short term soil parameters only (i.e undrained conditions).

The maximum excavation depths have been used for the purposes of this report with worst case ground movements provided.

Undrained removal of the overburden calculated using assumed unit weights (16kN/m3 for Made Ground and 19kN/m3 for Claygate Member) and thickness of strata, will cause a maximum unloading stresses of up to -60.40kPa at the base of the basement slab.

The PDISP analysis output showing the movements for load case 1 for the basement are presented in Appendix E.

Load case 2 (Loading, long term conditions): A Second load case has been analysed to simulate the conditions at the end of the construction phase when the site is to be re-loaded with the pressures from the proposed structure at the new formation level.

The PDISP analysis outputs for this load case for both the basement are presented in Appendix E.

PDISP Results

The results show that initially upon excavation and before construction the ground is expected to heave upwards by a maximum of -5mm. In the long term following construction of the basement the heave is expected to increase to -7mm.

PDISP uses individual layer properties to calculate the displacements resulting from applied stresses. The heave values described are considered to be overestimated and therefore conservative. It should be noted, Bowles in his text (Foundation Analysis and Design-Fifth Edition, page 542, (10)) states that *"In general, where heave is involved, considerable experience and engineering judgement are necessary in estimating probable soil response, for currently there are no reliable theories for the problem".*

Final designs for the basement retaining walls, basement slabs and internal load-bearing basement walls and columns should be designed to support heave movements. These movements should be taken into account particularly at party walls where additional loadings are proposed. Any proposed drainage system or pipe works within the vicinity should be designed to accommodate the predicted movements.

4.6 Ground Movement outside the proposed basement

Ground movements have been analysed using XDISP by Oasys and a building damage assessment has been undertaken based on the results of the analysis. Contours of vertical and horizontal ground movement are presented in Appendix F.

As detailed in the proposal drawings presented in Appendix A, the basement is to be constructed using traditional underpinning techniques to a depth of 3.20m bgl. A basement level slab is proposed as part of the new construction. Any temporary works have not been considered in this assessment.

The XDISP analysis considers both ‘excavation in front of a high stiffness wall in stiff clay’ (CIRIA C760 Fig. 6.15(a)) and ‘installation of contiguous bored pile wall in stiff clay’ (CIRIA 760 Fig. 6.8) to simulate the effects from the underpinning on neighbouring structures (5). The combined cumulative movements resulting from the wall installation (which includes the underpinning) and basement excavation have been used to carry out an assessment of the likely damage to adjacent properties as a conservative approach.

Stiffened walls have been used in the analysis which assumes adequate propping and workmanship.

Due to the irregular shape of the proposed basement, several polygons or composite excavations have been modelled in XDISP to replicate the basement as a whole. In accordance with guidance from Oasys (https://www.oasys-software.com) and to avoid re-entrant corners, no movements have been modelled to those sides of the excavations that form attachments within the centre of the proposed basement but cannot be eliminated.

The existing lower ground floors and basements beneath the adjacent buildings has been ignored in the modelling for conservatism.

Building Damage Assessment

The building damage assessment has been carried out on the relevant adjacent structures, as detailed in Appendix B.

Tensile strains induced within the building walls have been evaluated based on the deflection ratios Δ/L and horizontal extension mechanisms estimated from the analyses. The assessment considers the well-established Burland (1977) (11) damage classification method, as presented and summarised in Figure 4-6 and Figure 4-7 below. This method involves a relatively simple but robust means of assessment, which is widely adopted and is considered to comprise an industry standard/best practice basis for impact assessments of this typology.

Potential damage categories are directly related to the tensile strains induced by the proposed construction stages, arising from a combination of direct tension and bending induced tensile mechanisms.

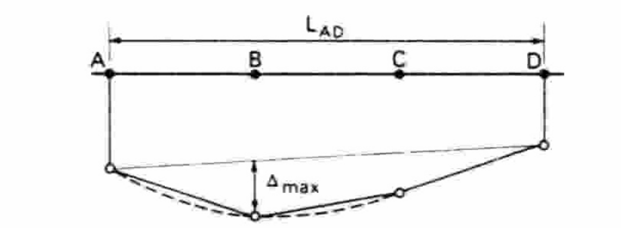


Figure 4-6 Definition of relative deflection Δ and deflection ratio Δ/L

Category of damage		Description of typical damage (ease of repair is underlined)	Approximate crack width (mm)	Limiting tensile strain ε_{lim} (per cent)
0	Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.0–0.05
1	Very slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection.	< 1	0.05–0.075
2	Slight	Cracks easily filled. Redecoration probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. 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. Weathertightness 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 frames distorted, floor sloping noticeably. Walls leaning or 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 involving partial or complete rebuilding. Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	usually > 25 but depends on number of cracks.	

After Burland et al. 1977 (11), Boscardin and Cording 1989 (12), and Burland 2001 (13)

Figure 4-7 Building damage classification – relationship between category of damage and limiting strain ε_{lim}

Results

A building impact/damage assessment has been undertaken, assuming the existing buildings walls/façades to behave as equivalent beams subject to a combination of bending, shear and axial extension/compression mechanisms, resulting from the greenfield ground movements evaluated.

On the basis of the available information the predicted level of damage to the houses at Nos 13 and 17 Lyndhurst Terrace, arising from the excavation of a basement at No 15, is 'very slight' or less, as defined in Figure 4-7. The above assumes a high standard of workmanship.

Damage to the separate garage structure at No 17 is predicted to lie near the boundary between 'very slight' and 'slight', but this structure is understood to be of basic bare brick construction and in a condition indicating limited past maintenance. The predicted level of damage is aesthetic only and intended for application in buildings with a fine plaster finish (Burland, 1997) (14). Therefore [and as also described by AGE, (1)] the predicted level of damage to the garage not applicable to this study.

The results of the assessment are presented in Table 4-6 below.

Table 4-6 *Evaluated damage categories extracted from XDISP*

Façade Reference (See App B)	Details	Damage Category
1	No. 13 Front Wall	Category 1 – Very Slight
2	No. 13 Side Wall	Category 0 – Negligible
3	No. 13 Rear Wall	Category 0 – Negligible
4	No. 17 Front Wall	Category 1 – Very Slight
5	No. 17 Main Side Wall	Category 0 – Negligible
6	No. 17 Minor Side Wall	Category 0 – Negligible
7	No. 17-19 Garage Front	Category 0 – Negligible
8	No. 17-19 Garage Side	Category 0 – Negligible
9	No. 17-19 Garage Rear	Category 2 – Slight***

*** The predicted level of damage is aesthetic only and only intended for application in buildings with a fine plaster finish (Burland, 1997 (14). Therefore the predicted level of damage to the garage which comprises a basic bare brick construction is not applicable to this study. It has been included for completeness only.

It should be noted that these movements are likely to be more affected by the quality of the workmanship and propping of the basement excavations. The construction details adopted at the junctions with the party walls and at return walls will also have a significant influence on the likelihood of any future movement at these locations. Extra care should be taken in these sections to provide appropriate support to the existing walls to prevent any excessive deflection.

Based on these results it is considered that appropriate consideration to the support & stability of neighbouring walls will be needed in the detailed structural design of the basement. Movement monitoring of the walls is recommended during the construction stage and trigger levels should be set in order to protect the neighbouring properties as a precautionary measure.

5.0 Conclusions

A Ground Movement Assessment has been carried out for 15 Lyndhurst Terrace to assist with pre-planning document submissions to Camden Council.

Providing that appropriate consideration is given to the detailed design of the basement in order to limit future movement, that good workmanship and construction sequences are used with appropriate support during excavations and that groundwater management is employed, then the proposed basement construction is unlikely to cause significant damage to the surrounding structures. Based on the predicted ground movements, the adjacent houses at Nos 13 and 17 Lyndhurst Terrace are expected to be within the CIRIA C760 Damage Category 1 (very slight).

Despite the groundwater monitoring standpipes being dry during the groundwater monitoring period, due to the presence of a Secondary A Aquifer below the site (Claygate Beds) it would be prudent to continue to monitor the existing installed standpipe for as long as possible in order to determine equilibrium level and the extent of any seasonal groundwater variations. Trial excavations to the proposed basement depth could be carried by the main contractor to confirm the stability of the soil and to further investigate the presence of groundwater inflows.

Early movement monitoring of the boundary walls to the neighbouring buildings is recommended during the construction stage and trigger levels should be set in order to protect the neighbouring properties as a precautionary measure. A specification for movement monitoring should be incorporated into the final construction scheme for the proposed development to monitor the adjacent properties and establish the extent of any future potential movement to the building. Any temporary and permanent works should be designed to limit eventual movement.

6.0 References

1 *Applied Geotechnical Engineering (AGE). Ground Movement Assessment at 15 Lyndhurst Terrace January 2018 (Reference P4118/03)*

2 *Site Analytical Services Limited. Basement Impact Assessment at 15 Lyndhurst Terrace. Reference 15/23908-2 dated January 2018*

3 *British Geological Survey Sheet 270, 'South London', Solid and Drift Edition*

4 *BS 5930:2015+A1:2020 Code of practice for ground investigations. British Standards*

5 *CIRIA Report 760 Guidance on embedded retaining wall design. CIRIA 2017*

6 *BS 8004: 2015+A1: 2020 Code of Practice for Foundations*

7 *Handbook of Geotechnical Investigation and Design Tables, Look 2007*

8 *Stroud and Butler, The Standard Penetration Test and the Engineering Properties of Glacial Materials, 1975 Conf. of the Midlands Geotechnical Society.*

9 *Tomlinson, 2001. Foundation Design and Construction*

10 *Bowles, J. 2001. Foundation Analysis and Design Fifth Edition*

11 *Burland, J., Broms, B. and de Mello, V. 1977. Behaviour of foundations and structures. Proc. 9th ICSMFE, State of-the-art Vol., 495-546*

12 *Boscardin, M. D., & Cording, E. J. (1989). Building response to excavation-induced settlement. Journal of Geotechnical Engineering, 115, 1-21. doi:10.1061/(asce)0733-9410(1989)115:1(1)*

13 *Burland, J.B. 2001. Building Response to Tunnelling: Case Studies from Construction of the Jubilee Line Extension. Report number: CIRIA Special Publication 200*

14 *Burland, J. B. (1997). Assessment of risk of damage to buildings due to tunnelling and excavation. In K. Ishihara (Ed.), Earthquake geotechnical engineering. Rotterdam: Balkema.*

15 *Stroud, M. A. 1989. The Standard Penetration Test. Thomas Telford*

17 *Peck.R,B. et al. Foundation Engineering. 1953*

18 *ICE manual of geotechnical engineering (2012), Volume II*

Appendices

Appendix A – Development Plans

Appendix B – Building Layout Plan

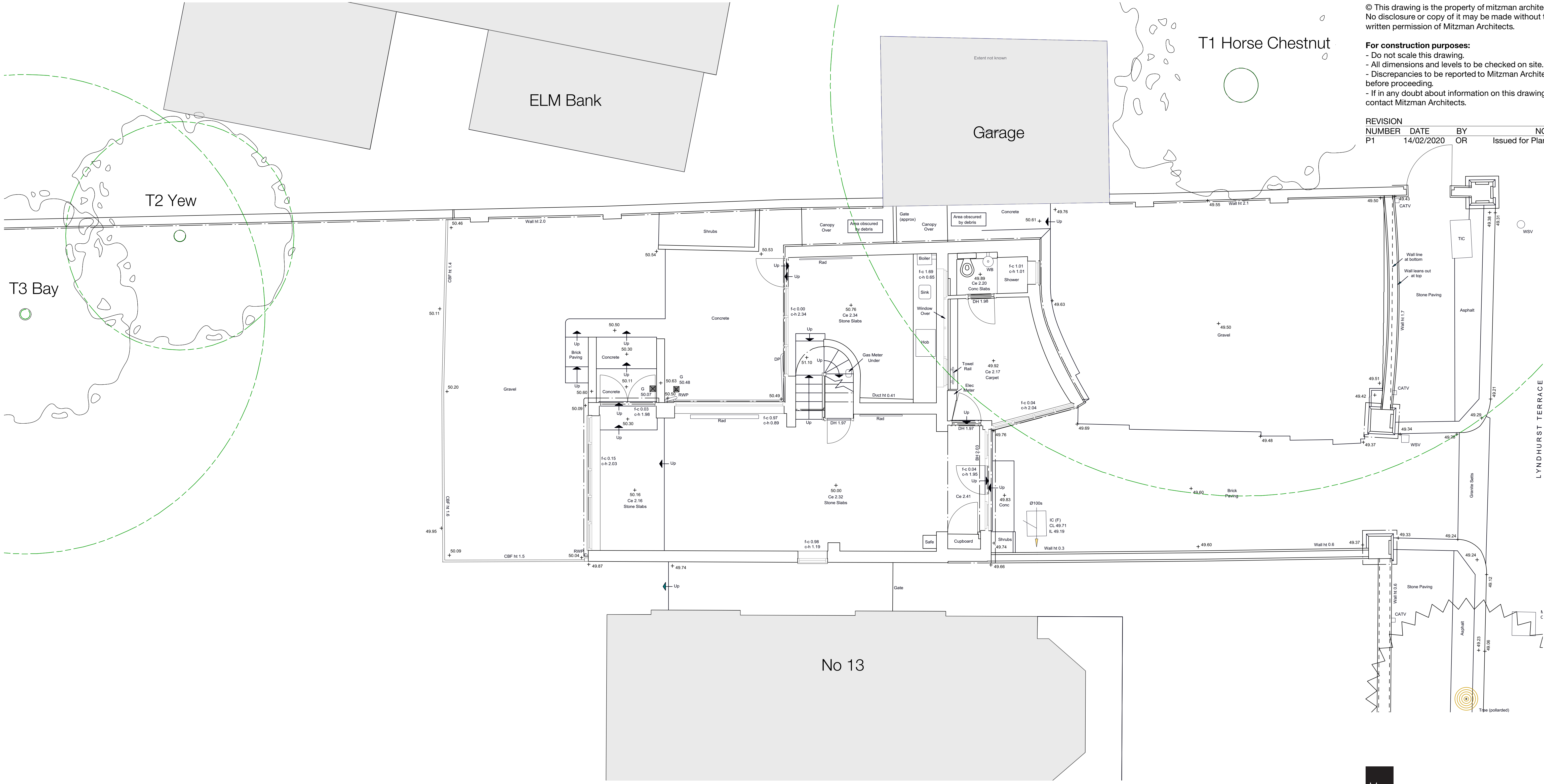
Appendix C – Site Investigation Factual Report

Appendix D – Structural Engineer Loads

Appendix E – PDISP Plans

Appendix F – XDISP Plans

Appendix A Development Plans



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SHEET TITLE
Existing Ground Floor Plan

SCALE
1:100

0 1 5 10m

DATE CREATED
29/01/2020

FILE REFERENCE
297-A-P-Bldg

DRAWING NUMBER
246-DWG-001

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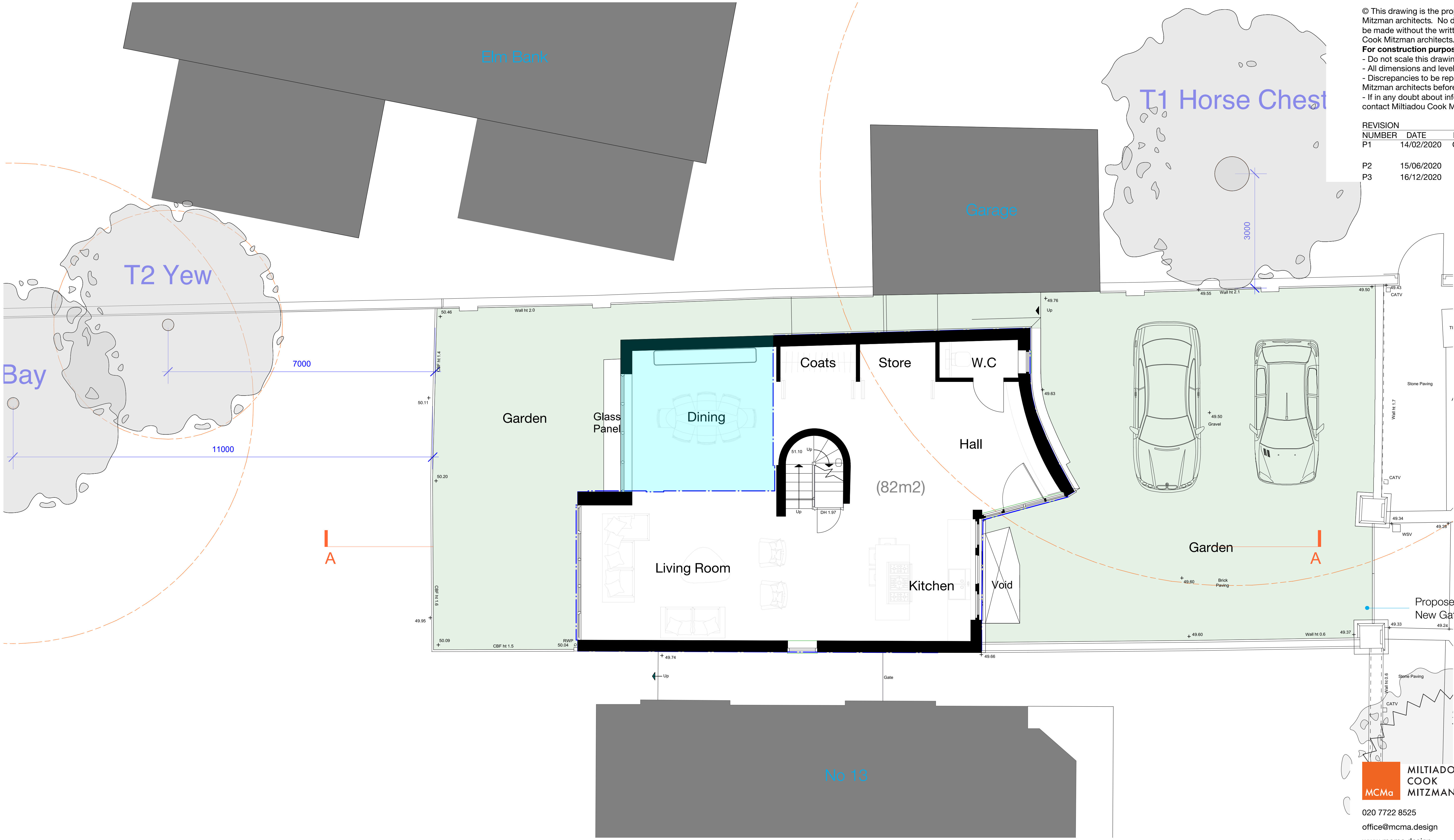

1 **Proposed Ground Floor Plan**
1:100

Approved under Application ref: 2020/0746/P

Root Protection Area

Outline of existing property (Ground level)

0 1 5 10m

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PROJECT
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SHEET TITLE
Proposed Ground Floor Plan

SCALE
1:100

DATE CREATED
16/12/2020

FILE REFERENCE
297-A-P-Bldg

DRAWING NUMBER
246-DWG-100

REVISION
P3

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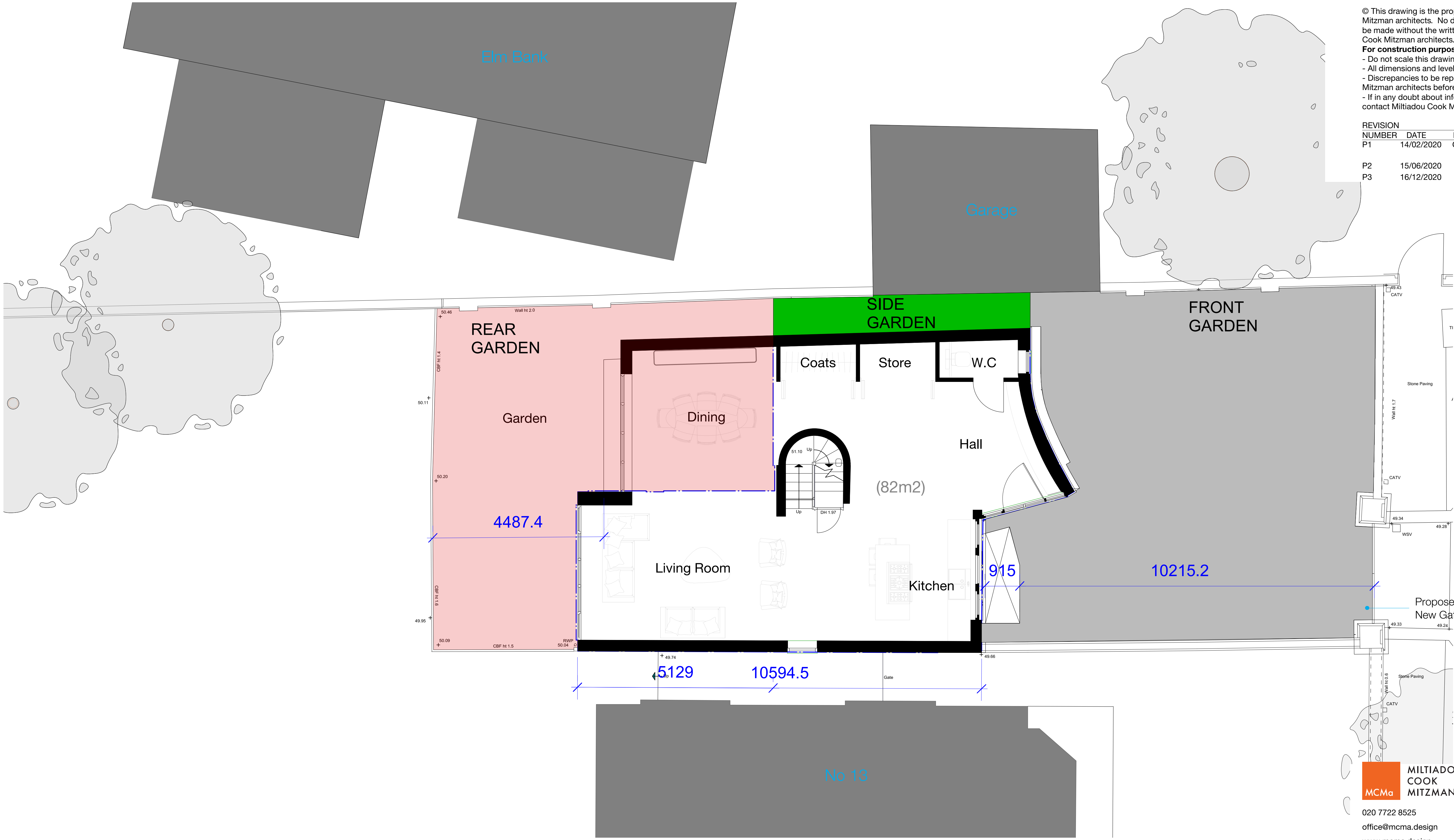
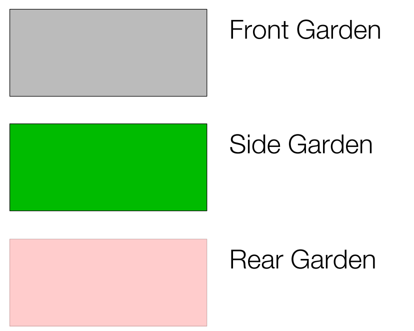
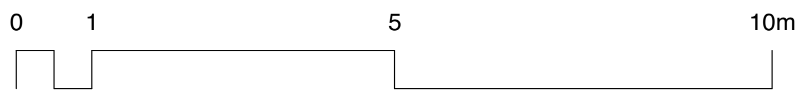




1 **Proposed Ground Floor Plan**

1:100



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SHEET TITLE
Garden Diagram

SCALE
1:100

DATE CREATED
16/12/2020

FILE REFERENCE
297-A-P-Bldg

DRAWING NUMBER
246-DWG-101

REVISION
P3

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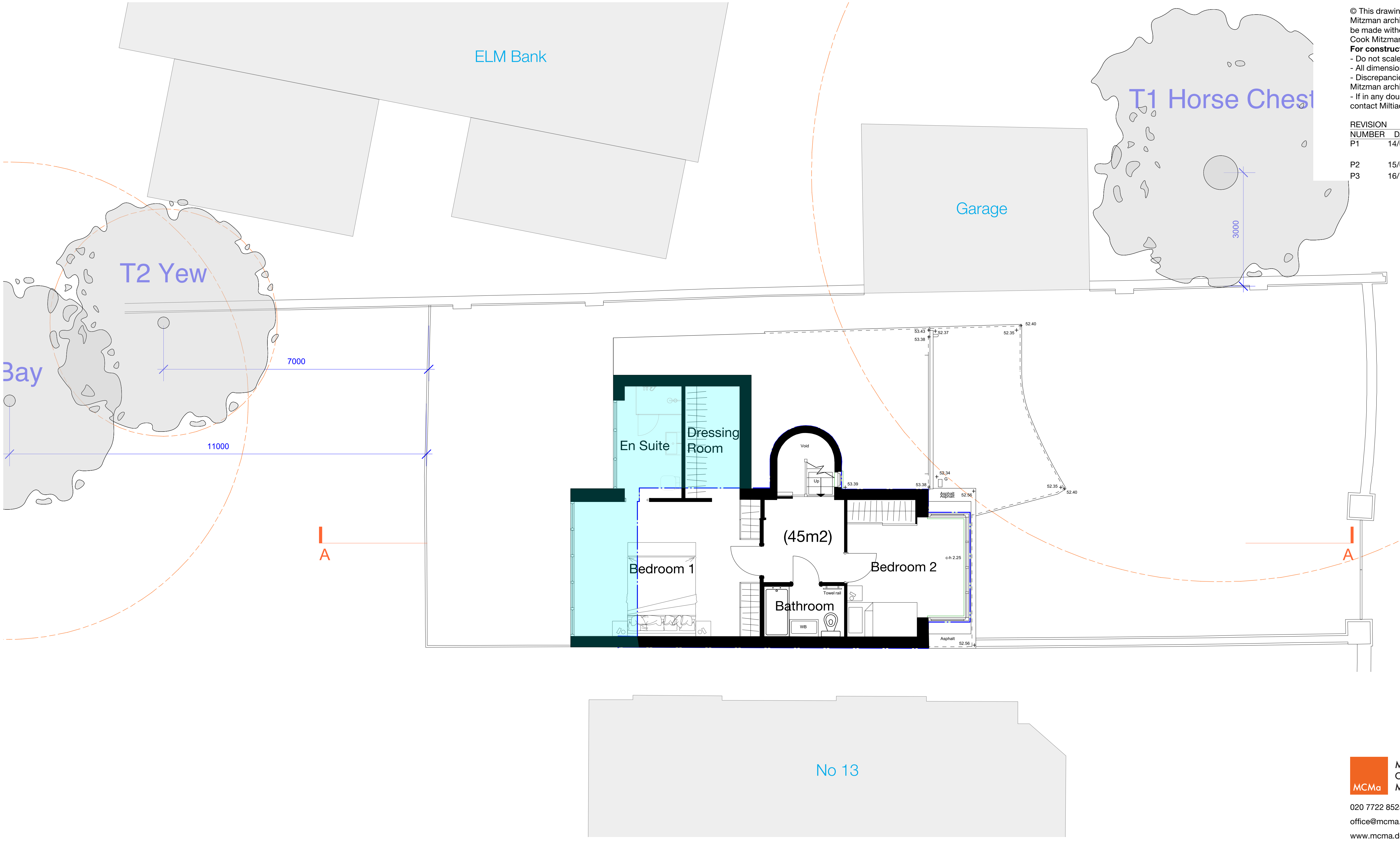
REVISION

NUMBER	DATE	BY	NOTES
P1	14/02/2020	OR	Issued to Planning
P2	15/06/2020		
P3	16/12/2020		



1 Proposed First Floor Plan

1:100

Approved under Application ref: 2020/0746/P

Root Protection Area

Outline of existing property (Ground level)

0 1 5 10m

MCMa MILTIADOU COOK MITZMAN architects llp

020 7722 8525
office@mcma.design
www.mcma.design

Unit 1 Primrose Mews
Sharpleshall Street
London NW1 8YW

CLIENT
Carmel & Emanuel Mond

PROJECT
15 Lyndhurst Terrace, London NW3 5QA

SHEET TITLE
Proposed First Floor Plan

SCALE
1:100

DATE CREATED
16/12/2020

FILE REFERENCE
297-A-P-Bldg

DRAWING NUMBER
246-DWG-102

REVISION
P3

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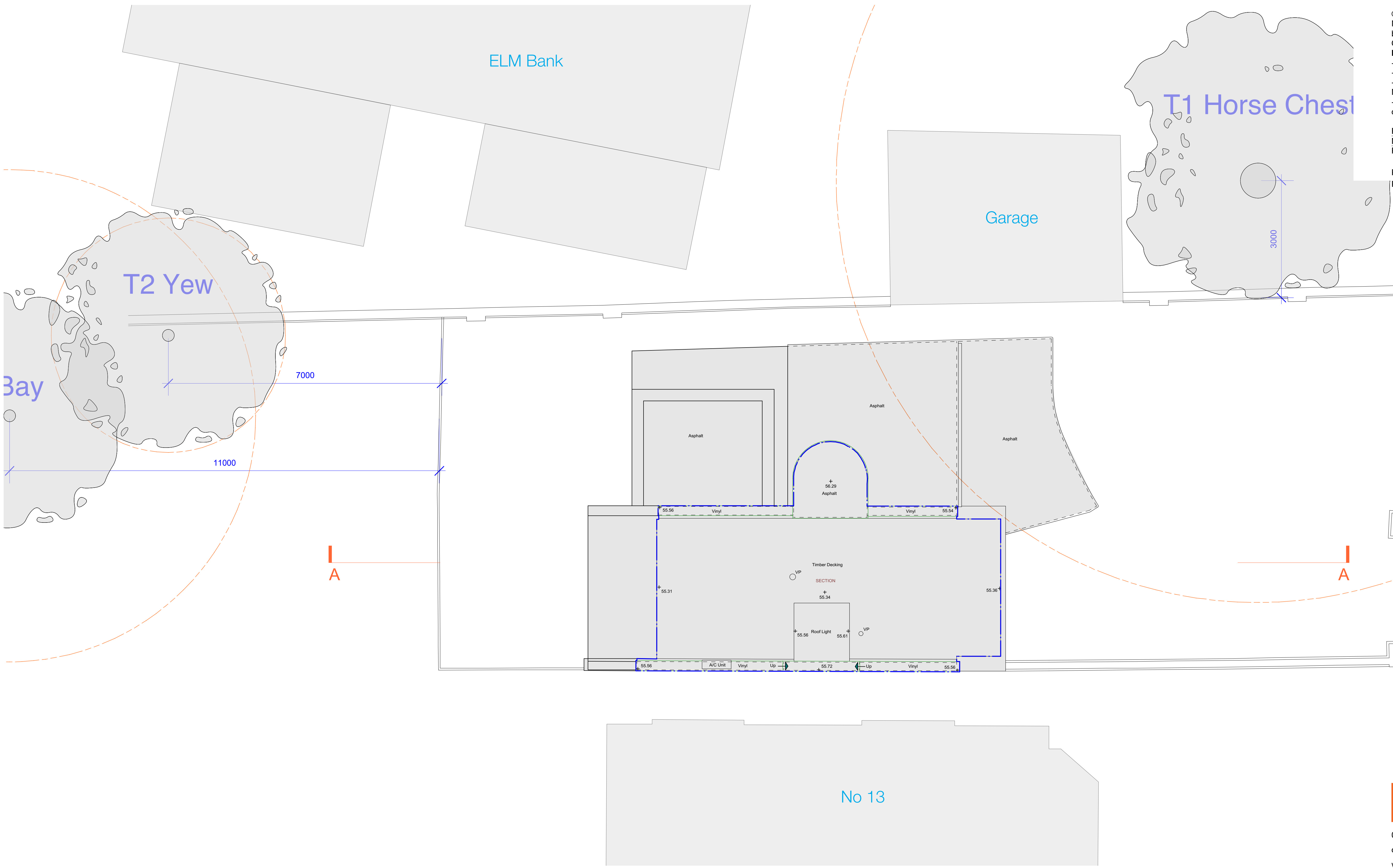
REVISION

NUMBER	DATE	BY	NOTES
P1	14/02/2020	OR	Issued to Planning
P2	15/06/2020		
P3	16/12/2020		



1 **Proposed Roof Plan**
1:100

Approved under Application ref: 2020/0746/P

Root Protection Area

Outline of existing property (Ground level)

0 1 5 10m

MCMa MILTIADOU COOK MITZMAN architects llp

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Sharpleshall Street
London NW1 8YW

CLIENT
Carmel & Emanuel Mond

PROJECT
15 Lyndhurst Terrace, London NW3 5QA

SHEET TITLE
Proposed Roof Plan

SCALE
1:100

DATE CREATED
16/12/2020

FILE REFERENCE
297-A-P-Bldg

DRAWING NUMBER
246-DWG-103

REVISION
P3

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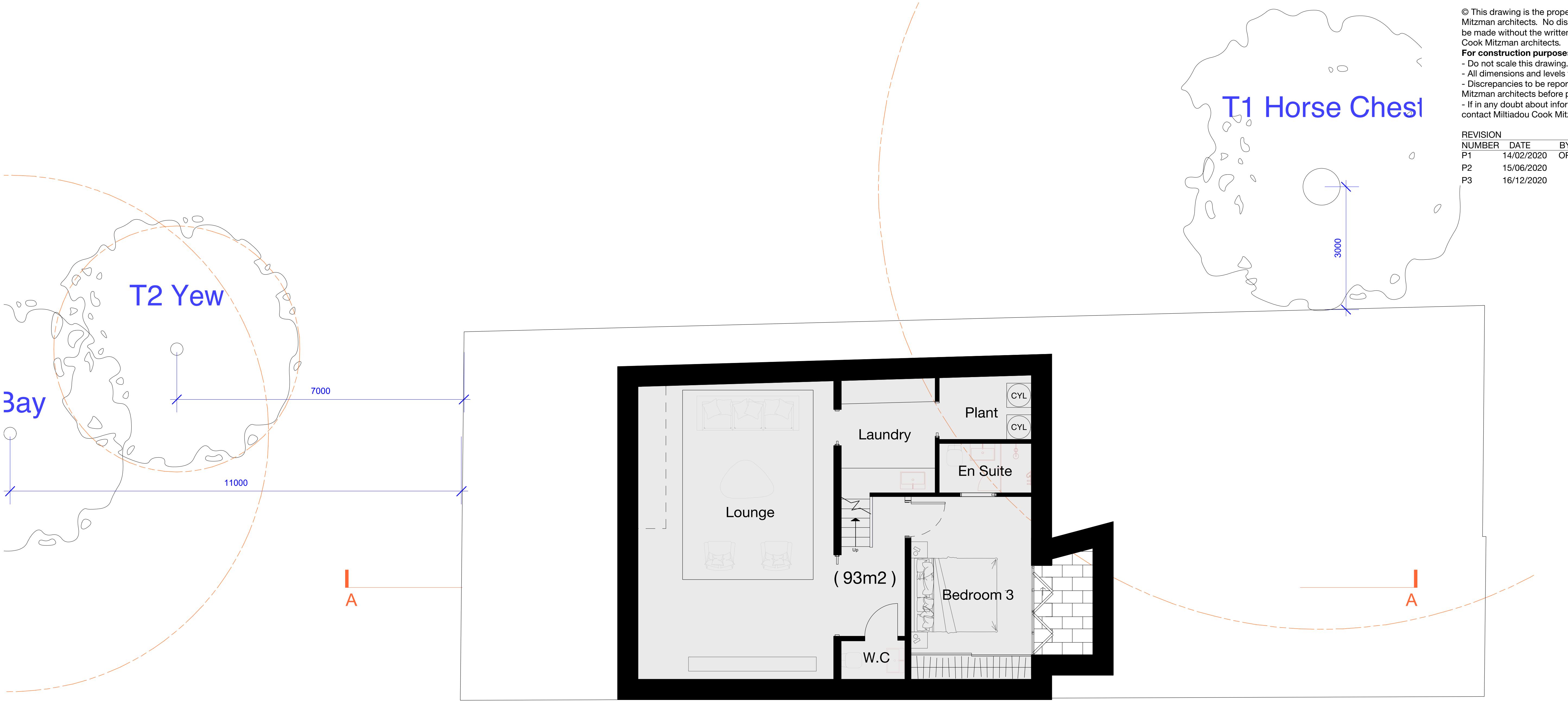
REVISION

NUMBER	DATE	BY	NOTES
P1	14/02/2020	OR	Issued to Planning
P2	15/06/2020		
P3	16/12/2020		



1 **Proposed Basement Plan**
1:100

Approved under Application ref: 2020/0746/P

Root Protection Area

Outline of existing property (Ground level)

0 1 5 10m

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CLIENT
Carmel & Emanuel Mond

PROJECT
15 Lyndhurst Terrace, London NW3 5QA

SHEET TITLE
Proposed Basement Plan (Subject To Planning)

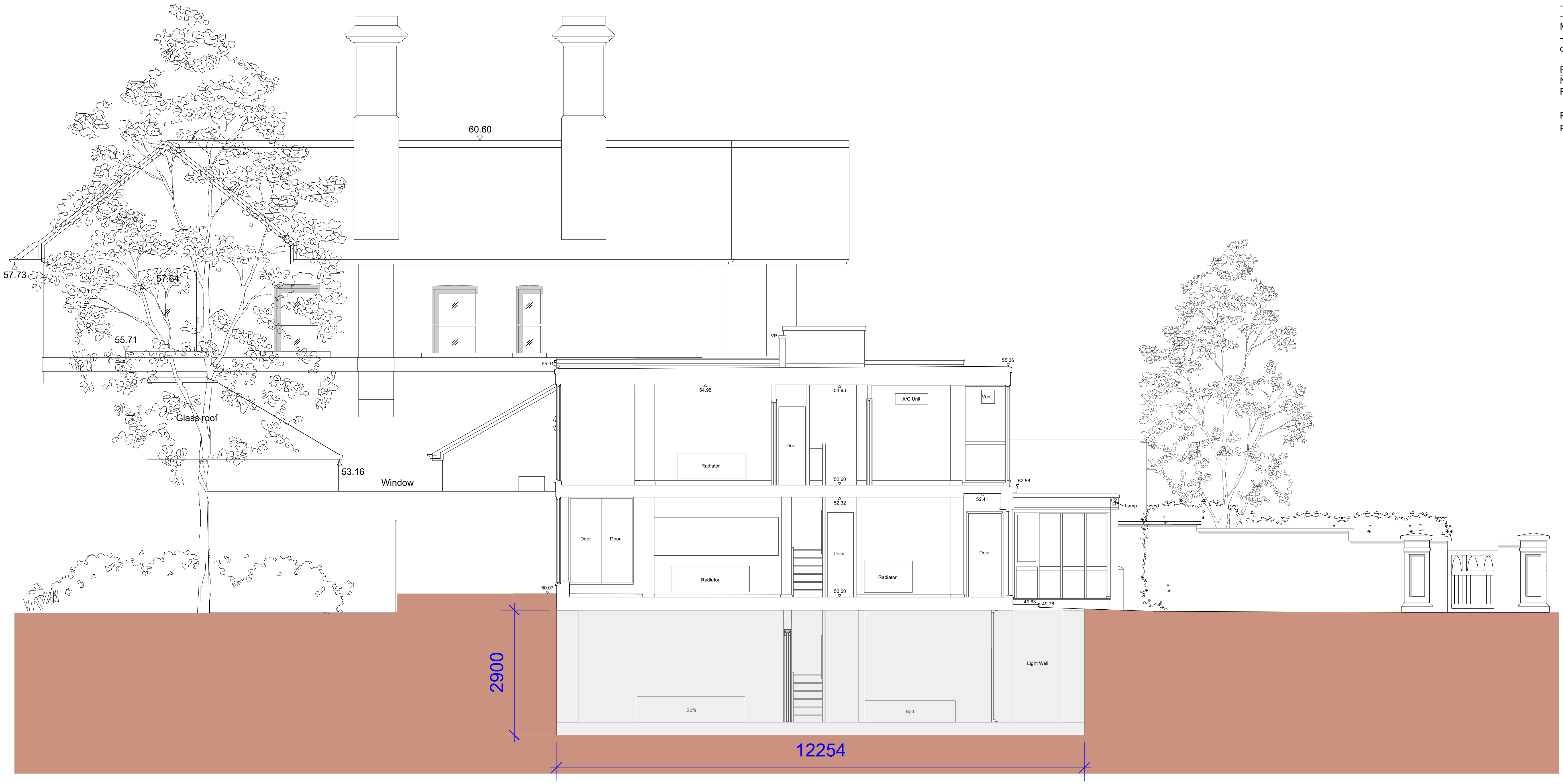
SCALE
1:100

DATE CREATED
16/12/2020

FILE REFERENCE
297-A-P-Bldg

DRAWING NUMBER
246-DWG-104

REVISION
P3



For construction purposes:
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REVISION

NUMBER	DATE	BY	NOTES
P1	14/02/2020	OR	Issued to Planning
P2	15/06/2020		
P3	16/12/2020		

1 **Proposed Site Section AA**
1:100

Ground

Proposed Basement

0 1 5 10m

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CLIENT
Carmel & Emanuel Mond

PROJECT
15 Lyndhurst Terrace, London NW3 5QA

SHEET TITLE
Proposed Site Section AA

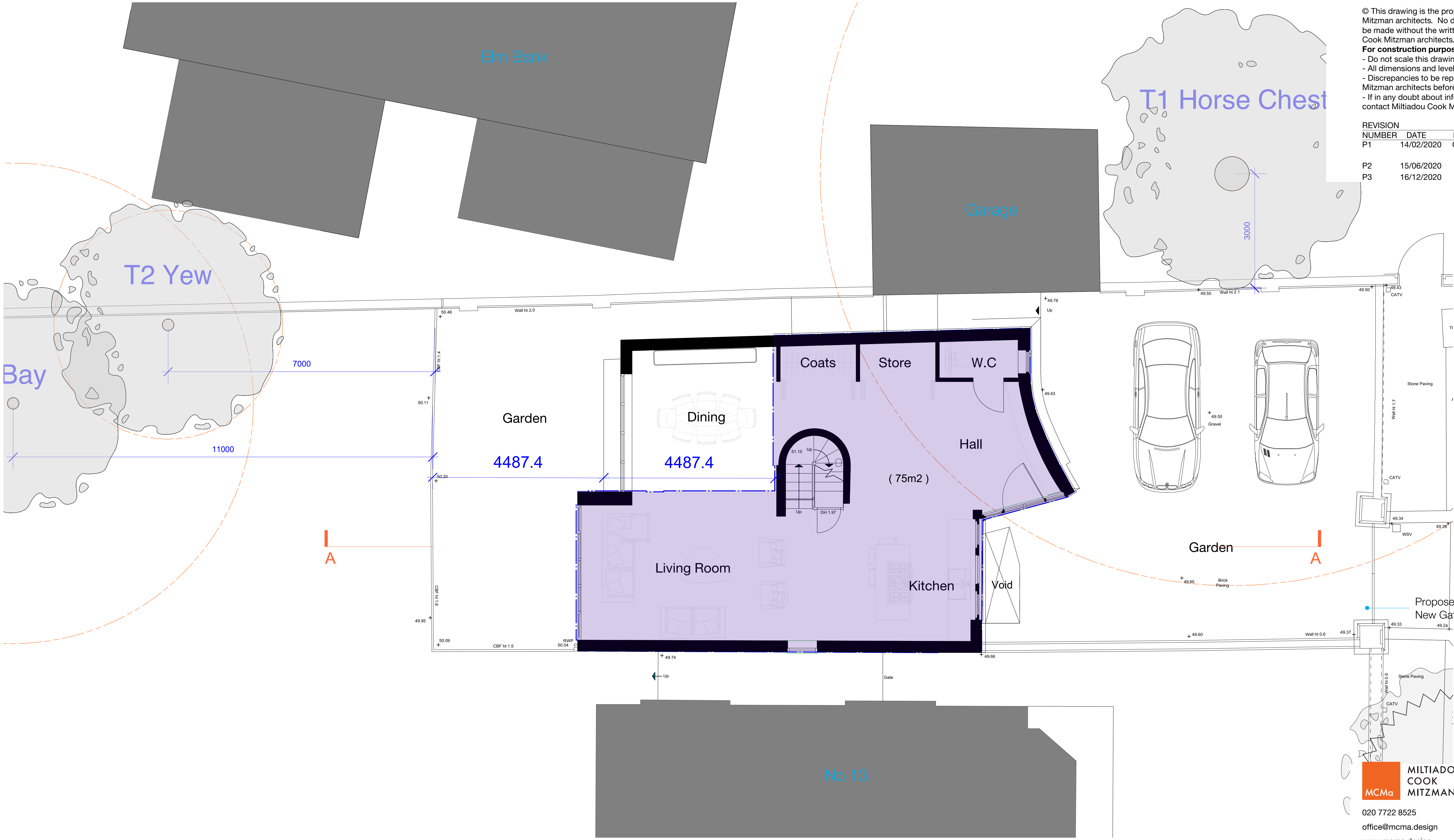
SCALE
1:100

DATE CREATED
16/12/2020

FILE REFERENCE
297-A-P-Bldg

DRAWING NUMBER
246-DWG-105

REVISION
P3



1 Proposed Ground Floor Plan

1:100

Host Building Area
75m2

0 1 5 10m

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REVISION

NUMBER	DATE	BY	NOTES
P1	14/02/2020	OR	Issued to Planning
P2	15/06/2020		
P3	16/12/2020		

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CLIENT
Carmel & Emanuel Mond

PROJECT
15 Lyndhurst Terrace, London NW3 5QA

SHEET TITLE
Host Building Area Diagram

SCALE
1:100

DATE CREATED
16/12/2020

FILE REFERENCE
297-A-P-Bldg

DRAWING NUMBER
246-DWG-106

REVISION
P3

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REVISION

NUMBER	DATE	BY	NOTES
P1	14/02/2020	OR	Issued to Planning
P2	15/06/2020		
P3	16/12/2020		

1 **Proposed Ground Floor Plan**
1:100

0 1 5 10m

	Front Garden 85m2
	Side Garden 6m2
	Existing Rear Garden 59m2
	Loss Of Garden Due To Basement 17m2

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CLIENT
Carmel & Emanuel Mond

PROJECT
15 Lyndhurst Terrace, London NW3 5QA

SHEET TITLE
Garden Area Diagram

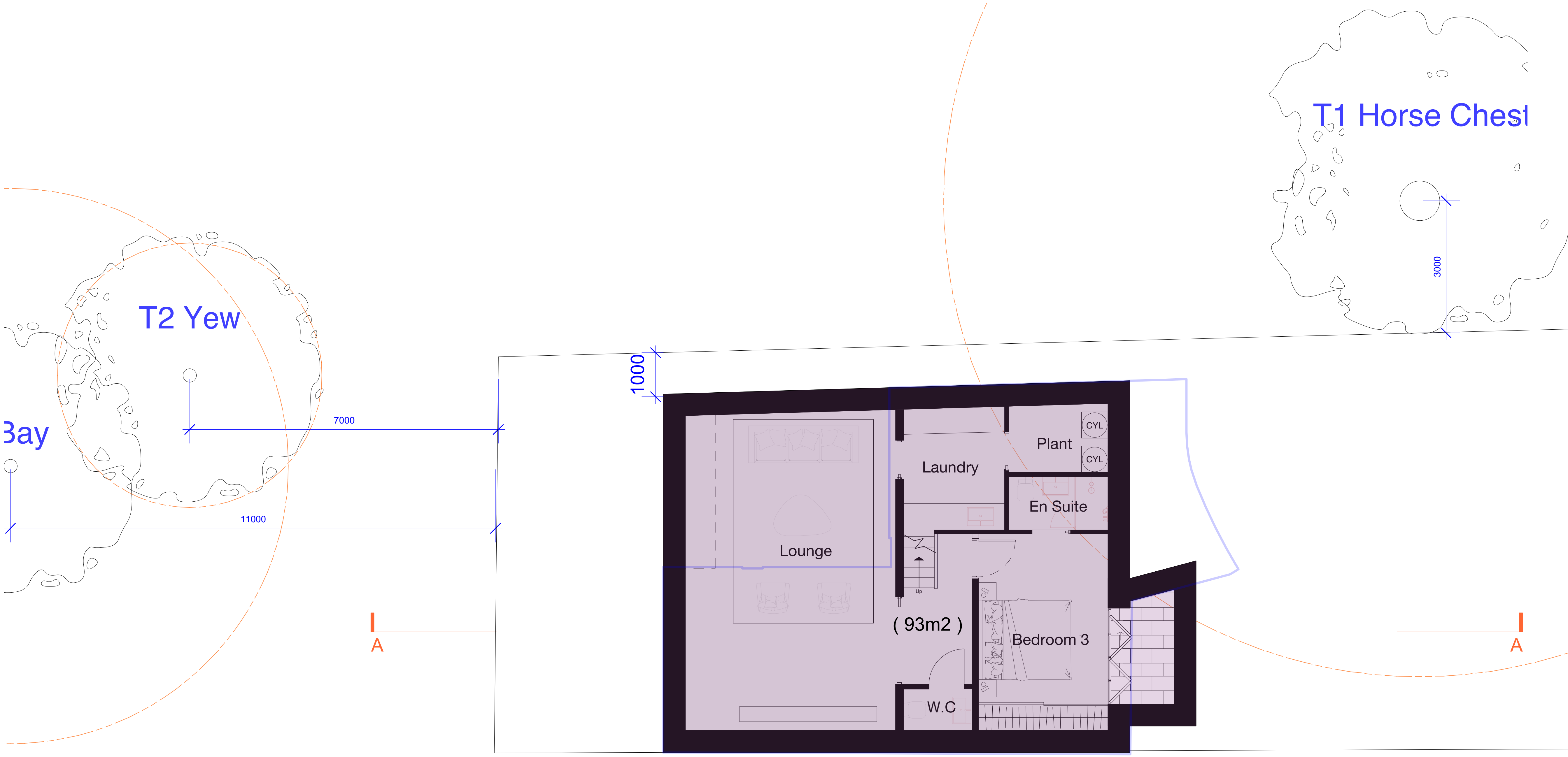
SCALE
1:100

DATE CREATED
16/12/2020

FILE REFERENCE
297-A-P-Bldg

DRAWING NUMBER
246-DWG-107

REVISION
P3



For construction purposes:
- Do not scale this drawing.
- All dimensions and levels to be checked on site.
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- If in any doubt about information on this drawing contact Miltiadou Cook Mitzman architects.

REVISION

NUMBER	DATE	BY	NOTES
P1	14/02/2020	OR	Issued to Planning
P2	15/06/2020		
P3	16/12/2020		

Area of Host building
75m2

Proposed Basement Area
93m2

1 **Proposed Basement Plan**
1:100

0 1 5 10m

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www.mcma.design
Unit 1 Primrose Mews
Sharpleshall Street
London NW1 8YW

CLIENT
Carmel & Emanuel Mond

PROJECT
15 Lyndhurst Terrace, London NW3 5QA

SHEET TITLE
Proposed Basement Plan Area

SCALE
1:100

DATE CREATED
16/12/2020

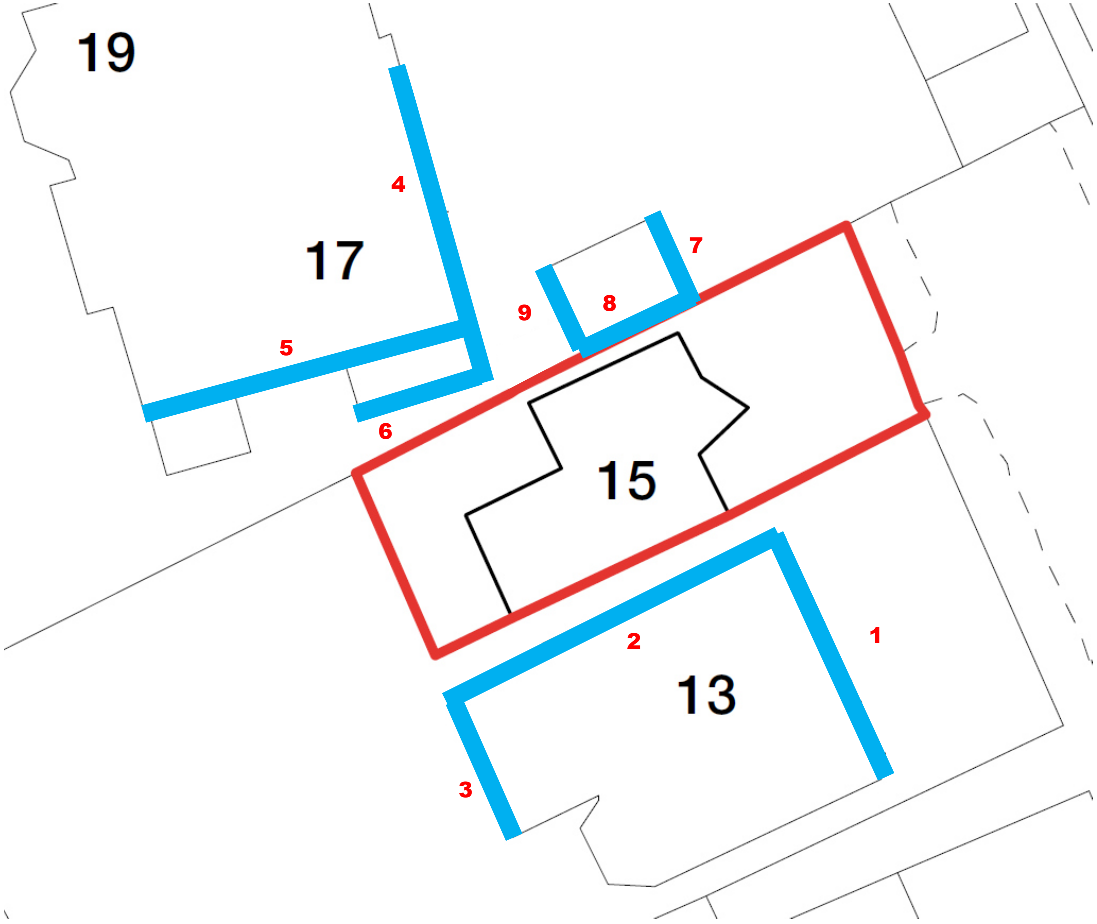
FILE REFERENCE
297-A-P-Bldg

DRAWING NUMBER
246-DWG-108

REVISION
P3

Appendix B – Building Layout Plan

Appendix B – Building and Analysis Plan



Line Ref	Description	Line Length	Assumed Height
1	No. 13 Front Wall		11
2	No. 13 Side Wall		11
3	No. 13 Rear Wall		11
4	No. 17 Front Wall		8
5	No. 17 Main Side Wall		8
6	No. 17 Minor Side Wall		3
7	No. 17-19 Garage Front		4
8	No. 17-19 Garage Side		4
9	No. 17-19 Garage Rear		4

Site is circled in red. Layout Drawing Simplified for Visual Purposes

Appendix C – Site Investigation Factual Report

Site Analytical Services Ltd.

Site Investigations, Analytical & Environmental Chemists, Laboratory Testing Services.

Units 14 + 15, River Road Business Park,
33 River Road, Barking, Essex IG11 0EA

Directors: J. S. Warren, M.R.S.C., P. C. Warren, J. I. Pattinson, BSc (Hons). MSc
Consultants: G. Evans, BSc., M.Sc., P.G. Dip., FGS., MIEnvSc. A. J. Kingston, BSc C.Eng. MIMM
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Tel: 0208 594 8134
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E-Mail: services@siteanalytical.co.uk

Your Ref: Our Ref:

Ref: 15/23908
November 2015

15 LYNDHURST TERRACE, LONDON
NW3 5QA

FACTUAL REPORT ON A GROUND INVESTIGATION

Prepared for

Emanuel and Carmel Mond

CONTENTS

1.0 INTRODUCTION

1.1 Outline and Limitations of Report

At the request of Richard Mitzman Architects LLP, acting on behalf of Emanuel and Carmen Mond, a ground investigation was carried out in connection with a proposed residential basement development at the above site. A Phase 1 Preliminary Risk Assessment (Desk Study) is presented under separate cover in Site Analytical Services Limited Report Reference 15/23908-1.

The information was required for the design and construction of foundations and infrastructure for the proposed development at the existing site.

The recommendations and comments given in this report are based on the ground conditions encountered in the exploratory holes made during the investigation and the results of the tests made in the field and the laboratory. It must be noted that there may be special conditions prevailing at the site remote from the exploratory hole locations which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

2.0 SITE DETAILS

(National Grid Reference: TQ 266 853)

2.1 Site Location

The site is located on the west side of Lyndhurst Terrace in Hampstead, North London, NW3 5QA and comprises a two-storey residential property with front and rear garden areas. The site is bound by residential properties to the north, south and west.

The site covers an area of approximately 0.03 hectares and the general area is under the authority of the London Borough of Camden.

2.2 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area indicates the site to be underlain by the Claygate Member with the London Clay Formation at depth.

2.3 Previous Investigations

A Phase 1 Preliminary Risk Assessment (PRA) (SAS Report Ref: 15/23908 dated August 2015) has been undertaken across the site by Site Analytical Services Limited.

3.0 SCOPE OF WORK

3.1 Site Works

The proposed scope of works was agreed by the Client prior to the commencement of the investigation. To achieve this, the following works were undertaken:-

- The drilling of one rotary percussive borehole to a depth of 15.00m below ground level (Borehole 1).
- The drilling of two continuous flight auger boreholes to 8.00m below ground level (Boreholes 2 and 3)
- The excavation of one trial pit to 1.50m maximum depth to expose existing foundations at the site (Trial Pit 1).
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the boreholes and trial pit.
- Laboratory testing to determine the engineering properties of the soils encountered in the exploratory holes.
- Factual reporting on the results of the investigation.

3.2 Ground Conditions

The locations of the exploratory holes are shown on the site sketch plan, Figure 1.

The boreholes revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 1.20m in thickness resting on deposits of the Claygate Member with the London Clay Formation at depth.

These ground conditions are summarised in the following table. For detailed information on the ground conditions encountered in the boreholes, reference should be made to the exploratory hole records presented in Appendix A.

The levels described in the table are related to an arbitrary site datum (SD); the general site level to Ordnance Datum is taken to be approximately 98mOD.

Strata	Depth to top of strata (mbgl)	Level to top of strata (mOD)	Depth to base of strata (mbgl)	Level to base of strata (mbgl)	Description
Made Ground	0.00	-	0.40 to 1.20	48.90 to 49.54	Pea gravel/brick paving over silty sandy clay with brick fragments.
Claygate Member	0.40 to 1.20	48.90 to 49.54	0.25 (Base of TP1) to 9.40	49.24 (Base of TP1) to 40.10	Soft becoming firm and then stiff silty sandy clay with lenses of clayey silty fine sand
London Clay Formation	9.40	40.10	15.00 (Base of BH 1)	34.50	Firm becoming stiff silty sandy clay with gypsum crystals

Table A: Summary of Ground Conditions in Exploratory Holes

3.3 Groundwater

Groundwater was not encountered within Boreholes 2 and 3 or the trial pit and the soils remained essentially dry throughout. Groundwater was encountered in the Borehole 1 as detailed in Table B below.

Exploratory Hole	Depth (m)	Level (mOD)	Notes	Stratum
BH1	15.00	34.50	Very Slight Seepage	London Clay Formation

Table B: Groundwater Strike Summary

It must be noted that the speed of excavation is such that there may well be insufficient time for further light seepages of groundwater to enter the boreholes and trial pit and hence be detected, particularly within more cohesive soils.

Isolated pockets of groundwater may also be present perched within any less permeable material found at shallower depth on other parts of the site especially within any Made Ground.

Following drilling operations groundwater monitoring standpipes were installed in Boreholes 1, 2 and 3 to approximately 6.00m below ground level (43.4 to 44.49mSD). Groundwater was not subsequently encountered in these monitoring standpipes after a period of approximately two months.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (July, August and September 2015) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

4.0 IN-SITU TESTING AND LABORATORY TESTS

4.1 Standard Penetration Tests

The results of the Standard Penetration Tests carried out in the natural soils are shown on the exploratory hole records in Appendix A. SPT 'N' values range between 11 and 31 with a general increase in depth apparent.

4.2 Mackintosh Probe / Hand Vane Tests

Mackintosh Probe tests were made at regular depth increments in order to assess the relative density of the soils encountered in Boreholes 2 and 3. The results can be interpreted using the generally accepted correlation for Mackintosh Probe Tests which is as follows:

Mackintosh N75 X 0.38 = SPT 'N' Value

or

Mackintosh N300 X 0.1 = SPT 'N' Value

The results of the in-situ tests are shown on the appropriate exploratory hole records contained in Appendix A.

4.3 Undrained Triaxial Compression Test Results

Undrained Triaxial Compression tests was carried out on two undisturbed 100mm diameter samples taken from Borehole 1.

The results of the tests are presented on Table 1, contained in Appendix B.

4.4 Classification Tests

Atterberg Limit tests were conducted on three samples taken at depth in Boreholes 1, 2 and 3 and showed the samples tested to fall into Class CI according to the British Soil Classification System.

Particle size distribution tests were conducted on two selected samples taken from the natural essentially granular soils present in the borehole using wet sieving methods.

The test results are given in Table 2, contained in Appendix B.

4.5 Sulphate and pH Analyses

The results of the sulphate and pH analyses made on three soil samples are presented on Table 3 contained in Appendix B.

p.p. SITE ANALYTICAL SERVICES LIMITED

A P Smith BSc (Hons) FGS MCIWEM
Senior Geologist

5.0 REFERENCES

1. British Standards Institution, 1986. Code of practice for foundations, BS 8004, BSI, London.

2. British Standards Institution, 1990. Methods for test for soils for civil engineering purposes, BS1377, BSI, London

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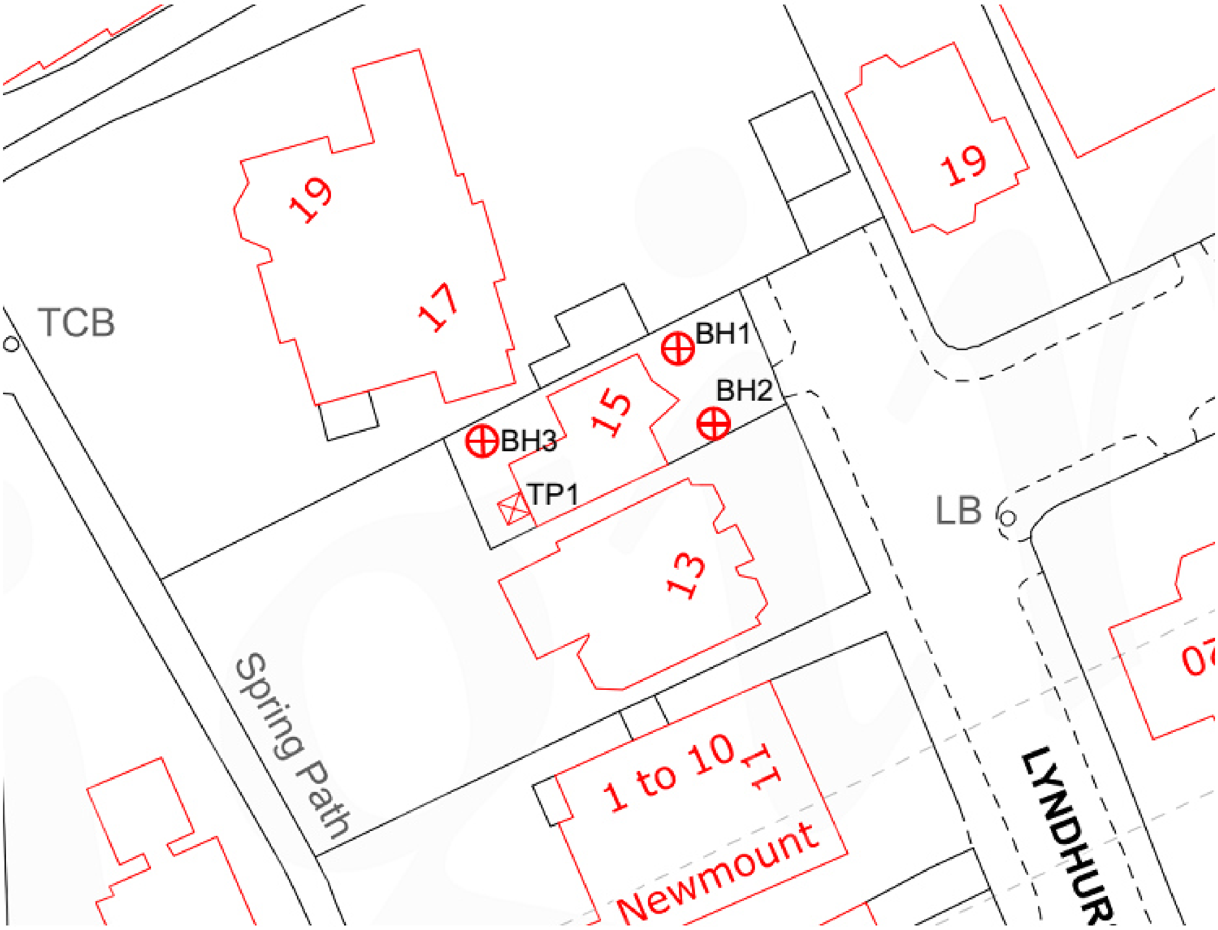
12. Tomlinson, M J, 2001. “Foundation Design and Construction”, Seventh Edition, Prentice Hall (ISBN 0-13-031180-4).

Site Analytical Services Ltd.		REF: 15/23908
LOCATION: 15 Lyndhurst Terrace, London, NW3 5QA		FIG: 1
TITLE: Site Sketch Plan	DATE: Nov' 2015	SCALE: NTS



A P P E N D I X `A'

Borehole / Trial Pit Logs

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH1

Boring Method	Casing Diameter	Ground Level (mSD)	Client	Job Number
ROTARY PERCUSSIVE	128mm cased to 0.00m	49.50	EMMANUEL AND CARMEN MOND	1523908
	Location	**Dates**	**Architect**	**Sheet**
	TQ266853	24/07/2015	RICHARD MITZMAN ARCHITECTS LLP	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mSD)	Depth (m) (Thickness)	Description	Legend	Water
					49.35	(0.15) 0.15	MADE GROUND: Pea gravel over a brick and hardcore rubble.		
0.25	D1					(0.25)			
					49.10	0.40	MADE GROUND: Silty sandy clay with occasional brick fragments.		
0.50	D2						Firm very silty very sandy CLAY with frequent laminations of yellow silty fine sand.		
0.75	D3								
1.00-1.45 1.00	SPT(C) N=11 D4		DRY	1,2/3,2,3,3					
1.75	D5								
2.00-2.45 2.00	SPT N=27 D6		DRY	3,6/7,6,7,7		(3.35)			
2.75	D7								
3.00-3.45 3.00	SPT N=25 D8		DRY	3,4/5,6,7,7					
3.75	D9				45.75	3.75	Medium dense slightly clayey silty fine SAND		
4.00-4.45 4.00	SPT N=17 D10		DRY	3,3/4,5,4,4					
4.75	D11					(2.15)			
5.00-5.45 5.00	SPT N=16 D12		DRY	3,3/4,4,4,4					
					43.60	5.90	Firm becoming stiff very silty very sandy CLAY with occasional laminations of yellow silty fine sand.		
6.00	D13								
6.50-6.95 6.50	SPT N=16 D14		DRY	2,3/3,4,4,5					
7.50	D15					(3.50)			
8.00-8.45 8.00	SPT N=16 D16		DRY	2,3/4,4,4,4					
9.00	D17								
					40.10	9.40	Stiff dark grey brown blue silty sandy CLAY with occasional partings of silty fine sand and occasional gypsum crystals.		
9.50-9.95	U1			100 blows		(0.60)			

Remarks
SPT = Standard Penetration Test
SPT(C) = Standard Penetration Test (Cone)
D = Disturbed sample
U = Undisturbed 100mm diameter sample
Excavating from 0.00m to 1.00m for 1 hour.

Scale (approx)	Logged By
1:50	TM

Figure No. 1523908.BH1

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH1

Boring Method	Casing Diameter	Ground Level (mSD)	Client	Job Number
ROTARY PERCUSSIVE	128mm cased to 0.00m	49.50	EMMANUEL AND CARMEN MOND	1523908
	Location	**Dates**	**Architect**	**Sheet**
	TQ266853	24/07/2015	RICHARD MITZMAN ARCHITECTS LLP	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mSD)	Depth (m) (Thickness)	Description	Legend	Water
					39.50	10.00	Stiff dark grey brown blue silty sandy CLAY with occasional partings of silty fine sand and occasional gypsum crystals.		
10.50	D18								
11.00-11.45 11.00	SPT N=27 D19		DRY	3,4/5,7,7,8					
12.00	D20								
12.50-12.95	U2			110 blows		(5.00)			
13.75	D21								
14.55-15.00 14.55	SPT N=31 D22		15.00	5,6/7,7,8,9					
				Very slight seepage(1) at 15.00m. 24/07/2015:15.00m	34.50	15.00	Complete at 15.00m		∇1

Remarks
SPT = Standard Penetration Test
SPT(C) = Standard Penetration Test (Cone)
D = Disturbed sample
U = Undisturbed 100mm diameter sample

Scale (approx)	Logged By
1:50	TM

Figure No. 1523908.BH1

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH2

Boring Method	Casing Diameter	Ground Level (mSD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m	49.60	EMMANUEL AND CARMEN MOND	1523908
	Location	**Dates**	**Architect**	**Sheet**
	TQ266853	24/07/2015	RICHARD MITZMAN ARCHITECTS LLP	1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mSD)	Depth (m) (Thickness)	Description
					49.55	0.05	MADE GROUND: Brick paving
0.25	D1					(0.65)	MADE GROUND: Brown silty sandy gravelly brown clay containing brick fragments. Gravel is fine to medium of subrounded to sub angular flint
0.50	D2						
0.75	D3				48.90	0.70	Soft becoming firm orange brown very silty very sandy CLAY with frequent laminations of yellow silty fine sand.
1.00 1.00-1.30	D4 M1 85/300						
1.50 1.50-1.80	D5 M2 82/300						
2.00 2.00-2.30	D6 M3 97/300						
2.50 2.50-2.80	D7 M4 91/300					(3.30)	
3.00 3.00-3.30	D8 M5 107/300						
3.50 3.50-3.80	D9 M6 120/300						
4.00 4.00-4.30	D10 M7 131/300				45.60	4.00	Medium dense yellow brown slightly clayey silty fine SAND
4.50 4.50-4.80	D11 M8 149/300						
5.00 5.00-5.30	D12 M9 158/300					(2.50)	
6.00 6.00-6.30	D13 M10 164/300						
					43.10	6.50	Firm becoming stiff orange brown and grey very silty very sandy CLAY with occasional laminations of yellow silty fine sand.
7.00 7.00-7.30	D14 M11 173/300					(1.80)	
8.00 8.00-8.30	D15 M12 186/300			24/07/2015:DRY	41.30	8.30	Complete at 8.30m

Remarks
D = Disturbed sample
M = Mackintosh Probe - Blows/Penetration (mm)
Groundwater was not encountered during the excavation
Excavating from 0.00m to 1.00m for 1 hour.

Scale (approx)	Logged By
1:50	TM

Figure No. 1523908.BH1

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH3

Boring Method	Casing Diameter	Ground Level (mSD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m	50.50	EMMANUEL AND CARMEN MOND	1523908
	Location	**Dates**	**Architect**	**Sheet**
	TQ266853	24/07/2015	RICHARD MITZMAN ARCHITECTS LLP	1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mSD)	Depth (m) (Thickness)	Description	Legend	Water
					50.45	0.05	MADE GROUND: Pea gravel over concrete underlay		
0.25	D1						MADE GROUND: Brick rubble		
0.50	D2					(1.15)			
0.75	D3								
1.00 1.00-1.30	D4 M1 111/300				49.30	1.20	Soft orange brown very silty very sandy CLAY with frequent laminations of yellow silty fine sand.		
1.50 1.50-1.80	D5 M2 80/300								
2.00 2.00-2.30	D6 M3 85/300								
2.50 2.50-2.80	D7 M4 97/300					(2.80)			
3.00 3.00-3.30	D8 M5 106/300								
3.50 3.50-3.80	D9 M6 102/300								
4.00 4.00-4.30	D10 M7 125/300				46.50	4.00	Firm becoming stiff orange brown very silty very sandy orange brown CLAY with laminations of yellow silty fine sand.		
4.50 4.50-4.80	D11 M8 130/300								
5.00 5.00-5.30	D12 M9 140/300								
6.00 6.00-6.30	D13 M10 158/300					(4.30)			
7.00 7.00-7.30	D14 M11 162/300								
8.00 8.00-8.30	D15 M12 184/300			24/07/2015:DRY	42.20	8.30	Complete at 8.30m		

Remarks
D = Disturbed sample
M = Mackintosh Probe - Blows/Penetration (mm)
Groundwater was not encountered during the excavation
Excavating from 0.00m to 1.00m for 1 hour.

Scale (approx)	Logged By
1:50	TM

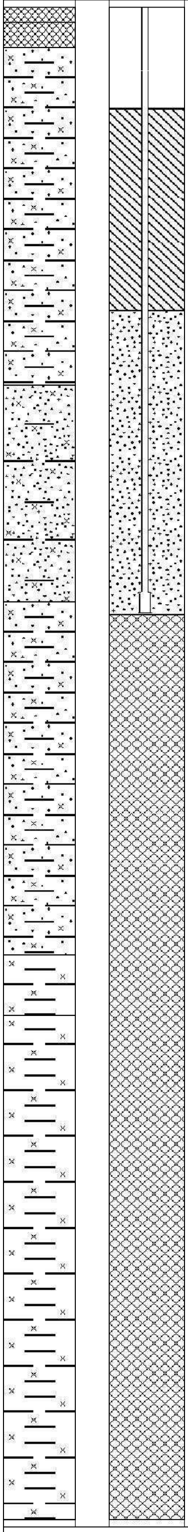
Figure No. 1523908.BH3

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH1

Installation Type	Dimensions	Client	Job Number
Single Installation	Internal Diameter of Tube [A] = 19 mm Diameter of Filter Zone = 128 mm	EMMANUEL AND CARMEN MOND	1523908

Location	Ground Level (mSD)	Architect	Sheet
TQ266853	49.50	RICHARD MITZMAN ARCHITECTS LLP	1/1



Legend	Water	Instr (A)	Level (mSD)	Depth (m)	Description
					Bentonite Seal
			48.50	1.00	
					Cement/Bentonite Grout
			46.50	3.00	
					Sand Filter
			43.70	5.80	
			43.50	6.00	Piezometer Tip
					General Backfill
			34.50	15.00	

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)
24/07/15		15.00	0.00	Very slight seepage					

Groundwater Observations During Drilling

Date	Start of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	End of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
24/07/15				DRY			15.00		15.00	34.50

Instrument Groundwater Observations

Inst. [A] Type : Standpipe Piezometer

Date	Instrument [A] Time	Depth (m)	Level (mOD)	Remarks

Remarks
Lockable cover set in concrete.

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH2

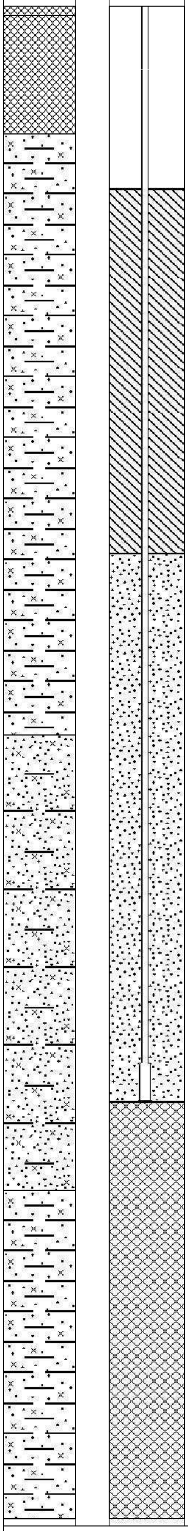
Installation Type
Single Installation

Dimensions
Internal Diameter of Tube [A] = 19 mm
Diameter of Filter Zone = 128 mm

Client	Job Number
EMMANUEL AND CARMEN MOND	1523908

Location	Ground Level (mSD)	Architect	Sheet
TQ266853	49.60	RICHARD MITZMAN ARCHITECTS LLP	1/1

Legend | Water | Instr (A)



Level (mSD)	Depth (m)	Description
		Bentonite Seal
48.60	1.00	
		Cement/Bentonite Grout
46.60	3.00	
		Sand Filter
43.80	5.80	
43.60	6.00	Piezometer Tip

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)

Groundwater Observations During Drilling

Date	Start of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	End of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
24/07/15				DRY			8.30		DRY	

Instrument Groundwater Observations

Inst. [A] Type : Standpipe Piezometer

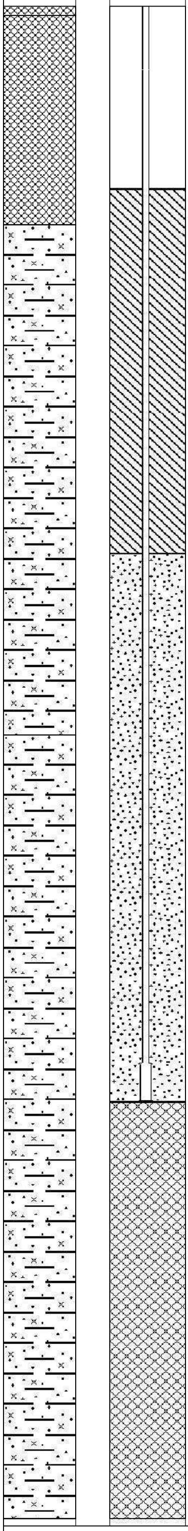
Date	Instrument [A] Time	Depth (m)	Level (mOD)	Remarks

Remarks
Lockable cover set in concrete.

Site Analytical Services Ltd.

Site	Borehole Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	BH3

Installation Type	Dimensions		Client	Job Number
Single Installation	Internal Diameter of Tube [A] = 19 mm Diameter of Filter Zone = 128 mm		EMMANUEL AND CARMEN MOND	1523908
	Location	**Ground Level (mSD)**	**Architect**	**Sheet**
	TQ266853	50.50	RICHARD MITZMAN ARCHITECTS LLP	1/1



Level (mSD)	Depth (m)	Description
		Bentonite Seal
49.50	1.00	
		Cement/Bentonite Grout
47.50	3.00	
		Sand Filter
44.70	5.80	
44.50	6.00	Piezometer Tip

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)

Groundwater Observations During Drilling

Date	Start of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	End of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
24/07/15				DRY			8.30		DRY	

Instrument Groundwater Observations

Inst. [A] Type : Standpipe Piezometer

Date	Instrument [A] Time	Depth (m)	Level (mOD)	Remarks

Remarks

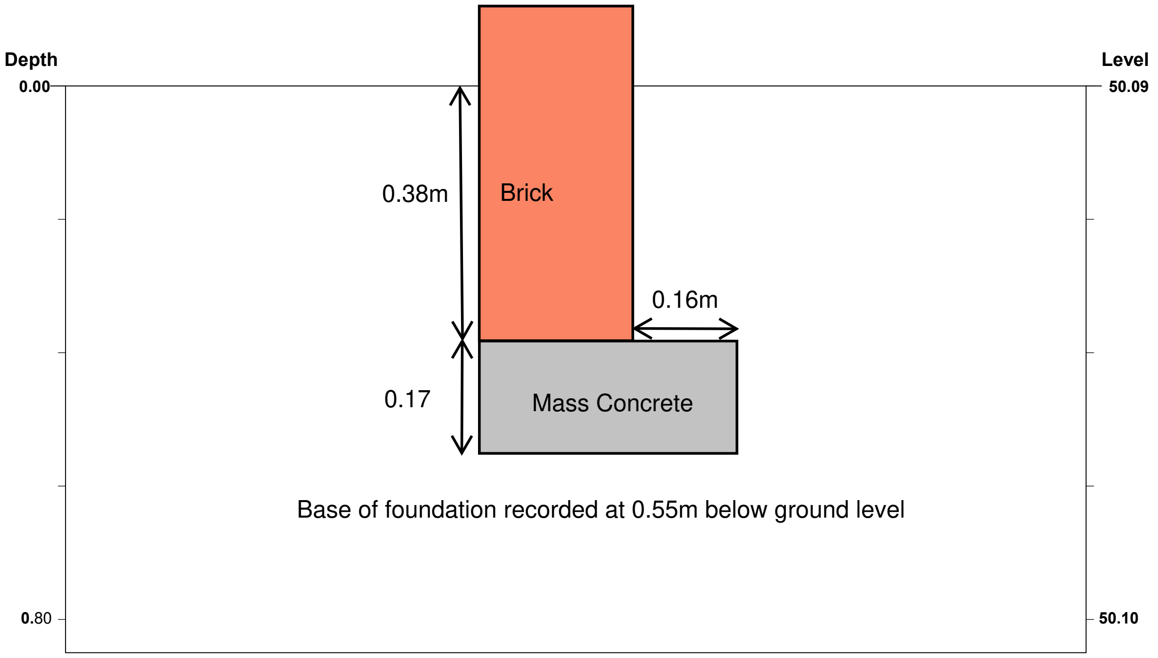
Lockable cover set in concrete.

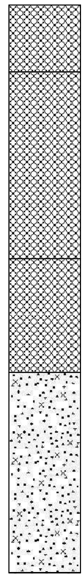
Site Analytical Services Ltd.

Site	Trial Pit Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	TP1

Method	Dimensions	Ground Level (mSD)	Client	Job Number
Trial Pit	300 x 300	50.09	EMMANUEL AND CARMEN MOND	1523908

Orientation	Location	Dates	Architect	Sheet
A / B / C / D	TQ 266 853	24/07/2015	RICHARD MITZMAN ARCHITECTS LLP	1/1





Strata

Depth (m)	No.	Description
0.00-0.10	1	MADE GROUND : Pea gravel over brick paving underlay
0.10-0.38	2	MADE GROUND : Soft silty very sandy clay
0.38-0.55	3	MADE GROUND : Loose silty fine sand with occasional brick fragments
0.55-0.85	4	Loose yellow brown silty fine sand

Samples and Tests

Depth (m)	Type	Field Records
0.25	D1	
0.55	D2	
0.55-0.85	M1 45/300	

Excavation Method:
HAND EXCAVATION

Shoring / Support:
N/A

Stability:
Good

Backfill:
Arisings

Remarks
Groundwater was not encountered during the excavation
M = Mackintosh Prove - Blows/Penetration (mm)
For details of foundation exposed - see sketch

Logged By	: APS
Checked By	: JW
Figure No.	: 1523908.TP1

Site Analytical Services Ltd.

Site	Trial Pit Number
15 LYNDHURST TERRACE, LONDON, NW3 5QA	TP1

Excavation Method	Dimensions	Ground Level (mSD)	Client	Job Number
HAND EXCAVATION	300 x 300	50.09	EMMANUEL AND CARMEN MOND	1523908
	Location	**Dates**	**Architect**	**Sheet**
	TQ 266 853	24/07/2015	RICHARD MITZMAN ARCHITECTS LLP	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mSD)	Depth (m) (Thickness)	Description	Legend	Water
				49.99	0.10	MADE GROUND : Pea gravel over brick paving underlay		
0.25	D1				(0.28)			
				49.71	0.38	MADE GROUND : Soft silty very sandy clay		
					(0.17)			
0.55	D2			49.54	0.55	MADE GROUND : Loose silty fine sand with occasional brick fragments		
0.55-0.85	M1 45/300				(0.30)			
			24/07/2015:DRY	49.24	0.85	Loose yellow brown silty fine sand		
						Complete at 0.85m		

Plan

Remarks

Groundwater was not encountered during the excavation
M = Mackintosh Prove - Blows/Penetration (mm)
For details of foundation exposed - see sketch

Scale (approx)	Logged By	Figure No.
1:50	APS	1523908.TP1

A P P E N D I X `B'

Laboratory Test Data

Ref: 15/23908

UNDRAINED TRIAXIAL COMPRESSION TEST

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

BH/TP No.	MOISTURE CONTENT %	BULK DENSITY Mg/m^3	LATERAL PRESSURE kN/m^2	COMPRESSIVE STRENGTH kN/m^2	COHESION kN/m^2	ANGLE OF SHEARING RESISTANCE degrees	DEPTH m
BH1	23	2.04	250	196	98		9.75
	24	2.01	190	298	149		12.75

Ref: 15/23908

PLASTICITY INDEX & MOISTURE CONTENT DETERMINATIONS

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

BH/TP No.	Depth m	Natural Moisture %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Passing 425 μm %	Class
BH1	1.75	21	39	18	21	100	CI
BH2	3.00	19	41	16	25	100	CI
	4.00	19	39	15	24	97	CI

Ref: 15/23908

SULPHATE & pH DETERMINATIONS

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

BH/TP No.	DEPTH BELOW GL m	SOIL SULPHATES AS SO_4 TOTAL %	SOIL SULPHATES AS SO_4 WATER SOL g/l	WATER SULPHATES AS SO_4 g/l	pH	CLASS	SOIL - 2mm %
BH1	6.00		0.04		5.4	DS-1	100
BH2	2.00		0.02		4.1	DS-1	100
BH3	8.00		0.03		4.9	DS-1	100

Classification – Tables C1 and C2 : BRE Special Digest 1 : 2005

Ref: 15/23908

GROUNDWATER MONITORING

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

MONITORING DATE 30th July 2015

BOREHOLE REF:		**BH1**	**BH2**	**BH3**
Water Level	(m.bgl)	DRY	DRY	DRY
Depth to base of well	(m.bgl)	6.10	6.19	6.01
Depth to base of well	(mSD)	43.4	43.41	44.49

Table 4

Ref: 15/23908

GROUNDWATER MONITORING

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

MONITORING DATE 21st August 2015

BOREHOLE REF:		**BH1**	**BH2**	**BH3**
Water Level	(m.bgl)	DRY	DRY	DRY
Depth to base of well	(m.bgl)	6.10	6.19	6.01
Depth to base of well	(mSD)	43.4	43.41	44.49

Table 4a

Ref: 15/23908

GROUNDWATER MONITORING

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

MONITORING DATE 28th September 2015

BOREHOLE REF:		**BH1**	**BH2**	**BH3**
Water Level	(m.bgl)	DRY	DRY	DRY
Depth to base of well	(m.bgl)	6.10	6.19	6.01
Depth to base of well	(mSD)	43.4	43.41	44.49

Table 4b

Ref: 15/23908

GROUNDWATER MONITORING

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

MONITORING DATE 12th December 2016

BOREHOLE REF:		**BH1**	**BH2**	**BH3**
Water Level	(m.bgl)	DRY	DRY	DRY
Depth to base of well	(m.bgl)	6.10	6.19	6.01
Depth to base of well	(mSD)	43.40	43.41	44.49

Table 4c

GROUNDWATER MONITORING

LOCATION 15 Lyndhurst Terrace, Hampstead, London, NW3 5QA

MONITORING DATE 22nd February 2017

BOREHOLE REF:		**BH1**	**BH2**	**BH3**
Water Level	(m.bgl)	DRY	DRY	DRY
Depth to base of well	(m.bgl)	6.10	6.19	6.01
Depth to base of well	(mSD)	43.40	43.41	44.49

Table 4d

Appendix D – Structural Engineer Loads

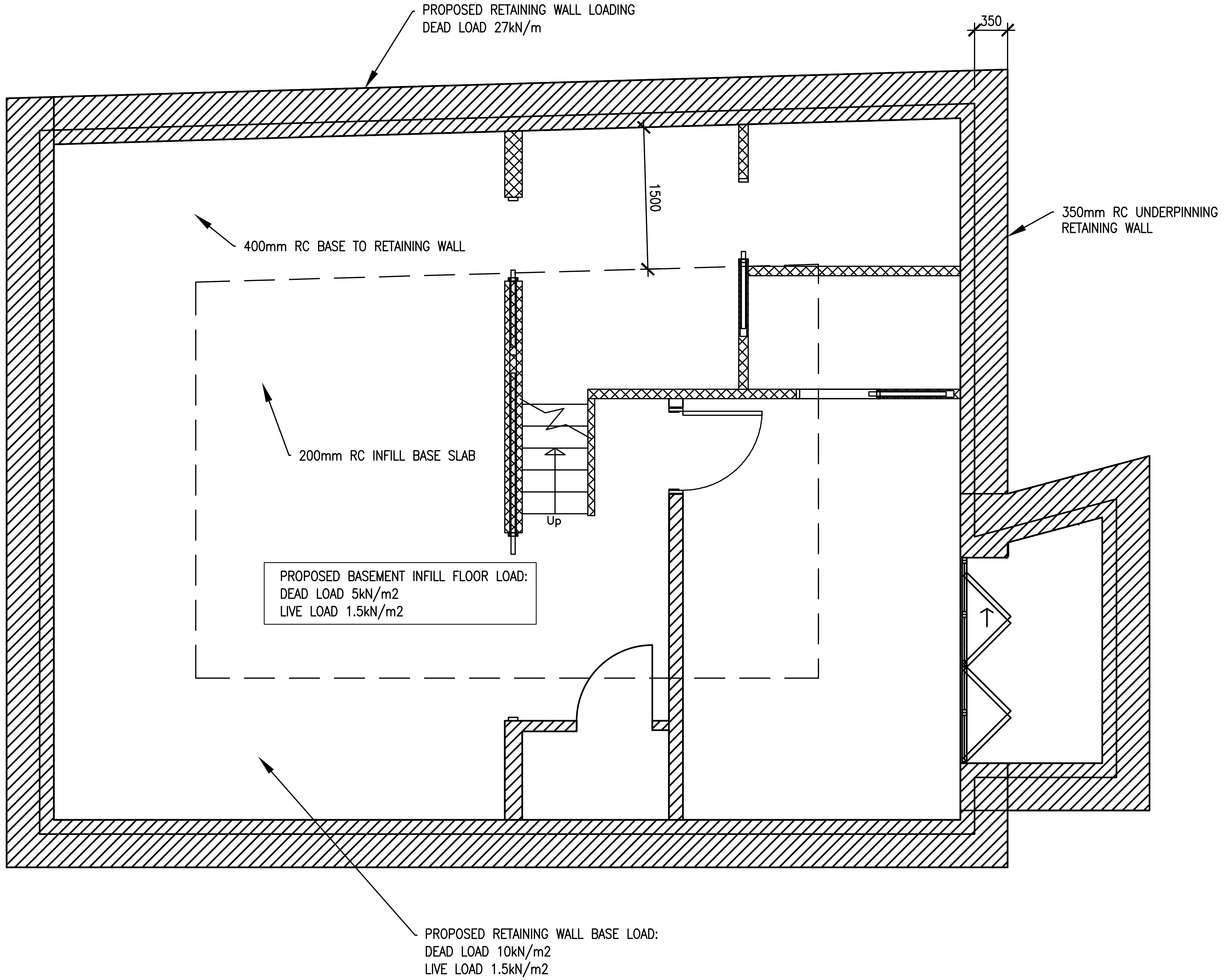
STRUCTURAL MEMBER SCHEDULE	
REF.	MEMBER SIZE
	BEAMS
B1	250x50 TIMBER JOIST @ 400mm c.c.
B2	254x254x73 UC
B3	305x305x97 UC
B1	250x50 TIMBER JOIST @ 400mm c.c.
	COLUMNS
C1	xx

NOTES:

1. All timbers to be C16 unless noted otherwise.
2. Non–loadbearing stud partitions to be constructed with 100mm x 50mm studs at 400mm centres.
3. Provide 2 rows of noggings on all stud partitions.
4. Ensure legs of hangers turned over back of wall plate before fixing.
5. Use 30x5x1200 straps at 1500 c/c to all roof timbers and roof joists.
6. Timber beams to be bolted together as required with M10 bolts @ min 600 c/c.
7. All concrete to be grade C35N20 UNO.
8. All steel to be grade S275 UNO.

LEGEND

- EXISTING WALL
- EXISTING STRUCTURAL WALL UNDER
- EXISTING WALL TO BE DEMOLISHED
- NEW STRUCTURAL WALL
- NEW STUD PARTITIONS



CONCEPT CONSULTANCY STRUCTURAL DESIGNERS LTD
3 Knoll House, 77 Carlton Hill ~ London, NW8 9XD ~
Tel: 020 76256106; Mob: 07955 919824; ~ e-mail: info@conceptconsultancy.eu

Client: Carmel & Emanuel Mond

Project: 15 Lyndhurst Terrace LONDON, NW3 5QA

Title: Proposed Basement Floor Plan

Revision	Date	Made by	Amendments
A	xx/xx/2020	GW.	xxxxx

Date	Drawn by	Checked	
20-01-2021	GW	CG	
Scales	Job No.	Drawing No.	Revision
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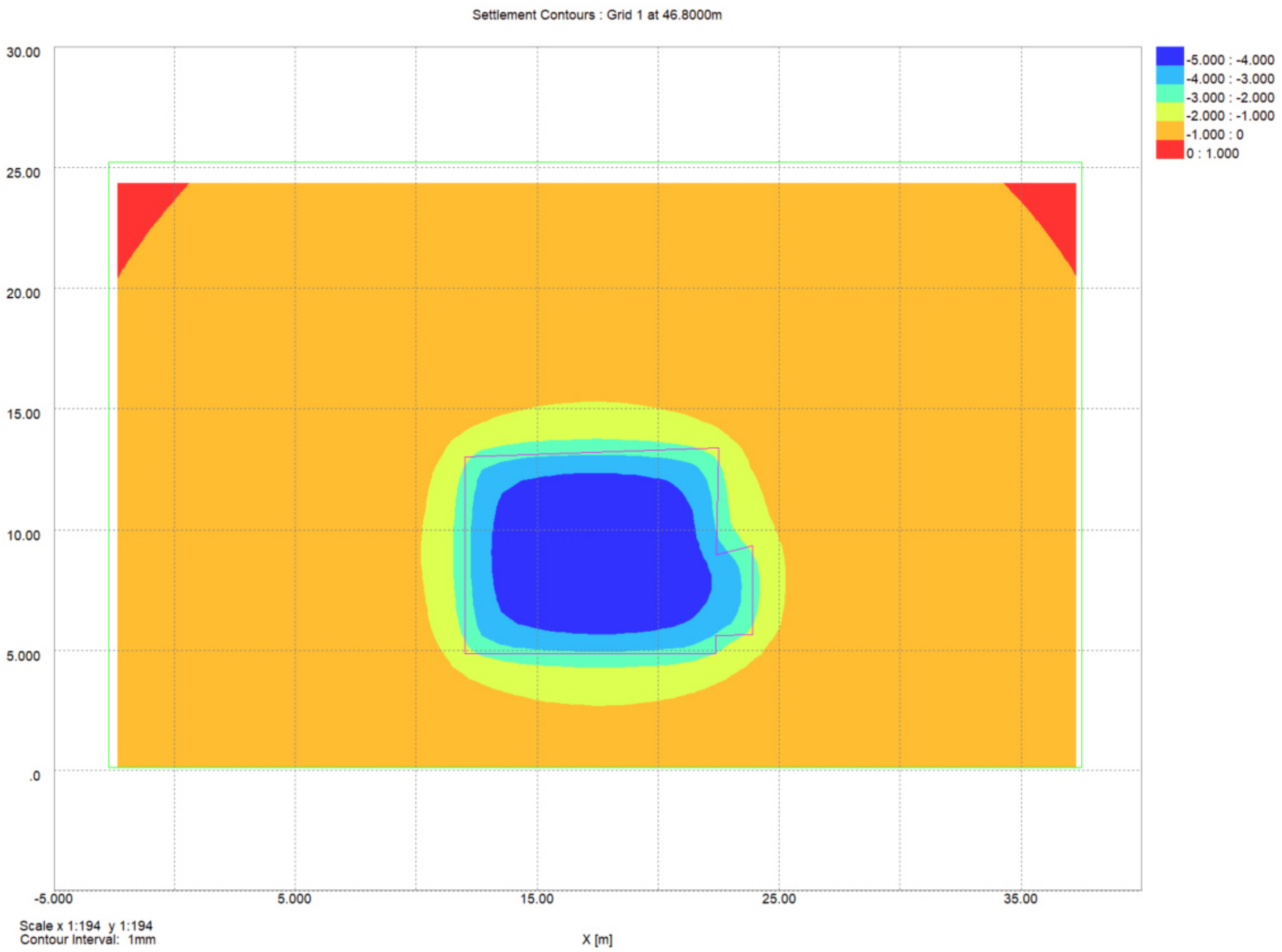
Appendix E – PDISP Plans

Appendix E – PDISP Plots

Load Case 1. Excavation unloading, short term (undrained)



Titles

Job No.: 078070
Job Title: 15 Lyndhurst
Sub-title: Ground Movement Assessment
Calculation Heading: Excavation - Undrained
Initials: APS
Checker:
Date Saved:
Date Checked:
Notes:
File Name: PDisp1.pdd
File Path: \\LOFS03\Projects\078000.000 - 078999.000\078070 - 15 Lyndhurst Terrace, NW3\Q4-Production\4B-Documentation\GE\PDISP

History

Date	Time	By	Notes
18-Jan-2021	16:31	Andrew.Smith	New
18-Jan-2021	17:10	Andrew.Smith	
18-Jan-2021	17:20	Andrew.Smith	
21-Jan-2021	13:36	Andrew.Smith	
27-Jan-2021	11:43	Andrew.Smith	Open

Analysis Options

General

Global Poisson's ratio: 0.20
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: 19.10 [m OD]
Displacements at load centroids: Yes
GSA piled raft data : No

Elastic

Elastic : Yes
Analysis: Boussinesq
Stiffness for horizontal displacement calculations: Weighted average
Using legacy heave correction factor: No

Consolidation

Consolidation : No

Soil ProfilesSoil Profile 1

Layer ref.	Name	Level at top	Number of intermediate displacement levels	Youngs Modulus : Top	Youngs Modulus : Btm.	Poissons ratio	Non-linear curve
		[mOD]		[kN/m²]	[kN/m²]		
1	Made Ground	50.000	10	5000.0	5000.0	0.45000	None
2	Claygate / London Clay Fm	49.100	10	35000.	257000.	0.50000	None

Soil Zones

Zone	Name	X min [m]	X max [m]	Y min [m]	Y max [m]	Profile
1	Soil Zone #	-2.7269	37.509	0.10694	25.211	Soil Profile 1

Polygonal Load Data

Load ref.	Name	Position : Level [m]	Position : Polygon : Coords. [m]	Position : Polygon : Rect. tolerance [%]	No. of Rectangles	Value : Normal (local z) [kN/m²]
1	Poly Load #	46.80000	(12,13) (22.5,13.4) (22.4,8.95) (23.9,9.31) (23.9,5.65) (22.4,5.62) (22.4,4.86) (12,4.86)	10.000	3	-60.400

Polygonal Loads' Rectangles

No.	Centre : x [m]	Centre : y [m]	Angle of local x from global X [Degrees]	Width x [m]	Depth y [m]
Load 1 : Poly Load #					
(Edge 2 optimal)					
1	17.19567	9.02098	0.0	10.323	8.3177
2	23.15570	7.38250	0.0	1.5114	3.5001
3	22.44991	12.26847	0.0	0.099809	2.2082

Displacement Grids

Name	Extrusion: Direction	X1 [m]	Y1 [m]	Z1 [m]	X2 [m]	Y2 [m]	Z2 [m]	Intervals Along Line [No.]	Extrusion: Distance [m]	Extrusion: Intervals Along [No.]	Calculate	Detailed Results
Grid 1	Global Y	-2.35264	0.18714	46.80000	37.26798	-	46.80000	50	24.64927	50	Yes	No

Results : Immediate : Load Centres : Polygonal

Ref.	Name	x [m]	y [m]	z [mOD]	δz [mm]	Stress: Calc. Level [mOD]	Stress: Vertical [kN/m²]	Stress: Sum Princ. [kN/m²]	Vert. Strain [µ]
1	Poly Load #	17.60110	8.93755	46.80000	-4.94048	45.593	-59.653	-112.18	-551.75E-6

Results : Consolidation : Load Centres : Polygonal

None

Results : Total : Load Centres : Polygonal

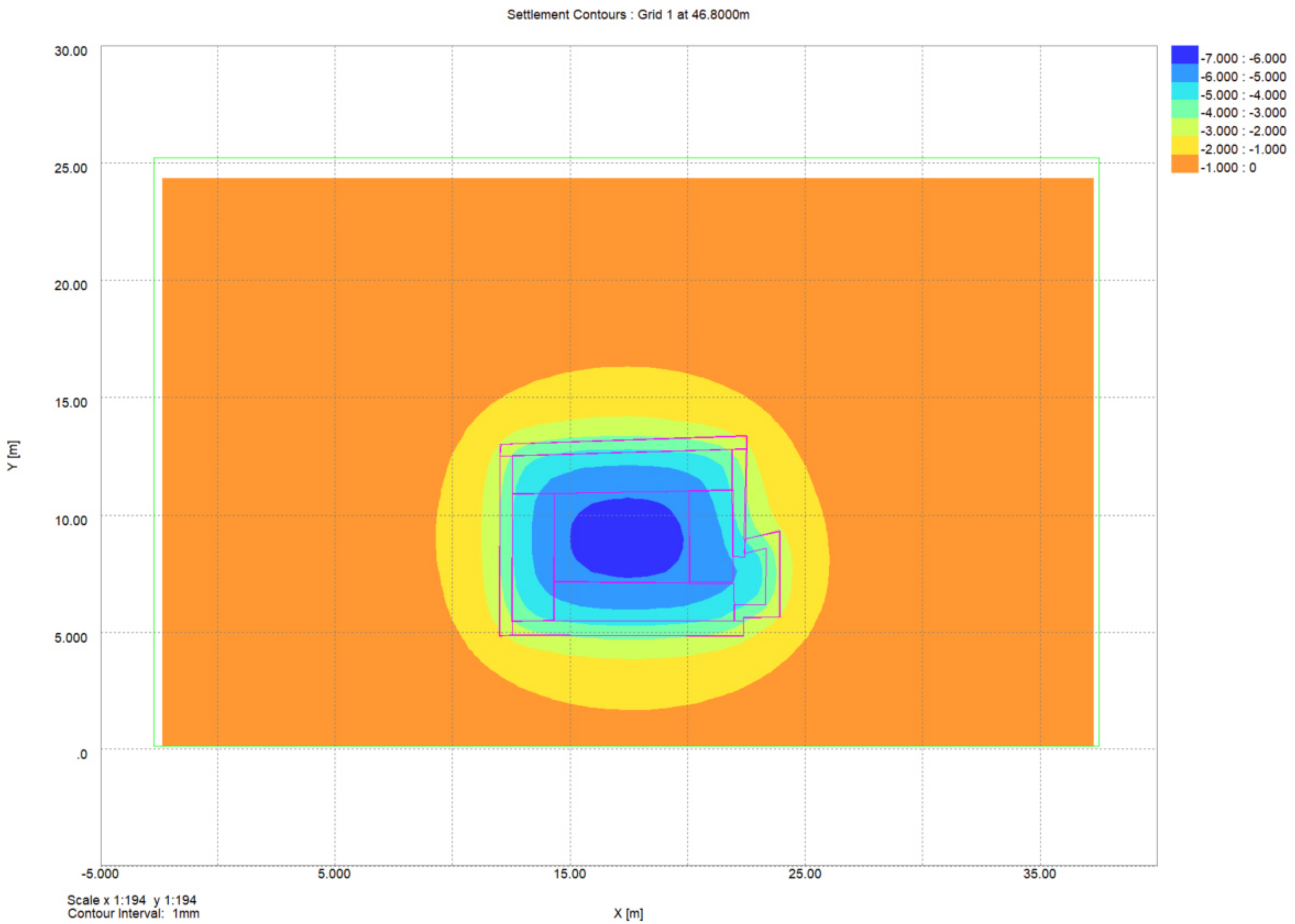
None

Results : Immediate : Displacement Data : Grids

Ref.	Name	x [m]	y [m]	z [mOD]	δz [mm]	Stress: Calc. Level [mOD]	Stress: Vertical [kN/m²]	Stress: Sum Princ. [kN/m²]	Vert. Strain [µ]
1	Grid 1	-2.35264	0.18714	46.80000	-0.00644	45.593	-0.0012371	-0.27222	2.2186E-6
1	Grid 1	-2.35264	0.68013	46.80000	-0.00769	45.593	-0.0013026	-0.28041	2.2847E-6
1	Grid 1	-2.35264	1.17311	46.80000	-0.00893	45.593	-0.0013688	-0.28852	2.3500E-6
1	Grid 1	-2.35264	1.66610	46.80000	-0.01016	45.593	-0.0014353	-0.29650	2.4143E-6
1	Grid 1	-2.35264	2.15908	46.80000	-0.01137	45.593	-0.0015016	-0.30429	2.4771E-6
1	Grid 1	-2.35264	2.65207	46.80000	-0.01254	45.593	-0.0015671	-0.31186	2.5380E-6

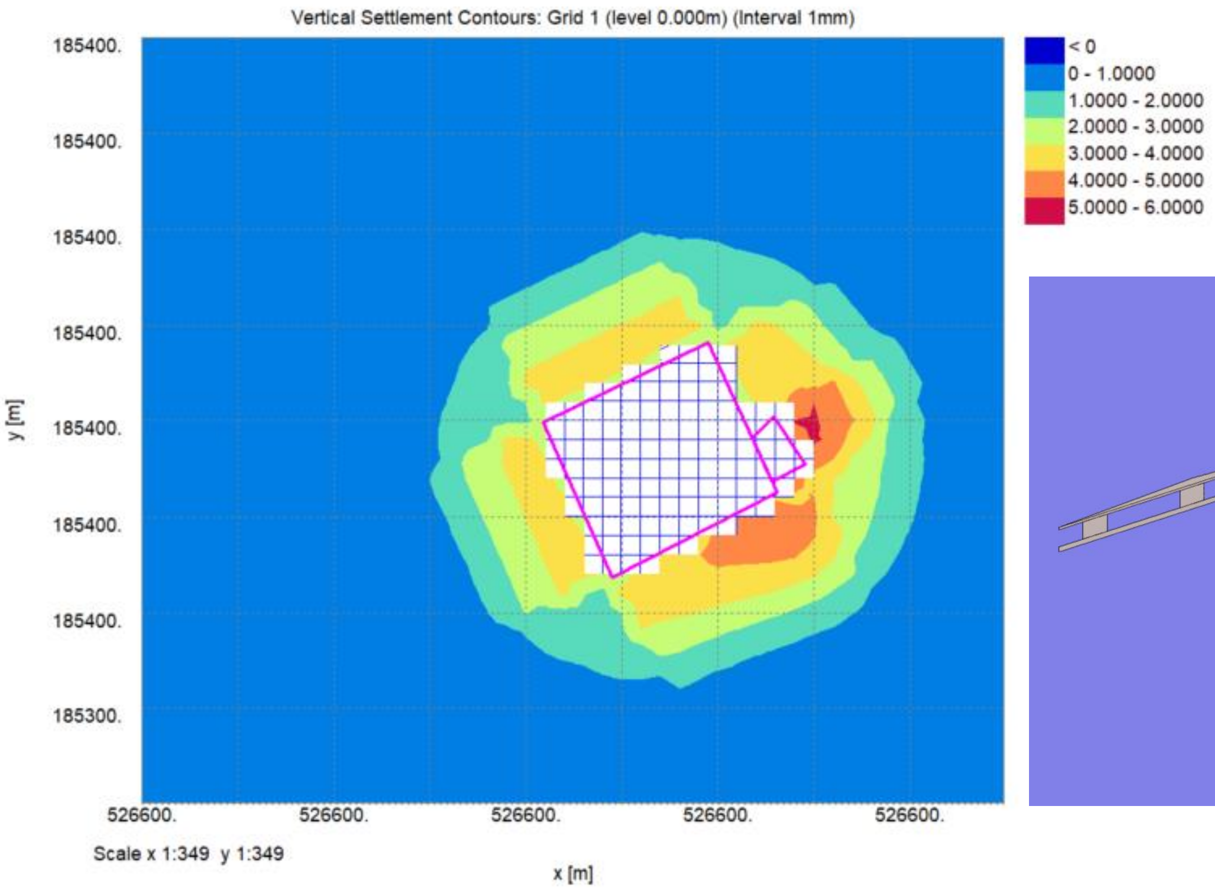
Appendix E – PDISP Plots

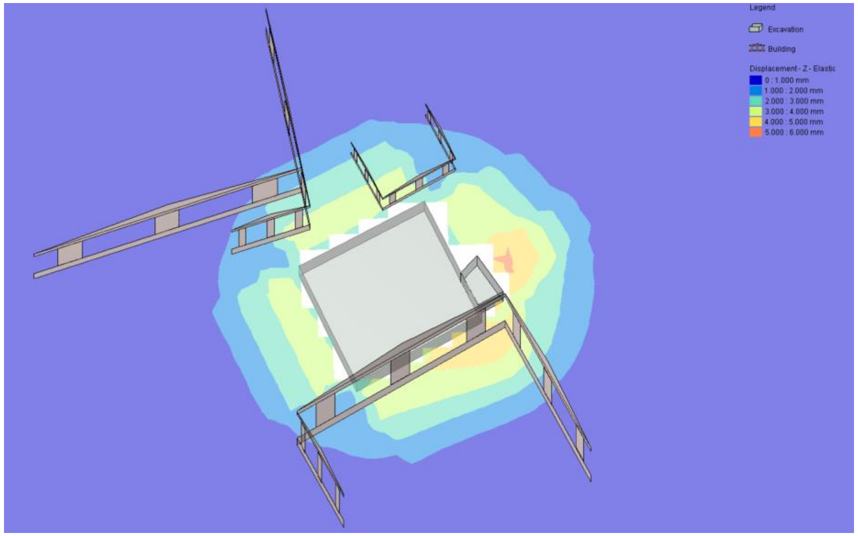
Load Case 2. Loading, Long Term (drained)



Appendix F – XDISP Plans

Appendix F – XDISP Plots





Titles

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Sub-title:	Damage Assessment	
Calculation Heading:		
Initials:	APS	
Checker:	DH	
Date Saved:	25-Jan-2021	
Date Checked:	25 Jan 2021	
Notes:		
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History

Date	Time	By	Notes
06-Jan-2021	16:03	Andrew.Smith	New
06-Jan-2021	17:09	Andrew.Smith	
07-Jan-2021	11:24	Andrew.Smith	
07-Jan-2021	17:25	Andrew.Smith	
18-Jan-2021	14:40	Andrew.Smith	
18-Jan-2021	16:31	Andrew.Smith	
25-Jan-2021	12:00	Andrew.Smith	
27-Jan-2021	11:14	Andrew.Smith	Open

Displacement Lines

Ref.	Name	x1 [m]	y1 [m]	z1 [m]	x2 [m]	y2 [m]	z2 [m]	Intervals [No.]	Calculate	Surface type for tunnels
1	No. 13 Front Wall	526624.61360	185355.23240	0.00000	526630.04500	185344.40080	0.00000	8	Surface	Yes
2	No. 13 Side Wall	526624.61360	185355.23240	0.00000	526610.37530	185347.64120	0.00000	10	Surface	Yes
3	No. 13 Rear Wall	526610.37530	185347.64120	0.00000	526613.27940	185341.82750	0.00000	10	Surface	Yes
4	No. 17 Front Wall	526611.71730	185362.40070	0.00000	526609.22300	185376.02940	0.00000	10	Surface	Yes
5	No. 17 Side Wall	526611.24000	185364.99500	0.00000	526593.02580	185359.67530	0.00000	10	Surface	Yes
6	No. 17 Minor Side Wall	526611.71730	185362.40070	0.00000	526606.39000	185360.88310	0.00000	4	Surface	Yes
7	Garage Front	526619.78680	185369.88570	0.00000	526621.65090	185366.10390	0.00000	2	Surface	Yes
8	Garage Side	526621.65090	185366.10390	0.00000	526616.65580	185363.53730	0.00000	2	Surface	Yes
9	Garage Rear	526616.65580	185363.53730	0.00000	526614.65580	185367.45380	0.00000	2	Surface	Yes

Displacement Grids

Ref.	Name	Extrusion: Direction	Base line start: X [m]	Base line start: Y [m]	Base line start: Z(level) [m]	Base line end: X [m]	Base line end: Y [m]	Base line end: Z(level) [m]	Base line: Intervals [No.]	Extrusion: Distance [m]	Extrusion: Intervals [No.]	Surface type for tunnels	Calculate
1	Grid 1	Global X	526550.00000	185300.00000	0.00000	-	185400.00000	0.00000	100	100.00000	100	Surface	Yes

Polygonal Excavations

Ref.	**1**
Excavation Name:	**Main Basement - Excavation**
Surface level [m]:	0.0
Contribution:	Positive

Corner	x [m]	y [m]	Base Level [m]	Arc Enabled	Stiffened	Prev. Side: d [m]	Prev. Side: p1 [%]	Prev. Side: p2* [%]	Next Side: d [m]	Next Side: p1 [%]	Next Side: p2* [%]
1	526620.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
2	526610.	185350.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
3	526610.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
4	526620.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal
1	526620.	185360.	526610.	185350.	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(a))
2	526610.	185350.	526610.	185360.	Exc. in front of high stiffness wall in stiff clay (CIRIA C580 Fig. 2.11(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C580 Fig. 2.11(a))
3	526610.	185360.	526620.	185360.	Exc. in front of high stiffness wall in stiff clay (CIRIA C580 Fig. 2.11(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C580 Fig. 2.11(a))
4	526620.	185360.	526620.	185360.	Exc. in front of high stiffness wall in stiff clay (CIRIA C580 Fig. 2.11(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C580 Fig. 2.11(a))

Ref.	**2**
Excavation Name:	**Lightwell - Excavation**
Surface level [m]:	0.0
Contribution:	Positive

Corner	x [m]	y [m]	Base Level [m]	Arc Enabled	Stiffened	Prev. Side: d [m]	Prev. Side: p1 [%]	Prev. Side: p2* [%]	Next Side: d [m]	Next Side: p1 [%]	Next Side: p2* [%]
1	526620.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
2	526620.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
3	526620.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
4	526620.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal
1	526620.	185360.	526620.	185360.	Exc. in front of high stiffness wall in stiff clay (CIRIA C580 Fig. 2.11(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C580 Fig. 2.11(a))
2	526620.	185360.	526620.	185360.	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(a))
3	526620.	185360.	526620.	185360.	Exc. in front of high stiffness wall in stiff clay (CIRIA C580 Fig. 2.11(b))	Exc. in front of high stiffness wall in stiff clay (CIRIA C580 Fig. 2.11(a))
4	526620.	185360.	526620.	185360.	No vertical ground movement	No horizontal ground movement

Ref.	**3**
Excavation Name:	**Main Basement - Piling**
Surface level [m]:	0.0
Contribution:	Positive

Corner	x	y	Base Level	Arc Enabled	Stiffened	Prev. Side: d	Prev. Side: p1	Prev. Side: p2*	Next Side: d	Next Side: p1	Next Side: p2*

	[m]	[m]	[m]			[m]	[%]	[%]	[m]	[%]	[%]
1	526620.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
2	526610.	185350.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
3	526610.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
4	526620.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal
1	526620.	185360.	526610.	185350.	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(b))	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(a))
2	526610.	185350.	526610.	185360.	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(b))	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(a))
3	526610.	185360.	526620.	185360.	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(b))	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(a))
4	526620.	185360.	526620.	185360.	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(b))	Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(a))

Ref.	**4**
Excavation Name:	**Lightwell - Piling**
Surface level [m]:	0.0
Contribution:	Positive

Corner	x [m]	y [m]	Base Level [m]	Arc Enabled	Stiffened	Prev. Side: d [m]	Prev. Side: p1 [%]	Prev. Side: p2* [%]	Next Side: d [m]	Next Side: p1 [%]	Next Side: p2* [%]
1	526620.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
2	526620.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
3	526620.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000
4	526620.	185360.	-3.2000	Yes	Yes	0.0	67.000	25.000	0.0	67.000	25.000

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal
1	526620.	185360.	526620.	185360.	No vertical ground movement	No horizontal ground movement
2	526620.	185360.	526620.	185360.	No vertical ground movement	No horizontal ground movement
3	526620.	185360.	526620.	185360.	No vertical ground movement	No horizontal ground movement
4	526620.	185360.	526620.	185360.	No vertical ground movement	No horizontal ground movement

Circular Excavations

Vertical Ground Movement Curves

Curve Name:	**No vertical ground movement**
Coordinates:	[Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z)(%)] [0.000,0.000,0.000][1.000,0.000,0.000][0.000,1.000,0.000][1.000,1.000,0.000]
Curve Fitting Method:	Polynomial
x Order:	1
y Order:	0
Polynomial: z =	0.0x + 0.0
Coeff. of Determination:	

Curve Name:	**Exc. in front of high stiffness wall in stiff clay (CIRIA C580 Fig. 2.11(b))**
Coordinates:	[Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z)(%)] [0.000,0.000,0.039][0.100,0.000,0.049][0.200,0.000,0.056][0.300,0.000,0.062] [0.400,0.000,0.067][0.500,0.000,0.070][0.600,0.000,0.072][0.700,0.000,0.073] [0.800,0.000,0.073][0.900,0.000,0.072][1.000,0.000,0.070][1.100,0.000,0.068] [1.200,0.000,0.065][1.300,0.000,0.061][1.400,0.000,0.058][1.500,0.000,0.054] [1.600,0.000,0.050][1.700,0.000,0.046][1.800,0.000,0.042][1.900,0.000,0.038] [2.000,0.000,0.034][2.100,0.000,0.030][2.200,0.000,0.027][2.300,0.000,0.023] [2.400,0.000,0.020][2.500,0.000,0.017][2.600,0.000,0.014][2.700,0.000,0.012] [2.800,0.000,0.010][2.900,0.000,0.008][3.000,0.000,0.007][3.100,0.000,0.005] [3.200,0.000,0.004][3.300,0.000,0.004][3.400,0.000,0.003][3.500,0.000,0.002] [3.600,0.000,0.002][3.700,0.000,0.002][3.800,0.000,0.001][3.900,0.000,0.001] [4.000,0.000,0.000]
Curve Fitting Method:	Polynomial
x Order:	4
y Order:	0
Polynomial: z =	$-2.6455\text{E-}3x^4 + 2.8495\text{E-}2x^3 - 1.0051\text{E-}1x^2 + 1.0569\text{E-}1x + 3.8990\text{E-}2$
Coeff. of Determination:	9.9991E-1

Curve Name:	**Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(b))**
Coordinates:	[Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z)(%)] [0.000,0.000,0.040][2.000,0.000,0.000]
Curve Fitting Method:	Polynomial
x Order:	1
y Order:	0
Polynomial: z =	-2.0E-2x + 4.0E-2
Coeff. of Determination:	1.0

Curve Name:	**Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(b))**
Coordinates:	[Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z)(%)] [0.000,0.000,0.039][0.100,0.000,0.049][0.200,0.000,0.056][0.300,0.000,0.062] [0.400,0.000,0.067][0.500,0.000,0.070][0.600,0.000,0.072][0.700,0.000,0.073] [0.800,0.000,0.073][0.900,0.000,0.072][1.000,0.000,0.070][1.100,0.000,0.068] [1.200,0.000,0.065][1.300,0.000,0.061][1.400,0.000,0.058][1.500,0.000,0.054] [1.600,0.000,0.050][1.700,0.000,0.046][1.800,0.000,0.042][1.900,0.000,0.038] [2.000,0.000,0.034][2.100,0.000,0.030][2.200,0.000,0.027][2.300,0.000,0.023] [2.400,0.000,0.020][2.500,0.000,0.017][2.600,0.000,0.014][2.700,0.000,0.012] [2.800,0.000,0.010][2.900,0.000,0.008][3.000,0.000,0.007][3.100,0.000,0.005] [3.200,0.000,0.004][3.300,0.000,0.004][3.400,0.000,0.003][3.500,0.000,0.002] [3.600,0.000,0.002][3.700,0.000,0.002][3.800,0.000,0.001][3.900,0.000,0.001] [4.000,0.000,0.000]
Curve Fitting Method:	Polynomial
x Order:	4
y Order:	0
Polynomial: z =	$-2.6455\text{E-}3x^4 + 2.8495\text{E-}2x^3 - 1.0051\text{E-}1x^2 + 1.0569\text{E-}1x + 3.8990\text{E-}2$
Coeff. of Determination:	9.9991E-1

Horizontal Ground Movement Curves

Curve Name:	**No horizontal ground movement**
Coordinates:	[Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z)(%)] [0.000,0.000,0.000][1.000,0.000,0.000][0.000,1.000,0.000][1.000,1.000,0.000]
Curve Fitting Method:	Polynomial
x Order:	0
y Order:	0
Polynomial: z =	0.0
Coeff. of Determination:	

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal

Curve Name: **Exc. in front of high stiffness wall in stiff clay (CIRIA C580 Fig. 2.11(a))**
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z)(%)]
[0.000,0.000,0.150][4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -3.75E-2x + 1.50E-1
Coeff. of Determination: 1.00

Curve Name: **Inst. of contiguous bored pile wall in stiff clay (CIRIA C760 Fig. 6.8(a))**
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z)(%)]
[0.000,0.000,0.041][0.050,0.000,0.038][0.100,0.000,0.036][0.150,0.000,0.034]
[0.200,0.000,0.032][0.250,0.000,0.030][0.300,0.000,0.029][0.350,0.000,0.027]
[0.400,0.000,0.025][0.450,0.000,0.023][0.500,0.000,0.022][0.550,0.000,0.020]
[0.600,0.000,0.019][0.650,0.000,0.018][0.700,0.000,0.016][0.750,0.000,0.015]
[0.800,0.000,0.014][0.850,0.000,0.013][0.900,0.000,0.011][0.950,0.000,0.010]
[1.000,0.000,0.009][1.050,0.000,0.008][1.100,0.000,0.007][1.150,0.000,0.006]
[1.200,0.000,0.005][1.250,0.000,0.004][1.300,0.000,0.004][1.350,0.000,0.003]
[1.400,0.000,0.002][1.450,0.000,0.001][1.500,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 3
y Order: 0
Polynomial: z = $-4.2486E{-}3x^3 + 1.9096E{-}2x^2 - 4.6221E{-}2x + 4.0729E{-}2$
Coeff. of Determination: 1.0000

Curve Name: **Exc. in front of high stiffness wall in stiff clay (CIRIA C760 Fig. 6.15(a))**
Coordinates: [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z)(%)]
[0.000,0.000,0.150][4.000,0.000,0.000]
Curve Fitting Method: Polynomial
x Order: 1
y Order: 0
Polynomial: z = -3.75E-2x + 1.50E-1
Coeff. of Determination: 1.00

Damage Category Strains

Ref.	Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
1	Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

Specific Buildings - Geometry

Ref.	Building Name	Sub-Building Name	Displacement Line	Distance Along Line: Start [m]	Distance Along Line: End [m]	Vertical Offsets from Line for Vertical Movement Calculations [m]	Vertical Displacement Limit Sensitivity [mm]	Damage Category Strains	Poisson's Ratio	E/G
1	No. 13 Front Wall	No. 13 Front Wall	No. 13 Front Wall	0.00000	12.11700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
2	No. 13 Side Wall	No. 13 Side Wall	No. 13 Side Wall	0.00000	16.13500	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
3	No. 13 Rear Wall	No. 13 Rear Wall	No. 13 Rear Wall	0.00000	6.49800	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
4	No. 17 Front Wall	No. 17 Front Wall	No. 17 Front Wall	0.00000	13.85500	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
5	No. 17 Side Wall	No. 17 Side Wall	No. 17 Side Wall	0.00000	18.97500	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
6	No. 17 Minor Side Wall	No. 17 Minor Side Wall	No. 17 Minor Side Wall	0.00000	5.53900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
7	No. 17-19 Garage Front	No. 17-19 Garage Front	Garage Front	0.00000	4.21600	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
8	No. 17-19 Garage Side	No. 17-19 Garage Side	Garage Side	0.00000	5.61500	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
9	No. 17-19 Garage Rear	No. 17-19 Garage Rear	Garage Rear	0.00000	4.39700	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

Specific Buildings - Bending Parameters

Ref.	Building Name	Sub-Building Name	Height [m]	Default	Hogging: 2nd Mom. of Area (per unit width) [m³]	Hogging: Dist. of Bending Strain from N.A. [m]	Hogging: Dist. of N.A. from Edge of Beam in Tension [m]	Sagging: 2nd Mom. of Area (per unit width) [m³]	Sagging: Dist. of Bending Strain from N.A. [m]	Sagging: Dist. of N.A. from Edge of Beam in Tension [m]
1	No. 13 Front Wall	No. 13 Front Wall	11.000	Yes	443.67	11.000	11.000	110.92	5.5000	5.5000
2	No. 13 Side Wall	No. 13 Side Wall	11.000	Yes	443.67	11.000	11.000	110.92	5.5000	5.5000
3	No. 13 Rear Wall	No. 13 Rear Wall	11.000	Yes	443.67	11.000	11.000	110.92	5.5000	5.5000
4	No. 17 Front Wall	No. 17 Front Wall	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
5	No. 17 Side Wall	No. 17 Side Wall	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
6	No. 17 Minor Side Wall	No. 17 Minor Side Wall	8.0000	Yes	170.67	8.0000	8.0000	42.667	4.0000	4.0000
7	No. 17-19 Garage Front	No. 17-19 Garage Front	4.0000	Yes	21.333	4.0000	4.0000	5.3333	2.0000	2.0000
8	No. 17-19 Garage Side	No. 17-19 Garage Side	4.0000	Yes	21.333	4.0000	4.0000	5.3333	2.0000	2.0000
9	No. 17-19 Garage Rear	No. 17-19 Garage Rear	4.0000	Yes	21.333	4.0000	4.0000	5.3333	2.0000	2.0000

Stage: Ref.	Stage: Name	Specific Building: Ref.	Specific Building: Name	Sub-building Name	Vertical Offset [m]	Dist. [m]	x [m]	y [m]	z [mm]	δz
		8	No. 17-19 Garage Side	No. 17-19 Garage Side	0.0	0.0	526621.65090	185366.10390	0.00000	1.9391
						2.8080	526619.15335	185364.82060	0.00000	3.0587
						5.6159	526616.65580	185363.53730	0.00000	3.0372
		9	No. 17-19 Garage Rear	No. 17-19 Garage Rear	0.0	0.0	526616.65580	185363.53730	0.00000	3.0372
						2.1988	526615.65580	185365.49555	0.00000	2.9787
						4.3976	526614.65580	185367.45380	0.00000	1.8501

Specific Building Damage Results - Detail

Stage: Ref.	Stage: Name	Specific Building: Ref.	Specific Building: Name	Sub-building Name	Vertical Offset from Line for Vertical Movement Calculations [m]	Segment	Start [m]	Length [m]	Curvature	Deflection Ratio [%]	Average Horizontal Strain [%]	Max Tensile Strain [%]	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature [m]	Damage Category
0	Base Model	1	No. 13 Front Wall	No. 13 Front Wall	0.0	1	0.0	3.7494	Sagging	0.012076	0.046278	0.052428	-575.43E-6	774.92E-6	2758.0	1 (Very Slight)
						2	3.7494	5.3384	Hogging	0.0095741	0.059156	0.062677	-609.10E-6	774.92E-6	7150.6	1 (Very Slight)
		2	No. 13 Side Wall	No. 13 Side Wall	0.0	1	0.0	10.550	Sagging	0.0071287	-0.014059	0.0045953	680.56E-6	938.24E-6	2759.7	0 (Negligible)
						2	10.550	3.4524	Hogging	0.012564	-0.012844	0.0095340	198.33E-6	938.24E-6	9107.7	0 (Negligible)
						3	14.003	2.1322	Sagging	0.0024056	0.0055864	0.0063470	-76.404E-6	287.11E-6	9048.6	0 (Negligible)
		3	No. 13 Rear Wall	No. 13 Rear Wall	0.0	1	0.0	0.63095	None	0.0	-0.011136	0.0022272	111.37E-6	165.89E-6	21941.	0 (Negligible)
						2	0.63095	5.2179	Hogging	0.0014954	-0.0017750	0.0011085	111.37E-6	180.25E-6	31593.	0 (Negligible)
		4	No. 17 Front Wall	No. 17 Front Wall	0.0	1	0.0	3.3942	Sagging	0.0066225	0.050403	0.054535	-554.98E-6	583.48E-6	4834.8	1 (Very Slight)
						2	3.3942	4.9189	Hogging	0.0066521	0.035248	0.038320	-374.62E-6	583.48E-6	9528.5	0 (Negligible)
		5	No. 17 Side Wall	No. 17 Side Wall	0.0	1	0.0	3.4780	Sagging	0.010064	0.0023807	0.010656	-34.459E-6	504.99E-6	3306.4	0 (Negligible)
						2	3.4780	6.0095	Hogging	0.0032029	311.36E-6	0.0032213	-92.096E-6	504.99E-6	16426.	0 (Negligible)
		6	No. 17 Minor Side Wall	No. 17 Minor Side Wall	0.0	1	0.0	2.5086	Sagging	0.023268	0.0049172	0.024854	-83.227E-6	971.41E-6	1022.2	0 (Negligible)
						2	2.5086	2.8045	Hogging	0.0060715	-0.0088297	0.0044903	142.18E-6	971.41E-6	5717.0	0 (Negligible)
						3	5.3132	0.22585	None	0.0	-0.0045435	908.70E-6	45.437E-6	196.82E-6	29303.	0 (Negligible)
		7	No. 17-19 Garage Front	No. 17-19 Garage Front	0.0	1	0.0	4.2160	Hogging	0.0018730	-0.015718	0.0033042	250.12E-6	-302.78E-6	27853.	0 (Negligible)
		8	No. 17-19 Garage Side	No. 17-19 Garage Side	0.0	1	0.0	5.6150	Sagging	0.010066	-0.041090	0.0091089	772.32E-6	-399.01E-6	6900.9	0 (Negligible)
		9	No. 17-19 Garage Rear	No. 17-19 Garage Rear	0.0	1	0.0	4.3970	Sagging	0.012041	0.060077	0.075624	-665.04E-6	513.03E-6	4522.1	2 (Slight)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Specific Building Damage Results - Critical Values for All Segments within Each Sub-Building

Stage: Ref.	Stage: Name	Specific Building: Ref.	Specific Building: Name	Sub-building Name	Vertical Offset from Line for Vertical Movement Calculations [m]	Deflection Ratio [%]	Average Horizontal Strain [%]	Max Slope	Max Settlement [mm]	Max Tensile Strain [%]	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging) [m]	Min Radius of Curvature (Sagging) [m]	Damage Category
0	Base Model	1	No. 13 Front Wall	No. 13 Front Wall	0.0	0.012076	0.059156	774.92E-6	4.1796	0.062677	-609.10E-6	774.92E-6	7150.6	2758.0	1 (Very Slight)
		2	No. 13 Side Wall	No. 13 Side Wall	0.0	0.012564	-0.014059	938.24E-6	4.6004	0.0095340	680.56E-6	938.24E-6	9107.7	2759.7	0 (Negligible)
		3	No. 13 Rear Wall	No. 13 Rear Wall	0.0	0.0014954	-0.011136	180.25E-6	0.80259	0.0022272	111.37E-6	180.25E-6	31593.	-	0 (Negligible)
		4	No. 17 Front Wall	No. 17 Front Wall	0.0	0.0066521	0.050403	583.48E-6	3.2298	0.054535	-554.98E-6	583.48E-6	9528.5	4834.8	1 (Very Slight)
		5	No. 17 Side Wall	No. 17 Side Wall	0.0	0.010064	0.0023807	504.99E-6	2.2837	0.010656	-92.096E-6	504.99E-6	16426.	3306.4	0 (Negligible)
		6	No. 17 Minor Side Wall	No. 17 Minor Side Wall	0.0	0.023268	-0.0088297	971.41E-6	3.2298	0.024854	142.18E-6	971.41E-6	5717.0	1022.2	0 (Negligible)
		7	No. 17-19 Garage Front	No. 17-19 Garage Front	0.0	0.0018730	-0.015718	-302.78E-6	1.9390	0.0033042	250.12E-6	-302.78E-6	27853.	-	0 (Negligible)
		8	No. 17-19 Garage Side	No. 17-19 Garage Side	0.0	0.010066	-0.041090	-399.01E-6	3.0584	0.0091089	772.32E-6	-399.01E-6	-	6900.9	0 (Negligible)
		9	No. 17-19 Garage Rear	No. 17-19 Garage Rear	0.0	0.012041	0.060077	513.03E-6	3.0372	0.075624	-665.04E-6	513.03E-6	-	4522.1	2 (Slight)

Specific Building Damage Results - Critical Segments within Each Building

Stage: Ref.	Stage: Name	Specific Building: Ref.	Specific Building: Name	Parameter	Critical Sub-Building	Critical Segment	Start [m]	End [m]	Curvature	Max Slope	Max Settlement [mm]	Max Tensile Strain [%]	Min Radius of Curvature (Hogging) [m]	Min Radius of Curvature (Sagging) [m]	Damage Category
0	Base Model	0	No. 13 Front Wall	Max Slope	No. 13 Front Wall	1	0.0	3.7494	Sagging	**774.92E-6**	4.1796	0.052428	-	2758.0	1 (Very Slight)
				Max Settlement	No. 13 Front Wall	1	0.0	3.7494	Sagging	774.92E-6	**4.1796**	0.052428	-	2758.0	1 (Very Slight)
				Max Tensile Strain	No. 13 Front Wall	2	3.7494	9.0878	Hogging	774.92E-6	2.3353	**0.062677**	7150.6	-	1 (Very Slight)
				Min Radius of Curvature (Hogging)	No. 13 Front Wall	2	3.7494	9.0878	Hogging	774.92E-6	2.3353	0.062677	**7150.6**	-	1 (Very Slight)
				Min Radius of Curvature (Sagging)	No. 13 Front Wall	1	0.0	3.7494	Sagging	774.92E-6	4.1796	0.052428	-	**2758.0**	1 (Very Slight)
		0	No. 13 Side Wall	Max Slope	No. 13 Side Wall	1	0.0	10.550	Sagging	**938.24E-6**	4.6004	0.0045953	-	2759.7	0 (Negligible)
				Max Settlement	No. 13 Side Wall	1	0.0	10.550	Sagging	938.24E-6	**4.6004**	0.0045953	-	2759.7	0 (Negligible)
				Max Tensile Strain	No. 13 Side Wall	2	10.550	14.003	Hogging	938.24E-6	2.5600	**0.0095340**	9107.7	-	0 (Negligible)
				Min Radius of Curvature (Hogging)	No. 13 Side Wall	2	10.550	14.003	Hogging	938.24E-6	2.5600	0.0095340	**9107.7**	-	0 (Negligible)
				Min Radius of Curvature (Sagging)	No. 13 Side Wall	1	0.0	10.550	Sagging	938.24E-6	4.6004	0.0045953	-	**2759.7**	0 (Negligible)
		0	No. 13 Rear Wall	Max Slope	No. 13 Rear Wall	2	0.63095	5.8488	Hogging	**180.25E-6**	0.69794	0.0011085	31593.	-	0 (Negligible)
				Max Settlement	No. 13 Rear Wall	1	0.0	0.63095	Sagging	165.89E-6	**0.80259**	0.0022272	-	21941.	0 (Negligible)
				Max Tensile Strain	No. 13 Rear Wall	1	0.0	0.63095	Sagging	165.89E-6	0.80259	**0.0022272**	-	21941.	0 (Negligible)
				Min Radius of Curvature (Hogging)	No. 13 Rear Wall	2	0.63095	5.8488	Hogging	180.25E-6	0.69794	0.0011085	**31593.**	-	0 (Negligible)
				Min Radius of Curvature (Sagging)	-	-	-	-	-	-	-	-	-	-	-
		0	No. 17 Front Wall	Max Slope	No. 17 Front Wall	1	0.0	3.3942	Sagging	**583.48E-6**	3.2298	0.054535	-	4834.8	1 (Very Slight)
				Max Settlement	No. 17 Front Wall	1	0.0	3.3942	Sagging	583.48E-6	**3.2298**	0.054535	-	4834.8	1 (Very Slight)

Stage: Ref.	Stage: Name	Specific Building: Ref.	Specific Building: Name	Parameter	Critical Sub-Building	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
				Max Tensile Strain	No. 17 Front Wall	1	0.0	3.3942	Sagging	583.48E-6	3.2298	**0.054535**	-	4834.8	1 (Very Slight)
				Min Radius of Curvature (Hogging)	No. 17 Front Wall	2	3.3942	8.3130	Hogging	583.48E-6	1.8462	0.038320	**9528.5**	-	0 (Negligible)
				Min Radius of Curvature (Sagging)	No. 17 Front Wall	1	0.0	3.3942	Sagging	583.48E-6	3.2298	0.054535	-	**4834.8**	1 (Very Slight)
		0	No. 17 Side Wall	Max Slope	No. 17 Side Wall	1	0.0	3.4780	Sagging	**504.99E-6**	2.2837	0.010656	-	3306.4	0 (Negligible)
				Max Settlement	No. 17 Side Wall	1	0.0	3.4780	Sagging	504.99E-6	**2.2837**	0.010656	-	3306.4	0 (Negligible)
				Max Tensile Strain	No. 17 Side Wall	1	0.0	3.4780	Sagging	504.99E-6	2.2837	**0.010656**	-	3306.4	0 (Negligible)
				Min Radius of Curvature (Hogging)	No. 17 Side Wall	2	3.4780	9.4876	Hogging	504.99E-6	1.2977	0.0032213	**16426.**	-	0 (Negligible)
				Min Radius of Curvature (Sagging)	No. 17 Side Wall	1	0.0	3.4780	Sagging	504.99E-6	2.2837	0.010656	-	**3306.4**	0 (Negligible)
		0	No. 17 Minor Side Wall	Max Slope	No. 17 Minor Side Wall	1	0.0	2.5086	Sagging	**971.41E-6**	3.2298	0.024854	-	1022.2	0 (Negligible)
				Max Settlement	No. 17 Minor Side Wall	1	0.0	2.5086	Sagging	971.41E-6	**3.2298**	0.024854	-	1022.2	0 (Negligible)
				Max Tensile Strain	No. 17 Minor Side Wall	1	0.0	2.5086	Sagging	971.41E-6	3.2298	**0.024854**	-	1022.2	0 (Negligible)
				Min Radius of Curvature (Hogging)	No. 17 Minor Side Wall	2	2.5086	5.3132	Hogging	971.41E-6	2.1062	0.0044903	**5717.0**	-	0 (Negligible)
				Min Radius of Curvature (Sagging)	No. 17 Minor Side Wall	1	0.0	2.5086	Sagging	971.41E-6	3.2298	0.024854	-	**1022.2**	0 (Negligible)
		0	No. 17-19 Garage Front	Max Slope	No. 17-19 Garage Front	1	0.0	4.2160	Hogging	**302.78E-6**	1.9390	0.0033042	27853.	-	0 (Negligible)
				Max Settlement	No. 17-19 Garage Front	1	0.0	4.2160	Hogging	302.78E-6	**1.9390**	0.0033042	27853.	-	0 (Negligible)
				Max Tensile Strain	No. 17-19 Garage Front	1	0.0	4.2160	Hogging	302.78E-6	1.9390	**0.0033042**	27853.	-	0 (Negligible)
				Min Radius of Curvature (Hogging)	No. 17-19 Garage Front	1	0.0	4.2160	Hogging	302.78E-6	1.9390	0.0033042	**27853.**	-	0 (Negligible)
				Min Radius of Curvature (Sagging)		-	-	-	-	-	-	-	-	-	-
		0	No. 17-19 Garage Side	Max Slope	No. 17-19 Garage Side	1	0.0	5.6150	Sagging	**399.01E-6**	3.0584	0.0091089	-	6900.9	0 (Negligible)
				Max Settlement	No. 17-19 Garage Side	1	0.0	5.6150	Sagging	399.01E-6	**3.0584**	0.0091089	-	6900.9	0 (Negligible)
				Max Tensile Strain	No. 17-19 Garage Side	1	0.0	5.6150	Sagging	399.01E-6	3.0584	**0.0091089**	-	6900.9	0 (Negligible)
				Min Radius of Curvature (Hogging)		-	-	-	-	-	-	-	-	-	-
				Min Radius of Curvature (Sagging)	No. 17-19 Garage Side	1	0.0	5.6150	Sagging	399.01E-6	3.0584	0.0091089	-	**6900.9**	0 (Negligible)
		0	No. 17-19 Garage Rear	Max Slope	No. 17-19 Garage Rear	1	0.0	4.3970	Sagging	**513.03E-6**	3.0372	0.075624	-	4522.1	2 (Slight)
				Max Settlement	No. 17-19 Garage Rear	1	0.0	4.3970	Sagging	513.03E-6	**3.0372**	0.075624	-	4522.1	2 (Slight)
				Max Tensile Strain	No. 17-19 Garage Rear	1	0.0	4.3970	Sagging	513.03E-6	3.0372	**0.075624**	-	4522.1	2 (Slight)
				Min Radius of Curvature (Hogging)		-	-	-	-	-	-	-	-	-	-
				Min Radius of Curvature (Sagging)	No. 17-19 Garage Rear	1	0.0	4.3970	Sagging	513.03E-6	3.0372	0.075624	-	**4522.1**	2 (Slight)

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