Job Number: 150607

CROFT STRUCTURAL ENGINEERS

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Basement Impact Assessment

Property Details:

1A St Johns Wood Park
Camden
NW8 6NE

Client Information:

Mike Ofori
Liv International

Structural Design Reviewed by Chris Tomlin MEng CEng MIStructE	**Above Ground Drainage Reviewed by** Phil Henry BEng MEng MICE
Hydrogeology Report Julian Maund BSc PhD CEng MIMMM CGeol FGS	**Land Stability Report** Julian Maund BSc PhD CEng MIMMM CGeol FGS
Report compiled by Noma Manzini BEng MSc	

Revision	Date	Comment
-	July 2015	First issue
1	Aug 2015	Drawings revised
2	2-12-2015	Various alterations
3	11-1-2016	Various alterations

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Contents

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Executive Summary / Non-technical Summary

The London Borough of Camden requires a Basement Impact Assessment (BIA) to be prepared for developments that include basements and lightwells. This document forms the main part of the BIA and gives details on the impact of surface water flow. The scheme design for the proposed subterranean structure is also included.

This document should be used in conjunction with the Hydrogeology and Land Stability BIA (dated 2 December 2015). This is a separate assessment and is referred to, where relevant, within this document.

This BIA follows the requirements contained within Camden Council's planning guidance CGP4 – Basements and Lightwells (2015). In summary, the council will only allow basement construction to proceed if it does not:

- cause harm to the built or natural environment and local amenity;
- result in flooding;
- lead to ground instability.

In order to comply with the above clauses, a BIA must undertake five stages detailed in CPG 4. This report has been produced in line with Camden planning guidance and associated supporting documents such as CPG1, DP23, DP26, DP25 and DP27. Technical information from 'Camden geological, hydrogeological and hydrological study - Guidance for subterranean development', Issue 01, November 2010 (GSD, hereafter) is also referred to in this assessment.

Project Summary

Description of Property

The site compirses an area of land adjacent to 1 St Johns Wood Park. The land is occupied by a row of garages and a gated access road that leads to St Johns Wood Park to the east and also to Middlesfield to the south-west. The row of garages continues to the west along the access road.

Proposed Works

The proposed development consists of the following:

- Demolition of existing garages
- Construction of a new detached house; this will comprise three stories above ground level and a single storey basement

Croft Structural Engineers Ltd has extensive knowledge of constructing new basements. Over the last 10 years Croft Structural Engineers has been

	involved in the design of over 500 basements in and around London. The outline method to be utilised at 1a St Johns Wood Park is: 1. Demolish the garages within the site boundary 2. Place a contiguous piled wall around the perimeter of the new basement 3. Excavate the soil within the piled wall, propping the retained soil as necessary. 4. Construct reinforced concrete inner walls around the building perimeter, within the contiguous piled wall. 5. Continue with construction of basement structure. 6. Waterproof the internal space with a drained cavity system. 7. Proceed with the construction of the above ground structure Drainage, stability and potential ground movements are addressed in Section 4.
Stage 1 – Screening	Screening addressed areas of concern relating to Land Stability, Hydrogeology, Surface Water and Flooding. This stage identified which of these should be carried forward to scoping stage.
Stage 2 – Scoping	The Scoping stage identified potential impacts and set the parameters required for further study. This included areas that should be given special attention during the site investigation.
Stage 3 – Site investigation and study	The property and the site were inspected and a walk over survey was completed by an engineer. The information from this was used to formulate the requirements for a ground investigation and also, where possible, to corroborate data that would be gathered from a desk study. Visual inspections were completed of the adjacent properties to determine if there were signs of structural movement. The immediate surrounding the sites have not been excavated. However, there are proposals to create basements in nearby plots of land. A ground investigation with 12.5m deep boreholes has been completed.

	• The formation level of the basement will be in London Clay • Initial standpipe readings did not encounter any water Laboratory testing was undertaken on the soil samples. Ground water was measured. The readings are as follows: • A repeat reading observed water at 0.5m below ground level
Stage 4 – Impact assessment	**Land stability** An assessment of land stability was made in view of the proposals for the excavation and construction of the basement. Ground heave was predicted and it was concluded that this can be accommodated with the use of void formers below the basement. From an evaluation of the ground conditions, it is concluded that a basement can be safely constructed at the site. **Hydrogeology** It is understood that a perched water table is present below the ground surface and that this can be suitably managed during construction. The perched water is present within a layer of permeable soil that rests on London Clay. Under permanent conditions, water can continue to migrate through this layer, around the basement. From an evaluation of the ground conditions, it is concluded that a basement can be safely constructed at the site. **Drainage & Surface Water Flow** No surface water features are noted within a 250m radius of the site. Examination of Environment Agency data shows that the site is not situated in a zone which is at risk of surface water flooding from rivers or seas. There will not be an increase in hard-surfaced areas. There will be no significant impacts on the risk of flooding or the surface water flow within or around the site.

1. Screening Stage

Camden Council stipulates that any subterranean development proposal should be screened to determine whether a full BIA is required.

The screening stage gives a brief description of the project and identifies areas of concern that will require further investigation.

Description of Property

The site compirses an area of land adjacent to 1 St Johns Wood Park.

Figure 1: Aerial view with approx. site area indicated

The land is occupied by a row of garages and a gated access road that leads to St Johns Wood Park to the east and Middlesfield to the south-west. The row of garages continues to the west along the access road.

Proposed Development

The proposed development involves the demolition of existing garages and subsequent construction of a new detached house. The new building will comprise three stories above ground level and a single storey basement.

The planning application drawings for this development have been produced by Shaun Knight Architecture and are submitted separately from this assessment.

The outline method to be utilised at 1a St Johns Wood Park is:

	1. Demolish the garages within the site boundary 2. Place a contiguous pile wall around the perimeter of the new basement 3. Excavate soil within the piled perimeter, propping the retained soil as necessary. 4. Construct reinforced concrete inner walls around the building perimeter, within the contiguous piled wall. 5. Continue with the construction of the basement structure. 6. Waterproof the internal space with a drained cavity system. 7. Proceed with the construction of the above ground structure A detailed method statement is proposed and appended.
	The questions below are taken from *Camden CPG 4 – Basements and Lightwells*.
Land Stability	Refer to the combined assessment on Hydrogeology and Land Stability (dated 2 December 2015)
Subterranean Flow	Refer to the combined assessment on Hydrogeology and Land Stability (dated 2 December 2015)

Surface Flow and Flooding

Question 1: Is the site within the catchment of the pond chains on Hampstead Heath?

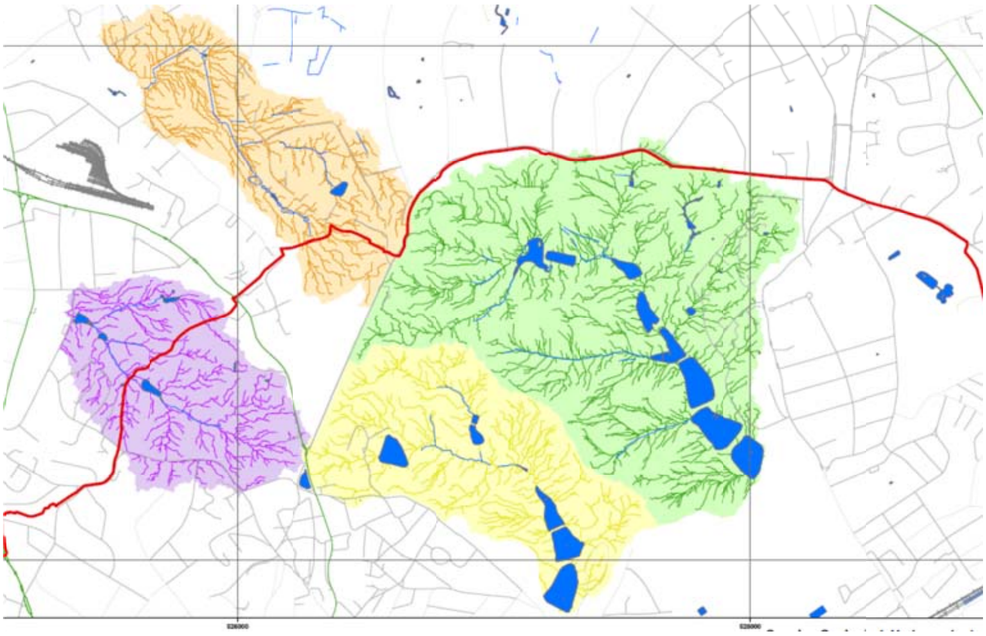

Figure 2: Extract from Figure 14 of the GSD (site lies to the south of the shaded areas)

No. The site lies outside the areas denoted by Figure 14 of the GSD (extract shown above)

Question 2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?

No – The surface water that flows from the proposed development will be routed the same way as before: water is and will be collected from hard surfaced areas and enter the existing drainage system.

Question 3. Will the proposed basement development result in a change to the hard surfaced /paved external areas?

No – Currently the site is fully occupied by buildings and hard-surfaced areas. This will remain the case with the proposed development.

Question 4. Will the proposed basement result in changes to the inflows (instantaneous and long term of surface water being received by adjacent properties or downstream watercourses?

No. The site will remain fully occupied by buildings and hard-surfaced areas so the inflows will remain unchanged.

Question 5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?

No. Collected surface water will be from building roofs and paving, as before. The quality of the water received downstream will therefore not change.

Question 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?

The potential sources of flooding are summarised below:

Potential Source	Potential Flood Risk at site?	Justification
Fluvial flooding	No	EA Flood Mapping Shows Flood Zone 1. Distance from nearest surface watercourse >1km
Tidal flooding	No	Site location is 'inland' and topography > 50mAOD.
Flooding from rising / high groundwater	No	Site is located on low permeability London Clay.
Surface water (pluvial) flooding	No	The development is not on the list of streets that were flooded in 1975 and/or 2002
Flooding from infrastructure failure	Yes	Drainage at or near the site could potentially become blocked or cracked and overflow or leak. Drainage of the basement areas may rely on pumping.
Flooding from reservoirs, canals and other artificial sources	No	There are no reservoirs, canals or other artificial sources in the vicinity of the site that could give rise to a flood risk.

The answers to Questions 1-5 above indicate that the issues related to

	surface water flow and flooding are not significant. These questions therefore do not have to be carried forward to Scoping Stage. In answering Question 6, a flood risk assessment is not considered necessary: the property is not on a street that has flooded in 1975 or 2002 and there are no risks to flooding that are greater than those inherent with all subterranean structures. However, the risks associated with infrastructure failure should be investigated further. The assessment, with regards to Surface Water Flow, should be carried forward to Scoping Stage.

2. Scoping Stage

	This stage identifies the potential impacts of the areas of concern that were highlighted in the Screening phase.
Land Stability	Refer to the combined assessment on Hydrogeology and Land Stability (dated 2 December 2015)
Subterranean Flow	Refer to the combined assessment on Hydrogeology and Land Stability (dated 2 December 2015)
Surface Flow & Flooding	The existing site has of garages that will be demolished to give way for new basement and a three storey above-ground structure. The basement will be below an area that is currently hard-surfaced. The development will therefore not affect the above ground flow. It is evident from the screening study that the only significant flood risks at 1a St Johns Wood Park are due to the failure of existing sewers in the vicinity of the site. The flow paths of surface water around the property should be investigated further. Carry forward to Site Investigation & Desk Study

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3. Site Investigation and Study

This section identifies the relevant features of the site and its immediate surroundings, providing further scoping where required.

Desk Study and Walkover Survey

The site compirses an area of land adjacent to 1 St Johns Wood Park. The land is occupied by a row of garages and a gated access road that links St Johns Wood Park (to the east) to Middlesfield (to the south-west). The row of garages continues to the west along the access road.

Figure 3: View of existing site looking from west to east

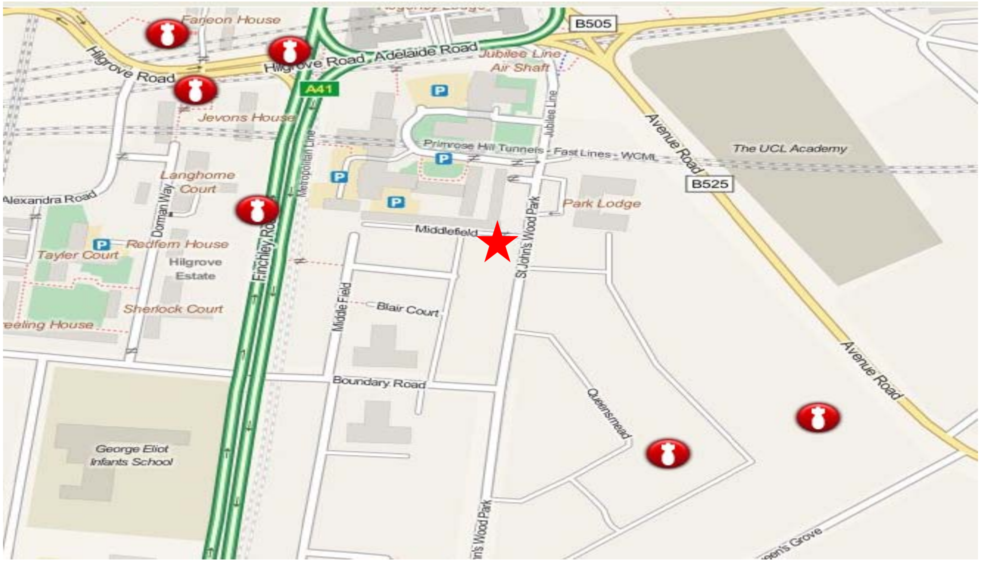
The site is covered with hard surfacing. There are trees, shrubs and soft landscaping close by, to the east and north-east of the property. Boundary walls constructed from brickwork separate these from the site.

The site is not in a conservation area.

Noma Manzini, a Structural Engineer from Croft Structural Engineers visited 1a St Johns Wood Park on 16th June 2015

Proposed Development

The garages within the site boundary will be demolished to give way for a new residential property. The new building will be three storeys high above ground level and will also include a basement. For further details of the

	architectural design, refer to drawings by Shaun Knight Architecture.
Site History	As referred to in the combined assessment on Hydrogeology and Land Stability, historical maps show that the site and the surrounding area have been residential for over 125 years.
Local Bombing	A highly explosive bomb is recorded in the Aggregate Night Time bomb census as having been dropped nearby, between 7th October and 6th June 1941.  *Figure 4: Extract from Bomb Survey Map*

Listed Buildings

The existing buildings (garages) are not listed. Data from Historic England shows that there are no listed buildings close by

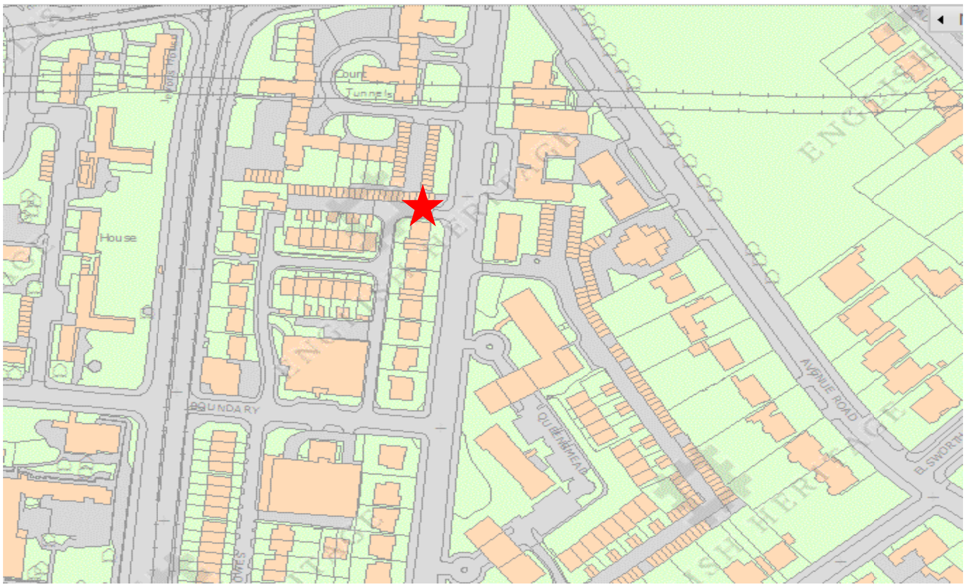


Figure 5: Extract showing listed buildings

Local topography & external features

The area surrounding the property has a general slope, downwards from north-west to south-east. The slope is gradual; there are no retaining walls for sudden changes in elevation.

There are rainwater pipes which discharge below ground level.

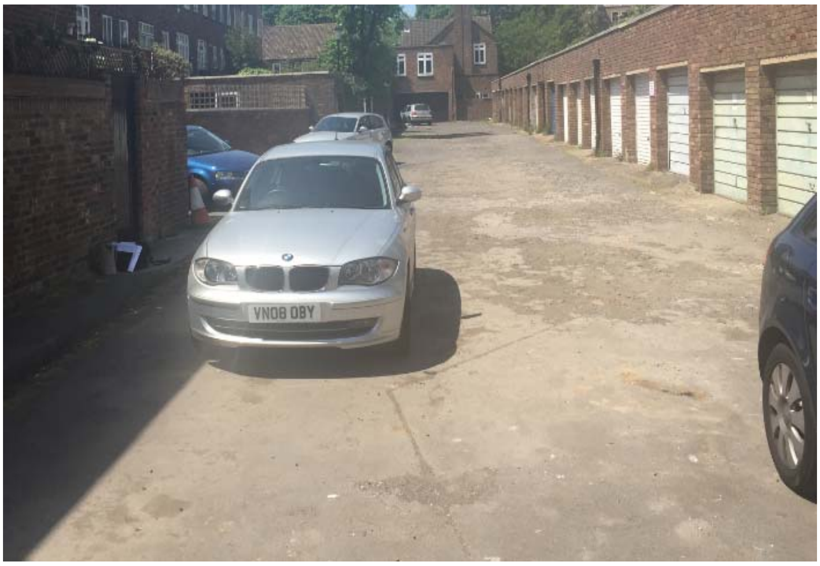


Figure 6: Hard standing area

The walk over survey has confirmed that there are no surface water features (natural or man-made) within the site or on the adjacent sites.

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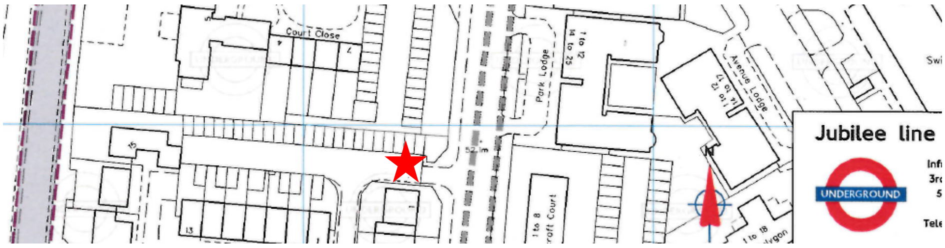
Geology	Refer to the Ground Investigation report and the Hydrogeological and Land Stability assessment.
Highways	The site is not within 5m of the public highway.
London Underground and Network Rail	The site is more than 20m away from the nearest national rail line. The proposed basement is unlikely to significantly affect this. The London Underground Jubilee Line runs close by.  *Figure 7: Extract from LUL map showing proximity of rail lines* LUL have been informed of this proposal (e-mails are appended). An initial response from them has confirmed that a correlation survey will be required. The design team should proceed with this at detailed design stage and follow any subsequent procedures (e.g. issue of Record of Commercial Details) considered applicable by LUL.
UK Power Networks	There are no significant items of electrical infrastructure (such as pylons or substations) in the immediate vicinity.
Vicinity of Trees	There are trees close by, in the neighbouring land. These do not have tree preservation orders. The closest tree is more than 4m away from the outline of the proposed basement. BS 5837: 2005 *Trees in relation to construction* estimates the root protection area (RPA) equivalent to a circle with a radius12 times the stem diameter. Based on the diameter of the tree as being 400mm, the diameter of this circle would be 4.8m. The roots concerned would therefore be within 2.4m from the trunk. These would not be affected by a basement that is 4m away.

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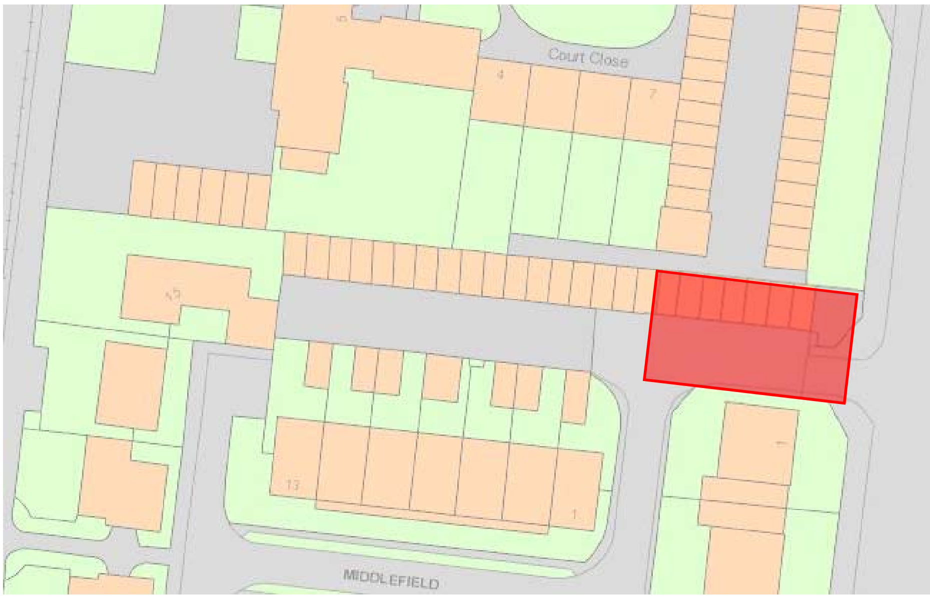
	Adjacent Properties The external facades of the neighbouring properties have been inspected.  *Figure 8: Plan view of site (approx. area marked red) and the surrounding properties (St Johns Wood Park is the road to the right)* Descriptions of the properties below are given in an anti-clockwise order starting from the neighbouring land to the north.
Garages off Boydell Court (properties to the North)	The land immediately to the north of the site is occupied by garages and an access road. Part of the area to the north is covered with soft landscaping. None of the structures immediately to the north appear to be occupied for continual habitable use. Searches of the Planning applications on Camden Council's website show that no basements are present below any of these structures.
Nos 4 to 7 Court Close and No 5 Boydell Court (properties to the North-west)	Nos 2 to 7 Court Close and No 5 Boydell Court are terraced houses and a high rise apartment block respectively. Given the height of the apartment block, piled foundations are assumed, which are likely to be deeper than the formation of the proposed basement. These properties are not immediately adjacent to the site boundary. No structural defects were noted externally by visual inspection Searches from the Planning applications on Camden Council's website show that no basements are present below these buidlings.

<table>
<tr><td></td><td>
Figure 9: Existing properties to the rear and north-west(behind the garages in the foreground)</td></tr>
<tr><td>Land off Middlefield (property to the west)</td><td>This area is currently occupied by garages. This land is registered to be developed with the inclusion of basements below new residential buildings. At detailed design and also at construction stage, co-ordination should be maintained with the developers of this property to ensure that any combined impacts on the neighbouring properties are adequately controlled and kept to an acceptable minimum.</td></tr>
<tr><td>Odd Nos 1-13 Middlefield (properties to the south-west)</td><td>These are residential terrace houses. From visual inspection, no structural defects were noted externally. A search among the planning applications on Camden Council's website shows that there are no basements present below these properties.

Figure 10: 1-13 Middlefield (on left)</td></tr>
</table>

1 St Johns Wood Park – Property to south	1 St Johns Wood Park is a three storey residential building. No structural defects were noted externally by visual inspection.  *Figure 11: 1 St Johns Wood Park* A search among the planning applications on Camden Council's website shows that there is no basement present below this property.
St Johns Wood Park – land to the east	The land immediately to the east of the property is occupied by a public highway and a pavement, at ground surface level. Either side of the highway, there are gullies, indicative of a surface water trunk sewer below. As described previously, there is an underground tube line below the road.
	Monitoring, Reporting and Investigation The ground investigation report, which has data from initial site investigations and data from subsequent monitoring, is available as a separate report.

Ground Investigation

Ground Investigation Brief	The ground investigation was completed by Ground & Water Ltd. From the Scoping stage Croft considered that the brief should cover: • Two trial pits to confirm the existing foundations of existing garages. The purpose is to consider the effect of the works on the neighbouring properties and the find the ground conditions below the site. • One borehole to a depth of 12.5m below ground level (i.e. more than twice the depth of the proposed basement). • Stand pipe to be inserted to monitor ground water; record initial strike and the water level after 1 month. • Site testing to determine insitu soil parameters. SPT testing to be undertaken. • Laboratory testing to confirm soil make up and properties. • The Historic maps and walk over survey did not highlight any significant contamination sources, therefore no site test of the ground has been requested. • Factual report on soil conditions. • Interpretative reports • Calculation of bearing pressures from SPT. • Indication of Ø (angle of friction) from SPT. • Indication of soil type Refer to the ground investigation report by Ground & Water Ltd, which is submitted as a separate document. Data relevant to land stability and subterranean flow is examined separate documents.

Land Stability	Refer to the combined assessment on Hydrogeology and Land Stability (dated 2 December 2015) for land stability issues addressed to Stage 3.
Subterranean Flow	Refer to the combined assessment on Hydrogeology and Land Stability (dated 2 December 2015) for hydrogeological issues addressed to Stage 3.

Surface Flow & Flooding	A walk over survey has confirmed that there are no surface water features, either within or close to the site. The survey has also confirmed that the site is covered with hard surfaces. Rainwater from these surfaces is likely to flow in the direction of the slope of the surrounding area, ie from north-west to south east. This will be towards St Johns Wood Park, which is drained by gullies.

4. Basement Impact Assessment

Subterranean Flow	Refer to the combined assessment on Hydrogeology and Land Stability (dated 2 December 2015)
Land Stability	Refer to the combined assessment on Hydrogeology and Land Stability (dated 2 December 2015)
Surface water flow and flooding	As described in previous sections, there are no significant risks of flooding. However, there are risks which are inherit in the construction of all subterranean structures, such as flooding due to unexpected failure of the drainage, water mains, etc. For this reason, Croft would recommend the following measures to reduce these risks: • To reduce the likelihood of flooding into the lightwells, these should be designed (at detailed design stage) with upstands above ground level. • A pumping mechanism with a non-return valve should be installed for the proposed basement. There is a likelihood that this may fail and allow excess water to accumulate. If this were to occur, the build-up of water would be gradual and noticeable before it becomes a significant life-threatening hazard. • Install a dual pumping system to maintain operation in the event of a failure. This should include a battery backup and a suitable alarm system for warning purposes. The risk of flooding from excess surface water is not considered significant. There is a risk of flooding due to the failure of the pumping system but this can be reduced to acceptable levels with appropriate design and installation measures. Given that the amount of hardstanding will remain unchanged, the installation of facilities for SUDS would not be necessary: the current drainage infrastructure can, and will be able to cope, with surface water discharged from this site.

Ground Movement Assessment & Predicted Damage Category

This assessment covers movements relating to the construction of the piled retaining walls. The design and construction methodology aims to limit damage to the existing building on the site, and to the neighbouring buildings, to Category 2 or lower as set out in Table 2.5 of CIRIA report C580. For construction that may result in damage within Category 1 or Category 2, Camden Council's CPG4 (2015) requires mitigation measures to be included with the proposed scheme. For this development, the proposed measures are in the form of suitable temporary propping during the construction phase. This is described in the Basement Method Statement (appended).

The movement assessment has used empirical means as set out in CIRIA C580 Embedded Retaining Walls: Guidance for Economic Design. An assessment has been done for the closest building; buildings further away will be affected to a lesser extent. The ground movement assessment calculations are appended. These are calculated in relation to 1 St Johns Wood Park, which is the closest habitable building to the development.

Figure 12: Front elevation of 1 St Johns Wood Park and 1a St John's Wood Park (left and right respectively)

The amount of ground movement is partly dependent on the excavation depth. Separate calculations for movement are appended for the excavation of the main habitable area of the basement (3.5m deep) and for the swimming pool to the rear (6m below ground level).

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Mitigation Measures

A method statement, appended, has been formulated with Croft's experience of over 500 basements completed without error. As mentioned previously, the procedures described in this statement will mitigate the impacts that the construction of the basement will have on nearby properties.

The works must be carried out in accordance with the Party Wall Act and condition surveys will be necessary at the beginning and the end of the works. The Party Wall Approval procedure will reinforce the use of the proposed method statement and, if necessary, require it to be developed in more detail with more stringent requirements than those required at planning stage.

It is not expected that any cracking will occur in nearby structures during the works. However, Croft's experience advises that there is a risk of movement to the neighbouring properties (garages).

To reduce the risk to the development:

- Employ a reputable firm that has extensive knowledge of basement works.
- Employ suitably qualified consultants; Croft Structural Engineers has completed over 500 basements in the last five years.
- Provide method statements for the contractors to follow
- Investigate the ground; this has now been done.
- Record and monitor the properties close by. This is completed by a condition survey under the Party Wall Act, before and after the works are completed. Refer to the end of the appended Basement Construction Method Statement.

With the measures listed above, the maximum level of cracking anticipated is 'Hairline' cracking. This can be repaired with normal decorative works. Under the Party Wall Act, minor damage, although unwanted, can be tolerated; it is permitted to occur to a neighbouring property as long as repairs are suitability undertaken to rectify this. To mitigate this risk, the Party Wall Act is to be followed and a Party Wall Surveyor will be appointed.

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Monitoring

	Monitoring - In order to safeguard the existing structures during the new basement construction, movement monitoring is to be undertaken.
Monitoring Conclusion	The degree of monitoring is proportionate to the size of the development and the types of building affected. Various levels are described within the proposed monitoring statement (appended). The level of Monitoring Croft recommend on this development is:

Monitoring 5	
Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of neighbour's wall during the works. Vertical & lateral monitoring movement by theodolite at specific times during the projects.	Underpinning works to Grade I listed buildings Basements to Listed building Basements deeper than 4m in gravels Basements deeper than 4.5m in clays Underpinning, basements to buildings that are expressing defects.

Before the works begin a detailed monitoring report is required to confirm the implementation of the monitoring. The items that this should cover are:

- Risk Assessment to determine level of monitoring
- Scope of Works
- Applicable standards
- Specification for Instrumentation
- Monitoring of Existing cracks
- Monitoring of movement
- Reporting
- Trigger Levels using a RED AMBER GREEN System

Recommend levels are shown within the proposed monitoring statement.

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Basement Design & Construction Impacts and Initial Design Considerations

Structural Scheme

A reinforced concrete slab and a contiguous piled wall will form the new foundation of the property. The piled wall, to be designed at detailed design stage, will resist the lateral pressures on the side of the basement.

The investigations highlight that water is present. The walls are designed to cope with the hydrostatic pressure. It is possible that a water main may break causing a local high water table. To account for this, the wall is designed for water at full height.

The detailed design should consider floatation as a risk. However, by inspection, the weight of the building is likely to be greater than the uplift forces from the water, resulting in a stable structure.

The site is within 5m of a road surface; the basement wall is further away. However, to account for the possibility of emergency services vehicles occupying the pavement, highways loading should be allowed for.

Drawings are appended. The details given on these should not be used for construction: detailed design will follow after the planning application process.

Intended use of structure and user requirements

Family/domestic use

Loading Requirements (EC1-1)

	UDL kN/m²	Concentrated Loads kN
Domestic Single Dwellings	1.5	2.0

Part A3 Progressive collapse

Number of Storeys — 3 stories over basement

Is the Building Multi Occupancy? — No

Class 1	Single occupancy houses not exceeding 4 storeys

To NHBC guidance compliance is only required to other floors if a material change of use occurs to the property.

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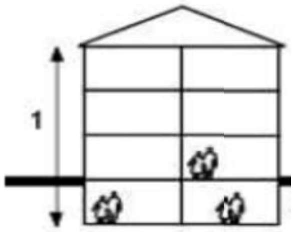
	Initial Building Class: 1 Proposed Building Class: 1 If class has changed material change has occurred: N/A 
Lateral Stability	
Exposure and wind loading conditions	Basic wind speed V_b = 21 m/s to EC1-2 Topography not considered significant.
Stability Design	The inner reinforced concrete walls should be suitable for carrying the loading applied from above; the piles should be designed to resist the lateral pressures.
Lateral Actions	The soil loads apply a lateral load on the contiguous piled wall Hydrostatic pressures will be applied to the wall. Imposed loading will surcharge the wall.
Retained soil Parameters	Design overall stability to K_a & K_p values. Lateral movement necessary to achieve K_a mobilisation is height/500 (from Tomlinson). This is tighter than the deflection limits of the concrete wall.
Water Table	Has a soil investigation been carried out? Yes Design permanent condition for water table level: If deeper than existing, design reinforcement for water table at full basement depth to allow for local failure of water mains, drainage and storm water. Global uplift forces can be ignored when the groundwater table is lower than the basement. BS8102 only indicates guidance.
Drainage and Waterproofing	Drainage and damp-proofing is by others: details are not provided within Croft SE's brief.

	It is recommended that a water proofing specialist is employed to ensure all the water proofing requirements are met. Croft SE is neither the waterproofing designer nor acting as the structural waterproofing designer. The waterproofing specialist must name their structural waterproofer. The structural waterproofer must inspect the structural details and confirm that he is happy with the robustness. Due to the segmental construction nature of the basement, it is not possible to water proof the joints. All water proofing must be made by the waterproofing specialist. He should review Croft's details and advise if water bars and stops are necessary. The waterproofing designer must not assume that the structure is watertight. To help reduce water flow through the joints, the following measures should be applied: • All faces should be cleaned of all debris and detritus • Faces between concrete segments should be needle hammered to improve key for bonding • All pipe work and other penetrations should have puddle flanges • or hydrophilic strips
Localised Dewatering	Localised dewater to pins may be necessary. Some engineers may raise the theoretical questions about pumping of water causing localised settlement. We believe that this argument is a red herring when applied to single storey basements and our reason for stating this is: • The water table in the area is variable, • The water level naturally rises and falls over time and does not lead to subsidence • The water table has naturally been rising and falling for over the last 20,000 years, any fines that will have been removed from the soil would have done so already. • If the water table rises and falls naturally why does this not cause subsidence due to fine removals every year? It does not because the soil has been soil is naturally consolidated by the rise and fall of the water table in the area. • The effect of local pumping for small excavations will not affect the local area. • There is only a risk of subsidence from large scale pumping of soil which lowers the water table below is natural lowest level.
Temporary Works	Temporary propping details will be required and this must be provided by the contractor. Their details should be forwarded to Croft Structural Engineers.

CTMP	The council may require a Construction Traffic Management plan to be produced. This is outside the brief of the Basement Impact Assessment and is not covered within Croft's brief

Appendix A : Calculations

These calculations are for the scheme design only and should not be used at detailed design or construction stage.

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Design Concept

Contiguous piles around the perimeter of the building will resist lateral loading from the retained soil. This should include full height hydrostatic pressures. The piled wall will be propped at the head by temporary props in the temporary condition (as indicated in drawing SL-50, appended) and by the ground floor structure in the permanent case (refer to drawings SL-10 and SL-30, appended). The ground floor structure will transfer theses horizontal loads to the opposite wall.

At detailed design stage, the contiguous piled wall should resist highways surcharge loads (10kN/m^2).

The geotechnical parameters that should be used in the design are as follows:

	Plasticity				Class	Undrained Cohesion	Effective cohesion	Effective angle of friction	Bulk unit weight	Modulus E'	Earth Pressures	
Strata	LL (%)	PL (%)	PI (%)	MC (%)		Cu (kPa)	kN/m^3	Φ'	kN/m^3	MPa	K_a	K_p
Made Ground	n/a	n/a	n/a	n/a	n/a	n/a	0	29	15	n/a	n/a	n/a
Head Material (Made Ground)	n/a	n/a	n/a	n/a	n/a	n/a	0	35	18	10	0.27	3.7
London Clay	67-80	23-30	40-52	27-31	CH /CV	25 to 250	0	24	20	7-45	0.42	2.4

Internal reinforced concrete walls will transfer verticals from the super structure to the ground.

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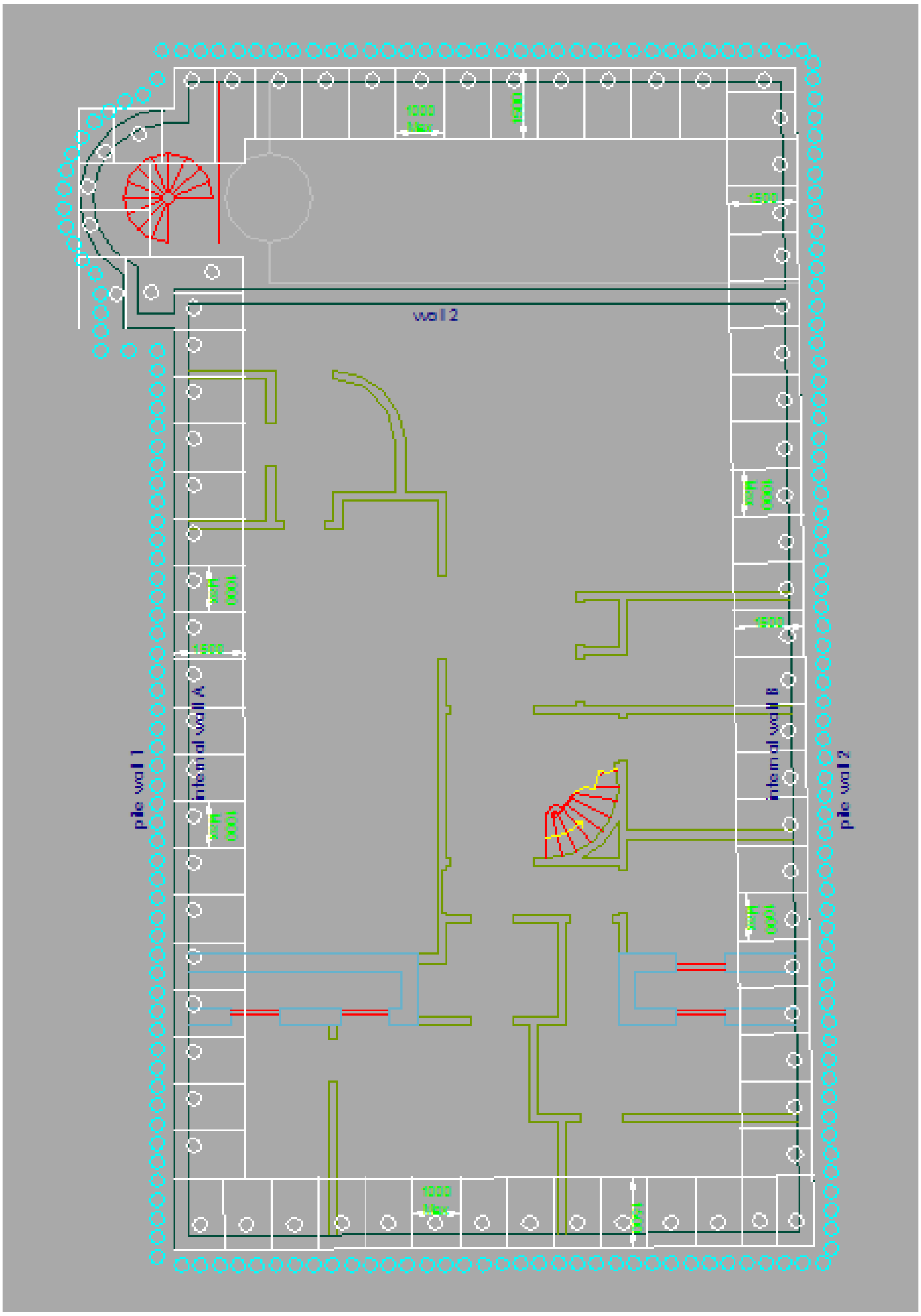

Member location plan – basement level

CROFT STRUCTURAL ENGINEERS

Reference

General Loadings

			Cavity Walls				
Sloped Roof			100 Facing Brick =	2.2		**Timber Partitions**	
Slate =	0.6	kN/m²	100 Block (16kN/m3)=	1.6		50x100 Studs @ 400 =	0.15
Battens =	0.02		Plaster & Skim =	0.18		Insulation =	0.04
Rafers	0.1125		Dead Load =	**3.98**	**kN/m2**	Plaster & Skim =	0.36
Felt =	0.02					**Dead Load =**	**0.55**
Insulation =	0.02		**Internal Walls**				
Plaster=	0.18		100 Block (20kN/m3)=	2			
	0.9525	**kN/m2**	Plaster & Skim =	0.36		**Existing Brick Walls**	
Roof Angle =	25	deg	**Dead Load =**	**2.36**	**kN/m2**	225 Facing Brick =	4.5
Plan Dead load =	**1.051**	**kN/m2**	**Existing Internal Walls**				
Live Load =	**0.6**	**kN/m2**	100 Brick (20kN/m3)=	2.1		Plaster & Lathe =	0.15
			Plaster & Skim =	0.36		**Dead Load =**	**4.65**
Flat Roof			**Dead Load =**	**2.46**	**kN/m2**		
20mm Asphalt =	0.46					**Beam & Block Ground Floors**	
Felt underlay =	0.02		**Timber Floors**			Beam & Block	3.1
insulation =	0.04		18mm Ply	0.15		Screed	1.4
Ply Sheeting =	0.1		Joists 50x225@400 =	0.16875		Insulation	0.07
Firring =	0.1		100 Insulation =	0.05		Finishes	0.05
of joists 50x200@400 =	0.15		Plaster & Skim =	0.18		**Dead Load =**	4.62
Plaster & Skim =	0.18		**Dead Load =**	**0.54875**	**kN/m2**	**Live Load =**	1.5
Plan Dead load =	**1.05**	**kN/m2**	**Live Load =**	**1.5**	**kN/m2**		
Live Load =	**0.75**	**kN/m2**	**Terrace Floor**			**Standing Seam**	
			Promonade Tiles =	0.4		Roof Sheet	0.08
Mansard Roof			20mm Asphalt =	0.46		Insulation	0.07
Slate Tiles =	0.4		Felt underlay =	0.02		Decking	0.2
Battens =	0.02		insulation =	0.04		Steelwork	0.6
Ply Sheeting =	0.125		Ply Sheeting =	0.1		**Dead Load =**	**0.95**
Rafters =	0.125		Firring =	0.1		**Live Load =**	**0.6**
100 Insulation =	0.06		Roof joists 50x200@400 =	0.175			
plaster & Skim =	0.18		Plaster & Skim =	0.18		**Filler joist Floor**	
Felt =	0.02		**Dead Load =**	**1.475**	**kN/m2**	Finishes	1.2
	0.93		**Live Load =**	**1.5**	**kN/m2**	Filler Joist Floor	2.5
			Ceiling			Ceiling	0.18
Roof Angle =	45	deg	50x100 Joists =	0.075		Steel	0.3
Plan Dead load =	**1.316**	**kN/m2**	100 Insulation =	0.06		**Dead Load =**	**4.18**
Live Load =	**0.3**	**kN/m2**	Plaster & Skim =	0.18		**Live Load =**	**3.5**
			Dead Load =	**0.315**	**kN/m2**		
Precast Floor on Steel			**Live Load =**	**0.25**	**kN/m2**		
200PC Floor units =	3.6						
60 Screed =	1.2						
Finishes =	0.1						
Steelwork =	0.6						
Dead Load =	**5.5**	**kN/m2**					
Live Load =	**3**	**kN/m2**					

Table 3 Live Load Reduction

Area			Floors		
	0	0%		1	0%
	50	5%		2	10%
	100	10%		3	20%
	150	15%		4	30%
	200	20%		5 to 10	40%

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Reference	basement plan									
Location		Area		Type	L	Load	Load kN			
	L	W	m2			kN/m2	Dead	%	Live	Total
internal wall A										
roof DL	3.2	1.0	3.2	g_k		1.05	3.4			
roof LL				q_k		0.75			2.4	
2nd fl DL	3.2	1.0	3.2	g_k		0.63	2.0			
2nd fl LL				q_k		1.50			4.8	
partitions DL	2.7	1.0	2.7	g_k		1.05	2.8			
1st fl DL	3.2	1.0	3.2	g_k		0.63	2.0			
1st fl LL				q_k		1.50			4.8	
partitions DL	3.0	1.0	3.0	g_k		1.05	3.2			
ground fl DL	3.2	1.0	3.2	g_k		4.62	14.8			
ground fl LL				q_k		1.50			4.8	
partitions DL	3.0	1.0	3.0	g_k		1.05	3.2			
							31.3	kN/m	16.8	kN/m
internal wall B										
roof DL	3.2	1.0	3.2	g_k		1.05	3.4			
roof LL				q_k		0.75			2.4	
2nd fl DL	3.2	1.0	3.2	g_k		0.63	2.0			
2nd fl LL				q_k		1.50			4.8	
partitions DL	2.7	1.0	2.7	g_k		1.05	2.8			
1st fl DL	3.2	1.0	3.2	g_k		0.63	2.0			
1st fl LL				q_k		1.50			4.8	
partitions DL	3.0	1.0	3.0	g_k		1.05	3.2			
ground fl DL	3.2	1.0	3.2	g_k		4.62	14.8			
ground fl LL				q_k		1.50			4.8	
partitions DL	3.0	1.0	3.0	g_k		1.05	3.2			
							31.3	kN/m	16.8	kN/m
wall 2										
ground fl DL	3.2	1.0	3.2	g_k		4.62	14.8			
ground fl LL				q_k		1.50			4.8	
partitions DL	3.0	1.0	3.0	g_k		1.05	3.2			
							17.9	kN/m	4.8	kN/m

INTERNAL WALL 1

RC WALL DESIGN (EN1992)

Loadings

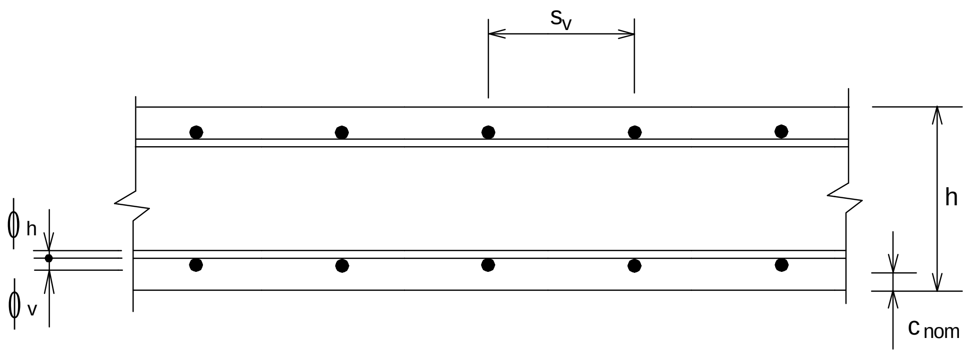
Dead loadDL=32kN/m

Live loadLL=17kN/m

RC WALL DESIGN

In accordance with EN1992-1-1:2004 incorporating corrigendum January 2008 and the UK national annex

Tedds calculation version 1.0.08



Wall geometry

Thickness	h = **300** mm	Length	b = **1000** mm/m
Stability about minor axis	**Braced**		

Concrete details

Concrete strength class	**C28/35**	Safety factor for concrete	γ_C = **1.50**
Coefficient α_{cc}	α_{cc} = **0.85**		
Maximum aggregate size	d_g = **20** mm		

Reinforcement details

Reinforcement in outer layer	**Vertical**	Nominal cover to outer layer	c_{nom} = **30** mm
Vertical bar diameter	ϕ_v = **16** mm	Horizontal bar diameter	ϕ_h = **10** mm
Spacing of vertical reinf	s_v = **100** mm	Spacing of horizontal reinft	s_h = **100** mm
Area of vertical reinft (per face)	A_{sv} = **2011** mm^2/m	Area of horiz. reinft (per face)	A_{sh} = **785** mm^2/m
Partial safety factor for reinft	γ_S = **1.15**	Modulus of elasticity of reinft	E_s = **200000** MPa

Fire resistance details

Fire resistance period	R = **60** min	Exposure to fire	**Exposed on two sides**
Ratio of fire design axial load to design resistance		μ_{fi} = **0.70**	

Axial load and bending moments from frame analysis

Design axial load	N_{Ed} = **73.5** kN/m		
Mt about minor axis at top	M_{top} = **7.0** kNm/m	Mt about minor axis at bottom	M_{btm} = **7.0** kNm/m

Wall effective length

Effective length	l_0 = **4000** mm

Check nominal cover for fire and bond requirements

Min. cover reqd for bond	$c_{min,b}$ = **16** mm	Min axis distance for fire	a_{fi} = **10** mm

Allowance for deviations	Δc_{dev} = **10** mm	Min allowable nominal cover	c_{nom_min} = **26.0** mm

PASS - the nominal cover is greater than the minimum required

Wall slenderness

Slenderness ratio	λ = **46.2**	Slenderness limit	λ_{lim} = **103.9**

$\lambda < \lambda_{lim}$ - Second order effects may be ignored

Design bending moment

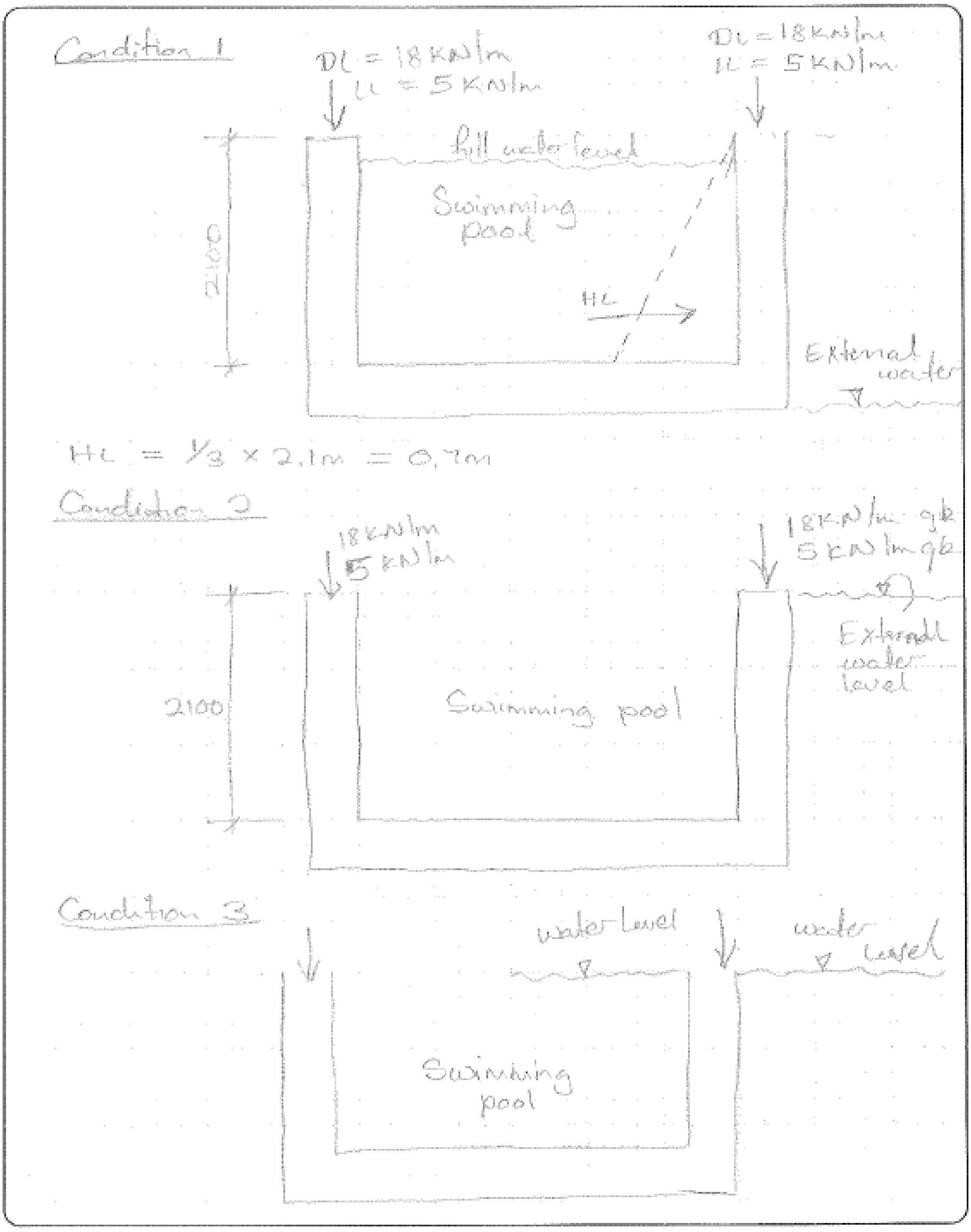
Design mt about minor axis M_{Ed} = **7.7** kNm/m

Moment of resistance

Mt of resist. about minor axis M_{Rd} = **215.4** kNm/m

PASS - The moment of resistance about the minor axis exceeds the design bending moment

WALL 2 (CONDITION 1)



RETAINING WALL ANALYSIS & DESIGN (EN1992/EN1996/EN1997)

RETAINING WALL ANALYSIS

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.6.04

Retaining wall details

Stem type	Cantilever		
Stem height	h_{stem} = **2100** mm		
Prop height	h_{prop} = **2000** mm		
Stem thickness	t_{stem} = **300** mm		
Angle to rear face of stem	α = **90** deg		
Stem density	γ_{stem} = **25** kN/m^3		
Toe length	l_{toe} = **1000** mm		
Heel length	l_{heel} = **1000** mm		
Base thickness	t_{base} = **350** mm		
Base density	γ_{base} = **25** kN/m^3		
Height of retained soil	h_{ret} = **2100** mm	Angle of soil surface	β = **0** deg
Depth of cover	d_{cover} = **0** mm		

Retained soil properties

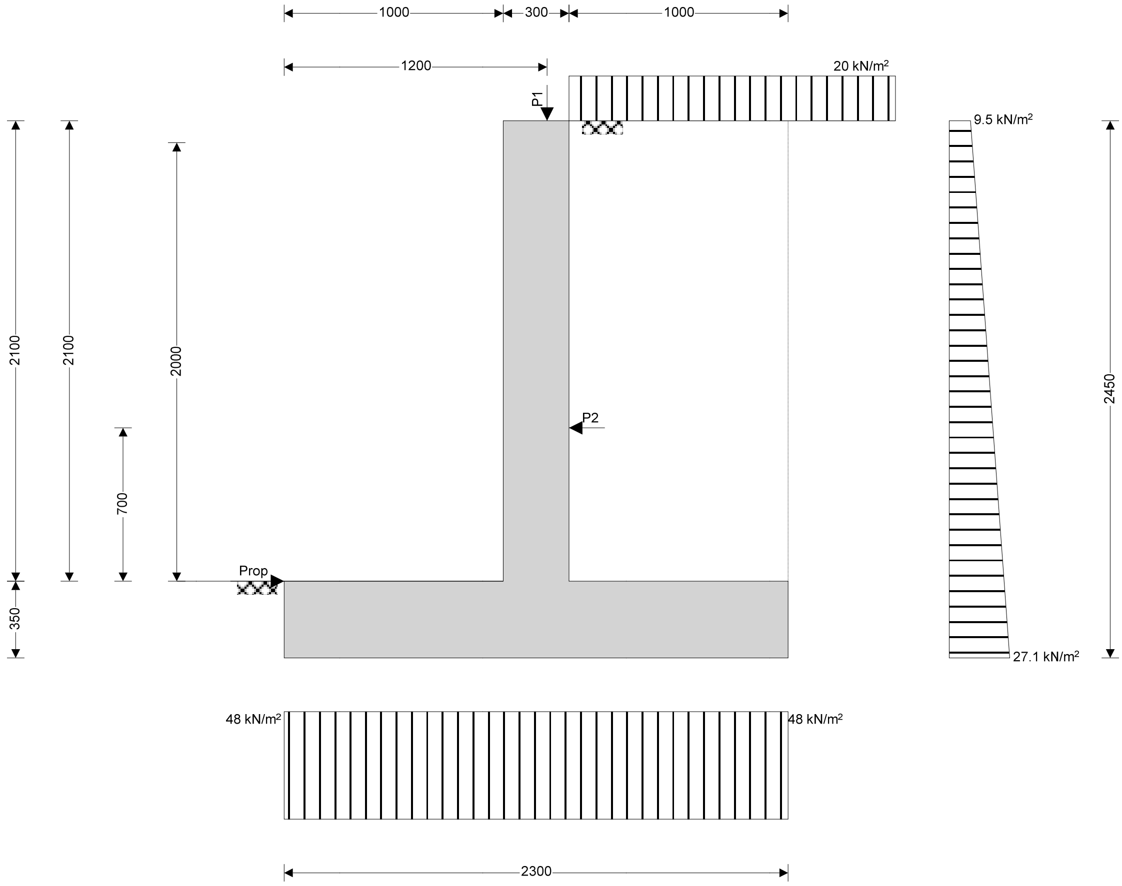
Soil type	Organic clay	
Moist density	γ_{mr} = **15** kN/m^3	
Saturated density	γ_{sr} = **15** kN/m^3	
Characteristic effective shear resistance angle		$\phi'_{r.k}$ = **18** deg
Characteristic wall friction angle	$\delta_{r.k}$ = **9** deg	

Base soil properties

Soil type	Medium dense well graded sand	
Moist density	γ_{mb} = **18** kN/m^3	
Characteristic effective shear resistance angle		$\phi'_{b.k}$ = **30** deg
Characteristic wall friction angle	$\delta_{b.k}$ = **15** deg	
Characteristic base friction angle		$\delta_{bb.k}$ = **30** deg
Presumed bearing capacity	$P_{bearing}$ = **150** kN/m^2	

Loading details

Permanent surcharge load	$Surcharge_G$ = **10** kN/m^2
Variable surcharge load	$Surcharge_Q$ = **10** kN/m^2
Vertical line load at 1200 mm	P_{G1} = **18** kN/m
	P_{Q1} = **5** kN/m
Horizontal line load at 700 mm	P_{G2} = **-10** kN/m
	P_{Q2} = **-10** kN/m



Calculate retaining wall geometry

Base length	l_{base} = **2300** mm		
Moist soil height	h_{moist} = **2100** mm		
Length of surcharge load	l_{sur} = **1000** mm		
Vertical distance	x_{sur_v} = **1800** mm		
Effective height of wall	h_{eff} = **2450** mm		
Horizontal distance	x_{sur_h} = **1225** mm		
Area of wall stem	A_{stem} = **0.63** m^2	Vertical distance	x_{stem} = **1150** mm
Area of wall base	A_{base} = **0.805** m^2	Vertical distance	x_{base} = **1150** mm
Area of moist soil	A_{moist} = **2.1** m^2	Vertical distance	x_{moist_v} = **1800** mm
		Horizontal distance	x_{moist_h} = **817** mm

Using Coulomb theory

Active pressure coefficient	K_A = **0.483**	Passive pressure coefficient	K_P = **4.977**

Bearing pressure check

Vertical forces on wall

Total $F_{total\_v} = F_{stem} + F_{base} + F_{moist\_v} + F_{sur\_v} + F_{P\_v}$ = **110.4** kN/m

Horizontal forces on wall

Total $F_{total\_h} = F_{moist\_h} + F_{pass\_h} + F_{sur\_h} + F_{P\_h}$ = **19.6** kN/m

Moments on wall

Total $M_{total} = M_{stem} + M_{base} + M_{moist} + M_{sur} + M_P$ = **136.4** kNm/m

Check bearing pressure

Propping force	F_{prop_base} = **19.6** kN/m		
Bearing pressure at toe	q_{toe} = **48** kN/m^2	Bearing pressure at heel	q_{heel} = **48** kN/m^2
Factor of safety	FoS_{bp} = **3.126**		

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

RETAINING WALL DESIGN

In accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 2.6.04

Concrete details - Table 3.1 - Strength and deformation characteristics for concrete

Concrete strength class C30/37

Char.comp.cylinder strength f_{ck} = **30** N/mm^2 Mean axial tensile strength f_{ctm} = **2.9** N/mm^2

Secant modulus of elasticity E_{cm} = **32837** N/mm^2 Maximum aggregate size h_{agg} = **20** mm

Design comp.concrete strength f_{cd} = **17.0** N/mm^2 Partial factor γ_C = **1.50**

Reinforcement details

Characteristic yield strength f_{yk} = **500** N/mm^2 Modulus of elasticity E_s = **200000** N/mm^2

Design yield strength f_{yd} = **435** N/mm^2 Partial factor γ_S = **1.15**

Cover to reinforcement

Front face of stem c_{sf} = **40** mm Rear face of stem c_{sr} = **50** mm

Top face of base c_{bt} = **50** mm Bottom face of base c_{bb} = **75** mm

Check stem design at base of stem

Depth of section h = **300** mm

Rectangular section in flexure - Section 6.1

Design bending moment M = **37.9** kNm/m K = **0.021** K' = **0.207**

K' > K - No compression reinforcement is required

Tens.reinforcement required $A_{sr.req}$ = **376** mm^2/m

Tens.reinforcement provided 12 dia.bars @ 200 c/c Tens.reinforcement provided $A_{sr.prov}$ = **565** mm^2/m

Min.area of reinforcement $A_{sr.min}$ = **368** mm^2/m Max.area of reinforcement $A_{sr.max}$ = **12000** mm^2/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Deflection control - Section 7.4

Limiting span to depth ratio 67.1 Actual span to depth ratio 8.6

PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3

Limiting crack width w_{max} = **0.3** mm Maximum crack width w_k = **0.189** mm

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force V = **39.9** kN/m Design shear resistance $V_{Rd.c}$ = **123** kN/m

PASS - Design shear resistance exceeds design shear force

Horizontal reinforcement parallel to face of stem - Section 9.6

Min.area of reinforcement $A_{sx.req}$ = **300** mm^2/m Max.spacing of reinforcement s_{sx_max} = **400** mm

Trans.reinforcement provided 10 dia.bars @ 200 c/c Trans.reinforcement provided $A_{sx.prov}$ = **393** mm^2/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Check base design at toe

Depth of section h = **350** mm

Rectangular section in flexure - Section 6.1

Design bending moment M = **27** kNm/m K = **0.012** K' = **0.207**

K' > K - No compression reinforcement is required

Tens.reinforcement required $A_{bb.req}$ = **243** mm^2/m

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Tens.reinforcement provided 12 dia.bars @ 200 c/c Tens.reinforcement provided $A_{bb.prov}$ = **565** mm²/m

Min.area of reinforcement $A_{bb.min}$ = **405** mm²/m Max.area of reinforcement $A_{bb.max}$ = **14000** mm²/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Limiting crack width w_{max} = **0.3** mm Maximum crack width w_k = **0.259** mm

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force V = **54** kN/m Design shear resistance $V_{Rd.c}$ = **131.1** kN/m

PASS - Design shear resistance exceeds design shear force

Rectangular section in flexure - Section 6.1

Design bending moment M = **8.5** kNm/m K = **0.003** K' = **0.207**

K' > K - No compression reinforcement is required

Tens.reinforcement required $A_{bt.req}$ = **70** mm²/m

Tens.reinforcement provided 12 dia.bars @ 200 c/c Tens.reinforcement provided $A_{bt.prov}$ = **565** mm²/m

Min.area of reinforcement $A_{bt.min}$ = **443** mm²/m Max.area of reinforcement $A_{bt.max}$ = **14000** mm²/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Limiting crack width w_{max} = **0.3** mm Maximum crack width w_k = **0.043** mm

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force V = **17.1** kN/m Design shear resistance $V_{Rd.c}$ = **138.9** kN/m

PASS - Design shear resistance exceeds design shear force

Secondary transverse reinforcement to base - Section 9.3

Min.area of reinforcement $A_{bx.req}$ = **113** mm²/m Max.spacing of reinforcement s_{bx_max} = **450** mm

Trans.reinforcement provided 10 dia.bars @ 200 c/c Trans.reinforcement provided $A_{bx.prov}$ = **393** mm²/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

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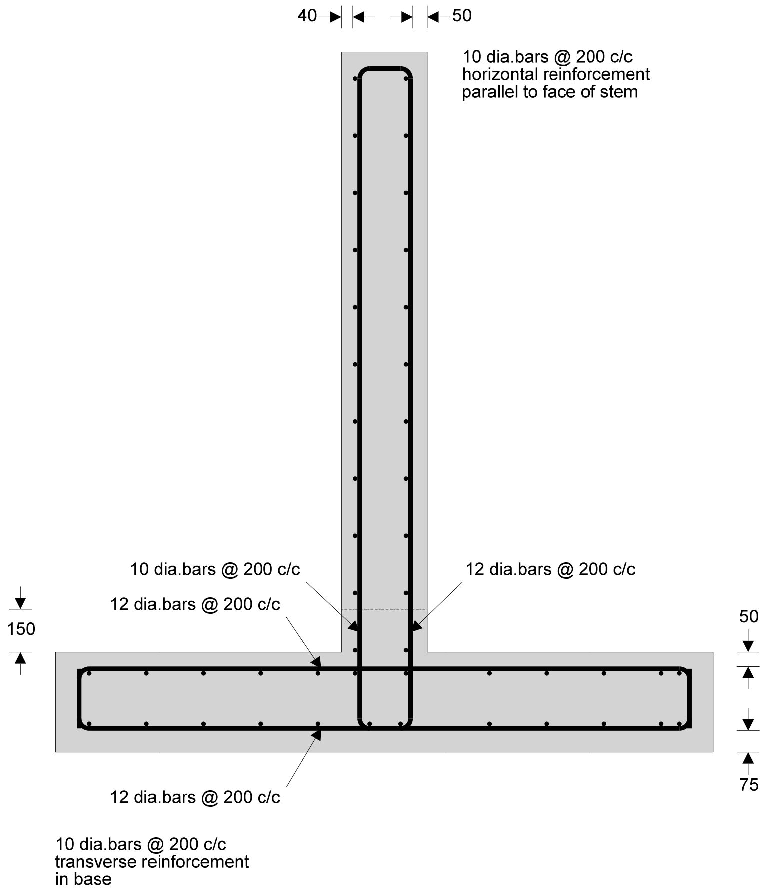

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WALL 2 (CONDITION 2)

RETAINING WALL ANALYSIS & DESIGN (EN1992/EN1996/EN1997)

RETAINING WALL ANALYSIS

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.6.04

Retaining wall details

Stem type	Cantilever		
Stem height	h_{stem} = **2100** mm		
Prop height	h_{prop} = **2000** mm		
Stem thickness	t_{stem} = **350** mm		
Angle to rear face of stem	α = **90** deg		
Stem density	γ_{stem} = **25** kN/m^3		
Toe length	l_{toe} = **1000** mm		
Heel length	l_{heel} = **300** mm		
Base thickness	t_{base} = **350** mm		
Base density	γ_{base} = **25** kN/m^3		
Height of retained soil	h_{ret} = **2100** mm	Angle of soil surface	β = **0** deg
Depth of cover	d_{cover} = **0** mm		
Height of water	h_{water} = **2100** mm		
Water density	γ_w = **9.8** kN/m^3		

Retained soil properties

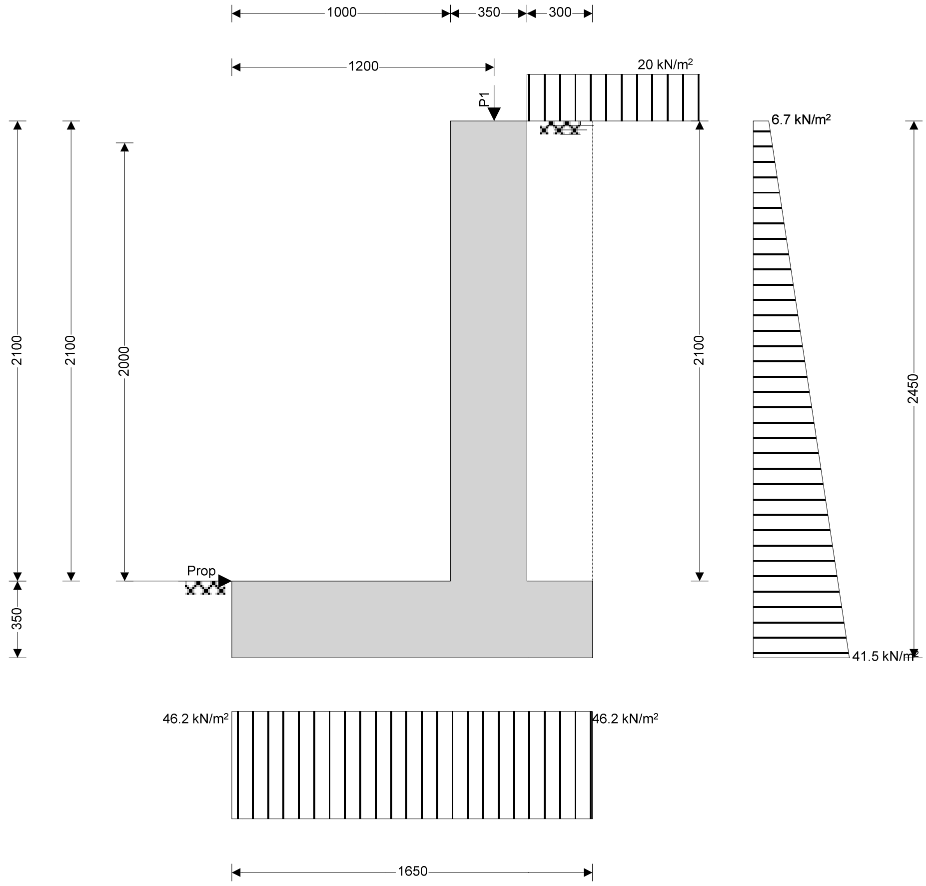
Soil type	Medium dense well graded sand	
Moist density	γ_{mr} = **21** kN/m^3	
Saturated density	γ_{sr} = **23** kN/m^3	
Characteristic effective shear resistance angle		$\phi'_{r.k}$ = **30** deg
Characteristic wall friction angle	$\delta_{r.k}$ = **0** deg	

Base soil properties

Soil type	Medium dense well graded sand	
Moist density	γ_{mb} = **18** kN/m^3	
Characteristic effective shear resistance angle		$\phi'_{b.k}$ = **30** deg
Characteristic wall friction angle	$\delta_{b.k}$ = **15** deg	
Characteristic base friction angle		$\delta_{bb.k}$ = **30** deg
Presumed bearing capacity	$P_{bearing}$ = **150** kN/m^2	

Loading details

Permanent surcharge load	$Surcharge_G$ = **10** kN/m^2
Variable surcharge load	$Surcharge_Q$ = **10** kN/m^2
Vertical line load at 1200 mm	P_{G1} = **18** kN/m
	P_{Q1} = **5** kN/m



Calculate retaining wall geometry

Base length	l_{base} = **1650** mm		
Saturated soil height	h_{sat} = **2100** mm		
Moist soil height	h_{moist} = **0** mm		
Length of surcharge load	l_{sur} = **300** mm		
Vertical distance	x_{sur_v} = **1500** mm		
Effective height of wall	h_{eff} = **2450** mm		
Horizontal distance	x_{sur_h} = **1225** mm		
Area of wall stem	A_{stem} = **0.735** m^2	Vertical distance	x_{stem} = **1175** mm
Area of wall base	A_{base} = **0.578** m^2	Vertical distance	x_{base} = **825** mm
Area of saturated soil	A_{sat} = **0.63** m^2	Vertical distance	x_{sat_v} = **1500** mm
		Horizontal distance	x_{sat_h} = **817** mm
Area of water	A_{water} = **0.63** m^2	Vertical distance	x_{water_v} = **1500** mm
		Horizontal distance	x_{water_h} = **817** mm

Using Coulomb theory

Active pressure coefficient K_A = **0.333** Passive pressure coefficient K_P = **4.977**

Bearing pressure check

Vertical forces on wall

Total $F_{total\_v} = F_{stem} + F_{base} + F_{sat\_v} + F_{water\_v} + F_{sur\_v} + F_{P\_v}$ = **76.3** kN/m

Horizontal forces on wall

Total $F_{total\_h} = F_{sat\_h} + F_{moist\_h} + F_{pass\_h} + F_{water\_h} + F_{sur\_h}$ = **53.7** kN/m

Moments on wall

Total $M_{total} = M_{stem} + M_{base} + M_{sat} + M_{moist} + M_{water} + M_{sur} + M_P$ = **37** kNm/m

Check bearing pressure

Propping force	F_{prop_base} = **53.7** kN/m		
Bearing pressure at toe	q_{toe} = **46.2** kN/m^2	Bearing pressure at heel	q_{heel} = **46.2** kN/m^2
Factor of safety	FoS_{bp} = **3.244**		

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

<u>RETAINING WALL DESIGN</u>

In accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 2.6.04

Concrete details - Table 3.1 - Strength and deformation characteristics for concrete

Concrete strength class	C30/37		
Char.comp.cylinder strength	f_{ck} = **30** N/mm^2	Mean axial tensile strength	f_{ctm} = **2.9** N/mm^2
Secant modulus of elasticity	E_{cm} = **32837** N/mm^2	Maximum aggregate size	h_{agg} = **20** mm
Design comp.concrete strength	f_{cd} = **17.0** N/mm^2	Partial factor	γ_C = **1.50**

Reinforcement details

Characteristic yield strength	f_{yk} = **500** N/mm^2	Modulus of elasticity	E_s = **200000** N/mm^2
Design yield strength	f_{yd} = **435** N/mm^2	Partial factor	γ_S = **1.15**

Cover to reinforcement

Front face of stem	c_{sf} = **40** mm	Rear face of stem	c_{sr} = **50** mm
Top face of base	c_{bt} = **50** mm	Bottom face of base	c_{bb} = **75** mm

Check stem design at base of stem

Depth of section h = **350** mm

Rectangular section in flexure - Section 6.1

Design bending moment	M = **50.6** kNm/m	K = **0.019**	K' = **0.207**

K' > K - No compression reinforcement is required

Tens.reinforcement required	$A_{sr.req}$ = **416** mm^2/m		
Tens.reinforcement provided	12 dia.bars @ 100 c/c	Tens.reinforcement provided	$A_{sr.prov}$ = **1131** mm^2/m
Min.area of reinforcement	$A_{sr.min}$ = **443** mm^2/m	Max.area of reinforcement	$A_{sr.max}$ = **14000** mm^2/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Deflection control - Section 7.4

Limiting span to depth ratio	76.8	Actual span to depth ratio	7.1

PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3

Limiting crack width	w_{max} = **0.3** mm	Maximum crack width	w_k = **0.115** mm

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force	V = **62.2** kN/m	Design shear resistance	$V_{Rd.c}$ = **138.9** kN/m

PASS - Design shear resistance exceeds design shear force

Horizontal reinforcement parallel to face of stem - Section 9.6

Min.area of reinforcement	$A_{sx.req}$ = **350** mm^2/m	Max.spacing of reinforcement	s_{sx_max} = **400** mm
Trans.reinforcement provided	10 dia.bars @ 200 c/c	Trans.reinforcement provided	$A_{sx.prov}$ = **393** mm^2/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Check base design at toe

Depth of section h = **350** mm

Rectangular section in flexure - Section 6.1

Design bending moment M = **25.7** kNm/m K = **0.012** K' = **0.207**

K' > K - No compression reinforcement is required

Tens.reinforcement required $A_{bb.req}$ = **231** mm^2/m

Tens.reinforcement provided 12 dia.bars @ 200 c/c Tens.reinforcement provided $A_{bb.prov}$ = **565** mm^2/m

Min.area of reinforcement $A_{bb.min}$ = **405** mm^2/m Max.area of reinforcement $A_{bb.max}$ = **14000** mm^2/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Limiting crack width w_{max} = **0.3** mm Maximum crack width w_k = **0.247** mm

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force V = **51.3** kN/m Design shear resistance $V_{Rd.c}$ = **131.1** kN/m

PASS - Design shear resistance exceeds design shear force

Rectangular section in flexure - Section 6.1

Design bending moment M = **1.9** kNm/m K = **0.001** K' = **0.207**

K' > K - No compression reinforcement is required

Tens.reinforcement required $A_{bt.req}$ = **16** mm^2/m

Tens.reinforcement provided 12 dia.bars @ 200 c/c Tens.reinforcement provided $A_{bt.prov}$ = **565** mm^2/m

Min.area of reinforcement $A_{bt.min}$ = **443** mm^2/m Max.area of reinforcement $A_{bt.max}$ = **14000** mm^2/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Limiting crack width w_{max} = **0.3** mm Maximum crack width w_k = **0.013** mm

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force V = **12.7** kN/m Design shear resistance $V_{Rd.c}$ = **138.9** kN/m

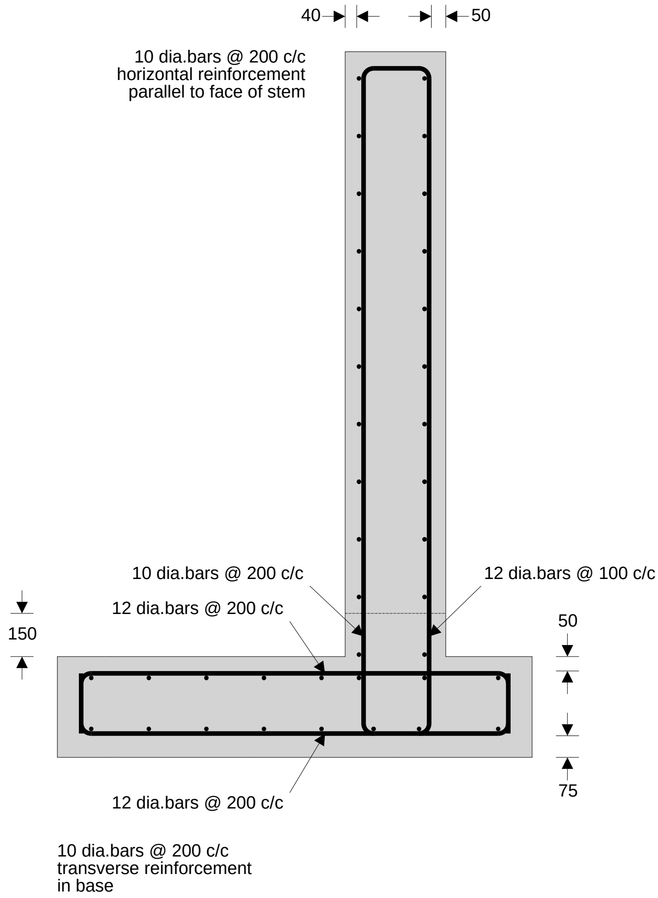
PASS - Design shear resistance exceeds design shear force

Secondary transverse reinforcement to base - Section 9.3

Min.area of reinforcement $A_{bx.req}$ = **113** mm^2/m Max.spacing of reinforcement s_{bx_max} = **450** mm

Trans.reinforcement provided 10 dia.bars @ 200 c/c Trans.reinforcement provided $A_{bx.prov}$ = **393** mm^2/m

PASS - Area of reinforcement provided is greater than area of reinforcement required



WALL 2 (CONDITION 3)

Water is on both sides of the wall therefer the wall is more stable

Appendix B : Ground Movement Assessment Calculations

These calculations are for the scheme design only and should not be used at detailed design or construction stage.

Separate assessments are done for the main part of the basement and for the swimming pool.

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Project: 1A St Johns Wood Park, NW8	Section	Sheet
Date: Jan-16 By: GW Checked	Rev / Date / Description	
Job No: 150607	Status	Rev

Ref

Movement of 1 St John's Wood Park affected by closest excavation

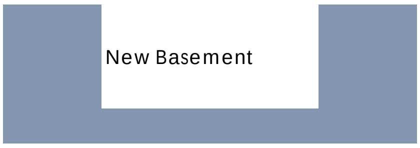
Neighbouring building

Building width, L = **12000** mm

Distance to furthest point of building from excavation & installation, L_1 **13000** mm

Height H= **9000** mm

L/H = 1.33



Excav'n depth H_b= **3.5** m

wall (pile) depth, D = 10.5 m

Movement Assessment CIRIA C580: Embedded retaining walls - guidance for ecomonic design

Potential movement due to installation of wall

using parameters from Table 2.2 of CIRIA C580 for contiguous bored piles

Horizontal Surface Movement / wall depth = -0.04%

max δ_h = -0.04% x 3.5 = -1.4 mm

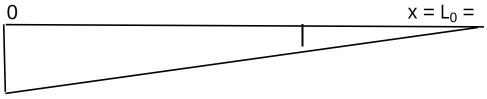
Distance behind wall to negligible movement (multiple of wall depth) = 1.5

L_0 = 10.5 x 1.5 = 15.75 m

Horizontal Movement gradient due to installation = -0.1 mm/m

(distances are measured from installed wall)

x = 0 x = L_0 = 15750 mm



(deflection graph is indicative and not to scale)

δ_h = -1.4 mm at x = 0

δ_h = -0.2 mm at x = L_1

strain across distance L_1 : ϵ_h = -0.009%

wall (pile) depth, D = 10.5 m

Vertical Surface Movement / wall depth = -0.04%

max δ_v = -0.04% x 3.5 = -1.4 mm

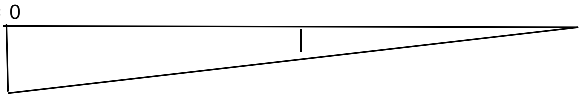
Distance behind wall to negligible movement (multiple of wall depth) = 2

L_0 = 10.5 x 2 = 21 m

Vertical Movement gradient due to installation = -0.1 mm/m

(distances are measured from excavation)

x = 0 x = L_0 = 21000 mm



(deflection graph is indicative and not to scale)

Δ = -1.4 mm at x = 0

Δ = -0.5 mm at x = L_1

strain across distance L_1 : Δ/L = -0.007%

Potential movement due to excavation of wall

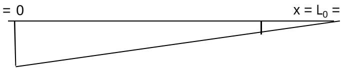
using parameters from Table 2.4 of CIRIA C580
(excavation will be propped during construction)

Horizontal Surface Movement / excavation depth = -0.15%

max δ_h = -0.15% x 3.5 = -5.25 mm
Distance behind wall wall to negligible movement (multiple of excavation depth) = 4
L_0 = 3.5 x 4 = 14 m

Horizontal Movement gradient due to excavation = -0.4 mm/m
(distances are measured from excavation)

x = 0 x = L_0 = 14000 mm
(deflection graph is indicative and not to scale)



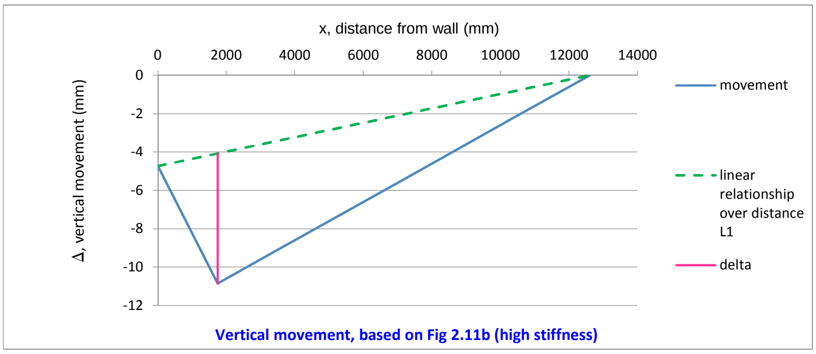
δ_h = -5.3 mm δ_h = -0.4 mm
at x = 0 at x = L_1

strain across distance L_1 : ϵ_h = -0.038%

Vertical Surface Movements

Distance behind wall wall to negligible movement (multiple of excavation depth) = 3.5
L_0 = 3.5 x 3.5 = 12.25 m

Vertical Movement due to excavation:



Relative vertical movement as defined by Figure 2.18 (a) in CIRIA C580
Δ = -6.8 mm Δ/L = -0.052%
at max sagging location

Total movement at wall location (excavation and installation)
Total Horizontal Movement (excavation and installation) δ_h = -6.7 mm
Total Vertical Movement (excavation and installation) Δ = -8.2 mm
Note: max relative vertical movements will not occur at the same dstance for excavation and installation.
However, these have been added and therefore the total vertical movement is conservative

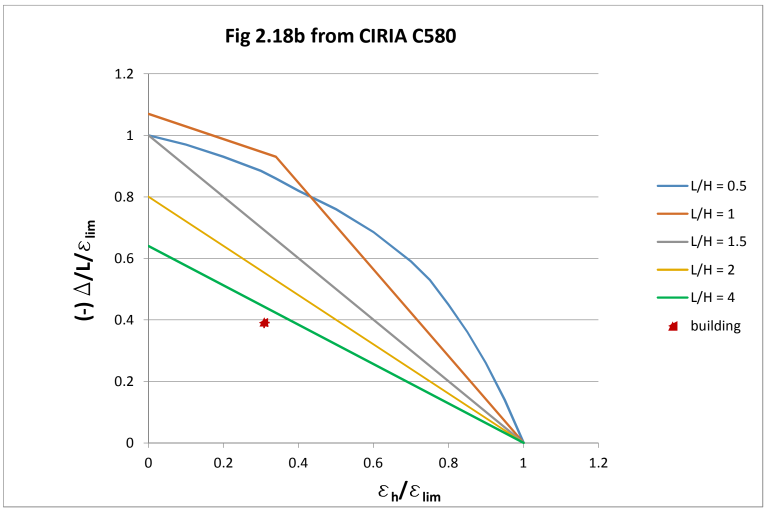
TOTAL STRAIN (EXCAVATION AND INSTALLATION)

Table 2.5 CIRIA C580

Category of Damage	Normal Degree	Limiting Tensile Strain %		
0	Negligible	0.00%	-	0.05%
1	Very slight	0.05%	-	0.075%
2	Slight	0.075%	-	0.15%
3	Moderate	0.15%	-	0.30%
4 to 5	Severe to Very Servere		>	0.30%

Anticipated Damage may be categorised as **'Negligible' to ' Slight' ; Category 0-2**
ϵ_{lim} = 0.150%

ϵ_h = -0.046% $\epsilon_h/\epsilon_{lim}$ = 0.31
Δ/L_1 = -0.059% $\Delta/L/\epsilon_{lim}$ = 0.39



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Project: 1A St Johns Wood Park, NW8	Section	Sheet
Date: Jan-16 By: GW Checked	Rev / Date / Description	
Job No: 150607	Status	Rev

Ref

Movement of 1 St John's Wood Park affected by deeper excavation

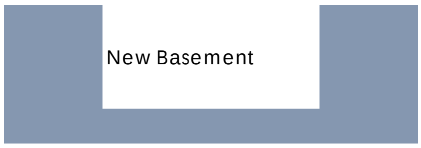
Neighbouring building

Building width, L = 12000 mm

Distance to furthest point of building from excavation & installation, L_1 13000 mm

Height H= 9000 mm

L/H = 1.33



Excav'n depth H_b= 6 m

wall (pile) depth, D = 18 m

Movement Assessment CIRIA C580: Embedded retaining walls - guidance for ecomonic design

Potential movement due to installation of wall

using parameters from Table 2.2 of CIRIA C580
for contiguous bored piles

Horizontal Surface Movement / wall depth = -0.04%

max δ_h = -0.04% x 6 = -2.4 mm

Distance behind wall to negligible movement (multiple of wall depth) = 1.5

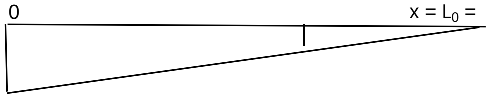
L_0 = 18 x 1.5 = 27 m

Horizontal Movement gradient due to installation = -0.1 mm/m

(distances are measured from installed wall)

x = 0 x = L_0 = 27000 mm

(deflection graph is indicative and not to scale)



δ_h = -2.4 mm at x = 0

δ_h = -1.2 mm at x = L_1

strain across distance L_1 : ϵ_h = -0.009%

wall (pile) depth, D = 18 m

Vertical Surface Movement / wall depth = -0.04%

max δ_v = -0.04% x 6 = -2.4 mm

Distance behind wall to negligible movement (multiple of wall depth) = 2

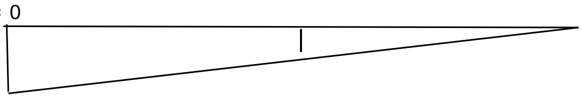
L_0 = 18 x 2 = 36 m

Vertical Movement gradient due to installation = -0.1 mm/m

(distances are measured from excavation)

x = 0 x = L_0 = 36000 mm

(deflection graph is indicative and not to scale)



Δ = -2.4 mm at x = 0

Δ = -1.5 mm at x = L_1

strain across distance L_1 : Δ/L = -0.007%

Potential movement due to excavation of wall

using parameters from Table 2.4 of CIRIA C580
(excavation will be propped during construction)

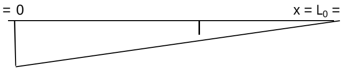
Horizontal Surface Movement / excavation depth = -0.15%

max δ_h = -0.15% x 6 = -9 mm
Distance behind wall wall to negligible movement (multiple of excavation depth) = 4
L_0 = 6 x 4 = 24 m

Horizontal Movement gradient due to excavation = -0.4 mm/m

(distances are measured from excavation)

x = 0 x = L_0 = 24000 mm



(deflection graph is indicative and not to scale)

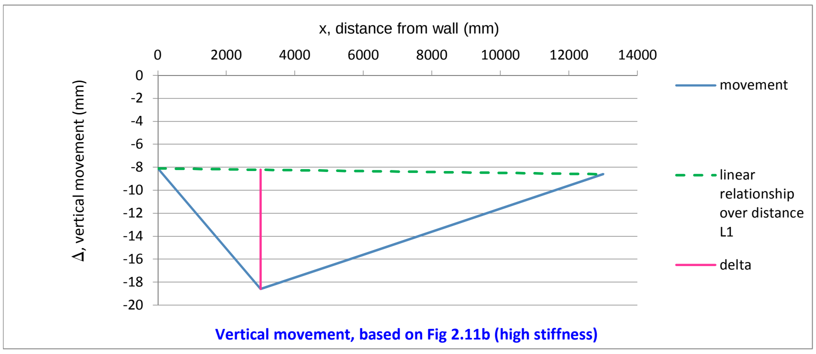
δ_h = -9.0 mm at x = 0
δ_h = -4.1 mm at x = L_1

strain across distance L_1 : ϵ_h = -0.038%

Vertical Surface Movements

Distance behind wall wall to negligible movement (multiple of excavation depth) = 3.5
L_0 = 6 x 3.5 = 21 m

Vertical Movement due to excavation:



Vertical movement, based on Fig 2.11b (high stiffness)

Relative vertical movement as defined by Figure 2.18 (a) in CIRIA C580
Δ = -10.4 mm
at max sagging location

Δ/L = -0.080%

Total movement at wall location (excavation and installation)
Total Horizontal Movement (excavation and installation) δ_h = -11.4 mm
Total Vertical Movement (excavation and installation) Δ = -12.8 mm

Note: max relative vertical movements will not occur at the same dstance for excavation and installation.
However, these have been added and therefore the total vertical movement is conservative

TOTAL STRAIN (EXCAVATION AND INSTALLATION)

Table 2.5 CIRIA C580

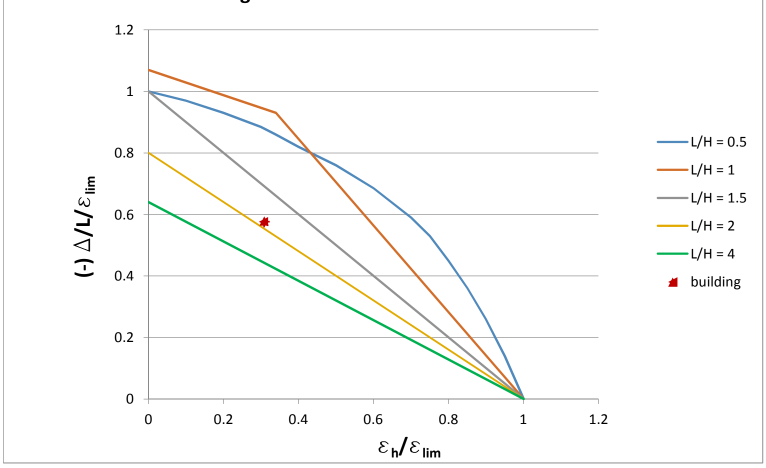
Category of Damage	Normal Degree	Limiting Tensile Strain %		
0	Negligible	0.00%	-	0.05%
1	Very slight	0.05%	-	0.075%
2	Slight	0.075%	-	0.15%
3	Moderate	0.15%	-	0.30%
4 to 5	Severe to Very Servere		>	0.30%

Anticipated Damage may be categorised as **'Negligible' to ' Slight' ; Category 0-2**

ϵ_{lim} = 0.150%

ϵ_h = -0.046% $\epsilon_h/\epsilon_{lim}$ = 0.31
Δ/L_1 = -0.087% $\Delta/L/\epsilon_{lim}$ = 0.58

Fig 2.18b from CIRIA C580



Appendix C : Construction Method Statement

Basement Method Statement

Site Details:

1B St Johns Wood Park
London
W8

Client Information:

Mike Ofori
Liv. International
1 Regency Parade
NW3 5EQ

CROFT STRUCTURAL ENGINEERS

1. Basement Formation Suggested Method Statement.

1.1. This method statement provides an approach which will allow the basement design to be correctly considered during construction, and the temporary support to be provided during the works. The Contractor is responsible for the works on site and the final temporary works methodology and design on this site and any adjacent sites.

1.2. This method statement for the development of 1a St Johns Wood Park. It has been written by a Chartered Engineer. The overall sequence is shown on drawing SL-50.

1.3. This proposed method has been developed to allow for improved costings and for inclusion in the Party Wall Award. Should the contractor provide alternative methodology the changes shall be at their own costs, and an Addendum to the Party Wall Award will be required.

1.4. Contact party wall surveyors to inform them of any changes to this method statement.

1.5. Contact the developers of any adjacent or nearby sites to inform them of the proposed works.

1.6. The approach followed in this design is:

  i. demolish the existing structures (garages)
  ii. install a contiguous piled wall with capping beam around the perimeter
  iii. excavate within the contiguous piled walls;
    - provide adequate propping, with propping to the head and include mass concrete thrust blocks for prop support at base
  iv. construct the new building from basement level upwards.

1.7. A soil investigation has been undertaken. The soil conditions are London Clay formation

1.8. The Chemical laboratory testing is revealed below. Lead specialists are to be called in before work commences to remove the lead from the ground and treat the soil. Work should only commence once lead contamination has been eliminated.

> Chemical laboratory testing revealed an elevated level of lead in one sample of Made Ground. A level of 470mg/kg was noted within BH1/0.30m bgl in excess of the LQM/CIEH S4ULs of 210mg/kg for a ***"Residential with homegrown produce"*** scenario.

1.9. The water is expected to be encountered at approximately 0.5m below ground level (BGL). Following piling around the perimeter, and during the subsequent excavations, dewater locally (create sumps from which water can be pumped out of).

1.10. The structural water proofer (not Croft) must comment on the proposed design and ensure that this will provide adequate water proofing.

1.1. Provide engineers with concrete mix, supplier, deliver and placement methods 2 weeks prior to first pour. Site mixing of concrete should not be employed apart from in small sections <1m^3. Contractor must provide method on how to achieve site mixing to the correct specification; the contractor must undertake tool box talks with staff to ensure site quality is maintained.

2. Enabling Works

2.1. The site is to be hoarded with ply sheet to 2.2m to prevent unauthorised public access.

2.2. Demolish the occupying garages. Refer to Section 4 for demolition proposals.

2.3. Licences for skips and conveyors to be posted on hoarding

2.4. On commencement of construction, the contractor should report any discrepancies to the structural engineer in order that the detailed design may be modified as necessary.

3. Piling Sequencing

For general piling procedures, refer to the piling contractor's method statement. The anticipated sequence is as follows:

3.1. Piles are to be installed at different levels and positions around the development. All piles are installed from the same level and cut down as required.

3.1.1. Prior to bringing the piling rig on site, check with the piling contractor the requirements of a working platform and install to their design and specification if required.

3.1.2. Mark out datum line to determine various surface heights

3.1.3. Mark out pile sequence locations as specified by Engineer's detailed design stage drawings.

3.1.4. Following the sequencing guidance from the Engineers detailed design stage drawings, mark out proposed pile position with a pair of reference markers at 1.0m from the pile pin, each forming a line to the pile, mutually rotated at 90 degrees.

3.1.5. Rig operator to set up over the pile pin position and position auger relative to reference marks. Directed and checked by banks man.

3.1.6. The flap at the tip of the auger is closed and secured. Auger tip lowered to ground level and position rechecked. Drilling to commence upon banks man approval.

3.1.7. Concrete is prepared while piling operatives grout up concrete pump, hoses and flight, concrete pump operator to check concrete complies with design mix. Concrete held in agitator.

3.1.8. Rig operator augers to require design depth. Reference makers are to be used to check pile position during the first few metres of drilling.

3.1.9. If obstruction encountered, Engineer to be notified of pile number and depth. Move rig to next pile position whilst obstruction removal is dealt with. Contractor to be advised on procedure should obstruction not be removable. If necessary, pile bores to be backfilled and made safe. Open excavation to be protected when open.

3.1.10. When design depth reached, the auger is to be kept rotating to allow spoil in the bore to rise.

3.1.11. Concrete can be pumped to rig while rig operator monitors instrumentation and adjust auger rate of withdrawal accordingly.

3.1.12. Pressure, concrete flow and over-break to be monitored throughout operation.

3.1.13. During the withdrawal the rig operator is to activate the flight cleaner. If an automatic cleaner is not fitted to the rig then the piling gang must clean the flight manually to prevent spoil/ arising travelling above head height – this will be controlled by the piling foreman who must ensure the auger is not rotating when it is manually cleaned.

3.1.14. When auger tip reaches platform level, concrete pumping is stopped.

3.1.15. Attendant excavator as directed by the banks man clears spoil and concrete slurry from pile heap.

3.1.16. Banks man to check position of the cage in the pile, centring where necessary. Reinforcement generally to be installed flush with Piling Platform Level (PPL). Anchor pile reinforcement or threaded bars that project above piling platform to have protective caps.

3.1.17. Concrete testing cube samples to be taken as per engineering specification.

3.1.18. Rig is moved onto next pile in the sequence and positioned as above, with piles installed as per points 3.1.5 – 3.1.12

3.1.19. Equipment to be cleaned and maintained as per normal methods.

3.1.20. This sequence of piling is to continue until all perimeter piles have been installed. As piling progresses wound perimeter, construct reinforced concrete capping beam to piles.

3.1.21. Excavate within the contiguous piled wall perimeter, construct mass concrete thrust blocks and install props as excavations progress.

3.1.21.1. <u>The piled wall should be propped until the permanent structure is complete (refer to item 3.2). Propping should include props to the head, ie to the capping beam. The contractor should provide proposals for propping to the structural engineer who is responsible for the detailed design of the permanent structure at least two weeks before the excavations commence.</u>

3.2. Once all piles have been installed, and bases for steel columns have been installed, the next step sequence is to install the steelwork at ground level. In the permanent condition, this will prop the external perimeter of the basement.

3.3. When steelwork has been set up, the excavation of the central mass can begin using mechanic excavators (an opening big enough to allow for access for machinery and spoil removal should be left).

3.4. As excavation continues down, a dewatering system will need to be considered. There are several methods of doing this but the most common method is to create sumps from which ground water can be pumped as mentioned in 1.9.

4. Demolition, Recycling, Dust/Noise Control and Site Hoarding

4.1. Demolition work is to take place within the hoarded confines of the materials such as stock bricks, timber etc. are to be recycled where possible. To minimise dust and dirt from demolition the following measures shall be implemented:

- 4.1.1. Any debris or dust or dirt falling on the street and public highway will be cleared as it occurs by designated cleaners and washed down fully every night.
- 4.1.2. Demolished materials are to be removed to a skip placed in front of the site which will be emptied regularly as required.
- 4.1.3. All brickwork and concrete demolition work is to be constantly watered to reduce airborne dust

4.2. Building work which can be heard at the boundary of the site will not be carried out on Sundays or bank holidays and will be carried out within working hours as agreed by the council.

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Appendix D : Monitoring Proposals

Job Number: 150607

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STRUCTURAL
ENGINEERS

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Clock Shop Mews
Rear of 60 Saxon Road
London SE25 5EH

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E: enquiries@croftse.co.uk
W: www.croftse.co.uk

Structural Monitoring Statement

Site Details:

1a St Johns Wood Park
Camden
NW8

Revision	Date	Comment
-	2.12.2015	First Issue

CROFT STRUCTURAL ENGINEERS

Contents

CROFT STRUCTURAL ENGINEERS

1. Introduction

Basement works are intended at 1a St Johns Wood Park. The structural works for this require Party Wall Awards. This statement describes the procedures for the Principal Contractor to follow to observe any movement that may occur to the existing properties, and also describes mitigation measures to apply if necessary.

2. Risk Assessment

The purpose of this risk assessment is to consider the impact of the proposed works and how they impact the party wall. There are varying levels of inspection that can be undertaken and not all works, soil conditions and properties require the same level of protection.

Monitoring Level Proposed	Type of Works.
Monitoring 1 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works.	Loft conversions, cross wall removals, insertion of padstones Survey of LUL and Network Rail tunnels. Mass concrete, reinforced and piled foundations to new build properties

Monitoring 2 Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate.	Removal of lateral stability and insertion of new stability fames Removal of main masonry load bearing walls. Underpinning works less than 1.2m deep
Monitoring 3 Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical monitoring movement by standard optical equipment	Lowering of existing basement and cellars more than 2.5m Underpinning works less than 3.0m deep in clays Basements up to 2.5m deep in clays
Monitoring 4 Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical monitoring movement by standard optical equipment Lateral movement between walls by laser measurements	New basements greater than 2.5m and shallower than 4m Deep in gravels Basements up to 4.5m deep in clays Underpinning works to Grade I listed building
Monitoring 5 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Vertical & lateral monitoring movement by theodolite at specific times during the projects.	Underpinning works to Grade I listed buildings Basements to Listed building Basements deeper than 4m in gravels Basements deeper than 4.5m in clays Underpinning, basements to buildings that are expressing defects.
Monitoring 6 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and	Double storey basements supported by piled retaining walls in gravels and soft

also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical & lateral monitoring movement by electronic means with live data gathering. Weekly interpretation	sands. (N<12)
Monitoring 7 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical & lateral monitoring movement by electronic means with live data gathering with data transfer.	Larger multi-storey basements on particular projects.

3. Scheme Details

This document has been prepared by Croft Structural Engineers Ltd. It covers the proposed construction of a new basement for 1A St Johns Wood Park. Most of the basement will require excavations no greater than 3.5m deep. To the rear of the property, a portion of the basement will require excavations greater than 4.5m (down to 6m below ground level). Therefore monitoring level 5 is proposed for this development.

Scope of Works

The works comprise:

- Visual Monitoring of the party wall
- Attachment of Tell tales or Demec Studs to accurately record movement of significant cracks.
- Attachment of levelling targets to monitor settlement.
- The monitoring of the above instrumentation is in accordance with Appendix A. The number and precise locations of instrumentation may change during the works; this shall be subject to agreement with the Principal Contractor (PC).
- All instruments are to be adequately protected against any damage from construction plant or private vehicles using clearly visible markings and suitable head protection e.g. manhole rings or similar. Any damaged instruments are to be immediately replaced or repaired at the contractors own cost.
- Reporting of all data in a manner easily understood by all interested parties.

- Co-ordination of these monitoring works with other site operations to ensure that all instruments can be read and can be reviewed against specified trigger values both during and post construction.
- Regular site meetings by the Principal Contractor (PC) and the Monitoring Surveyor (MS) to review the data and their implications.
- Review of data by Croft Structural Engineers

In addition, the PC will have responsibility for the following:

- Review of methods of working/operations to limit movements, and
- Implementation of any emergency remedial measures if deemed necessary by the results of the monitoring.

The Monitoring Surveyor shall allow for settlement and crack monitoring measures to be installed and monitored on various parts of the structure described in Table 1 as directed by the PC and Party Wall Surveyor (PWS) for the Client.

Item	Instrumentation Type
Party Wall Brickwork	
Settlement monitoring	Levelling equipment & targets
Crack monitoring	Visual inspection of cracking, Demec studs where necessary

Table 1: Instrumentation

General

The site excavations and substructure works up to finished ground slab stage have the potential to cause vibration and ground movements in the vicinity of the site due to the following:

a) Removal of any existing redundant foundations / obstructions;
b) Installation of reinforced concrete retaining walls under the existing footings;
c) Excavations within the site

The purpose of the monitoring is a check to confirm building movements are not excessive.

This specification is aimed at providing a strategy for monitoring of potential ground and building movements at the site.

This specification is intended to define a background level of monitoring. The PC may choose to carry out additional monitoring during critical operations. Monitoring that should be carried out is as follows:

a) Visual inspection of the party wall and any pre-existing cracking
b) Settlement of the party wall

All instruments are to be protected from interference and damage as part of these works.

Access to all instrumentation or monitoring points for reading shall be the responsibility of the Monitoring Surveyor (MS). The MS shall be in sole charge for ensuring that all instruments or monitoring points can be read at each visit and for reporting of the data in a form to be agreed with the PWS. He shall inform the PC if access is not available to certain instruments and the PC will, wherever possible, arrange for access. He shall immediately report to the PC any damage. The Monitoring Surveyor and the Principal Contractor will be responsible for ensuring that all the instruments that fall under their respective remits as specified are fully operational at all times and any defective or damaged instruments are immediately identified and replaced.

The PC shall be fully responsible for reviewing the monitoring data with the MS - before passing it on to Croft Structural Engineers - determining its accuracy and assessing whether immediate action is to be taken by him and/or other contractors on site to prevent damage to instrumentation or to ensure safety of the site and personnel. All work shall comply with the relevant legislation, regulations and manufacturer's instructions for installation and monitoring of instrumentation.

Applicable Standards and References

The following British Standards and civil engineering industry references are applicable to the monitoring of ground movements related to activities on construction works sites:

1. BS 5228: Part 1: 1997 - Noise and Vibration Control on Construction and Open Sites -Part 1.Code of practice for basic information and procedures for noise and vibration control, Second Edition, BSI 1999.
2. BS 5228: Part 2: 1997 - Noise and Vibration Control on Construction and Open Sites -Part 2.Guide to noise and vibration control legislation for construction and demolition including road construction and maintenance, Second Edition, BSI 1997.
3. BS 7385-1: 1990 (ISO 4866:1990) - Evaluation and measurement for vibration in buildings - Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings, First Edition, BSI 1990.
4. BS 7385-2: 1993 - Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from ground-borne vibration, First Edition, BSI 1999.
5. CIRIA SP 201 - Response of buildings to excavation-induced ground movements, CIRIA 2001.

SPECIFICATION FOR INSTRUMENTATION

General

The Monitoring Contractor is required to monitor, protect and reinstall instruments as described. The readings are to be recorded and reported. The following instruments are defined:

a) Automatic level and targets: A device which allows the measurement of settlement in the vertical axis. To be installed by the MS.

b) Tell-tales and 3 stud sets: A device which allows measurement of movement to be made in two axes perpendicular to each other. To be installed by the MS.

Monitoring of existing cracks

The locations of tell-tales or Demec studs to monitor existing cracks shall be agreed with Croft Structural Engineers.

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Instrument Installation Records and Reports

Where instrumentation is to be installed or reinstalled, the Monitoring Surveyor, or the Principal Contractor, as applicable, shall make a complete record of the work. This should include the position and level of each instrument. The records shall include base readings and measurements taken during each monitoring visit. Both tables and graphical outputs of these measurements shall be presented in a format to be agreed with the CM. The report shall include photographs of each type of instrumentation installed and clear scaled sections and plans of each instrument installed. This report shall also include the supplier's technical fact sheet on the type of instrument used and instructions on monitoring.

Two signed copies of the report shall be supplied to the PWS within one week of completion of site measurements for approval.

Installation

All instruments shall be installed to the satisfaction of the PC. No loosening or disturbance of the instrument with use or time shall be acceptable. All instruments are to be clearly marked to avoid damage.

All setting out shall be undertaken by the Monitoring Surveyor or the Principal Contractor as may be applicable. The precise locations will be agreed by the PC prior to installation of the instrument.

The installations are to be managed and supervised by the Instrumentation Engineer or the Measurement Surveyor as may be applicable.

Monitoring

The frequencies of monitoring for each Section of the Works are given in Appendix A.

The following accuracies/ tolerances shall be achieved:

Party Wall settlement	±1.5mm
Crack monitoring	±0.75mm

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REPORT OF RESULTS AND TRIGGER LEVELS

General

Within 24 hours of taking the readings, the Monitoring Surveyor will submit a single page summary of the recorded movements. All readings shall be immediately reviewed by Croft Structural Engineers prior to reporting to the PWS.

Within one working day of taking the readings the Monitoring Contractor shall produce a full report (see below).

The following system of control shall be employed by the PC and appropriate contractors for each section of the works. The Trigger value, at which the appropriate action shall be taken, for each section, is given in Table 2, below.

The method of construction by use of sequential piles limits the deflections in the party wall.

Between the trigger points, which are no greater than 2 m apart, there should be no more than:

Allowable movement to BS5950 for brittle finishes

Vertical = Span / 360 = 4000mm / 360 = 11.1mm

Croft proposes a tighter recommendation of Span / 500
= Span / 900 = 4000mm / 900 = 4mm

Above Monitoring Level 3, lateral movement is required to be measured and the figures should be:

Horizontal = Height / 500 = 5000mm / 500 = 10mm

Croft proposes a tighter recommendation of
= Height / 900 = 5000mm / 900 = 5mm

The reference height is the sum of the depth of the excavation (3.5m) and the position of the monitoring stud above ground level (1.5m). For the pool excavation (6m deep) the lateral movement limits are as follows:

Horizontal = Height / 500 = 7500mm / 500 = 15mm

Croft proposes a tighter recommendation to match the excavation of the rest of the basement, i.e. 5mm.

During works measurements are taken, these are compared with the limits set out below:

MOVEMENT		CATEGORY	ACTION
Vertical	Horizontal		
0mm-4mm	0-5mm	Green	No action required
4mm-7mm	5-7mm	AMBER	Detailed review of Monitoring: Check studs are OK and have not moved. Ensure site staff have not moved studs. If studs have moved reposition. Relevel to ensure results are correct and tolerance is not a concern. Inform Party Wall surveyors of amber readings. Double the monitoring for 2 further readings. If stable revert back. Carry out a local structural review and inspection. Preparation for the implementation of remedial measures should be required. Double number of lateral props
7mm-10mm	7-9mm		Implement remedial measures review method of working and ground conditions
>10mm	>9mm	RED	Implement structural support as required; Cease works with the exception of necessary works for the safety and stability of the structure and personnel; Review monitoring data and implement revised method of works

Table 2 – Movement limits between adjacent sets of Tell-tales or stud sets

Any movements which exceed the individual amber trigger levels for a monitoring measure given in Table 2 shall be immediately reported to the PWS, and a review of all of the current monitoring data for all monitoring measures must be implemented to determine the possible causes of the trigger level being exceeded. Monitoring of the affected location must be increased and the actions described above implemented. Assessment of exceeded trigger levels must not be carried out in isolation from an assessment of the entire monitoring regime as the monitoring measures are inter-related. Where required, measures may be implemented or prepared as determined by the specific situation and combination of observed monitoring measurement data.

Standard Reporting

1 No. electronic copy of the report in PDF format shall be submitted to the PWS.

The Monitoring Surveyor shall report whether the movements are within (or otherwise) the Trigger Levels indicated in Table 2. A summary of the extent of completion of any of the elements of works and any other significant events shall be given. These works shall be shown in the form of annotated plans (and sections) for each survey visit both local to the instrumentation and over a wider area. The associated changes to readings at each survey or monitoring point shall be then regulated to the construction activity so that the cause of any change, if it occurs, can be determined.

The Monitoring Surveyor shall also give details of any events on site which in his opinion could affect the validity of the results of any of the surveys.

The report shall contain as a minimum, for each survey visit the following information:

a) The date and time of each reading:
b) The weather on the day:
c) The name of the person recording the data on site and the person analysing the readings together with their company affiliations;
d) Any damage to the instrumentation or difficulties in reading;
e) Tables comparing the latest reading with the last reading and the base reading and the changes between these recorded data;
f) Graphs showing variations in crack width with time for the crack measuring gauges; and
g) Construction activity as described. It is very important that each set of readings is associated with the extent of excavation and construction at that time. Readings shall be accompanied by information describing the extent of works at the time of readings. This shall be agreed with the PC.

Spread-sheet columns of numbers should be clearly labelled together with units. Numbers should not be reported to a greater accuracy than is appropriate. Graph axis should be linear and clearly labelled together with units. The axis scales are to be agreed with the PC before the start of monitoring and are to remain constant for the duration of the job unless agreed otherwise. The specified trigger values are also to be plotted on all graphs.

The reports are to include progress photographs of the works both general to the area of each instrument and globally to the main Works. In particular, these are to supplement annotated plans/sections described above. Wherever possible the global photographs are to be taken from approximately the same spot on each occasion.

Erroneous Data

All data shall be checked for errors by the Monitoring Surveyor prior to submission. If a reading that appears to be erroneous (i.e. it shows a trend which is not supported by the surrounding instrumentation), he shall notify the PC immediately, resurvey the point in question and the neighbouring points and if the error is repeated, he shall attempt to identify the cause of the error. Both sets of readings shall be processed and submitted, together with the reasons for the errors and details of remedial works. If the error persists at subsequent survey visits, the Monitoring Surveyor shall agree with the PC how the data should be corrected. Correction could be achieved by correcting the readings subsequent to the error first being identified to a new base reading.

The Monitoring Surveyor shall rectify any faults found in or damage caused to the instrumentation system for the duration of the specified monitoring period, irrespective of cause, at his own cost.

Trigger Values

Trigger values for maximum movements as listed in Table 2. If the movement exceeds these values then action may be required to limit further movement. The PC should be immediately advised of the movements in order to implement the necessary works.

It is important that all neighbouring points (not necessarily a single survey point) should be used in assessing the impact of any movements which exceed the trigger values, and that rechecks are carried out to ensure the data is not erroneous. A detailed record of all activities in the area of the survey point will also be required as specified elsewhere.

Responsibility for Instrumentation

The Monitoring Surveyor shall be responsible for: managing the installation of the instruments or measuring points, reporting of the results in a format which is user friendly to all parties; and immediately reporting to all parties any damage. The Monitoring Surveyor shall be responsible for informing the PC of any movements which exceed the specified trigger values listed in Table 2 so that the PC can implement appropriate procedures. He shall immediately inform the PWS of any decisions taken.

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APPENDIX A
MONITORING FREQUENCY

INSTRUMENT	FREQUENCY OF READING
Settlement monitoring and Monitoring existing cracks	**<u>Pre-construction</u>** Monitored once. **<u>During construction</u>** Monitored after every pile is cast for first **4** no. piles to gauge effect of piling. If all is well, monitor after every other pile. **<u>Post construction works</u>** Monitored once.

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APPENDIX B

An Analysis on allowable settlements of structures (Skempton and MacDonald (1956))

The most comprehensive studies linking self-weight settlements of buildings to structural damage were carried out in the 1950's by Skempton and MacDonald (1956) and Polshin and Tokar. These studies show that damage is most often caused by differential settlements rather than absolute settlements. More recently, similar empirical studies by Boscardin and Cording (1989) and Boone (1996) have linked structural damage to ground movements induced by excavations and tunnelling activities.

In 1955 Skempton and MacDonald identified the parameter $\delta\rho/L$ as the fundamental element on which to judge maximum admissible settlements for structures. This criterion was later confirmed in the works of Grant *et al.* [1975] and Walsh [1981]. Another important approach to the problem was that of Burland and Wroth [1974], based on the criterion of maximum tensile strains.

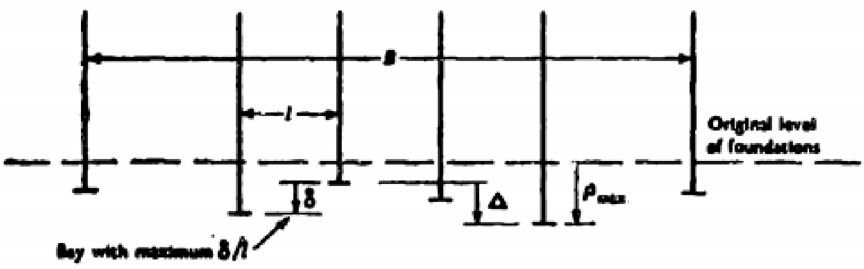

Figure 2.1 – Diagram illustrating the definitions of maximum angular distortion, δ/l, maximum settlement, ρ_{max}, and greatest differential settlement, Δ, for a building with no tilt (Skempton and MacDonald, 1956).

Figure 1: Diagram illustrating the definitions of maximum angular distortion, δ/l, maximum settlement, ρ_{max}, and greatest differential settlement ,Δ , for a building with no tilt (Skempton and MacDonald, 1956)

The differential settlement is defined as the greatest vertical distance between two points on the foundation of a structure that has settled, while the angular distortion, is the difference in elevation between two points, divided by the distance between those points.

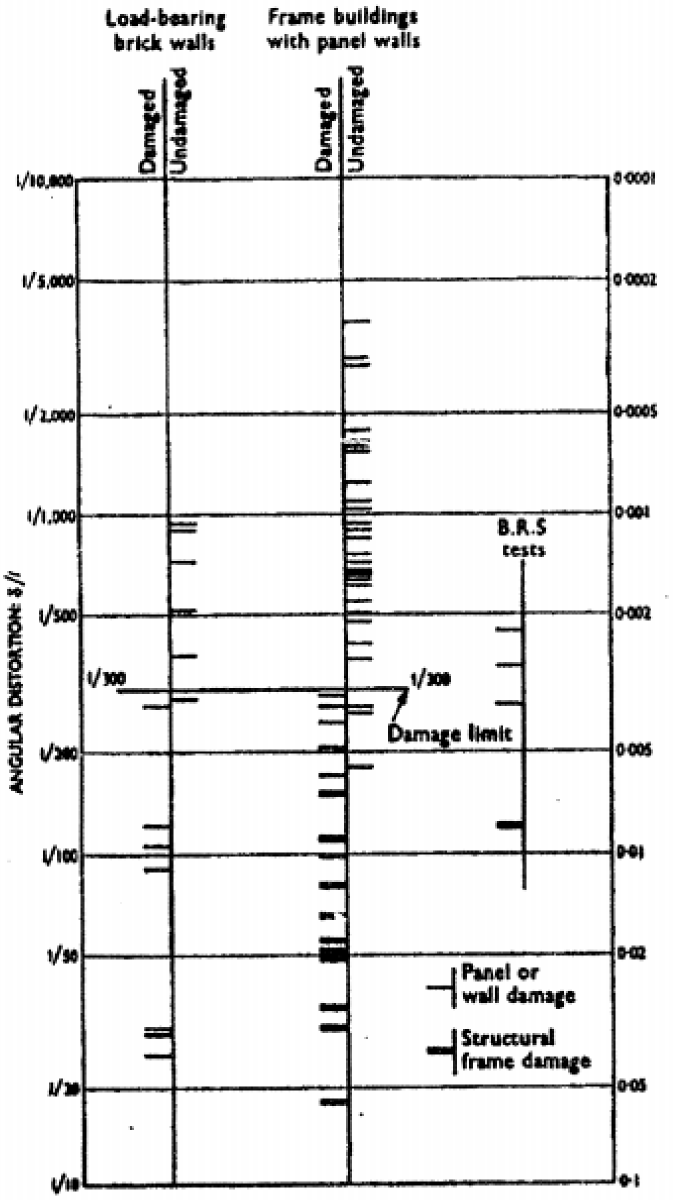

Figure 2: Skempton and MacDonald's analysis of field evidence of damage on traditional frame buildings and loadbearing brick walls

Data from Skempton and MacDonald's work suggest that the limiting value of angular distortion is 1/300. Angular distortion, greater than 1/300 produced visible cracking in the majority of buildings studied, regardless of whether it was a load bearing or a frame structure. As shown in the figure 2.

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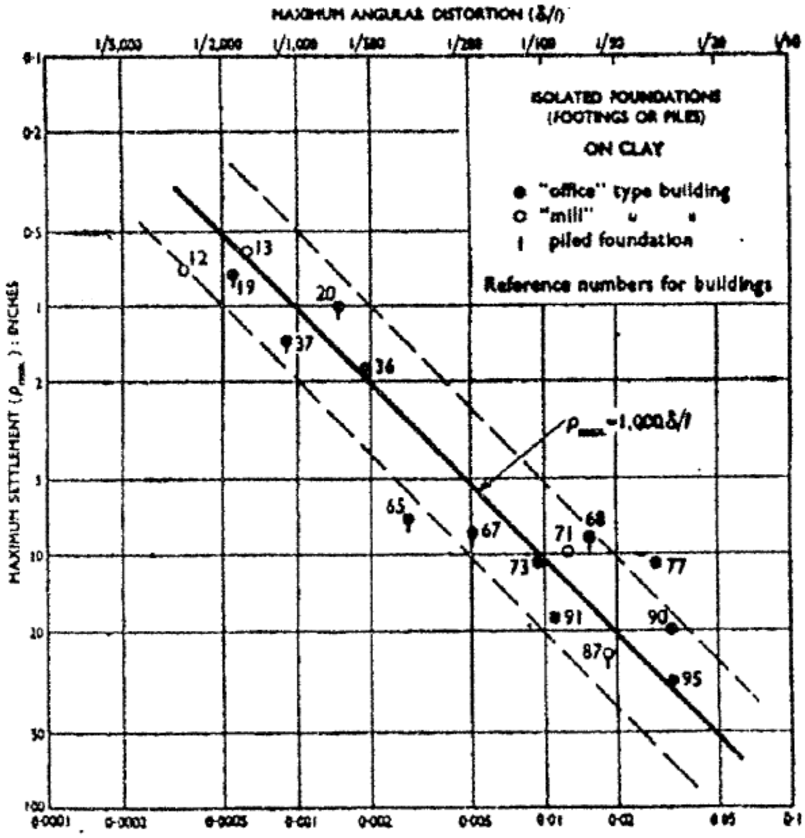
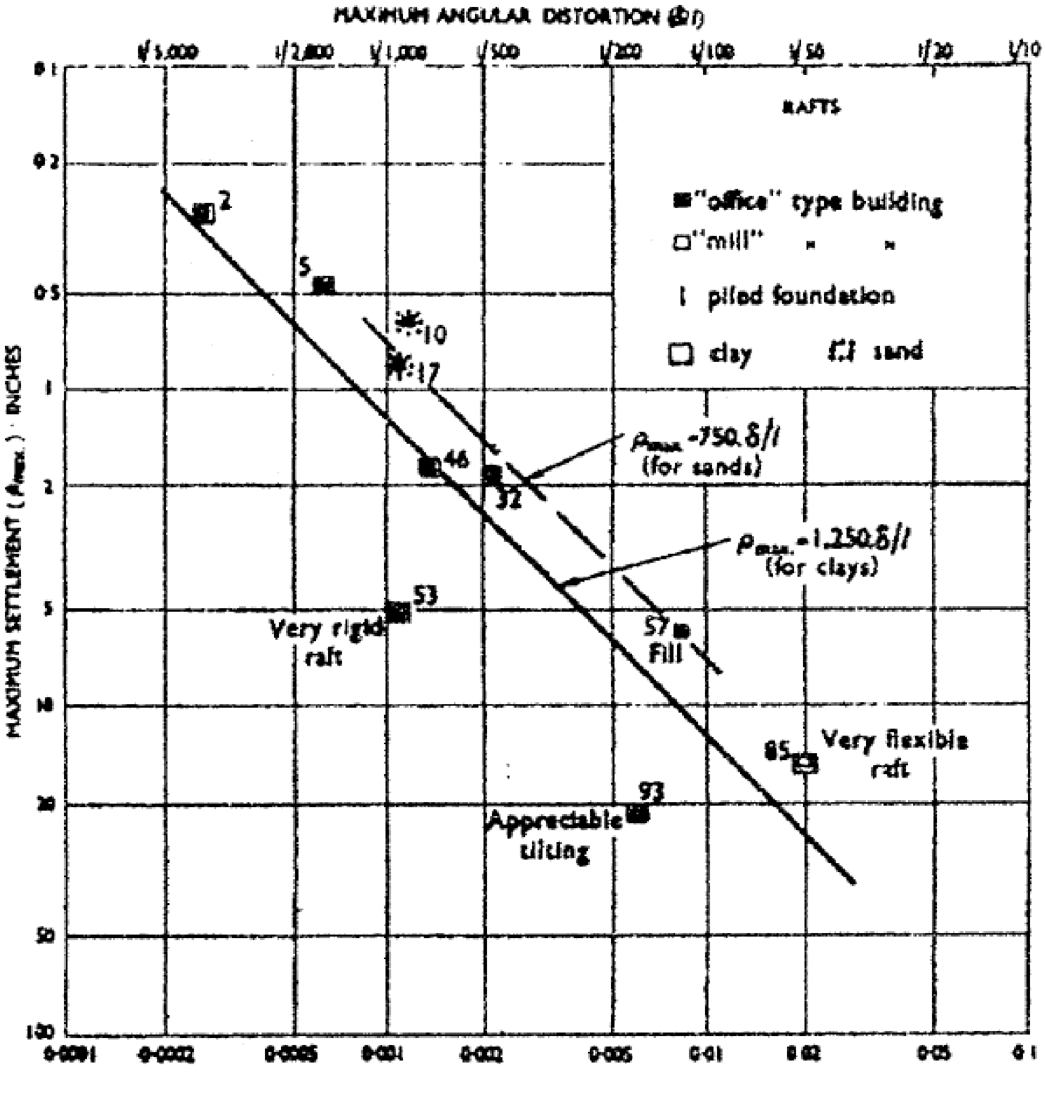
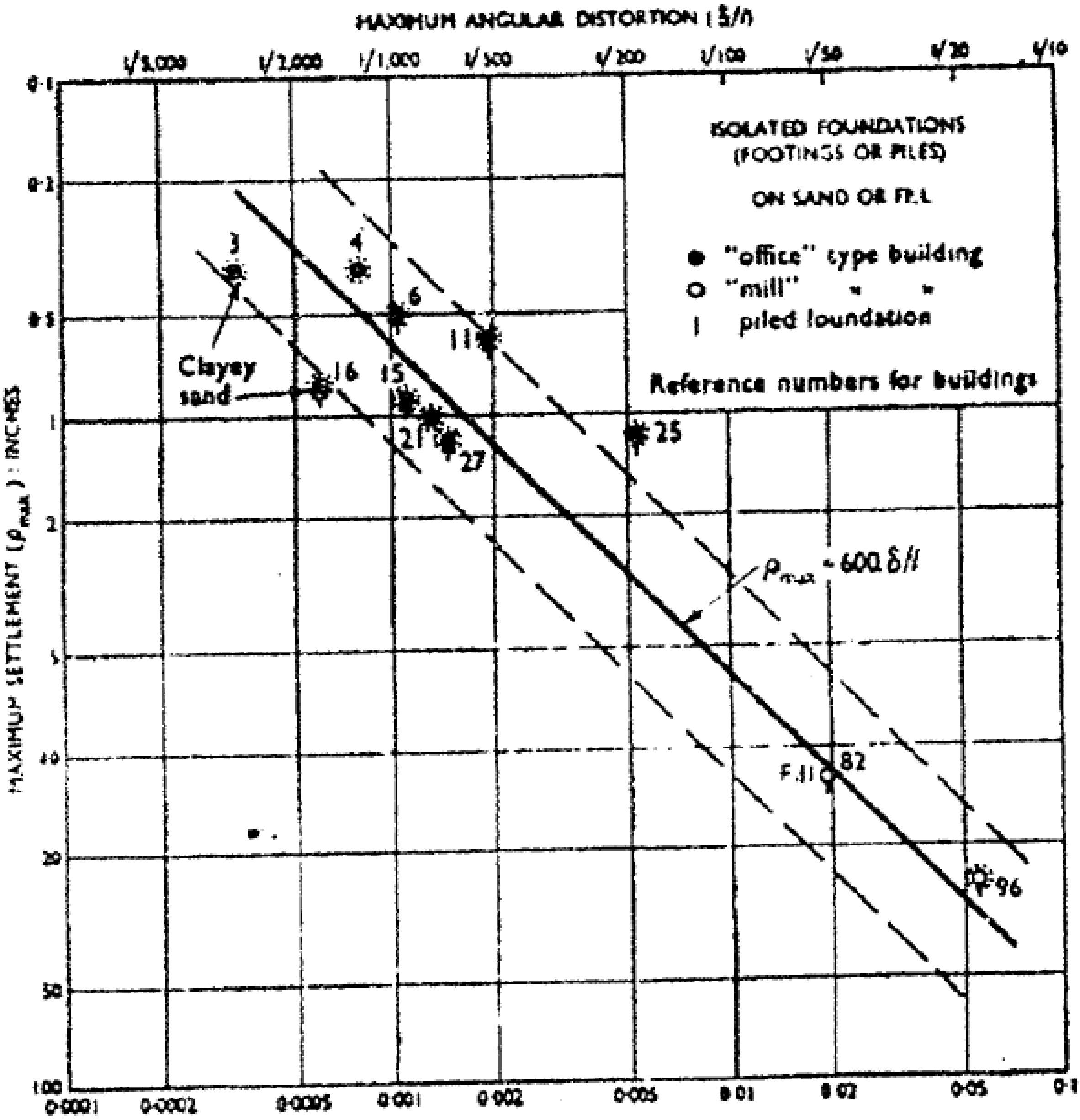
Other key findings by Skempton and MacDonald include limiting values of δ/l for structure, and a relationship between maximum settlement, ρ_{max} and δ/l for structures founded on sands and clays. The charts below show these relations for raft foundations and isolated footings.






MAXIMUM ANGULAR DISTORTION (δ/l)
1/5,000
1/2,000
1/1,000
1/500
1/200
1/100
1/50
1/20
1/10
ISOLATED FOUNDATIONS (FOOTINGS OR PILES)
ON SAND OR FILL
"office" type building
"mill"
piled foundation
Reference numbers for buildings
Clayey sand
MAXIMUM SETTLEMENT (ρ_{max}) : INCHES
ρ_{max} = 600 δ/l
0·0001
0·0002
0·0005
0·001
0·002
0·005
0·01
0·02
0·05
0·1

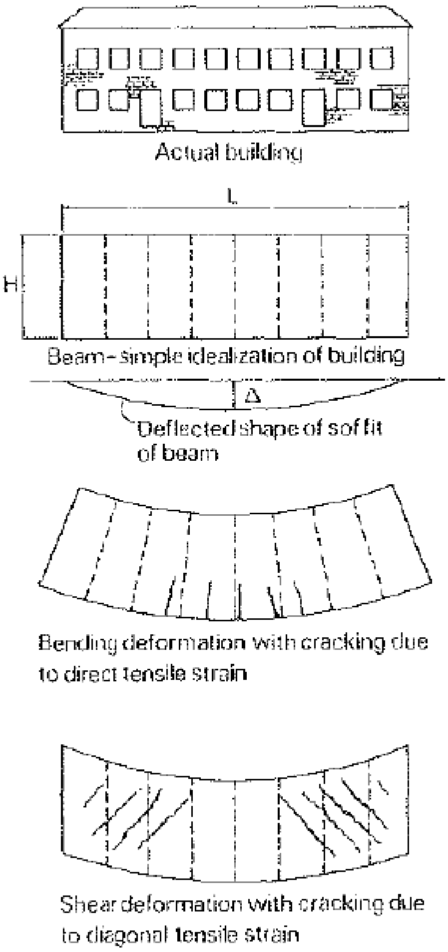


TABLE I

Angular distorsion	Characteristic situation
1/300	Cracking of the panels in frame buildings of the traditional type, or of the walls in load-bearing wall buildings;
1/150	Structural damage to the stanchions and beams;
1/500	Design limit to avoid cracking;
1/1000	Design limit to avoid any settlement damage.

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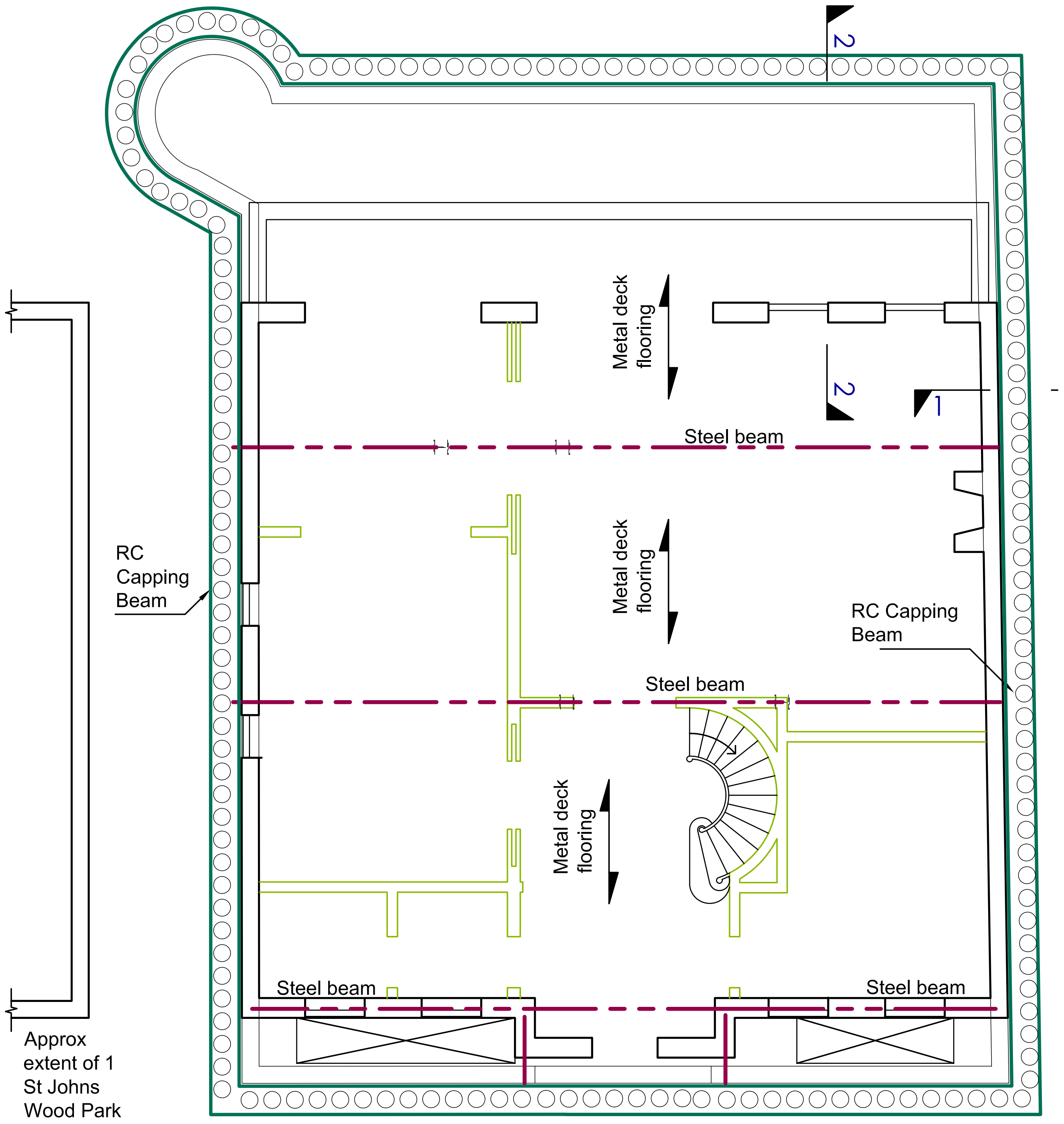
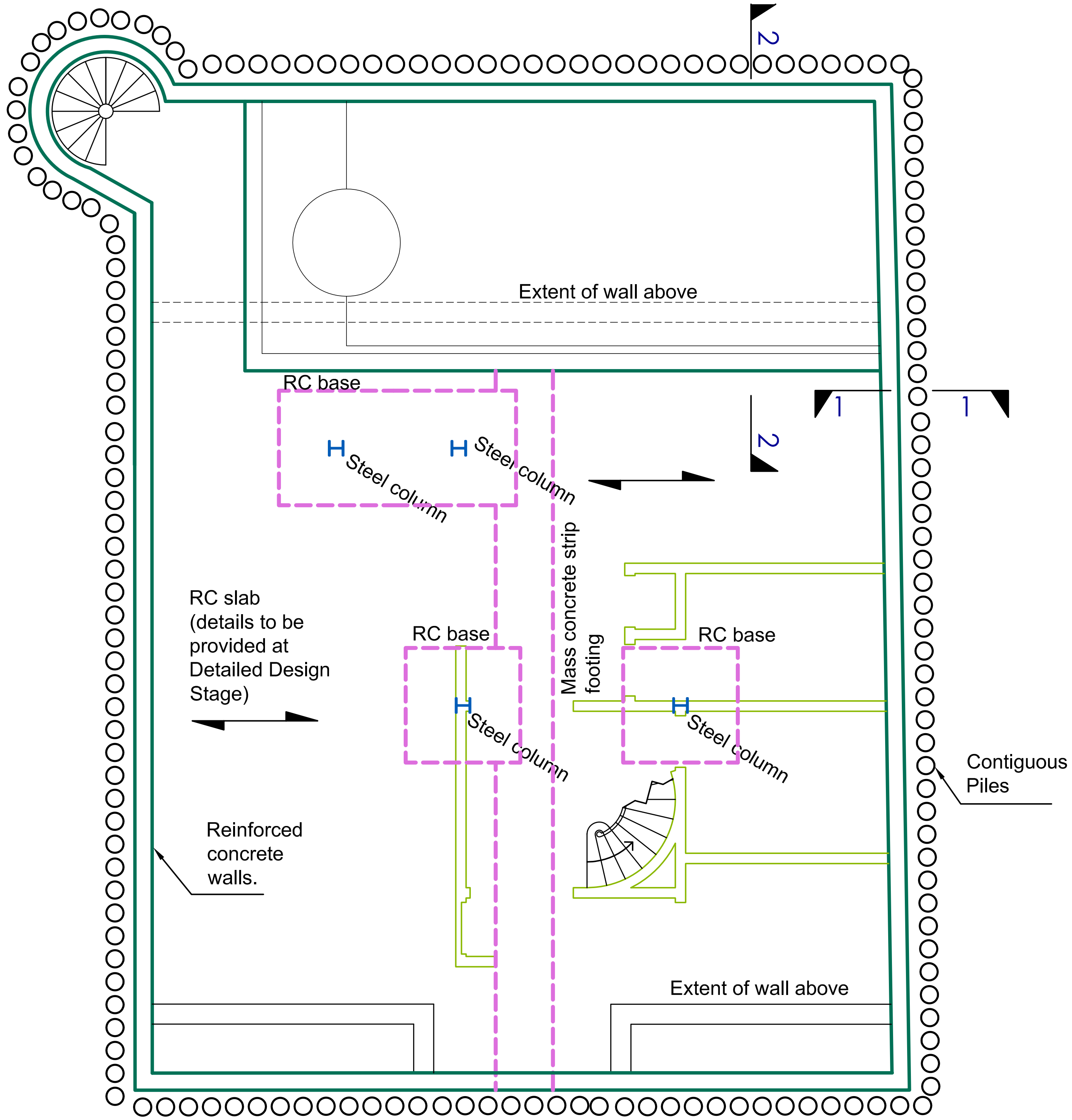
Appendix E : Structural Drawings



Very High Levels Of Lead Were Found In The Soil. Lead Specialists Are To Be Called To Treat Soil Before Construction

Ground floor plan

Scale (1:100)



Basement plan

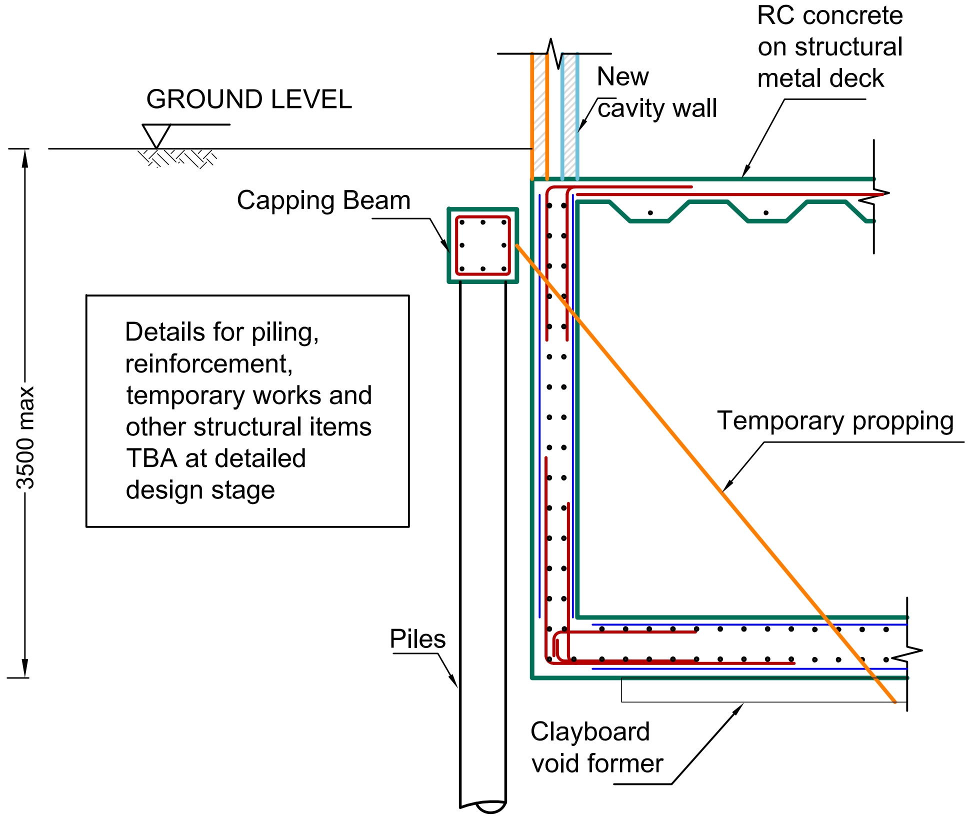
Scale (1:100)

PLANING ISSUE: NOT FOR CONSTRUCTION

Rev	Date	Amendments
3	2/12/2015	Ground floor added
2	28/08/15	Basement floor plan changed
1	26/08/15	Basement floor plan changed
-	14/08/15	First issue for comment

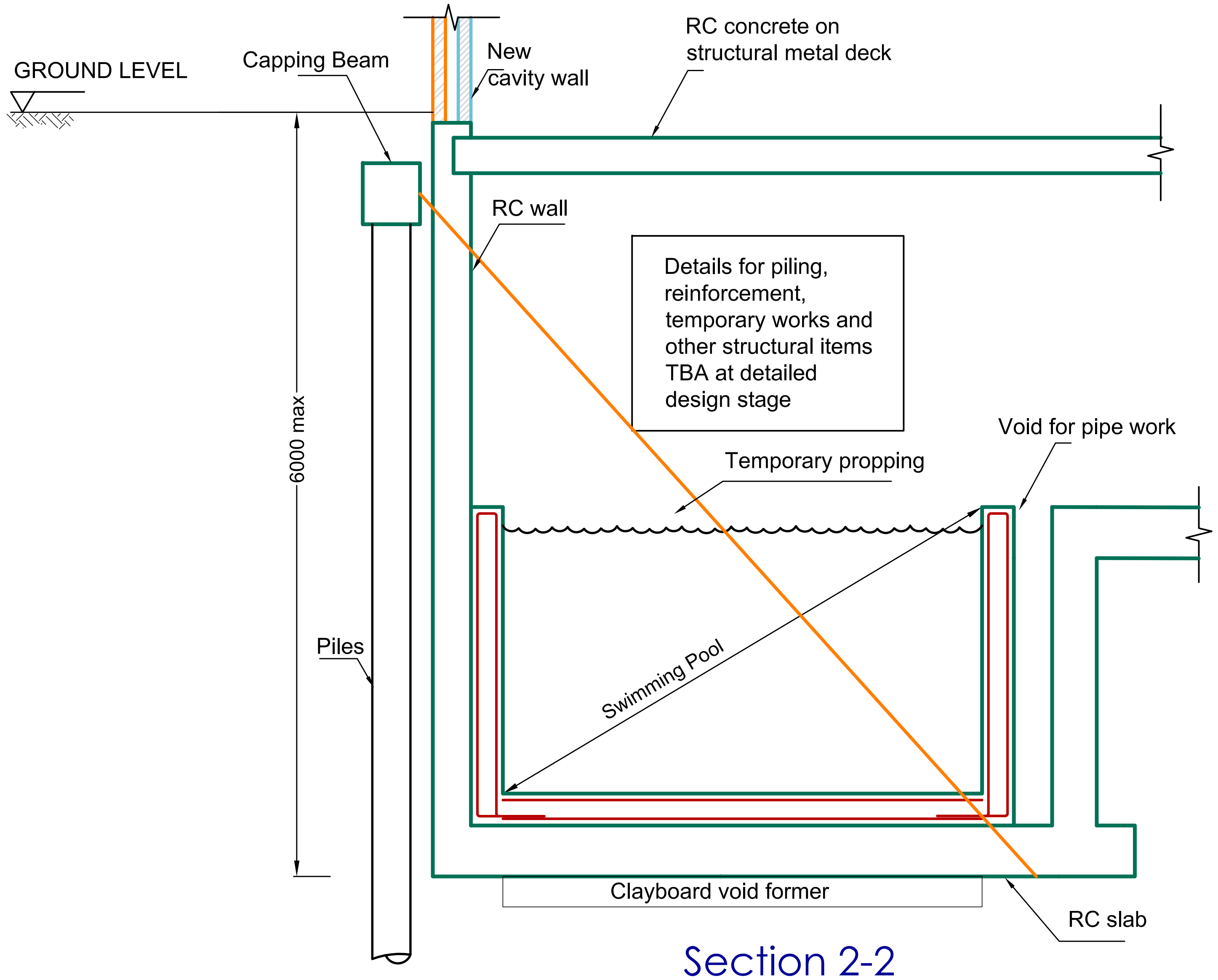
Job No.s: 150607	Client: Mike Ofori
Dwg Nos: SL-10	Project: 1b St Johns Wood Park
Date: July15	Title : Floor plans
Drawn: SB	Chk'd: NM
Scale: As shown @ A3	Rev: 3

Croft Structural Engineers



Section 1-1

Scale (1:50)



Section 2-2

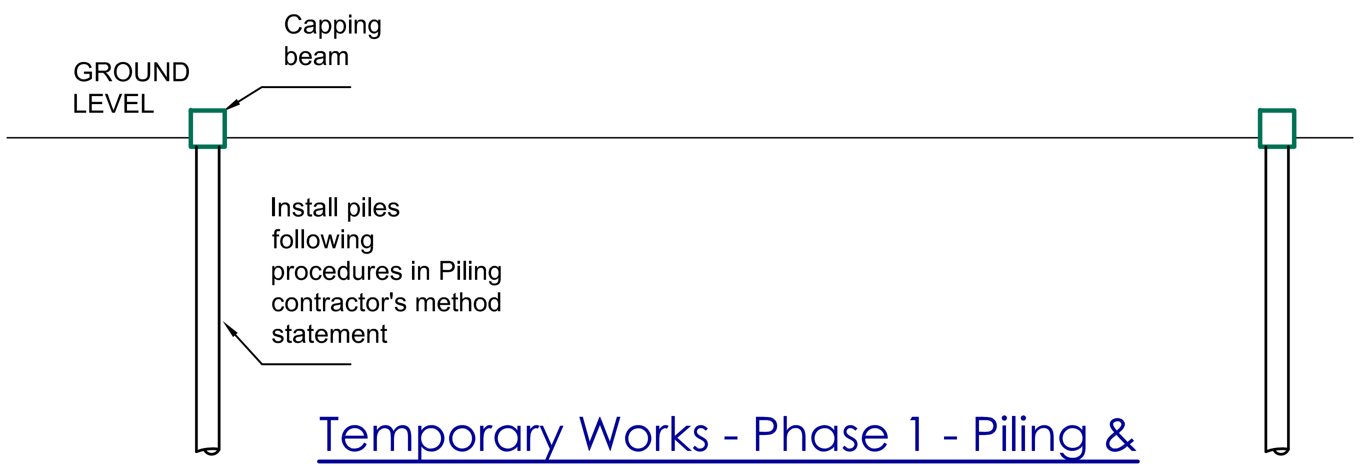
Scale (1:50)

PLANING ISSUE:
NOT FOR
CONSTRUCTION

Rev	Date	Amendments
2	11/1/2016	Propping details altered
1	2/12/2015	Various details altered/added
-	14/08/15	First issue for comment

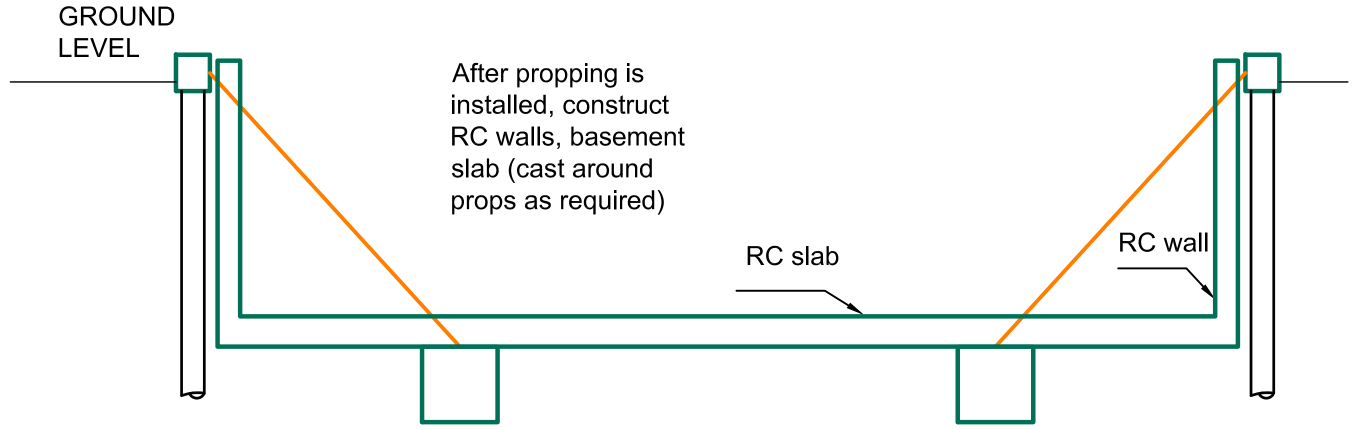
Job No.s 150607	Client: Mike Ofori
Dwg Nos SL-30	Project: 1a St Johns Wood Park
Date July15	Title : Sections
Drawn SB / Chk'd NM	
Scale As shown @ A3 / Rev 2	

Croft Structural Engineers



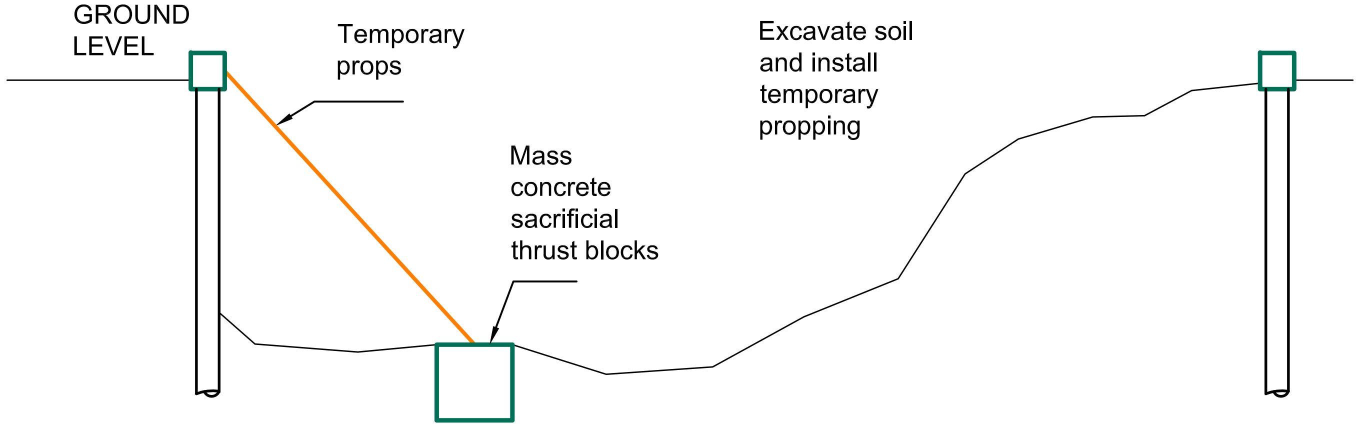
Temporary Works - Phase 1 - Piling & capping beam construction
Typical Section through building

Scale (1:100)



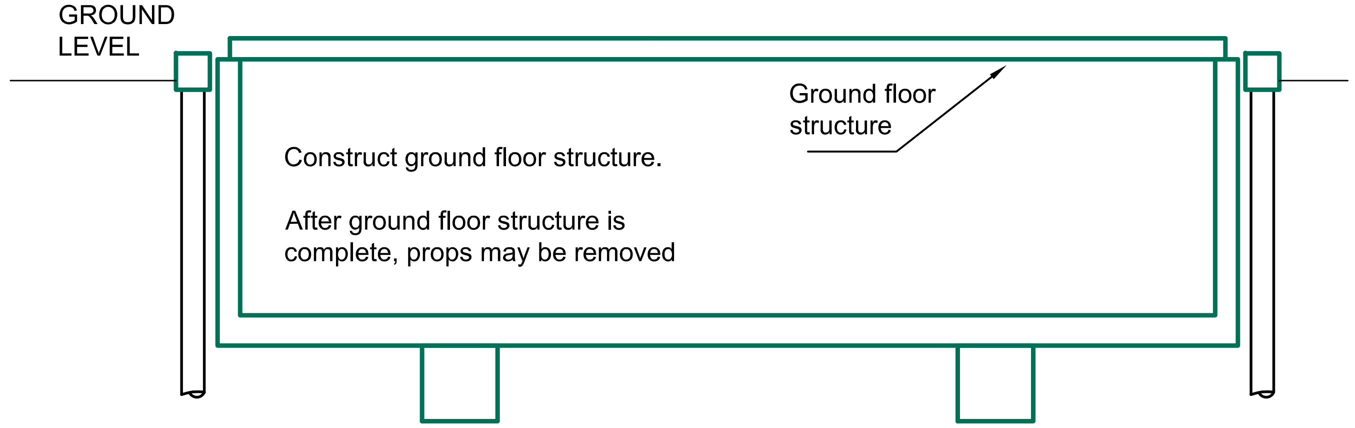
Temporary Works - Phase 3 - RC wall construction
Typical section through building

Scale (1:100)



Temporary Works - Phase 2 - Excavation and propping
Typical section through building

Scale (1:100)



Temporary Works - Phase 4 - Ground Floor construction
Typical section through building

Scale (1:100)

PLANING ISSUE: NOT FOR CONSTRUCTION

USE IN CONJUNCTION WITH BASEMENT CONSTRUCTION METHOD STATEMENT

Rev	Date	Amendments
1	07/1/2016	Sequence details altered
-	02/12/2015	First issue for comment

Job No	150607
Dwg No	SL-50
Date	Dec 2015
Drawn	GW
Chk'd	PH
Scale	As shown @ A3
Rev	1

Client: Liv International

Project: 1a St Johns Wood Park

Title : Outline basement construction sequence

Croft Structural Engineers

Appendix F : Correspondence with LUL

Geoff Watson

From: Geoff Watson <gwatson@croftse.co.uk>
Sent: 20 November 2015 11:23
To: 'john.cadman@tube.tfl.gov.uk'
Cc: nmanzini@croftse.co.uk
Subject: 1b St John's Wood Park, NW8 6QS
Attachments: Railway + tunnels map, NW8 6QS.pdf

Dear John,

Thanks for taking my calls.

As discussed we are working on the planning application for a basement for a new build property at the above address.

Please find attached the extract from Groundsure which has our property marked. The Jubilee line appears to run close by and this may be one or all of the tracks indicated on the attachment. Please could you provide us with a better indication of horizontal distance and depth of the nearest LUL tunnel, to our site. If applicable, please could you also confirm the extent to which LUL will need to be involved in the development, from planning stage and beyond.

Kind regards

Geoff Watson
Structural Engineer

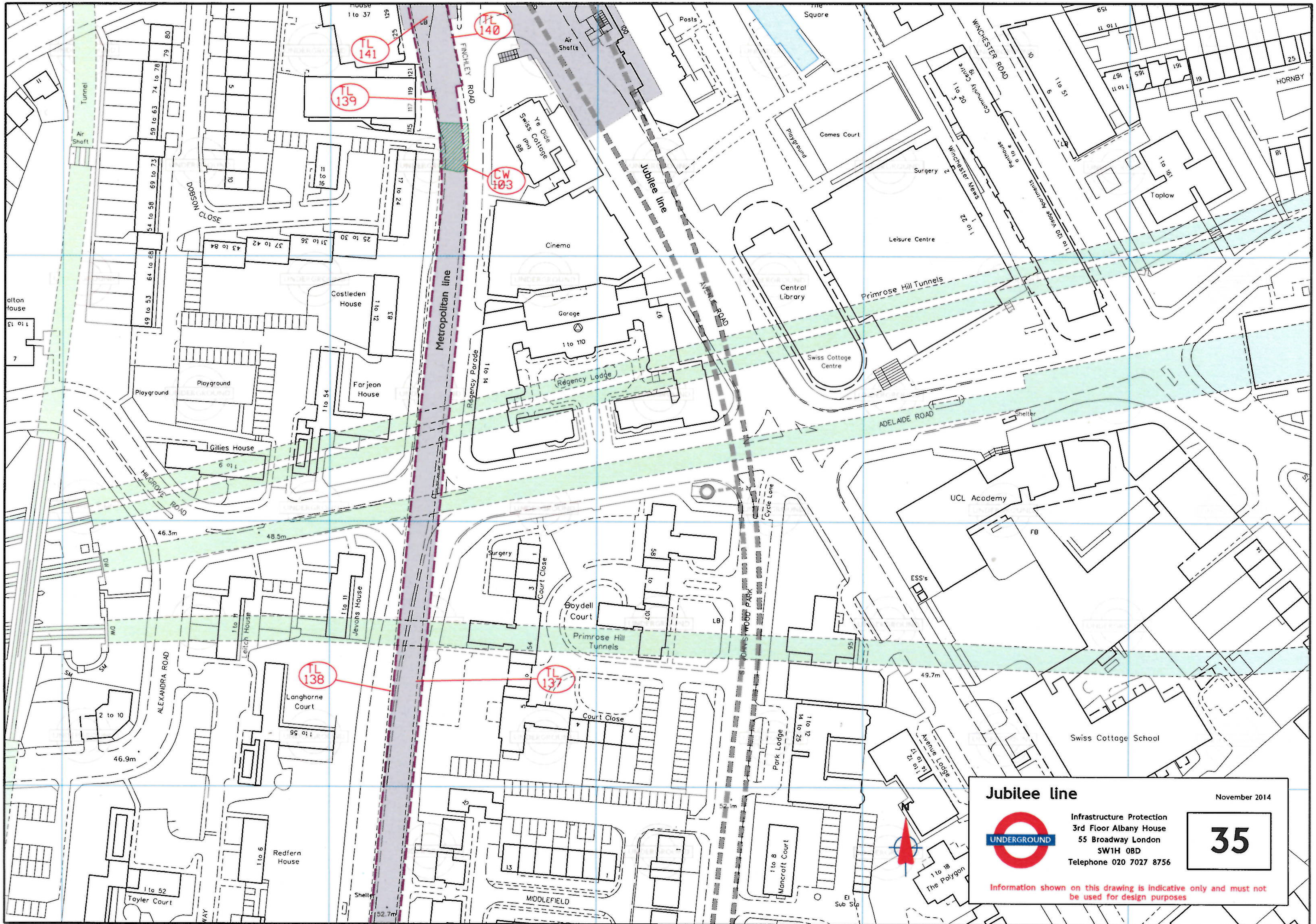
CROFT STRUCTURAL ENGINEERS
Clock Shop Mews, Rear of 60 Saxon Rd, SE25 5EH
t: 020 8684 4744
e: gwatson@croftse.co.uk
w: www.croftse.co.uk
Follow us at @CroftStructures

Geoff Watson

From: Cadman John <John.Cadman@tube.tfl.gov.uk>
Sent: 20 November 2015 12:06
To: 'gwatson@croftse.co.uk'
Subject: 1b St John's Wood Park
Attachments: Untitled.pdf

Plot of Jubilee line as requested, it shows the approximate centre line of tunnels. Dependant upon what your proposals are you may need a correlation survey to accurately plot the tunnel location.

John Cadman | Senior Infrastructure Protection Engineer, Capital Programmes Directorate
London Underground | 3rd Floor, Albany House, 55 Broadway, London, SW1H 0BD
Tel: 020 7027 2928 | Mobile: 07764 177326 | E-mail: john.cadman@tube.tfl.gov.uk



Jubilee line

November 2014

Infrastructure Protection
3rd Floor Albany House
55 Broadway London
SW1H 0BD
Telephone 020 7027 8756

35

Information shown on this drawing is indicative only and must not be used for design purposes

Scale 1:1250 at A3 size

Appendix G : Outline Construction Programme

The Contractor is responsible for the final construction programme

Construction Program for St Johns Wood Park